Relationships between Dissolved Oxygen Levels and Benthos in Hood Canal

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Low Dissolved Oxygen in Hood Canal Historical and Recent Events

- **Historical** measures of seasonally low DO in water column and periodic fish kills indicates natural predisposition of Hood Canal to hypoxia
- **Recent** attention on prolonged low DO in water column and effects on biota
  - Increased frequency and duration of low DO events
  - Observed fish and invertebrate kills in each of last several years
  - Observed movement of species to shallow waters
  - Chronic effects not known

Hood Canal Dissolved Oxygen Program

- Program designed to examine and address low DO issues in Hood Canal
- The HCDOP's Integrated Assessment and Modeling scientific study is a multi-year, multi-agency effort
- HCODP-IAM Science Plan includes:
  - Program Administration
  - Marine Water Monitoring
  - Freshwater Flow and Loading
  - Marine Life Studies
  - Modeling and Analysis
  - Rapid Response and Diver Program

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Task 4: Marine Life Studies

Assess DO effect on biota and biota effect on DO

- Establish how various fish, shellfish, and other sea life respond to low oxygen concentrations, for both chronic and episodic exposure.
- Evaluate the historic and future marine life balance, evaluate differences with current marine life and recommend whether these changes may be partially responsible for low oxygen.

Ecology/WWU Proposal to Task 4 workgroup:

Measurement of and relationships between near-bottom dissolved oxygen levels and benthos (i.e., sediment-dwelling invertebrates) in Hood Canal

- **Phase 1 (2005)**

  Analysis of existing data and development of initial critical values/thresholds as indicators of adverse effects of lowered DO on benthos.

  - **Compile** existing benthos and bottom water DO data and associated sediment chemistry and toxicity data
  - **Examine patterns & relationships** between variables
  - **Identify** data **gaps**
  - Work on **identification of critical values/ thresholds** of DO levels and related effects to biota

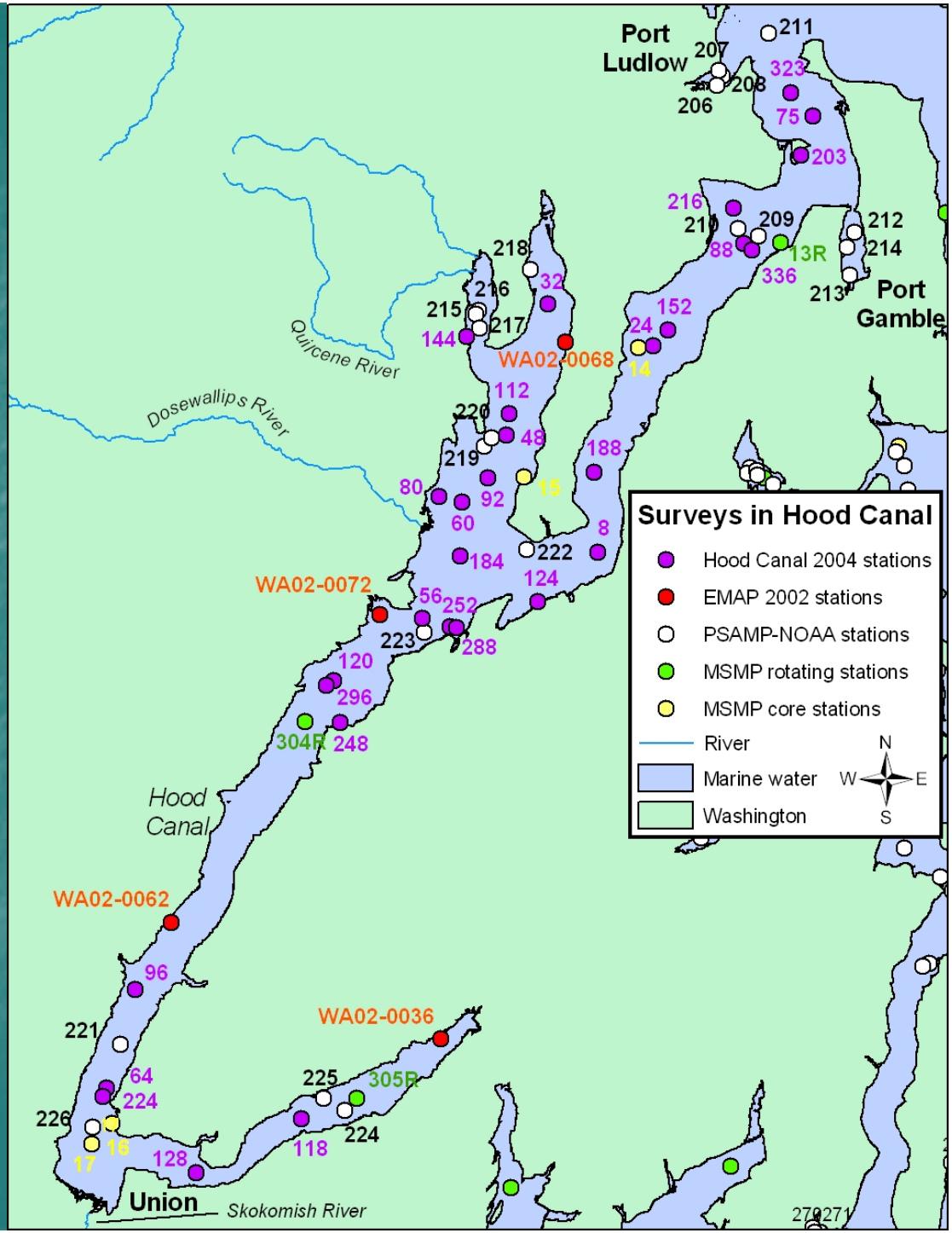
Compile existing data

Sediment Data Available 1989-2004

- **1989-1995 PSAMP** – 4 fixed stations
- **1989-1995 PSAMP** – 3 rotational stations
- **1999 PSAMP/NOAA** – 21 stations
- **2002 EMAP** – 4 stations
- **2004 PSAMP** – 30 stations

Parameters Sampled

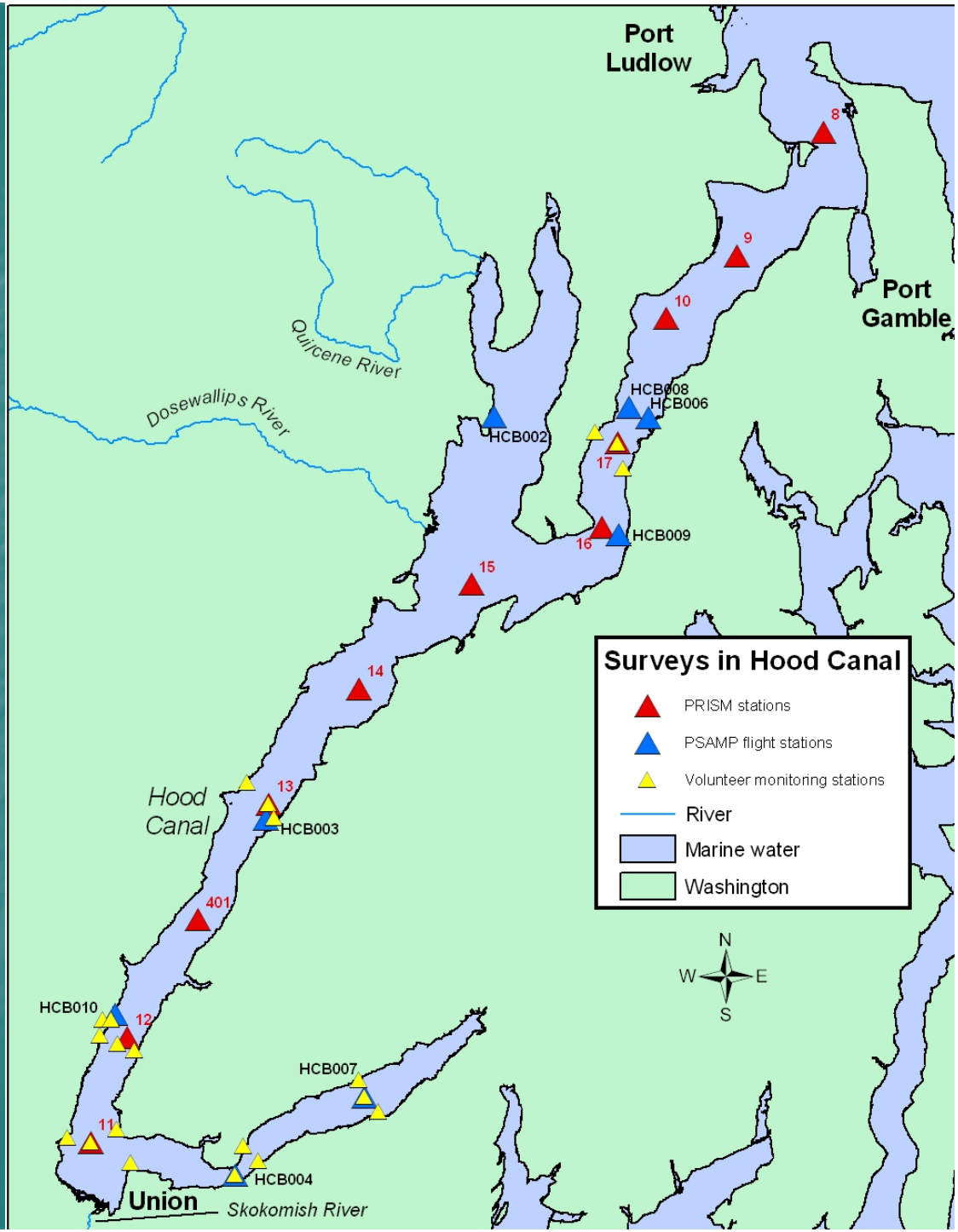
- **Habitat and Chemistry** – grain size, TOC, 180+ metals and organics
- **Toxicity** – 4 tests
- **Benthos** – count and identify sediment-dwelling invertebrates



Bottom Water DO Data Available

1989-2005

- **1989-2005 PSAMP Marine flights** – 8 stations
- **1998-2005 PRISM cruises** –11 stations
- **2003-2005 Hood Canal volunteer monitoring** – 21 stations
- **2004 PSAMP sediment cruise** – 30 stations

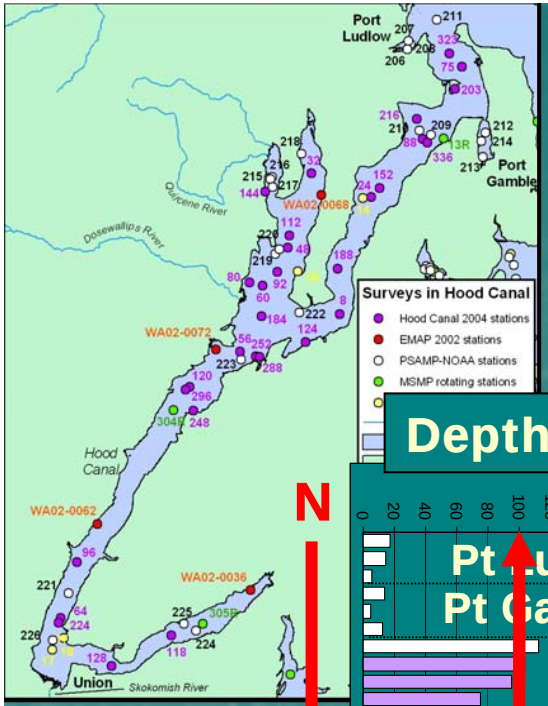


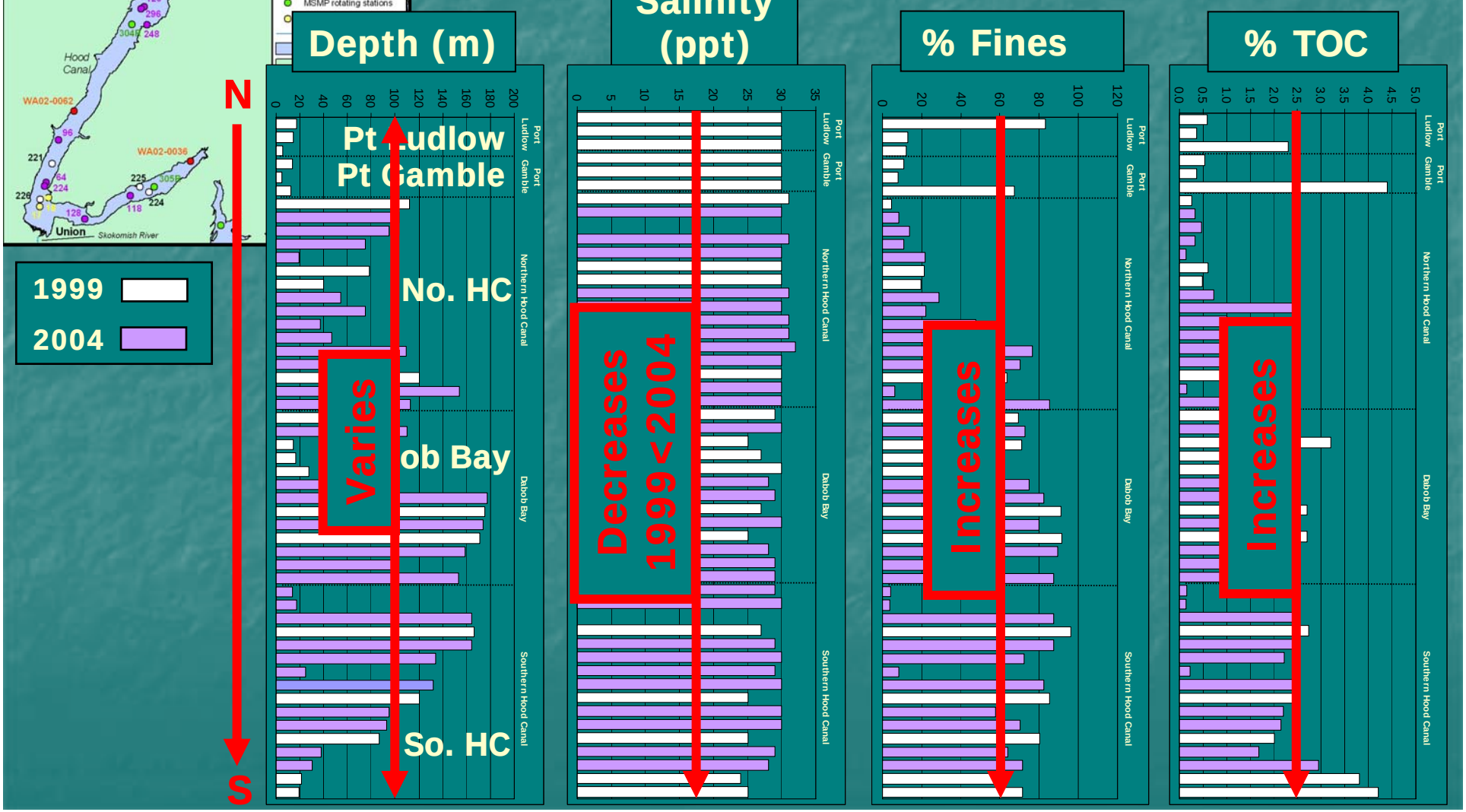
Examine patterns in variables

Patterns within variables

- Habitat
- Chemistry
- Toxicity
- Benthic infauna
- DO

Habitat parameters measured in PSAMP Hood Canal sediment stations June 1999 and 2004





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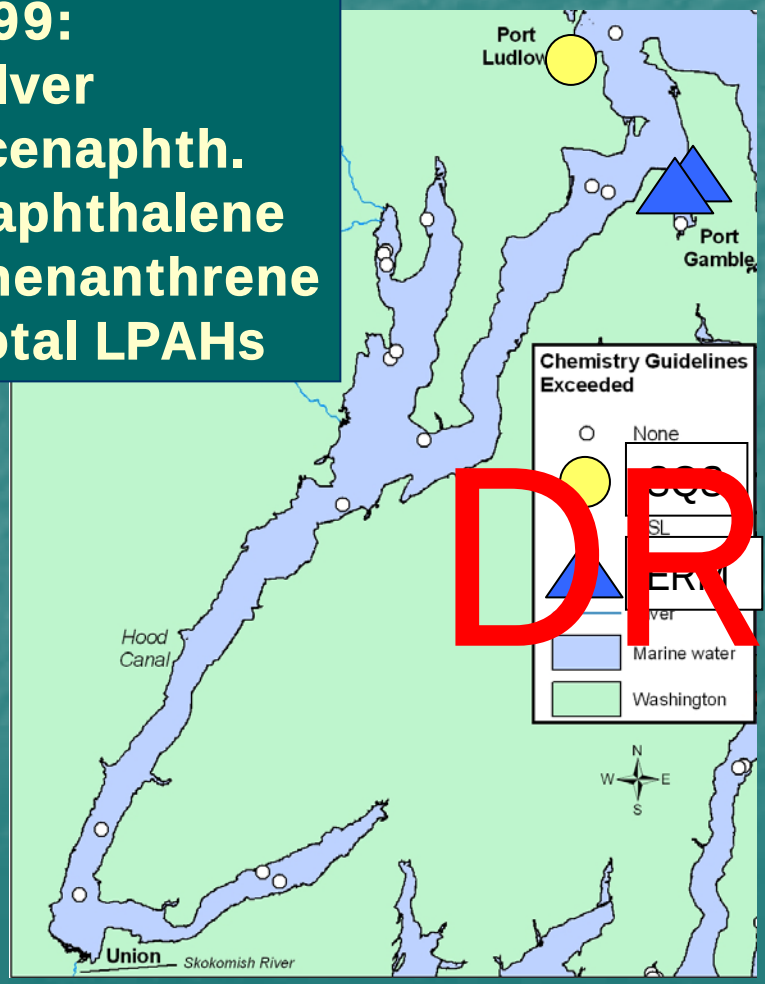
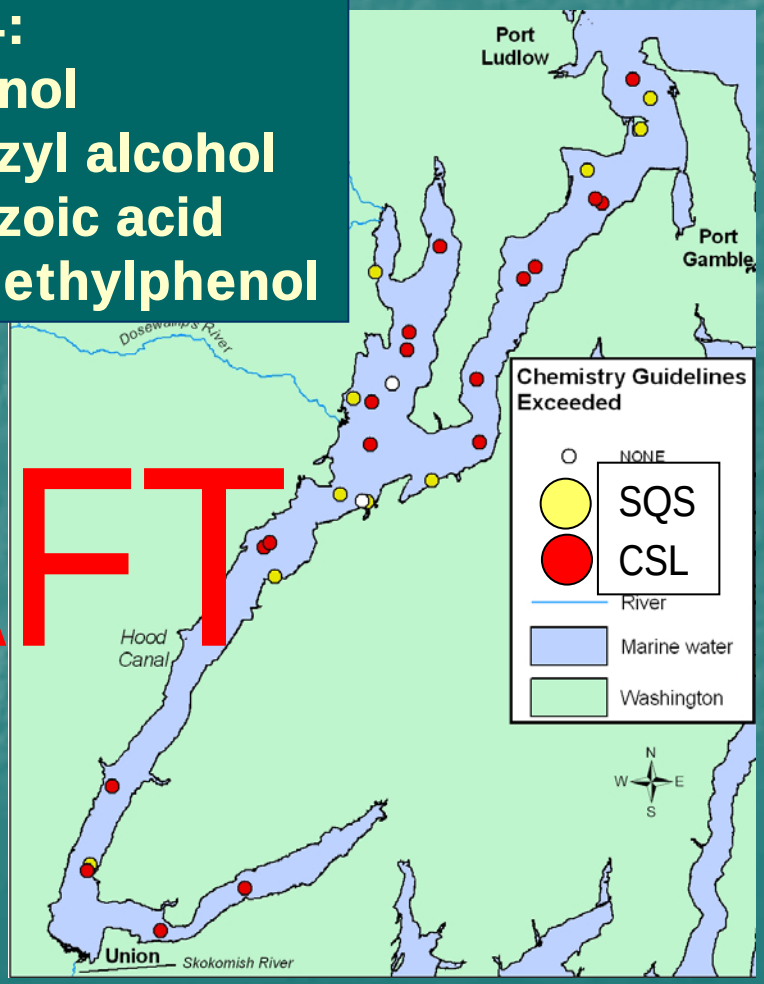
Chemical compounds detected above sediment guidelines and critical values in PSAMP Hood Canal stations – June 1999 and 2004

1999:
- **Silver**
- **Acenaphth.**
- **Naphthalene**
- **Phenanthrene**
- **Total LPAHs**



2004:
- **Phenol**
- **benzyl alcohol**
- **benzoic acid**
- **2-methylphenol**



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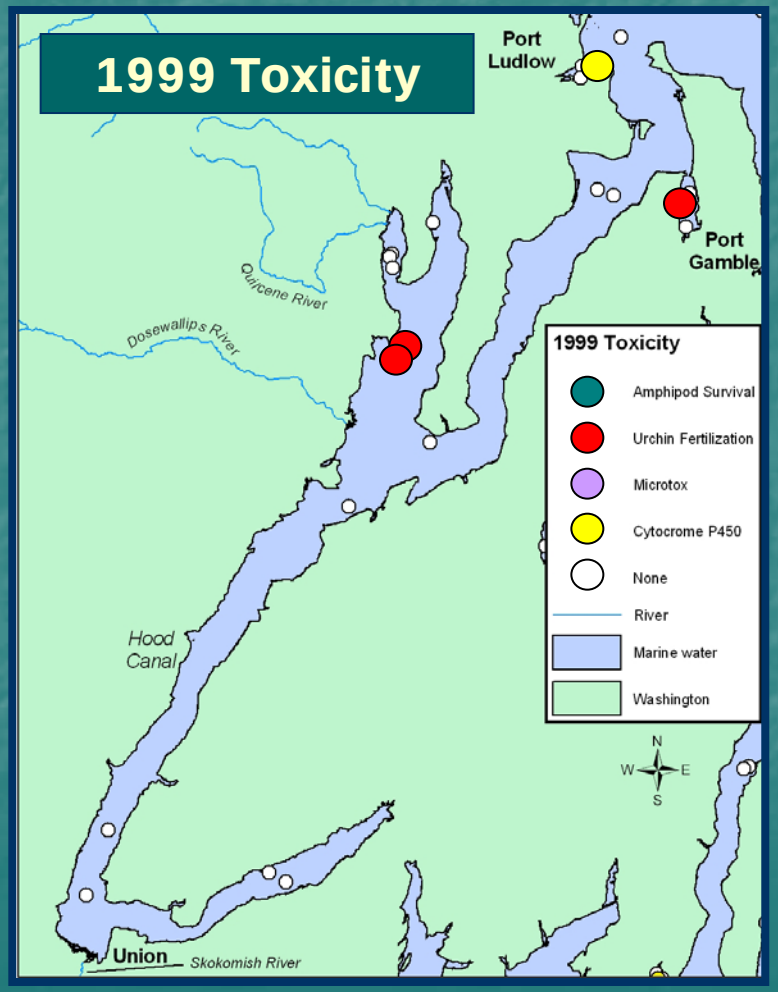
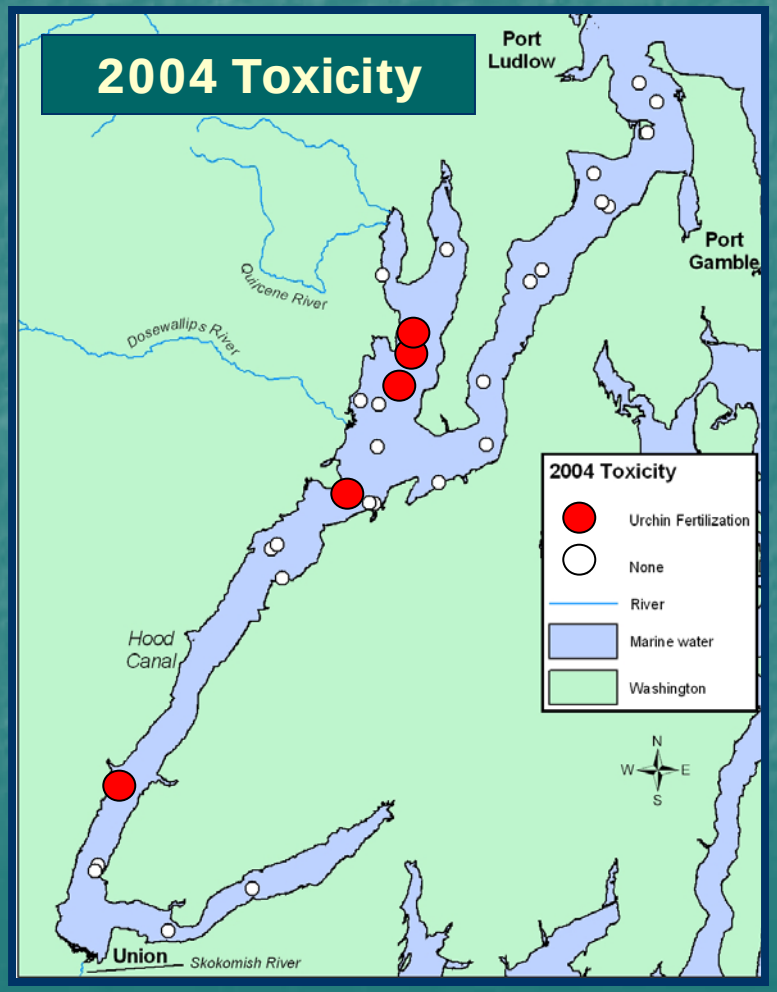
Toxicity exceeding critical values in Hood Canal PSAMP sediment stations June 1999 and 2004





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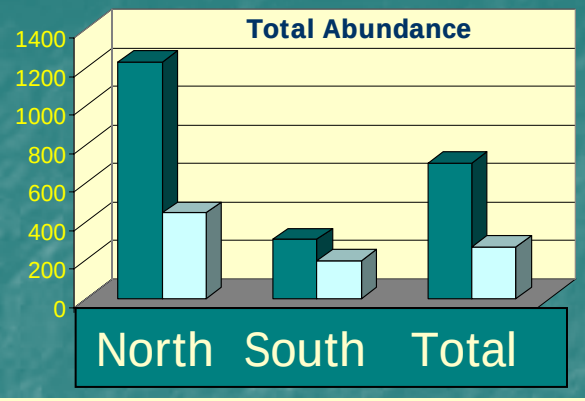
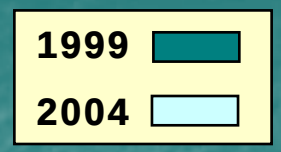
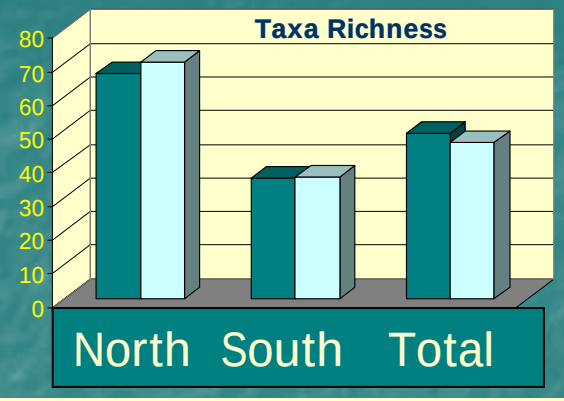
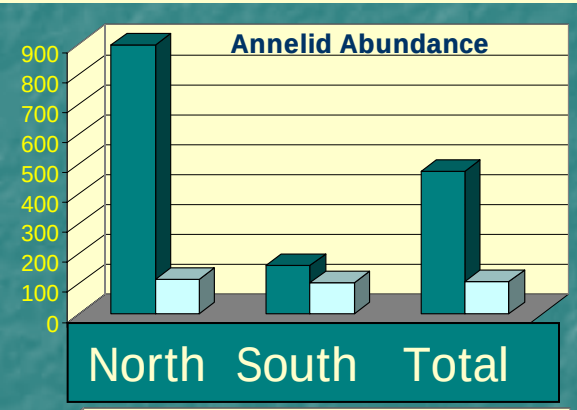
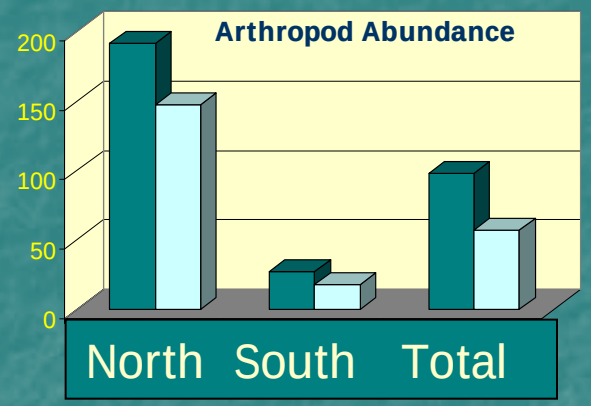
1999 vs. 2004 Hood Canal Mean Benthic Infauna Measures

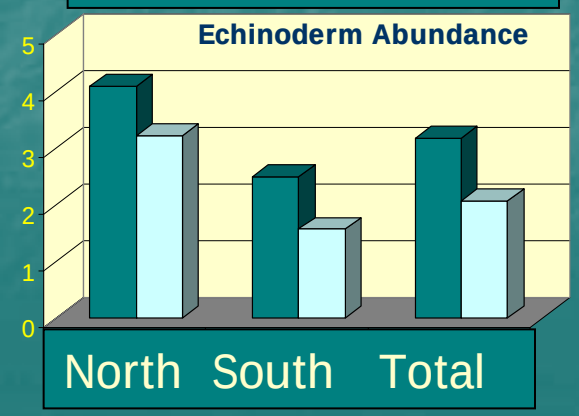


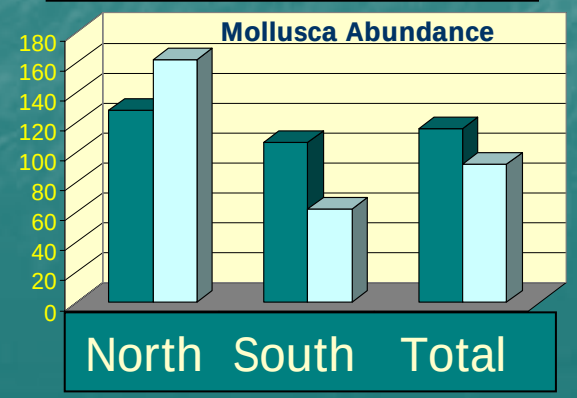












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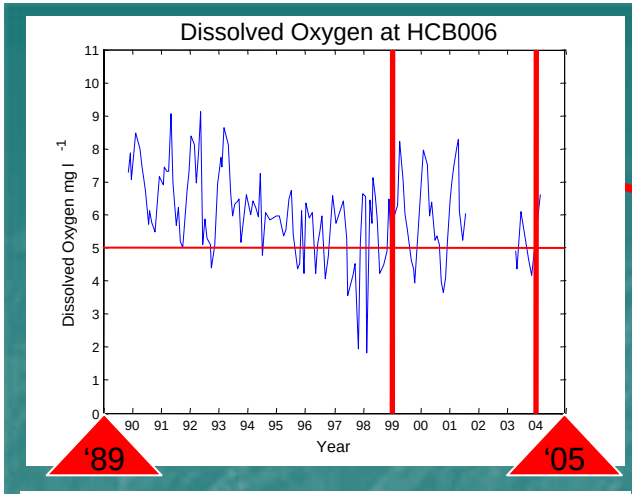
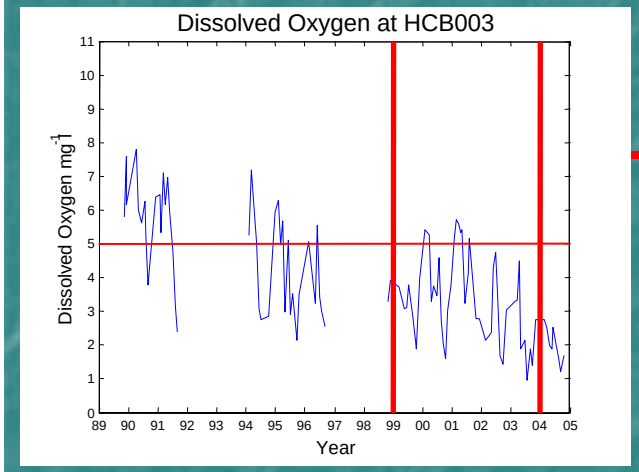
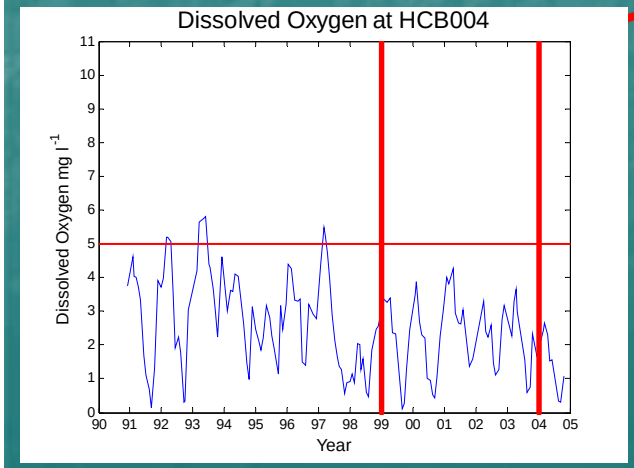
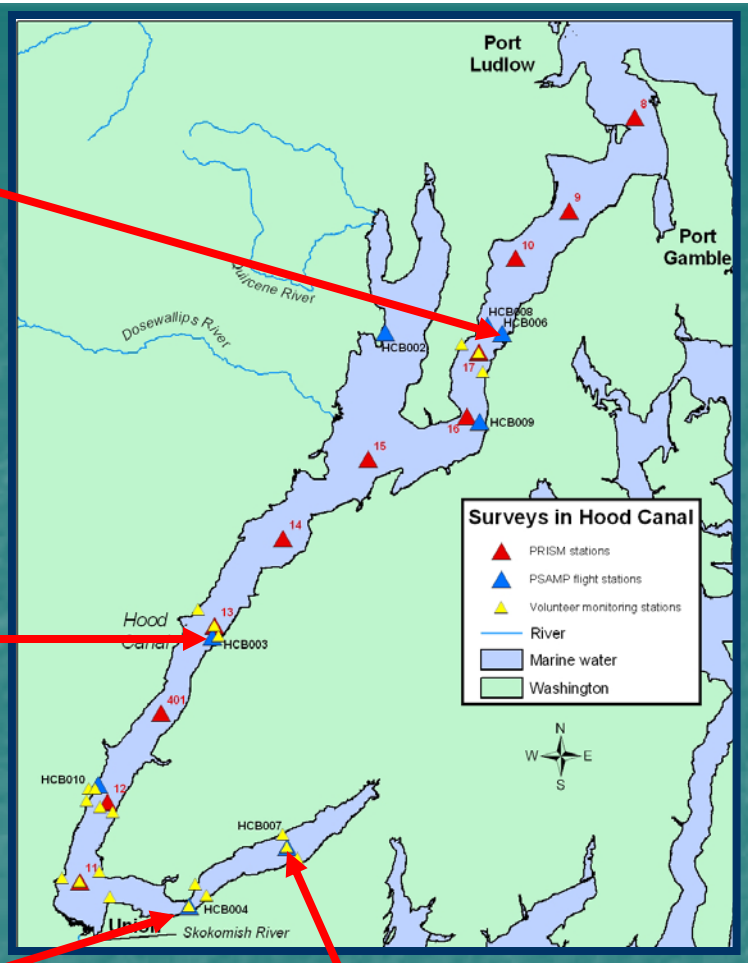
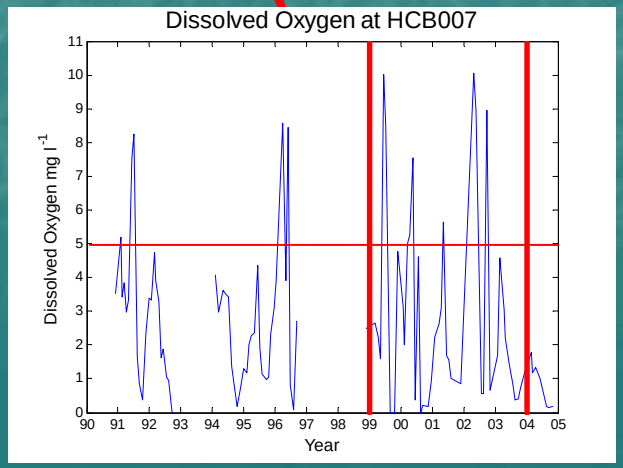




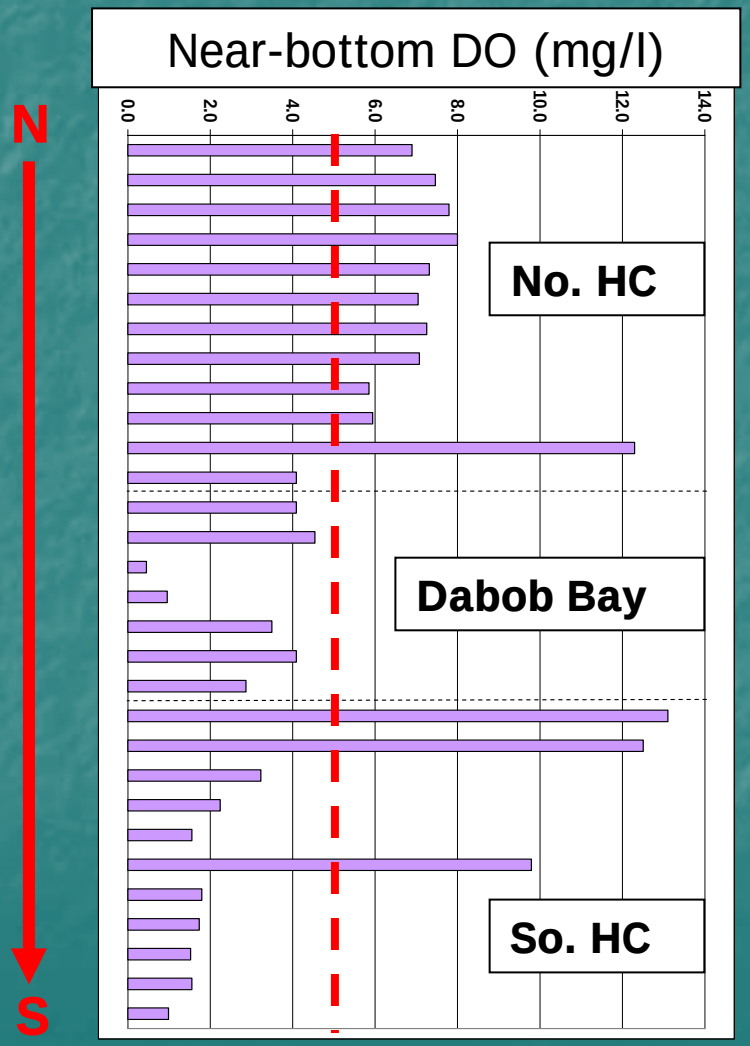


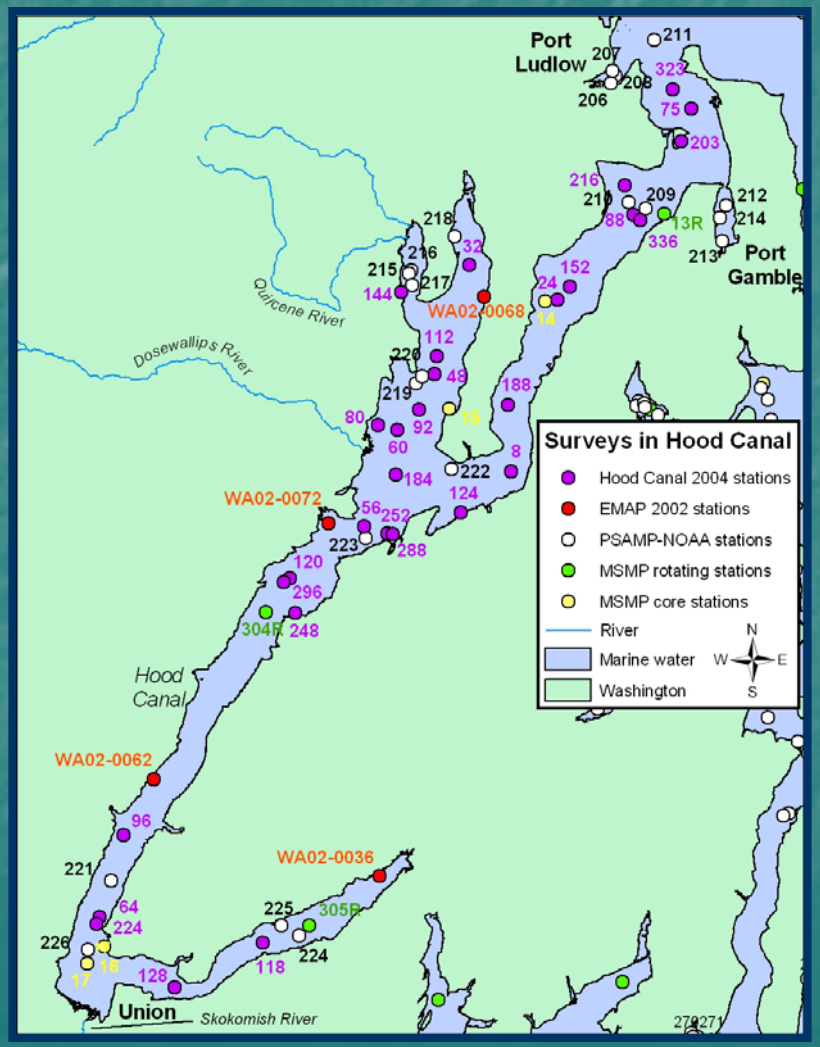




Near-bottom dissolved oxygen (mg/l) levels at 4 PSAMP marine waters stations (1989-2005)

Near-bottom dissolved oxygen levels at 30 PSAMP Hood Canal sediment stations June 2004





Next steps:

Complete Phase 1:

- Complete data compilation & review
- Relationships between variables, focus on DO - benthos (with D. Shull)
  - Summary Statistics
  - Graphical Displays
  - Univariate Analyses
  - Multivariate Analyses
- Identify data gaps
- Identification of critical DO levels/ thresholds affecting benthos

Future years:

- **Phase 2 - Field survey**

  Fill in gaps in sets of matching field data, to refine understanding of relationships between variables and development of the interim critical values/thresholds.

- **Phase 3 – Benthic index development and refinement**

  Application to other embayments and areas in Puget Sound that may also be susceptible to low DO stress

- **Phase 4 – Colonization/recruitment surveys**

  Experimental surveys on colonization/recruitment of benthos to determine Hood Canal recovery time

For more PSAMP Sediment Component information and downloadable data and reports:

Photo by CM Eaton

http://www.ecy.wa.gov/programs/eap/mar_sed/msm_intr.html