Characterizing changes in Puget Sound benthic infaunal invertebrate assemblages: A functional approach

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Salish Sea Ecosystem Conference
April-May 2014
Spatial Monitoring

- Baseline 1997-2003
- 2\textsuperscript{nd} Round 2004-2014
- 10-yr regional and 6-yr urban bay rotation
- Probabilistic, random stratified design
- **Sediment Quality Triad** = Chemistry, Toxicity, Benthos
Changes in Regions and Bays

Toxicity: Increase in low-level toxicity

Chemistry: No change or slight improvement

Benthos: Increase in adversely affected

Triad: Deterioration in overall sediment quality, driven primarily by benthos
Declines in Abundance, Richness

**Total Abundance**

- **Hood Canal**
- **Str. of Georgia**
- **Whidbey Basin**
- **Central Puget**
- **South Sound**
- **San Juan Is.**
- **All 6 Regions**
- **Elliott Bay**
- **Commence. Bay**
- **Bainbridge Basin**
- **All 3 Urban Bays**

**Taxa Richness**

- **Hood Canal**
- **Str. of Georgia**
- **Whidbey Basin**
- **Central Puget**
- **South Sound**
- **San Juan Is.**
- **All 6 Regions**
- **Elliott Bay**
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- **Bainbridge Basin**
- **All 3 Urban Bays**

* = significant

- **Percent Change in Median**
Bellingham Bay 2010
100% Adversely Affected benthos

2010
(n=30)

Benthic Index
- Unaffected
- Adversely affected
Change Between 1997 and 2006?
Correlation of Benthos & Env. Variables

- Bio-Env (PRIMER)
- Input Variables: Metals, ΣPAHs, TOC, Grain Size, Toxicity Index, Depth
- Spearman correlation = 0.53 (all samples)
- Range 0.57 – 0.80 for individual regions/bays
- Top Variables: Depth, Grain Size, Cd, Toxicity Index
Hypothesis: Changes in the Marine Food Web and Energy Transfer in Puget Sound

**Microbial-based food web**

- + Nitrogen
- + nutrient cycling in the water

**Diatom-based food web**

- Si:N
- Nitrogen
- - nutrient cycling in the sediment

**Changing food web and more near-surface nutrient cycling**

- Noctiluca
- Zooplankton
- Fish

- 10% grazing
- 10% nutrient transfer

- Less sinking of diatom particles

- Decreased coupling between the water and sediment

**Benthic animals**

- Declining community of organisms in the sediment

Drawn by Christopher Krembs
## Feeding Guilds

(Macdonald et al., 2012)

<table>
<thead>
<tr>
<th>Surface Detritivore</th>
<th>Subsurface Detritivore</th>
<th>Facultative Detritivore</th>
<th>Benthic Carnivore</th>
<th>Facultative Carnivore</th>
<th>Other:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aphelochaeta sp N5</td>
<td>Heteromastus filobranchus</td>
<td>Axinopsida serricata</td>
<td>Pholoe minuta</td>
<td>Scoleoma luti</td>
<td>Suspensivore</td>
</tr>
<tr>
<td>Eudorella pacifica</td>
<td>Cossura pygodactylata</td>
<td>Owenia johnsoni</td>
<td>Odostomia sp</td>
<td>Bupalpnonephys cornuta</td>
<td>Herbivore</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Euphilomedes carcharodonta</td>
<td>Sigambra bassi</td>
<td>Lumbrineris californiens</td>
<td>Planktivorous Carnivore</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Macro-Omnivore</td>
</tr>
</tbody>
</table>
Facultative Detritivores

1997-2003

2004-2012

Abundance (# orgs/0.1 m^2)
- 0 - 295
- 300 - 717
- 751 - 1680
- 2188 - 3044
- 4515 - 5387
Other Possible Mechanisms?

- Low DO in porewater and at sediment/water interface
- Ammonia/sulfides
- Changing pH
- Contaminants
  - Point/nonpoint
  - Contaminants of Emerging Concern
  - Slow migration to deeper areas
  - Delayed population-level effects
- Natural cycles