The Influence of Sediment Quality and Dissolved Oxygen on Benthic Invertebrate Communities in Hood Canal

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Photos courtesy of Dr. Jeff Cordell

I. A Retrospective Data Analysis

As part of the Hood Canal Dissolved Oxygen Program, sediment quality, water-column dissolved oxygen (DO), and sediment-dwelling invertebrate (benthic infauna) data from Hood Canal studies from 1932 to 2005 were gathered. These data were examined to (1) determine their characteristics in Hood Canal, (2) evaluate their relationship to each other, and (3) determine how low DO may affect benthic infauna in Hood Canal. Highlights from each data set are described below, along with an examination of the relationships between the parameters and a brief interpretation of the results.

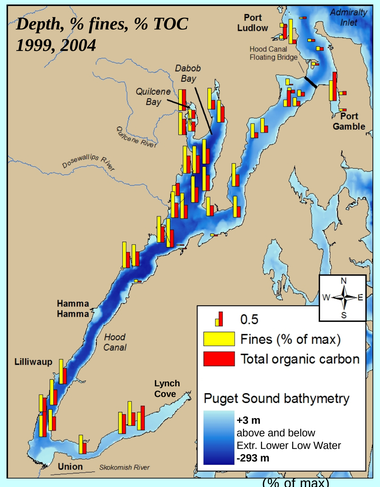

Figure 1. Depth, percent fines, and percent total organic carbon in Hood Canal sediments. (1999 and 2004).

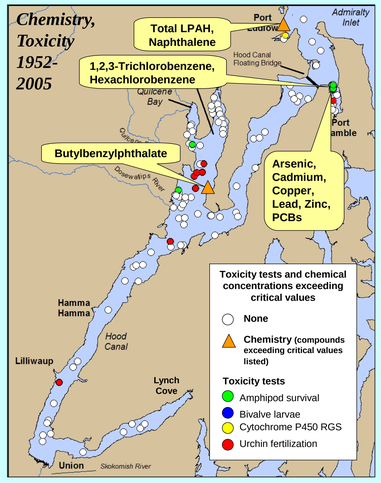

Figure 2. Chemical contaminants and toxicity in Hood Canal sediments. (1952-2005)

II. Sediments in Hood Canal – What's It Like at the Bottom?

Relatively coarse sands with low TOC were found in shallower northern Hood Canal and along shorelines (Figure 1).

Fine-grained sediments with higher TOC occurred in the embayments, in the deep middle and southern reaches of the central axis, in deep central Dabob Bay, and in Lynch Cove (Figure 1).

Sediment chemical contamination and toxicity were low in Hood Canal, rarely exceeding Washington State Sediment Quality Standards or other criteria. Highest levels occurred primarily in Port Ludlow, Port Gamble, and Dabob Bay (Figure 2).

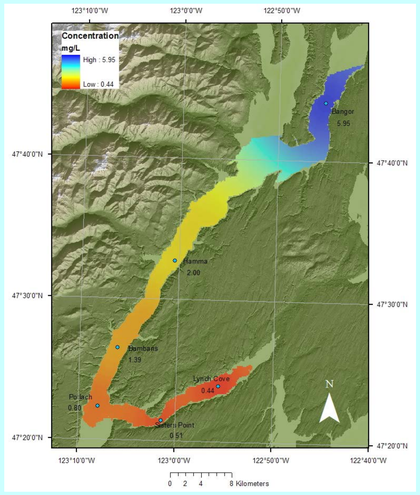

Figure 3. Measured and estimated levels of dissolved oxygen in Hood Canal (example - August 2002). Source: HCDOP

III. Dissolved Oxygen in Hood Canal Waters – How Low Does It Go?

Dissolved oxygen levels varied throughout Hood Canal due to bathymetry, water circulation, and wind patterns.

DO was generally highest in the canal entrance, over the shallow entrance sill, and along the shorelines. Lowest concentrations were usually found southward and in deep locations in the late summer and early fall (Figure 3).

Lowest DO concentrations measured since 1932 have steadily decreased over time.

Since the late 1990s, DO levels have periodically fallen below critical levels thought to protect bottom-dwelling biota (< 5 mg/L to < 1 mg/L) in most southern stations and at an increasing number of central and northern stations.

website www.hoodcanal.washington.edu/observations/hypoxia.jsp.

VI. What Does This Study Tell Us?

- Benthic infaunal communities in Hood Canal are generally less abundant and diverse than elsewhere in Puget Sound, and differ from one area to another throughout Hood Canal.
- Existing sediment, DO, and benthos data suggested that the total number and variety of benthic invertebrates declined, and several stress-tolerant species became dominant, from north to south in Hood Canal as (1) sediment texture became finer-grained, (2) DO levels near the bottom decreased, (3) organic content in the sediments increased, and (4) depth increased.
- Chemical contamination and toxicity in Hood Canal sediments were limited, so had less influence on benthos.
- Initial steps have been taken to develop critical DO thresholds which can be used to determine when benthic infauna are at risk. Noticeable changes in community structure occurred as DO levels decreased from >10 mg/L to >3-6 mg/L and then to <1 mg/L. Various benthic infauna responded differently, with either increased or decreased abundance, to changes in the range of near-bottom DO levels.
- It is clear from the review of existing data that the benthic infauna in Hood Canal are likely to be sensitive to future natural and anthropogenic (human-caused) changes in Hood Canal in any or all of the environmental factors examined in this study.
- The existing data set posed some limitations for relating sediment quality, DO, and benthic infauna in Hood Canal.
- The full report gives recommendations for further work needed to refine our understanding of relationships between parameters, and particularly, how changes in DO may affect the benthos in Hood Canal.

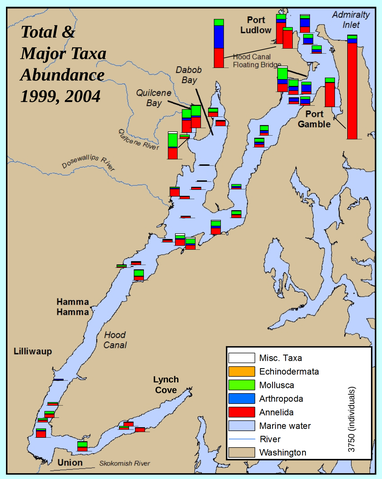

Figure 4. Total and major species abundance measured in Hood Canal sediment-dwelling invertebrate communities (1999 and 2004).

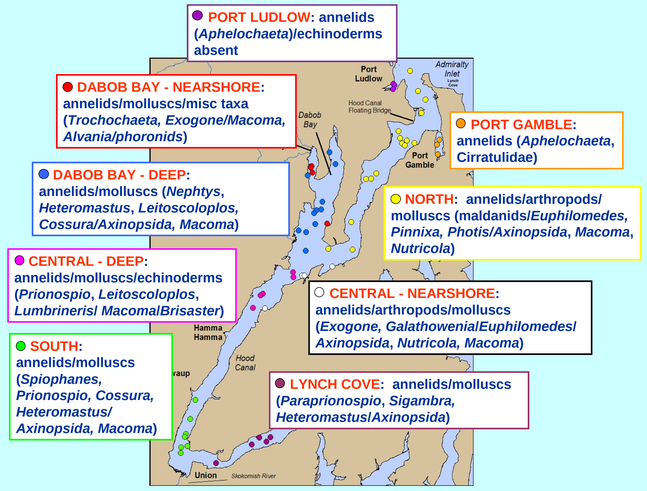

Figure 5. Nine Hood Canal sub-regions with distinct invertebrate communities. Dominant organisms are listed by genus (1989-2005).

IV. Sediment-dwelling Invertebrates – Who Lives Where in Hood Canal?

Total numbers and types of sediment-dwelling invertebrates generally decreased from north to south along Hood Canal's main axis, with increasing percent fines and total organic carbon, decreasing DO concentrations, and from shallow to deep waters (Figure 4).

Relatively well-defined invertebrate communities were distinguished for nine sub-regions (Figure 5). Northern Hood Canal sub-region sediments, with relatively low percent fines and TOC, supported the most diverse communities, with a well-balanced mix of annelids (worms), arthropods (crabs and shrimp), and bivalves (clams). Less stress-tolerant arthropods, echinoderms (brittle stars and sea urchins), and other species generally became rare or absent progressing southward, with increasing percent fines and TOC, and in the deepest locations and terminal inlets. The more stress-tolerant annelids and several bivalves became dominant in these southern locations.

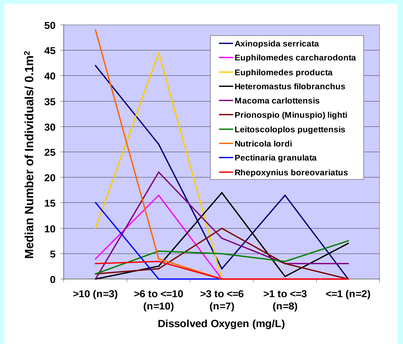

Figure 6. Changes in abundance for 10 benthic species from 30 Hood Canal samples grouped into five DO ranges.

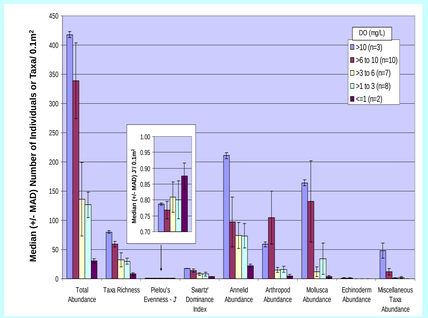

Figure 7. Median (± mean absolute deviation) benthic index values from 30 Hood Canal samples grouped into five DO ranges.

V. Relationships between Sediments, Dissolved Oxygen, and Benthic Invertebrates

Analyses suggested that measures of percent fines, near-bottom DO, TOC, and depth (in this order) were strongly related to each other and to the total numbers and species of benthic invertebrates. It is possible that all of these variables jointly influenced benthic invertebrate community structure in Hood Canal.

Community characteristics changed as near-bottom DO levels decreased. When samples were grouped into five declining DO ranges, differing patterns of declining abundance were observed for various species (Figure 6). Nine indicators used to characterize benthic communities also generally declined, especially at DO ranges of >3 to 6 mg/L and ≤1 mg/L (Figure 7). These two ranges may be critical levels for many benthic species in Hood Canal.

This poster is based on the report:

Long, E.R., S. Aasen, M.E. Dutch, K.I. Welch, V.A. Partridge, and D.H. Shull, 2007. *Relationships between the Composition of the Benthos and Sediment and Water Quality Parameters in Hood Canal: Task IV – Hood Canal Dissolved Oxygen Program.* Washington State Department of Ecology and Western Washington University. Department of Ecology Publication No. 7-03-040. 197pp+appendices. www.ecy.wa.gov/biblio/0703040.html.

and is summarized in:

Dutch, M.E., Long, E.R., S. Aasen, V.A. Partridge, K.I. Welch, and D.H. Shull, 2007. *The Influence of Sediment Quality and Dissolved Oxygen on Benthic Invertebrate Communities in Hood Canal.* Washington State Department of Ecology and Western Washington University. Department of Ecology Publication No. 7-03-047. 4pp. www.ecy.wa.gov/biblio/0703047.html.

Dutch, M.E. 2007. *Relationships between Sediment Quality, Dissolved Oxygen, and Benthic Invertebrates in Hood Canal.* Washington State Department of Ecology, Publication No. 7-03-048. 2pp. www.ecy.wa.gov/biblio/0703048.html.

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

This poster was prepared for the 2008 PERS Conference, Newport, Oregon; the 2008 PNW SETAC Conference, Corvallis, Oregon; and the 2008 South Sound Science Symposium, Lacey, Washington.