Chemical Contamination and Toxicity in Sediments from Hood Canal, WA (1952 – 2005)

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I. Findings

- Chemical contamination and toxicity were generally low in Hood Canal and usually confined to Port Ludlow, Port Gamble, and Dabob Bay.
- Metals were detected more frequently (81% of samples) than organic pollutants (0%-44% of samples for most, 74-77% for PAHs).
- Chemicals exceeded WA Sediment Quality Standards for some metals, PCBs, and benzenes at stations collected in Port Gamble; for low PAHs and naphthalene in Port Ludlow; and for butylbenzylphthalate in Dabob Bay.
- Sea urchin fertilization toxicity tests suggested increasing toxicity in Hood Canal sediments from 1999 to 2004.
- Critical toxicity test values were exceeded at stations located in Port Ludlow, Port Gamble, in and near Dabob Bay, and near Lilliwap for 4 different tests.

II. Introduction

Levels of chemical contamination and toxicity measured in Hood Canal sediments were examined by Ecology's Marine Sediment Monitoring Team to assess relationships between sediment quality, dissolved oxygen levels, and benthic community structure in Hood Canal.

Existing data generated from 1952 – 2005 for the Puget Sound Assessment and Monitoring Program's (PSAMP) Sediment Component, and for various regulatory surveys whose data are housed in Ecology's SEDQUAL database, were assembled.

Examination of these data revealed a number of spatial patterns in chemical contamination and sediment toxicity in Hood Canal.

Table 1. Mean percent of samples in which metal and organic chemicals were detected in sediments collected from Hood Canal between 1952 and 2005.

Parameter	Average % Detected
Inorganics	
Ancillary Metals	100.0
Priority Pollutant Metals	81.1
Organics	
High Molecular Weight Polycyclic Aromatic Hydrocarbons (HPAH)	77.0
Low Molecular Weight Polycyclic Aromatic Hydrocarbons (LPAH)	74.4
Miscellaneous Extractable Compounds	40.3
Ketone	15.4
Polybrominated Diphenylether (PBDE)	14.0
Aromatic and Chlorinated Aromatic	11.3
Organonitrogen Compounds	6.6
Phthalate Esters	4.1
Polychlorinated Biphenyls (PCB)	3.5
Chlorinated Pesticides	2.6
Halogenated Alkane	1.5
Chlorinated Alkanes	0.6
Chlorinated Aromatic Compounds	0.5
Chlorinated and Nitro-Substituted Phenols	0.0
Ether	0.0
Organotin, Butyl tin	0.0

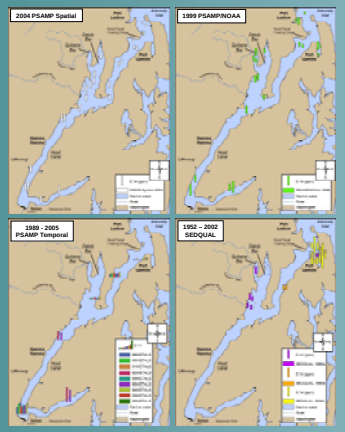

Figure 1. Mean SQS quotients[1] for metals measured at all Hood Canal stations (1952 – 2005).

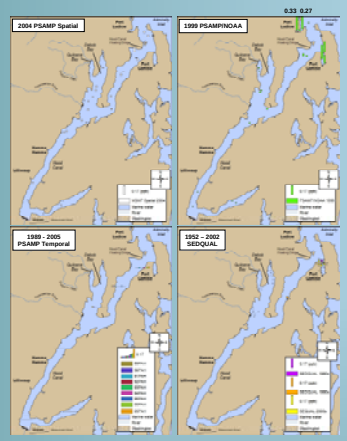

Figure 2. Mean SQS quotients[1] for PAHs measured at all Hood Canal stations (1952 – 2005).

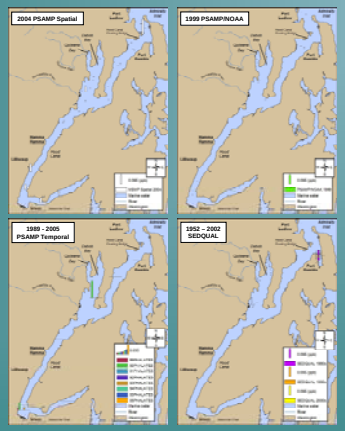

Figure 3. Mean SQS quotients[1] for phthalates measured at all Hood Canal stations (1952 – 2005).

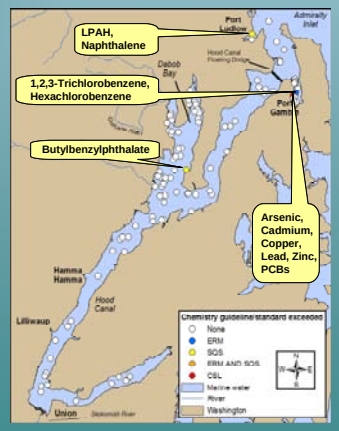

Figure 4. Sediment chemistry exceeding Washington State Sediment Quality Standards at all Hood Canal stations (1952 – 2005).

[1] Mean SQS quotients - The large classes of detected contaminants in the Hood Canal samples, including metals, polycyclic aromatic hydrocarbons (PAHs), and phthalates, were summarized into a series of Mean Sediment Quality Standard (SQS) quotients. These are calculated as the mean of the quotients derived by dividing the chemical concentrations in the samples by their respective SQS values. Mean SQS quotients are used to account for the presence of mixtures of these potential toxicants. The greater the mean SQS quotient, the greater the overall contamination of the sample as determined by the mixture of substances.

III. Sediment Chemistry

The percentages of sediment samples with detected concentrations of trace metal and organic chemicals are listed in Table 1. Metals were detected most frequently (81% of samples), followed by Polycyclic Aromatic Hydrocarbons (PAHs) (74-77% of samples), and other organic pollutants (0%-44% of samples).

Levels of detected metals, PAHs, and phthalates measured from 1952 – 2005 throughout Hood Canal are displayed as mean SQS quotients[1] in Figures 1 – 3. Trace metals concentrations were relatively low in northern and shallow nearshore stations, higher in deeper central axis and inlet stations, and highest in Port Gamble. PAH concentrations were generally low throughout the canal, but higher in Port Ludlow and Port Gamble. Phthalates were either undetected or very low at all but a few samples located in northern Hood Canal, Port Gamble, Dabob Bay, and near the Great Bend and Lynch Cove.

Chemicals rarely exceeded Washington State Sediment Quality Standards, but did for a suite of metals, PCBs, and benzenes at stations collected from Port Gamble in 2000; for low PAHs and naphthalene from Port Ludlow in 1999; and for butylbenzylphthalate from Dabob Bay in 1990 (Figure 4).

IV. Sediment Toxicity

Sediment toxicity levels measured in 1999 and 2004 at PSAMP stations throughout Hood Canal are displayed in Figure 5. Sea urchin fertilization, amphipod survival, Microtox®, and Cytochrome P-450 HRGS tests were used.

The 1999 test results for amphipod survival were relatively uniform throughout the canal. Microtox® test results were relatively less toxic within and just outside of Dabob Bay, while Cytochrome P-450 test responses were uniformly low throughout the canal, with the exception of Port Gamble and Port Ludlow.

The 1999 and 2004 urchin fertilization results were most toxic in Dabob Bay. Samples tested in 2004 were more toxic than those tested in 1999, and the number of toxic samples and percent of study area they represented was larger than in 1999.

Stations with sediments exceeding critical toxicity test values for bivalve larval development, amphipod survival, sea urchin fertilization, and Cytochrome P-450 HRGS are displayed in Figure 6. They are located in Port Ludlow, Port Gamble, in and near Dabob Bay, and near Lilliwaup. The high percentage of bivalve larve tests exceeding critical values in Port Gamble were collected from a survey for a regulated industrial facility.

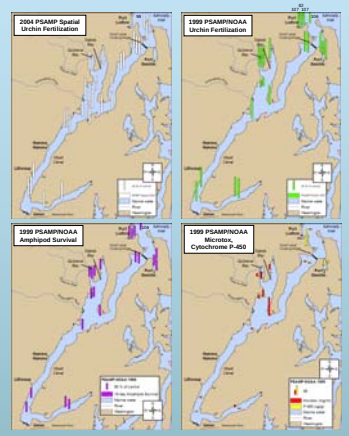

Figure 5. Toxicity[2] measured at each station in Hood Canal for the 1999 and 2004 PSAMP Spatial Monitoring Programs.

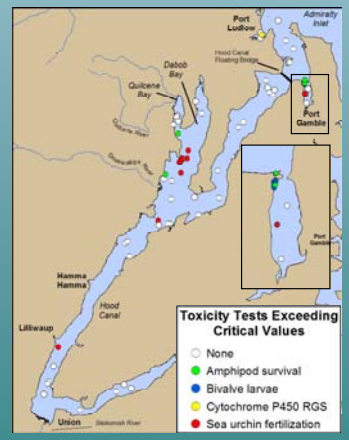

Figure 6. Sediment toxicity exceeding critical values in Hood Canal stations (1989 – 2004).

[2] Toxicity tests and endpoints included sea urchin fertilization (% of control), amphipod survival (% of control), Microtox® (mg/ml organic solvent extract), and Cytochrome P-450 HRGS (µg/g B[a]P equivalents). Highest bars are most toxic results for Cytochrome P-450 HRGS, least toxic results for amphipod survival, sea urchin fertilization, and Microtox® tests.

General information and all data generated during this survey will be available in:

Long, ER, ME Dutch, S Aasen, KI Welch, VA Partridge, and DH Shull, *in draft*. Relationships between the Composition of the Benthos and Sediment and Water Quality Parameters in Hood Canal, WA. Task IV – Hood Canal Dissolved Oxygen Program. Washington State Department of Ecology, Olympia, WA and Western Washington University, Bellingham, WA.

and at Ecology's Marine Sediment Monitoring Website:

http://www.ecy.wa.gov/programs/eap/psamp/index.htm

This poster was prepared for the 2007 Georgia Basin/Puget Sound Research Conference, Vancouver, BC; and the 2007 Pacific Northwest SETAC Conference, Pt Townsend, WA.