Sediment Quality Assessment of the Hood Canal Region of Puget Sound, 2004

Spatial/Temporal Sediment Monitoring Element of the *Puget Sound Assessment and Monitoring Program*

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Cover photos: Waters of Hood Canal; sampling from the *RV Centennial*.

Sediment Quality Assessment of the Hood Canal Region of Puget Sound, 2004

Spatial/Temporal Sediment Monitoring Element of the *Puget Sound Assessment and Monitoring Program*

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Abstract

As part of the Puget Sound Assessment and Monitoring Program, the Washington State Department of Ecology (Ecology) conducted a survey of sediment quality in the Hood Canal region in 2004. The goal of this survey was to evaluate the spatial extent and geographic patterns in relative sediment quality throughout the Hood Canal region.

Samples were collected at 30 locations throughout Hood Canal. The Sediment Quality Triad of chemistry, toxicity, and sediment-dwelling invertebrate community structure (benthos) measured for each sample indicated that:

- None of the samples were classified as chemically contaminated.
- The incidence and spatial extent of toxic response in the sea urchin fertilization test were greatest in deep stations in south-central Dabob Bay and lowest near the entrance of Hood Canal at Admiralty Inlet.
- Two deep stations in Dabob Bay supported infaunal assemblages with the lowest abundance and taxa richness. Shallower stations near the canal entrance and along the eastern shoreline had the highest abundance and taxa richness.

Ecology's Sediment Quality Triad Index was calculated for each station, and then used to estimate the incidence and spatial extent of sediment quality degradation for each region. Findings indicated that:

- Highest sediment quality was measured in shallow sediments in the entrance sill and along the eastern shoreline of central Hood Canal.
- The majority of sediments in central and southern Hood Canal were of intermediate/high quality.
- Sediments in the deep, south-central Dabob Bay stations were of intermediate/degraded quality.
- No sediments were of degraded quality.

The high percentage of stations with only impaired benthos and no chemical contamination or toxicity may be a result of low near-bottom dissolved oxygen levels. Further studies are needed to determine the magnitude and nature of hypoxia effects on the benthos in Hood Canal.

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    - Mark Anderson captained the *RV Centennial*.
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Executive Summary

During 2004, the Washington State Department of Ecology (Ecology) conducted a sediment quality survey in the Hood Canal monitoring region as a part of the Puget Sound Assessment and Monitoring Program (PSAMP). The goal of this survey was to evaluate the relative quality of sediments throughout this region based on a weight-of-evidence method. Data from the 2004 study were compared with results of a previous study conducted in the same region in 1999. Data from both surveys can serve as a basis for evaluating changes in sediment quality in the future.

Samples were collected at 30 randomly selected locations throughout the 295 km^2 study area. Analyses were performed on all samples to determine the concentrations of potentially toxic chemicals, the degree of response in a laboratory toxicity test, and the composition of resident benthos. These three kinds of analyses represent the components of the Sediment Quality Triad. Most methods were similar to those used in 1997-99 for the PSAMP/NOAA surveys of Hood Canal and other adjoining regions of Puget Sound, and in a 2002-03 Ecology survey of the San Juan Islands, eastern Strait of Juan de Fuca, and Admiralty Inlet.

Physical Characteristics

Hood Canal is a narrow fjord-like inlet of Puget Sound formed by glacial scouring, and is approximately 100 km in length. The study area included (1) the entire length of Hood Canal from its entrance at Admiralty Inlet to Lynch Cove at the head of the canal, and (2) adjoining Port Gamble, Port Ludlow, and Quilcene and Dabob Bays (Figure 1).

Station depth, which ranged from 14 to 177 meters, was an important variable in characterizing the sampling sites. The northernmost stations near the entrance to the canal were located on the sill of the Hood Canal fjord and were among the shallowest. Progressing southward into the canal, the station depths increased to over 100 m at the confluence of Hood Canal and Dabob Bay and generally were greatest (> 150 m) in central Dabob Bay. Stations remained relatively deep in southern Hood Canal, then gradually decreased toward the head of the canal.

Sediment grain size, total organic carbon (TOC) content, and near-bottom water dissolved oxygen (DO) concentrations co-varied with station depths down the length of Hood Canal. Sediments collected on the sill in the northern reaches of the canal were predominantly coarse to fine sand, had relatively low TOC concentrations, and had relatively high near-bottom DO levels. As station depths increased south of the entrance sill, the sediments changed to predominantly fine-grained silts and clays, TOC concentrations increased, and DO levels decreased. The lowest DO levels occurred in central Dabob Bay and at the head of the canal.

Chemical Contamination

Laboratory analyses were performed for over 120 chemicals and sediment properties. All 30 samples had at least one chemical concentration that did not meet (exceeded) a Washington State

Sediment Quality Standard (SQS), and 28 of the 30 samples had at least one chemical concentration that exceeded a Cleanup Screening Level (CSL) value. Fourteen (14) chemicals (all organic compounds) exceeded a State standard in at least one sample. Data for these compounds were determined to be unreliable because of analytical issues, or the concentrations were reported as either estimates or below detection limits. Because of the uncertainty as to the actual concentrations of these chemicals, these data were excluded from subsequent analyses.

Based on the amended data set, the incidence of chemical contamination was zero, relative to the State standards and National Oceanic and Atmospheric Administration (NOAA) guidelines. Therefore, the spatial extent (i.e., the area within the Hood Canal region) of chemical contamination also was zero. However, the concentrations of some chemicals (although less than the State standards and NOAA guidelines) were slightly higher in the south-central Dabob Bay stations than elsewhere; these concentrations tended to decrease slightly toward the entrance to Hood Canal.

Toxicity

The toxicity of the sediments was determined with an acute test of the porewaters extracted from the sediment samples, using the gametes of the Pacific purple sea urchin. Five (5) of the 30 samples had a mean response classified as toxic in 100% porewater for an incidence of significant responses of 17%. There were 4 samples classified as toxic in the tests of 50% porewater concentrations, giving an incidence of significant responses of 13%. Two (2) of 30 samples (7%) were classified as toxic in the tests of 25% porewater concentrations.

The estimates of the spatial extent of toxicity as measured with the urchin fertilization tests of 100%, 50%, and 25% porewater were 52 km^2, 43 km^2, and 22 km^2, equivalent to 18%, 15%, and 8% of the total survey area, respectively. The toxicity data showed a distinct spatial pattern, with toxicity highest at the deepest stations in south-central Dabob Bay and generally diminishing away from that area.

Benthic Community Composition

Composition, diversity, and abundance of the infaunal assemblages at the 30 sampled stations changed noticeably both along the length of the canal and with station depth. Many of the stations on the relatively shallow entrance sill and along the eastern shoreline of central Hood Canal had the highest abundance, diversity, and number of dominant species. The relatively stress-tolerant species of annelids were less abundant near the canal entrance, whereas some of the more stress-sensitive amphipods, molluscs, and echinoderms were relatively abundant.

In contrast, the benthos at many of the deepest stations in south-central Dabob Bay and in central Hood Canal near the confluence with Dabob Bay were dominated by stress-tolerant annelids (e.g., capitellids). Arthropods and echinoderms were rare or absent at those stations. Abundance, diversity, and dominance often were lowest in these locations. Most of the stations in central and southern Hood Canal also had relatively low taxa richness, and were dominated by annelids and bivalves.

The benthos were classified as unaffected at four stations in the entrance of Hood Canal and at three stations along the eastern shoreline of central Hood Canal. These stations had low percent fines and TOC, and relatively high DO. The infaunal assemblages were considered to be adversely affected at 23 of the 30 Hood Canal stations. These stations occurred throughout Hood Canal from the northern entrance to southern Hood Canal, and in Dabob Bay.

Sediment Quality Triad

The chemistry, toxicity, and benthic data were compiled for each station and compared against respective critical values to classify the sediments at each station as either high quality, intermediate quality, or degraded. Among the 30 stations, there were 7 classified as high quality, 18 as intermediate/high quality, 5 as intermediate/degraded, and none as degraded based on the methods used. These stations represented 65, 178, 52, and 0 km^2 of the area of the region, respectively, equivalent to 22%, 60%, 18%, and 0%, respectively, of the total survey area.

Overall, the sediments in the deep, south-central Dabob Bay stations were most degraded. They were highly toxic in the laboratory tests of porewaters, and they supported impaired benthic assemblages often dominated by species that are known to tolerate hypoxia and/or chemical contamination. Sediments in central and southern Hood Canal were moderately degraded. Sediments at the shallow stations in the entrance sill and along the eastern shoreline of central Hood Canal were the least degraded.

Comparisons Among Puget Sound Sediment Monitoring Regions

The Hood Canal sediments sampled in 2004 were slightly less contaminated than those sampled there in 1999, and less contaminated than those sampled throughout all of Puget Sound in 1997-2003. Sediments were somewhat more toxic in the sea urchin tests than those tested in 1999 and more toxic than sediments tested throughout the Sound in 1997-2003. The incidence of stations that had adversely affected benthic assemblages was higher in 2004 than in 1999 and 1997-2003.

Based on the weight of evidence compiled using the Sediment Quality Triad Index, the percentage of the Hood Canal monitoring region with high quality sediments decreased somewhat from 1999 to 2004. During this same time, the area classified as intermediate in quality increased considerably. However, because of the lack of chemical contamination, the area classified as degraded was zero in both 1999 and 2004. In comparison to Puget Sound from 1997-2003, Hood Canal in 2004 had a much lower incidence and spatial extent of high quality sediments, much higher incidence and spatial extent of intermediate sediments, and a somewhat lower amount of degraded sediments.

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Introduction

Project Background

Toxic substances introduced into estuarine ecosystems, such as Puget Sound, can bind to suspended particles, settle to the bottom, and become incorporated into deposited soft sediments (NRC, 1989). Sediments that have accumulated in low-energy, depositional zones where they are not disturbed by physical processes or other factors can provide a relatively stable record of toxicant inputs (Power and Chapman, 1992). As a result, sediments are an important medium in which to estimate the degree and history of chemical contamination of environmental regimes such as estuaries and bays. Although this sedimentation process tends to rid the water column of toxicants, their concentrations in sediments can increase to the point that the toxicants eventually represent a potential toxicological threat to the resident benthic biota (Burton, 1992).

Toxic chemicals occur in a wide range of concentrations in surficial (recently deposited) sediments of Puget Sound (Llansó et al., 1998a,b). Previous studies in Puget Sound have shown that high concentrations of toxic chemicals in water, biota, and sediments often were accompanied by a variety of adverse biological effects (Long, 1987). In studies conducted during 1978 to 1990, it was determined that acute mortality occurred in toxicity tests of water samples (Cardwell et al., 1979), sea surface microlayer samples (Hardy et al., 1987a,b ; PTI, 1990) and surficial sediments (Chapman et al., 1982, 1983, 1984a, 1984b). In sediments from the industrial waterways of Commencement Bay, low amphipod abundance in the benthic samples was coincidental with low amphipod survival in toxicity tests and elevated chemical concentrations (Swartz et al., 1982).

Data from the Sediment Quality Triad of analyses (chemical analyses, toxicity tests, benthic analyses) verified previous observations that degraded conditions existed in portions of Elliott Bay near Seattle and Commencement Bay near Tacoma (Chapman et al., 1984b; Long and Chapman, 1985). Histopathology studies of demersal fishes indicated that pollution-related disorders, such as hepatic neoplasms, were found most frequently in association with contaminated sediments near industrialized urban areas of Puget Sound (Malins et al., 1982, 1984; Becker et al., 1987).

From 1997 through 1999, the Washington State Department of Ecology (Ecology) Marine Sediment Monitoring Program conducted a large-scale sediment quality assessment of Puget Sound. This assessment was part of the Puget Sound Ambient Monitoring Program (PSAMP), in partnership with the National Oceanic and Atmospheric Administration (NOAA). During this study, sediment quality data were collected throughout Puget Sound (Long et al., 2003) and included six of the eight sediment monitoring regions currently defined for Puget Sound by the PSAMP Sediment Component (Figure 1).

The study area sampled in 1999 included Hood Canal and adjoining bays in which 21 samples were tested for chemical contamination, toxicity, and benthic community composition (Long et al., 2003). Based on the data from that survey, about 35% of the Hood Canal region was classified as having high quality sediments, 52% was classified as intermediate/high quality, 13% was classified as intermediate/degraded, and 0% as degraded. Because Hood Canal has a history of biological impairment related to low near-bottom dissolved oxygen (DO) concentrations (Newton et al., 1998, 2002), further study of the region was warranted.

The current survey, conducted in 2004, was designed and implemented to provide further information on the quality of sediments in this region. The study was especially targeted to determine the degree to which the resident benthos were negatively impacted, and to identify changes in sediment quality over time.

Site Description

The study described in this report focused on the Hood Canal region of Puget Sound (Figure 1). Hood Canal is located in northwestern Washington State and is bordered by the Olympic Peninsula to the west and the Kitsap Peninsula to the east. The study area included the entire length of Hood Canal from its entrance at Admiralty Inlet to the mudflats at the end of the canal, and adjoining Port Gamble, Port Ludlow, and Quilcene and Dabob Bays. The overall study area sampled during 2004 encompassed approximately 331.7 km^2 (Table 1).

Hood Canal is a narrow fjord-like inlet of Puget Sound, formed by glacial scouring, and approximately 100 km in length. At the entrance there is a relatively shallow region, or sill, with a water depth of 25 to 50 m. South of the sill, water depths increase to 150 to 200 m. Hood Canal continues southwest, turns sharply northeast at the Great Bend, and ends in Lynch Cove (Figure 2).

Seawater enters Hood Canal through the entrance from the Pacific Ocean via the Strait of Juan de Fuca and Admiralty Inlet. Freshwater enters through several small rivers, including the Skokomish, Hamma Hamma, Dosewallips, and Quilcene.

Natural habitats in this region are a complex mixture of physical, chemical, and biological systems that support major populations of invertebrates, vascular plants, marine algae, as well as resident and migratory fish, birds, and mammals. Minimal contamination is vital to the health and sustainability of these habitats, yet a rapidly increasing human population and associated activity subject the region to the possibilities of increasing degradation. Uncontaminated sediments are vital to sustaining healthy benthic populations which are important sources of food for many key taxa of fish and wildlife.

The Hood Canal region is not highly urbanized or industrialized. Most of the shoreline is rural and sparsely populated with individual homes, rental properties, vacation cabins, and resorts. There are no industrial harbors. Potential sources of chemical contamination to the canal include many small marinas, several small towns and villages, septic systems, farms, plant nurseries, a bordering highway, a Navy submarine base, and stormwater runoff entering via the tributary rivers and streams.

High water and sediment quality in Hood Canal are necessary to support robust populations of valuable living marine resources. Large salmon and steelhead runs in most of the tributary rivers and streams traverse the canal to and from the Pacific Ocean. Large shrimp and crab populations support local recreational and commercial fisheries. There are several commercial oyster farms along the shoreline as well as tribal and recreational intertidal clam beds. Bottom fishing for demersal fishes such as rockfish, lingcod, and perch is common along the length of the canal.

Sediment Quality Related Research

A limited number of studies have been conducted to characterize toxicity and benthic community composition in the sediments of the Hood Canal region. Several small-scale studies have been conducted in the region to quantify contaminant levels in sediments (Appendix A, Table A-1). These studies showed that levels of contaminants were generally below Washington State standards and often below analytically detectable concentrations.

Contaminant levels did not meet (exceeded) at least one sediment quality standard at 13 sites (Appendix A, Figure A-1). Most of the exceeded state standards occurred in Port Gamble with 8 chemicals: arsenic, cadmium, copper, lead, zinc, 1,2,4-trichlorobenzene, hexachlorobenzene, and total polychlorinated biphenyls (PCBs). Total low molecular weight polycyclic aromatic hydrocarbons (PAHs) and naphthalene exceeded State standards in Port Ludlow at one site. Dabob Bay had one site with butylbenzylphthalate concentrations above standards.

Goals and Objectives

The overall goals of the sediment monitoring component of the PSAMP are to:

1. Assess the health of Puget Sound sediments and document geographic patterns in the condition of the sediments.
2. Document changes over time in the quality of Puget Sound sediments.
3. Identify existing sediment problems and, where possible, provide data to help target in-depth point (discrete) and nonpoint (diffuse) source investigations.
4. Provide sediment data to assist environmental managers and others in measuring the success of environmental programs.
5. Support sediment-related research activities by making available scientifically valid sediment quality data.

Ecology conducted the current 2004 study as part of the PSAMP Sediment Component. The survey was designed to satisfy a specific set of programmatic goals and technical objectives. Therefore, methods were selected that were not necessarily the same as those frequently used in enforcement or other regulatory decisions. Rather, methods were selected that best met the goals and technical objectives of the monitoring program.

The objectives of the 2004 survey were the same as those adopted for the previous surveys conducted during 1997 through 1999 and 2002 through 2003:

1. Determine the incidence and severity of chemical contamination, toxicity, and benthic infauna impairment of sediments (i.e., the number and percent of stations with sediment quality degradation).
2. Identify spatial patterns and gradients in sediment chemical concentrations, toxicity, and degree of benthic infauna impairment as defined with the selected methods.
3. Estimate the spatial extent of chemical contamination, toxicity, and benthic infauna impairment in surficial sediments as km^2 and percentages of the total survey area.
4. Describe the composition, abundance, and diversity of benthic infaunal assemblages at each sampling location.
5. Determine the spatial patterns and extent of degraded conditions based upon a weight-of-evidence formed with the triad of measures (chemical contamination, sediment toxicity, and benthic infauna impairment).

Some analyses of the data collected in the 2004 Hood Canal survey have been reported previously by Ecology (Long et al., 2007). In that report, the data were examined to determine the relationships between near-bottom DO concentrations and the composition of the benthos. The primary purpose of this report is to document the spatial patterns and extent (i.e., area) of chemical degradation of the region using the triad approach.

Methods

Sampling Design

The 2004 monitoring effort conducted in Hood Canal followed the initial 1997-1999 PSAMP/NOAA Sound-wide survey of sediment quality (Long et al., 2003) and the 2002-2003 survey of the bays and inlets of the San Juan Islands, eastern Strait of Juan de Fuca, and Admiralty Inlet (Long et al., 2008).

Many aspects of the sampling design, sample collection, and analyses used in the 2004 survey of Hood Canal followed those used in the 1997-1999 survey. However, some modifications were made to the sampling design, and only one toxicity test was used in the 2004 survey. Sample collection and analytical methods followed the Puget Sound Estuary Program (PSEP) Protocols (www.psparchives.com/our_work/science/protocols.htm) as much as possible to ensure compatibility with data from previous studies. These methods have also recently been documented in the PSAMP Sediment Monitoring Component revised Quality Assurance Project Plan (QAPP) (Dutch, 2009)

The stratified-random sampling design that was used for the 1997-1999 PSAMP/NOAA baseline sediment surveys was modified slightly with assistance from the U.S. Environmental Protection Agency (EPA) Monitoring Design and Analysis Team statisticians in Corvallis, Oregon. Sampling stations were selected using a generalized random tessellation stratified (GRTS) multi-density survey design, as described by Stevens (1997) and Stevens and Olsen (1999; 2003). Generally in this process, a hexagon grid is randomly located over the study region, and a random point is selected in each hexagon cell. The number of hexagon cells is sufficiently large to guarantee that all sample-size requirements are met. These random points are then assigned unequal weights before the final set of stations is selected.

The GRTS design incorporates a hierarchical randomization process to ensure the sample is spatially-balanced across the PSAMP study region. It also allows stations to be selected with unequal probability to satisfy the sample size requirements by basin and category. The unequal probability (i.e., multi-density) selection is similar to defining explicit strata to meet all the sample-size requirements. Extra stations are selected to be used as alternates in the event that a station cannot be sampled for any reason (e.g., inaccessible, rocky).

Empirical experience suggests that 30 to 50 samples are sufficient to provide an accurate representation of environmental conditions within a region the size of the 2004 study area. During June 2004, 30 samples were collected throughout Hood Canal in the relatively protected waters of the region. Surficial sediments (i.e., the upper 2-3 cm) were collected to ensure that the data represented sediment-sorbed toxicants that were recently introduced into the area. Of the 331.7 km^2 study area, only about 294.8 km^2 could actually be sampled due to rocky sediment **(**Table 1).

Five large-scale habitat types, or strata, were identified in Puget Sound during the 1997-99 baseline surveys (Long et al., 2003). These strata included harbors, urban bays, passages, basins, and rural bays. Two of these stratum types, basins and rural bays, were encountered in the 2004 survey.

Station numbers, names, the stratum (habitat) type and the spatial area they represent are listed in Table 2 and displayed geographically in Figure 2. Target and actual station coordinates, along with water depths, are compiled in the navigation report (Appendix B).

Sample Collection

Sediments were collected during June 2-14, 2004 with the 58-foot research vessel *Centennial*. Vessel positioning at the pre-selected station locations followed PSEP methods (1998). Differential Global Positioning System (DGPS) with an accuracy of better than 5 meters (m) was used to position the vessel at the station coordinates. One set of water column and sediment samples was collected from each station. The water column and sediment sampling gear was deployed and retrieved with a hydraulic winch and cable system. All samples were collected in water depths of 2 m or more (mean lower low water), the operating limit of the sampling vessel.

Water Column Samples

A water column profile, and one discrete grab sample of near-bottom water for an analysis of dissolved oxygen (DO) concentration, were collected at each location with a Seabird 19 conductivity/temperature/depth (CTD) meter and a Niskin bottle attached to the cable immediately above the CTD. The Niskin bottle was fired with a messenger when the CTD was suspended just above the seabed. CTD deployment and sample collection followed Ecology's standard operating procedures detailed in Appendix C.

When obtaining the water sample, great care was taken to avoid introducing air bubbles into the sample. A 30–50 cm length of Tygon tubing was connected to the Niskin bottle spout. The end of the tube was elevated before the spout was opened to prevent the trapping of bubbles in the tube. With the water flowing, the tube was placed in the bottom of the horizontally held biological oxygen demand (BOD) bottle in order to rinse the sides of the flask and the stopper. The bottle was turned upright and the side of the bottle tapped to ensure that no air bubbles adhered to the bottle walls. Four to five volumes of water were allowed to overflow from the bottle. The tube was then slowly withdrawn from the bottle while water was still flowing.

Immediately after obtaining the seawater sample, the following reagents were introduced into the filled BOD bottles by submerging the tip of a pipette or automatic dispenser well into the sample: 1 ml of manganous chloride, followed by 1 ml of sodium iodide-sodium hydroxide solution. The stopper was then carefully placed in the bottle, ensuring that no bubbles were trapped inside. The bottle was vigorously shaken, then shaken again about 20 minutes later when the precipitate had settled to the bottom of the bottle. Sample bottles were then stored upright in a cooler and the bottle necks sealed with deionized water.

Sediment Samples

Collection of sediments for chemistry, toxicity, and benthic infauna followed the protocols specified in the PSAMP Sediment Component's recently revised QAPP (Dutch et al., 2009).

Sediment samples were collected with a double 0.1 m^2, stainless steel, modified vanVeen grab sampler in accordance with regional sampling protocols (PSEP, 1997a). Sediment for toxicity testing and chemical analyses was collected simultaneously with sediment collected for the benthic community analyses to ensure synoptic data.

One 0.1 m^2 grab sample from one side of the sampler was collected from each station for the benthic infaunal analyses. From the other side of the sampler, the top two to three cm of sediment was removed for chemical and toxicity.

Samples for near-bottom water DO and sediment chemical and toxicity tests were stored on deck in sealed containers placed in insulated coolers filled with ice. Infauna samples were stored on deck in plastic storage bags placed in sealed 5-gallon HDPE buckets.

All samples were off-loaded from the research vessel every 1-3 days and transported to Ecology's headquarters building in Lacey, WA. The near-bottom water DO samples were held at 4°C until processed by Ecology's Marine Sediment Monitoring Program (MSMP) personnel. Sediment samples were held at 4°C until shipped on ice by overnight courier to either the contractor laboratory for the toxicity test or to Ecology's Manchester Environmental Laboratory (MEL) for chemical analyses. Benthic infauna sediment samples were stored at Ecology's headquarters building at room temperature prior to processing.

Laboratory Analyses

Physical and Chemical Analyses

Grain size analyses were conducted by Analytical Resources, Incorporated in Tukwila, WA. Laboratory analyses for potentially toxic substances were performed for 120 chemicals and total organic carbon content (TOC) by MEL, in Manchester, WA (Table 3).

The classes of contaminants included in the chemical analyses were:

- Metals
- Base/Neutral/Acid (BNA) Organic Chemicals
- Polycyclic Aromatic Hydrocarbons (PAH)
- Chlorinated Pesticides and Polychlorinated Biphenyls (PCB)
- Polybrominated Diphenyl Ethers (PBDE)

The analytical methods and reporting limits used were those specified in the QAPP (Table 4) (Dutch et al., 2009).

Analytical procedures provided data quality that met or exceeded objective performance criteria specified in the QAPP (Dutch et al., 2009) including analyses of blanks and standard reference materials. Information was reported on recovery of spiked blanks, analytical precision with standard reference materials, and duplicate analyses of every 20th sample. Practical quantitation limits (reporting limits) were reported for chemicals that were at or below the detection limits and were qualified as being undetected.

Methods and resolution levels for field collection of temperature and salinity are listed in Table 5.

Dissolved Oxygen

Dissolved oxygen concentrations were determined for the near-bottom water samples with the Carpenter method for marine waters (Carpenter, 1965). The method is a modification of the Winkler titration method (Winkler, 1888) and uses a Dosimat titrator with magnetic stirrer and stir bar.

Toxicity Testing

Unlike the previous surveys of sediment quality in Puget Sound in which multiple toxicity tests were performed, in 2004 only one test was performed to evaluate the toxicological condition of each sample. During the baseline study in 1997-1999, four toxicity tests were performed: an amphipod (*Ampelisca abdita*) survival test on solid phase sediments; a sea urchin (*Strongylocentrotus purpuratus*) fertilization test of porewaters; a Microtox bioluminescence test on organic solvent extracts; and a cytochrome P450 HRGS (Human Recorder Gene System) assay on solvent extracts.

For the present 2004 survey, only the sea urchin fertilization test of porewaters was conducted because of funding constraints. The methods used in the sea urchin fertilization test were the same in the 1997-1999 (Long et al., 2003) and subsequent 2002-2003 (Long et al., 2008) baseline surveys.

Sea Urchin (*Strongylocentrotus purpuratus*) Fertilization in Porewater

Tests of fertilization success of sea urchin gametes in sediment porewaters were conducted by the U.S. Geological Survey (USGS) using methods largely developed by the laboratory in Corpus Christi, Texas (Carr and Chapman, 1995; Carr et al. 1996a,b; Carr, 1998). These methods were developed initially for *Arbacia punctulata* for sediment quality surveys along southeastern U.S. estuaries, and adapted for use in the Pacific Northwest using *Strongylocentrotus purpuratus*. The methods used in 2004 were consistent with those used in 1997-1999 and 2002-2003. The methods used in these tests as well as QA procedures are detailed in the USGS laboratory report (Appendix D).

Benthic Community Analyses

All infauna sample processing methods, procedures, and documentation (including sample sorting, taxonomy, QA/QC, chain-of-custody forms, tracking logs, and data sheets) were similar to those described in the PSEP protocols (1987), and are detailed in the QAPP (Dutch et al., 2009).

Data Summary, Display, and Statistical Analysis

Data from the chemical analyses, toxicity tests, and benthic analyses were summarized to determine incidence, severity, spatial patterns, and spatial extent of degraded conditions separately and together for the Hood Canal region. Data from the 2004 survey were also compared with those from the 1999 survey of the Hood Canal region and from the other Puget Sound regions.

Chemical Concentrations

The concentrations of chemicals in each sample were compared with the Sediment Quality Standards (SQSs) and Cleanup Screening Levels (CSLs) specified in the Washington State Sediment Management Standards (Washington Department of Ecology, 1995a) for 47 substances (Appendix E). They were also compared to national Effects Range Median (ERM) guidelines derived by NOAA for 25 chemicals (Long et al., 1995). This was done to determine the incidence, degree, spatial patterns, and spatial extent of contamination.

The incidence of contamination was calculated as the number of samples that were contaminated divided by the total number of samples. The degree of contamination was calculated as mean Effects Range Median (ERM) quotients (Long et al., 2000b). These values were calculated for each sample to provide a single, effects-based, unitless index of contamination over a continuous range that accounted for both the presence of mixtures and their concentrations.

Spatial patterns of chemical concentrations were illustrated by plotting stations in which the Washington State Sediment Management Standards were not met (exceeded) on base maps of the area. In addition, mean ERM quotients for each station were plotted to illustrate regional patterns in the concentrations of chemical mixtures.

The spatial extent of sediment contamination was determined as the sum of the areas within each stratum type or total survey area in which the Washington State SQS or CSL values were exceeded. The chemical data were weighted to the areas (km^2) of each region, divided by the number of samples in the region. Using this method, results were expressed as total km^2 and percentages of the total regional area or total stratum area in which any of the standards were exceeded.

Several conventions were followed in these comparisons of the chemical data to the state standards and national guidelines. For comparisons with summed classes of chemicals (i.e., the sums of PAHs, PCB aroclors or congeners, and DDD/DDE/DDTs), the concentrations of individual compounds reported by the laboratory as undetected (laboratory symbol of U) or undetected and estimated (symbol of UJ) were eliminated from the analyses. The same procedure was followed with comparisons to the NOAA guidelines.

Concentrations for individual chemicals reported as estimated (coded as J or NJ) were examined on a sample-by-sample basis. If the estimate appeared to be reliable, the estimated value was treated as a real concentration. Because of the inconsistent nature of the analyses and quantification of five base neutral acid compounds (benzyl alcohol, benzoic acid, phenol, 2-methylphenol, and 4-methylphenol) between years, the data for these substances were not included in the estimates of the spatial extent of contamination.

Sediment Toxicity

Results of the sea urchin fertilization tests were analyzed by USGS using ANOVA and Dunnett's one-tailed *t*-test (which controls the experiment-wise error rate) on the arcsine square root transformed data with the aid of SAS (SAS, 1989).

To ensure consistency with the 1997-2003 treatments of PSAMP sediment data, samples were classified as “toxic” in tests of 100% porewater when mean fertilization success was significantly lower than in the Texas control sediment, and “highly toxic” when significant and less than 80% of the control response. Detailed descriptions of the analyses are presented in Appendix D.

The incidence of toxicity was determined as the percentage of the total numbers of samples tested that were classified as “highly toxic.” Spatial patterns and gradients in toxicity were illustrated by plotting these results on base maps. The spatial extent of toxicity was determined as the sum of the areas of all sampling stations found to have highly toxic sediments. Results were expressed as total km^2 and percentages of the total regional area in which toxicity was recorded.

Benthic Community Analyses

All benthic infaunal data were reviewed and standardized for any taxonomic nomenclatural inconsistencies by Ecology personnel using an internally developed standardization process. This process involved comparing the species identified in the survey with a master species list based on the 1991 Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) benthic invertebrate species list. This list has been continually updated with current taxonomic changes.

Nine benthic infaunal indices were calculated to summarize the standardized raw data and characterize the infaunal invertebrate assemblages identified from each station. These indices included total abundance, major taxa abundance (for Annelida, Mollusca, Echinodermata, Arthropoda, and miscellaneous taxa), taxa richness, Pielou’s evenness (J’), and Swartz’s Dominance Index (SDI). These indices are defined in Table 6.

Assessment of Infaunal Assemblages

Because no numerical benthic health index has been developed for Puget Sound, classification of stations as having an adversely affected benthic assemblage was necessarily based on the best professional judgment (BPJ) of Ecology benthic ecologists. The species composition of each assemblage (absence or low abundance of stress-sensitive taxa and/or the presence and abundance of stress-tolerant taxa) and the calculated index values were used together to classify stations as having adversely affected or unaffected infauna. The benthos were considered to be affected when the majority of calculated indices and the species composition indicated that the community was adversely different from communities in uncontaminated areas and from the median indices calculated for the 300 PSAMP/NOAA stations surveyed in 1997-1999 (Long et al., 2005).

In order to identify spatial patterns and gradients, the benthic indices for each station were displayed on base maps as bars, the heights of which indicated the relative benthic index value. Following the classification of stations as adversely affected or unaffected, the percentage of stations that were affected was calculated. The benthic data were treated the same way as the chemistry and toxicity data to determine the spatial extent of benthic impairment. These results were expressed as km^2 and percentage of the total study area.

Sediment Quality Triad Analyses

The data from the chemical analyses, toxicity tests, and benthic infaunal analyses were compiled to form a weight-of-evidence matrix with which to classify sediment quality at each station (Chapman, 1996). The same triad approach was developed and applied in the initial Ecology/NOAA baseline surveys (Long et al., 2003, 2005, 2008).

Sediments were classified as highest quality when no chemical concentrations exceeded any of the State standards, significant results were not recorded in the toxicity test, and the majority of the benthic indices indicated that the sediment supported a relatively abundant and diverse infauna. Sediments with a significant result in one element of the triad (i.e., one or more chemical concentrations greater than any SQS, a highly significant result in the toxicity test, or an adversely affected benthic assemblage) were considered to be intermediate/high quality. Those with significant results in two of the triad elements were considered to be intermediate/degraded. Degraded sediments were those with one or more chemical concentrations greater than the SQSs, a significant outcome in the toxicity test, and an adversely affected benthos.

The triad classifications were illustrated on base maps for each station to help identify spatial patterns. Color-coded symbols were used to identify the station triad classifications. The results of these evaluations were compared with sediment quality triad data from the 1999 Hood Canal survey and from other regions of Puget Sound.

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Results

Station and Stratum Characteristics

Sampling station numbers, names, locations, and the sizes of the areas that they represent, are listed in Table 2. Final station coordinates and water depths for all 33 stations and rejected stations sampled during 2004 are listed in the navigation report (Appendix B).

The physical and visual characteristics of each sample are included in the field notes (Appendix F). These characteristics include water salinity, sediment temperature, observed sediment description, sediment color, odor, and sampler penetration depth.

The entire Hood Canal survey region was estimated to cover 331.7 km^2, 294.8 km^2 of which could be sampled (Table 1). The 30 sampled stations were categorized into two of five stratum types (deep basin, industrialized harbor, passage between land masses, rural bay, and urban bay) (Long et al., 2003).

There were 21 basin stations, 9 rural bay stations, and no harbor, passage, or urban bay stations in the study area (Table 1). Basin stratum stations were located in the main channel of Hood Canal and encompassed 231 km^2. Rural bay stratum stations were located in Port Ludlow, Port Gamble, Dabob Bay, Quilcene Bay, and Lynch Cove, covering an area of 101 km^2 (Table 1, Figure 2).

Physical and Chemical Analyses

The degree and spatial patterns in chemical contamination can be influenced by both proximity to sources and by a battery of natural factors, including depth, sediment texture (grain size), and TOC content. The degree of contamination would be expected to increase with increasing station depth, percent fines, and percent TOC because all three factors would be indicative of low-energy accumulation zones. Figures 3-6 illustrate the spatial patterns in these natural characteristics.

Station Depth

Station depths among the 30 sampled stations ranged from 14 to 177 meters (Figure 3; Appendix B). The deepest stations were generally located in the central portions of Hood Canal and Dabob Bay (e.g., stations 48, 56, 112, and 120). The shallower stations were located along the shoreline (e.g., stations 252 and 288) and in Lynch Cove at the head of the canal (e.g., stations 118 and 128).

Grain Size

Percent gravel, sand, silt, and clay measured for these samples (Figure 4; Appendix G, Table G-1 and Figure G-1) are summarized in Table 7. Based on the four classes of sediment types, 7 stations were classified as sandy, 4 stations had silty sand, 11 stations had mixed sediments, and 8 stations were classified as silt-clay. Spatial distribution of the percent fines (silt-clay) fraction for all stations is shown in Figure 5.

Sediment type in the 30 sampled stations ranged from very sandy to very silty. Sediments at stations nearest the Hood Canal entrance and at shallow stations along the eastern shoreline of the canal were composed of 86% to 96% sand (Figures 4 and 5). Southward from the entrance into the canal, percent sand decreased and percent silt-clay increased through the central canal and into Lynch Cove. The deepest stations in central Dabob Bay and central and southern Hood Canal had the highest percentages of silt-clay, ranging up to about 90% at several stations.

Total Organic Carbon (TOC)

TOC concentrations (Appendix G, Table G-2 and Figure G-2) are summarized in Table 8 and graphically displayed in Figure 6. Concentrations measured at the 30 stations ranged from 0.13% to 2.94% with an average value of 1.58%. TOC concentrations were lowest near the entrance to the canal and in the shallow sandy stations along the eastern shoreline. TOC concentrations increased with depth and percent silt and clay in both Hood Canal and Dabob Bay. Concentrations exceeded 2% in the deepest stations in central and southern Hood Canal and Dabob Bay (Figure 6).

Dissolved Oxygen (DO)

Near-bottom water DO levels (Appendix G, Table G-3) are summarized in Table 8 and graphically displayed relative to station depths in Figure 7. DO levels differed considerably among the 30 stations, ranging from 0.44 to 13.1 milligrams per liter (mg/L). DO concentrations generally decreased with increasing station depths (Figure 7). In the 8 stations nearest the canal entrance, the DO levels were greater than 6 mg/L. They decreased to 5-6 mg/L at stations 8 and 188, decreased again slightly to approximately 3-4 mg/L in the entrance to Dabob Bay (stations 60 and 184), then dropped to the lowest values (<2 mg/L) in central Dabob Bay.

The near-bottom DO level at station 112 in central Dabob Bay was 0.44 mg/L, the lowest value recorded in the survey. Except for four shallower stations (124, 252, 288, 248) sampled along the eastern shoreline of central Hood Canal where DO levels were the highest (10 -13 mg/L), DO values continued to be relatively low (1-3 mg/L) in the deeper stations down the remaining length of the canal. The DO levels at the two stations at the very end of the canal were 1.0 and 1.6 mg/L, indicating that low DO levels found in central Hood Canal continued around the Great Bend into Lynch Cove.

Chemical Concentrations

Chemistry case narratives, with QA data, are included in Appendix G-1. Concentrations of individual trace metals and organic compounds in each sample (Appendix G, Figure G-3 and Table G-2) are summarized in Table 8, and graphically compared among stations as mean ERM quotients in Figure 8. Chemical concentrations in the sediments were compared to Washington

State Sediment Management Standards and NOAA guidelines (Appendix E; Appendix G, Figure G-3).

Many of the concentrations of individual chemicals were qualified values; that is, they were undetected at the detection limits attained by the lab, or were detectable but estimated values because the concentrations were very low. The numbers of samples in which non-detectable concentrations were reported ranged from 0 to 30 among the different chemicals.

Chemicals Excluded from Analysis

Chemical data analyses were conducted after excluding the non-detected and estimated values described above. Additionally, data for 5 other organic compounds (benzyl alcohol, benzoic acid, phenol, 2-methylphenol, and 4-methylphenol) were previously found to be unreliable, and excluded from past data summaries (Long et al., 2008). These data have been similarly examined for the 2004 Hood Canal data. To increase the reliability of subsequent data analyses and to improve comparability with previous data sets (Long et al., 2003), these unreliable data were omitted from further analyses.

Incidence and Degree of Chemical Contamination

When unreliable data were excluded from the calculations, none of the remaining chemicals exceeded any SQS or CSL. Thus, the incidence of chemical contamination relative to the State standards was zero.

Mean ERM quotients were used to determine the degree of chemical contamination in the Hood Canal study region. The range in mean ERM quotients based on the normalization of 25 chemical concentrations to their respective ERM values was very small (0.03 to 0.09) (Figure 8). The sample from station 96 toward the south end of the canal had the highest mean ERM quotient (0.09) as a result of slightly elevated levels of copper and several PAHs. The ERM quotient values of less than 0.1 correspond to a very low incidence of toxicity based on empirical studies (Long et al., 2000a).

Spatial Patterns and Gradients, and Spatial Extent of Chemical Contamination

Since none of the Washington State Sediment Management Standards were exceeded, spatial patterns and gradients were not plotted on base maps for this report. These patterns and gradients were examined instead by calculating and observing the distribution of the mean ERM quotients for each station (Figure 8). The range in values was very small among the 30 stations. Elevated levels of contamination, as indicated by the mean ERM concentration, occurred in both shallow and deep stations and in stations with both high and low concentrations of TOC and fine-grained sediment particles. However, some of the highest mean ERM quotients occurred at deep stations in south-central Dabob Bay and central Hood Canal. Many of the lowest concentrations occurred at the stations nearest the entrance to the canal and along the eastern shoreline (e.g., stations 203, 323,124, 252, and 288) (Figure 8).

Because no chemical concentrations in the amended data set exceeded any State standard, the spatial extent (i.e., the area within the Hood Canal region) of chemical contamination was zero.

Summary

Percent silt-clay ranged from about 10% in shallow stations along the shoreline and near the Hood Canal entrance to over 80% in the deepest stations in central and southern Hood Canal and Dabob Bay. Similar patterns were observed for TOC, with higher concentrations, up to 2.94%, found in the deeper stations in sediments with higher percent fines. DO levels were highest in northern Hood Canal and along the eastern shoreline, and lowest in central Dabob Bay and the southern end of the canal.

Following elimination of the qualified, undetected, and unreliable data, the incidence and spatial extent of contamination in the Hood Canal study region were zero relative to the State standards (SQS and CSL values). Therefore, based on the amended database and the methods used in these analyses, this region was determined to be uncontaminated. The mean ERM quotients indicated that the 25 substances for which there are ERM values occurred in very low concentrations based on a national scale.

There was a general pattern of slightly higher chemical concentrations in south-central Dabob Bay and towards the end of Hood Canal, and lowest concentrations in the shallow stations near the shoreline of central Hood Canal and at the canal entrance. Relatively high chemical concentrations tended to accumulate in the deepest stations with highest percent fines and TOC. The lowest concentrations often occurred in the shallowest stations with lowest percent fines and TOC.

Toxicity Analyses

Results of the sea urchin (*Strongylocentrotus purpuratus*) fertilization tests in porewater conducted for this survey (Appendix D) are summarized in Table 9 and graphically displayed in Figures 9 and 10. A review and summary of the toxicity QA/QC information, the toxicity test report, and reference toxicant control charts are summarized in Appendix D.

Incidence of Toxicity

Mean percent fertilization success in 100% porewater ranged from 0.0% in one sample to more than 100% of the Texas control response (Table 9).

Among the 30 samples, mean fertilization success in 100% porewater was significantly less than the Texas control sediments in 6 samples (Table 9). Mean control-adjusted fertilization success was significantly lower and less than 80% of the Texas controls in 5 of these 6 samples. Thus, the overall incidence of significant responses for the Hood Canal region was 17% (5 of 30). Mean fertilization success was lowest (0%, 2.5% and 4.7%, respectively) in samples from stations 112, 48, and 92 in Dabob Bay (Table 9, Figure 9).

There were 4 samples in which the mean response was significantly different and less than 80% of the control response in the tests of 50% porewater concentrations, giving an incidence of significant responses of 13% (4 out of 30). There were 2 samples in which the mean response was significantly different and less than 80% of the control response in the tests of 25%

porewater concentrations, giving an incidence of significant responses of 7% (2 out of 30) (Table 9).

Spatial Patterns and Gradients, and Spatial Extent of Toxicity

Although there were no obvious or discernible spatial patterns or gradients in toxicity with this test, 4 of the 5 significant toxicity responses occurred in Dabob Bay (Figure 10).

Two samples from neighboring stations 48 and 112 in central Dabob Bay were the most toxic, with highly significant results in all 3 porewater concentrations. The sample from nearby station 92 was toxic in both the 100% and 50% porewater concentrations. These 3 stations were the deepest (>150 m) of the survey. Sediments at these stations consisted of 80% or greater fines and had relatively high TOC concentrations (2.4%).

Stations 56 (at the mouth of Dabob Bay) and 96 (in southern Hood Canal), respectively, were toxic in 100% porewater only (station 56) or in both 100% and 50% porewater concentrations (station 96).

Test results approximated or exceeded 100% of the Texas control response in most of the other samples (Table 9).

The spatial extent of toxicity as measured with the urchin fertilization test was calculated, using the results of testing with 100%, 50%, and 25% porewater concentrations (Table 10). These estimates represented 52 km^2, 43 km^2, and 22 km^2, equivalent to 18%, 15%, and 8% of the total survey area, respectively.

Summary

There were 5, 4, and 2 samples classified as toxic in the tests of 100%, 50%, and 25% porewater concentrations, respectively. They represented about 18%, 15%, and 8% of the total survey area, respectively. The most toxic samples were collected in the deepest stations in central Dabob Bay. With one exception (station 96 in southern Hood Canal), toxicity was negligible throughout the remainder of the canal.

Benthic Community Analyses

Community Composition and Benthic Indices

Definitions of the benthic indices can be found in Table 6. The benthic taxa identified in this survey are listed in Appendix H, Table H-1; sorting and taxonomy QA results are included in Appendix H, Tables H-2 and H-3. The spatial distributions of the calculated benthic condition indices are illustrated in Figures 11-21.

Total Abundance

Among the 30 stations sampled in Hood Canal, total abundance ranged from 27 animals at station 112 in Dabob Bay to 1,075 animals at station 203 north of the Hood Canal bridge (Table 11). The average total abundance for the 30 stations was 274 animals.

Total abundance was lowest at stations 112 and 48 in Dabob Bay (27 and 33 animals, respectively). Total abundance also was relatively low (<100 animals) at deeper stations in central (stations 56, 92, and 184) and southern (station 96) Hood Canal.

Total abundance was highest (1,075 animals) at station 203 near the entrance to Hood Canal and second highest (883 animals) at station 216, also located in the northern reaches of Hood Canal. Total abundance also was relatively high (exceeded the median of 225 animals) at stations 75, 88, 323, and 336 in northern Hood Canal nearest the entrance, and at stations 80,124, 128, 248, 252, and 288, all shallow stations located along the eastern shoreline of the canal (Table 11, Figure 11).

Major Taxa Abundance

For the most part, annelids, molluscs, and arthropods were relatively well-represented at stations in northern Hood Canal and along the eastern shoreline of central Hood Canal (Table 12, Figures 12 and 13). Most stations in Dabob Bay and in southern Hood Canal were dominated by molluscs and/or annelids, and relative abundance of arthropods was quite low. The abundance of the echinoderms and miscellaneous taxa was low in most of the samples, which is not unusual for infauna samples in Puget Sound.

- Annelids (segmented marine worms) were the most abundant taxonomic group, representing an average of nearly 50% of total abundance among the 30 stations (Table 12, Figures 12, 13 and 14). Annelid abundance ranged from 19 to 266 individuals, and made up 10% to 84% of the total abundance. Annelids contributed 70% or more to total abundance at 8 stations (32, 48, 56, 60, 80, 92, 112, and 296) in Dabob Bay and central Hood Canal, and 30% or less to total abundance at 7 stations (75, 152, 188, 203, 216, 323, and 336) in northern Hood Canal.

- Molluscs (bivalves and gastropods) were the second most abundant major taxonomic group in Hood Canal, averaging 92 individuals per sample and 27% of total abundance (Table 12, Figures 12, 13, and 15). Mollusc abundance ranged from 1 to 382 individuals in a sample, and contributed from 0.44% to 57% to total abundance. Stations with highest mollusc abundance (40% or more of total abundance) included all but one (station 88) of those in northern Hood Canal and the 4 shallow, nearshore stations (stations 128, 248, 252, and 288) in central and south Hood Canal. Stations in which mollusc abundance was lowest were primarily in Dabob Bay, and in central and southern Hood Canal.

- Arthropods (shrimps, crabs, amphipods, and other crustaceans) were well-represented in many samples from Hood Canal, with an average abundance of 58 individuals and averaging 20% of total abundance (Table 12, Figures 12, 13, and 16). Arthropod abundance ranged from 0 to 405 individuals per sample and contributed 0% to 57% to total abundance.

Stations with highest arthropod abundance (50% or more of total abundance) included stations 88, 323 and 336 near the canal entrance and station 96 in southern Hood Canal. Stations with relatively low arthropod abundance (10% or less of total abundance) included 11 stations in Dabob Bay, and central and southern Hood Canal. No arthropods were found in the benthic sample from station 118 at the far southern end of the canal.

- Echinoderms (brittle stars, sea stars, heart urchins, and sea cucumbers) were relatively rare in all locations in Hood Canal. The range in abundance was 0 to 10 individuals, with a percent of total abundance of 0% to 8% (Table 12, Figures 12, 13, and 17). These were the lowest values for any major taxonomic group. Stations with the highest percent abundance of echinoderms included the two stations on the sill (stations 24 and 152), and deep stations in central Hood Canal (e.g., numbers 120, 56, 296). Fifteen (15) samples had no echinoderms. All of the stations in southern Hood Canal (64. 96, 118. 128 and 224) and most of the stations in Dabob Bay (32, 48, 80, 92, 112, and 144) lacked echinoderms.

- The miscellaneous taxa (cnidarians, phoronid worms, nemertean worms, echiurids, and other small taxonomic groups) were not abundant in Hood Canal, with a range in abundance of 0 to 70 individuals and a percent of total abundance of 0% to 17% (Table 12, Figures 12, 13, and 18). The miscellaneous taxa were most numerous (35 individuals or more) at 2 stations at the entrance to the canal (203 and 216) and 3 stations along the eastern shoreline of central Hood Canal (124, 252, and 288). Miscellaneous taxa were absent from 5 stations in Dabob Bay, and central and southern Hood Canal.

Taxa Richness

Taxa richness ranged from 6 to 146 taxa (Table 11, Figure 19). Half of the 30 stations had 40 or more taxa represented. Most of these stations occurred near the Hood Canal entrance and in the central canal along the eastern shoreline. As was the case with total abundance, the fewest taxa occurred in the two deepest stations in Dabob Bay, stations 48 (9 taxa) and 112 (6 taxa). Stations with lowest taxa richness were located in Dabob Bay and in the south end of Hood Canal.

Evenness

The index of evenness ranged from 0.6 to 0.95 (Table 11, Figure 20). Most of the 13 stations with the highest evenness (>0.8) were located in Dabob Bay and central Hood Canal (e.g., stations 56, 112, 184, and 296). Stations in which evenness was lowest (0.7 or lower) were scattered throughout the region with no obvious spatial gradient or pattern. They included one station at the northern end of Dabob Bay (32), two stations at the head of Hood Canal (118 and 128), and one station in central Hood Canal (248).

Swartz's Dominance Index (SDI)

SDI values ranged from 4 to 29 taxa among the 30 stations (Table 11, Figure 21). Stations with the highest SDI values (18 or more taxa) were located in central (124, 203, and 252) and northern (88, 203, and 216) Hood Canal. Stations with the lowest values (< 10 taxa) occurred in Dabob Bay and southern Hood Canal. They included the deepest stations (48 and 112) in

Dabob Bay and relatively shallow stations 118 and 128 in southern Hood Canal where there were only 4 to 5 dominant taxa in the assemblages.

Species Composition

As indicated by the 10 most abundant taxa and the calculated indices of benthic assemblage condition, the composition of the benthic assemblages changed along the length of the canal (Appendix I, Table I-2). In general, species composition at the 30 sampled stations appeared to be related to station depth, sediment grain size, TOC, and near-bottom DO.

In the northern portion of the canal, most stations were characterized by ostracods (*Euphilomedes producta, E. carcharodonta*) and bivalves (*Axinopsida serricata*, *Macoma carlottensis, Alvania compacta, Nutricola lordi*). Capitellid worms (*Mediomastus californiensis, Heteromastus* spp.), amphipods (*Rhepoxynius boreovariatus, Gammaropsis thompsoni*), and juvenile benthic crabs (*Pinnixa* spp.) also occurred in many of these stations. At shallower stations with higher percent fines (stations 24, 152, and 216), *Axinopsida serricata* was the numerically dominant species, while at deeper, sandier stations (75, 323, and 336), *Euphilomedes* spp. were the most abundant species.

In central Hood Canal, at deeper stations with higher percent fines (8, 56, 120, 184, 188, and 296), annelid species were numerically dominant. These species included *Prionospio lighti*, *Cossura bansei*, *Heteromastus filobranchus,* and *Aricidea lopezi*. Other taxa found at these stations were the bivalve species *Axinopsida serricata* and *Macoma carlottensis*, and the echinoderm heart urchin *Brisaster latifrons*.

The shallow, sandier stations along the eastern shoreline (248, 252, and 288) were dominated by the bivalves *Axinopsida serricata*, *Parvilucina tenuisculpta*, and *Nutricola lordi*. The annelids *Exogone lourei*, *Pectinaria granulata*, and *Scoletoma luti* were also present along with the ostracods *Euphilomedes* spp. The infaunal assemblage at the deep sandy station off Seabeck, station 124, had affinities with these shallow sandy stations. *Axinopsida serricata*, *Nutricola lordi*, *Euphilomedes producta*, *Exogone lourei*, and *Pectinaria granulata* were the numerically dominant species at this station.

In Dabob Bay, stations for the most part were relatively deep with higher percent fines. The benthic assemblages were dominated by annelids (*Heteromastus filobranchus*, *Mediomastus californiensis*, *Prionospio lighti*, *Cossura bansei*, and *Leitoscoloplos pugettensis),* along with the bivalve *Macoma carlottensis*. Arthropods, echinoderms, and miscellaneous taxa were relatively rare in Dabob Bay.

At stations in the southern end of Hood Canal, the benthic communities were similar to those of the central region of the canal. These stations were dominated primarily by *Axinopsida serricata* and *Macoma carlottensis*, and a number of annelid species (*Leitoscoloplos pugettensis*, *Prionospio lighti*, and *Heteromastus filobranchus*). There were few arthropods and no echinoderms at these stations.

Station Classification

The benthic assemblages at 23 of the 30 stations were classified as adversely affected (Figure 22). That is, the infauna were judged to be affected negatively by natural or anthropogenic stressors that caused reduced total abundance and species diversity, decreased abundance of stress-sensitive species, and increased abundance of stress-tolerant species.

The benthos were classified as unaffected at 4 stations in the entrance and sill of Hood Canal (24, 152, 203 and 216) and at 3 stations along the eastern shoreline of central Hood Canal (124, 252, and 288). Overall, these stations had low percent fines and TOC, and relatively high DO. Total abundance, taxa richness, and species dominance were high at all of these stations, and there was a good mix of annelid, arthropod, and mollusc species. Miscellaneous taxa and echinoderms were well-represented in most of these samples.

The 23 stations with adversely affected infaunal assemblages occurred throughout the entire Hood Canal study region from the entrance to the head of the canal and throughout Dabob Bay (Figure 22). Generally, these stations had higher percent fines and TOC, and lower DO than the unaffected stations. Total abundance, taxa richness, and dominance were all relatively low, and fewer arthropods and echinoderms were present.

Two deep stations located in central Dabob Bay (48 and 122) had the most adversely affected benthic community. These stations had extremely low total abundance, taxa richness, and species dominance, as well as a depauperate infaunal assemblage of a few stress-tolerant annelid, arthropod, and mollusc species. These two stations also had the lowest DO concentrations of the 30 sampled stations.

Summary

Composition, diversity, and abundance of the benthic assemblages varied considerably among the 30 sampling locations. Physical factors such as station depth, sediment grain size, TOC, and near-bottom DO levels contributed to the differences among the infaunal communities along the canal.

In northern Hood Canal, relatively shallow stations in the entrance and sill area had the highest abundance, taxa richness, and numbers of dominant taxa of all the stations sampled. The sediments at these stations were silty sand, and DO values were relatively high. The infaunal assemblages included a diverse variety of bivalves, arthropods, gastropods, annelids, and other invertebrate taxa. Deeper stations with sandy sediments had somewhat lower total abundance, taxa richness, and fewer dominant species.

In central Hood Canal and Dabob Bay, station depth and percent fines generally increased while the near-bottom water DO and many of the indices of benthic community composition decreased. These stations supported benthic assemblages dominated by stress-tolerant annelids, whereas the more stress-sensitive arthropods and echinoderms were either lower in abundance or absent.

The two deepest stations in Dabob Bay had the lowest DO and supported infaunal assemblages with the lowest total abundance, taxa richness, and fewest dominant species of all the stations sampled. Three stations along the eastern shoreline of central Hood Canal differed from other stations in central Hood Canal, having higher DO levels and a more abundant and diverse infaunal assemblage.

In southern Hood Canal, water depths and DO values generally decreased, and total abundance and taxa richness were somewhat lower than in stations farther to the north. The infaunal assemblages were dominated by stress-tolerant annelids and molluscs, and echinoderms were absent.

The 7 stations classified as having an unaffected infaunal communities occurred at the entrance of Hood Canal and along the eastern shoreline in central Hood Canal. Some stations with adversely affected infaunal communities occurred at the entrance of the canal, but the majority occurred in central and southern Hood Canal and Dabob Bay.

The Sediment Quality Triad Index: A Compilation of Chemistry, Toxicity, and Infaunal Parameters

The chemistry, toxicity, and benthic data were compiled to classify an overall Sediment Quality Triad Index (SQTI) at each station, as was done in the previous PSAMP sediment quality surveys (Figure 23; Table 13; Appendix I, Tables I-1 and I-2).

- Stations were classified as “high” quality when none of the 3 parameters (chemistry, toxicity, or infauna) indicated impairment.
- Stations classified as “intermediate/high” quality were either contaminated relative to one or more sediment quality standards or guidelines, or were toxic, or had an affected benthos, but not a combination of 2 or 3 of these conditions.
- Stations classified as “intermediate/degraded” had a combination of 2 of these conditions.
- Stations classified as “degraded” had all 3 conditions (chemical contamination, toxicity, and impaired benthos).

Using this SQTI synthesis, the chemistry, toxicity, and benthic data were treated with equal weight in classifying sediment quality. Station classifications were then used to generate the incidence and spatial extent of sediment quality degradation for the Hood Canal sediment monitoring region.

Incidence and Spatial Extent of Sediment Quality Degradation

Among the 30 stations sampled in Hood Canal, 7 were classified as high quality, 18 as intermediate/high quality, 5 as intermediate/degraded, and none as degraded (Figure 23, Table 13). These stations represented 65, 178, 52, and 0 km^2 of the Hood Canal region, respectively, equivalent to 22%, 60%, 18%, and 0%, respectively, of the total Hood Canal survey area.

The 18 stations listed as intermediate/high quality had only an impaired benthic assemblage; none were contaminated or toxic. The 5 stations classified as intermediate/degraded had both impaired benthos and elevated toxicity. None had a combination of chemical contamination and toxicity or contamination and impaired benthos.

The 5 intermediate/degraded stations shared some common features. Station depths were 132 to 177 meters, among the deepest in the survey. The sediments were primarily fine-grained materials (range of 80% to 90% fines). The TOC content in all 5 locations was relatively high, approximately 2.4%. Near-bottom DO concentrations ranged from 0.4 to 3.5 mg/L, indicating varying degrees of hypoxia. Sea urchin fertilization success in 100% porewater ranged from 0% to 61.6% and was statistically significant in these samples. The benthos were composed of relatively few species (taxa richness ranged from 6 to 21) with relatively small numbers of species classified as dominants (SDI range of 4 to 9). In all 5 stations, the benthic assemblages were dominated by annelids, along with smaller numbers of arthropods and molluscs. There were few or no echinoderms and miscellaneous taxa.

Spatial Patterns and Gradients in Sediment Quality Degradation

The highest quality stations were found in the northern reaches of Hood Canal, on the entrance sill, and along the eastern shoreline of central Hood Canal (Figure 23). Stations classified as intermediate/high quality were scattered throughout the region from the entrance to the head of the canal and throughout Dabob Bay. The 5 intermediate/degraded stations (48, 56, 92, 96, and 112) were located in south-central Dabob Bay and in the central and southern reaches of Hood Canal. Thus, there was a general, but inconsistent pattern, of highest quality near and within the entrance to Hood Canal and declining quality towards and in Dabob Bay and the southern reaches of Hood Canal.

Summary

The chemistry, toxicity, and infauna data were used together as the Sediment Quality Triad Index to classify the relative quality of the sediments at each station. Based on this compilation, 7 and 18 sampling stations were classified as high quality and intermediate/high quality, respectively, representing 22% and 60%, respectively, of the Hood Canal study area. Thus, a large majority of the Hood Canal region was not degraded or only slightly degraded, the latter occurring always as a result of impaired benthic assemblages. None of the stations was classified as both contaminated and toxic.

The 5 stations classified as intermediate/degraded in quality were both toxic in the laboratory tests and had adversely affected benthic assemblages. These 5 stations were located in south-central Dabob Bay, and in the central and southern reaches of Hood Canal. All 5 stations were relatively deep and hypoxic, and the sediments were high in percent fines and percent TOC. All 5 were highly toxic in sea urchin fertilization tests. The benthos in all 5 were dominated by stress-tolerant annelids, and supported relatively few or no arthropods, echinoderms, and other taxa.

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Discussion

Incidence and Spatial Extent of Chemical Contamination

Evaluation of the amended chemistry data set indicated that none of the 30 samples from this survey were contaminated at levels that did not meet (exceeded) the Washington State SQSs and CSLs. These results are compared with similar data from previous surveys in Table 14.

In the joint PSAMP/NOAA survey of the Hood Canal region in 1999, 21 samples were analyzed for the same list of chemicals. Based on a similarly amended data set composed of those 21 samples, there were 2 samples, 1 sample, and zero samples in which 1 or more ERMs, SQSs, or CSLs were exceeded, respectively. They represented less than 1% to 0% of the area of the study region.

From 1997 through 2003, 381 sediment samples collected throughout Puget Sound for the PSAMP/NOAA surveys were analyzed for chemical contamination. This large, pooled database covers a combined area of 2,389 km^2 from the U.S./Canada border, throughout all regions of Puget Sound, Hood Canal, and the San Juan Islands. Significantly, the database includes results of analyses of samples from the 4 largest urban bays in Puget Sound (Elliott Bay, Commencement Bay, Everett Harbor, and Sinclair Inlet) and numerous smaller urban bays. Of the 381 samples, there were 39, 59, and 24 in which one or more ERMs, SQSs, or CSLs, respectively, were exceeded, representing 1%, 5%, and 3%, respectively, of the combined area (Table 14).

These comparisons suggest that the Hood Canal sediments tested in 2004 were slightly less contaminated than in 1999 when Hood Canal was previously tested with the same methods, and noticeably less contaminated than the Puget Sound basin as a whole.

Surveys of sediment quality have been conducted elsewhere in the U.S. with methods similar to those employed in the 2004 survey. Most of these surveys were conducted with stratified-random sampling designs as either a part of the Environmental Monitoring and Assessment Program (EMAP) or National Status and Trends (NS&T) Program. Most of the surveys encompassed both relatively rural and highly industrialized regions. The chemical concentrations reported in those studies have been compared to the NOAA ERM values to determine the incidence and/or spatial extent of contamination (Long et al., 2003). Among 22 data sets assembled from numerous regions or on a nationwide scale, from 1.2% to 96% of samples were contaminated by one or more chemicals at levels that exceeded an ERM value.

Perhaps the most significant databases that can serve as baselines against which to compare the 2004 Hood Canal results are those assembled by EPA (1997) and Long et al. (1998) in which data were compiled from multiple studies and inventories nationwide. In these large data sets, 26% and 27% of samples, respectively, had at least one chemical concentration that exceeded an ERM value (Long et al., 2003).

The mean ERM quotients in all 30 samples from the 2004 Hood Canal study ranged from 0.03 to 0.09. These results correspond to the category with the lowest risk of toxicity to amphipods as determined empirically in a national database (Long et al., 2000b). These comparisons suggest that the level of contamination in Hood Canal in 2004 was relatively low when compared with effects-based sediment quality guidelines and with other regions nationwide.

Incidence and Spatial Extent of Toxicity

In the 2004 survey, 5 of the 30 samples were toxic in the tests of 100% porewater concentrations for an incidence of 17% (Table 15). Also, 4 samples and 2 samples were toxic in tests of 50% and 25% porewater concentrations for an incidence of 13% and 7%, respectively. These 5, 4, and 2 samples represented 18%, 15%, and 8% of the Hood Canal study area.

In the 1997-2003 baseline survey, the incidence of toxicity in these tests was 10%, 4%, and 3% in the 3 porewater concentrations, respectively, in samples from all 381 stations. In the Hood Canal region sampled in 1999, the incidence of toxicity was 14%, 0%, and 0%, respectively. The spatial extent of toxicity in the combined 1997-2003 PSAMP/NOAA survey was 5%, 0.9%, and 0.6%, whereas in the Hood Canal region alone it was 12%, 0%, and 0% in the 3 porewater concentrations.

These data suggest that the incidence and spatial extent of toxicity as determined with the sea urchin fertilization test has increased from 1999 to 2004, and in 2004 exceeded that of the greater Puget Sound region as estimated in 1997-2003. However, this observation must be tempered with the knowledge that only 21 samples were tested in Hood Canal in the 1999 survey; the usual sample size for each of the other regions was 30 samples.

As a part of its NS&T Program, NOAA conducted surveys of sediment quality in marine bays and estuaries along all 3 U.S. coastlines (Long et al., 1996; Long and Sloane, 2005). In most of these surveys, sediment porewater was tested for toxicity, usually with a sea urchin fertilization test similar to that used in the 2004 Hood Canal survey. In the surveys of regions along the Atlantic and Gulf of Mexico coastlines, the test species was *Arbacia punctulata*, which is native to both areas. Side-by-side comparisons in sensitivity to several chemicals with *Strongylocentrotus purpuratus* performed as a part of the joint PSAMP/NOAA surveys indicated that the 2 species differed in sensitivity to different chemicals. However, the results of the comparisons also indicated that the incidence of classifications of samples as toxic was sufficiently similar to warrant comparisons among regions with data from the 2 species.

In data sets compiled from 22 U.S. marine bays and estuaries in which sea urchin fertilization was tested in 100% sediment porewater concentrations, the spatial extent of toxicity ranged from 0.0% to 98% (Long et al., 2003). The median of these 22 results was 32%, and the average among all data sets nationwide was 25.3%, as calculated with data compiled through 1997. Thus, the 2004 Hood Canal results (18%) were below both the average and the median on a nationwide scale.

Incidence of Degradation Based on the Sediment Quality Triad Index (SQTI)

Results from comparisons of the sediment chemistry data with the Washington State standards, from the laboratory toxicity tests with sea urchins, and classifications of benthic assemblages as affected were compiled for all 30 stations in the 2004 Hood Canal survey to derive an overall station classification (Table 13). Stations were classified as high quality if none of the triad of measurements indicated degradation. If 1, 2, or 3 of the measurements indicated degraded conditions, the stations were classified as intermediate/high quality, intermediate/ degraded quality, or degraded quality, respectively.

In this 2004 study, the percentage of stations in each of the 4 categories (high quality, intermediate/high quality, intermediate/degraded quality, degraded) was 23%, 60%, 17%, and 0%, respectively, and represented 22%, 60%, 18%, and 0% of the study area, respectively. The highest percentage of the stations (60%) was classified as intermediate/high quality, with an adversely affected infauna assemblage and no chemical contamination or toxicity reported.

The 2004 results represent similar incidence and spatial extent of the 4 categories of degradation when compared with conditions reported in the 1999 Hood Canal survey, and notably different results from the combined 1997-2003 PSAMP database (Table 16). Both the incidence and spatial extent of high quality sediments were much lower in Hood Canal in both 1999 and 2004 than in the combined 1997-2003 PSAMP database.

Whereas the majority of stations (60% in 2004 and 48% in 1999) and area (60% in 2004 and 52% in 1999) in the Hood Canal surveys were classified as intermediate/high quality, the majority of stations (63%) and area (84%) were classified as high quality in the PSAMP 1997-2003 database for 381 sampling stations. There was a higher incidence (17% in 2004 and 19% in 1999) and spatial extent (18% in 2004 and 13% in 1999) of intermediate/degraded conditions compared to lower incidence (9%) and spatial extent (2%) in 1997-2003. No stations were classified as degraded in Hood Canal in either 1999 or 2004, while somewhat higher incidence (4%) and spatial extent (0.2%) of degraded conditions occurred in the combined PSAMP 1997-2003 database.

There are several possible explanations for differences in sediment quality between the 2004 and 1999 Hood Canal surveys and the combined PSAMP database. Some possible explanations are related to changes in the quality of the data, while others are related to changes or differences in the environment. Although the same sampling and analytical protocols were followed in all of these surveys, subtle differences could have occurred resulting in shifts in the outcomes of chemical analyses, toxicity tests, and benthic analyses.

Sampling Site Distribution

Although the SQTI results were similar in Hood Canal in 2004 and 1999, the slight differences in chemical contamination and toxicity may have resulted from the different stations sampled in the 2 years. Due to the sampling design used in the surveys, different locations were intentionally sampled in both 1999 and 2004 to provide unbiased representation of the conditions throughout the region during both time periods. The intent of these surveys was to represent conditions throughout each monitoring region, not to characterize specific sampling locations. Therefore, a different set of locations was sampled during each time period or survey.

Unknown differences in conditions at the station locations selected in 1999 versus those selected in 2004 may have influenced the results. For example, two small rural harbors (Port Ludlow and Port Gamble) were sampled in 1999, but not in 2004. There were 30 sampling stations in 2004, whereas there were only 21 in 1999. Otherwise, station distributions within the Hood Canal region in the 2 time periods were similar. Stations were sampled in both surveys throughout the length of the canal from its entrance to the end. These stations were at the entrance sill, in the deep basin inland of the sill, and in adjoining Dabob Bay.

Chemical Analyses

As mentioned previously, there were some subtle changes in the analytical procedures used in the chemistry lab that resulted in elimination of some data. Some data were eliminated to minimize their influence on incorrect classifications of samples as contaminated. Some of the samples with estimated or undetected concentrations that exceeded the State standards that were excluded from analysis may have, in fact, been legitimately contaminated at those concentrations.

By eliminating these data, a station could not be categorized as degraded because none of the samples were impaired in all 3 elements of the triad. Nevertheless, all data summarized in Table 16 were treated the same way to ensure analyses of only the highest quality results. However, other unknown and undetected issues with the chemistry data that were not addressed could have had an influence on classifications.

Toxicity Tests

Only one toxicity test was conducted in the 2004 survey. This test was accompanied by 3 other tests in Hood Canal in 1999 and in the other survey regions in 1997-1999; therefore there were other data available with which to classify samples as toxic in 1999. The incidence of toxicity would not necessarily be expected to increase with the numbers of tests that were run. However, each test has a unique set of sensitivities to different chemicals. For example, the HRGS (Human Reporter Gene System) assay, used in the 1997-99 PSAMP/NOAA survey but not in the 2004 survey, is responsive to only PAHs, dioxins, and dioxin-like PCBs and was very sensitive.

The sea urchin test is one of the most sensitive tests used in the PSAMP surveys, and it accounted for many of the classifications of samples as “toxic”. However, there is some evidence that because it is such a short-term test and because it is performed with a rather primitive life form, the test is responsive primarily to relatively short-term acting toxicants, especially trace metals.

It is possible that the decline in samples classified as degraded in the 2004 Hood Canal survey could have been attributable at least in part to having only one toxicity test. Also, there was a slight change in the exposure time and temperature in the sea urchin tests in 2004 to improve the sensitivity and reproducibility of the sea urchin test. These subtle changes could have had an influence on classifications of samples as toxic.

Benthic Analyses

In many other estuarine regions of the U.S., statistically-derived numerical indices have been developed to classify the condition of benthic infaunal invertebrate communities. Index values for each station are compared against a predetermined numerical scale that indicates a healthy or reference area condition, or a slightly, moderately, or highly impaired condition (e.g., Engle et al., 1994; Weisberg et al., 1997; Van Dolah et al., 1999; Llansó et al., 2002a,b; Janicki Environmental, 2003). However, because no numerical benthic health index has been developed for Puget Sound, classification of stations as having an adversely affected benthic assemblage was necessarily based on the best professional judgment (BPJ) of Ecology benthic ecologists.

The Ecology experts who evaluated the benthic data have performed these evaluations for more than a decade with hundreds of samples throughout all regions of Puget Sound, and used the same criteria to classify the relative health of the benthic assemblages at each station in all surveys. Classification of the benthic assemblages in Hood Canal was based on knowledge of and experience with Puget Sound overall, and did not attempt to separate natural and anthropogenic stressors. It is possible that a statistically-derived benthic index developed for Puget Sound might have classified the quality of the benthos at some stations in Hood Canal differently from the BPJ technique that was employed by Ecology. Support for the development of benthic indices for Puget Sound is highly recommended.

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Summary and Conclusions

As part of the Puget Sound Assessment and Monitoring Program (PSAMP), the Washington State Department of Ecology conducted a survey of sediment quality in the Hood Canal region in 2004.

Samples were collected at 30 locations throughout the 295 square meter study area. Laboratory analyses were performed on all samples to determine the concentrations of potentially toxic chemicals, the degree of response in a laboratory toxicity test, and the composition of resident benthos. Most methods were similar to those used by Ecology in 1997-99 during surveys of Hood Canal and other adjoining regions of Puget Sound and in a 2002-03 survey of the San Juan Islands, eastern Strait of Juan de Fuca, and Admiralty Inlet.

The primary objective of the 2004 study was to estimate the incidence and spatial extent of degraded conditions in Hood Canal as determined with the Sediment Quality Triad of measures. Data were used to compare conditions in 2004 with the results of a previous survey conducted in the same region in 1999 and with the combined 1997-2003 surveys of Puget Sound.

Physical Characteristics

There were wide ranges in sediment grain size, total organic carbon (TOC) content, and near-bottom water dissolved oxygen (DO) concentrations among the 30 sampling sites, all of which changed with depth along the length of the study area. Sediments collected in northern Hood Canal were predominantly coarse to fine sand, and had relatively low TOC concentrations and high near-bottom DO levels. As station depths increased inland of the entrance sill, the sediments gradually shifted to predominantly fine-grained silt-clays, the TOC concentrations increased, and the DO levels decreased. The lowest DO levels occurred in central Dabob Bay and at the terminal end of the canal at Lynch Cove.

The relationships among the physical, chemical, and biological variables are further described in a separate report (Long et al., 2007).

Chemical Contamination

All 30 samples from the 2004 Hood Canal study had at least one chemical concentration that did not meet (exceeded) a Washington State Sediment Quality Standard (SQS) and 28 samples had at least one concentration that exceeded a Cleanup Screening Level (CSL) value. However, the chemicals that exceeded these standards were those for which the data were considered unreliable due to analytical issues. Because of this, the data for these chemicals were excluded from the analyses.

After elimination of data that were considered unreliable due to analytical issues, and values that were either estimates or were below detection limits, none of the 30 samples exceeded any SQS, CSL, or Effects Range Median (ERM) value. Therefore, the spatial extent of chemical contamination in the 2004 Hood Canal study region was zero. The degree or severity of contamination could not be calculated since none of the concentrations of the remaining chemicals exceeded any State standards or NOAA guidelines. However, the concentrations of some chemicals (although less than the State standards and NOAA guidelines) and chemical mixtures (as determined by mean ERM quotients) were slightly higher in the south-central Dabob Bay stations than elsewhere. These concentrations tended to decrease slightly toward the entrance to Hood Canal at Admiralty Inlet.

Toxicity

Mean sea urchin fertilization success in laboratory tests of 100% porewater ranged from 0.0% in one sample to 100% or more of the control response. The incidence of significant toxicity in tests of 100%, 50%, and 25% porewater was 17%, 13%, and 7%, respectively. Toxic samples represented 18%, 15%, and 8% of the total survey area, respectively, in the 3 porewater concentrations.

The toxicity data showed a distinct spatial pattern, with highest toxicity occurring in the deepest stations in central Dabob Bay. Toxicity diminished away from Dabob Bay and was lowest near the entrance to the canal.

Benthic Invertebrates

The composition, diversity, and abundance of the benthic assemblages differed considerably among the 30 stations, most noticeably along the length of the canal. Relatively shallow stations in the entrance and along the eastern shoreline had the highest abundance, taxa richness, and numbers of dominant taxa of the 30 stations sampled. Stress-sensitive benthic species were most abundant at these stations. In contrast, the benthos in many of the deepest stations in south-central Dabob Bay and in central Hood Canal were dominated by stress-tolerant annelids (e.g., capitellids), and indices of abundance, diversity, and dominance often were lowest in these locations.

The benthos were classified as unaffected at 4 stations in the entrance of Hood Canal and at 3 stations along the eastern shoreline of central Hood Canal. These stations had low percent fines and TOC, and relatively high DO. The infaunal assemblages were considered to be adversely affected at 23 of the 30 stations. These stations occurred throughout Hood Canal from the entrance to southern Hood Canal, and in Dabob Bay.

Generally, stations with adversely affected infauna had higher percent fines and TOC, and lower DO, than the unaffected stations. The 2 deep stations in Dabob Bay with severely adversely affected benthic communities (extremely low total abundance, taxa richness, and species dominance) had the lowest DO of all the 30 stations sampled. The benthic assemblages at many of the deepest stations with the lowest bottom-water DO levels were impaired relative to assemblages that occurred at stations with higher DO values near the entrance to the canal.

Sediment Quality Triad

Based on the Sediment Quality Triad of measures (chemical contamination, toxicity, and adversely affected benthos), there were 7 stations classified as high quality, 18 as intermediate/high quality, 5 as intermediate/degraded, and none classified as degraded. The majority of the stations (60%) were classified as intermediate/high quality based on an adversely affected benthos with no toxicity or chemical contamination. None of the stations were degraded in all 3 parameters (chemistry, toxicity, and benthos).

Overall, based on the data from the triad of analyses, the sediments in the deep, south-central Dabob Bay stations were most degraded. These sediments were highly toxic in the laboratory tests of porewaters and supported impaired benthic assemblages often dominated by species that are able to tolerate hypoxia and/or chemical contamination. However, because of unreliable chemistry data for some chemicals, we could not determine whether or not the sediments were chemically contaminated. Sediments in central and southern Hood Canal also were moderately to highly degraded. Sediments at the shallow stations on the entrance sill and along the eastern shoreline of central Hood Canal were the least degraded.

Temporal Comparisons within Hood Canal

In both 1999 and 2004, the most significant results in the sea urchin fertilization test occurred in Dabob Bay at deep stations (>159 meters) with sediments high in silt-clay (>80%). The only chemical contamination occurred in 1999 in Port Ludlow and Port Gamble, neither of which was sampled in 2004.

Comparisons of data from the 30 Hood Canal stations sampled in 2004 with data from the 21 stations sampled in 1999 showed similarities in incidence and spatial extent of degraded sediments. Based on the Sediment Quality Triad, 33% of the 21 stations sampled in 1999 were classified as high quality, covering 35% of the study area. In 2004, 23% of the 30 stations sampled were considered to be high quality, encompassing 22% of the study area. In both years, the majority of stations (67% in 1999 and 77% in 2004) were in the 2 intermediate categories. None of the stations in either year were categorized as degraded.

Comparisons between Puget Sound Sediment Monitoring Regions

The methods used to sample, test, and classify samples in the 1997-99 baseline PSAMP/NOAA surveys were similar to those used in the 2004 Hood Canal survey, but not exactly the same. The chemical and benthic data are based on internally consistent methods and are directly comparable. In the combined data from the 1997-99 PSAMP/NOAA surveys and the 2002-03 San Juan Archipelago, Admiralty Inlet, and eastern Strait of Juan de Fuca survey, 63% of samples were high quality, 23% were intermediate/high, 9% were intermediate/degraded, and 4% were degraded. These samples represented 84%, 14%, 2%, and >1%, respectively, of the total Puget Sound survey area sampled from 1997 through 2003.

When compared with the 1997-03 baseline for Puget Sound, the 2004 results show notable differences. Whereas 4% of the samples and 0.2% of the area sampled throughout the Sound in 1997-03 were degraded, none of the samples analyzed in the 2004 Hood Canal survey were classified as degraded. A minority of samples (32%) and area (16%) surveyed in 1997-03 was included in the 2 intermediate categories, whereas the majority of samples (77%) and area (78%) in the Hood Canal region were intermediate in quality in 2004.

A notable difference between the Hood Canal Sediment Quality Triad results and results from Puget Sound overall is the high percentage of stations with only impaired benthic assemblages in Hood Canal. In all of the intermediate/high quality samples in Hood Canal, there was no detected chemical contamination or toxicity, only an adversely affected benthos. There was a much lower percentage of stations in Puget Sound overall in which only the benthos was impaired and the sediments were neither contaminated nor toxic. Because the near-bottom DO concentrations in Hood Canal indicated hypoxic conditions, and there was a strong correspondence between impairment to the benthos and hypoxia, it is possible that hypoxia, which was not measured in other regions, may have had a strong influence.

Hood Canal has had a history of hypoxia, and there is evidence that these conditions have become worse in recent years, causing numerous fish kills. We are only beginning to look at the adverse effects of hypoxia on living sediment-dwelling marine organisms in Hood Canal. Therefore, to fully understand the magnitude and nature of these hypoxia effects in Hood Canal and similar regions of Puget Sound, further study is required.

Recommendations

The 2004 survey of sediment quality in Hood Canal completes the first year of sediment sampling following establishment of the 1997-2003 PSAMP sediment quality baseline for Puget Sound (Long et al., 2008). The survey provides a 5-year follow-up to, and change-over-time comparison with, data collected in Hood Canal in 1999 for PSAMP and NOAA (Long et al., 2002, 2003). The survey also provided information for the Hood Canal Dissolved Oxygen Program about the relationships between sediment quality, benthos, and dissolved oxygen levels in Puget Sound (Long et al., 2007).

A number of recommendations for the Ecology Marine Sediment Monitoring Team's (MSMT) future activities have been generated based on this 2004 Hood Canal study, including the following:

- **Continue to provide *status and trends* and *effectiveness monitoring* information for Hood Canal and 7 other Puget Sound monitoring regions to the Puget Sound Partnership and others for use in developing adaptive management strategies.**

  The PSAMP Spatial/Temporal Sediment Monitoring element (www.ecy.wa.gov/programs/eap/psamp/SpatialMon/Spatial.htm) provides environmental scientists and managers with a recent spatial characterization of sediment condition (i.e., the areal extent of sediment quality degradation) in 8 Puget Sound regions sampled on an annual, rotational cycle. Temporal changes are also assessed by comparison of new regional data with baseline data to determine whether sediment quality in each Puget Sound region is improving, degrading, or remaining the same over time.

  Region and stratum estimates of the spatial extent of sediment quality degradation, as measured by Ecology's Sediment Quality Triad Index, characterizes the cumulative effects of natural and human-influenced toxic loading events, other stressors, and source control and cleanup activities occurring in each of the major oceanographic basins of Puget Sound.

  These data provide environmental managers and scientists with a unique "effectiveness monitoring" tool for regional and Puget Sound-wide examination of sediment quality. Environmental managers should review ambient monitoring results on a routine basis, and implement adaptive management strategies as needed, based on changes to, and the current status of, sediment quality in Puget Sound.

- **Continue to cooperate with scientists and managers from the Hood Canal Dissolved Oxygen Program (HCDOP) to provide the most current information on sediment quality in Hood Canal and its relationship to low dissolved oxygen in water and sediments.**

  Sediment quality data from the 1999 and 2004 PSAMP Sediment Component sampling in Hood Canal were used, in combination with existing Hood Canal water column data, to examine the relationships between sediment quality, benthos, and dissolved oxygen levels in Puget Sound (Long et al., 2007). This work was conducted by the MSMT as part of the HCDOP (www.hoodcanal.washington.edu/).

As part of the scheduled rotation through the PSAMP regional sediment sampling frames, Hood Canal will again be sampled in 2012 to reassess sediment quality. PSAMP sampling efforts should be coordinated with HCDOP scientists to maximize the usefulness of the samples collected and the information interpreted from them.

- **Develop a multi-metric benthic index or indices for Puget Sound, and examine the Sediment Quality Triad Index (SQTI) to refine the interpretation of benthic community health and the relationships between sediment chemistry, toxicity, and benthos data.**

  As described in the Methods section of this report, multi-metric benthic infaunal indices have never been successfully developed and widely accepted for Puget Sound. Given this limitation, the MSMT has developed alternative methods for evaluating the condition of Puget Sound benthic invertebrate communities.

  Through recent funding opportunities, the MSMT has begun initial work on developing benthic indicators for Puget Sound. Funding of this work should be continued through completion, post-development evaluation, and acceptance of indicators for use in Puget Sound.

  Additionally, the MSMT is currently re-examining the SQTI to determine whether it should be refined to improve its interpretive power as a higher-level indicator of sediment condition.

- **Ensure comparability of past and future data.**

  While improvement and revision of analytical methods is sometimes necessary, methods used in Puget Sound ambient sediment monitoring surveys should remain similar over time to ensure continued generation of comparable data.

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Figures

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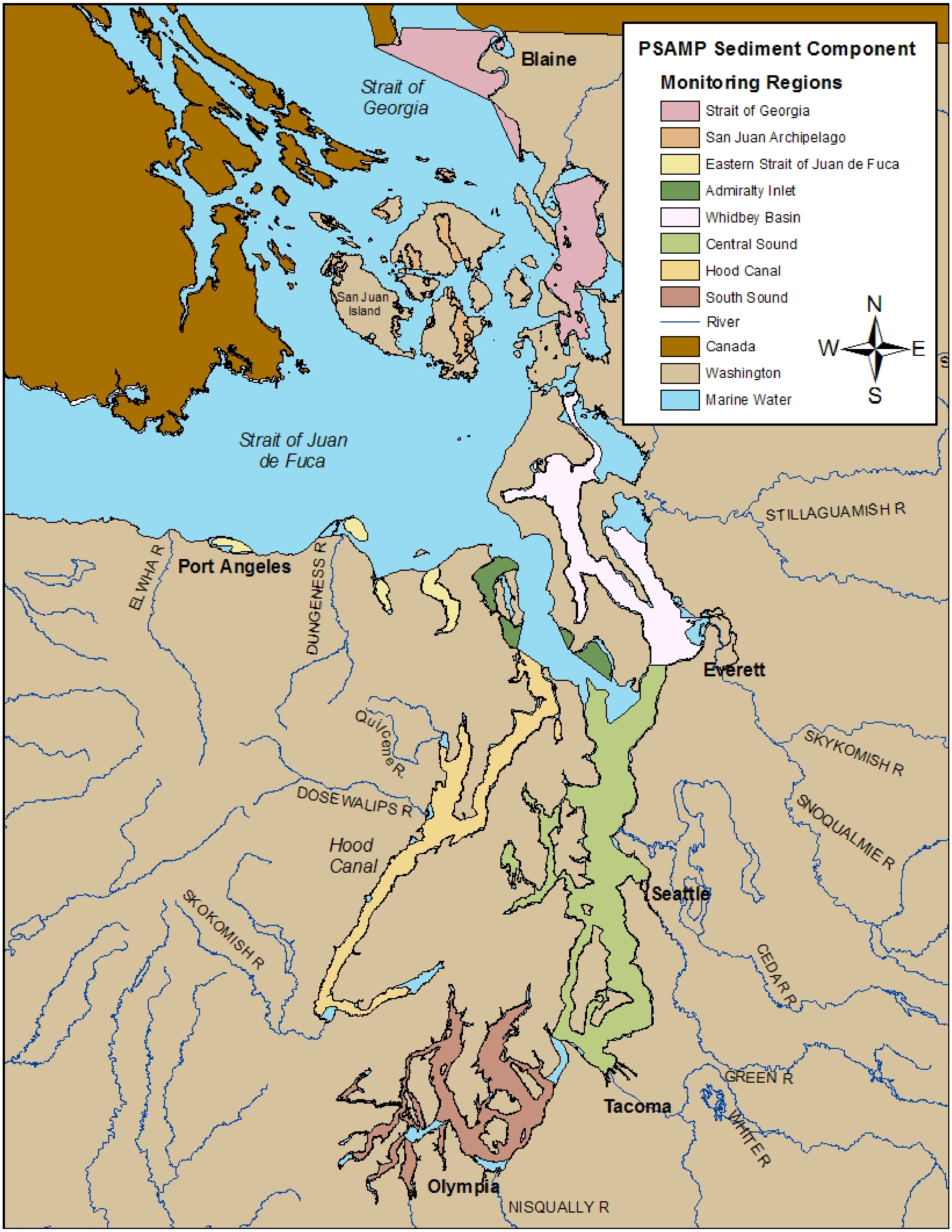

Figure 1. Eight sediment monitoring regions in Puget Sound defined for the PSAMP sediment component.

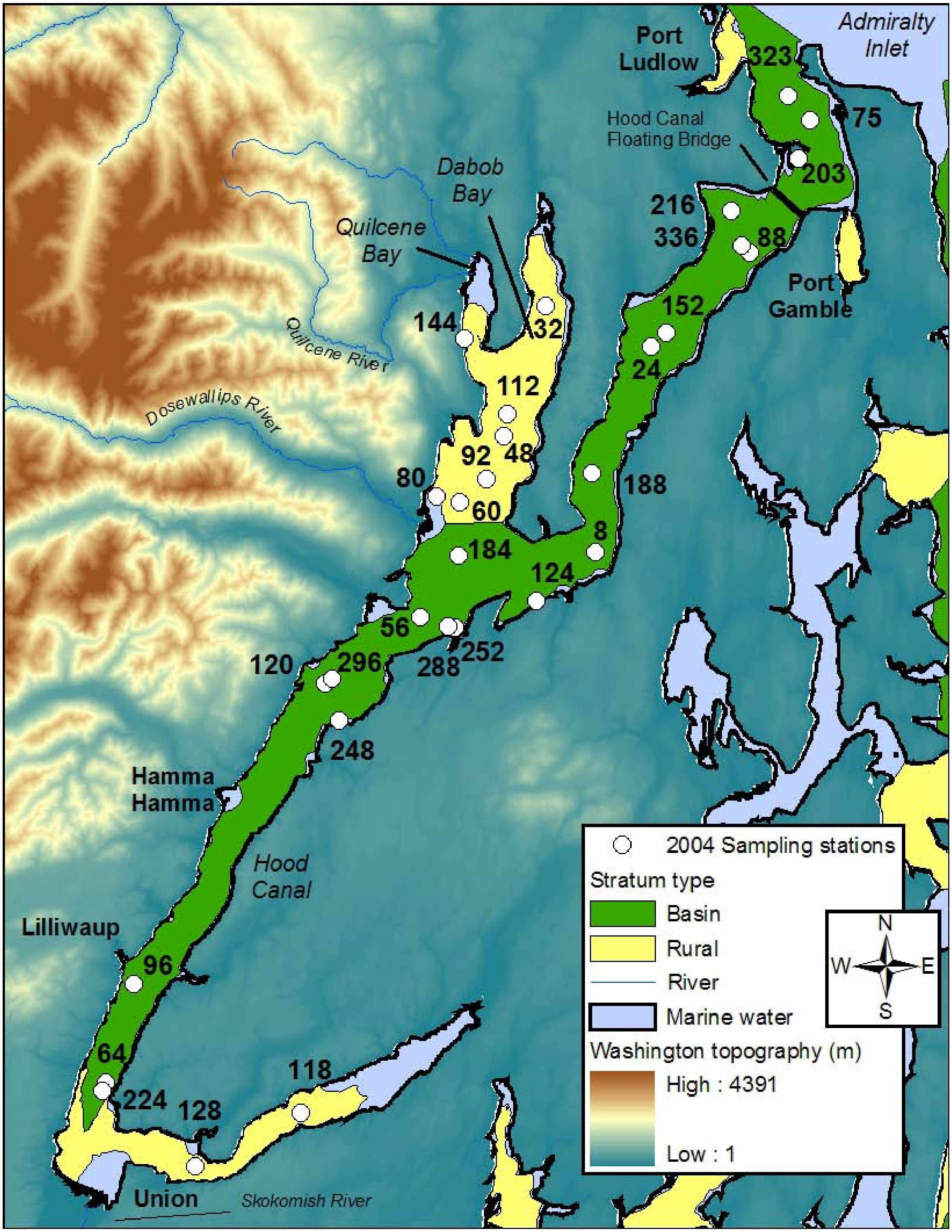

Figure 2. Locations of the 30 sampling stations for the 2004 PSAMP Sediment Component Hood Canal monitoring region.

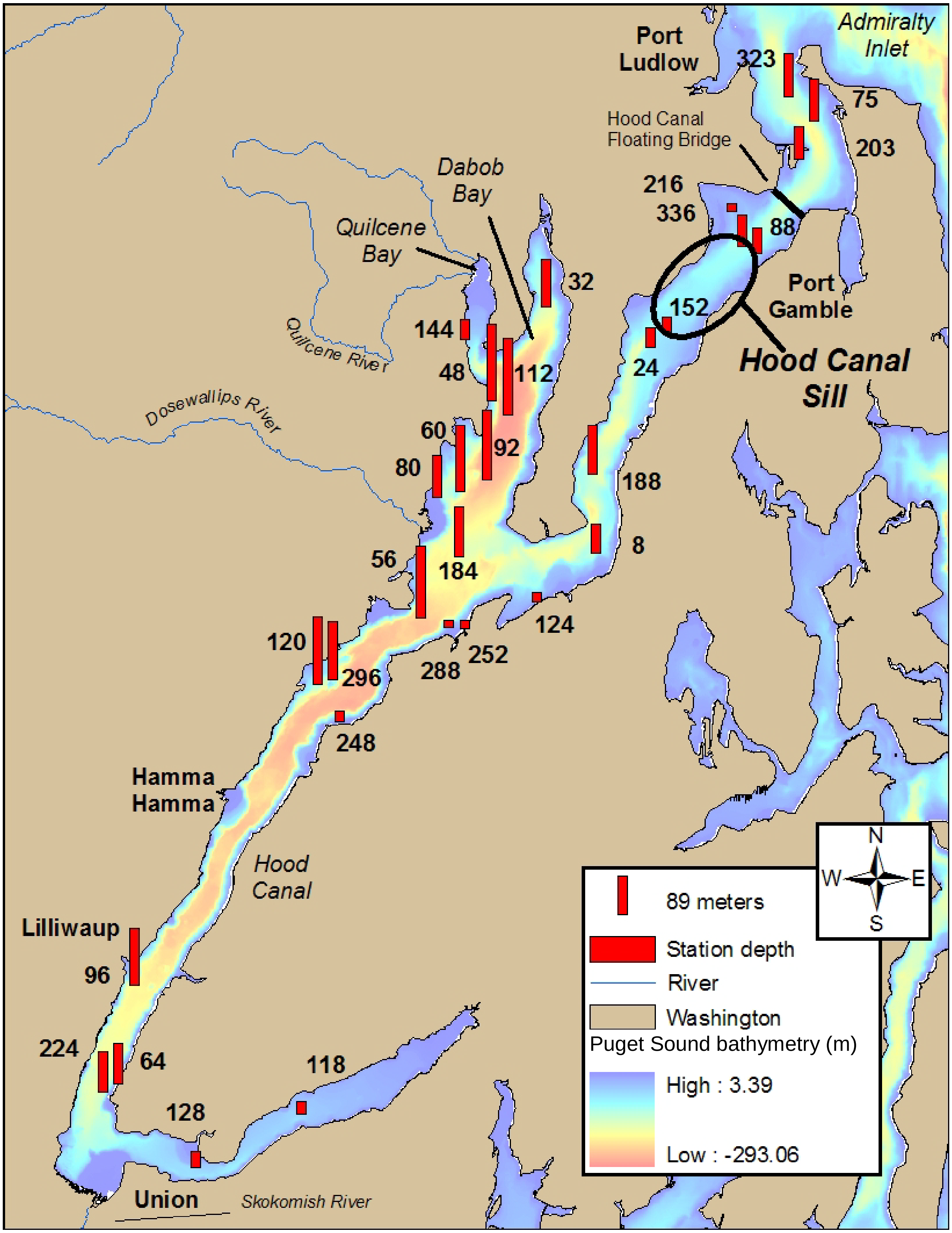

Figure 3. Water depths at the 30 stations sampled for the 2004 PSAMP Sediment Component Hood Canal regional survey. Numbers represent station numbers, not depths.

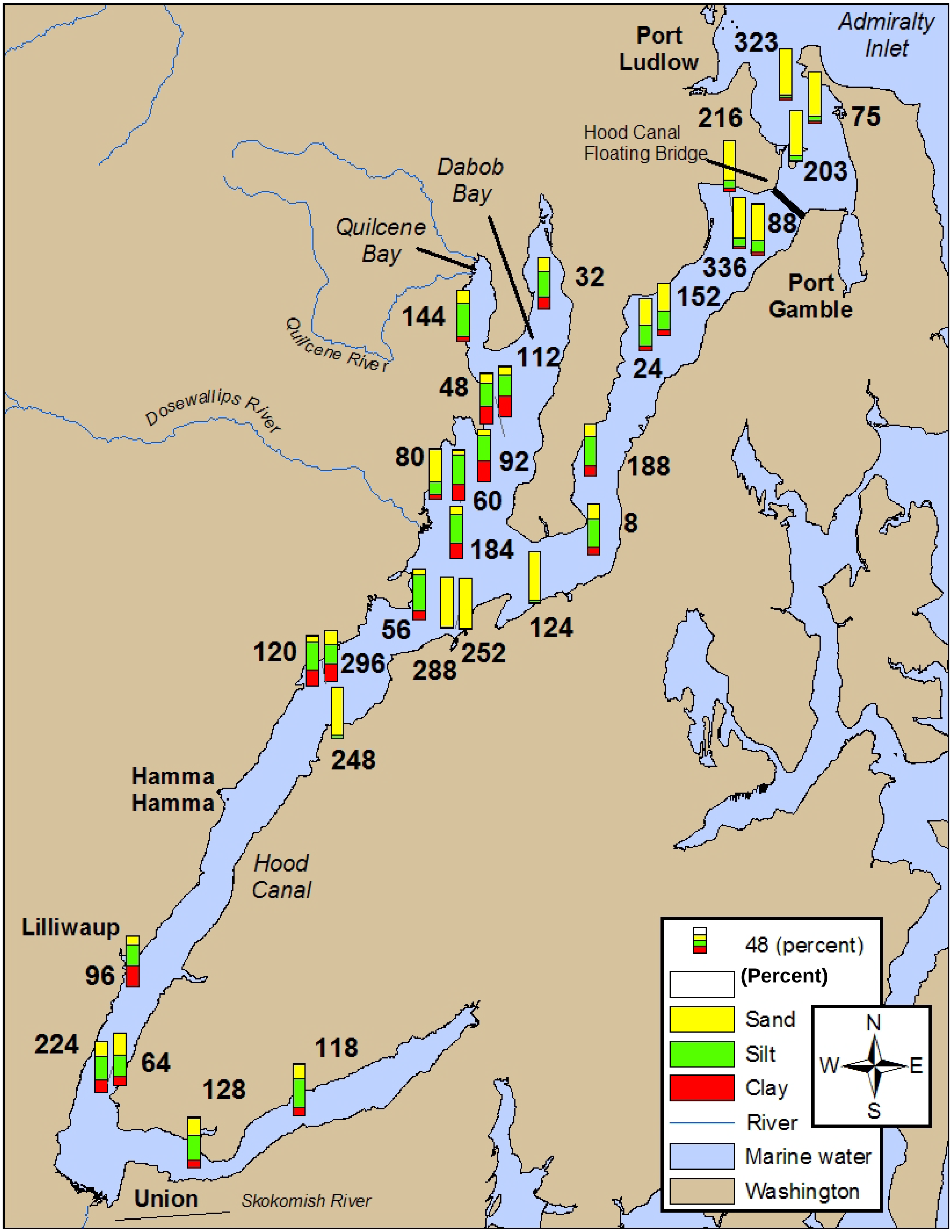

Figure 4. Spatial patterns in the distribution of four particle-size classes (percent gravel, sand, silt, and clay) in the 2004 PSAMP Sediment Component Hood Canal regional survey.

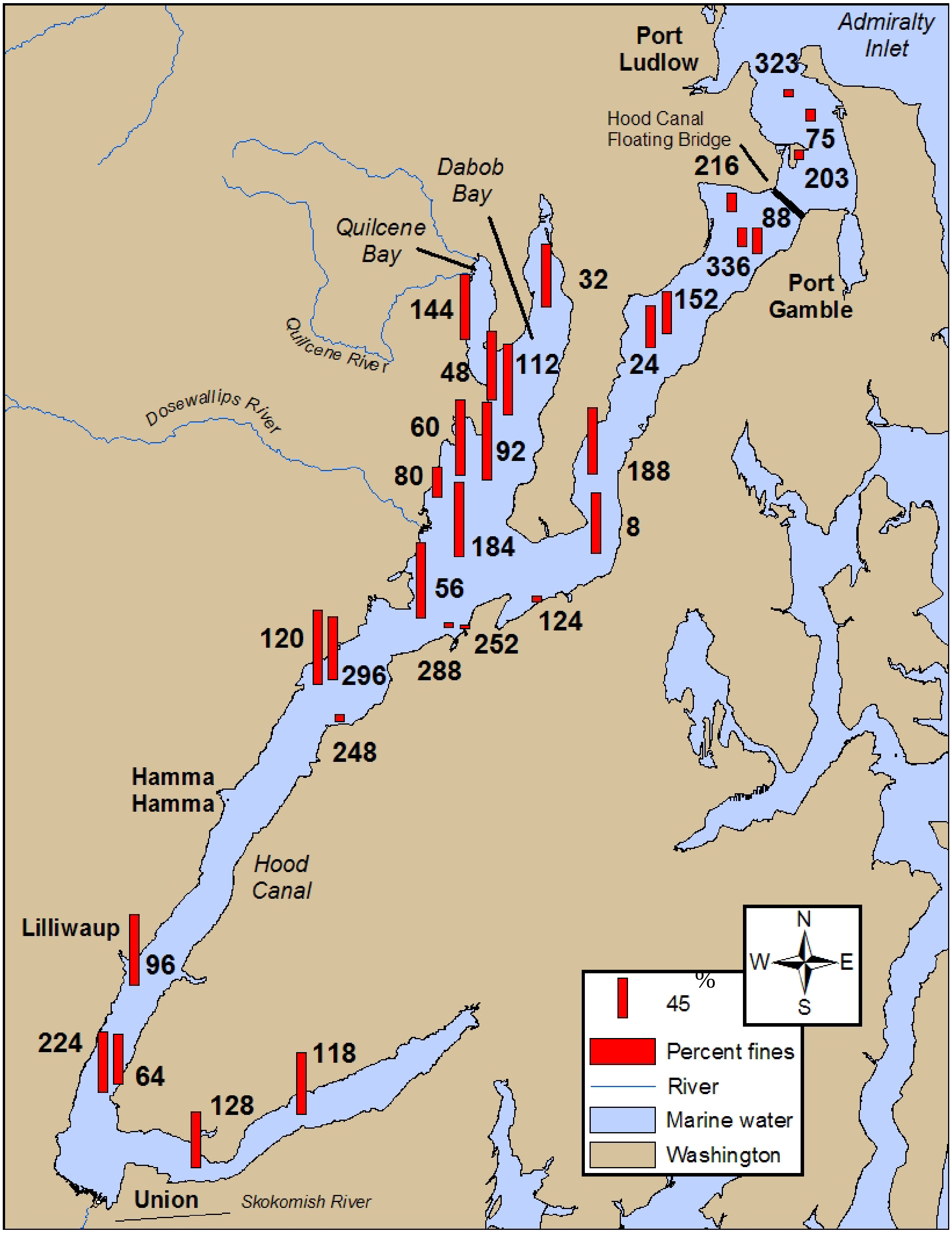

Figure 5. Spatial distribution of percent fines in the 2004 PSAMP Sediment Component Hood Canal regional survey.

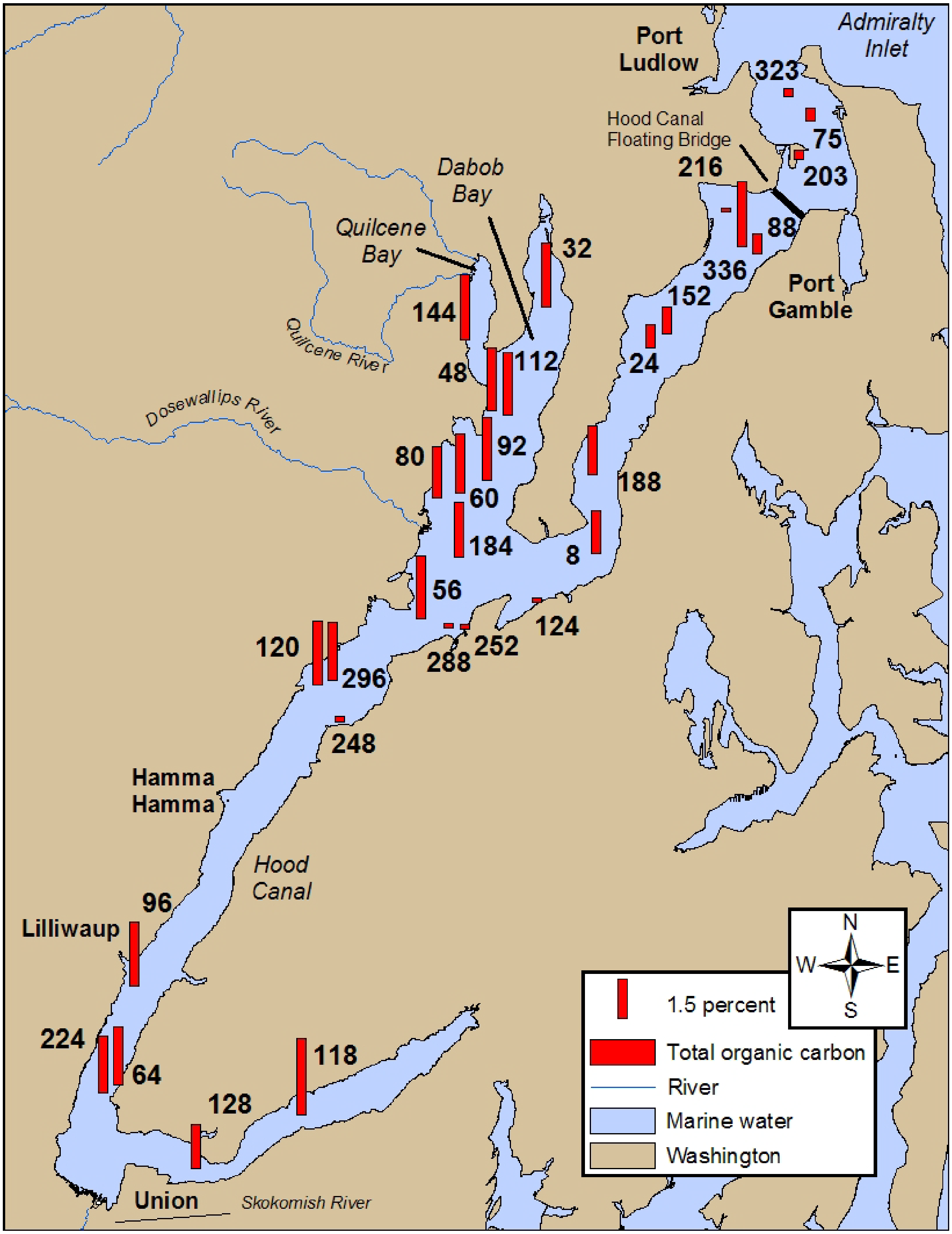

Figure 6. Spatial distribution of total organic carbon concentrations in the 2004 PSAMP Sediment Component Hood Canal regional survey.

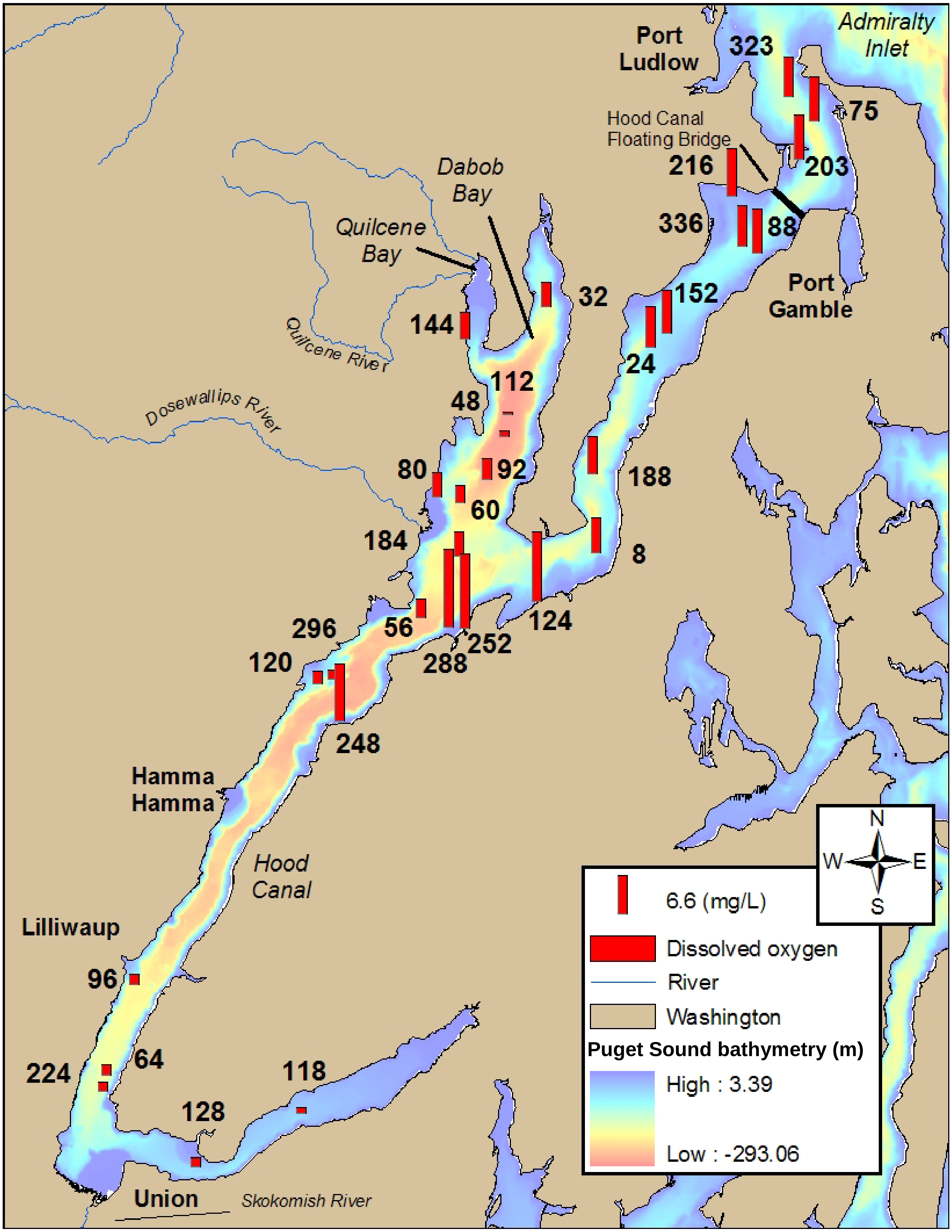

Figure 7. Bathymetry and near-bottom dissolved oxygen concentrations in the 2004 PSAMP Sediment Component Hood Canal regional survey.

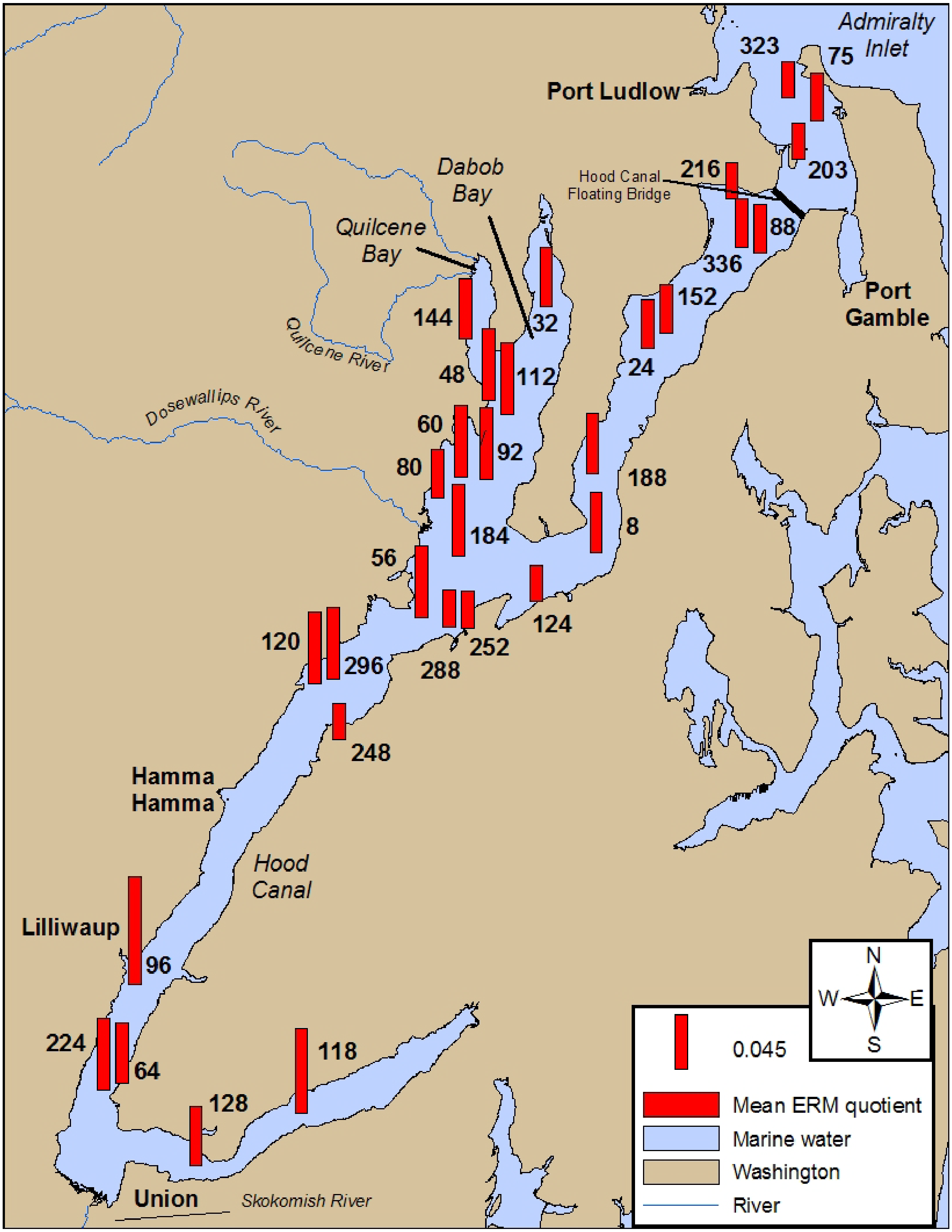

Figure 8. Spatial patterns in chemical contamination in the 2004 PSAMP Sediment Component Hood Canal regional survey as determined with mean Effects Range Median (ERM) quotients.

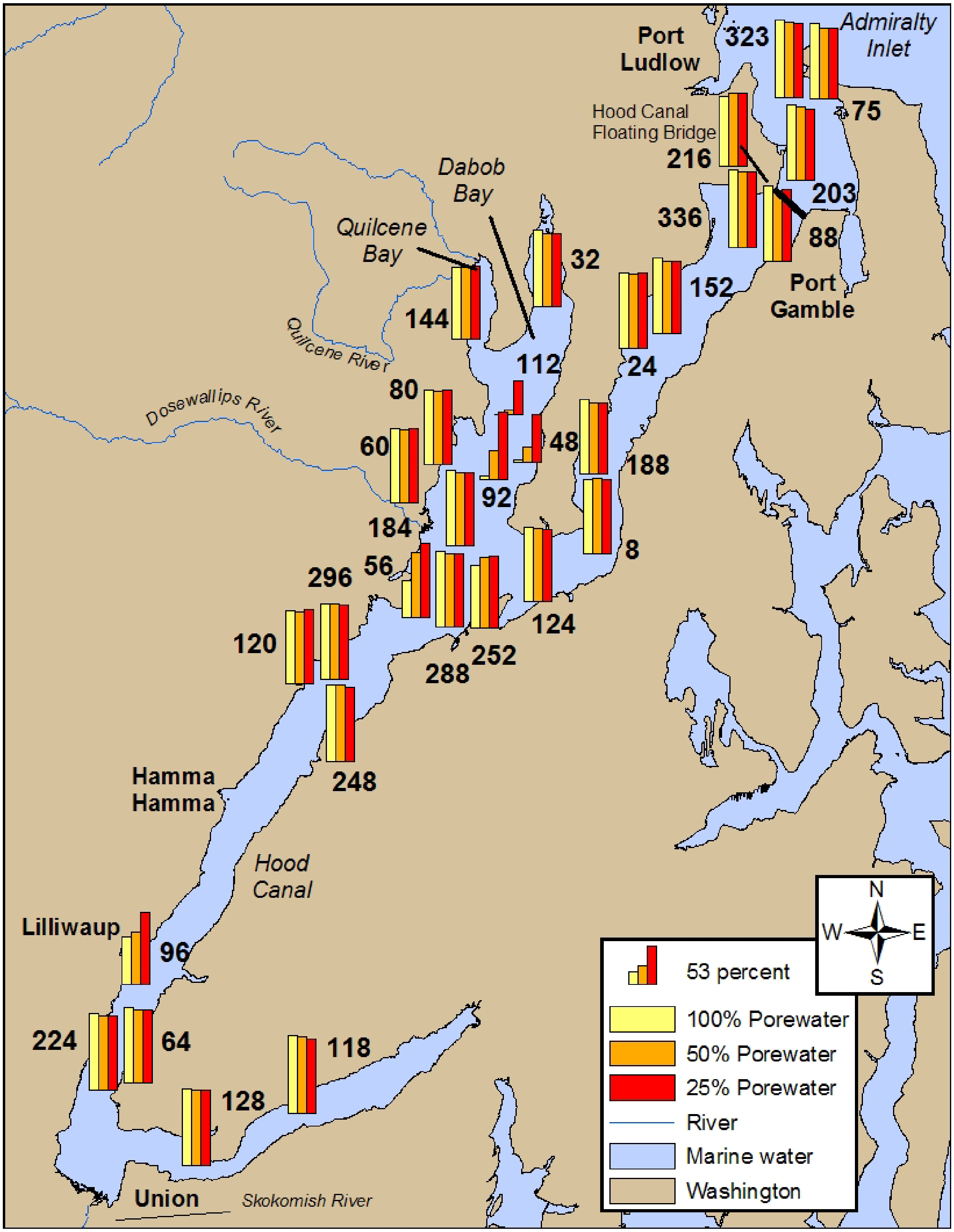

Figure 9. Spatial patterns in percent fertilization of control response in tests of 100%, 50%, and 25% porewater concentrations from sediments collected for the 2004 PSAMP Sediment Component Hood Canal regional survey. Tests were performed with the gametes of Pacific purple sea urchin (*Strongylocentrotus purpuratus*).

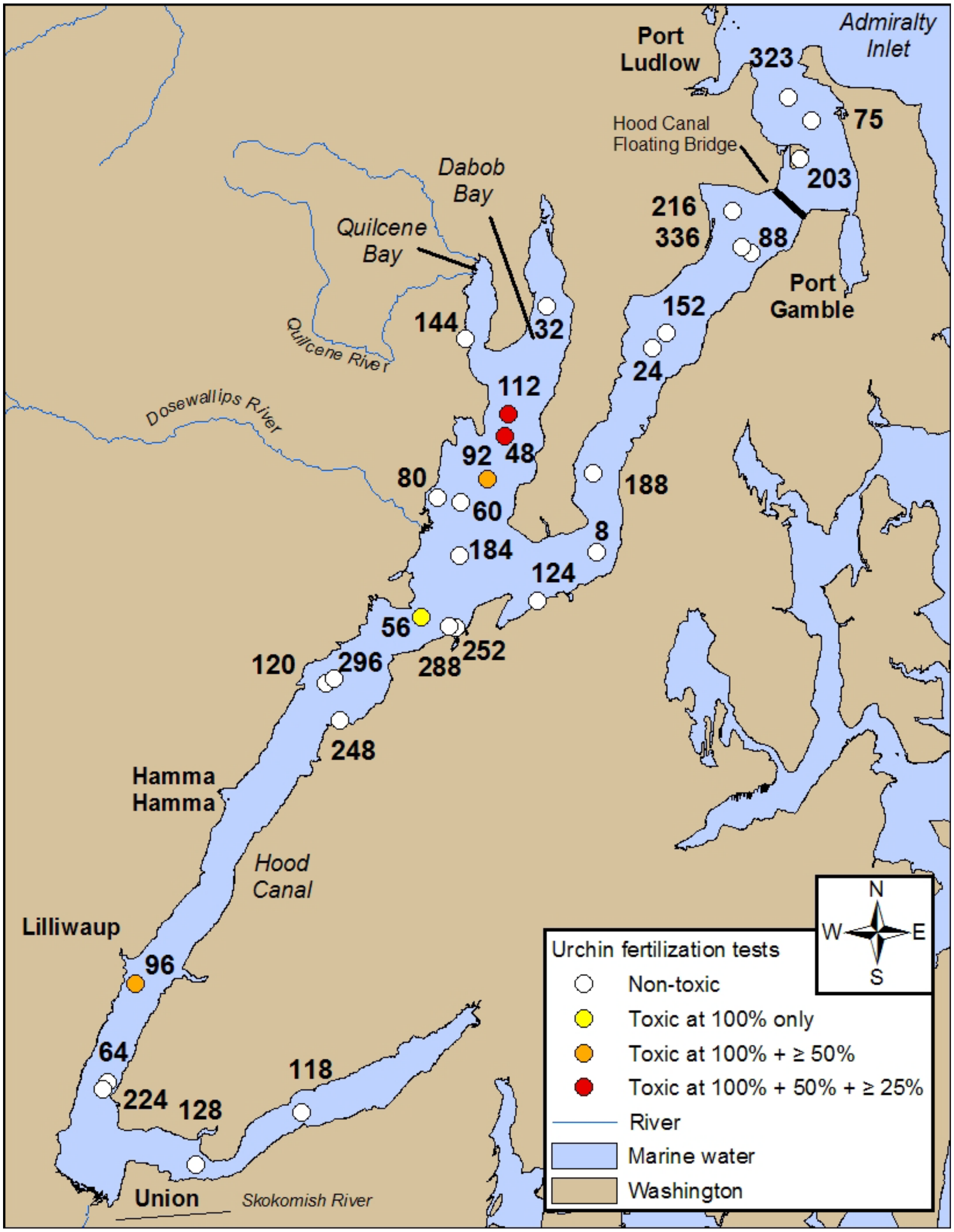

Figure 10. Spatial patterns in sediment toxicity as determined in tests of 100%, 50%, and 25% porewater concentrations from sediments collected for the 2004 PSAMP Sediment Component Hood Canal regional survey. Tests were performed with the gametes of Pacific purple sea urchin (*Strongylocentrotus purpuratus*). Color differentiation of circles indicates those stations at which mean percent fertilization was significantly different from the Texas reference control (Dunnett's t-test, $\leq$ 0.05 and mean fertilization <80% of the control response).

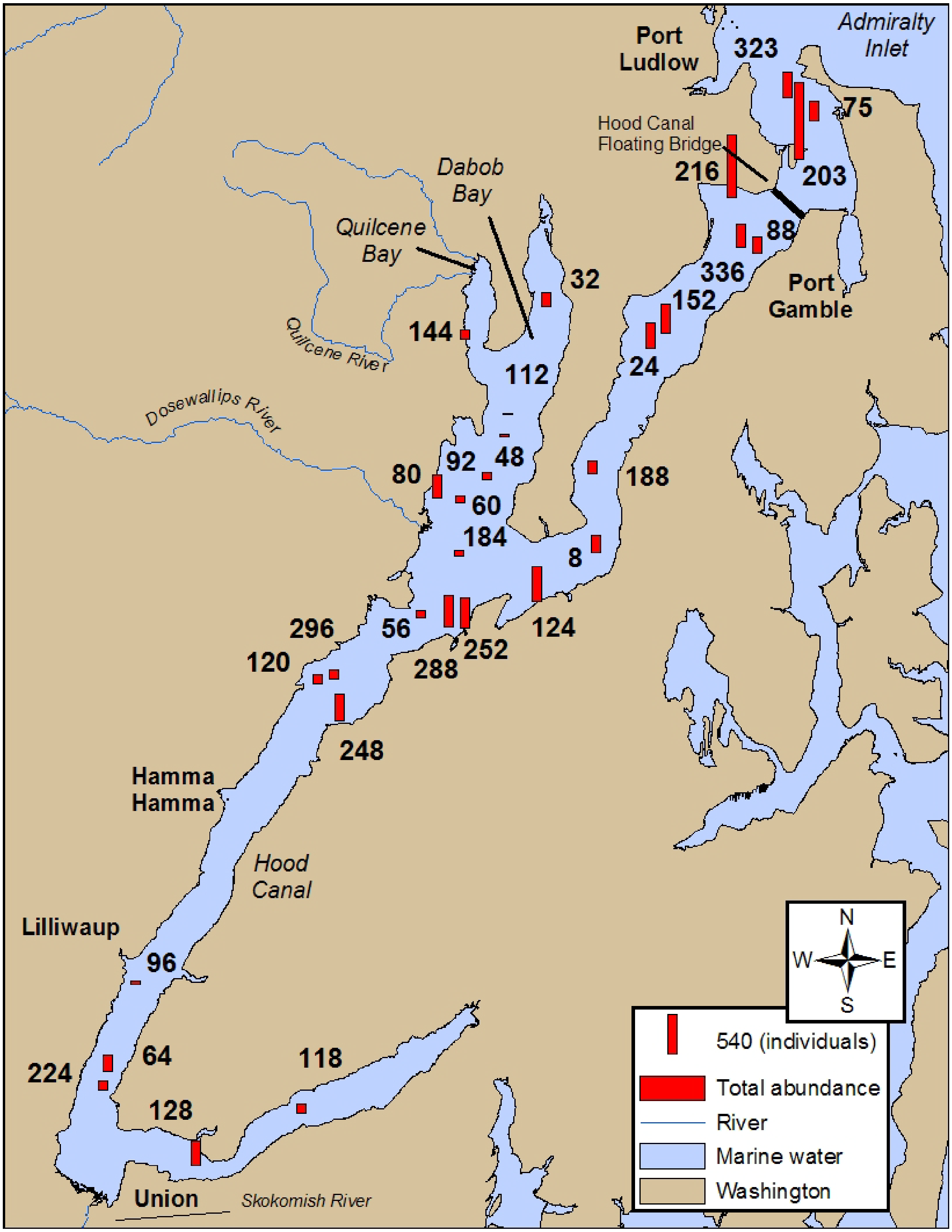

Figure 11. Spatial patterns in total benthic infaunal abundance in the 2004 PSAMP Sediment Component Hood Canal regional survey.

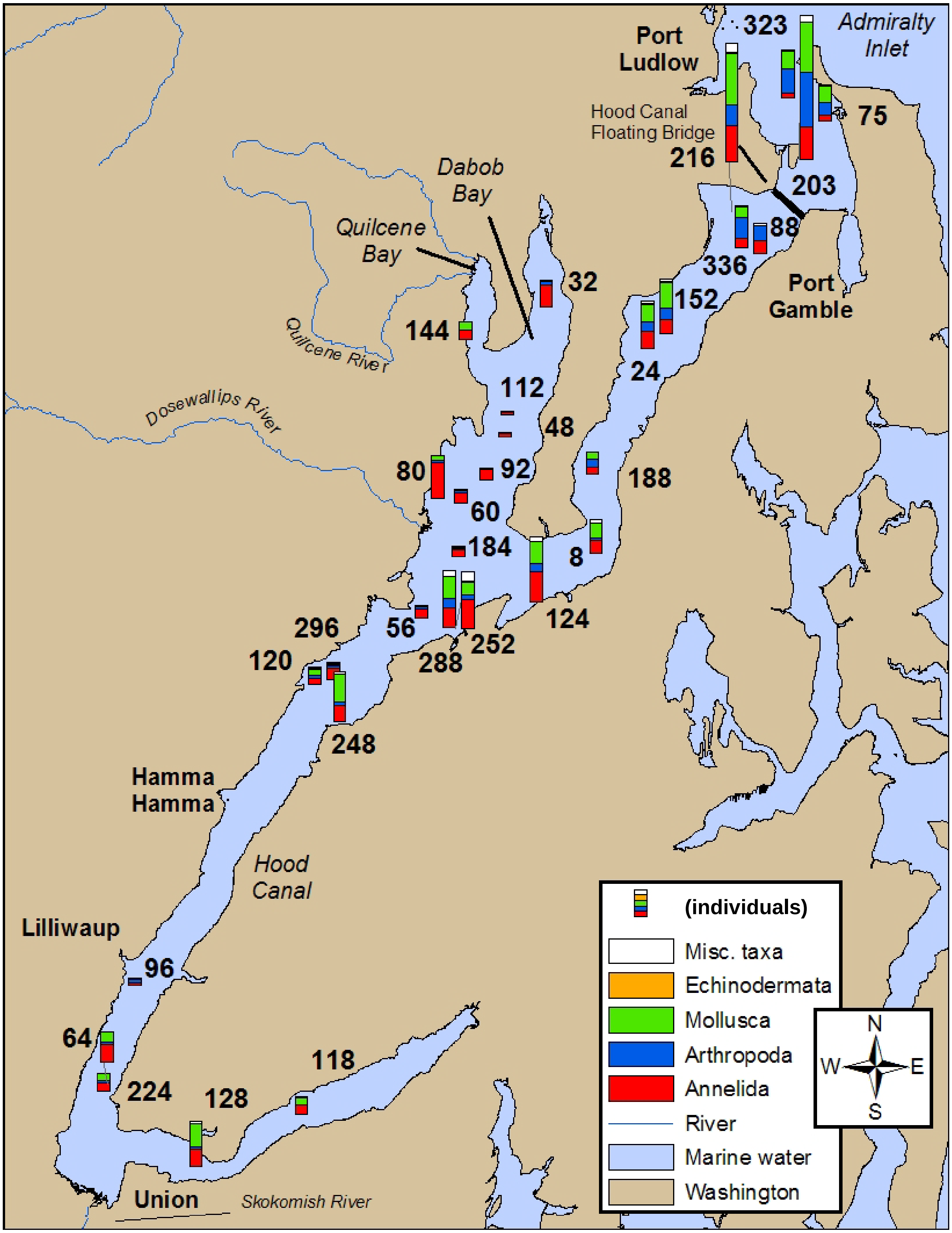

Figure 12. Spatial patterns in major taxa abundance in the 2004 PSAMP Sediment Component Hood Canal regional survey.

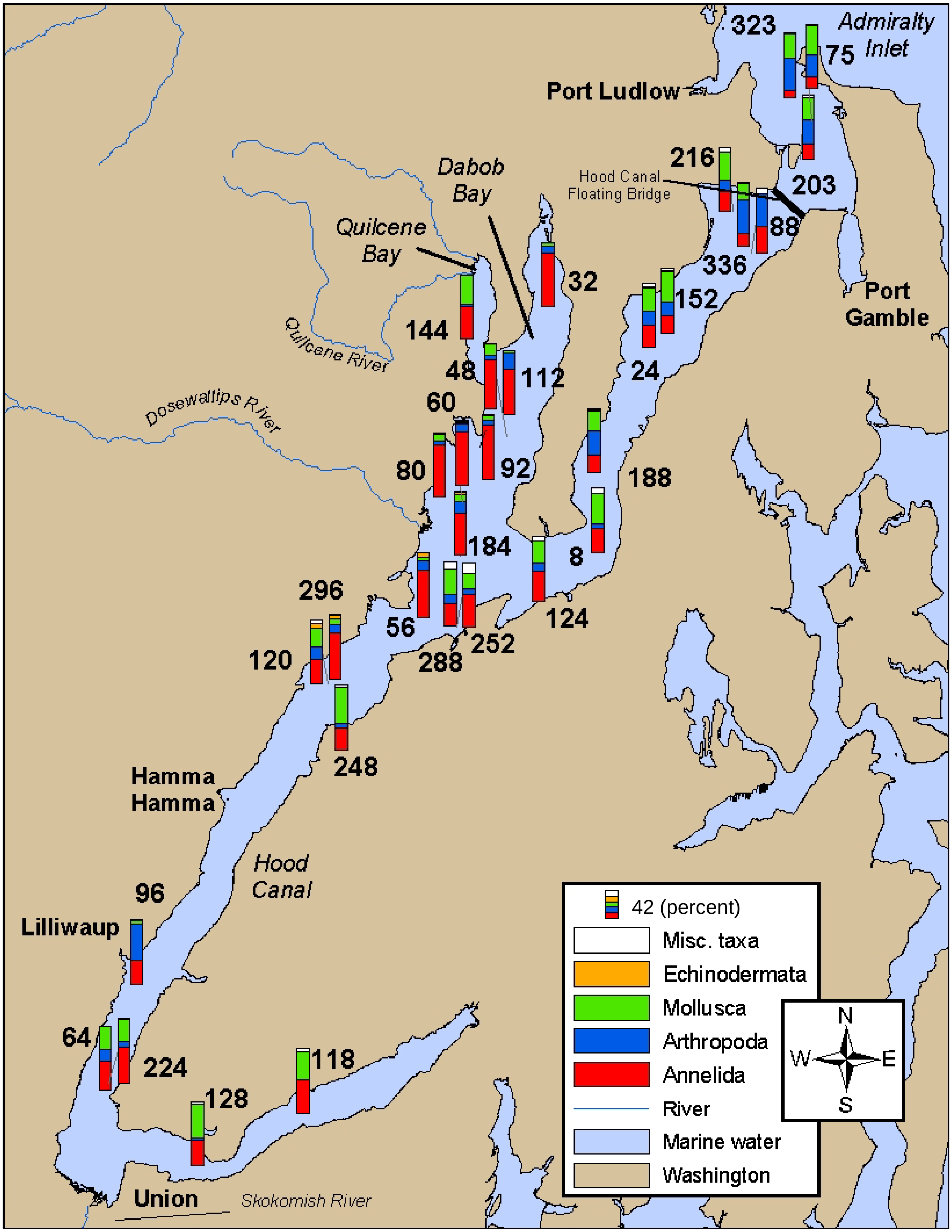

Figure 13. Spatial patterns in major taxa abundance as percent of total abundance in the 2004 PSAMP Sediment Component Hood Canal regional survey.

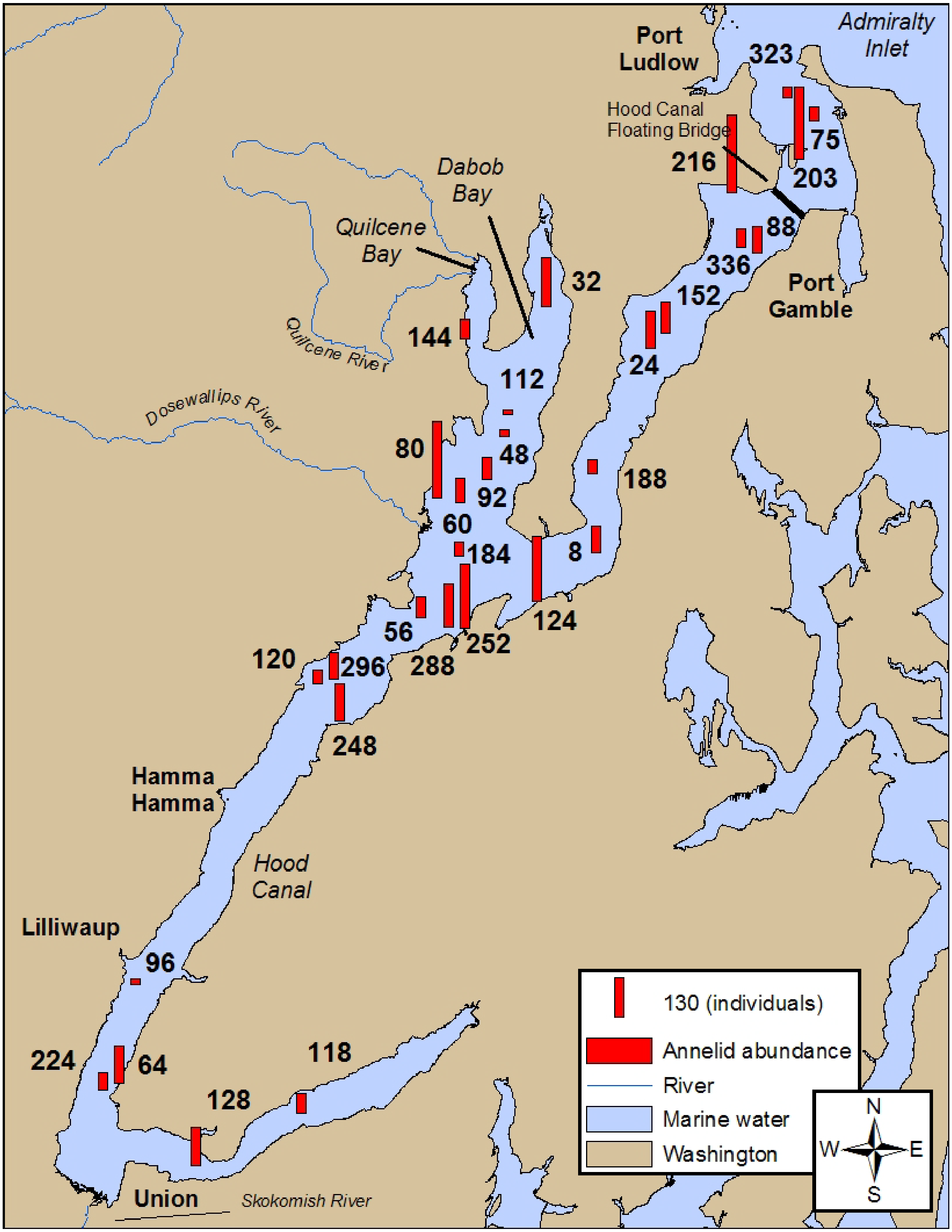

Figure 14. Spatial patterns in annelid abundance in the 2004 PSAMP Sediment Component Hood Canal regional survey.

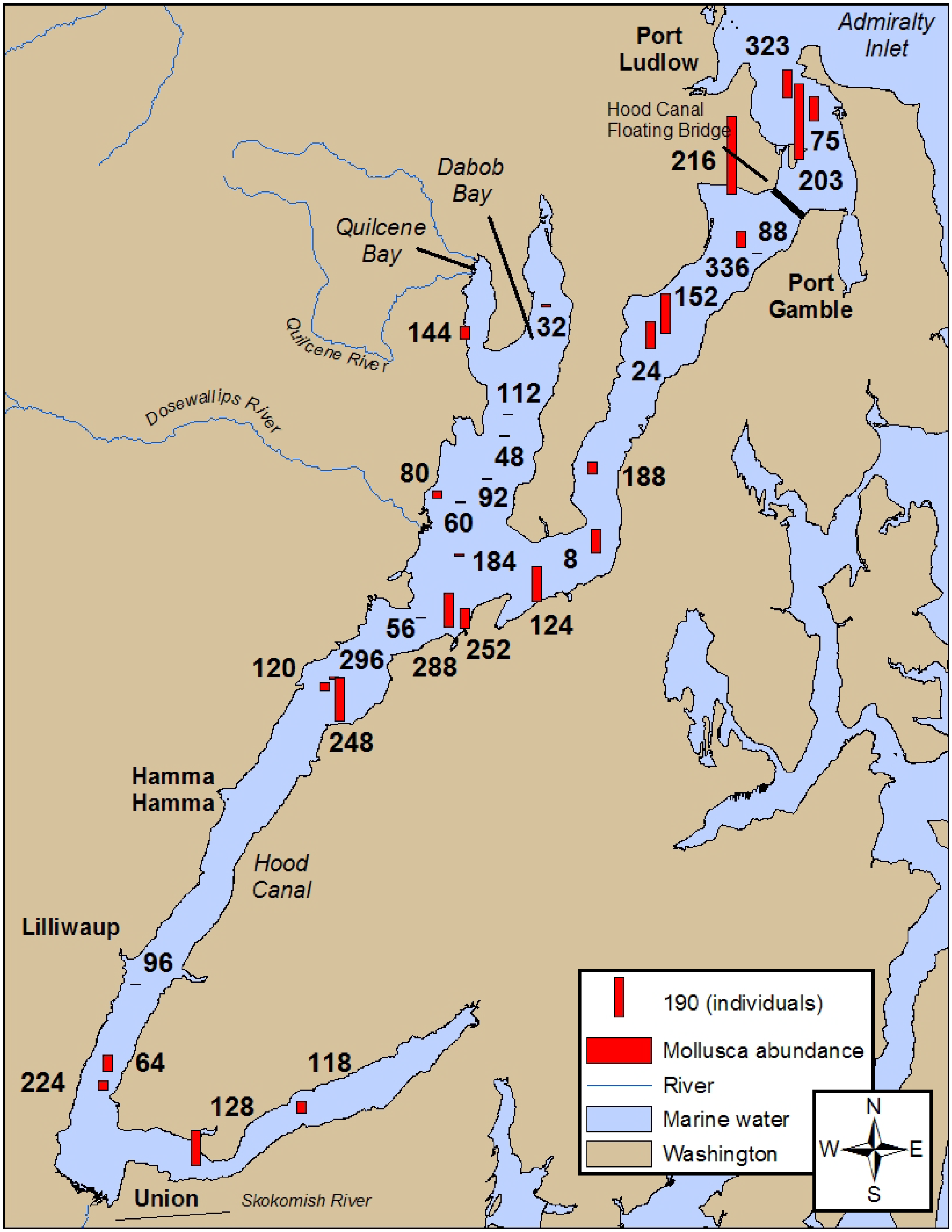

Figure 15. Spatial patterns in mollusc abundance in the 2004 PSAMP Sediment Component Hood Canal regional survey.

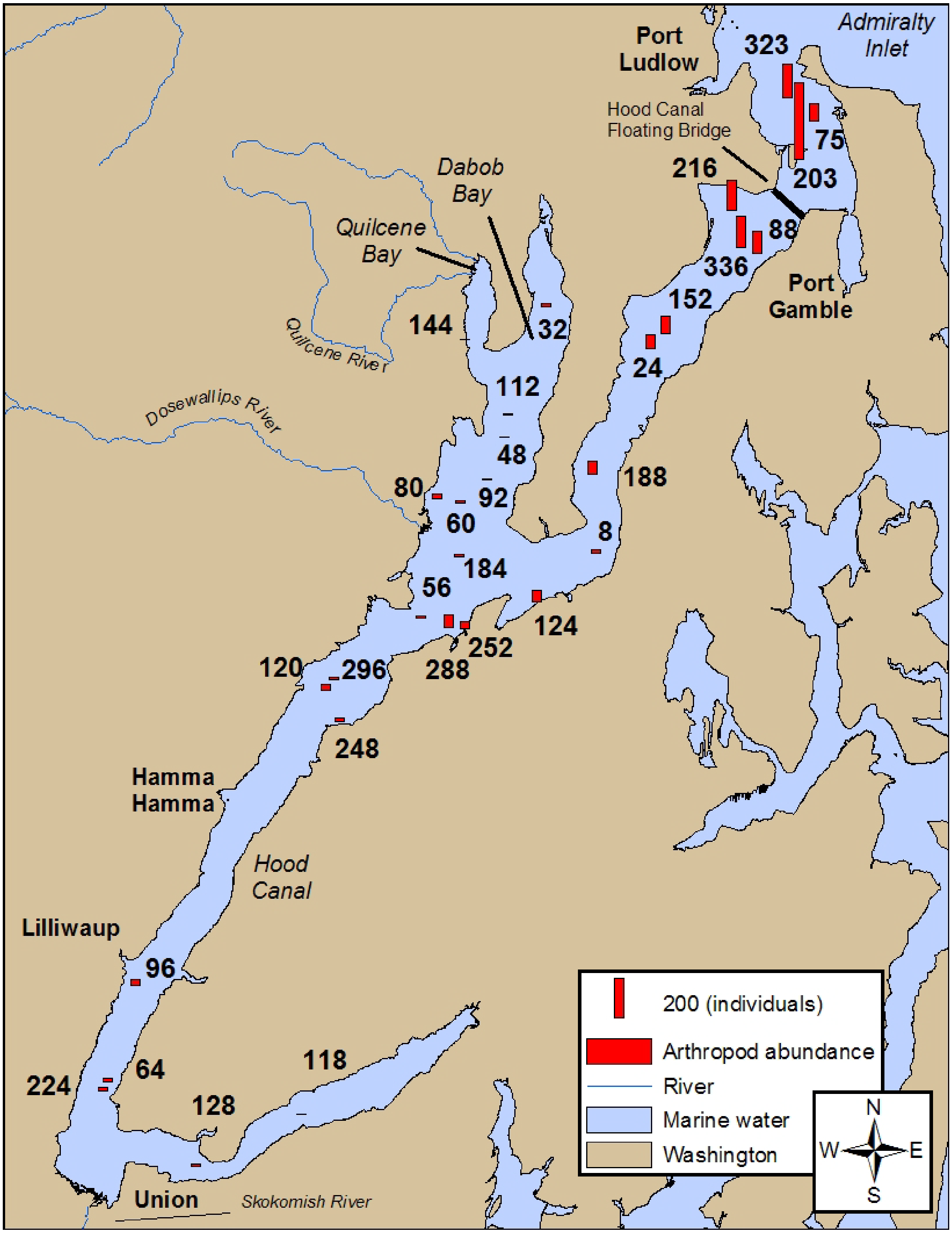

Figure 16. Spatial patterns in arthropod abundance in the 2004 PSAMP Sediment Component Hood Canal regional survey.

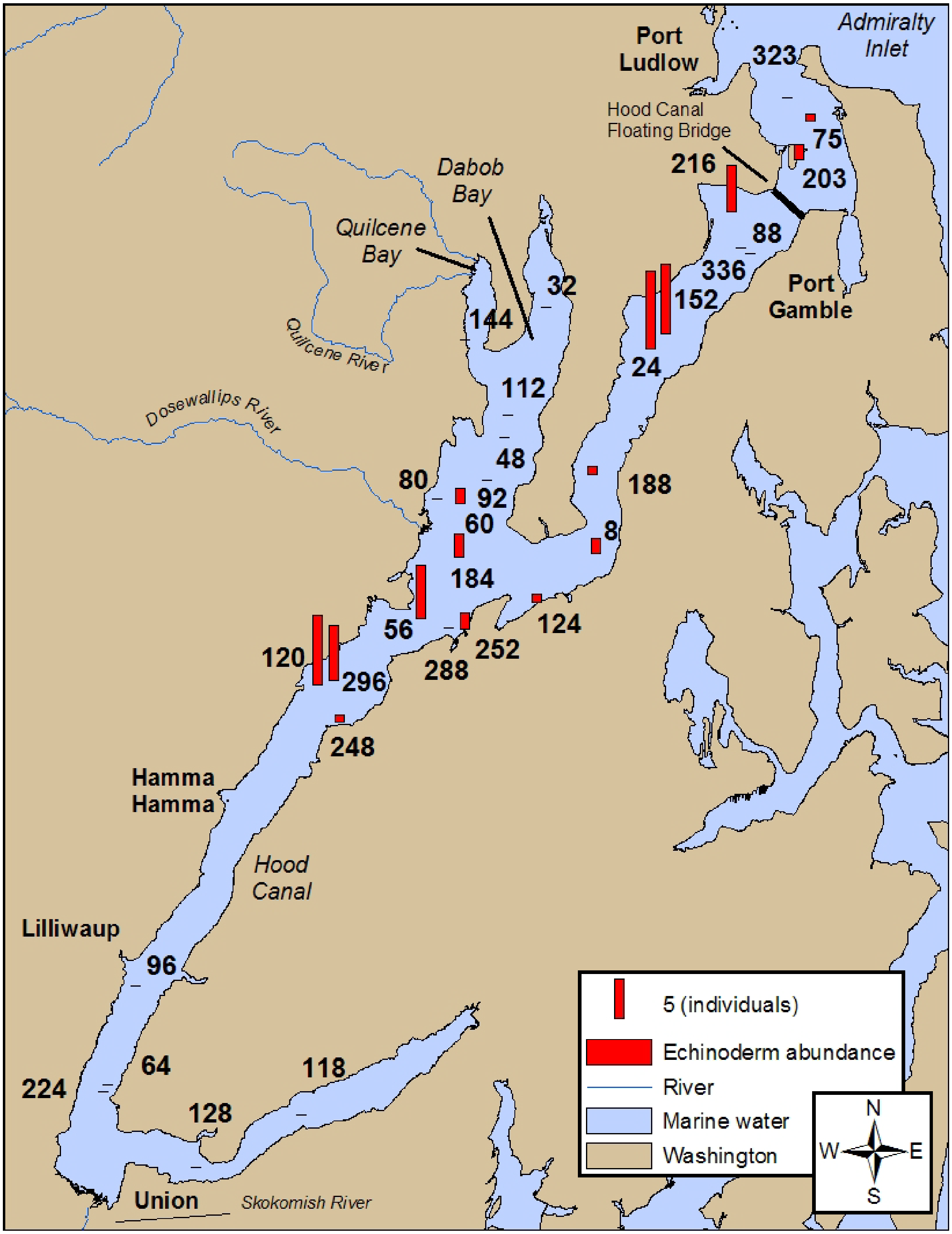

Figure 17. Spatial patterns in echinoderm abundance in the 2004 PSAMP Sediment Component Hood Canal regional survey.

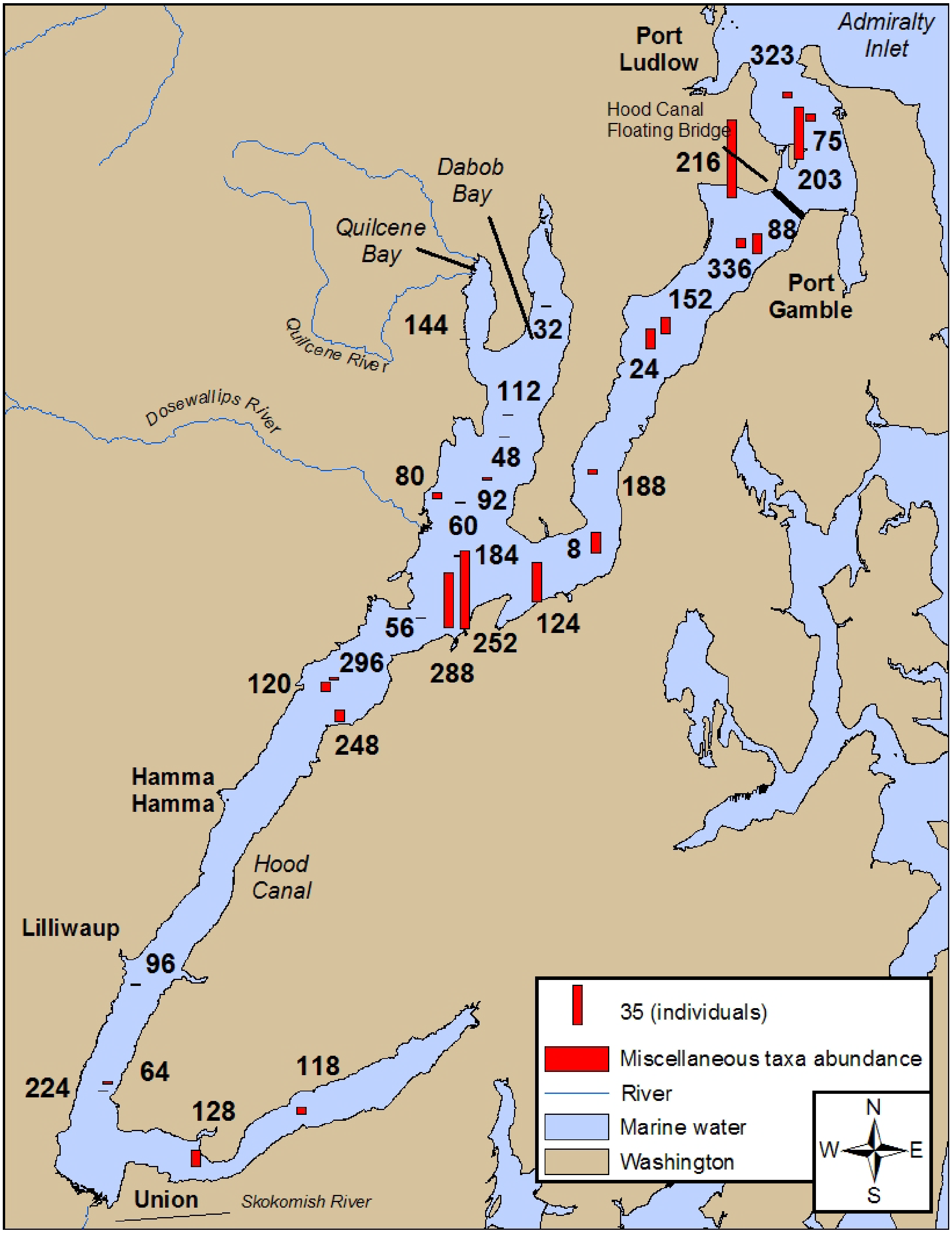

Figure 18. Spatial patterns in miscellaneous taxa abundance in the 2004 PSAMP Sediment Component Hood Canal regional survey.

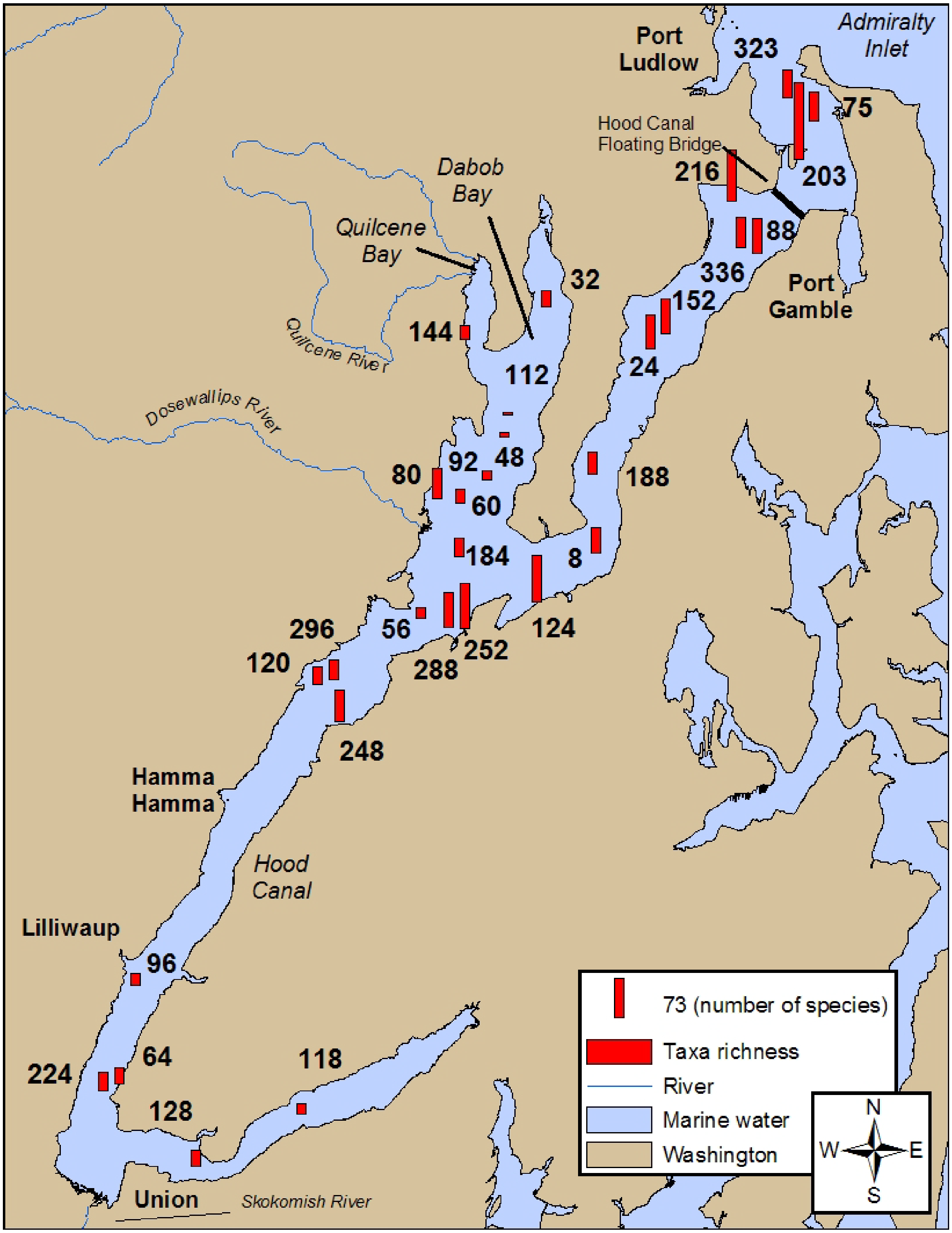

Figure 19. Spatial patterns in taxa richness in the 2004 PSAMP Sediment Component Hood Canal regional survey.

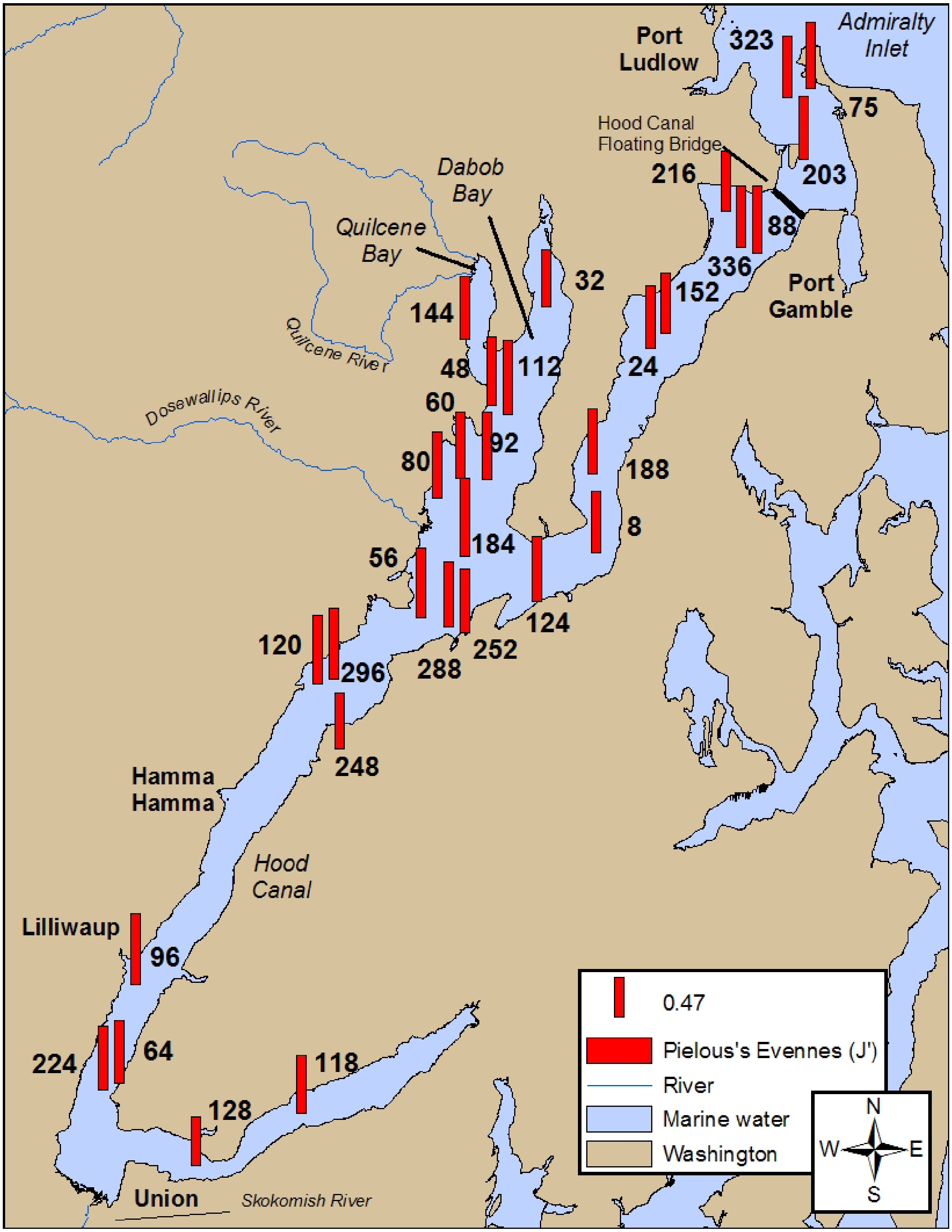

Figure 20. Spatial patterns in Pielou's Evenness (J') (Pielou, 1966) in the 2004 PSAMP Sediment Component Hood Canal regional survey.

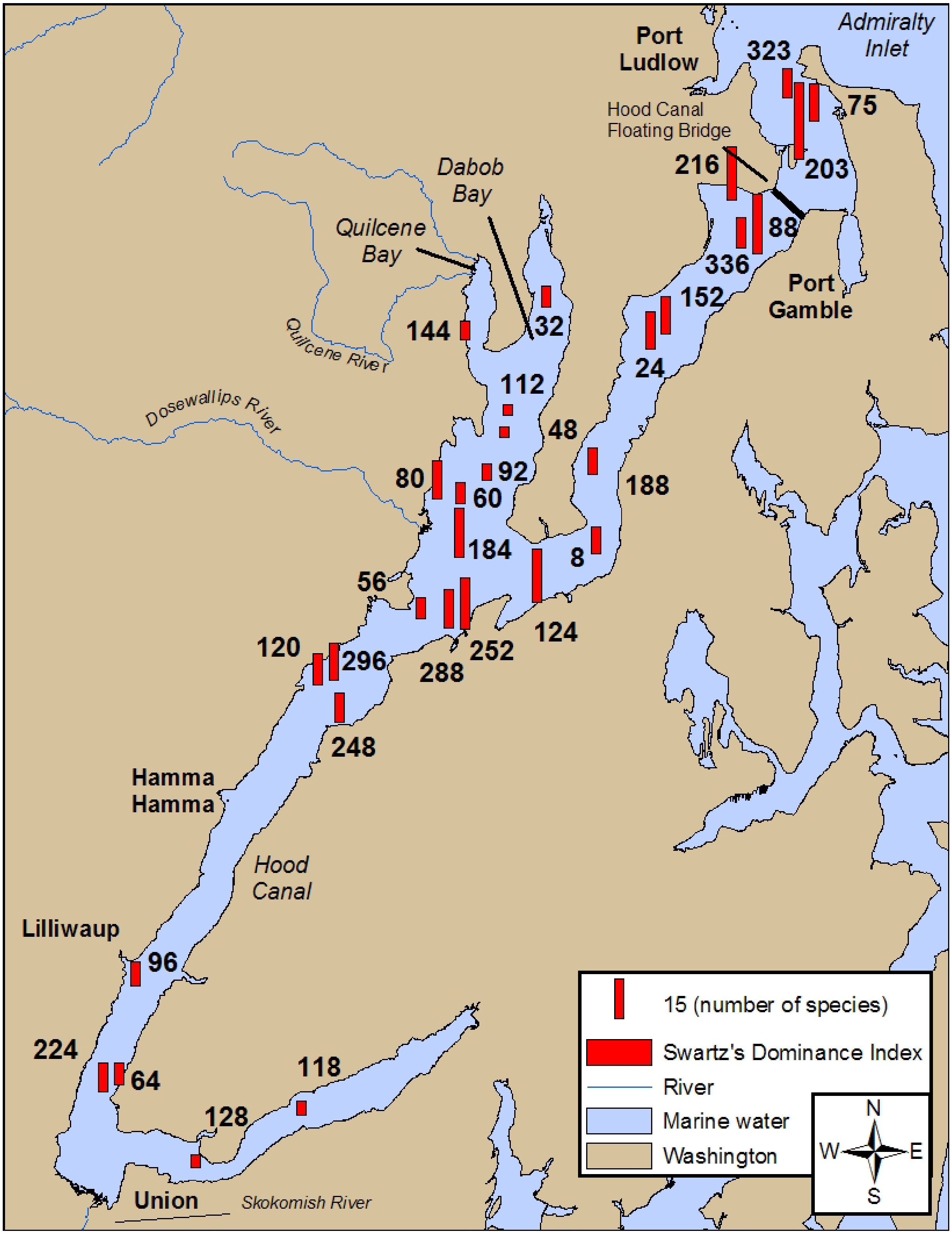

Figure 21. Spatial patterns in Swartz's Dominance Index (SDI) (Swartz et al., 1985) in the 2004 PSAMP Sediment Component Hood Canal regional survey.

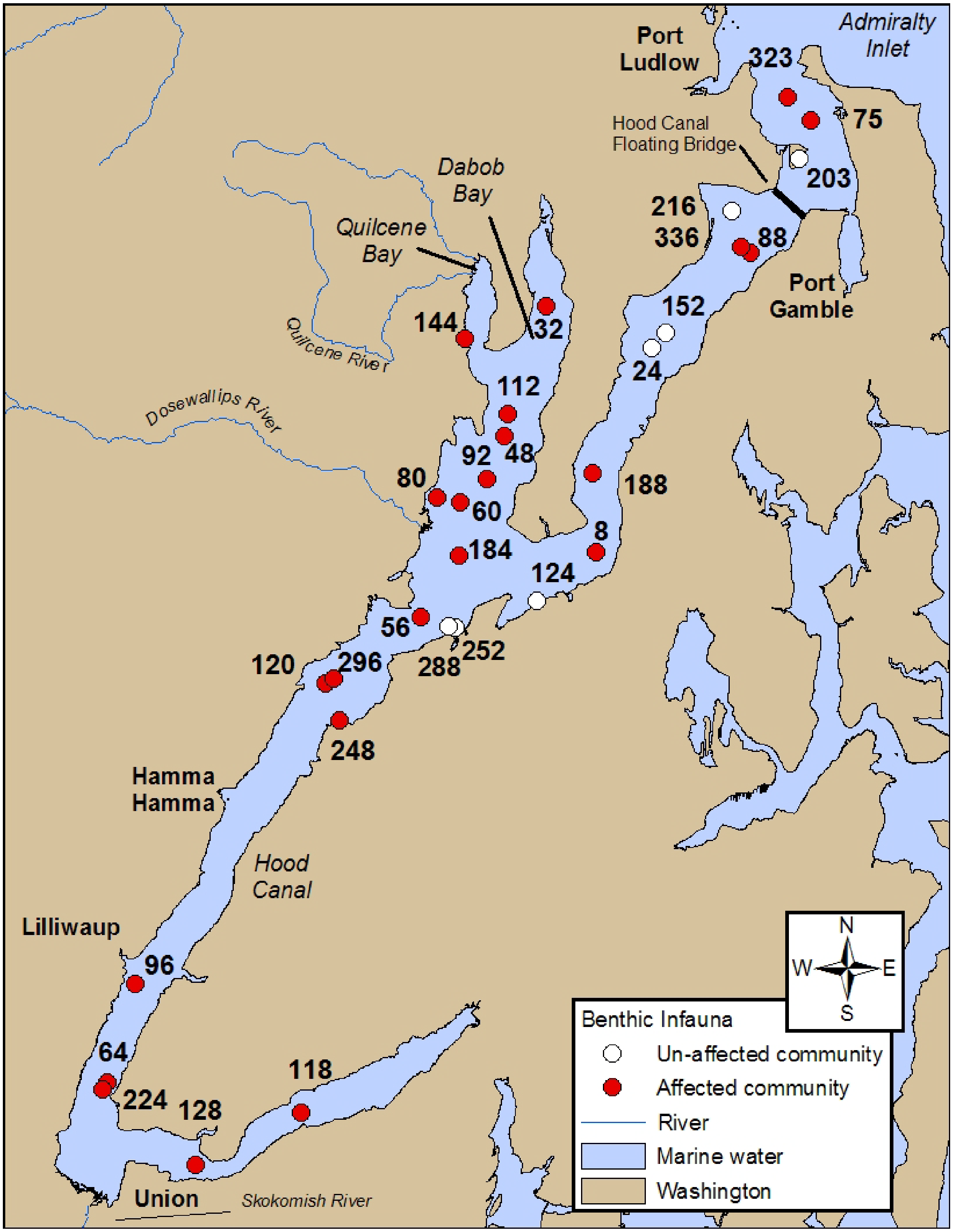

Figure 22. Spatial patterns in adversely affected benthic infaunal community composition in the 2004 PSAMP Sediment Component Hood Canal regional survey.

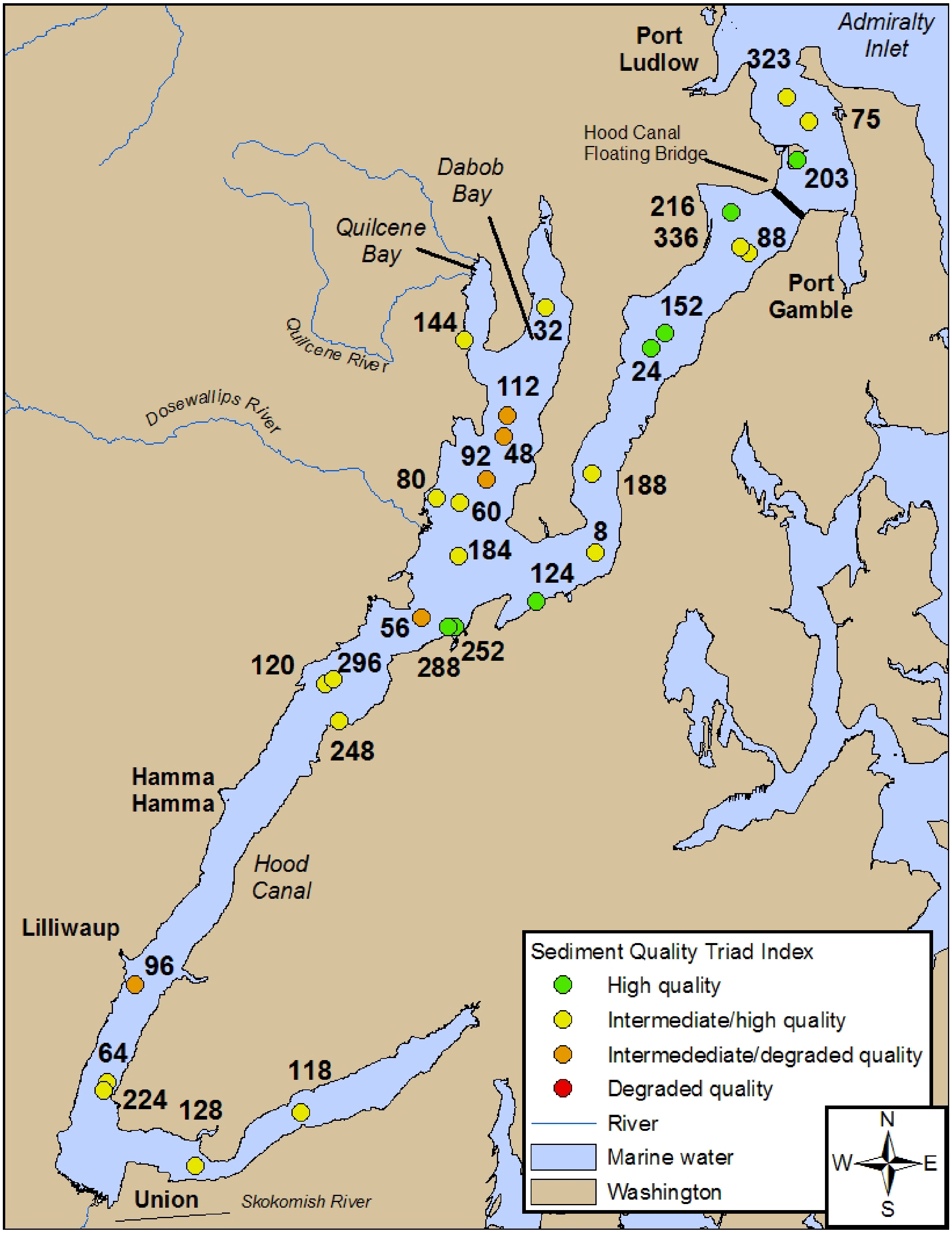

Figure 23. Spatial patterns in sediment quality based upon the Sediment Quality Triad in the 2004 PSAMP Sediment Component Hood Canal regional survey.

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Tables

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Table 1. Number of stations and area (km^2) represented in each stratum type for the 2004 PSAMP Sediment Component Hood Canal regional survey.

Sampling Stratum	Number of stations	Area that could be sampled (km^2)	Total area (km^2)
Basin	21	193.84	230.76
Harbor	0	0.00	0.00
Passages	0	0.00	0.00
Rural	9	100.97	100.97
Urban	0	0.00	0.00
Total	**30**	**294.81**	**331.73**

Table 2. Station numbers, names, stratum type, and sample weights (km^2) for the 2004 PSAMP Sediment Component Hood Canal regional survey.

Basin (each station represents 9.23 km^2)		Rural (each station represents 11.22 km^2)	
Station	Location	Station	Location
8	Hazel Pt.	32	Broad Spit
24	Vinland	48	Pulali Pt.
56	Stavis Bay	60	Seal Rock
64	Musquiti Pt. North	80	Sylopash Pt.
75	Coon Bay	92	Zelatched Pt.
88	North Four Corners	112	Tabook Pt.
96	Sund Creek	118	Shoofly Creek
120	Fulton Creek South	128	Sisters Pt.
124	Seabeck	144	Fishermans Pt.
152	Transit Station		
184	Misery Pt.		
188	King Spit		
203	Hood Head		
216	Sisters		
224	Musquiti Pt.		
248	Tekiu Pt.		
252	Maple Beach North		
288	Maple Beach South		
296	Fulton Creek North		
323	Coon Bay		
336	Bridgehaven		

Table 3. Chemical and physical parameters measured in sediments collected for the 2004 PSAMP Sediment Component Hood Canal regional survey.

Related Parameters

Grain Size

Total Organic Carbon

Priority Pollutant Metals

- Arsenic
- Cadmium
- Chromium
- Copper
- Lead
- Mercury
- Nickel
- Selenium
- Silver
- Zinc

Trace Elements

- Tin

Organics

Chlorinated Alkenes

- Hexachlorobutadiene

Chlorinated and Nitro-Substituted Phenols

- Pentachlorophenol

Chlorinated Aromatic Compounds

- 1,2,4-Trichlorobenzene
- 1,2-Dichlorobenzene
- 1,3-Dichlorobenzene
- 1,4-Dichlorobenzene
- 2-Chloronaphthalene
- Hexachlorobenzene

Chlorinated Pesticides

- 2,4'-DDD
- 2,4'-DDE
- 2,4'-DDT
- 4,4'-DDD
- 4,4'-DDE
- 4,4'-DDT
- Aldrin
- Cis-Chlordane
- Dieldrin
- Endosulfan I
- Endosulfan II
- Endosulfan Sulfate
- Endrin
- Endrin Aldehyde
- Endrin Ketone
- Gamma-BHC (Lindane)
- Heptachlor
- Heptachlor Epoxide
- Mirex
- Oxychlordane
- Toxaphene
- Trans-Chlordane (Gamma)

Polycyclic Aromatic Hydrocarbons

LPAHs

- 1,6,7-Trimethylnaphthalene
- 1-Methylnaphthalene
- 1-Methylphenanthrene
- 2,6-Dimethylnaphthalene
- 2-Methylnaphthalene
- 2-Methylphenanthrene
- Acenaphthene
- Acenaphthylene
- Anthracene
- Biphenyl
- Dibenzothiophene
- Fluorene
- Naphthalene
- Phenanthrene
- Retene

HPAHs

- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(e)pyrene
- Benzo(g,h,i)perylene
- Benzo(k)fluoranthene
- Chrysene
- Dibenzo(a,h)anthracene
- Fluoranthene
- Indeno(1,2,3-c,d)pyrene
- Perylene
- Pyrene

Miscellaneous Extractable Compounds

- Benzoic Acid
- Benzyl Alcohol
- Beta-coprostanol
- Beta-Sitosterol
- Carbazole
- Cholesterol
- p-Isopropyltoluene
- Dibenzofuran

Organonitrogen Compounds

- Caffeine
- N-Nitrosodiphenylamine

Phenols

- 2,4-Dimethylphenol
- 2-Methylphenol
- 4-Methylphenol
- Phenol
- P-nonylphenol

Phthalate Esters

- Bis(2-Ethylhexyl) Phthalate
- Butylbenzylphthalate
- Diethylphthalate
- Dimethylphthalate
- Di-N-Butylphthalate
- Di-N-Octyl Phthalate

Polychlorinated Biphenyls (PCBs)
PCB Congeners

- PCB Congener 8
- PCB Congener 18
- PCB Congener 28
- PCB Congener 44
- PCB Congener 52
- PCB Congener 66
- PCB Congener 77
- PCB Congener 101
- PCB Congener 105
- PCB Congener 110
- PCB Congener 118
- PCB Congener 126
- PCB Congener 128
- PCB Congener 138
- PCB Congener 153
- PCB Congener 169
- PCB Congener 170
- PCB Congener 180
- PCB Congener 187
- PCB Congener 195
- PCB Congener 206
- PCB Congener 209

PCB Aroclors:

- PCB Aroclor 1016
- PCB Aroclor 1221
- PCB Aroclor 1232
- PCB Aroclor 1242
- PCB Aroclor 1248
- PCB Aroclor 1254
- PCB Aroclor 1260

Polybrominated Diphenylethers

- PBDE - 47
- PBDE - 99
- PBDE - 100
- PBDE - 153
- PBDE - 154

Table 4. Laboratory analytical methods and reporting limits for the 2004 PSAMP Sediment Component Hood Canal regional survey.

Parameter	Method	Reference	Practical Quantitation Limit
Near-bottom dissolved oxygen	Carpenter method	Carpenter, 1965	0.001 mg/L
Grain Size	Sieve-pipette method	PSEP, 1986	>2000 to <3.9 microns
Total Organic Carbon	Conversion to CO_2 measured by nondispersive infra-red spectroscopy	PSEP, 1986	0.1 %
Metals (Partial digestion)	Strong acid (aqua regia) digestion and analyzed via ICP-MS	digestion - PSEP, 1997b; EPA SW 846 3050 analysis - PSEP, 1997b; EPA SW 846 6020, EPA 200.8	1-10 ppm
Mercury	Cold Vapor Atomic Absorption	PSEP, 1997b EPA 245.5	1-10 ppm
Base/Neutral/Acid Organic Chemicals	Capillary column Gas Chromatography/ Mass Spectrometry	PSEP 1997c, EPA 8270 & 8081	100-200 ppb
Polycyclic Aromatic Hydrocarbons (PAH)	Capillary column Gas Chromatography/ Mass Spectrometry	PSEP 1997c, extraction following Manchester modification of EPA 8270	100-200 ppb
Chlorinated Pesticides and PCB (Aroclors)	Gas Chromatography Electron Capture Detection	PSEP 1997c, EPA 8081/8082	1-5 ppb
PCB Congeners	Gas Chromatography Electron Capture Detection	Lauenstein, G. G. and A. Y. Cantillo, 1993, EPA 8081/8082	1-5 ppb
Polybrominated Diphenylethers	Gas Chromatography Electron Capture Detection	Lauenstein, G. G. and A. Y. Cantillo, 1993, EPA 8082	1-5 ppb

Table 5. Field analytical methods and resolution for the 2004 PSAMP Sediment Component Hood Canal regional survey.

Parameter	Method	Resolution
Temperature	Alcohol Thermometer	1.0 °C
Surface salinity	Refractometer	1.0 ppt

Table 6. Benthic infaunal indices calculated to characterize the infaunal invertebrate assemblages for the 2004 PSAMP Sediment Component Hood Canal regional survey.

Infaunal index	Definition	Calculation
Total Abundance	A measure of density equal to the total number of organisms per sample area	Sum of all organisms counted in each sample
Major Taxa Abundance	A measure of density equal to the total number of organisms in each major taxa group (Annelida, Mollusca, Echinodermata, Arthropoda, Miscellaneous Taxa) per sample area	Sum of all organisms counted in each major taxa group per sample
Taxa Richness	Total number of taxa (taxa = lowest level of identification for each organism) per sample area	Sum of all taxa identified in each sample
Pielou's Evenness (J') (Pielou, 1966)	Relates the observed diversity in benthic assemblages as a proportion of the maximum possible diversity for the data set (the equitability (evenness) of the distribution of individuals among taxa)	$J' = H'/\log s$ Where: $H' = -\sum_{i=1}^{s} p_i \log p_i$ where p_i = the proportion of the assemblage that belongs to the ith taxa ($p=n_i/N$, where n_I=the number of individuals in the i taxa and N= total number of individuals), and where s = the total number of taxa
Swartz's Dominance Index (SDI)(Swartz et al., 1985)	The minimum number of taxa whose combined abundance accounted for 75 percent of the total abundance in each sample	Sum of the minimum number of taxa whose combined abundance accounted for 75 percent of the total abundance in each sample

Table 7. Sediment types characterizing the 30 samples collected for the 2004 PSAMP Sediment Component Hood Canal regional survey.

Sediment Type	% Gravel	% Sand	% Silt+clay	No. of stations with this sediment type
Sand	0.1 – 0.2	> 80	<20	7
Silty sand	0.1 – 1.8	60 - 80	20 -<60	4
Mixed	0.1 – 1.6	20 -<60	60 - 80	11
Silt clay	0.1 – 3.7	<20	> 80	8

Table 8. Summary statistics for concentrations of percent fines, dissolved oxygen, total organic carbon, metals and organic chemicals collected for the 2004 PSAMP Sediment Component Hood Canal regional survey. The reporting limit was used for undetected values.

Parameter	Mean	Median	Minimum	Maximum	Range	N	No. of non-detects
Near-bottom Dissolved Oxygen (mg/L)	5.78	5.94	0.44	13.13	12.69	30	0
Percent Fines (%)	52.39	67.00	3.60	89.60	86.0	30	0
Total Organic Carbon (%)	1.58	2.00	0.13	2.94	2.81	30	0
Priority Pollutant Metals (ppm)							
Arsenic	4.93	5.04	1.59	10.10	8.51	30	0
Cadmium	0.27	0.26	0.10	1.05	0.95	30	4
Chromium	37.02	37.90	21.20	63.90	42.70	30	0
Copper	32.37	26.80	5.02	98.90	93.89	30	0
Lead	8.44	7.28	1.66	15.60	13.94	30	0
Mercury	0.05	0.05	0.01	0.09	0.09	30	2
Nickel	31.55	32.35	14.40	43.80	29.40	30	0
Selenium	0.77	0.77	0.50	1.20	0.70	30	12
Silver	0.13	0.13	0.10	0.18	0.08	30	13
Zinc	63.18	71.35	19.00	93.10	74.10	30	0
Trace Elements (ppm)							
Tin	0.80	0.77	0.24	1.60	1.36	30	0
Organics (ppb)							
Chlorinated Alkenes							
Hexachlorobutadiene	11.97	10.45	3.00	21.00	18.00	30	29
Chlorinated and Nitro-Substituted Phenols							
Pentachlorophenol	122.63	116.75	60.00	213.00	153.00	30	30
Chlorinated Aromatic Compounds							
1,2,4-Trichlorobenzene	12.70	11.50	6.00	25.00	19.00	30	30
1,2-Dichlorobenzene	12.27	11.50	6.00	21.00	15.00	30	30
1,3-Dichlorobenzene	12.27	11.50	6.00	21.00	15.00	30	30
1,4-Dichlorobenzene	12.27	11.50	6.00	21.00	15.00	30	30
2-Chloronaphthalene	1.01	1.00	1.00	1.20	0.20	30	30
Hexachlorobenzene	12.27	11.50	6.00	21.00	15.00	30	30
Chlorinated Pesticides							
2,4'-DDD	1.17	1.10	0.60	2.90	2.30	30	30
2,4'-DDE	1.17	1.10	0.60	2.90	2.30	30	30
2,4'-DDT	1.17	1.10	0.60	2.90	2.30	30	30
4,4'-DDD	0.79	1.10	0.12	1.30	1.18	30	20
4,4'-DDE	0.52	0.43	0.13	1.10	0.97	30	6

Parameter	Mean	Median	Minimum	Maximum	Range	N	No. of non-detects
4,4'-DDT	1.03	1.10	0.13	2.90	2.77	30	25
Aldrin	1.17	1.10	0.60	2.90	2.30	30	30
Cis-Chlordane	1.17	1.10	0.60	2.90	2.30	30	30
Dieldrin	1.17	1.10	0.60	2.90	2.30	30	30
Endosulfan I	1.17	1.10	0.60	2.90	2.30	30	30
Endosulfan II	1.17	1.10	0.60	2.90	2.30	30	30
Endosulfan Sulfate	1.17	1.10	0.60	2.90	2.30	30	30
Endrin	1.17	1.10	0.60	2.90	2.30	30	30
Endrin Aldehyde	1.17	1.10	0.60	2.90	2.30	30	30
Endrin Ketone	1.17	1.10	0.60	2.90	2.30	30	30
Gamma-BHC (Lindane)	1.17	1.10	0.60	2.90	2.30	30	30
Heptachlor	1.17	1.10	0.60	2.90	2.30	30	30
Heptachlor Epoxide	1.17	1.10	0.60	2.90	2.30	30	30
Mirex	1.17	1.10	0.60	2.90	2.30	30	30
Oxychlordane	1.17	1.10	0.60	2.90	2.30	30	30
Toxaphene	11.75	11.00	6.00	29.00	23.00	30	30
Trans-Chlordane (Gamma)	1.17	1.10	0.60	2.90	2.30	30	30
Polycyclic Aromatic Hydrocarbons (PAHs)							
Low Molecular Weight PAHs							
1,6,7-Trimethylnaphthalene	9.71	8.05	0.49	22.00	21.51	30	1
1-Methylnaphthalene	17.78	14.09	0.16	48.00	47.84	30	0
1-Methylphenanthrene	14.48	12.00	0.70	36.00	35.31	30	3
2,6-Dimethylnaphthalene	39.90	36.00	1.95	115.00	113.05	30	0
2-Methylnaphthalene	18.12	15.50	0.75	50.00	49.26	30	3
2-Methylphenanthrene	9.64	8.20	0.39	22.00	21.62	30	3
Acenaphthene	2.02	2.08	0.16	5.90	5.75	30	2
Acenaphthylene	8.00	7.10	0.23	45.00	44.78	30	2
Anthracene	6.10	6.25	0.28	13.00	12.72	30	4
Biphenyl	6.53	5.75	0.66	18.00	17.34	30	3
Dibenzothiophene	3.16	3.30	0.29	6.80	6.52	30	1
Fluorene	7.29	5.90	0.70	18.00	17.31	30	2
Naphthalene	31.90	32.00	0.67	188.00	187.33	30	0
Phenanthrene	38.82	37.00	1.85	97.00	95.15	30	1
Retene	29.00	24.50	1.20	106.00	104.80	30	0

Parameter	Mean	Median	Minimum	Maximum	Range	N	No. of non-detects
High Molecular Weight PAHs							
Benzo(a)anthracene	11.33	8.55	0.80	25.00	24.20	30	0
Benzo(a)pyrene	14.67	10.18	0.78	36.00	35.22	30	0
Benzo(b)fluoranthene	15.98	12.75	1.00	35.00	34.00	30	0
Benzo(e)pyrene	15.06	12.50	0.93	33.00	32.08	30	0
Benzo(g,h,i)perylene	17.80	16.00	1.20	40.00	38.80	30	0
Benzo(k)fluoranthene	17.70	14.50	0.98	39.00	38.02	30	0
Chrysene	18.83	15.00	1.17	42.00	40.84	30	0
Dibenzo(a,h)anthracene	4.16	3.25	0.71	8.90	8.19	30	2
Fluoranthene	36.98	32.25	2.00	83.00	81.00	30	0
Indeno(1,2,3-c,d)pyrene	13.15	11.39	1.10	30.00	28.90	30	0
Perylene	46.67	39.00	0.98	105.00	104.02	30	0
Pyrene	32.94	28.50	1.80	86.00	84.20	30	0
Miscellaneous Extractable Compounds							
Benzoic Acid	744.90	710.75	307.00	1370.00	1063.00	30	24
Benzyl Alcohol	58.37	39.50	13.00	281.00	268.00	30	11
Beta-coprostanol	690.78	421.25	80.00	2591.25	2511.25	30	4
Beta-Sitosterol	2185.93	1935.00	697.00	4520.00	3823.00	30	13
Carbazole	2.28	1.11	1.00	6.90	5.90	30	18
Cholesterol	1734.12	1465.00	648.50	6330.00	5681.50	30	5
p-Isopropyltoluene	12.27	11.50	6.00	21.00	15.00	30	30
Dibenzofuran	8.01	6.50	0.44	19.00	18.57	30	4
Organonitrogen Compounds							
Caffeine	24.33	23.50	6.50	43.00	36.50	30	30
N-Nitrosodiphenylamine	24.55	23.50	12.00	43.00	31.00	30	30
Phenols							
2,4-Dimethylphenol	24.55	23.50	12.00	43.00	31.00	30	30
2-Methylphenol	33.71	17.00	6.40	270.00	263.60	30	18
4-Methylphenol	37.01	23.00	6.40	171.00	164.60	30	15
Phenol	1124.43	1117.50	88.00	3380.00	3292.00	30	5
P-nonylphenol	12.27	11.50	6.00	21.00	15.00	30	30
Phthalate Esters							
Bis(2-Ethylhexyl) Phthalate	162.35	104.00	27.00	774.00	747.00	30	30
Butylbenzylphthalate	12.27	11.50	6.00	21.00	15.00	30	30
Diethylphthalate	102.45	42.75	8.05	557.00	548.95	30	30
Dimethylphthalate	22.94	18.75	2.10	43.00	40.90	30	29

Parameter	Mean	Median	Minimum	Maximum	Range	N	No. of non-detects
Di-N-Butylphthalate	411.06	64.75	9.90	2990.00	2980.10	30	23
Di-N-Octyl Phthalate	24.55	23.50	12.00	43.00	31.00	30	30
Polychlorinated Biphenyls							
PCB Congeners							
PCB Congener 8	1.17	1.10	0.60	2.90	2.30	30	30
PCB Congener 18	1.17	1.10	0.60	2.90	2.30	30	30
PCB Congener 28	1.12	1.10	0.25	2.90	2.65	30	29
PCB Congener 44	1.17	1.10	0.60	2.90	2.30	30	30
PCB Congener 52	1.17	1.10	0.60	2.90	2.30	30	30
PCB Congener 66	1.14	1.10	0.19	2.90	2.71	30	29
PCB Congener 77	1.17	1.10	0.60	2.90	2.30	30	30
PCB Congener 101	1.11	1.10	0.16	2.90	2.74	30	29
PCB Congener 105	1.17	1.10	0.60	2.90	2.30	30	30
PCB Congener 110	1.08	1.10	0.14	2.90	2.76	30	28
PCB Congener 118	0.98	1.10	0.17	2.90	2.73	30	25
PCB Congener 126	1.17	1.10	0.60	2.90	2.30	30	30
PCB Congener 128	1.17	1.10	0.60	2.90	2.30	30	30
PCB Congener 138	0.92	1.10	0.12	2.90	2.78	30	22
PCB Congener 153	0.93	1.10	0.16	2.90	2.74	30	22
PCB Congener 169	1.17	1.10	0.60	2.90	2.30	30	30
PCB Congener 170	1.14	1.10	0.18	2.90	2.72	30	29
PCB Congener 180	1.13	1.10	0.37	2.90	2.53	30	29
PCB Congener 187	1.15	1.10	0.28	2.90	2.62	30	29
PCB Congener 195	1.17	1.10	0.60	2.90	2.30	30	30
PCB Congener 206	1.17	1.10	0.60	2.90	2.30	30	30
PCB Congener 209	1.17	1.10	0.60	2.90	2.30	30	30
PCB Aroclors:							
PCB Aroclor 1016	5.91	5.70	3.00	14.00	11.00	30	30
PCB Aroclor 1221	5.91	5.70	3.00	14.00	11.00	30	30
PCB Aroclor 1232	5.91	5.70	3.00	14.00	11.00	30	30
PCB Aroclor 1242	5.80	5.69	3.00	14.00	11.00	30	28
PCB Aroclor 1248	5.39	5.60	2.80	14.00	11.20	30	23
PCB Aroclor 1254	5.61	5.60	3.00	14.00	11.00	30	19
PCB Aroclor 1260	5.92	5.70	3.00	14.00	11.00	30	28
Polybrominated Diphenylether							
PBDE- 47	0.63	0.37	0.06	1.30	1.24	30	14
PBDE- 99	0.88	1.10	0.07	2.90	2.83	30	21

Parameter	Mean	Median	Minimum	Maximum	Range	N	No. of non-detects
PBDE-100	1.14	1.10	0.13	2.90	2.77	30	29
PBDE-153	1.16	1.10	0.60	2.90	2.30	30	29
PBDE-154	1.18	1.10	0.60	2.90	2.30	30	30

Table 9. Results of sea urchin fertilization tests in porewater from 30 sediment samples for the 2004 PSAMP Sediment Component. Data are expressed as mean percent fertilization and as percentage of control response. Tests performed with *Strongylocentrotus purpuratus*.

** Mean fertilization as % of control is statistically significantly different than control (alpha<0.05)*

*** Mean fertilization as % of control is statistically significantly different than control (alpha<0.05) and <80% of control.)*

Station	100% porewater			50% porewater			25% porewater		
	Mean % fertil-ization	% of control		Mean % fertil-ization	% of control		Mean % fertil-ization	% of control	
8, Hazel Pt.	95.6	101.5		97.2	102.3		96.6	101.2	
24, Vinland	96.4	102.3		95.6	100.6		97.6	102.2	
32, Broad Spit	99.4	105.5		95.0	100.0		96.0	100.5	
48, Pulali Pt.	2.4	2.5	**	19.0	20.0	**	61.6	64.5	**
56, Stavis Bay	47.4	50.3	**	84.0	88.4	*	96.4	100.9	
60, Seal Rock	95.4	101.3		94.2	99.2		96.2	100.7	
64, Musquiti Pt. North	96.6	102.5		95.0	100.0		94.8	99.3	
75, Coon Bay	96.6	102.5		91.8	96.6		92.4	96.8	
80, Sylopash Pt.	95.6	101.5		95.2	100.2		96.6	101.2	
88, North Four Corners	97.8	103.8		92.4	97.3		94.2	98.6	
92, Zelatched Pt.	4.4	4.7	**	36.8	38.7	**	87.2	91.3	*
96, Sund Creek	61.6	65.4	**	67.4	70.9	**	93.2	97.6	
112, Tabook Pt.	0.0	0.0	**	6.8	7.2	**	44.8	46.9	**
118, Shoofly Creek	99.0	105.1		98.8	104.0		96.8	101.4	
120, Fulton Creek South	94.2	100.0		94.2	99.2		97.2	101.8	
124, Seabeck	94.4	100.2		94.6	99.6		93.2	97.6	
128, Sisters Pt.	99.0	105.1		98.0	103.2		98.4	103.0	
144, Fishermans Pt.	93.2	98.9		94.4	99.4		95.0	99.5	
152, Transit Station	96.8	102.8		93.6	98.5		93.8	98.2	
184, Misery Pt.	96.4	102.3		93.8	98.7		94.8	99.3	
188, King Spit	94.8	100.6		91.8	96.6		91.6	95.9	
203, Hood Head	96.4	102.3		94.2	99.2		92.8	97.2	
216, Sisters	88.8	94.3		94.6	99.6		95.2	99.7	
224, Musquiti Pt.	99.2	105.3		96.2	101.3		97.8	102.4	
248, Tekiu Pt.	98.4	104.5		98.6	103.8		96.8	101.4	
252, Maple Beach North	80.4	85.4	*	91.4	96.2		92.4	96.8	
288, Maple Beach South	95.6	101.5		94.6	99.6		95.0	99.5	

Station	100% porewater			50% porewater			25% porewater		
	Mean % fertil-ization	% of control		Mean % fertil-ization	% of control		Mean % fertil-ization	% of control	
296, Fulton Creek North	97.0	103.0		97.6	102.7		97.0	101.6	
323, Coon Bay	99.4	105.5		98.4	103.6		97.0	101.6	
336, Bridgehaven	98.8	104.9		96.8	101.9		97.2	101.8	

Table 10. Estimated incidence and spatial extent of toxicity calculated for sea urchin fertilization in samples collected for the 2004 PSAMP Sediment Component Hood Canal regional survey.

The number and percent of stations and the size (km^2) and percent of the total study area are shown for significant mean responses (alpha < 0.05) that were less than 80% of the control samples. The shaded area = total number of stations and total area sampled.

Toxicity test	Incidence		Spatial Extent	
	No. of stations	(%) of stations	km^2	(%) of study area
Hood Canal	30	(100.0)	294.8	(100.0)
Urchin fertilization(mean fertilization < 80% of controls)				
• 100% porewater	5	(16.7)	52.1	(17.7)
• 50% porewater	4	(13.3)	42.9	(14.5)
• 25% porewater	2	(6.7)	22.4	(7.6)

Table 11. Total abundance, taxa richness, Pielou's evenness, and Swartz's Dominance Index calculated for the 2004 PSAMP Sediment Component Hood Canal regional survey.

Station	Total abundance	Taxa richness	Pielou's evenness (J')	Swartz's Dominance Index
8	251	49	0.76	11
24	354	64	0.76	14
32	205	32	0.70	8
48	33	9	0.84	4
56	97	21	0.86	8
60	100	26	0.81	8
64	224	31	0.76	8
75	271	56	0.81	14
80	321	56	0.81	14
88	226	66	0.82	22
92	88	18	0.82	6
96	51	21	0.87	9
112	27	6	0.92	4
118	127	19	0.71	5
120	109	31	0.85	11
124	487	88	0.79	20
128	339	31	0.60	5
144	136	27	0.78	7
152	408	66	0.74	14
184	73	34	0.95	18
188	166	40	0.80	10
203	1075	146	0.78	29
216	883	95	0.75	20
224	131	36	0.79	11
248	373	59	0.68	11
252	418	84	0.78	19
288	423	64	0.79	14
296	126	37	0.87	14
323	356	53	0.76	11
336	308	56	0.75	11
Minimum	27	6	0.60	4
Maximum	1075	146	0.95	29
Median	225	38.50	0.79	11
Mean	273.53	47.40	0.79	12.00
STDEV	233.41	29.47	0.07	5.87

STDEV – standard deviation.

Table 12. Total abundance, major taxa abundance, and major taxa percent abundance calculated for the 2004 PSAMP Sediment Component regional survey.

Station	Total abundance	Annelida		Arthropoda		Mollusca		Echinodermata		Miscellaneous taxa	
		abundance	% of total	abundance	% of total	abundance	% of total	abundance	% of total	abundance	% of total
8	251	96	38	18	7	116	46	2	1	19	8
24	354	125	35	73	21	128	36	10	3	18	5
32	205	171	83	21	10	12	6	0	0	1	0
48	33	25	76	2	6	6	18	0	0	0	0
56	97	71	73	15	15	4	4	7	7	0	0
60	100	82	82	12	12	3	3	2	2	1	1
64	224	125	56	17	8	80	36	0	0	2	1
75	271	48	18	95	35	120	44	1	0	7	3
80	321	263	82	19	6	34	11	0	0	5	2
88	226	93	41	114	50	1	0	0	0	18	8
92	88	74	84	6	7	6	7	0	0	2	2
96	51	19	37	29	57	2	4	0	0	1	2
112	27	19	70	7	26	1	4	0	0	0	0
118	127	65	51	0	0	56	44	0	0	6	5
120	109	50	46	27	25	19	17	9	8	4	4
124	487	223	46	59	12	169	35	1	0	35	7
128	339	134	40	14	4	176	52	0	0	15	4
144	136	69	51	4	3	63	46	0	0	0	0
152	408	105	26	87	21	192	47	9	2	15	4
184	73	48	66	13	18	8	11	3	4	1	1
188	166	46	28	62	37	53	32	1	1	4	2
203	1075	247	23	405	38	373	35	2	0	48	4
216	883	266	30	159	18	382	43	6	1	70	8
224	131	60	46	22	17	49	37	0	0	0	0

Station	Total abundance	Annelida		Arthropoda		Mollusca		Echinodermata		Miscellaneous taxa	
		abundance	% of total	abundance	% of total	abundance	% of total	abundance	% of total	abundance	% of total
248	373	128	34	21	6	212	57	1	0	11	3
252	418	216	52	33	8	97	23	2	0	70	17
288	423	147	35	63	15	164	39	0	0	49	12
296	126	91	72	15	12	11	9	7	6	2	2
323	356	36	10	178	50	137	38	0	0	5	1
336	308	62	20	159	52	79	26	0	0	8	3
Minimum	27.00	19.00	10.11	0.00	0.00	1.00	0.44	0.00	0.00	0.00	0.00
Maximum	1075.00	266.00	84.09	405.00	56.86	382.00	56.84	10.00	8.26	70.00	16.75
Median	225.00	86.50	45.80	21.50	15.18	59.50	33.31	0.50	0.09	5.00	2.50
Mean	272.87	106.80	48.36	58.30	19.83	91.77	27.02	2.10	1.19	13.90	3.60
STDEV	233.91	72.94	21.66	82.33	16.21	101.71	17.59	3.18	2.23	20.14	3.82

STDEV – standard deviation.

Table 13. Estimated incidence and spatial extent of sediment quality in the 2004 PSAMP Sediment Component Hood Canal regional survey as measured with the Sediment Quality Triad Index.

Sediment Quality Triad Index Category	Incidence		Spatial extent	
	Number of stations	(%) of stations	km^2	(%) of study area
Hood Canal	30	(100.0)	294.8	(100.0)
High[1]	7	(23.3)	64.6	(21.9)
Intermediate/high[2]	18	(60.0)	178.1	(60.4)
Chemistry	0	(0.0)	0.0	(0.0)
Toxicity	0	(0.0)	0.0	(0.0)
Infaunal	18	(60.0)	178.1	(60.4)
Intermediate/degraded[3]	5	(16.7)	52.1	(17.7)
Chemistry/toxicity	0	(0.0)	0.0	(0.0)
Chemistry/infaunal	0	(0.0)	0.0	(0.0)
Infaunal/toxicity	5	(16.7)	52.1	(17.7)
Degraded[4]	0	(0.0)	0.0	(0.0)

[1] No parameters impaired.
[2] One parameter impaired (chemistry, toxicity, or benthos).
[3] Two parameters impaired (chemistry, toxicity, and/or benthos).
[4] Three parameters impaired (chemistry, toxicity, and benthos).

Table 14. Comparisons in estimated incidence and spatial extent of chemical contamination in surveys of Hood Canal and Puget Sound.

Survey Guideline	Incidence		Spatial extent	
	Number of stations	(%) of stations	km^2	(%) of study area
Hood Canal 2004	30	(100.0)	294.8	(100.0)
ERM	0	(0.0)	0	(0.0)
SQS	0	(0.0)	0	(0.0)
CSL	0	(0.0)	0	(0.0)
Hood Canal 1999	21	(100.0)	316.4	(100.0)
ERM	2	(9.5)	2.8	(0.9)
SQS	1	(4.8)	1.6	(0.5)
CSL	0	(0.0)	0	(0.0)
Puget Sound 1997-2003	381	(100.0)	2388.6	(100.0)
ERM	39	(10.2)	30.7	(1.3)
SQS	59	(15.5)	109.6	(4.6)
CSL	24	(6.3)	60.1	(2.5)

ERM = Effects Range Median (Long et al., 1995).
SQS = Sediment Quality Standard (Washington Dept. of Ecology, 1995a,b).
CSL = Cleanup Screening Level (Washington Dept. of Ecology, 1995a,b).

Table 15. Comparisons in estimated incidence and spatial extent of toxicity measured with sea urchin fertilization test in surveys of Hood Canal and Puget Sound.

Toxicity to sea urchins	Incidence		Spatial extent	
	Number of stations	(%) of stations	km^2	(%) of study area
Hood Canal 2004	30	(100.0)	294.8	(100.0)
100% porewater	5	(16.7)	52.1	(17.7)
50% porewater	4	(13.3)	42.9	(14.5)
25% porewater	2	(6.7)	22.4	(7.6)
Hood Canal 1999	21	(100.0)	316.4	(100.0)
100% porewater	3	(14.3)	38.5	(12.2)
50% porewater	0	(0.0)	0.00	(0.0)
25% porewater	0	(0.0)	0.00	(0.0)
Puget Sound 1997-2003	381	(100.0)	2388.6	(100.0)
100% porewater	40	(10.5)	117.6	(4.9)
50% porewater	15	(3.9)	21.5	(0.9)
25% porewater	12	(3.1)	14.6	(0.6)

Table 16. Comparisons in estimated incidence and spatial extent of categories of relative sediment Quality based on the Sediment Quality Triad for Hood Canal surveys.

Sediment Quality Triad Index Category	Incidence		Spatial extent	
	Number of stations	(%) of stations	km^2	(%) of study area
Hood Canal 2004	30	(100.0)	294.8	(100.0)
High[1]	7	(23.3)	64.6	(21.9)
Intermediate/high[2]	18	(60.0)	178.1	(60.4)
Intermediate/degraded[3]	5	(16.7)	52.1	(17.7)
Degraded[4]	0	(0.0)	0	(0.0)
Hood Canal 1999	21	(100.0)	316.4	(100.0)
High[1]	7	(33.3)	111.2	(35.1)
Intermediate/high[2]	10	(47.6)	165.1	(52.2)
Intermediate/degraded[3]	4	(19.1)	40.1	(12.7)
Degraded[4]	0	(0.0)	0.0	(0.0)
Puget Sound 1997-2003	381	(100.0)	2388.6	(100.0)
High[1]	241	(63.3)	2006.8	(84.0)
Intermediate/high[2]	89	(23.4)	332.9	(13.9)
Intermediate/degraded[3]	36	(9.4)	44.8	(1.9)
Degraded[4]	15	(3.9)	4.1	(0.2)

[1] No parameters impaired.
[2] One parameter impaired (chemistry, toxicity, or benthos).
[3] Two parameters impaired (chemistry, and/or toxicity, and/or benthos).
[4] All three parameters impaired (chemistry, toxicity, and benthos).

Appendices

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Appendix A. Historical Surveys Conducted in Hood Canal and SEDQUAL Station Locations and Chemicals Exceeding Washington State Sediment Quality Standards

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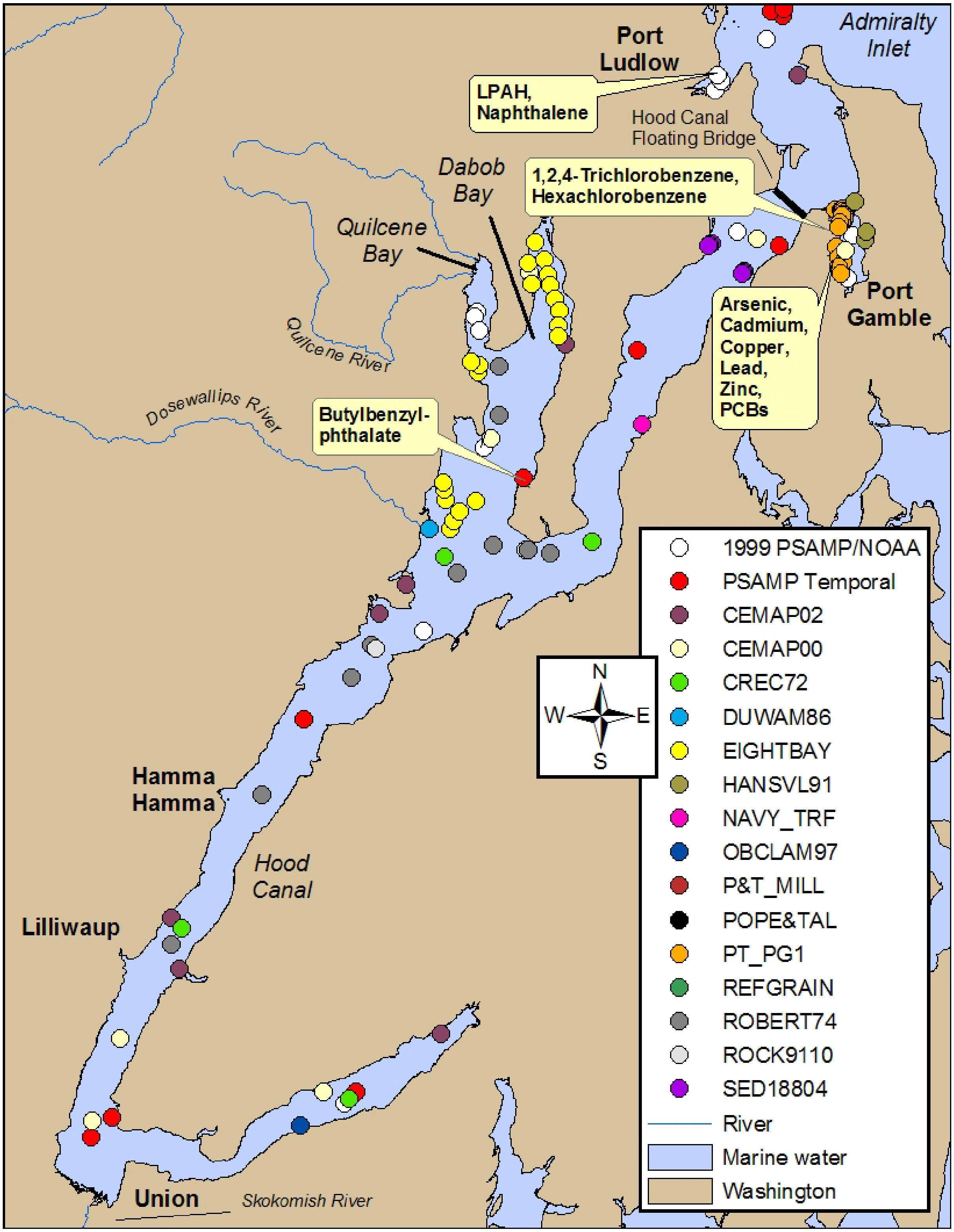

Figure A-1. SEDQUAL station locations and chemicals exceeding Washington State Sediment Quality Standards (SQS) in 17 sediment quality surveys conducted in the PSAMP Sediment Component Hood Canal region.

Table A-1. Historical surveys previously conducted in Hood Canal from which data were archived in the SEDQUAL database.

Survey ID	Reference Title	Survey Description	Survey Begin Date	Survey End Date	Survey Chief Scientist	Survey Agency Name
CEMAP00	National Coastal Assessment QA Project Plan 2001-2004	Coastal EPA/EMAP 2000	6/3/1997	10/11/2000	Valerie Partridge	U.S. Environmental Protection Agency/Washington State Department of Ecology
CEMAP02	National Coastal Assessment QA Project Plan 2001-2004	Coastal EPA/EMAP 2002	6/1/2002	11/12/2002	Valerie Partridge	U.S. Environmental Protection Agency/Washington State Department of Ecology
CREC72	Metals in Puget Sound Sediments 1970-1972	Metals in Puget Sound sediments 1970-72	1/1/1972	1/1/1972	Eric A. Crecelius	Department of Oceanography, University of Washington
DUWAM86	National Benthic Surveillance Project: Pacific Coast. Part II. Technical Presentation of the Results for Cycles I to III (1984-1986). NOAA Technical Memorandum NMFS F/NWC-170.	NOAA'S Duwamish River Study	5/1/1986	6/20/1986		NOAA
EIGHTBAY	Reconnaissance Survey of Eight Bays in Puget Sound. Volumes I and II.	1985 Puget Sound Eight-Bay survey.	8/6/1983	5/29/1984		
HANSVL91	Site Hazard Assessment Report; Hansville Landfill Kitsap County, Washington	Hansville Landfill Site Hazard Assessment	5/31/1991	6/5/1991	Elaine Atkinson	Washington State Department of Ecology
MSMP/ NOAA	Puget Sound Assessment and Monitoring Program Marine Sediment Monitoring Component - Final Quality Assurance Project and Implementation Plan. Measures of bioeffects associated with toxicants in Puget Sound:	1999 PSAMP/NOAA Measures of Bioeffects	6/2/1997	6/30/1999	Maggie Dutch and Ed Long	Washington State Department of Ecology/NOAA
NAVY_TRF	U.S. Navy Bangor TRF Drydock Dredge	U.S. Navy Bangor TRF Drydock dredge	2/7/1992	4/7/1992	S. Stirling, Corps	U.S. Navy
OBCLAM97	Treatability Study for Operable Unit 2, Marine Areas, Jackson Park Housing Complex/Naval Hospital, Bremerton. Volumes I and II.	Clam study, Ostrich Bay	12/1/1997	12/11/1997	Larry Tucker, USN	U.S. Navy Eng Field Activity-NW Poulsbo WA

Survey ID	Reference Title	Survey Description	Survey Begin Date	Survey End Date	Survey Chief Scientist	Survey Agency Name
P&T_MILL	Former Pope & Talbot, Inc. Mill Site - Port Gamble, WA	Pope and Talbot Mill Site Sediment	6/24/2002	9/5/2002	Phil Struck	Pope & Talbot
POPE&TAL	Log Raft/Chip Barge Area, Port Gamble	Log raft/chip barge area, Port Gamble.	12/28/1988	12/29/1988	D. Kendall (Corps)	U.S. Army Corps of Engineers
PSAMP_LT	Puget Sound Assessment and Monitoring Program 1989 Marine Sediment Monitoring Final Report	PSAMP Sediment Monitoring	1/1/1989	5/5/2001	Maggie Dutch	Washington State Department of Ecology
PT_PG1	Pope and Talbot - Port Gamble 1	Pope and Talbot - Port Gamble 1	3/6/2000	3/8/2000	Jennifer Hawkins	Parametrix, Inc.
REFGRAIN	Misc. PS Reference Area Grain Size	Misc. PS Reference area grain size	11/23/1981	7/1/1987	Dewitt, Broad, Chapman	Western Washington University, NOAA, Oregon State University
ROBERT74	Puget Sound & Strait JdF Grain Size	Puget Sound & Strait Juan de Fuca Grain Size	6/19/1950	3/1/1973	Richard W. Roberts	Department of Oceanography, University of Washington
SED18804	Puget Sound Reconnaissance Survey-Spri	Puget Sound Reconnaissance Survey	4/19/1988	5/28/1988	Eric Crecelius	U.S. Environmental Protection Agency, Region X, Seattle

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Appendix B. Navigation Report for the 2004 PSAMP Sediment Component Sampling Stations

Table B-1. Navigation report for the 2004 PSAMP Sediment Monitoring Program sampling stations.

Station number	Station location	Date	Time	Meter wheel depth (m)	Station target NAD 1983 (degrees, decimal minutes)				Actual NAD 1983 (degrees, decimal minutes)			
					Latitude		Longitude		Latitude		Longitude	
8	Hazel Pt.	04/Jun/2004	10:44	66	47	40.668	122	45.667	Not Recorded		Not Recorded	
			Not Recorded		47	40.668	122	45.667				
					47	40.668	122	45.667				
16	Oak Lake	09/Jun/2004	11:32	80	47	29.511	123	2.431	47	29.428	123	2.478
			11:57		47	29.511	123	2.431	47	29.421	123	2.479
24	Vinland	03/Jun/2004	16:14	47	47	47.023	122	43.392	47	47.015	122	43.233
			16:30		47	47.023	122	43.392	47	47.015	122	43.236
			16:45		47	47.023	122	43.392	47	47.013	122	43.235
			16:55		47	47.023	122	43.392	47	47.012	122	43.233
			17:09		47	47.023	122	43.392	47	47.015	122	43.235
32	Broad Spit	07/Jun/2004	10:50	110	47	48.192	122	48.269	47	48.119	122	48.161
			11:05		47	48.192	122	48.269	47	48.114	122	48.166
			11:20		47	48.192	122	48.269	47	48.113	122	48.169
48	Pulali Pt.	07/Jun/2004	15:10	174	47	44.156	122	49.982	47	44.104	122	49.589
			15:20		47	44.156	122	49.982	47	44.088	122	49.594
			15:37		47	44.156	122	49.982	47	44.102	122	49.596
			15:52		47	44.156	122	49.982	47	44.089	122	49.589
56	Stavis Bay	04/Jun/2004	Not Recorded	164	47	38.502	122	53.543	Not Recorded		Not Recorded	
					47	38.502	122	53.543				
					47	38.502	122	53.543				

Station number	Station location	Date	Time	Meter wheel depth (m)	Station target NAD 1983 (degrees, decimal minutes)				Actual NAD 1983 (degrees, decimal minutes)			
					Latitude		Longitude		Latitude		Longitude	
60	Seal Rock	07/Jun/2004	17:52	153	47	42.088	122	51.909	47	42.048	122	51.547
			18:13		47	42.088	122	51.909	47	42.053	122	51.55
			18:29		47	42.088	122	51.909	47	42.062	122	51.55
64	Musquiti Pt. North	10/Jun/2004	11:07	95	47	23.873	123	7.165	47	23.579	123	7.325
			11:22		47	23.873	123	7.165	47	23.584	123	7.326
			11:34		47	23.873	123	7.165	47	23.59	123	7.322
75	Coon Bay	02/Jun/2004	17:10	95	47	54.148	122	36.417	47	54.088	122	36.249
			17:30		47	54.148	122	36.417	47	54.086	122	36.251
			17:51		47	54.148	122	36.417	47	54.088	122	36.248
			18:07		47	54.148	122	36.417	47	54.086	122	36.249
80	Sylopash Pt.	08/Jun/2004	9:23	98	47	42.224	122	52.969	47	40.136	122	52.586
			9:41		47	42.224	122	52.969	47	40.137	122	52.587
			9:55		47	42.224	122	52.969	47	40.135	122	52.588
88	North Four Corners	03/Jun/2004	12:03	57	47	50.033	122	39.010	47	50.023	122	39.056
			12:11		47	50.033	122	39.010	47	50.02	122	39.056
			12:24		47	50.033	122	39.010	47	50.021	122	39.057
			12:35		47	50.033	122	39.010	47	50.023	122	39.055
			12:54		47	50.033	122	39.010	47	50.023	122	39.056
92	Zelatched Pt.	07/Jun/2004	16:43	159	47	42.833	122	50.754	47	42.498	122	50.448
			16:56		47	42.833	122	50.754	47	42.501	122	50.45
			17:14		47	42.833	122	50.754	47	42.497	122	50.455
96	Sund Creek	10/Jun/2004	8:21	132	47	26.930	123	6.048	47	23.551	123	6.291
			8:35		47	26.930	123	6.048	47	23.555	123	6.292
			8:53		47	26.930	123	6.048	47	23.559	123	6.292
112	Tabook Pt.	07/Jun/2004	13:53	177	47	44.832	122	49.892	47	44.5	122	49.522
			14:14		47	44.832	122	49.892	47	44.497	122	49.518
			14:26		47	44.832	122	49.892	47	44.499	122	49.54

Station number	Station location	Date	Time	Meter wheel depth (m)	Station target NAD 1983 (degrees, decimal minutes)				Actual NAD 1983 (degrees, decimal minutes)			
					Latitude		Longitude		Latitude		Longitude	
118	Shoofly Creek	09/Jun/2004	14:47	30	47	23.138	122	58.310	47	23.081	123	58.18
			14:50		47	23.138	122	58.310	47	23.075	123	58.175
			15:00		47	23.138	122	58.310	47	23.082	123	58.177
			15:12		47	23.138	122	58.310	47	23.087	123	58.176
			15:25		47	23.138	122	58.310	47	23.076	123	58.176
120	Fulton Creek South	08/Jun/2004	16:01	154	47	36.368	122	57.797	47	36.222	122	57.479
			16:11		47	36.368	122	57.797	47	36.226	122	57.471
			16:27		47	36.368	122	57.797	47	36.231	122	57.472
124	Seabeck	04/Jun/2004	Not Recorded	21	47	39.125	122	48.308	Not Recorded		Not Recorded	
					47	39.125	122	48.308				
					47	39.125	122	48.308				
					47	39.125	122	48.308				
					47	39.125	122	48.308				
128	Sisters Pt.	09/Jun/2004	16:16	38	47	21.403	123	3.014	47	21.239	123	3.011
			16:24		47	21.403	123	3.014	47	21.244	123	3.012
			16:41		47	21.403	123	3.014	47	21.239	123	3.005
			16:54		47	21.403	123	3.014	47	21.244	123	3.012
139	Twin Spits	02/Jun/2004	15:47	13	47	55.756	122	37.002	47	55.451	122	37.082
144	Fishermans Pt.	07/Jun/2004	12:12	45	47	47.122	122	51.918	47	47.077	122	51.553
			12:27		47	47.122	122	51.918	47	47.78	122	51.556
			12:33		47	47.122	122	51.918	47	47.75	122	51.55
			12:46		47	47.122	122	51.918	47	47.075	122	51.554
			12:58		47	47.122	122	51.918	47	47.078	122	51.554
152	Transit Station	03/Jun/2004	13:39	37	47	47.498	122	42.748	47	47.298	122	42.449
			13:51		47	47.498	122	42.748	47	47.301	122	42.45
			14:07		47	47.498	122	42.748	47	47.299	122	42.449
			14:22		47	47.498	122	42.748	47	47.298	122	42.451

Station number	Station location	Date	Time	Meter wheel depth (m)	Station target NAD 1983 (degrees, decimal minutes)				Actual NAD 1983 (degrees, decimal minutes)			
					Latitude		Longitude		Latitude		Longitude	
184	Misery Pt.	08/Jun/2004	10:46	113	47	40.448	122	51.924	47	40.264	122	55.422
			10:56		47	40.448	122	51.924	47	40.27	122	55.428
			11:14		47	40.448	122	51.924	47	40.267	122	55.422
			11:23		47	40.448	122	51.924	47	40.273	122	55.429
			11:38		47	40.448	122	51.924	47	40.277	122	45.425
188	King Spit	04/Jun/2004	8:25	109	47	43.112	122	45.931	Not Recorded		Not Recorded	
			8:45		47	43.112	122	45.931				
			9:05		47	43.112	122	45.931				
			9:25		47	43.112	122	45.931				
			9:40		47	43.112	122	45.931				
203	Hood Head	03/Jun/2004	10:11	75	47	52.954	122	36.905	47	52.574	122	36.542
			10:35		47	52.954	122	36.905	47	52.57	122	36.542
			10:51		47	52.954	122	36.905	47	52.572	122	36.542
			11:07		47	52.954	122	36.905	47	52.574	122	36.542
			11:15		47	52.954	122	36.905	47	52.572	122	36.542
216	Sisters	02/Jun/2004	Not Recorded	19	47	51.288	122	39.897	Not Recorded		Not Recorded	
			12:35		47	51.288	122	39.897	47	51.173	122	39.538
			12:51		47	51.288	122	39.897	47	51.176	122	39.541
224	Musquiti Pt.	10/Jun/2004	9:57	93	47	23.636	123	7.321	47	23.369	123	7.439
			10:09		47	23.636	123	7.321	47	23.372	123	7.32
			10:21		47	23.636	123	7.321	47	23.375	123	7.437
248	Tekiu Pt.	08/Jun/2004	15:41	25	47	35.239	122	57.132	47	35.305	122	57.107
			17:01		47	35.239	122	57.132	47	35.299	122	57.101
			17:06		47	35.239	122	57.132	47	35.305	122	57.107
			17:17		47	35.239	122	57.132	47	35.302	122	57.111
			17:34		47	35.239	122	57.132	47	35.304	122	57.106
			17:49		47	35.239	122	57.132	47	35.303	122	57.107
			17:55		47	35.239	122	57.132	47	35.3	122	57.101

Station number	Station location	Date	Time	Meter wheel depth (m)	Station target NAD 1983 (degrees, decimal minutes)				Actual NAD 1983 (degrees, decimal minutes)			
					Latitude		Longitude		Latitude		Longitude	
252	Maple Beach North	04/Jun/2004	Not Recorded	17	47	38.238	122	51.984	Not Recorded		Not Recorded	
					47	38.238	122	51.984				
					47	38.238	122	51.984				
					47	38.238	122	51.984				
272	South Holly	09/Jun/2004	10:15	48	47	32.597	122	59.775	47	32.453	123	0.112
			10:21		47	32.597	122	59.775	47	32.45	123	0.114
			10:31		47	32.597	122	59.775	47	32.467	123	0.205
288	Maple Beach South	04/Jun/2004	Not Recorded	14	47	38.266	122	52.267	Not Recorded		Not Recorded	
					47	38.266	122	52.267				
					47	38.266	122	52.267				
					47	38.266	122	52.267				
					47	38.266	122	52.267				
296	Fulton Creek North	08/Jun/2004	14:07	134	47	36.532	122	57.470	47	36.322	122	57.278
			14:25		47	36.532	122	57.470	47	36.323	122	57.272
			14:31		47	36.532	122	57.470	47	36.325	122	57.274
			14:47		47	36.532	122	57.470	47	33.224	122	57.282
			14:57		47	36.532	122	57.470	47	36.317	122	57.275
323	Coon Bay	14/Jun/2004	15:47	99	47	54.854	122	37.461	47	54.523	122	37.285
			15:57		47	54.854	122	37.461	47	54.521	122	37.288
			16:05		47	54.854	122	37.461	47	54.522	122	37.278
			16:16		47	54.854	122	37.461	47	54.527	122	37.284
			16:26		47	54.854	122	37.461	47	54.529	122	37.283
336	Bridgehaven	14/Jun/2004	13:49	72	47	50.216	122	39.403	47	50.389	122	39.137
			13:59		47	50.216	122	39.403	47	50.385	122	39.139
			14:13		47	50.216	122	39.403	47	50.379	122	39.137

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Appendix C. Department of Ecology Standard Operating Procedures for Measuring Dissolved Oxygen

SOP applies to Seacat 19

Pre-field Check and Preparation

If there is no note on the CTD, check batteries and general setup with seaterm (Windows-based program) or term1621, term19, term25, termafm, etc. (DOS based programs).

Secure the CTD to the line/cable (e.g., with a BOWLINE on marine flights: tape the tail of the knot to the line with duct tape, or secure it with an extra half-hitch to help prevent loosening. Tie the other end of the line to an emergency float). Terminate the electrical connection if acquiring real-time data. Note: the CTD must be correctly configured to work with a deck box.

If there is a pH probe, remove the pH storage solution bottle and either discard the solution, or cap to save. Remove Tygon tubing & syringe with distilled water from the base of the TC duct. Try to be gentle!

Sampling Procedure

Turn CTD on while still on deck. Record the "on" time.

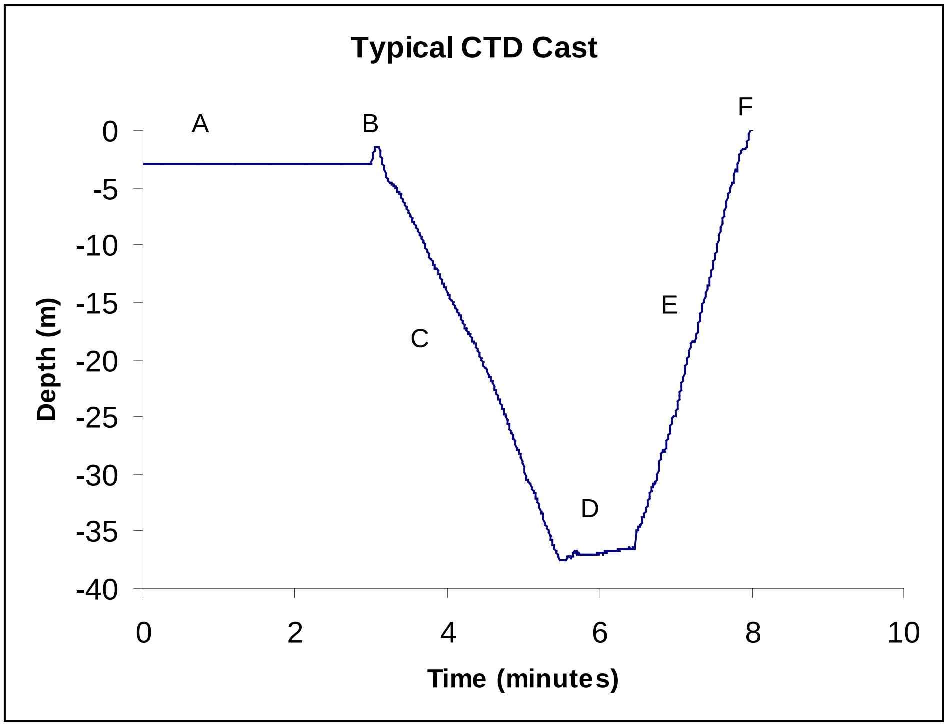
Lower the unit completely into the water, deeper if there are waves. Hold for at least 3 MINUTES (Fig. 2, "A"). Purpose: this helps to condition the DO sensor & bring the CTD to water temperature.

Raise the CTD to the mark (often-yellow tape - or- top of the instruments) and hold for 6 SECONDS (Fig. 2, "B"). Purpose: this helps us to get as much of the water column as possible. Using the position tape will allow us to compare surface-bin data from other locations. The delay also allows for entrainment caused by raising the CTD to pass. More than a 6-second delay might cause a loss of prime. Note the time of downcast.

Lower the CTD at a constant rate of 25 cm/s or 0.25 m/s (Fig. 2, "C"). On deeper casts it may be advisable to double this speed ***below 30m*** or so. The rate of lowering and raising depends on station depth, conditions, etc.

The time to hold near the bottom depends on the station. If there is low DO and little danger of mud or snagging, try to hold it for at least 1 MINUTE (Fig. 2, "D"). Otherwise, at least 6 SECONDS. Purpose: the DO sensor again needs time to adapt to ambient conditions.

The upcast can be done faster, unless you're firing bottles (Fig. 2, "E"). If using the AFM experience will dictate which depth offsets to use at faster winch speeds. Check to make sure that the CTD is pumping at the end of the cast (visually or by feel at the pump exhaust). Clean if necessary or use wire for purge valve.



Turn the CTD off -- note the time. The pressure offset (Poff) will be set so that the last scan, when the CTD is out of the water and at water temperature, is 0 dbar (Fig. 2, “F”).

Clean the fluorometer and transmissometer surfaces (if sensors are included on the package) with DI water. Secure the CTD between stations.

Post Field Procedure

Rinse the CTD with copious amounts of freshwater. Replace the pH storage solution. Backflush and fill from the TC duct to a point above the DO sensor with 1% Triton-X detergent solution (use gloves - possibly carcinogenic). After a 20-minute soak, flush with tap water until all suds disappear, then fill with DI water to a point above the DO sensor for storage. Stow the CTD someplace where it will not go below freezing.

Uploading Data from CTD:

Take dummy plug off CTD connection and plug in 4-prong end of communication cable to the CTD and the 9-pin serial connection to the serial port of the computer.

Launch SEATERM.
Click “Connect”.

Click “Status” – Check # of casts and voltage. (When CTD batteries are full voltage ~ 12.0, marginal charge if voltage <8.0 --- change batteries before next use. ** CTD uses 6 D batteries)

Click “Upload”

Put in project folder within data directory (D:\ drive) and name the file according to this filename format:
YYMMDDSTN.HEX

(e.g., 021210000 would be the first station for 10 December 2002).

→ Check file size in D:\ ~20 - 200 KB is normal

S.O.P.JGOFS Dissolved Oxygen Sample Collection Protocol

6.0 Sampling

6.1 Collection of water at sea

6.1.1 From the Niskin bottle or other sampler, must be done soon after opening the Niskin, preferably before any other samples have been drawn. This is necessary to minimize exchange of oxygen with the head space in the Niskin which typically results in contamination by atmospheric oxygen.

6.2 Sampling procedure

6.2.1 Before the oxygen sample is drawn the spigot on the sampling bottle is opened while keeping the breather valve closed. If no water flows from the spigot it is unlikely that the bottle has leaked. If water does leak from the bottle it is likely that the Niskin has been contaminated with water from shallower depths. The sample therefore may be contaminated, and this should be noted on the cast sheet.

6.2.2 The oxygen samples are drawn into the individually numbered BOD bottles. It is imperative that the bottle and stopper are a matched pair. Two samples are drawn from each Niskin and the order of sampling is recorded.

6.2.3 When obtaining the water sample, great care is taken to avoid introducing air bubbles into the sample. A 30–50 cm length of Tygon tubing is connected to the Niskin bottle spout. The end of the tube is elevated before the spout is opened to prevent the trapping of bubbles in the tube. With the water flowing, the tube is placed in the bottom of the horizontally held BOD bottle in order to rinse the sides of the flask and the stopper. The bottle is turned upright and the side of the bottle tapped to ensure that no air bubbles adhere to the bottle walls. Four-five volumes of water are allowed to overflow from the bottle. The tube is then slowly withdrawn from the bottle while water is still flowing.

6.2.4 Immediately after obtaining the seawater sample, the following reagents are introduced into the filled BOD bottles by submerging the tip of a pipette or automatic dispenser well into the sample: 1 ml of manganous chloride, followed by 1 ml of sodium iodide-sodium hydroxide solution.

6.2.5 The stopper is carefully placed in the bottle ensuring that no bubbles are trapped inside. The bottle is vigorously shaken, then reshaken roughly 20 minutes later when the precipitate has settled to the bottom of the bottle.

6.2.6 After the second oxygen sample is drawn, the temperature of the water from each Niskin is measured and recorded.

6.2.7 Sample bottles are stored upright in a cool, dark location and the necks water sealed with saltwater. These samples are analyzed after a period of at least 6-8 hours but within 24 hours. The samples are stable at this stage.

Dissolved Oxygen Determination with Dosimat. The Carpenter method for marine waters

This Standard Operating Procedure (SOP) does not attempt to describe the entire procedure for marine waters Dissolved Oxygen (DO) determination, but only the laboratory portion. It assumes that proper sampling protocols have been followed, that the sample was collected in a 130 mL DO flask, and that the sample has had 1 mL manganous chloride solution, followed by 1 ml of alkaline sodium hydroxide-sodium iodide reagent added soon after sampling. Care must have been taken to seal the sample bottle(s), excluding all air bubbles.

*Prior to titration, **1 mL of sulfuric acid** must be added. If samples are expected to be low in oxygen (<2 mg/L), then sodium azide should be added to the alkaline sodium hydroxide-sodium iodide reagent.

Materials Needed

a. Personal Protective Equipment:

- Safety glasses
- Butyl rubber gloves
- Chemical apron

b. Equipment Needed:

- Dosimat titrator with magnetic stirrer and stir bar
- Squeeze bottle of DI water
- Sulfuric acid (H_2SO_4), 10 N
- Sodium thiosulfate ($Na_2S_2O_3$), ~0.0100 N (will be standardized)
- Potassium iodate (KIO_3), 0.0100 N
- Starch, aqueous solution
- Manganous chloride, 3 M
- Sodium hydroxide-sodium iodide, 8 N

1. Cleaning

   This is an analytical chemistry technique. The glassware and equipment -- standard and sample bottles, pipettes, stir bars, and buret tip must be kept ***scrupulously clean***. Thoroughly rinse the glassware with clean hot water before and after every analysis. Clean every three months using Liqui-Nox® and water. Clean the buret as needed.

2. To turn on the Dosimat

   a. Press the **FILL** button at the same time you turn on the **POWER** button (the red button in back).
   b. Press **GO**.
   c. Press **CLEAR**. The display should read **DOS 0.000 ml**.

3. To prepare to titrate

   a. Gently lift the amber bottle of thiosulfate. Shake, then replace in the Dosimat.
   b. Turn the dispense speed knob to 10. Dispense 15 ml of thiosulfate to flush out the buret (3-5 ml aliquots) by pressing the hand control button.
   c. Turn the dispense speed knob to 1.

d. Press the **CLEAR** button.
e. Rinse off the buret tip with deionized water.
f. Make sure there are no bubbles in the buret or moving bubbles in the line leading to the buret tip. (Some tiny bubbles may cling to tubing but, if not moving, can be ignored.)
g. Turn on the stirrer to 4.

4. Preparing and running O_2 standards
   a. Fill clean standard sample bottle ¾ full of distilled water.
   b. Add **1 ml H_2SO_4** and mix well.
   c. Slowly add **1 ml of NaOH-NaI** solution. Mix well.
      -- If sample is not clear, discard and start again.
   d. Using a 10 ml volumetric pipette, add **10 ml of the KIO_3 standard**.
   e. Add **1 ml of starch**.

Pipetting Tips:
-- Always shake the reagent before pipetting.
-- Draw reagent from a smaller vessel.
-- Hold the pipette straight up & down, never angled.
IMPORTANT: NEVER DRAIN LIQUID BACK INTO THE REAGENT BOTTLE.
-- Dispense into the sample bottle. Do not put the tip of the pipette against the wall of the sample bottle.
-- Rinse the sides of the sample bottle w/ DI water to rinse down any reagent that may have splashed onto the side.

The O_2 standard is now ready for titration.

   f. Run at least 3 standards; at least 2 out of 3 should agree to ± 0.001 ml.
   g. After analysis, rinse the bottles with hot water.
   h. Rinse the 10 ml volumetric pipette with hot water.
   i. Standards are run to determine the actual concentration of the thiosulfate (standardization).

5. Blanks
   a. Fill a standard sample bottle ¾ full of distilled water.
   b. Add **1 ml H_2SO_4** and mix well.
   c. Slowly add **1 ml of NaOH-NaI** solution. Mix well.
   d. Add **1 ml $MnCl_2$**. Mix well.
   e. Using an automatic pipette, add **1 ml KIO_3 standard**.
   f. Titrate sample to the endpoint.
      -- Add **starch** immediately (because the sample is light yellow.)
      -- Titrate slowly. Remember this is only 1/10 as strong as the standard.
   g. Record endpoint #1; this is Blank1.
   h. Add **1 ml more of KIO_3 standard**.
   i. Titrate to endpoint #2.
      -- (Endpoint #2) - (Endpoint #1) = Blank2.

j. (Blank1) - (Blank2) = Correction blank
k. Definitions:
   Blank1 (in ml) = volume of thiosulfate needed to titrate the first 1 ml KIO_3 + reagents
   Blank2 (in ml) = volume of thiosulfate needed to titrate the second 1 ml KIO_3
   Therefore, Blank1 - Blank2 = correction factor to account for any impurities in reagents.
   This value may be negative or positive or zero.

6. Titrating samples or standards
   a. If titrating a sample, carefully remove the cap, and rinse the glass bar.
   b. Add a clean stir bar.
   c. Position the sample bottle on the stirrer; make sure the buret tip is under the surface of the sample.
   d. Make sure that the Dosimat reads 0.000 ml (press **CLEAR** to zero).
   e. Titrate sample by dispensing thiosulfate in the sample.
      -- Use the thumb button to dispense thiosulfate.
   f. When the sample is light yellow in color, add **1 ml of starch** indicator.
   g. Titrate to endpoint.
      -- Endpoint is when all color is gone. Watch the vortex in the upper half of the bottle.
      -- The endpoint is subtle -- the difference between clear and sparkling clear.
   h. Record endpoint.
   i. Remove sample bottle; dispense a few drops of thiosulfate through the buret tip to flush out any sample residue.
   j. Rinse down the buret tip with deionized water.
   k. Press **CLEAR** to zero the Dosimat.

7. Disposal

The titrated sample, as well as the excess sample in the DO bottle, is rinsed down the drain with copious amounts of tap water. The solution is acidic so it must be diluted as much as possible to reduce any impact on the wastewater treatment plant. Do not pour down the “live” sink.

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Appendix D. Final Report on Toxicity Testing of Sediment Porewater from Hood Canal and Surrounding Areas, PSAMP 2004 and Retesting of Porewater from the San Juan Islands, Strait of Juan de Fuca, and Admiralty Inlet, Washington PSAMP 2003.

Appendix D is available only electronically **--** on the web and on a compact disk.
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Appendix E. NOAA Sediment Quality Guidelines and Washington State Sediment Management Standards

Table E-1. NOAA Sediment Quality Guidelines and Washington State Sediment Management Standards.

Chemical	NOAA Guidelines			Washington State Criteria		
	ERL[1]	ERM[1]	Unit[1]	SQS[2]	CSL[2]	Unit[2]
Trace metals						
Arsenic	8.2	70	PPM Dry Weight	57	93	PPM Dry Weight
Cadmium	1.2	9.6	PPM Dry Weight	5.1	6.7	PPM Dry Weight
Chromium	81	370	PPM Dry Weight	260	270	PPM Dry Weight
Copper	34	270	PPM Dry Weight	390	390	PPM Dry Weight
Lead	46.7	218	PPM Dry Weight	450	530	PPM Dry Weight
Mercury	0.15	0.71	PPM Dry Weight	0.41	0.59	PPM Dry Weight
Nickel	20.9	51.6	PPM Dry Weight	NA	NA	PPM Dry Weight
Silver	1	3.7	PPM Dry Weight	6.1	6.1	PPM Dry Weight
Zinc	150	410	PPM Dry Weight	410	960	PPM Dry Weight
Organic Chemicals						
LPAH						
2-Methylnaphthalene	70	670	PPB dry weight	38	64	PPM Organic Carbon
Acenaphthene	16	500	PPB dry weight	16	57	PPM Organic Carbon
Acenaphthylene	44	640	PPB dry weight	66	66	PPM Organic Carbon
Anthracene	85.3	1100	PPB dry weight	220	1200	PPM Organic Carbon
Fluorene	19	540	PPB dry weight	23	79	PPM Organic Carbon
Naphthalene	160	2100	PPB dry weight	99	170	PPM Organic Carbon
Phenanthrene	240	1500	PPB dry weight	100	480	PPM Organic Carbon
Sum of LPAHs:						
Sum of 6 LPAH (Ch. 173-204 WAC)	NA	NA		370	780	PPM Organic Carbon
Sum of 7 LPAH (Long et al., 1995)	552	3160	PPB dry weight	NA	NA	
HPAH						
Benzo(a)anthracene	261	1600	PPB dry weight	110	270	PPM Organic Carbon
Benzo(a)pyrene	430	1600	PPB dry weight	99	210	PPM Organic Carbon
Benzo(g,h,I)perylene	NA	NA		31	78	PPM Organic Carbon
Chrysene	384	2800	PPB dry weight	110	460	PPM Organic Carbon
Dibenzo(a,h)anthracene	63.4	260	PPB dry weight	12	33	PPM Organic Carbon

Chemical	NOAA Guidelines			Washington State Criteria		
	ERL[1]	ERM[1]	Unit[1]	SQS[2]	CSL[2]	Unit[2]
Fluoranthene	600	5100	PPB dry weight	160	1200	PPM Organic Carbon
Indeno(1,2,3-c,d)pyrene	NA	NA		34	88	PPM Organic Carbon
Pyrene	665	2600	PPB dry weight	1000	1400	PPM Organic Carbon
Total Benzofluoranthenes	NA	NA		230	450	PPM Organic Carbon
Sum of HPAHs:						
Sum of 9 HPAH (Ch. 173-204 WAC)	NA	NA		960	5300	PPM Organic Carbon
Sum of 6 HPAH (Long et al., 1995)	1700	9600	PPB dry weight	NA	NA	
Sum of 13 PAHs	4022	44792	PPB dry weight	NA	NA	
Phenols						
2,4-Dimethylphenol	NA	NA		29	29	PPB Dry Weight
2-Methylphenol	NA	NA		63	63	PPB Dry Weight
4-Methylphenol	NA	NA		670	670	PPB Dry Weight
Pentachlorophenol	NA	NA		360	690	PPB Dry Weight
Phenol	NA	NA		420	1200	PPB Dry Weight
Phthalate Esters						
Bis (2-Ethylhexyl) Phthalate	NA	NA		47	78	PPM Organic Carbon
Butylbenzylphthalate	NA	NA		4.9	64	PPM Organic Carbon
Diethylphthalate	NA	NA		61	110	PPM Organic Carbon
Dimethylphthalate	NA	NA		53	53	PPM Organic Carbon
Di-N-Butyl Phthalate	NA	NA		220	1700	PPM Organic Carbon
Di-N-Octyl Phthalate	NA	NA		58	4500	PPM Organic Carbon
Chlorinated Pesticide and PCBs						
4,4'-DDE	2.2	27	PPB dry weight	NA	NA	
Total DDT	1.58	46.1	PPB dry weight	NA	NA	
Total PCB:						
Total Aroclors (Ch. 173-204 WAC)	NA	NA		12	65	PPM Organic Carbon
Total congeners (Long et al., 1995):	22.7	180	PPB dry weight	NA	NA	
Miscellaneous Chemicals						
1,2-Dichlorobenzene	NA	NA		2.3	2.3	PPM Organic Carbon
1,2,4-Trichlorobenzene	NA	NA		0.81	1.8	PPM Organic Carbon
1,4-Dichlorobenzene	NA	NA		3.1	9	PPM Organic Carbon
Benzoic Acid	NA	NA		650	650	PPB Dry Weight

Chemical	NOAA Guidelines			Washington State Criteria		
	ERL[1]	ERM[1]	Unit[1]	SQS[2]	CSL[2]	Unit[2]
Benzyl Alcohol	NA	NA		57	73	PPB Dry Weight
Dibenzofuran	NA	NA		15	58	PPM Organic Carbon
Hexachlorobenzene	NA	NA		0.38	2.3	PPM Organic Carbon
Hexachlorobutadiene	NA	NA		3.9	6.2	PPM Organic Carbon
N-Nitrosodiphenylamine	NA	NA		11	11	PPM Organic Carbon

1. Long, Edward R., Donald D. Macdonald, Sherri L. Smith and Fred D. Calder. 1995. Incidence of adverse biological effect with ranges of chemical concentrations in marine and estuarine sediments. Environmental Management 19(1): 81-97.
2. Washington Department of Ecology, Sediment Management Standard Chapter 173-204, Amended December 1995

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Appendix F. Field Notes for the 2004 PSAMP Sediment Component Sampling Stations

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Table F-1. Field notes for the 2004 PSAMP Sediment Monitoring sampling stations. NR = Not Recorded.

Station number	Station location	Strata type	Depth (m)	Grab penetration (cm)	Sediment color	Composition	Odor	Odor intensity	Shell hash	Wood frag	Salinity (ppt)	Sediment temperature (°C)	RPD	Sheen	Submerged vegetation
8	Hazel Pt.	Basin	66	17	Olive over black	Silt/Clay	None	None	No	No	30	9.7	>5	No	No
24	Vinland	Basin	47	17	Brown	Silt/Clay	None	None	No	No	31	10.1	0	No	No
32	Broad South pit	Rural	110	17	Olive	Silt/Clay	None	None	No	No	30	9.4	0	No	No
48	Pulali Pt.	Rural	174	17	Olive over gray	Silt/Clay	None	None	No	No	30	10.3	NR	No	No
56	Stavis Bay	Basin	164	17	Olive over gray	Silt/Clay	None	None	No	No	NR	9.9	NR	No	No
60	Seal Rock	Rural	153	17	Olive	Silt/Clay	None	None	No	No	29	10.2	0	No	No
64	Musquiti Pt. North	Basin	95	17	Olive	Silt/Clay	None	None	No	No	30	9.8	0	No	No
75	Coon Bay	Basin	95	NR	Olive brown	Sand with fines	None	None	No	No	NR	NR	NR	No	No
80	Sylopash Pt.	Rural	98	17	NR	Sand with fines	None	None	No	No	29	9.3	NR	No	No
88	North Four Corners	Basin	57	12	Brown	Sand	None	None	No	No	31	10.1	1	No	No
92	Zelatched Pt.	Rural	159	17	Olive	Silt/Clay	None	None	No	No	28	10.2	0	No	No
96	Sund Creek	Basin	132	17	Olive	Silt/Clay	None	None	Yes	No	30	10	0	No	No
112	Tabook Pt.	Rural	177	17	Olive	Silt/Clay	None	None	No	Yes	29	10.6	0	No	Yes
118	Shoofly Creek	Rural	30	NR	Olive	Silt/Clay	None	None	No	No	28	9.9	0	No	No
120	Fulton Creek South	Basin	154	17	Olive	Silt/Clay	None	None	Yes	No	29	9.9	0	No	No
124	Seabeck	Basin	21	8	Brown	Sand	None	None	No	No	30	11.1	0	No	No
128	Sisters Pt.	Rural	38	16	Olive	Silt/Clay	None	None	No	No	29	11.2	0	No	No
144	Fishermans Pt.	Rural	45	17	Olive over black	Silt/Clay	None	None	No	No	28	9.2	0	No	No
152	Transit station	Basin	37	17	Brown	Sand with fines	None	None	No	No	31	10	0	No	No
184	Misery Pt.	Basin	113	16	Brown over olive	Sand with fines	None	None	No	No	30	10.4	0	No	No
188	King Spit	Basin	109	17	Olive over black	Silt/Clay	None	None	No	No	32	9.8	>5	No	No
203	Hood Head	Basin	75	14	Brown	Sand	None	None	No	No	31	9.9	0	No	Yes
216	Sisters	Basin	19	7	Brown	Sand with fines	None	None	No	No	30	10.5	0	No	No
224	Musquiti Pt.	Basin	93	17	Olive	Silt/Clay	None	None	No	No	30	9.8	0	No	No
248	Tekiu Pt.	Basin	25	6	Brown	Sand	None	None	No	No	29	10.3	0	No	No

Station number	Station location	Strata type	Depth (m)	Grab penetration (cm)	Sediment color	Composition	Odor	Odor intensity	Shell hash	Wood frag	Salinity (ppt)	Sediment temperature (°C)	RPD	Sheen	Submerged vegetation
252	Maple Beach North	Basin	17	7	Brown	Sand	None	None	No	No	30	11.5	0	No	No
288	Maple Beach South	Basin	14	7.5	Brown	Sand	None	None	No	No	29	11.6	0	No	No
296	Fulton Creek North	Basin	134	17	Olive	Silt/Clay	None	None	No	No	30	9.9	0	No	No
323	Coon Bay	Basin	99	6.5	Brown	Sand	None	None	No	No	30	10.3	0	No	No
336	Bridgehaven	Basin	72	14	Brown	Sand with fines	None	None	No	No	30	10.1	0	No	No

Appendix G. Sediment Grain Size Distribution, Total Organic Carbon Values, Near-bottom Dissolved Oxygen Measurements, and Chemical Concentrations at All Stations

Table G-1. Chemistry Case Narratives.

Table G-1 is available only electronically -- on the web and on a compact disk.

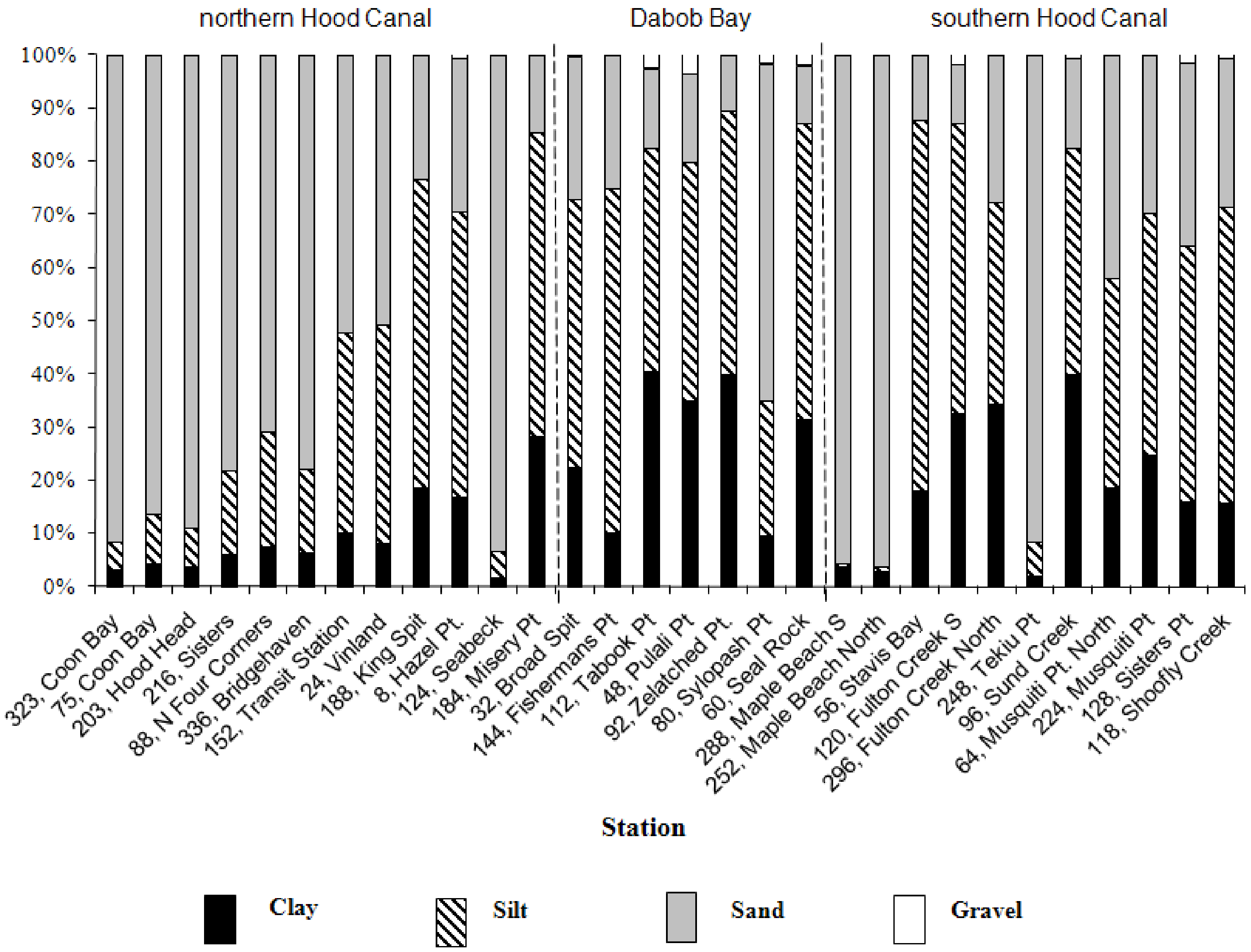

Figure G-1. Grain size distribution in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component (grain size fractions in percent).

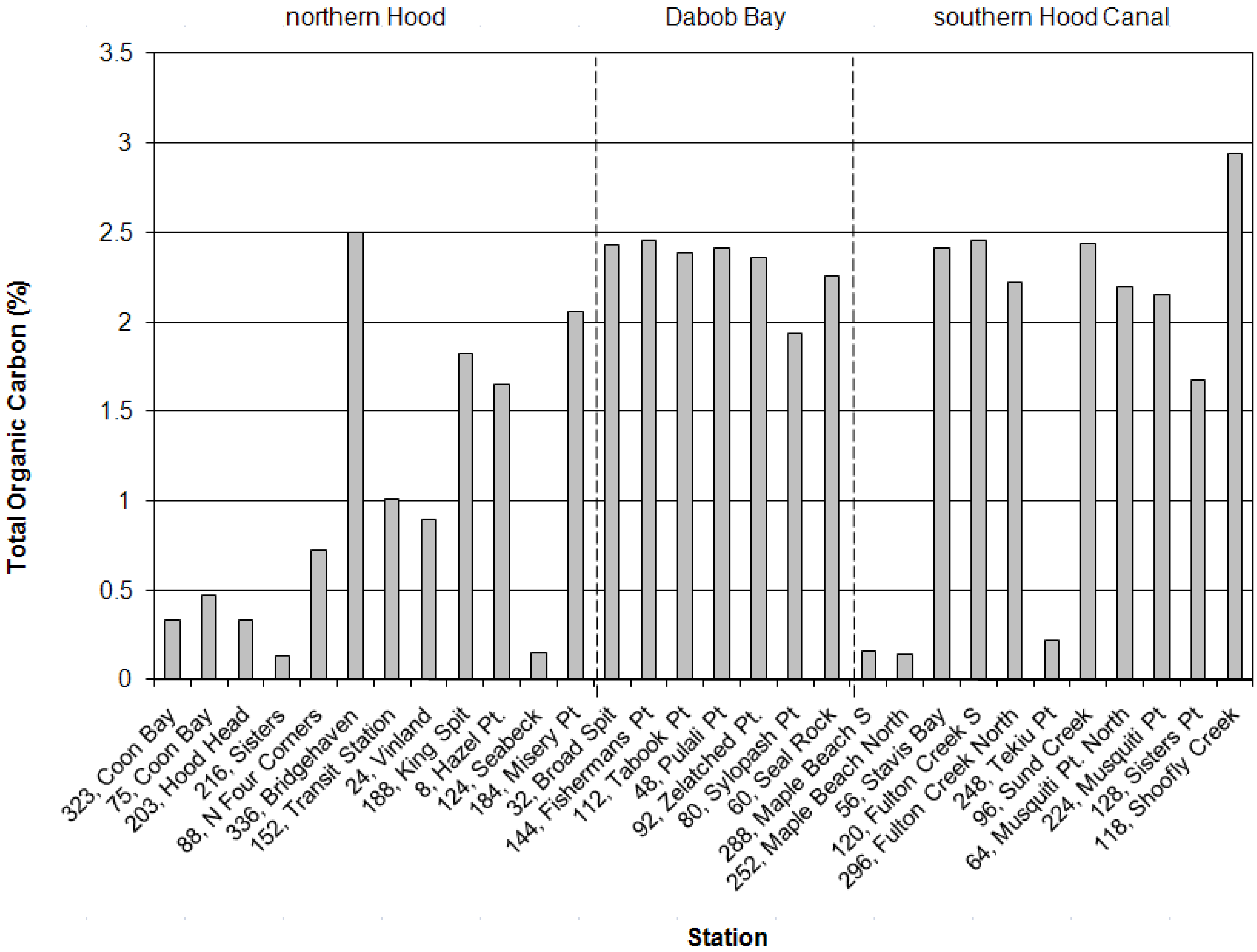

Figure G-2. Total organic carbon distribution in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.

Figure G-3. Metal and organic chemical distributions in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.
White bars = undetected values, gray bars = qualified values, and black = unqualified values.

Figure G-3 Cont. page 2. Metal and organic chemical distributions in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.
White bars = undetected values, gray bars = qualified values, and black = unqualified values.

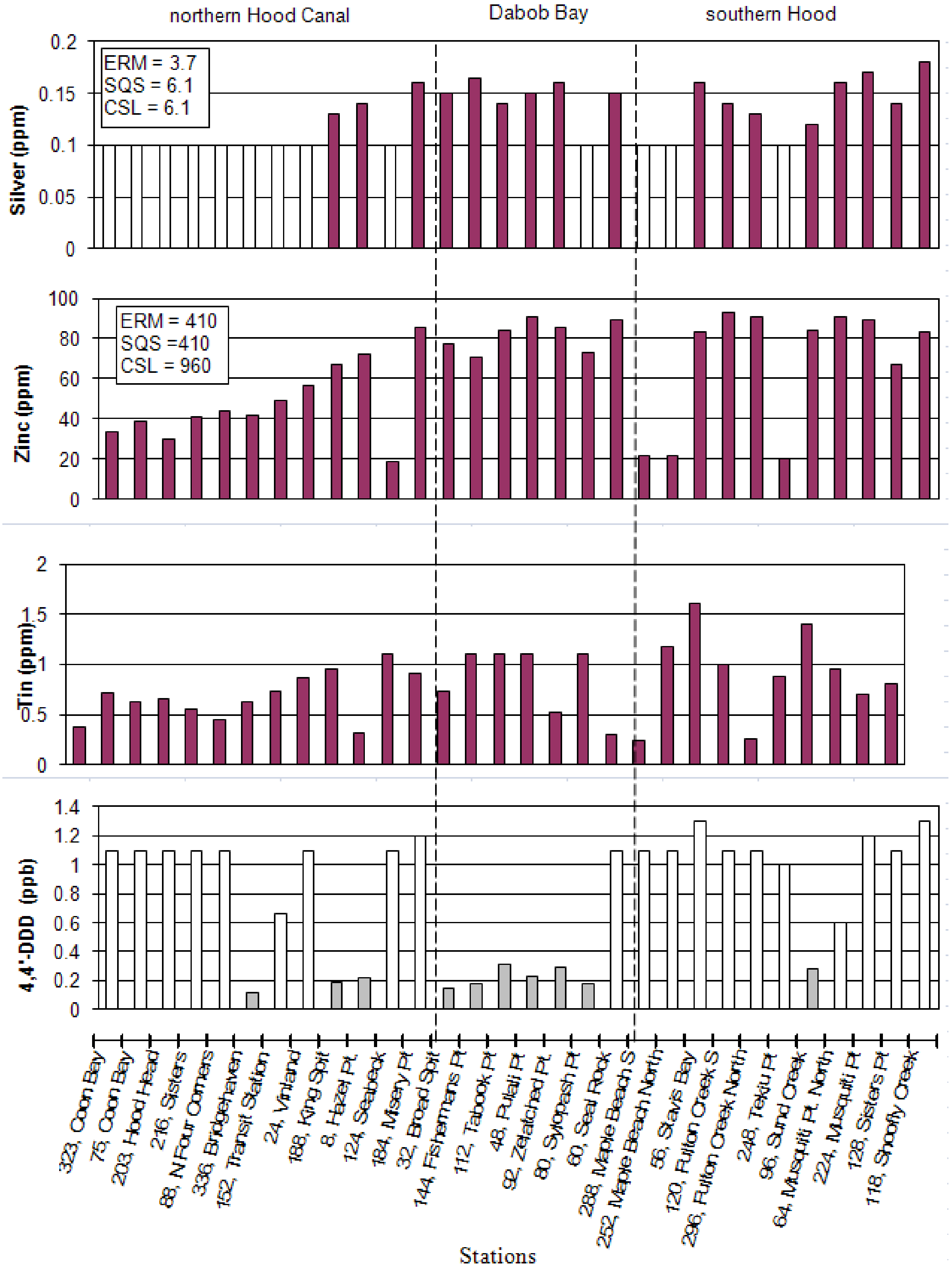

Figure G-3 Cont. page 3. Metal and organic chemical distributions in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.
White bars = undetected values, gray bars = qualified values, and black = unqualified values.

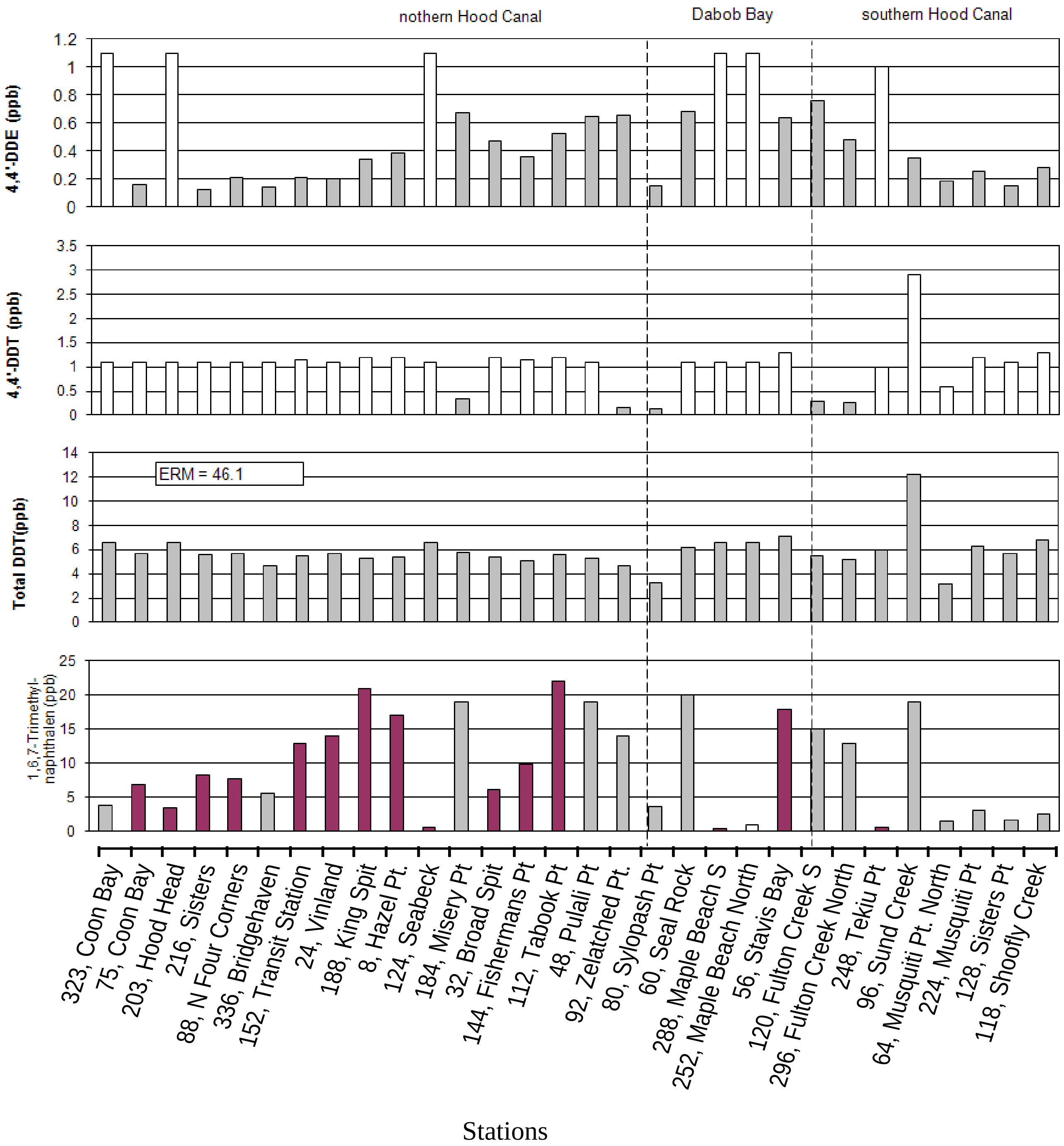

Figure G-3 Cont. page 4. Metal and organic chemical distributions in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.
White bars = undetected values, gray bars = qualified values, and black = unqualified values.

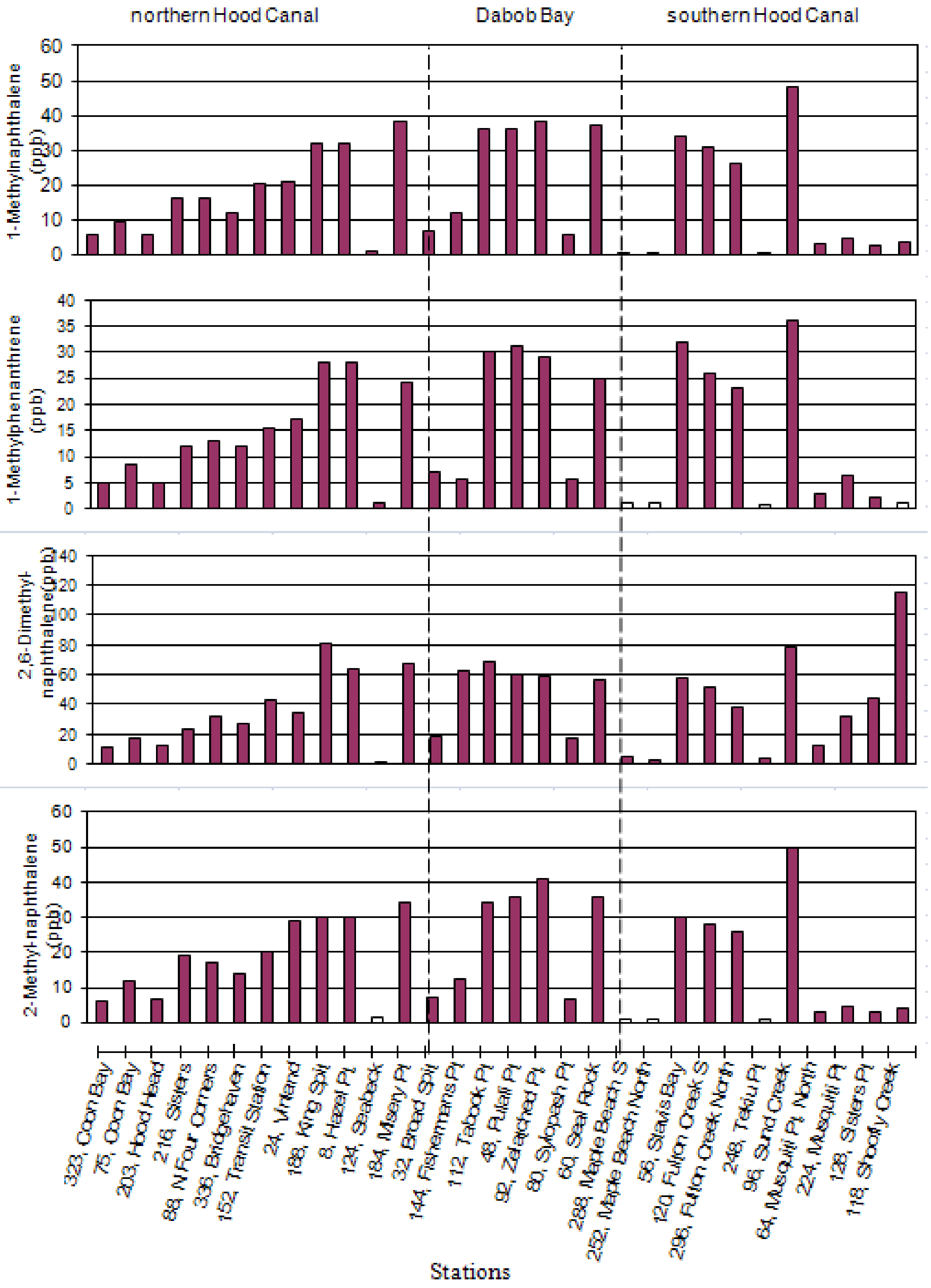

Figure G-3 Cont. page 5. Metal and organic chemical distributions in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.
White bars = undetected values, gray bars = qualified values, and black = unqualified values.

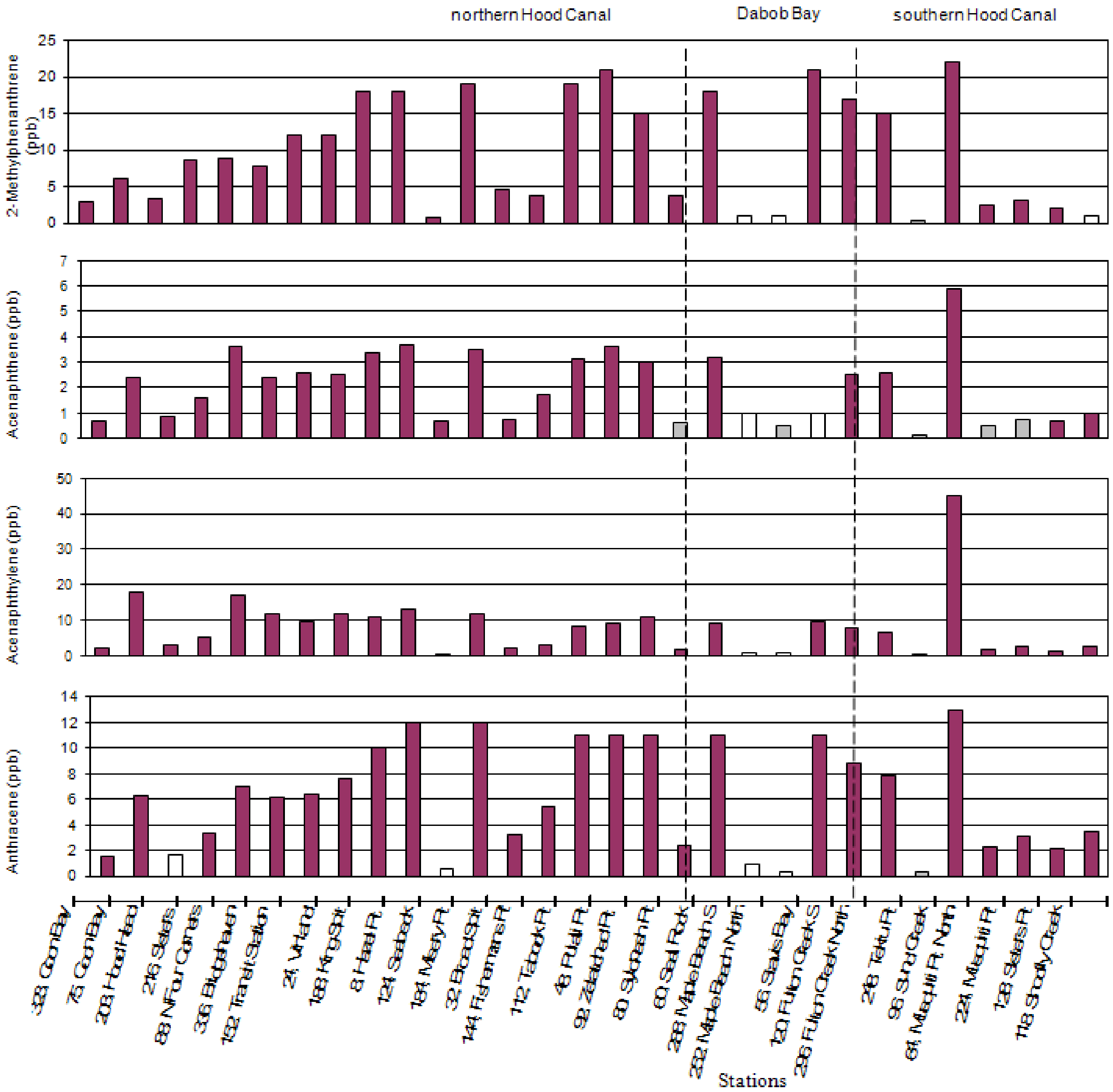

Figure G-3 Cont. page 6. Metal and organic chemical distributions in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.
White bars = undetected values, gray bars = qualified values, and black = unqualified values.

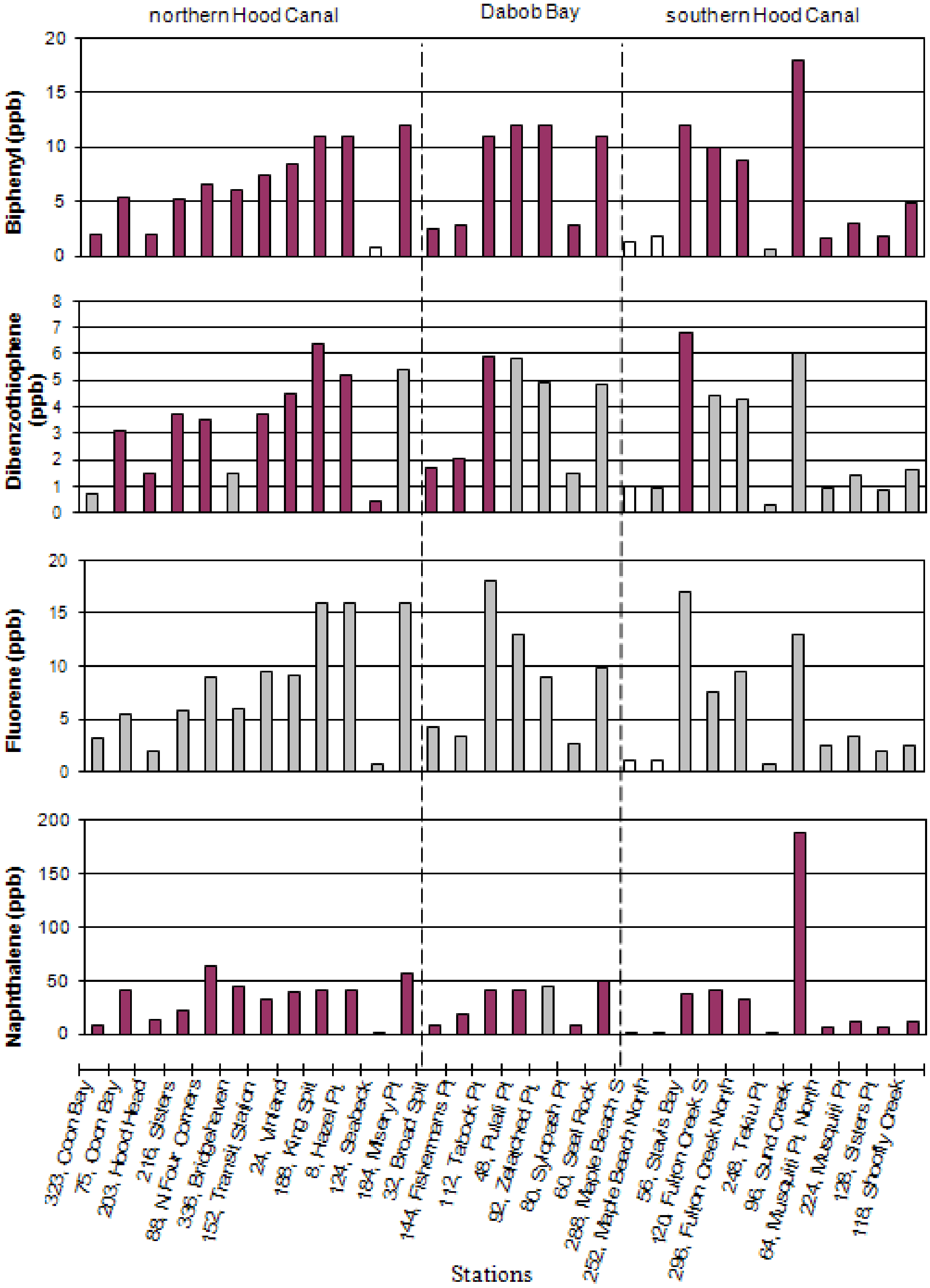

Figure G-3 Cont. page 7. Metal and organic chemical distributions in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.
White bars = undetected values, gray bars = qualified values, and black = unqualified values.

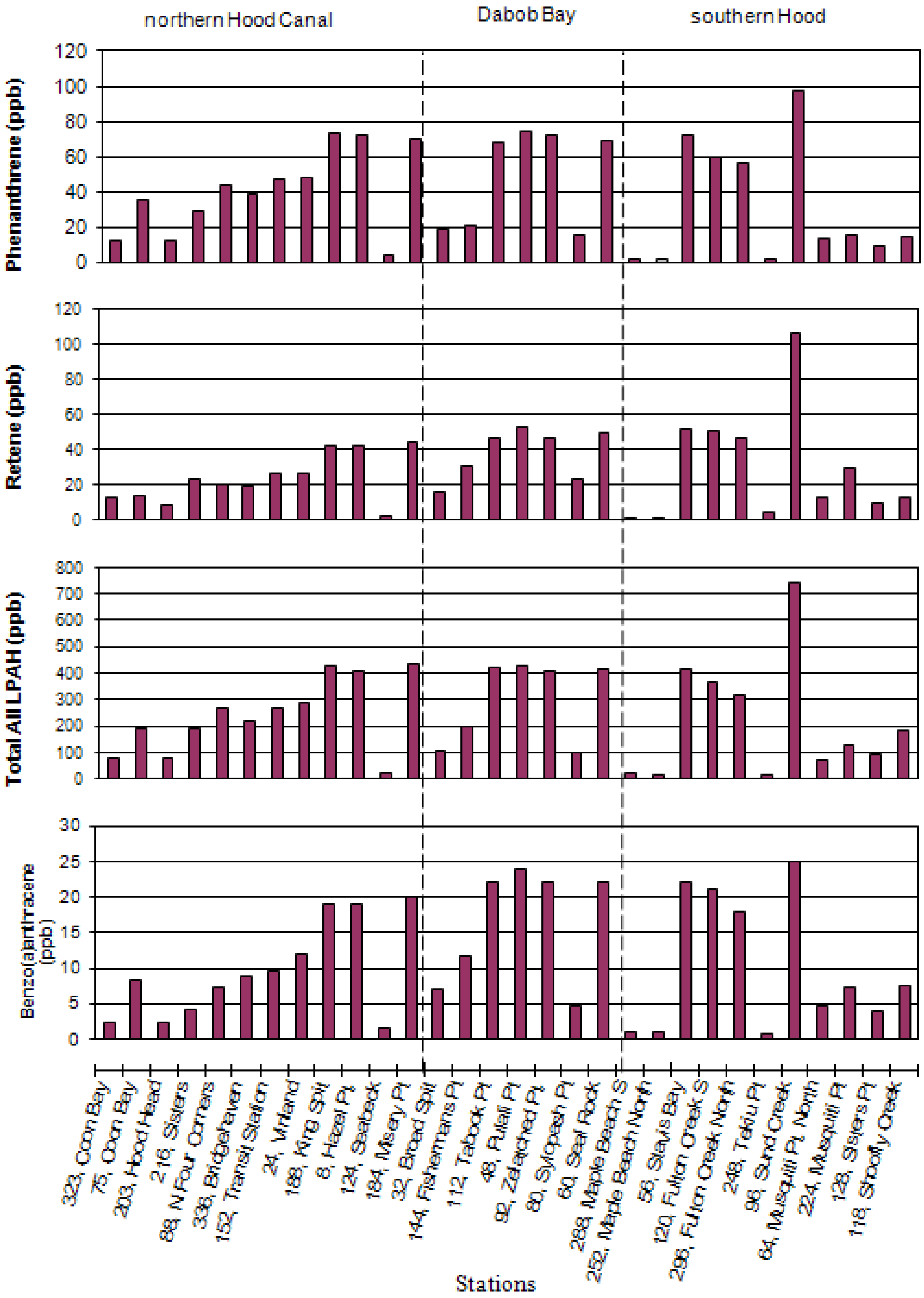

Figure G-3 Cont. page 8. Metal and organic chemical distributions in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.

White bars = undetected values, gray bars = qualified values, and black = unqualified values.

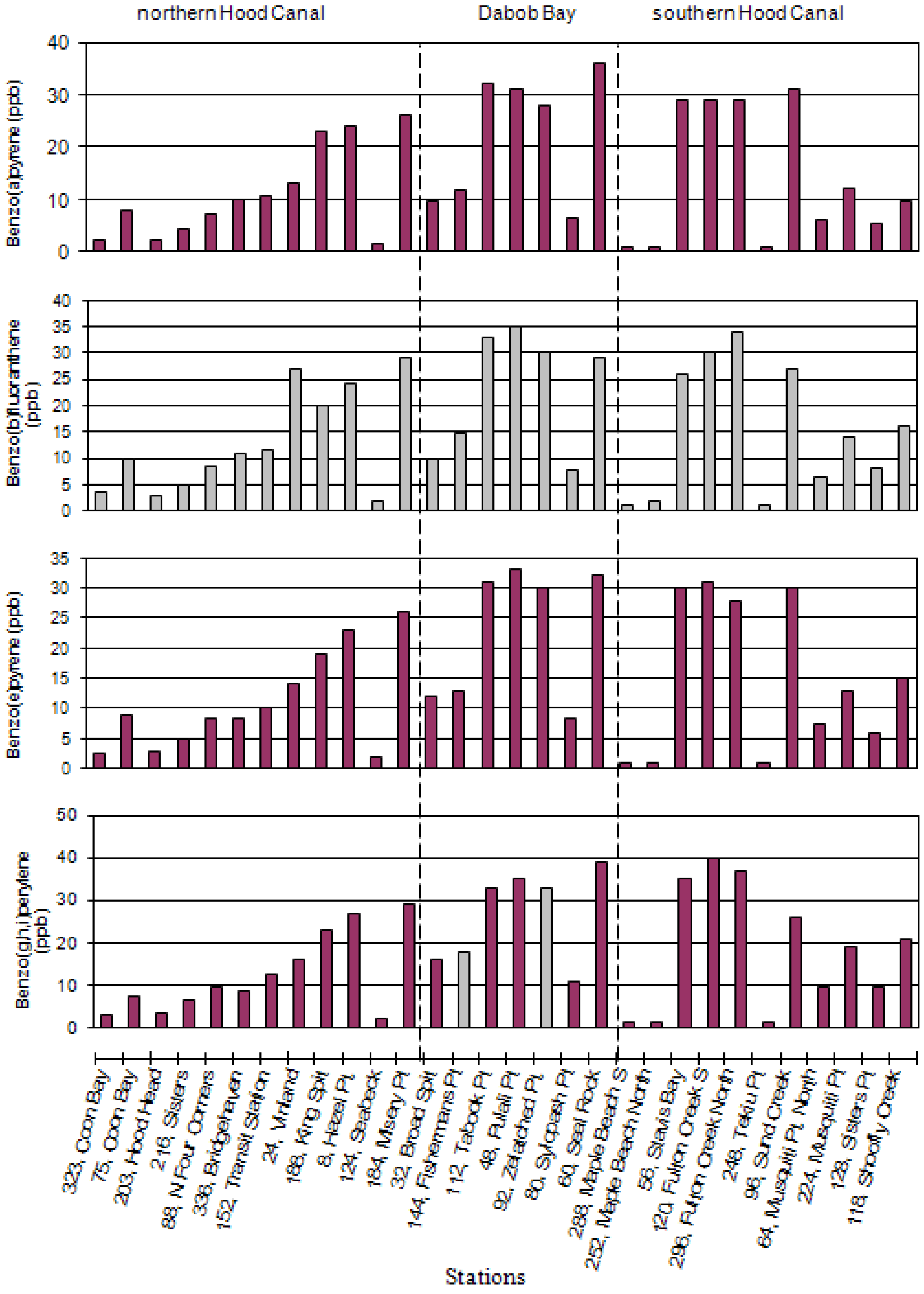

Figure G-3 Cont. page 9. Metal and organic chemical distributions in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.
White bars = undetected values, gray bars = qualified values, and black = unqualified values.

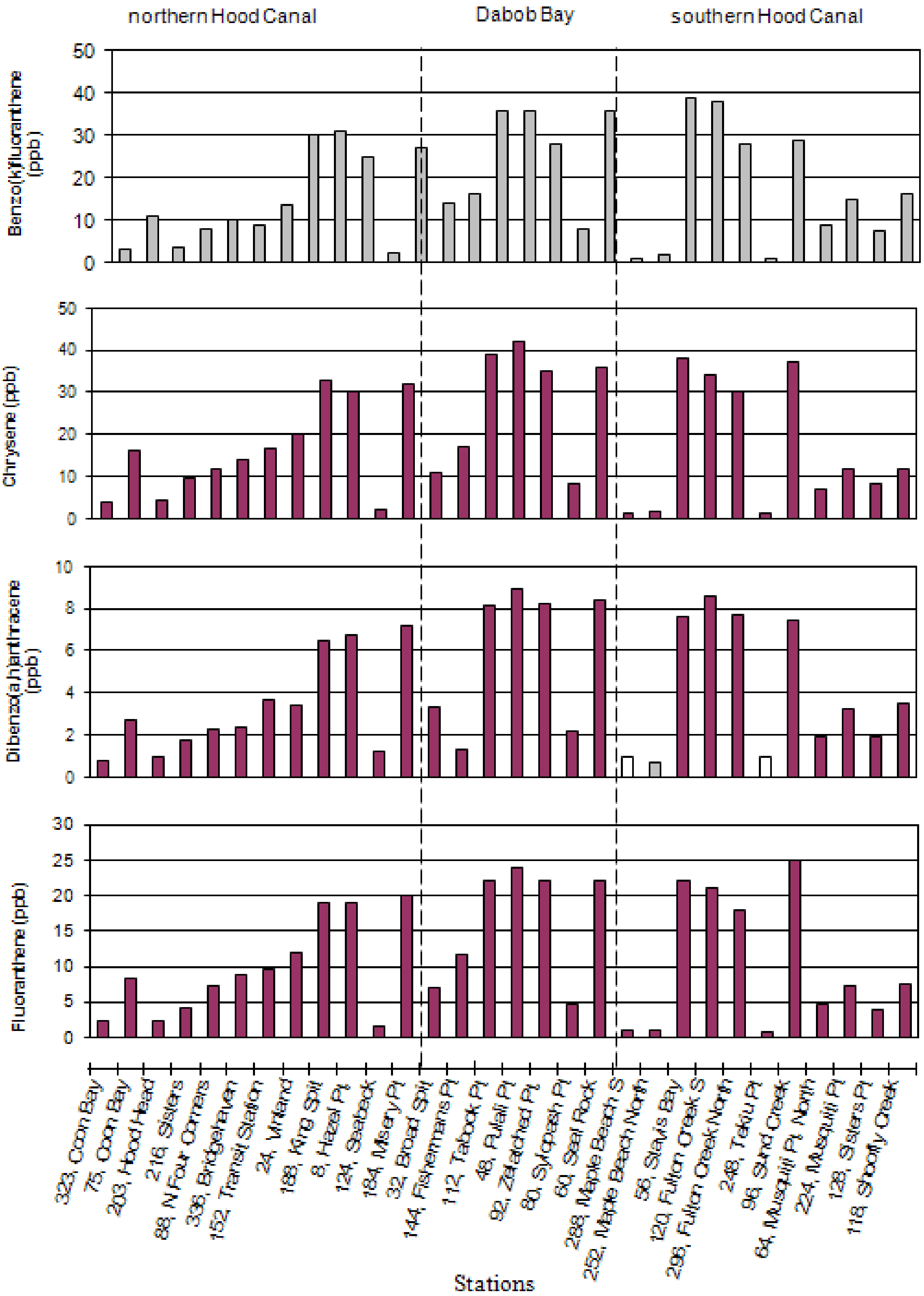

Figure G-3 Cont. page 10. Metal and organic chemical distributions in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.
White bars = undetected values, gray bars = qualified values, and black = unqualified values.

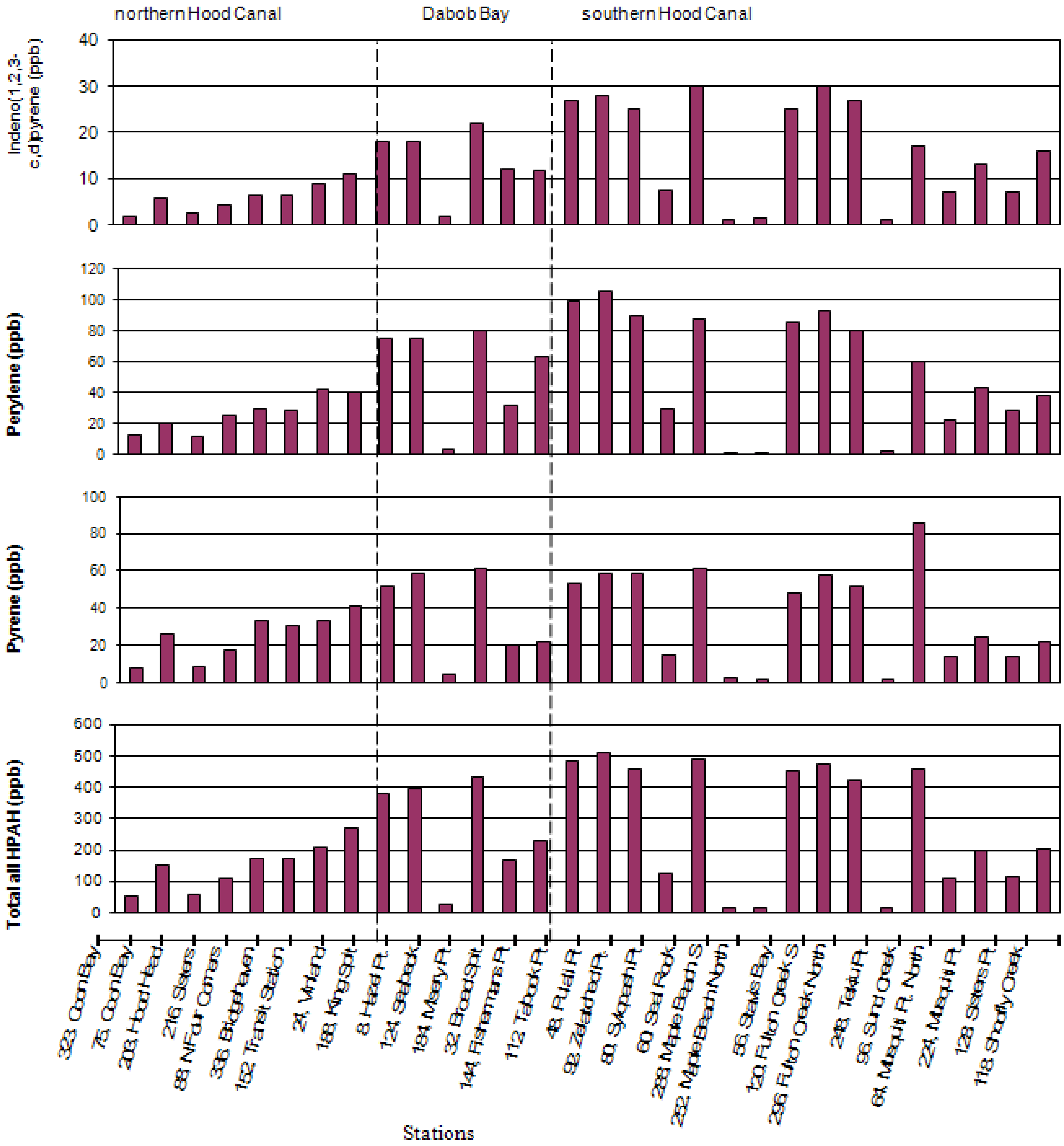

Figure G-3 Cont. page 11. Metal and organic chemical distributions in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.
White bars = undetected values, gray bars = qualified values, and black = unqualified values.

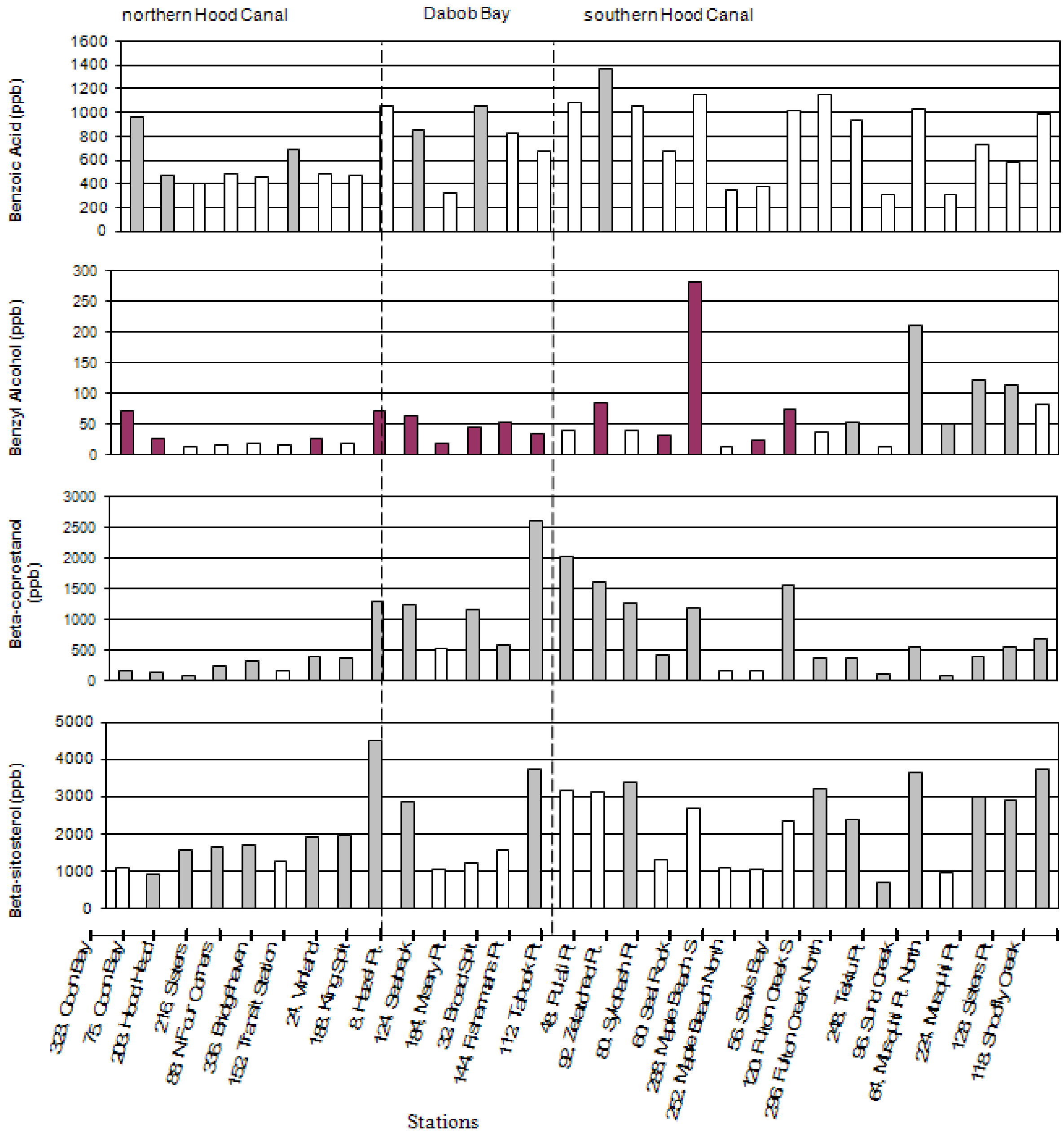

Figure G-3 Cont. page 12. Metal and organic chemical distributions in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.
White bars = undetected values, gray bars = qualified values, and black = unqualified values.

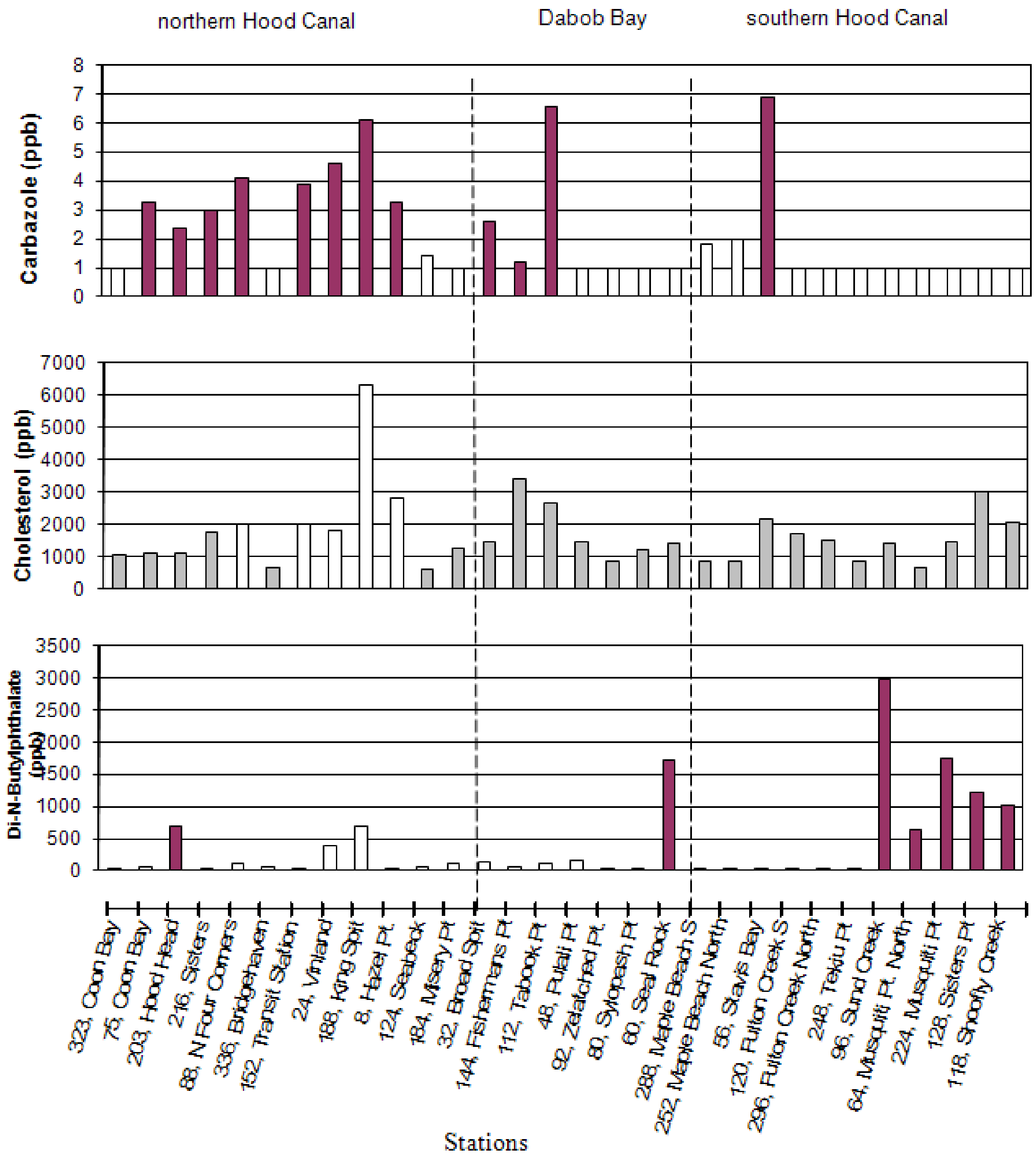

Figure G-3 Cont. page 13. Metal and organic chemical distributions in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.
White bars = undetected values, gray bars = qualified values, and black = unqualified values.

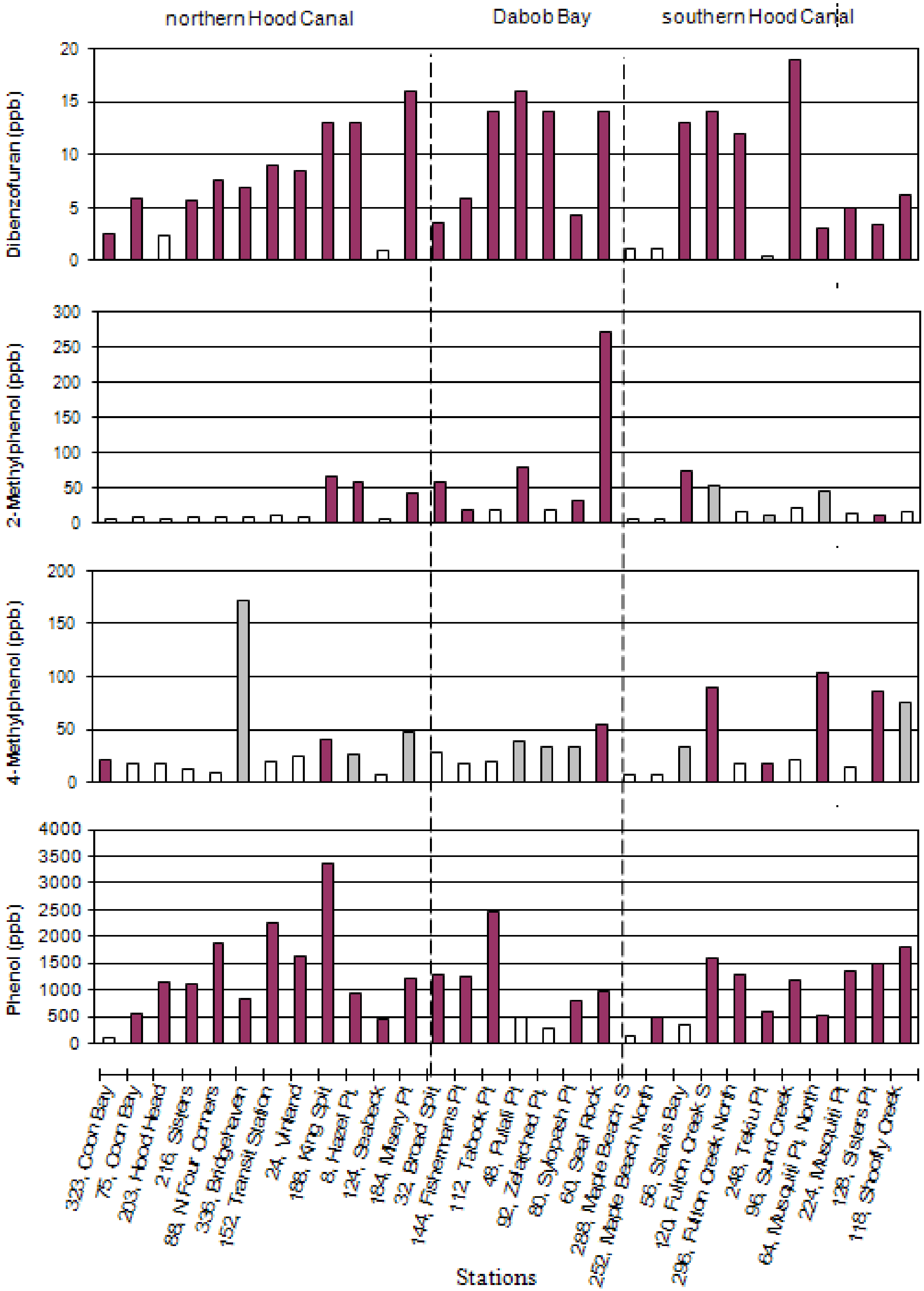

Figure G-3 Cont. page 14. Metal and organic chemical distributions in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.
White bars = undetected values, gray bars = qualified values, and black = unqualified values.

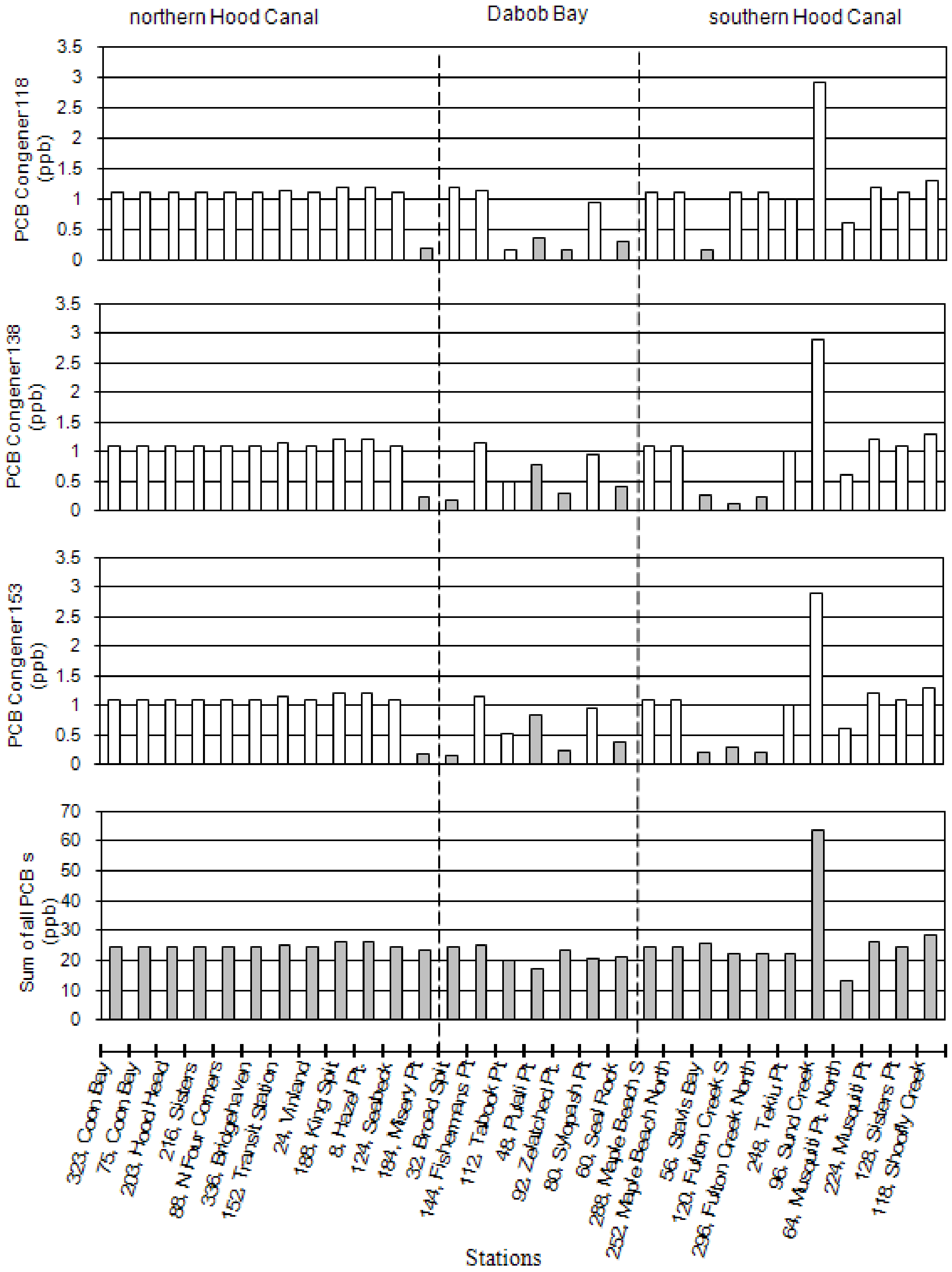

Figure G-3 Cont. page 15. Metal and organic chemical distributions in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.
White bars = undetected values, gray bars = qualified values, and black = unqualified values.

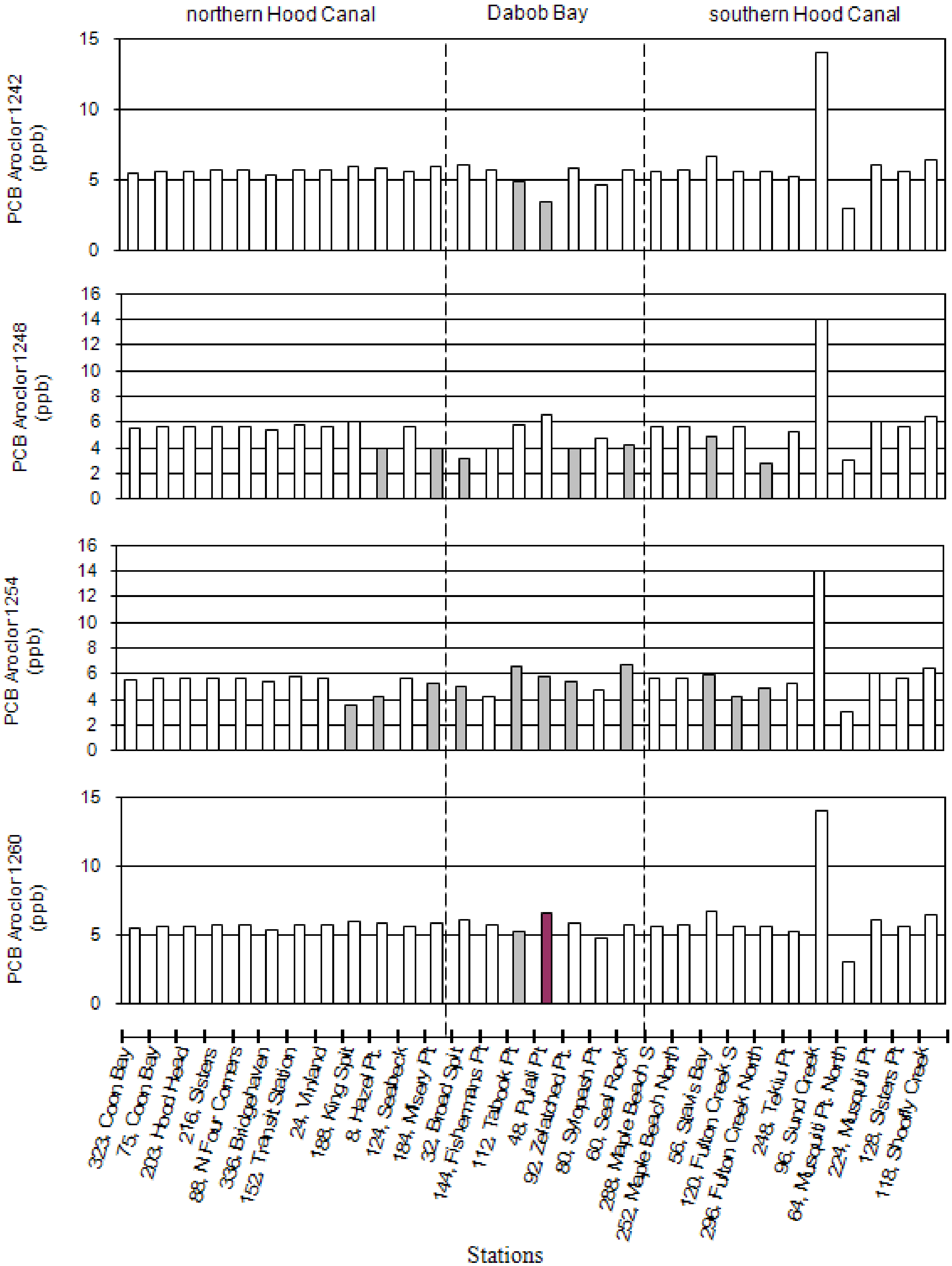

Figure G-3 Cont. page 16. Metal and organic chemical distributions in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.
White bars = undetected values, gray bars = qualified values, and black = unqualified values.

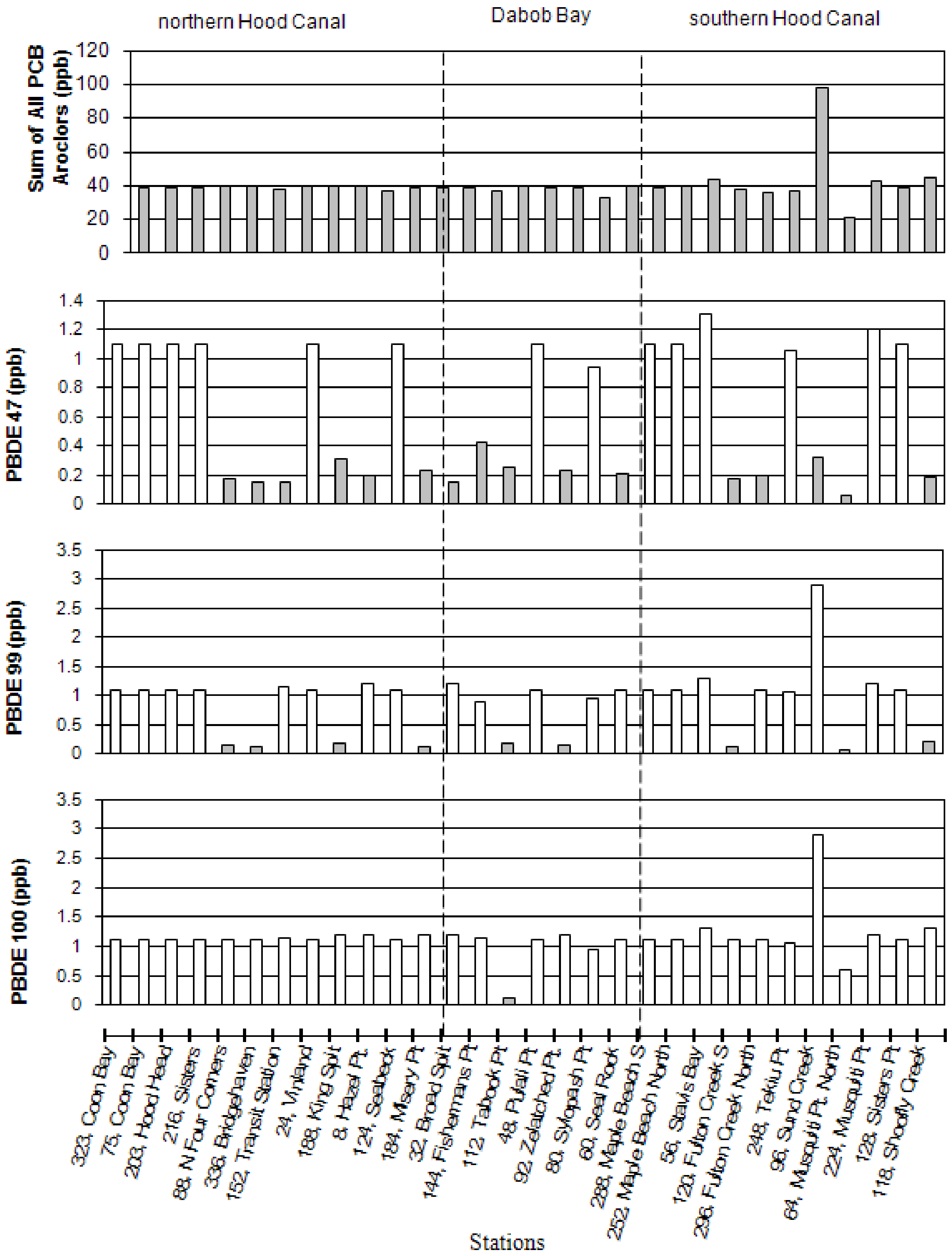

Figure G-3 Cont. page 17. Metal and organic chemical distributions in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.
White bars = undetected values, gray bars = qualified values, and black = unqualified values.

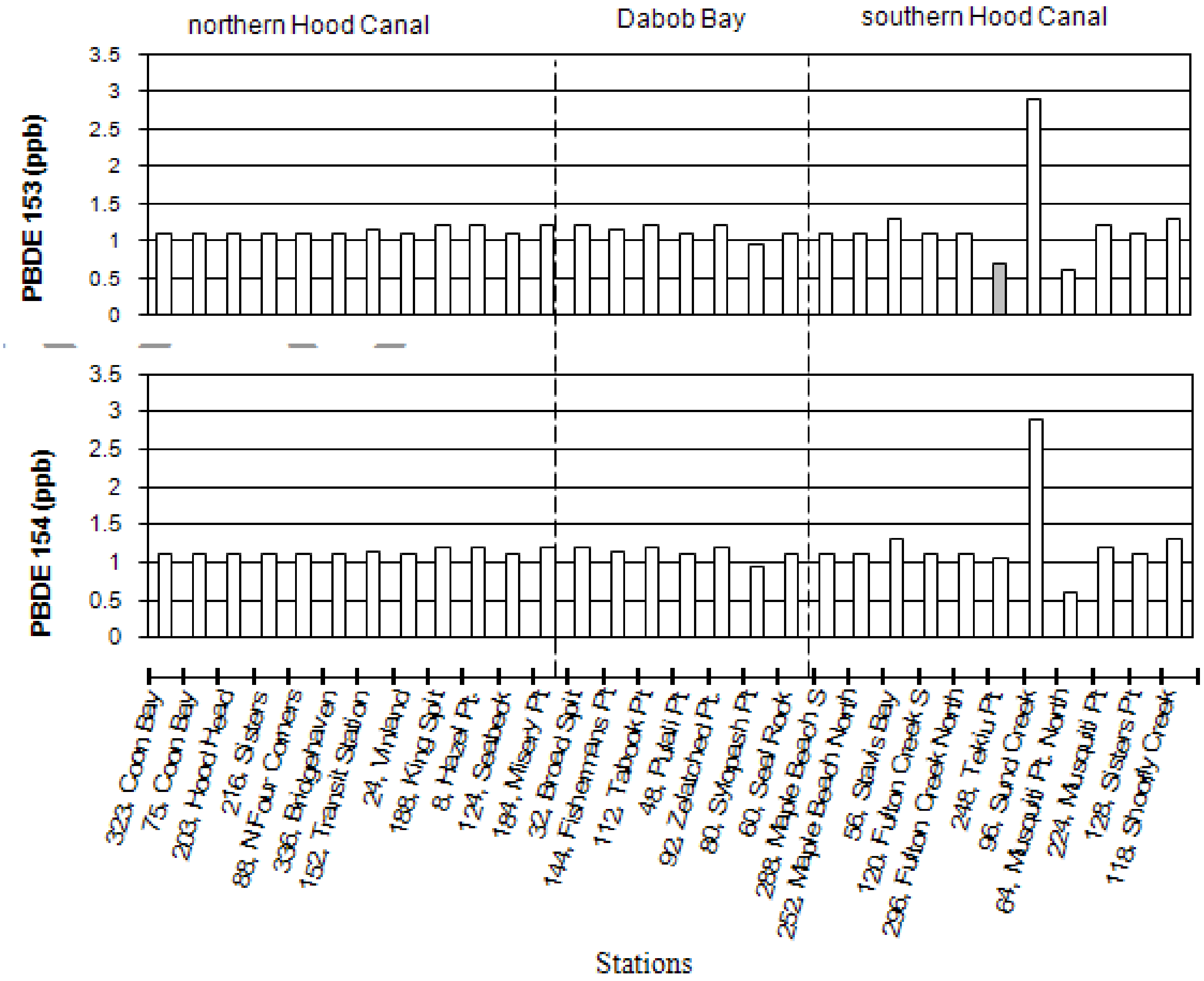

Figure G-3 Cont. page 18. Metal and organic chemical distributions in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.
White bars = undetected values, gray bars = qualified values, and black = unqualified values.

Table G-1. Grain size measurements in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component (grain size in fractional percent).

Station, Location	% Solids	% Gravel	% Very Coarse Sand	% Coarse Sand	% Medium Sand	% Fine Sand	% Very Fine Sand	Total % Sand	% Silt	% Clay	% Fines (Silt-Clay)
		>2000 mm	2000-1000 mm	1000-500 mm	500-250 mm	250-125 mm	125-62.5 mm	2000-62.5 mm	62.5-3.9 mm	<3.9 mm	<62.5 mm
8, Hazel Pt.	39.00	0.80	4.90	3.50	6.40	4.10	10.00	28.90	53.40	16.80	70.20
24, Vinland	53.20	0.10	0.60	1.20	1.80	5.50	41.70	50.80	41.10	8.10	49.20
32, Broad Spit	31.10	0.30	14.90	5.40	2.80	1.60	2.20	26.90	50.50	22.30	72.80
48, Pulali Pt	25.10	3.70	9.70	3.50	2.10	0.80	0.50	16.60	44.90	34.90	79.80
56, Stavis Bay	28.40	0.20	1.30	3.70	3.40	2.30	1.60	12.30	69.60	17.90	87.50
60, Seal Rock	27.10	2.10	5.70	2.70	1.10	0.60	0.70	10.80	55.90	31.30	87.20
64, Musquiti Pt. North	35.30	0.10	1.60	13.50	11.70	9.90	5.40	42.10	39.50	18.40	57.90
75, Coon Bay	65.70	0.20	0.60	0.50	0.80	42.10	42.20	86.20	9.40	4.30	13.70
80, Sylopash Pt	53.10	1.80	3.30	6.40	14.30	23.30	16.10	63.40	25.30	9.60	34.90
88, North Four Corners	55.67	0.13	0.47	0.90	1.37	21.63	46.57	70.93	21.73	7.30	29.03
92, Zelatched Pt.	25.40	0.10	4.50	2.70	1.60	0.80	0.90	10.50	49.80	39.80	89.60
96, Sund Creek	23.53	0.80	9.07	3.50	1.87	1.63	0.73	16.80	42.47	39.90	82.37
112, Tabook Pt	24.40	2.70	7.20	3.90	2.20	1.00	0.80	15.10	42.00	40.30	82.30
118, Shoofly Creek	28.60	0.80	2.20	14.40	5.40	3.30	2.50	27.80	55.80	15.50	71.30
120, Fulton Creek South	26.00	2.00	4.30	2.80	1.30	0.90	1.60	10.90	54.70	32.60	87.30
124, Seabeck	76.35	0.10	0.40	4.15	28.05	48.80	12.15	93.55	4.80	1.65	6.45
128, Sisters Pt	43.20	1.60	0.80	4.60	9.40	10.10	9.50	34.40	47.80	16.00	63.80
144, Fishermans Pt	37.25	0.10	0.70	1.85	5.20	6.30	11.25	25.30	64.55	10.20	74.75
152, Transit Station	47.75	0.10	0.60	1.10	1.50	4.75	44.25	52.20	37.60	10.20	47.80
184, Misery Pt	31.70	0.10	3.80	3.70	2.70	1.50	2.80	14.50	57.40	28.10	85.50
188, King Spit	33.10	0.10	1.00	2.80	3.20	5.50	11.00	23.50	58.00	18.50	76.50
203, Hood Head	69.20	0.10	0.30	0.80	12.60	58.40	16.80	88.90	7.40	3.60	11.00
216, Sisters	61.30	0.10	0.50	0.60	0.90	11.40	65.00	78.40	15.50	6.10	21.60
224, Musquiti Pt	33.50	0.10	1.50	15.30	6.80	3.50	2.70	29.80	45.50	24.80	70.30
248, Tekiu Pt	73.40	0.10	0.10	1.40	11.20	37.30	41.40	91.40	6.60	1.80	8.40
252, Maple Beach North	75.90	0.10	0.10	8.50	47.50	34.00	6.30	96.40	0.80	2.80	3.60
288, Maple Beach South	73.50	0.20	4.50	31.10	43.60	15.60	0.80	95.60	0.50	3.70	4.20
296, Fulton Creek North	28.80	0.10	1.60	11.30	6.60	4.00	4.10	27.60	38.10	34.20	72.30
323, Coon Bay	70.00	0.10	0.10	0.50	4.00	71.80	15.20	91.60	5.20	3.10	8.30
336, Bridgehaven	60.00	0.10	0.10	0.80	1.30	29.90	45.70	77.80	15.70	6.40	22.10

Table G-2. Chemistry concentrations in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.

Parameter Code	8		24		32		48		56		60		64		75		80		88		92	
	Basin		Basin		Rural		Rural		Basin		Rural		Basin		Basin		Rural		Basin		Rural	
Total Organic Carbon (%)	1.65		0.9		2.43		2.41		2.41		2.26		2.2		0.47		1.94		0.72		2.36	
Priority Pollutant Metals (ppm)																						
Arsenic	4.78		4.2		6.3		5.32		5.85		5.58		6.84		4.36		3.63		4.27		5.31	
Cadmium	0.29		0.26		0.29		0.29		0.28		0.29		0.28		0.2		0.13		0.22		0.27	
Chromium	36.6		29.9		48.7		40.9		41.9		41.1		60.7		26.8		33.8		28		40.9	
Copper	22.8		14.6		37.6		33.2		35.4		33.8		97.1		9.23		25.2		12		31.6	
Lead	10.6		7.27		12.1		14.5		14.7		15.3		7.64		4.75		7.28		5.99		14.2	
Mercury	0.062		0.04		0.069		0.074		0.091		0.08		0.057		0.024		0.048		0.03		0.078	
Nickel	30.4		27.3		43.8		35.1		34.8		35		43.1		31.3		29.4		28.3		34.4	
Selenium	0.75		0.5	U	1		1.1		1		1		0.96		0.5	U	0.57		0.5	U	1.1	
Silver	0.14		0.1	U	0.15		0.15		0.16		0.15		0.16		0.1	U	0.1	U	0.1	U	0.16	
Zinc	71.9		56.5		77.7		90.7		83.6		89.3		90.5		39		73		44		85.2	
Trace Elements (ppm)																						
Tin	0.96		0.73		0.91		1.1		1.18		1.1		1.4		0.71		0.53		0.56		1.1	
Organics (ppb)																						
Chlorinated Alkenes																						
Hexachlorobutadiene	3	NJ	9.2	U	15	U	20	U	17	U	18	U	6	U	7.4	U	9.6	U	8.8	U	20	U
Chlorinated and Nitro-Substituted Phenols																						
Pentachlorophenol	125	UJ	92	UJ	150	UJ	196	UJ	172	UJ	176	UJ	60	UJ	74	UJ	96	UJ	88	UJ	195	UJ
Chlorinated Aromatic Compounds																						
1,2,4-Trichlorobenzene	25	U	9.2	U	15	U	20	U	17	U	18	U	6	U	7.4	U	9.6	U	8.8	U	20	U
1,2-Dichlorobenzene	12	U	9.2	U	15	U	20	U	17	U	18	U	6	U	7.4	U	9.6	U	8.8	U	20	U
1,3-Dichlorobenzene	12	U	9.2	U	15	U	20	U	17	U	18	U	6	U	7.4	U	9.6	U	8.8	U	20	U
1,4-Dichlorobenzene	12	U	9.2	U	15	U	20	U	17	U	18	U	6	U	7.4	U	9.6	U	8.8	U	20	U
2-Chloronaphthalene	1	U	1	U	1	U	1	U	1.2	U	1	U	1	U	1	U	1	U	1	U	1	U
Hexachlorobenzene	12	U	9.2	U	15	U	20	U	17	U	18	U	6	U	7.4	U	9.6	U	8.8	U	20	U
Chlorinated Pesticides																						
2,4'-DDD	1.2	U	1.1	U	1.2	U	1.1	U	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
2,4'-DDE	1.2	U	1.1	U	1.2	U	1.1	UJ	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
2,4'-DDT	1.2	U	1.1	U	1.2	U	1.1	UJ	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
4,4'-DDD	0.22	J	1.1	U	0.15	J	0.23	J	1.3	U	1.1	U	0.6	U	1.1	U	0.18	NJ	1.1	U	0.29	J
4,4'-DDE	0.39	J	0.2	J	0.47	J	0.65	J	0.64	J	0.68	J	0.19	J	0.16	J	0.15	J	0.21	J	0.66	J
4,4'-DDT	1.2	UJ	1.1	UJ	1.2	UJ	1.1	UJ	1.3	UJ	1.1	U	0.6	U	1.1	UJ	0.13	NJ	1.1	UJ	0.17	J

Parameter Code	8		24		32		48		56		60		64		75		80		88		92	
	Basin		Basin		Rural		Rural		Basin		Rural		Basin		Basin		Rural		Basin		Rural	
Aldrin	1.2	UJ	1.1	UJ	1.2	UJ	1.1	UJ	1.3	UJ	1.1	UJ	0.6	UJ	1.1	UJ	0.94	UJ	1.1	UJ	1.2	UJ
Cis-Chlordane	1.2	U	1.1	U	1.2	U	1.1	U	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
Dieldrin	1.2	U	1.1	U	1.2	U	1.1	U	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
Endosulfan I	1.2	U	1.1	U	1.2	U	1.1	U	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
Endosulfan II	1.2	U	1.1	U	1.2	U	1.1	U	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
Endosulfan Sulfate	1.2	UJ	1.1	UJ	1.2	UJ	1.1	UJ	1.3	UJ	1.1	UJ	0.6	UJ	1.1	UJ	0.94	UJ	1.1	UJ	1.2	UJ
Endrin	1.2	U	1.1	U	1.2	U	1.1	U	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
Endrin Aldehyde	1.2	UJ	1.1	UJ	1.2	UJ	1.1	UJ	1.3	UJ	1.1	UJ	0.6	UJ	1.1	UJ	0.94	UJ	1.1	UJ	1.2	UJ
Endrin Ketone	1.2	U	1.1	U	1.2	U	1.1	U	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
Gamma-BHC (Lindane)	1.2	UJ	1.1	UJ	1.2	UJ	1.1	UJ	1.3	UJ	1.1	U	0.6	U	1.1	UJ	0.94	U	1.1	UJ	1.2	UJ
Heptachlor	1.2	U	1.1	U	1.2	UJ	1.1	UJ	1.3	UJ	1.1	UJ	0.6	UJ	1.1	U	0.94	UJ	1.1	U	1.2	UJ
Heptachlor Epoxide	1.2	U	1.1	U	1.2	U	1.1	U	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
Mirex	1.2	U	1.1	U	1.2	U	1.1	UJ	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
Oxychlordane	1.2	U	1.1	U	1.2	U	1.1	U	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
Toxaphene	12	U	11	U	12	U	11	U	13	U	11	U	6	U	11	U	9.4	U	11	U	12	U
Trans-Chlordane (Gamma)	1.2	U	1.1	U	1.2	U	1.1	U	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
Polynuclear Aromatic Hydrocarbons																						
LPAHs																						
1,6,7-Trimethylnaphthalene	17		14		6.1		19	J	18		20	J	1.5	J	6.8		3.6	J	7.8		14	J
1-Methylnaphthalene	32		21		6.9		36		34		37		2.8		9.3		5.7		16		38	
1-Methylphenanthrene	28		17		7.2		31		32		25		3		8.4		5.6		13		29	
2,6-Dimethylnaphthalene	64		34		18		60		58		57		13		17		17		32		59	
2-Methylnaphthalene	30		29		7.1		36		30		36		2.9		12		6.4		17		41	
2-Methylphenanthrene	18		12		4.6		21		21		18		2.5		6.2		3.8		8.9		15	
Acenaphthene	3.7		2.5		0.75		3.6		1	U	3.2		0.49	J	2.4		0.64	J	3.6		3	
Acenaphthylene	13		12		2.3		9.4		9.6		9.3		1.6		18		1.8		17		11	
Anthracene	12		7.6		3.2		11		11		11		2.3		6.3		2.4		7		11	
Biphenyl	11		8.5		2.5		12		12		11		1.6		5.4		2.8		6.5		12	
Dibenzothiophene	5.2		4.5		1.7		5.8	J	6.8		4.8	J	0.91	J	3.1		1.5	J	3.5		4.9	J
Fluorene	16	J	9.1	J	4.2	J	13	J	17	J	9.8	J	2.4	J	5.5	J	2.6	J	9	J	8.9	J
Naphthalene	41		39		8.8		41		38		50		6.6		42		9		64		44	J
Phenanthrene	72		48		19		74		72		69		13		35		15		44		72	
Retene	42		26		16		53		51		49		13		14		23		20		46	
HPAHs																						
Benzo(a)anthracene	19		12		7		24		22		22		4.6		8.2		4.6		7.4		22	

Parameter Code	8		24		32		48		56		60		64		75		80		88		92	
	Basin		Basin		Rural		Rural		Basin		Rural		Basin		Basin		Rural		Basin		Rural	
Benzo(a)pyrene	24		13		9.5		31		29		36		6		8		6.5		7.3		28	
Benzo(b)fluoranthene	24	J	27	J	10	J	35	J	26	J	29	J	6.4	J	9.9	J	7.9	J	8.6	J	30	J
Benzo(e)pyrene	23		14		12		33		30		32		7.4		8.8		8.4		8.3		30	
Benzo(g,h,i)perylene	27		16		16		35		35		39		9.6		7.5		11		9.7		33	J
Benzo(k)fluoranthene	25	J	30	J	14	J	36	J	39	J	36	J	8.6	J	11	J	7.8	J	10	J	28	J
Chrysene	30		20		11		42		38		36		7.2		16		8.2		12		35	
Dibenzo(a,h)anthracene	6.7		3.4		3.3		8.9		7.6		8.4		1.9		2.7		2.2		2.3		8.2	
Fluoranthene	67		43		20		72		68		72		14		26		16		36		69	
Indeno(1,2,3-c,d)pyrene	18		11		12		28		25		30		7.3		5.7		7.6		6.5		25	
Perylene	75		40		32		105		85		87		22		20		30		29		89	
Pyrene	59		41		20		59		48		61		14		26		15		33		59	
Miscellaneous Extractable Compounds																						
Benzoic Acid	853	J	475	UJ	821	UJ	1370	J	1010	UJ	1150	UJ	307	UJ	471	J	671	UJ	464	UJ	1060	UJ
Benzyl Alcohol	63		18	U	52		85		75		281		50	J	27		32		18	U	39	U
Beta-coprostanol	1230	J	362	J	574	J	1600	J	1560	J	1180	J	80	J	129	J	435	J	330	J	1260	J
Beta-Sitosterol	2850	J	1950	J	1580	UJ	3130	UJ	2320	UJ	2680	UJ	960	UJ	921	J	1280	UJ	1710	J	3390	J
Carbazole	3.3		4.6		2.6		1	U	6.9		1	U	1	U	3.3		1	U	4.1		1	U
Cholesterol	2810	UJ	1840	UJ	1460	J	1480	J	2160	NJ	1440	J	695	J	1140	J	1210	J	2000	UJ	896	J
p-Isopropyltoluene	12	U	9.2	U	15	U	20	U	17	U	18	U	6	U	7.4	U	9.6	U	8.8	U	20	U
Dibenzofuran	13		8.4		3.6		16		13		14		3		5.8		4.2		7.5		14	
Organonitrogen Compounds																						
Caffeine	25	U	18	U	30	U	39	U	34	U	35	U	12	U	15	U	19	U	18	U	39	U
N-Nitrosodiphenylamine	25	U	18	U	30	U	39	U	34	U	35	U	12	U	15	U	19	U	18	U	39	U
Phenols																						
2,4-Dimethylphenol	25	U	18	U	30	U	39	U	34	U	35	U	12	U	15	U	19	U	18	U	39	U
2-Methylphenol	59		9.2	U	57		78		74		270		46	J	7.4	U	31		8.8	U	20	U
4-Methylphenol	26	NJ	24	U	29	U	39	NJ	34	NJ	54		103		18	U	33	NJ	8.8	U	34	NJ
Phenol	952		1620		1280		476	U	358	U	980		533		541		813		1880		288	U
P-nonylphenol	12	U	9.2	U	15	U	20	U	17	U	18	U	6	U	7.4	U	9.6	U	8.8	U	20	U
Phthalate Esters																						
Bis(2-Ethylhexyl) Phthalate	104	U	108	U	105	U	169	U	82	U	612	U	229	U	43	U	89	U	36	U	83	U
Butylbenzylphthalate	12	U	9.2	U	15	U	20	U	17	U	18	U	6	U	7.4	U	9.6	U	8.8	U	20	U
Diethylphthalate	29	U	35	U	150	U	154	U	53	U	275	U	114	U	67	U	37	U	18	U	39	U
Dimethylphthalate	25	U	18	U	30	U	39	U	34	U	35	U	12	U	7.4	U	19	U	18	U	39	U
Di-N-Butylphthalate	25	U	378	U	146	U	153	U	17	U	1720		650		67	U	44	U	117	U	42	U

Parameter Code	8		24		32		48		56		60		64		75		80		88		92	
	Basin		Basin		Rural		Rural		Basin		Rural		Basin		Basin		Rural		Basin		Rural	
Di-N-Octyl Phthalate	25	U	18	U	30	U	39	U	34	U	35	U	12	U	15	U	19	U	18	U	39	U
Polychlorinated Biphenyls																						
PCB Congeners																						
PCB Congener 8	1.2	U	1.1	U	1.2	U	1.1	UJ	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
PCB Congener 18	1.2	U	1.1	U	1.2	U	1.1	UJ	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
PCB Congener 28	1.2	U	1.1	U	1.2	U	0.25	J	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
PCB Congener 44	1.2	U	1.1	U	1.2	U	1.1	UJ	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
PCB Congener 52	1.2	U	1.1	U	1.2	U	1.1	UJ	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
PCB Congener 66	1.2	U	1.1	U	1.2	U	0.19	NJ	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
PCB Congener 77	1.2	U	1.1	U	1.2	U	1.1	U	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
PCB Congener 101	1.2	U	1.1	U	1.2	U	0.2	NJ	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
PCB Congener 105	1.2	U	1.1	U	1.2	U	1.1	UJ	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
PCB Congener 110	1.2	U	1.1	U	1.2	U	0.25	J	1.3	U	0.16	J	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
PCB Congener 118	1.2	U	1.1	U	1.2	U	0.36	J	0.17	J	0.3	J	0.6	U	1.1	U	0.94	U	1.1	U	0.17	NJ
PCB Congener 126	1.2	U	1.1	U	1.2	U	1.1	U	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
PCB Congener 128	1.2	U	1.1	U	1.2	U	1.1	UJ	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
PCB Congener 138	1.2	U	1.1	U	0.17	J	0.79	J	0.26	J	0.4	J	0.6	U	1.1	U	0.94	U	1.1	U	0.28	J
PCB Congener 153	1.2	U	1.1	U	0.16	NJ	0.84	J	0.22	J	0.39	J	0.6	U	1.1	U	0.94	U	1.1	U	0.24	J
PCB Congener 169	1.2	UJ	1.1	UJ	1.2	UJ	1.1	UJ	1.3	UJ	1.1	U	0.6	U	1.1	UJ	0.94	U	1.1	UJ	1.2	UJ
PCB Congener 170	1.2	U	1.1	U	1.2	U	0.18	J	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
PCB Congener 180	1.2	U	1.1	U	1.2	U	0.64	J	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
PCB Congener 187	1.2	U	1.1	U	1.2	U	0.28	J	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
PCB Congener 195	1.2	U	1.1	U	1.2	U	1.1	UJ	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
PCB Congener 206	1.2	U	1.1	U	1.2	U	1.1	UJ	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
PCB Congener 209	1.2	U	1.1	U	1.2	U	1.1	UJ	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
PCB Aroclors:																						
PCB Aroclor 1016	5.8	U	5.7	U	6.1	U	5.6	UJ	6.7	U	5.7	U	3	U	5.6	U	4.7	U	5.7	U	5.8	U
PCB Aroclor 1221	5.8	U	5.7	U	6.1	U	5.6	UJ	6.7	U	5.7	U	3	U	5.6	U	4.7	U	5.7	U	5.8	U
PCB Aroclor 1232	5.8	U	5.7	U	6.1	U	5.6	UJ	6.7	U	5.7	U	3	U	5.6	U	4.7	U	5.7	U	5.8	U
PCB Aroclor 1242	5.8	U	5.7	U	6.1	U	3.4	J	6.7	U	5.7	U	3	U	5.6	U	4.7	U	5.7	U	5.8	U
PCB Aroclor 1248	4	J	5.7	U	3.2	J	6.5	UJ	4.8	J	4.2	NJ	3	U	5.6	U	4.7	U	5.7	U	4	J
PCB Aroclor 1254	4.2	J	5.7	U	5	NJ	5.8	NJ	5.9	J	6.7	NJ	3	U	5.6	U	4.7	U	5.7	U	5.4	J
PCB Aroclor 1260	5.8	U	5.7	U	6.1	U	6.6		6.7	U	5.7	U	3	U	5.6	U	4.7	U	5.7	U	5.8	U
Polybrominated Diphenylethers																						
PBDE- 47	0.2	NJ	1.1	U	0.15	J	1.1	U	1.3	U	0.21	NJ	0.061	NJ	1.1	U	0.94	U	0.18	NJ	0.23	J

Parameter Code	8		24		32		48		56		60		64		75		80		88		92	
	Basin		Basin		Rural		Rural		Basin		Rural		Basin		Basin		Rural		Basin		Rural	
PBDE- 99	1.2	U	1.1	U	1.2	U	1.1	U	1.3	U	1.1	U	0.073	J	1.1	U	0.94	U	0.14	NJ	0.14	J
PBDE-100	1.2	U	1.1	U	1.2	U	1.1	U	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
PBDE-153	1.2	U	1.1	U	1.2	U	1.1	U	1.3	U	1.1	U	0.6	U	1.1	U	0.94	U	1.1	U	1.2	U
PBDE-154	1.2	UJ	1.1	UJ	1.2	UJ	1.1	UJ	1.3	UJ	1.1	UJ	0.6	UJ	1.1	UJ	0.94	UJ	1.1	UJ	1.2	UJ

Table G-2. Chemistry concentrations in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.

Parameter Code	96		112		118				120		124								128	
	Basin		Rural		Rural		Lab Dup		Basin		Basin		Field Dup		Lab Dup		Lab Trip		Rural	
Total Organic Carbon	2.44		2.39		2.94				2.46		0.15		0.17		0.15		0.15		1.68	
Priority Pollutant Metals																				
Arsenic	4.78		5.41		10.1				5.98		2.53		2.58						7.2	
Cadmium	0.26		0.28		1.05				0.3		0.1	U	0.1	U					0.37	
Chromium	42.5		39.2		63.9				41.8		22.8		19.6						44.7	
Copper	72		32.4		86.9				41.2		4.96		5.07						75.3	
Lead	11.1		13.8		7.26				15.6		2.63		5.7						4.74	
Mercury	0.064		0.062		0.057				0.087		0.0084		0.009						0.04	
Nickel	38.5		34.2		42				36.7		14.2		14.6						37.8	
Selenium	1.1		1		1.2				1.1		0.5	U	0.5	U					0.74	
Silver	0.12		0.14		0.18				0.14		0.1	U	0.1	U					0.14	
Zinc	84.1		83.9		83.3				93.1		19		19						67.3	
Trace Elements																				
Tin	0.88		1.1		0.81				1.6		0.32								0.7	
Organics																				
Chlorinated Alkenes																				
Hexachlorobutadiene	21	U	20	U	17	U	17	U	18	U	6.5	U	6.5	U					11	U
Chlorinated and Nitro-Substituted Phenols																				
Pentachlorophenol	213	UJ	198	UJ	171	UJ	172	UJ	185	UJ	65	UJ	65	UJ					113	UJ
Chlorinated Aromatic Compounds																				
1,2,4-Trichlorobenzene	21	U	20	U	17	U	17	U	18	U	6.5	U	6.5	U					11	U
1,2-Dichlorobenzene	21	U	20	U	17	U	17	U	18	U	6.5	U	6.5	U					11	U
1,3-Dichlorobenzene	21	U	20	U	17	U	17	U	18	U	6.5	U	6.5	U					11	U
1,4-Dichlorobenzene	21	U	20	U	17	U	17	U	18	U	6.5	U	6.5	U					11	U
2-Chloronaphthalene	1	U	1	U	1	U			1	U	1	U	1	U					1	U
Hexachlorobenzene	21	U	20	U	17	U	17	U	18	U	6.5	U	6.5	U					11	U
Chlorinated Pesticides																				
2,4'-DDD	2.9	U	1.2	U	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
2,4'-DDE	2.9	U	1.2	UJ	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
2,4'-DDT	2.9	U	1.2	UJ	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
4,4'-DDD	0.28	J	0.31	NJ	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
4,4'-DDE	0.35	J	0.53	J	0.28	J			0.76	J	1.1	U	1.1	U					0.15	J
4,4'-DDT	2.9	U	1.2	UJ	1.3	U			0.28	NJ	1.1	UJ	1.1	UJ					1.1	U
Aldrin	2.9	UJ	1.2	UJ	1.3	UJ			1.1	UJ	1.1	UJ	1.1	UJ					1.1	UJ

Parameter Code	96		112		118				120		124								128	
	Basin		Rural		Rural		Lab Dup		Basin		Basin		Field Dup		Lab Dup		Lab Trip		Rural	
Cis-Chlordane	2.9	U	1.2	U	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
Dieldrin	2.9	U	1.2	U	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
Endosulfan I	2.9	U	1.2	U	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
Endosulfan II	2.9	U	1.2	U	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
Endosulfan Sulfate	2.9	UJ	1.2	UJ	1.3	UJ			1.1	UJ	1.1	UJ	1.1	UJ					1.1	UJ
Endrin	2.9	U	1.2	U	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
Endrin Aldehyde	2.9	UJ	1.2	UJ	1.3	UJ			1.1	UJ	1.1	UJ	1.1	UJ					1.1	UJ
Endrin Ketone	2.9	U	1.2	U	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
Gamma-BHC (Lindane)	2.9	U	1.2	UJ	1.3	U			1.1	U	1.1	UJ	1.1	UJ					1.1	U
Heptachlor	2.9	UJ	1.2	UJ	1.3	UJ			1.1	UJ	1.1	U	1.1	U					1.1	UJ
Heptachlor Epoxide	2.9	U	1.2	U	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
Mirex	2.9	U	1.2	UJ	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
Oxychlordane	2.9	U	1.2	U	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
Toxaphene	29	U	12	U	13	U			11	U	11	U	11	U					11	U
Trans-Chlordane (Gamma)	2.9	U	1.2	U	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
Polynuclear Aromatic Hydrocarbons																				
LPAHs																				
1,6,7-Trimethylnaphthalene	19	J	22		2.5	J			15	J	0.58		0.72						1.7	J
1-Methylnaphthalene	48		36		3.6				31		1		1						2.3	
1-Methylphenanthrene	36		30		1	U			26		1.4		1.1						2	
2,6-Dimethylnaphthalene	78		69		115				51		1.9		2						44	
2-Methylnaphthalene	50		34		4.2				28		1.8	UJ	1.4	UJ					3	
2-Methylphenanthrene	22		19		1	U			17		0.86		0.89						2.1	
Acenaphthene	5.9		3.1		1				2.5		0.37		1	U					0.71	
Acenaphthylene	45		8.3		2.5				7.8		0.53		0.44						1.3	
Anthracene	13		11		3.5				8.8		0.65	UJ	0.61	U					2.1	
Biphenyl	18		11		4.8				10		0.72	UJ	1	U					1.9	
Dibenzothiophene	6	J	5.9		1.6	J			4.4	J	0.47		0.45						0.84	J
Fluorene	13	J	18	J	2.5	J			7.5	J	0.6	J	0.79	J					2	J
Naphthalene	188		41		11				42		1.4		1.8						6.6	
Phenanthrene	97		68		14				60		3.3	UJ	4.3						9.1	
Retene	106		46		13				50		2.4		2.3						10	
HPAHs																				
Benzo(a)anthracene	25		22		7.6				21		1.5		1.6						4	

Parameter Code	96		112		118				120		124								128	
	Basin		Rural		Rural		Lab Dup		Basin		Basin		Field Dup		Lab Dup		Lab Trip		Rural	
Benzo(a)pyrene	31		32		9.7				29		1.4								5.5	
Benzo(b)fluoranthene	27	J	33	J	16	J			30	J	1.9	J	1.7	J					8.1	J
Benzo(e)pyrene	30		31		15				31		1.8		1.8						5.8	
Benzo(g,h,i)perylene	26		33		21				40		2.2		2						9.3	
Benzo(k)fluoranthene	29	J	36	J	16	J			38	J	2.4	J	1.9	J					7.6	J
Chrysene	37		39		12				34		2.1		2.2						8.5	
Dibenzo(a,h)anthracene	7.4		8.1		3.5				8.6		2	U	0.55	J					1.9	
Fluoranthene	83		68		25				62		4.2		4.6						14	
Indeno(1,2,3-c,d)pyrene	17		27		16				30		1.7		1.7						7.2	
Perylene	60		99		38				92		3.1		3.5						28	
Pyrene	86		53		22				58		4.2		4.4						14	
Miscellaneous Extractable Compounds																				
Benzoic Acid	1030	UJ	1090	UJ	981	UJ	984	UJ	1150	UJ	260	UJ	378	UJ					581	UJ
Benzyl Alcohol	210	J	40	U	34	U	128	J	37	U	13	U	26						112	J
Beta-coprostanol	551	J	2010	J	673	J	683	J	363	J	520	UJ	540	UJ					545	J
Beta-Sitosterol	3630	J	3180	UJ	3540	J	3880	J	3220	J	1050	UJ	1040	UJ					2910	J
Carbazole	1	U	6.6		1	U			1	U	1.9	UJ	1	U					1	U
Cholesterol	1430	J	2690	J	2280	J	1900	J	1720	J	637	J	660	J					3000	J
p-Isopropyltoluene	21	U	20	U	17	U	17	U	18	U	6.5	U	6.5	U					11	U
Dibenzofuran	19		14		6.1				14		0.8	U	1	U					3.4	
Organonitrogen Compounds																				
Caffeine	43	U	40	U	34	U	34	U	37	U	6.5	U	6.5	U					23	U
N-Nitrosodiphenylamine	43	U	40	U	34	U	34	U	37	U	13	U	13	U					23	U
Phenols																				
2,4-Dimethylphenol	43	U	40	U	34	U	34	U	37	U	13	U	13	U					23	U
2-Methylphenol	21	UJ	20	U	17	UJ	17	UJ	53	J	6.5	U	6.5	U					11	U
4-Methylphenol	21	U	20	U	84	NJ	68	NJ	89		6.5	U	6.5	U					85	
Phenol	1180		2460		1800		1780		1590		399		522						1480	
P-nonylphenol	21	U	20	U	17	U	17	U	18	U	6.5	U	6.5	U					11	U
Phthalate Esters																				
Bis(2-Ethylhexyl) Phthalate	774	U	104	U	120	U	323	U	65	U	58	U	47	U					340	U
Butylbenzylphthalate	21	U	20	U	17	U	17	U	18	U	6.5	U	6.5	U					11	U
Diethylphthalate	557	U	88	U	65	U	401	U	20	UJ	72	U	26	U					287	U
Dimethylphthalate	43	U	40	U	34	U	34	U	37	U	6.5	U	13	U					23	U
Di-N-Butylphthalate	2990		123	U	70	U	1980		18	U	75	U	30	U					1210	

Parameter Code	96		112		118				120		124								128	
	Basin		Rural		Rural		Lab Dup		Basin		Basin		Field Dup		Lab Dup		Lab Trip		Rural	
Di-N-Octyl Phthalate	43	U	40	U	34	U	34	U	37	U	13	U	13	U					23	U
Polychlorinated Biphenyls																				
PCB Congeners																				
PCB Congener 8	2.9	U	1.2	UJ	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
PCB Congener 18	2.9	U	1.2	UJ	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
PCB Congener 28	2.9	U	0.26	UJ	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
PCB Congener 44	2.9	U	1.2	UJ	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
PCB Congener 52	2.9	U	1.2	UJ	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
PCB Congener 66	2.9	U	1.2	UJ	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
PCB Congener 77	2.9	U	1.2	U	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
PCB Congener 101	2.9	U	0.16	UJ	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
PCB Congener 105	2.9	U	1.2	UJ	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
PCB Congener 110	2.9	U	0.14	UJ	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
PCB Congener 118	2.9	U	0.18	UJ	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
PCB Congener 126	2.9	U	1.2	U	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
PCB Congener 128	2.9	U	1.2	UJ	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
PCB Congener 138	2.9	U	0.5	UJ	1.3	U			0.12	NJ	1.1	U	1.1	U					1.1	U
PCB Congener 153	2.9	U	0.53	UJ	1.3	U			0.28	J	1.1	U	1.1	U					1.1	U
PCB Congener 169	2.9	U	1.2	UJ	1.3	U			1.1	U	1.1	UJ	1.1	UJ					1.1	U
PCB Congener 170	2.9	U	1.2	UJ	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
PCB Congener 180	2.9	U	0.37	UJ	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
PCB Congener 187	2.9	U	1.2	UJ	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
PCB Congener 195	2.9	U	1.2	UJ	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
PCB Congener 206	2.9	U	1.2	UJ	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
PCB Congener 209	2.9	U	1.2	UJ	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
PCB Aroclors:																				
PCB Aroclor 1016	14	U	5.9	UJ	6.4	U			5.6	U	5.6	U	5.6	U					5.6	U
PCB Aroclor 1221	14	U	5.9	UJ	6.4	U			5.6	U	5.6	U	5.6	U					5.6	U
PCB Aroclor 1232	14	U	5.9	UJ	6.4	U			5.6	U	5.6	U	5.6	U					5.6	U
PCB Aroclor 1242	14	U	4.9	J	6.4	U			5.6	U	5.6	U	5.6	U					5.6	U
PCB Aroclor 1248	14	U	5.8	UJ	6.4	U			5.6	U	5.6	U	5.6	U					5.6	U
PCB Aroclor 1254	14	U	6.6	NJ	6.4	U			4.2	NJ	5.6	U	5.6	U					5.6	U
PCB Aroclor 1260	14	U	5.2	J	6.4	U			5.6	U	5.6	U	5.6	U					5.6	U
Polybrominated Diphenylethers																				
PBDE- 47	0.32	NJ	0.25	J	0.19	NJ			0.18	NJ	1.1	U	1.1	U					1.1	U

Parameter Code	96		112		118				120		124								128	
	Basin		Rural		Rural		Lab Dup		Basin		Basin		Field Dup		Lab Dup		Lab Trip		Rural	
PBDE- 99	2.9	U	0.19	J	0.2	NJ			0.12	J	1.1	U	1.1	U					1.1	U
PBDE-100	2.9	U	0.13	J	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
PBDE-153	2.9	U	1.2	U	1.3	U			1.1	U	1.1	U	1.1	U					1.1	U
PBDE-154	2.9	UJ	1.2	UJ	1.3	UJ			1.1	UJ	1.1	UJ	1.1	UJ					1.1	UJ

Table G-2. Chemistry concentrations in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.

Parameter Code	144						152				184		188		203		216				224	
	Rural		Field Dup		Lab Dup		Basin		Field Dup		Basin		Basin		Basin		Basin		Lab Dup		Basin	
Total Organic Carbon	2.42		2.5				0.93		1.09		2.06		1.82		0.33		0.13				2.15	
Priority Pollutant Metals																						
Arsenic	6		5.99				4.02		4.03		5.41		5.29		4.12		3.33				7.08	
Cadmium	0.48		0.49				0.26		0.26		0.3		0.27		0.16		0.22				0.26	
Chromium	42.1		42.9				30.2		29.6		40.7		34.5		23.3		27.3				59.7	
Copper	48.7		49.8				14.1		13.8		28.4		21		7.1		10				98.9	
Lead	6.22		6.32				6.8		6.69		13		9.8		3.88		4.65				7.81	
Mercury	0.053		0.052				0.038		0.037		0.073		0.061		0.017		0.014				0.058	
Nickel	37.2		38.3				27.3		27		33.4		29		25.1		27.1				43.6	
Selenium	0.78		0.83				0.5	U	0.5		0.95		0.78		0.5	U	0.5	U			0.99	
Silver	0.16		0.17				0.1	U	0.1	U	0.16		0.13		0.1	U	0.1	U			0.17	
Zinc	69		72.6				50		49		85.3		66.7		30		41				89.3	
Trace Elements																						
Tin	0.75		0.72				0.61		0.63		1.1		0.87		0.62		0.65				0.96	
Organics																						
Chlorinated Alkenes																						
Hexachlorobutadiene	13	U	11	U			9.8	U	10	U	15	U	15	U	6.6	U	8.1	U	8	U	14	U
Chlorinated and Nitro-Substituted Phenols																						
Pentachlorophenol	130	UJ	111	UJ			98	UJ	101	UJ	148	UJ	149	UJ	66	UJ	81	UJ	80	UJ	140	UJ
Chlorinated Aromatic Compounds																						
1,2,4-Trichlorobenzene	13	U	11	U			9.8	U	10	U	15	U	15	U	6.6	U	8.1	U	8	U	14	U
1,2-Dichlorobenzene	13	U	11	U			9.8	U	10	U	15	U	15	U	6.6	U	8.1	U	8	U	14	U
1,3-Dichlorobenzene	13	U	11	U			9.8	U	10	U	15	U	15	U	6.6	U	8.1	U	8	U	14	U
1,4-Dichlorobenzene	13	U	11	U			9.8	U	10	U	15	U	15	U	6.6	U	8.1	U	8	U	14	U
2-Chloronaphthalene	1	U	1	U			1	U	1	U	1	U	1	U	1	U	1	U			1	U
Hexachlorobenzene	13	U	11	U			9.8	U	10	U	15	U	15	U	6.6	U	8.1	U	8	U	14	U
Chlorinated Pesticides																						
2,4'-DDD	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
2,4'-DDE	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
2,4'-DDT	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
4,4'-DDD	0.19	J	0.19	J	0.16	J	1.2	U	0.12	J	1.2	U	0.19	J	1.1	U	1.1	U			1.2	U
4,4'-DDE	0.32	J	0.42	J	0.35	J	0.21	J	0.21	J	0.67	J	0.34	J	1.1	U	0.13	J			0.26	J
4,4'-DDT	1.2	UJ	1.2	U	1.1	U	1.2	UJ	1.1	UJ	0.33	NJ	1.2	UJ	1.1	UJ	1.1	UJ			1.2	U
Aldrin	1.2	UJ	1.2	UJ	1.1	UJ	1.2	UJ	1.1	UJ	1.2	UJ	1.2	UJ	1.1	UJ	1.1	UJ			1.2	UJ

Parameter Code	144						152				184		188		203		216				224	
	Rural		Field Dup		Lab Dup		Basin		Field Dup		Basin		Basin		Basin		Basin		Lab Dup		Basin	
Cis-Chlordane	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
Dieldrin	1.2	UJ	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
Endosulfan I	1.2	UJ	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
Endosulfan II	1.2	UJ	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
Endosulfan Sulfate	1.2	UJ	1.2	UJ	1.1	UJ	1.2	UJ	1.1	UJ	1.2	UJ	1.2	UJ	1.1	UJ	1.1	UJ			1.2	UJ
Endrin	1.2	UJ	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
Endrin Aldehyde	1.2	UJ	1.2	UJ	1.1	UJ	1.2	UJ	1.1	UJ	1.2	UJ	1.2	UJ	1.1	UJ	1.1	UJ			1.2	UJ
Endrin Ketone	1.2	UJ	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
Gamma-BHC (Lindane)	1.2	UJ	1.2	U	1.1	U	1.2	UJ	1.1	UJ	1.2	U	1.2	UJ	1.1	UJ	1.1	UJ			1.2	U
Heptachlor	1.2	UJ	1.2	UJ	1.1	UJ	1.2	U	1.1	U	1.2	UJ	1.2	U	1.1	U	1.1	U			1.2	UJ
Heptachlor Epoxide	1.2	UJ	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
Mirex	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
Oxychlordane	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
Toxaphene	12	U	12	U	11	U	12	U	11	U	12	U	12	U	11	U	11	U			12	U
Trans-Chlordane (Gamma)	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
Polynuclear Aromatic Hydrocarbons																						
LPAHs																						
1,6,7-Trimethylnaphthalene	5.5		12	J	11	J	15		11		19	J	21		3.5		8.3				3.2	J
1-Methylnaphthalene	5.7		13		15		20		21		38		32		5.4		16				4.4	
1-Methylphenanthrene	2.2		6.5		6.8		16		15		24		28		4.8		12				6.4	
2,6-Dimethylnaphthalene	22		73		78		44		43		67		81		12		24				32	
2-Methylnaphthalene	5.4		13		16		22		18		34		30		6.6		19				4.7	
2-Methylphenanthrene	1.7		4.5		4.5		12		12		19		18		3.4		8.7				3.1	
Acenaphthene	1.1		1.9		2		2.4		2.8		3.5		3.4		0.85		1.6				0.75	J
Acenaphthylene	1.8		3.2		3.6		9.3		10		12		11		3.3		5.4				2.5	
Anthracene	2.8		5.6		6.7		6.2		6.6		12		10		1.7	U	3.4				3.1	
Biphenyl	1.8		2.8		3.4		6.4		8.3		12		11		2		5.2				3	
Dibenzothiophene	1.2		2	J	2.5	J	3.8		3.6		5.4	J	6.4		1.5		3.7				1.4	J
Fluorene	3.3	J	1	U	4.7		7.9	J	11	J	16	J	16	J	2	J	5.8	J			3.3	J
Naphthalene	6.3		15		25		30		34		57		42		13		22				12	
Phenanthrene	11		22		24		47		46		70		73		12		29				16	
Retene	16		36		35		27		26		44		42		8.1		23				30	
HPAHs																						
Benzo(a)anthracene	5.8		13		14		10		9.1		20		19		2.3		4.2				7.4	
Benzo(a)pyrene	5.6		11		15		12		9.1		26		23		2.2		4.2				12	

Parameter Code	144						152				184		188		203		216				224	
	Rural		Field Dup		Lab Dup		Basin		Field Dup		Basin		Basin		Basin		Basin		Lab Dup		Basin	
Benzo(b)fluoranthene	7	J	20	J	16	J	12	J	11	J	29	J	20	J	2.8	J	4.9	J			14	J
Benzo(e)pyrene	6.1		14		16		10		10		26		19		2.8		4.8				13	
Benzo(g,h,i)perylene	9.3	J	18	J	22		13		12		29		23		3.5		6.3				19	
Benzo(k)fluoranthene	8.4	J	16	J	20	J	13	J	14	J	27	J	31	J	3.4	J	7.8	J			15	J
Chrysene	8.7		20		20		17		16		32		33		4.3		9.6				12	
Dibenzo(a,h)anthracene	2.4		1	U	1	U	3.6		3.8		7.2		6.5		0.97		1.8				3.2	
Fluoranthene	15		31		36		36		37		70		62		9.7		19				20	
Indeno(1,2,3-c,d)pyrene	6.1		13		14		9.1		8.5		22		18		2.5		4.2				13	
Perylene	31		70		75		40		45		80		75		12		25				43	
Pyrene	8.2		23		28		32		34		61		52		8.5		18				25	
Miscellaneous Extractable Compounds																						
Benzoic Acid	739	UJ	610	UJ			494	UJ	487	UJ	1060	J	1050	UJ	409	U	474	U	496	U	728	UJ
Benzyl Alcohol	26		43	NJ			20	U	33		44		71		13	U	16	U	16	U	120	J
Beta-coprostanol	1490	J	635	J	4120	J	386	NJ	429	J	1160	J	1280	J	83	J	317	J	188	J	393	J
Beta-Sitosterol	4120	J	3350	J			1820	J	2020	J	1200	UJ	4520	J	1550	J	1690	J	1630	J	2980	J
Carbazole	1.9		1	U	1	U	3.7		4.1		1	U	6.1		2.4		3				1	U
Cholesterol	3530	J	3310	J			1790	UJ	2230	UJ	1270	J	6330	UJ	1120	J	1800	J	1730	J	1470	J
p-Isopropyltoluene	13	U	11	U			9.8	U	10	U	15	U	15	U	6.6	U	8.1	U	8	U	14	U
Dibenzofuran	3		6.4		7		8.2		9.6		16		13		2.3	U	5.6				5	
Organonitrogen Compounds																						
Caffeine	26	U	22	U			20	U	20	U	30	U	30	U	13	U	16	U			28	U
N-Nitrosodiphenylamine	26	U	22	U			20	U	20	U	30	U	30	U	13	U	16	U			28	U
Phenols																						
2,4-Dimethylphenol	26	U	22	U			20	U	20	U	30	U	30	U	13	U	16	U	16	U	28	U
2-Methylphenol	25		13	U			9.8	U	10	U	41		67		6.6	U	8	U	8	U	14	UJ
4-Methylphenol	23	U	13	U			18	U	20	U	48	NJ	40		18	U	8	U	18	U	14	U
Phenol	1380		1130				2300		2190		1200		3380		1140		1060		1130		1340	
P-nonylphenol	13	U	11	U			9.8	U	10	U	15	U	15	U	6.6	U	8.1	U	8	U	14	U
Phthalate Esters																						
Bis(2-Ethylhexyl) Phthalate	38	U	49	U			35	U	43	U	115	U	412	U	247	U	27	U	27	U	352	U
Butylbenzylphthalate	13	U	11	U			9.8	U	10	U	15	U	15	U	6.6	U	8.1	U	8	U	14	U
Diethylphthalate	26	U	67	U			20	U	43	U	119	U	206	U	39	U	8.1	U	8	U	258	U
Dimethylphthalate	26	U	11	U			20	U	10	U	30	U	15	U	13	U	16	U	16	U	28	U
Di-N-Butylphthalate	50	U	75	U			52	U	29	U	109	U	698	U	698		38	U	31	U	1760	
Di-N-Octyl Phthalate	26	U	22	U			20	U	20	U	30	U	30	U	13	U	16	U	16	U	28	U

Parameter Code	144						152				184		188		203		216				224	
	Rural		Field Dup		Lab Dup		Basin		Field Dup		Basin		Basin		Basin		Basin		Lab Dup		Basin	
Polychlorinated Biphenyls																						
PCB Congeners																						
PCB Congener 8	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
PCB Congener 18	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
PCB Congener 28	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
PCB Congener 44	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
PCB Congener 52	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
PCB Congener 66	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
PCB Congener 77	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
PCB Congener 101	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
PCB Congener 105	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
PCB Congener 110	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
PCB Congener 118	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	0.2	J	1.2	U	1.1	U	1.1	U			1.2	U
PCB Congener 126	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
PCB Congener 128	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
PCB Congener 138	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	0.24	J	1.2	U	1.1	U	1.1	U			1.2	U
PCB Congener 153	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	0.18	J	1.2	U	1.1	U	1.1	U			1.2	U
PCB Congener 169	1.2	UJ	1.2	U	1.1	U	1.2	UJ	1.1	UJ	1.2	U	1.2	UJ	1.1	UJ	1.1	UJ			1.2	U
PCB Congener 170	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
PCB Congener 180	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
PCB Congener 187	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
PCB Congener 195	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
PCB Congener 206	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
PCB Congener 209	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
PCB Aroclors:																						
PCB Aroclor 1016	5.8	UJ	5.9	U	5.5	U	5.8	U	5.7	U	5.9	U	6	U	5.6	U	5.7	U			6.1	U
PCB Aroclor 1221	5.8	UJ	5.9	U	5.5	U	5.8	U	5.7	U	5.9	U	6	U	5.6	U	5.7	U			6.1	U
PCB Aroclor 1232	5.8	UJ	5.9	U	5.5	U	5.8	U	5.7	U	5.9	U	6	U	5.6	U	5.7	U			6.1	U
PCB Aroclor 1242	5.8	UJ	5.9	U	5.5	U	5.8	U	5.7	U	5.9	U	6	U	5.6	U	5.7	U			6.1	U
PCB Aroclor 1248	5.8	UJ	3.1	NJ	3.5	J	5.8	U	5.7	U	4	NJ	6	U	5.6	U	5.7	U			6.1	U
PCB Aroclor 1254	5.8	UJ	3.4	J	3.7	J	5.8	U	5.7	U	5.2	NJ	3.5	J	5.6	U	5.7	U			6.1	U
PCB Aroclor 1260	5.8	UJ	5.9	U	5.5	U	5.8	U	5.7	U	5.9	U	6	U	5.6	U	5.7	U			6.1	U
Polybrominated Diphenylethers																						
PBDE- 47	1.2	U	0.18	NJ	0.15	NJ	0.15	J	0.16	NJ	0.23	J	0.31	J	1.1	U	1.1	U			1.2	U
PBDE- 99	1.2	U	0.18	J	1.1	U	1.2	U	1.1	U	0.12	J	0.18	J	1.1	U	1.1	U			1.2	U

Parameter Code	144						152				184		188		203		216				224	
	Rural		Field Dup		Lab Dup		Basin		Field Dup		Basin		Basin		Basin		Basin		Lab Dup		Basin	
PBDE-100	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
PBDE-153	1.2	U	1.2	U	1.1	U	1.2	U	1.1	U	1.2	U	1.2	U	1.1	U	1.1	U			1.2	U
PBDE-154	1.2	UJ	1.2	UJ	1.1	UJ	1.2	UJ	1.1	UJ	1.2	UJ	1.2	UJ	1.1	UJ	1.1	UJ			1.2	UJ

Table G-2. Chemistry concentrations in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.

Parameter Code	248						252		288		296		323						336			
	Basin		Lab Dup		Lab Trip		Basin		Basin		Basin		Basin		Lab Dup		Lab Trip		Basin		Lab Dup	
Total Organic Carbon	0.23		0.22		0.22		0.14		0.16		2.22		0.32		0.32		0.36		2.5			
Priority Pollutant Metals																						
Arsenic	1.59						1.95		1.64		6.29		4.47						4.25			
Cadmium	0.1	U					0.1	U	0.1	U	0.26		0.13						0.2			
Chromium	25.9						22.2		22.4		42.9		27.8						28.9			
Copper	7.17						6.07		6.54		39.3		7.08						11.1			
Lead	1.66						2.34		2.09		14.6		3.83						5.51			
Mercury	0.0075						0.0059	U	0.005	U	0.078		0.016						0.027			
Nickel	18.9						14.4		15.9		36.7		30.6						30.3			
Selenium	0.5	U					0.5	U	0.5	U	1		0.5	U					0.5	U		
Silver	0.1	U					0.1	U	0.1	U	0.13		0.1	U					0.1	U		
Zinc	20.4						22		22		90.8		33.8						41.7			
Trace Elements																						
Tin	0.25						0.24		0.3		1		0.37						0.45			
Organics																						
Chlorinated Alkenes																						
Hexachlorobutadiene	6.3	U					6.4	U	6.7	U	17	U	6.8	U					7.7	U	8	U
Chlorinated and Nitro-Substituted Phenols																						
Pentachlorophenol	64	UJ					64	UJ	67	UJ	166	UJ	68	U					77	U	80	U
Chlorinated Aromatic Compounds																						
1,2,4-Trichlorobenzene	6.3	U					6.4	U	6.7	U	17	U	6.8	U					7.7	U	8	U
1,2-Dichlorobenzene	6.3	U					6.4	U	6.7	U	17	U	6.8	U					7.7	U	8	U
1,3-Dichlorobenzene	6.3	U					6.4	U	6.7	U	17	U	6.8	U					7.7	U	8	U
1,4-Dichlorobenzene	6.3	U					6.4	U	6.7	U	17	U	6.8	U					7.7	U	8	U
2-Chloronaphthalene	1	U	1	U			1	U	1	U	1	U	1	U					1	U		
Hexachlorobenzene	6.3	U					6.4	U	6.7	U	17	U	6.8	U					7.7	U	8	U
Chlorinated Pesticides																						
2,4'-DDD	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
2,4'-DDE	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
2,4'-DDT	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
4,4'-DDD	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					0.12	J		
4,4'-DDE	1	U	1	U			1.1	U	1.1	U	0.48	J	1.1	U					0.14	J		
4,4'-DDT	1	U	1	U			1.1	UJ	1.1	UJ	0.26	NJ	1.1	U					1.1	U		
Aldrin	1	UJ	1	UJ			1.1	UJ	1.1	UJ	1.1	UJ	1.1	UJ					1.1	UJ		

Parameter Code	248						252		288		296		323						336			
	Basin		Lab Dup		Lab Trip		Basin		Basin		Basin		Basin		Lab Dup		Lab Trip		Basin		Lab Dup	
Cis-Chlordane	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
Dieldrin	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
Endosulfan I	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
Endosulfan II	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
Endosulfan Sulfate	1	UJ	1	UJ			1.1	UJ	1.1	UJ	1.1	UJ	1.1	UJ					1.1	UJ		
Endrin	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
Endrin Aldehyde	1	UJ	1	UJ			1.1	UJ	1.1	UJ	1.1	UJ	1.1	UJ					1.1	UJ		
Endrin Ketone	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
Gamma-BHC (Lindane)	1	U	1	U			1.1	UJ	1.1	UJ	1.1	U	1.1	U					1.1	U		
Heptachlor	1	UJ	1	UJ			1.1	U	1.1	U	1.1	UJ	1.1	UJ					1.1	UJ		
Heptachlor Epoxide	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
Mirex	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
Oxychlordane	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
Toxaphene	10	U	10	U			11	U	11	U	11	U	11	U					11	U		
Trans-Chlordane (Gamma)	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
Polynuclear Aromatic Hydrocarbons																						
LPAHs																						
1,6,7-Trimethylnaphthalene	1	UJ	0.28	J			1	U	0.49		13	J	3.9	J					5.7	J		
1-Methylnaphthalene	0.47	J	0.37	J			0.22	J	0.16		26		5.4						12			
1-Methylphenanthrene	0.89	J	0.5	J			1	U	1	U	23		5						12			
2,6-Dimethylnaphthalene	3.3		3.5				3		4.5		38		11						27			
2-Methylnaphthalene	0.72	J	0.77	J			0.81	UJ	1	UJ	26		6						14			
2-Methylphenanthrene	0.5	J	0.27	J			1	U	1	U	15		3						7.7			
Acenaphthene	0.22	J	0.09	J			0.52	J	1	U	2.6		0.67						2.4			
Acenaphthylene	0.26	J	0.19	J			1	U	1	U	6.4		2.2						12			
Anthracene	0.52	J	0.22	J			0.28	UJ	1	U	7.8		1.6						6.2			
Biphenyl	0.94	J	0.38	J			1.8	UJ	1.3	UJ	8.8		2						6.1			
Dibenzothiophene	0.33	J	0.24	J			0.9	J	1	UJ	4.3	J	0.73	J					1.5	J		
Fluorene	0.49	J	1	U			1	UJ	1	U	9.5	J	3.2	J					6	J		
Naphthalene	0.97	J	0.82	J			0.83	J	0.67		32		8.2						45			
Phenanthrene	2.2		1.5				2.1	UJ	2		56		12						39			
Retene	3		6.5				1.2		1.7		46		13						19			
HPAHs																						
Benzo(a)anthracene	1.1		0.5	J			1		0.92		18		2.2						8.9			
Benzo(a)pyrene	1.1		0.7	J			0.78		0.94		29		2.3						9.8			

Parameter Code	248						252		288		296		323						336			
	Basin		Lab Dup		Lab Trip		Basin		Basin		Basin		Basin		Lab Dup		Lab Trip		Basin		Lab Dup	
Benzo(b)fluoranthene	1.5	J	0.95	J			1.7	J	1	J	34	J	3.7	J					11	J		
Benzo(e)pyrene	1.3		0.55	J			1.1		0.94		28		2.4						8.2			
Benzo(g,h,i)perylene	1.5		1.2				1.4		1.2		37		3						8.6			
Benzo(k)fluoranthene	1.1	J	0.86	J			1.5	J	1	J	28	J	3	J					8.6	J		
Chrysene	1.6		0.73	J			1.9		1.2		30		3.9						14			
Dibenzo(a,h)anthracene	1	U	1	U			0.71	J	1	U	7.7		0.78						2.4			
Fluoranthene	2.8		1.5				2		2.6		53		8.6						35			
Indeno(1,2,3-c,d)pyrene	1.2		1				1.5		1.2		27		1.8						6.5			
Perylene	2		1.9				0.98		1.5		80		13						28			
Pyrene	2.6		1.2				1.8		2.4		52		7.6						31			
Miscellaneous Extractable Compounds																						
Benzoic Acid	314	UJ					380	UJ	353	UJ	939	UJ	966	J					681	J	706	J
Benzyl Alcohol	13	U					23		13	U	52	J	70	NJ					15	U	16	U
Beta-coprostanol	110	J					168	U	171	UJ	359	J	174	J					154	UJ	160	UJ
Beta-Sitosterol	697	J					1030	U	1070	UJ	2400	J	1090	UJ					1240	UJ	1280	UJ
Carbazole	1	U					2	UJ	1.8	UJ	1	U	1	U					1	U		
Cholesterol	888	J					880	J	888	J	1500	J	1080	J					880	NJ	506	J
p-Isopropyltoluene	6.3	U					6.4	U	6.7	U	17	U	6.8	U					7.7	U	8	U
Dibenzofuran	0.45	J	0.42	J			1	UJ	1	U	12		2.5						6.9			
Organonitrogen Compounds																						
Caffeine	13	U					13	U	13	U	33	U	14	U					15	U	16	U
N-Nitrosodiphenylamine	13	U					13	U	13	U	33	U	14	U					15	U	16	U
Phenols																						
2,4-Dimethylphenol	13	U					13	U	13	U	33	U	14	U					15	U	16	U
2-Methylphenol	12	J					6.4	U	6.7	U	17	UJ	6.8	U					7.7	U	8	U
4-Methylphenol	17						6.4	U	6.7	U	17	U	22						166	J	176	
Phenol	575						470		131	U	1290		88	UJ					841		844	
P-nonylphenol	6.3	U					6.4	U	6.7	U	17	U	6.8	U					7.7	U	8	U
Phthalate Esters																						
Bis(2-Ethylhexyl) Phthalate	41	U					51	U	34	U	105	U	112	UJ					67	U	83	U
Butylbenzylphthalate	6.3	U					6.4	U	6.7	U	17	U	6.8	U					7.7	U	8	U
Diethylphthalate	13	U					26	U	30	U	22	U	32	UJ					24	UJ	51	U
Dimethylphthalate	13	U					13	U	13	U	33	U	2.1	NJ					15	U	16	U
Di-N-Butylphthalate	9.9	U					21	U	13	U	17	U	37	UJ					36	U	72	U
Di-N-Octyl Phthalate	13	U					13	U	13	U	33	U	14	U					15	U	16	U

Parameter Code	248						252		288		296		323						336			
	Basin		Lab Dup		Lab Trip		Basin		Basin		Basin		Basin		Lab Dup		Lab Trip		Basin		Lab Dup	
Polychlorinated Biphenyls																						
PCB Congeners																						
PCB Congener 8	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
PCB Congener 18	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
PCB Congener 28	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
PCB Congener 44	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
PCB Congener 52	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
PCB Congener 66	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
PCB Congener 77	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
PCB Congener 101	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
PCB Congener 105	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
PCB Congener 110	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
PCB Congener 118	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
PCB Congener 126	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
PCB Congener 128	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
PCB Congener 138	1	U	1	U			1.1	U	1.1	U	0.24	J	1.1	U					1.1	U		
PCB Congener 153	1	U	1	U			1.1	U	1.1	U	0.22	J	1.1	U					1.1	U		
PCB Congener 169	1	U	1	U			1.1	UJ	1.1	UJ	1.1	U	1.1	U					1.1	U		
PCB Congener 170	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
PCB Congener 180	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
PCB Congener 187	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
PCB Congener 195	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
PCB Congener 206	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
PCB Congener 209	1	U	1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
PCB Aroclors:																						
PCB Aroclor 1016	5	U	5.4	U			5.7	U	5.6	U	5.6	U	5.5	U					5.4	U		
PCB Aroclor 1221	5	U	5.4	U			5.7	U	5.6	U	5.6	U	5.5	U					5.4	U		
PCB Aroclor 1232	5	U	5.4	U			5.7	U	5.6	U	5.6	U	5.5	U					5.4	U		
PCB Aroclor 1242	5	U	5.4	U			5.7	U	5.6	U	5.6	U	5.5	U					5.4	U		
PCB Aroclor 1248	5	U	5.4	U			5.7	U	5.6	U	2.8	J	5.5	U					5.4	U		
PCB Aroclor 1254	5	U	5.4	U			5.7	U	5.6	U	4.8	NJ	5.5	U					5.4	U		
PCB Aroclor 1260	5	U	5.4	U			5.7	U	5.6	U	5.6	U	5.5	U					5.4	U		
Polybrominated Diphenylethers																						
PBDE- 47	1	U	1.1	U			1.1	U	1.1	U	0.2	J	1.1	U					0.15	NJ		
PBDE- 99	1	U	1.1	U			1.1	U	1.1	U	1.1	U	1.1	U					0.12	J		

Parameter Code	248						252		288		296		323						336			
	Basin		Lab Dup		Lab Trip		Basin		Basin		Basin		Basin		Lab Dup		Lab Trip		Basin		Lab Dup	
PBDE-100	1	U	1.1	U			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
PBDE-153	1	U	0.4	J			1.1	U	1.1	U	1.1	U	1.1	U					1.1	U		
PBDE-154	1	UJ	1.1	UJ			1.1	UJ	1.1	UJ	1.1	UJ	1.1	UJ					1.1	UJ		

Table G-3. Near-bottom dissolved oxygen measurements in waters from Hood Canal for the 2004 PSAMP Sediment Component.

Station and Location	Collection Date	Analysis Date	Sample Depth (m)	Station depth (m)	DO Bottle #	Btl vol. (mL)	Buret Rdg.	btl factor	O2 (mg-at/L)	O2 (mg/L)	Comments
8, Hazel Pt.	6/4/2004	6/9/2004	62	65	160	139.36	0.50	0.74	0.37	5.94	
8, Hazel Pt.	6/4/2004	6/9/2004	31	65	161	138.78	0.50	0.75	0.72	11.50	
8, Hazel Pt.	6/4/2004	6/9/2004	0	65	162	140.46	0.97	0.74	0.44	7.12	
24, Vinland	6/3/2004	6/9/2004	46	45	152	141.35	0.61	0.73	0.44	7.07	
24, Vinland	6/3/2004	6/9/2004	46	45	153	138.89	0.60	0.74	0.44	7.09	
24, Vinland	6/3/2004	6/9/2004	46	45	154	137.02	0.59	0.76	0.44	7.07	
24, Vinland	6/3/2004	6/9/2004	24	45	155	138.56	0.76	0.75	0.58	9.25	
24, Vinland	6/3/2004	6/9/2004	24	45	156	142.27	0.78	0.73	0.61	9.83	
24, Vinland	6/3/2004	6/9/2004	0	45	157	141.43	0.85	0.73	0.62	9.99	
24, Vinland	6/3/2004	6/9/2004	0	45	158	142.77	0.86	0.72	0.24	3.79	
32, Broad Spit	6/7/2004	6/9/2004	112	112	125	133.84	0.33	0.77	0.25	4.05	pipette tip came off during chem, redone.
32, Broad Spit	6/7/2004	6/9/2004	112	112	126	138.91	0.36	0.74	0.26	4.23	
48, Pulali Pt	6/7/2004	6/9/2004	170	176	131	142.08	0.08	0.73	0.06	0.95	
48, Pulali Pt	6/7/2004	6/9/2004	170	176	144	143.27					locked stopper, broke bottle during analysis.
56, Stavis Bay	6/4/2004	6/9/2004	156	164	168	140.66	0.28	0.74	0.20	3.23	
60, Seal Rock	6/7/2004	6/9/2004	147	153	143	137.67	0.24	0.75	0.18	2.87	
64, Musquiti Pt. North	6/10/2004	6/11/2004	NB	95	133	141.64	0.16	0.70	0.11	1.74	
75, Coon Bay	6/2/2004	6/9/2004	NB	95	148	136.63	0.62	0.76	0.47	7.45	
80, Sylopash Pt	6/8/2004	6/9/2004	95	99	124	140.18	0.34	0.74	0.25	4.05	
80, Sylopash Pt	6/8/2004	6/9/2004	95	99	130	137.56	0.35	0.75	0.26	4.22	
88, N Four Corners	6/3/2004	6/9/2004	48	54	150	140.40	0.62	0.74	0.46	7.31	
92, Zelatched Pt.	6/7/2004	6/9/2004	155	161	137	141.01	0.30	0.73	0.22	3.48	
96, Sund Creek	6/10/2004	6/11/2004	NB	132	127	140.98	0.16	0.71	0.11	1.79	

Station and Location	Collection Date	Analysis Date	Sample Depth (m)	Station depth (m)	DO Bottle #	Btl vol. (mL)	Buret Rdg.	btl factor	O2 (mg-at/L)	O2 (mg/L)	Comments
112, Tabook Pt	6/7/2004	6/9/2004	175	182	138	141.39	0.04	0.73	0.03	0.44	
118, Shoofly Creek	6/9/2004	6/11/2004	27	31	121	143.89	0.10	0.69	0.07	1.14	
118, Shoofly Creek	6/9/2004	6/11/2004	27	31	122	139.85	0.08	0.71	0.06	0.91	
120, Fulton Creek S	6/8/2004	6/9/2004	153	159	123	141.59	0.19	0.73	0.14	2.24	
124, Seabeck	6/4/2004	6/9/2004	9	10	163	140.36	1.00	0.74	0.10	1.59	station moved 300m.
128, Sisters Pt	6/9/2004	6/11/2004	32	37	128	138.21	0.14	0.72	0.10	1.55	
144, Fishermans Pt	6/7/2004	6/9/2004	45	45	132	141.80	0.39	0.73	0.28	4.54	
152, Transit Station	6/3/2004	6/9/2004	33	37	151	140.81	0.62	0.73	0.45	7.25	
184, Misery Pt	6/8/2004	6/9/2004	107	113	136	139.89	0.35	0.74	0.26	4.08	
188, King Spit	6/4/2004	6/9/2004	100	104	159	140.41	0.53	0.74	0.46	7.44	
203, Hood Head	6/3/2004	6/9/2004	75	~80	149	140.32	0.63	0.74	0.47	7.44	
216, Sisters	6/2/2004	6/9/2004	NB	19	145	140.43	0.68	0.74	0.50	8.00	
224, Musquiti Pt	6/10/2004	6/11/2004	NB	93	134	134.40	0.13	0.74	0.10	1.53	
248, Tekiu Pt	6/8/2004	6/9/2004	15	19	129	138.00	0.82	0.75	0.61	9.79	
252, Maple Beach North	6/4/2004	6/9/2004	NB	9	164	137.91	1.04	0.75	0.78	12.52	CTD soaking at 6m, cast was only ~6m deep.
252, Maple Beach North	6/4/2004	6/9/2004	6	9	165	137.55	1.04	0.75	0.78	12.48	CTD soaking at 6m, cast was only ~6m deep.
288, Maple Beach S	6/4/2004	6/9/2004	8	11	166	141.58	1.12	0.73	0.82	13.10	
288, Maple Beach S	6/4/2004	6/9/2004	8	11	167	142.59	1.13	0.73	0.82	13.13	
296, Fulton Creek North	6/8/2004	6/9/2004	155	164	142	140.37	0.13	0.74	0.10	1.57	
323, Coon Bay	6/14/2004	6/15/2004	NB	103	60	132.29	0.55	0.79	0.43	6.89	
336, Bridgehaven	6/14/2004	6/15/2004	NB	70	59	132.32	0.56	0.79	0.44	7.05	

Appendix H. List of Benthic Infauna and Quality Assurance/ Quality Control Data

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Table H-1. Benthic infaunal taxa identified in sediments collected from Hood Canal for the 2004 PSAMP Sediment Component.

10 pages

Phylum	Class	Order	Family	**Taxonomy Level Reported**	**Authorship**
Cnidaria					
	Hydrozoa				
		Hydroida			
			Tubulariidae	*Euphysa* sp	
			Campanulariidae	Campanulariidae	
				Campanularia gelatinosa	
			Sertulariidae	*Abietinaria* sp	
				Sertularella sp	
			Plumulariidae	*Aglaophenia* sp	
			Calycellidae	*Calycella syringa*	(Linnaeus, 1767)
	Anthozoa				
		Ceriantharia			
			Cerianthidae	*Pachycerianthus fimbriatus*	McMurrich, 1910
				Pachycerianthus sp	
		Pennatulacea		Pennatulacea	
			Virgulariidae	*Acanthoptilum gracile*	(Gabb, 1862)
				Acanthoptilum sp	
				Stylatula elongata	(Gabb, 1862)
				Virgularia sp	
		Actiniaria			
			Edwardsiidae	*Edwardsia* sp G	MEC, 1992 §
			Halcampidae	*Halcampa decemtentaculata*	Hand, 1954
			Haloclavidae	*Peachia quinquecapitata*	McMurrich, 1913
Platyhelminthes					
	Turbellaria				
		Polycladida			
			Leptoplanidae	Leptoplanidae	
Nemertea					
	Anopla				
		Paleonemertea			
			Tubulanidae	*Tubulanus capistratus*	(Coe, 1901)
				Tubulanus cingulatus	(Coe, 1904)
				Tubulanus polymorphus	Renier, 1804
				Tubulanus sp	
		Paleonemertea			
			Carinomidae	*Carinoma mutabilis*	Griffin, 1898
		Heteronemertea			
			Lineidae	*Cerebratulus* sp	
				Lineidae	
				Lineus sp	
				Micrura sp	
	Enopla				
		Hoplonemertea			

Phylum	Class	Order	Family	Taxonomy Level Reported	Authorship
			Emplectonematidae	*Paranemertes californica*	Coe, 1904
			Prosorhochmidae	*Oerstedia dorsalis*	(Abildgaard, 1806)
			Tetrastemmatidae	Tetrastemmatidae	
				Tetrastemma aberrans	Coe, 1901
				Tetrastemma sp	
				Tetrastemma sp C	
Annelida					
	Polychaeta				
		Aciculata			
			Capitellidae	*Barantolla nr americana*	Hartman, 1963
				Capitella capitata Cmplx	(Fabricius, 1780)
				Decamastus gracilis	Hartman, 1963
				Heteromastus filobranchus	Berkeley & Berkeley, 1932
				Mediomastus californiensis	Hartman, 1944
				Mediomastus sp	
			Chrysopetalidae	*Paleanotus bellis*	(Johnson, 1897)
			Cossuridae	*Cossura bansei*	Hilbig, 1996
				Cossura pygodactylata	Jones, 1956
			Dorvilleidae	*Dorvillea pseudorubrovittata*	Berkeley, 1927
			Glyceridae	*Glycera americana*	Leidy, 1855
				Glycera nana	Johnson, 1901
			Goniadidae	*Glycinde armigera*	Moore, 1911
				Glycinde polygnatha	Hartman, 1950
				Goniada brunnea	Treadwell, 1906
				Goniada maculata	Ørsted, 1843
			Hesionidae	*Kefersteinia cirrata*	(Keferstein, 1862)
				Podarkeopsis glabra	(Hartman, 1961)
				Podarkeopsis perkinsi	Hilbig, 1992
			Lumbrineridae	*Eranno bicirrata*	(Treadwell, 1922)
				Lumbrineridae	
				Lumbrineris californiensis	Hartman, 1944
				Lumbrineris cruzensis	Hartman, 1944
				Scoletoma luti	(Berkeley & Berkeley, 1945)
			Nephtyidae	*Nephtys caeca*	(Fabricius, 1780)
				Nephtys caecoides	Hartman, 1938
				Nephtys californiensis	Hartman, 1938
				Nephtys cornuta	Berkeley & Berkeley, 1945
				Nephtys ferruginea	Hartman, 1940
				Nephtys punctata	Hartman, 1938
			Nereididae	*Nereis procera*	Ehlers, 1868
				Platynereis bicanaliculata	(Baird, 1863)
			Oenonidae	*Arabella* sp	
			Onuphidae	*Diopatra ornata*	Moore, 1911
				Onuphidae	
				Onuphis iridescens	(Johnson, 1901)
				Onuphis sp	
			Orbiniidae	*Leitoscoloplos pugettensis*	(Pettibone, 1957)

Phylum	Class	Order	Family	**Taxonomy Level Reported**	**Authorship**
				Leitoscoloplos sp	
				Naineris uncinata	Hartman, 1957
				Phylo felix	Kinberg, 1866
			Opheliidae	*Armandia brevis*	(Moore, 1906)
				Ophelina acuminata	Ørsted, 1843
				Travisia pupa	Moore, 1906
			Paraonidae	*Aricidea (Acmira) lopezi*	Berkeley & Berkeley, 1956
				Aricidea (Allia) ramosa	Annenkova, 1934
				Cirrophorus branchiatus	Ehlers, 1908
				Levinsenia gracilis	(Tauber, 1879)
				Levinsenia oculata	(Hartman, 1957)
			Pholoidae	*Pholoe glabra*	Hartman, 1961
				Pholoe minuta	(Fabricius, 1780)
				Pholoe sp N1	NAMIT, 1999 §
				Pholoides asperus	(Johnson, 1897)
			Phyllodocidae	*Eteone californica*	Hartman, 1936
				Eteone sp	
				Eteone spilotus	Kravitz & Jones, 1979
				Eumida longicornuta	(Moore, 1906)
				Paranaitis polynoides	(Moore, 1909)
				Phyllodoce cuspidata	McCammon & Montagne, 1979
				Phyllodoce hartmanae	Blake & Walton, 1977
				Phyllodoce longipes	Kinberg, 1866
				Phyllodoce sp	
			Pilargidae	*Pilargis maculata*	Hartman, 1947
				Sigambra bassi	(Hartman, 1945)
			Polynoidae	*Eunoe uniseriata*	Banse & Hobson, 1968
				Gattyana ciliata	Moore, 1902
				Gattyana sp	
				Gattyana treadwelli	Pettibone, 1949
				Harmothoinae	
				Harmothoe fragilis	Moore, 1910
				Harmothoe imbricata	(Linnaeus, 1767)
				Lepidasthenia berkeleyae	Pettibone, 1948
				Malmgreniella scriptoria	(Moore, 1910)
				Tenonia priops	(Hartman, 1961)
			Sphaerodoridae	*Sphaerodoropsis sphaerulifer*	(Moore, 1909)
			Syllidae	*Eusyllis blomstrandi*	Malmgren, 1867
				Eusyllis habei	Imajima, 1966
				Eusyllis sp	
				Exogone dwisula	Kudenov & Harris, 1995
				Exogone lourei	Berkeley & Berkeley, 1938
				Exogone molesta	Banse, 1972
				Pionosyllis magnifica	Moore, 1906
				Proceraea cornuta	(Agassiz, 1862)
				Sphaerosyllis ranunculus	Kudenov & Harris, 1995
				Typosyllis cornuta	Rathke, 1843

Phylum Class Order Family				**Taxonomy Level Reported**	**Authorship**
				Typosyllis heterochaeta	(Moore, 1909)
		Canalipalpata			
			Ampharetidae	*Ampharete acutifrons*	(Grube, 1860)
				Ampharete finmarchica	Malmgren, 1866
				Ampharete sp	
				Ampharetidae	
				Amphicteis mucronata	Moore, 1923
				Anobothrus gracilis	(Malmgren, 1866)
				Asabellides lineata	(Berkeley & Berkeley, 1943)
				Asabellides sibirica	(Wiren, 1883)
				Lysippe labiata	Malmgren, 1866
				Lysippe sp	
				Melinna sp	
			Chaetopteridae	*Mesochaetopterus* sp	
				Phyllochaetopterus claparedii	McIntosh, 1885
				Phyllochaetopterus prolifica	Potts, 1914
				Spiochaetopterus pottsi	(Berkeley, 1927)
			Cirratulidae	*Aphelochaeta glandaria*	Blake, 1996
				Aphelochaeta monilaris	(Hartman, 1960)
				Aphelochaeta sp	
				Chaetozone commonalis	Blake, 1996
				Chaetozone nr setosa	Malmgren, 1867
				Chaetozone sp N2	NAMIT, 2000 §
				Cirratulus sp	
				Monticellina serratiseta	(Banse & Hobson, 1968)
			Flabelligeridae	*Brada sachalina*	Annenkova, 1922
				Brada villosa	(Rathke, 1843)
			Magelonidae	*Magelona longicornis*	Johnson, 1901
			Maldanidae	*Chirimia similis*	(Moore, 1906)
				Clymenura gracilis	Hartman, 1969
				Euclymeninae	
				Euclymeninae sp A	SCAMIT, 1987 §
				Maldane sarsi	Malmgren, 1865
				Microclymene caudata	Imajima & Shiraki, 1982
				Nicomache personata	Johnson, 1901
				Praxillella gracilis	(M. Sars, 1861)
				Praxillella pacifica	E. Berkeley, 1929
				Praxillella sp	
				Rhodine bitorquata	Moore, 1923
			Oweniidae	*Galathowenia oculata*	(Zaks, 1923)
				Myriochele olgae	Blake 2000
				Owenia fusiformis	Delle Chiaje, 1841
			Pectinariidae	*Pectinaria californiensis*	Hartman, 1941
				Pectinaria granulata	(Linnaeus, 1767)
				Pectinaria sp	
			Sabellidae	*Chone duneri*	Malmgren, 1867
				Demonax rugosus	(Moore, 1904)

Phylum	Class	Order	Family	**Taxonomy Level Reported**	**Authorship**
				Euchone incolor	Hartman, 1965
				Megalomma splendida	(Moore, 1905)
				Sabellidae	
			Spionidae	*Boccardia pugettensis*	Blake, 1979
				Dipolydora cardalia	(Berkeley, 1927)
				Dipolydora caulleryi	(Mesnil, 1897)
				Dipolydora socialis	(Schmarda, 1861)
				Laonice cirrata	(M. Sars, 1851)
				Laonice sp	
				Paraprionospio pinnata	(Ehlers, 1901)
				Prionospio (Minuspio) lighti	Maciolek, 1985
				Prionospio (Minuspio) multibranchiata	E. Berkeley, 1927
				Prionospio (Prionospio) jubata	Blake, 1996
				Prionospio (Prionospio) steenstrupi	Malmgren, 1867
				Spio cirrifera	(Banse & Hobson, 1968)
				Spiophanes berkeleyorum	Pettibone, 1962
				Spiophanes bombyx	(Claparède, 1870)
			Terebellidae	*Artacama coniferi*	Moore, 1905
				Eupolymnia sp	
				Lanassa nordenskioeldi	Malmgren, 1866
				Lanassa venusta	(Malm, 1874)
				Pista estevanica	Berkeley & Berkeley, 1942
				Pista sp	
				Polycirrus californicus	Moore, 1909
				Polycirrus sp	
				Polycirrus sp III	Banse, 1980
				Streblosoma bairdi	(Malmgren, 1866)
			Trichobranchidae	*Terebellides californica*	Williams, 1984
				Terebellides reishi	Williams, 1984
				Terebellides sp	
			Trochochaetidae	*Trochochaeta multisetosa*	(Ørsted, 1844)
				Trochochaeta sp	
		Terebellida			
			Ampharetidae	*Ampharete cf crassiseta*	Annenkova, 1929
	Oligochaeta				
				Oligochaeta	
Mollusca					
	Gastropoda				
				Gastropoda	
		Architectibranchia			
			Aplustridae	*Parvaplustrum* sp	
		Cephalaspidea			
			Cylichnidae	*Acteocina eximia*	(Baird, 1863)
				Cylichna attonsa	Carpenter, 1865
			Diaphanidae	*Diaphana californica*	Dall, 1919
			Gastropteridae	*Gastropteron pacificum*	Bergh, 1893

Phylum	Class	Order	Family	**Taxonomy Level Reported**	**Authorship**
		Heterostropha			
			Pyramidellidae	*Cyclostremella concordia*	Bartsch, 1920
				Odostomia sp	
				Turbonilla sp	
		Neogastropoda			
			Columbellidae	*Astyris gausapata*	(Gould, 1850)
			Conidae	*Oenopota* sp	
		Neotaenioglossa			
			Cerithiidae	*Lirobittium* sp	
			Naticidae	*Euspira lewisii*	(Gould, 1847)
				Euspira pallida	(Broderip & G.B. Sowerby I, 1829)
			Rissoidae	*Alvania compacta*	Carpenter, 1864
		Nudibranchia			
			Arminidae	*Armina californica*	(J. G. Cooper, 1863)
			Corambidae	*Corambe* sp	
			Flabellinidae	Flabellinidae	
		Saccoglossa			
				Saccoglossa sp	
	Aplacophora				
		Chaetodermatida			
			Chaetodermatidae	*Chaetoderma* sp	
	Bivalvia				
		Mytiloida			
			Mytilidae	*Musculus discors*	(Linnaeus, 1767)
				Musculus sp	
				Mytilus sp	
				Solamen columbianum	(Dall, 1897)
		Nuculoida			
			Nuculanidae	*Nuculana minuta*	(Muller, 1776)
			Nuculidae	*Acila castrensis*	(Hinds, 1843)
				Ennucula tenuis	(Montagu, 1808)
			Yoldiidae	*Megayoldia thraciaeformis*	(Storer, 1838)
			Yoldiidae	*Yoldia seminuda*	Dall, 1871
			Yoldiidae	*Yoldia* sp	
		Ostreoida			
			Pectinidae	*Delectopecten vancouverensis*	(Whiteaves, 1893)
		Pholadomyoida			
			Cuspidariidae	*Cardiomya pectinata*	(Carpenter, 1864)
			Lyonsiidae	*Lyonsia californica*	Conrad, 1837
			Pandoridae	*Pandora filosa*	(Carpenter, 1864)
				Pandora sp	
			Thraciidae	*Thracia trapezoides*	Conrad, 1849
		Veneroida			
			Astartidae	*Astarte elliptica*	(Brown, 1827)
			Cardiidae	*Nemocardium centifilosum*	(Carpenter, 1864)
			Lasaeidae	*Neaeromya rugifera*	(Carpenter, 1864)
				Rochefortia tumida	(Carpenter, 1864)

Phylum	Class	Order	Family	Taxonomy Level Reported	Authorship
			Lucinidae	*Lucinoma annulatum*	(Reeve, 1850)
				Parvilucina tenuisculpta	(Carpenter, 1864)
			Solenidae	*Solen sicarius*	Gould, 1850
			Tellinidae	*Macoma calcarea*	(Gmelin, 1791)
				Macoma carlottensis	
				Macoma elimata	Dunnill & Coan, 1968
				Macoma golikovi	(Sowerby, 1817)
				Macoma nasuta	(Conrad, 1837)
				Macoma sp	
				Tellina modesta	(Carpenter, 1864)
				Tellina nuculoides	(Reeve, 1854)
			Thyasiridae	*Adontorhina cyclia*	Berry, 1947
				Axinopsida serricata	(Carpenter, 1864)
				Thyasira flexuosa	(Montagu, 1803)
			Veneridae	*Compsomyax subdiaphana*	(Carpenter, 1864)
				Nutricola lordi	(Baird, 1863)
				Protothaca staminea	(Conrad, 1837)
	Scaphopoda				
		Dentaliida			
			Rhabdidae	*Rhabdus rectius*	(Carpenter, 1865)
		Gadilida			
			Pulsellidae	*Pulsellum salishorum*	E. Marshall, 1980
Arthropoda					
	Pycnogonida				
		Pantopoda			
			Nymphonidae	*Nymphon* sp	
	Ostracoda				
		Myodocopida			
			Cylindroleberididae	Cylindroleberididae	
			Philomedidae	*Euphilomedes carcharodonta*	(Smith, 1952)
				Euphilomedes producta	Poulsen, 1962
			Rutidermatidae	*Rutiderma lomae*	(Juday, 1907)
	Maxillipoda				
		Calanoida			
				Calanoida	
	Malacostraca				
		Amphipoda			
				Caprellidea	
			Ampeliscidae	*Ampelisca brevisimulata*	J. L. Barnard, 1954
				Ampelisca careyi	Dickinson, 1982
				Ampelisca cristata	Holmes, 1908
				Ampelisca hancocki Cmplx	J. L. Barnard, 1954
				Byblis sp	
			Aoridae	*Aoroides intermedius*	Conlan & Bousfield, 1982
				Aoroides sp	
			Caprellidae	*Caprella mendax*	Mayer, 1903
				Caprella sp	

Phylum	Class	Order	Family	Taxonomy Level Reported	Authorship
				Metacaprella kennerlyi	(Stimpson, 1864)
			Eusiridae	*Eusirus columbianus*	Bousfield & Hendrycks, 1995
				Pontogeneia rostrata	Gurjanova, 1938
				Rhachotropis clemens	J.L. Barnard, 1967
				Rhachotropis oculata	Hansen, 1888
			Hyperiidae	Hyperiidae	
			Isaeidae	*Gammaropsis thompsoni*	(Walker, 1898)
				Photis bifurcata	J. L. Barnard, 1962
				Photis brevipes	Shoemaker, 1942
				Photis sp	
				Protomedeia prudens	J. L. Barnard, 1966
			Ischyroceridae	*Ischyrocerus* sp	
				Microjassa sp	
			Lysianassidae	*Acidostoma* sp	
				Opisa tridentata	Hurley, 1963
				Orchomene pacificus	(Gurjanova, 1938)
			Melitidae	*Desdimelita desdichada*	(J. L. Barnard, 1962)
			Oedicerotidae	*Americhelidium shoemakeri*	Mills, 1962
				Americhelidium variabilum	Bousfield & Chevier, 1996
				Bathymedon pumilus	J. L. Barnard, 1962
				Kroyera carinata	Bate, 1857
				Westwoodilla caecula	(Bate, 1857)
			Pardaliscidae	*Rhynohalicella halona*	(Barnard, 1971)
			Phoxocephalidae	*Eyakia robusta*	(Holmes, 1908)
				Harpiniopsis fulgens	J. L. Barnard, 1960
				Heterophoxus affinis	(Holmes, 1908)
				Heterophoxus conlanae	Jarrett & Bousfield, 1994
				Rhepoxynius abronius	(J. L. Barnard, 1960)
				Rhepoxynius boreovariatus	Jarrett & Bousfield, 1994
				Rhepoxynius daboius	(J. L. Barnard, 1960)
			Pleustidae	Parapleustinae	
			Podoceridae	*Dyopedos* sp	
				Podocerus cristatus	(Thomson, 1879)
			Stenothoidae	*Metopa dawsoni*	J. L. Barnard, 1962
				Stenothoidae	
			Synopiidae	*Syrrhoe longifrons*	Shoemaker, 1964
		Cumacea			
			Campylaspidae	*Campylaspis canaliculata*	Zimmer, 1936
				Campylaspis hartae	Lie, 1969
				Campylaspis rubromaculata	Lie, 1971
			Diastylidae	*Diastylis bidentata*	Calman, 1912
				Diastylis pellucida	Hart, 1930
				Diastylis santamariensis	Watling & McCann, 1997
			Lampropidae	*Lamprops quadriplicatus*	Smith, 1879
			Leuconidae	*Eudorella pacifica*	Hart, 1930
				Eudorellopsis longirostris	Given, 1961
				Leucon sp	

Phylum	Class	Order	Family	**Taxonomy Level Reported**	**Authorship**
		Decapoda			
				Anomura	
				Brachyura	
				Caridea	
				Decapoda	
				Thalassinidea	
			Alpheidae	*Eualus avinus*	(Rathbun, 1899)
			Axiidae	*Calocarides spinulicauda*	(Rathbun, 1902)
			Cancridae	*Cancer oregonensis*	(Dana, 1852)
				Cancer sp	
			Crangonidae	Crangonidae	
			Hippolytidae	Hippolytidae	
				Spirontocaris sica	Rathbun, 1902
				Spirontocaris sp	
			Majidae	Majidae	
			Paguridae	*Pagurus capillatus*	(Benedict, 1892)
				Pagurus sp	
			Pinnotheridae	*Fabia subquadrata*	Dana, 1851
				Pinnixa scamit	Martin & Zmarzly, 1994
				Pinnixa schmitti	Rathbun, 1918
				Pinnixa sp	
				Pinnotheridae	
			Porcellanidae	Porcellanidae	
		Euphausiacea			
				Euphausiacea	
		Isopoda			
				Asellota	
			Anthuridae	*Haliophasma geminatum*	Menzies & J. L. Barnard, 1959
			Cyphocaridae	*Cyphocaris challengeri*	Stebbing, 1888
			Gnathiidae	*Araphura breviaria*	Dojiri & Sieg, 1997
			Idoteidae	*Synidotea nodulosa*	(Krøyer, 1848)
		Leptostraca			
			Nebaliidae	*Nebalia* sp	
		Mysida			
			Mysidae	*Meterythrops robusta*	S. I. Smith, 1879
				Mysidella americana	Banner, 1948
				Pacifacanthomysis nephrophthalma	(Banner, 1948)
				Pseudomma sp	
				Xenacanthomysis pseudomacropsis	W. Tattersall, 1933
		Tanaidacea			
			Pseudozeuxidae	*Leptochelia dubia*	(Krøyer, 1842)
Sipuncula					
	Sipunculidea				
		Golfingiformes			
			Golfingiidae	*Thysanocardia nigra*	(Ikeda, 1904)
Echiura					
	Echiuridae				

Phylum	Class	Order	Family	Taxonomy Level Reported	Authorship
		Echiuroidea			
			Echiuridae	*Arhynchite pugettensis*	Fisher, 1949
				Echiuridae	
				Echiurus echiurus alaskanus	Fisher, 1946
Phoronida					
				Phoronida	
			Phoronidae	*Phoronis* sp	
Ectoprocta					
	Gymnolaemata				
		Cheilostomata			
			Hippothoidae	*Celleporella hyalina*	(Linnaeus, 1767)
			Teuchoporidae	*Lagenicella neosocialis*	Dick & Ross, 1988
			Alcyonidiidae	*Alcyonidium* sp	
Echinodermata					
	Stelleroidea				
		Ophiurida			
			Amphiuridae	Amphiuridae	
				Amphiodia sp	
	Echinoidea				
		Spatangoida			
			Schizasteridae	*Brisaster latifrons*	(A. Agassiz, 1898)
	Holothuroidea				
		Apodida			
				Apodida	
		Dendrochirotida			
				Dendrochirotida	
			Cucumariidae	*Pentamera populifera*	(Stimpson, 1857)
				Pentamera pseudocalcigera	Deichmann, 1938
			Phyllophoridae	Phyllophoridae	
		Molpadiida			
			Molpadiidae	*Molpadia intermedia*	(Ludwig, 1894)
Hemichordata					
	Enteropneusta				
				Enteropneusta	
Chaetognatha					
	Sagittoidea				
		Aphragmophora			
			Sagittidae	*Sagitta* sp	
Chordata					
	Ascidiacea				
		Aplousobranchiata			
			Polycitoridae	*Distaplia* sp	
		Stolidobranchiata			
			Molgulidae	*Molgula pugetiensis*	Herdman, 1898
			Styelidae	*Styela* sp	

Table H-2. Infauna sediment sample sorting quality assurance and quality control for the 2004 PSAMP Sediment Component Hood Canal regional survey.

Station	Sampling Location	Sampling Date	Sorted by	QA/QC Sorter	QA/QC Percent Sorted	QA/QC Pass/Fail
8	Hazel Pt.	6/4/2004	SA	MED	100%	Pass
24	Vinland	6/3/2004	SA	MED	50%	Pass
32	Broad Spit	6/7/2004	SA	MED	50%	Pass
48	Pulali Pt.	6/7/2004	SA	MED	75%	Pass
56	Stavis Bay	6/4/2004	SA	MED	100%	Pass
60	Seal Rock	6/7/2004	SA	MED	50%	Pass
64	Musquiti Pt. North	6/10/2004	SA	MED	25%	Pass
75	Coon Bay	6/2/2004	SA	MED	100%	Pass
80	Sylopash Pt.	6/8/2004	SA	MED	25%	Fail
88	North Four Corners	6/3/2004	SA	MED	50%	Pass
92	Zelatched Pt.	6/7/2004	SA	MED	100%	Pass
96	Sund Creek	6/10/2004	SA	MED	100%	Pass
112	Tabook Pt.	6/7/2004	SA	MED	50%	Pass
118	Shoofly Creek	6/9/2004	SA	MED	50%	Pass
120	Fulton Creek South	6/8/2004	SA	MED	50%	Pass
124	Seabeck	6/4/2004	SA	MED	50%	Pass
128	Sisters Pt.	6/9/2004	SA	MED	25%	Pass
144	Fishermans Pt.	6/7/2004	SA	MED	100%	Pass
152	Transit Station	6/3/2004	SA	MED	25%	Pass
184	Misery Pt.	6/8/2004	SA	MED	100%	Pass
188	King Spit	6/4/2004	SA	MED	100%	Pass
203	Hood Head	6/3/2004	SA	MED	25%	Pass
216	Sisters	6/2/2004	SA	MED	100%	Pass
224	Musquiti Pt. North	6/10/2004	SA	MED	100%	Pass
248	Tekiu Pt.	6/8/2004	SA	MED	100%	Pass
252	Maple Beach North	6/4/2004	SA	MED	100%	Pass
288	Maple Beach South	6/4/2004	SA	MED	50%	Fail
296	Fulton Creek North	6/8/2004	SA	MED	25%	Pass
323	Coon Bay	6/14/2004	SA	MED	100%	Pass
336	Bridgehaven	6/14/2004	SA	MED	50%	Pass

Table H-3. Infauna sediment sample taxonomy QA and quality control for the 2004 PSAMP Sediment Component Hood Canal regional survey.

Taxon:	Crustacea	Misc Taxa	Echinodermata	Annelida	Mollusca
Primary Taxonomist	Jeffery Cordell	Steve Hulsman	Steve Hulsman	Eugene Ruff	Susan Weeks
QA Taxonomist	NA	John Ljubenkov	John Ljubenkov	Kathy Welch	Allan Fukuyama
Number of Bulk Samples QAed	0	1	1	2	2
Number of Vouchers QAed	0	3	0	1	1
Identifications confirmed	NA	99%	100%	100%	99%
Identifications changed (includes species-level changes)	NA	1	0	0	1
Species-level changes	NA	0	0	0	0

Appendix I. Weight of Evidence, Ordered by Station Number and Location

Appendix I is available only electronically -- on the web and on a compact disk.

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Appendix J. Glossary, Acronyms, and Abbreviations

Glossary

Amphipod – a type of small, sediment-dwelling crustacean.

Anthropogenic – caused or created by humans.

Assemblage – a group of organisms collected from the same location.

Benthic – relating to the bottom of a waterbody.

Benthic infauna (or **benthos**) – organisms living at the bottom of, or in the sediments of, a waterbody.

Biota – animals.

Community – a group of organisms occurring in a particular environment, presumably interacting with each other and with the environment.

Degree of response – in toxicity testing, the magnitude of the response.

Demersal – living near the bottom.

Dissolved Oxygen (DO) – a measure of the amount of oxygen dissolved in water.

Echinoderm – a group of invertebrates including brittle stars, sea urchins, and sea cucumbers.

Exceeded – did not meet (or fell below).

Histopathology – the microscopic study of body tissues (e.g., muscle, organs), especially of abnormal tissue.

Hypoxia – low oxygen.

Incidence – for chemical contamination, toxicity, or the Sediment Quality Triad, the number and percentage of samples indicating a response.

Infauna – the benthic invertebrates that live within the sediment.

Invertebrates – animals without backbones (e.g., crustaceans, worms, clams).

Occurrence – in toxicity testing, the presence or absence of a toxic response.

Percent fines – proportion of fine particles such as silt or clay in a sediment sample.

Porewater – the water filling the spaces between grains of sediment.

Spatial extent – for chemical contamination, toxicity, or the Sediment Quality Triad, the areal extent, in km^2, and percentage of total study area affected.

Surficial – relating to or occurring on a surface.

Taxa, taxon – a group of organisms sharing common characteristics which makes up a category in taxonomic classification, such as a phylum, order, family, genus, or species.

Taxa richness – number of different taxa.

Temporal – occurring over a period of time.

Acronyms and Abbreviations

BCRI	BC Research Institute
BNA	Base/neutral/acid organic compounds
BOD	Biological oxygen demand
Cd	Cadmium
CL	Confidence limit
CSL	Cleanup screening level
CTD	Conductivity/temperature/depth meter
DDD	Dichloro-diphenyl-dichloroethane
DDE	Dichloro-diphenyl-dichloroethylene
DDT	Dichloro-diphenyl-trichloroethane
DO	Dissolved oxygen (see glossary above)
DSC	Detectable significance criteria
EC50	Median Effective Concentration (concentration required to induce a toxic response in 50% of the test population)
Ecology	Washington State Department of Ecology
EMAP	Environmental Monitoring and Assessment Program
EPA	U.S. Environmental Protection Agency
ERL	Effects range low
ERM	Effects range median
GRTS	Generalized random tessellation stratified
HCDOP	Hood Canal Dissolved Oxygen Program
HRGS	Human Reporter Gene System
MEL	Manchester Environmental Laboratory
MSMP	Marine Sediment Monitoring Program
NOAA	National Oceanic and Atmospheric Administration
NOEC	No observed effect concentration
NS&T	National Status and Trends Program
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyls
PSAMP	Puget Sound Assessment and Monitoring Program
PSEP	Puget Sound Estuary Program
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
SD	Standard deviation
SDI	Swartz’s Dominance Index
SDS	Sodium dodecyl sulfate
SOP	Standard operation procedure
SQS	Sediment Quality Standards
SQTI	Sediment Quality Triad Index
TOC	Total organic carbon
USGS	U.S. Geological Survey