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Recent conditions highlight regional differences in temperature, salinity and dissolved oxygen between Strait of Juan de Fuca and Puget Sound sites under anomalous 2014-2017 climate patterns

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Bos, Julia; Krembs, Christopher; Albertson, Skip; Keyzers, Mya; Brownlee, Allison; and Maloy, Carol, "Recent conditions highlight regional differences in temperature, salinity and dissolved oxygen between Strait of Juan de Fuca and Puget Sound sites under anomalous 2014-2017 climate patterns" (2018). Salish Sea Ecosystem Conference. 388.  
Speaker
Julia Bos, Christopher Krembs, Skip Albertson, Mya Keyzers, Allison Brownlee, and Carol Maloy

This event is available at Western CEDAR: https://cedar.wwu.edu/ssec/2018ssec/allsessions/388
Regional variances in temperature, salinity and dissolved oxygen between Strait of Juan de Fuca and Puget Sound.
Status and trends in water quality indicators
(collected monthly at 39 stations and compared to baselines)

Water Quality variables

**Physical variables**
- Temperature
- Salinity
- Density

**Chemical variables**
- Oxygen
- Nitrate
- Silicate
- Phosphate
- Ammonium
- Nutrient ratios
- pH

**Bio-optical variables**
- Water clarity
- Chlorophyll a
- Euphotic depth
Using water mass characteristics to understand water quality in the Strait of Juan de Fuca and Puget Sound.

Low DO? …something’s come between us….

- What waters are entering Puget Sound?
- What are the key characteristics of source waters?
- When and how do these waters affect DO (and other WQ indicators?)
- Tele-effects? When do outlying regions affect nearby conditions?
DO Profiles at SJF002; 2017

Apr – Jul 2017

Aug – Nov 2017

* Note scale change
The ocean to river link in Salish Sea basins.

Estuarine circulation connects Puget Sound/Salish Sea to the ocean.
Bathymetry & freshwater outflow can act as barriers to seawater inflow.

Thomson, R.E. et al. 2007. Estuarine vs. transient flow regimes in Juan de Fuca Strait.
Water Types:
A: Deeper Pacific water (excluded by bottom contour)
B: Pacific water (50 – 250 m depths)
C: Superficial Pacific water (excluded by net outflow of Strait)
D: Surface Juan de Fuca, San Juan Channel, deep Georgia Strait
E: Georgia Strait surface water + Type B

### Water Types:

- **A: Deeper Pacific water**
- **B: Pacific water (50 – 250 m depths)**
- **C: Superficial Pacific water (all depths)**
- **D: Superficial Juan de Fuca, San Juan, deep Georgia Strait**
- **E: Georgia Strait surface water + Type B**

#### T-S Diagram

<table>
<thead>
<tr>
<th>Ocean</th>
<th>River</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="T-S Diagram" /></td>
<td><img src="image" alt="T-S Diagram" /></td>
</tr>
</tbody>
</table>

**JEMS 1999 – 2017; All Data**
Water Types:
A: Deeper Pacific water
B: Pacific water (50 – 250 m depths)
C: Superficial Pacific water (all depths)
D: Superficial Juan de Fuca, San Juan, deep Georgia Strait
E: Georgia Strait surface water + Type B

+ ???

Comparing JEMS sites to Redfield’s Water Masses
Analyses of Water Masses for the Straits

**Source water type**

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>SW1</strong>: River</td>
<td>(Fraser)</td>
</tr>
<tr>
<td><strong>SW2</strong>: Deep South</td>
<td>(Deep Shelf/Upwelled Pacific Ocean water)</td>
</tr>
<tr>
<td><strong>SW3</strong>: Pre-Season</td>
<td>(Mixed Estuary &quot;stagnant&quot; water)</td>
</tr>
<tr>
<td><strong>SW4</strong>: Surface South</td>
<td>(Surface Pacific Ocean/Columbia River water)</td>
</tr>
</tbody>
</table>


Fig. 4  Mean contributions for the source water type.
Comparison of T-S end member properties described by Redfield, Masson with JEMS data.

**Masson:**
- SW1 (river)
- SW3 ("pre-season"/mixed estuary water)
- SW2 (Pacific ocean water)
Mapping DO using water mass characteristics at sites.

*Hood Canal Possession Snd.
*all years & months.

Strait of Juan de Fuca

**Hood Canal Possession Snd.**

-Jul-Oct 1999
-2005
-2006
-2008
-2013
-2017

DO <3 mg/L
Mapping DO using water mass characteristics at sites.

**T-S Diagram**

- **Strait of Juan de Fuca**
- **Hood Canal**
- **Possession Snd.**
- **Admiralty Inlet**
  - *Outer ADM site!
- **Saratoga Passage**
- **Georgia Strait**

**DO <3 mg/L**

- **SJF000**
- **SJF001**
- **SJF002**

[Map showing locations with DO <3 mg/L]
Mapping DO using water mass characteristics at sites.
Mapping DO using water mass characteristics at sites.

T-S Diagram

DO 4-5 mg/L
Mapping DO using water mass characteristics at sites.

T-S Diagram

DO 5-6 mg/L
Mapping DO using water mass characteristics at sites.
Mapping DO using water mass characteristics at sites.

T-S Diagram

DO >7 mg/L
Salish Sea model quantifies exchange and shows reflux occurring at sills.

Summary:

- Admiralty sill is a barrier to exchange of very salty (>33 PSU), low DO (<3 mg/L) water into Puget Sound.
- Water masses are transformed & oxygenated between the ocean & Puget Sound.
- Sites with the lowest DO are distant & separated from low DO ocean water and thus issues are locally driven.
- Reflux (pre-season) water is impacting water quality!