Surface Conditions Report, November 22, 2016

Up-to-date observations of water quality conditions in Puget Sound and coastal bays
## Marine conditions from 11-22-2016 at a glance

<table>
<thead>
<tr>
<th>Field log</th>
<th>Climate</th>
<th>Water column</th>
<th>Aerial photos</th>
<th>Continuous monitoring</th>
<th>Streams</th>
</tr>
</thead>
</table>

### Personal impressions
Particulate organic matter is important.

### Climate influences
Wet and warm conditions prevail, with above-normal downwelling and cold phase ENSO present (La Niña).

### Water column
Record-breaking water temperatures, salinities, and oxygen are returning to mostly normal.

### Aerial photography
Large jellyfish aggregations in finger Inlets of South Sound. Slowly fading red-brown blooms in Eld and Budd Inlets. Masses of suspended sediment east of Steamboat Island.

### Continuous monitoring
The water has cooled but Puget Sound is still a little warmer. Decrease in chlorophyll fluorescence coincided with increase in turbidity, most likely from rain and winds.

### Streams
Strong precipitation in October greatly improved Puget Sound streamflows. In October, many streams recovered dramatically.

---

**Editorial assistance provided by:** Suzan Pool, Carol Maloy
Nutrients in the form of particulate material in the water

Why do we care?

- There could be a big difference how organic material and energy is cycling through the marine food web of Puget Sound in recent years.

- Near the surface, roughly 30% of nutrients are in the particulate phase. When and how quickly particulate material sinks is important to understand the release of nutrients back into the water at depth and when nutrients become again available for algae growth at the surface.

- If you have buoyant or ballasted organic material (e.g. ballasted by silicate from diatoms), organic material sinks at different rates. Because of difference in sinking speed particles are broken down by microbes and remineralize either in the water column or in the sediment.

The study requires us to take on more samples in the confined space of the plane. But it works well.

Collection of total organic carbon, total nitrogen, particulate organic carbon, and dissolved inorganic nutrients from 10-m depth and near bottom.
What was the visibility in the water for divers?

Find depths with high and low visibility

- **Best visibility** was 35 feet around Seacrest Park (2), but South Puget Sound (8-10) and Hood Canal (5) below 20 ft are better than normal.

- **Poor visibility** occurred in many places within the upper 20 feet of the water.

- South Puget Sound visibility is better than normal except by Shelton (7) and Olympia (11).

- We use transmissometer readings from our CTD package and convert them into horizontal visibility.
Climate Influences leading to 11-22-2016

Climate and natural influences, including weather, rivers, and the adjacent ocean, can affect our marine waters. Graphics are based on provisional data and are subject to change. [http://www.ecy.wa.gov/programs/eap/mar_wat/weather.html](http://www.ecy.wa.gov/programs/eap/mar_wat/weather.html), page 26.

Summary:

Air temperatures in October have been above normal, after a cool spell in September.

Precipitation levels have been very high.

Sunshine levels were generally low (higher cloud cover).

River flows were all above normal.

Downwelling was very strong. ENSO has entered the La Niña phase and PDO is trending towards neutral.

*Upwelling Anomalies (PFEL)*

PDO = Pacific Decadal Oscillation
NPGO = North Pacific Gyre Oscillation
ENSO = El Niño Southern Oscillation
We use a boat and a chartered float plane equipped with a CTD package to access our monthly monitoring stations.

We communicate data and environmental marine conditions using:

1. Marine Water Condition Index (MWCI)
2. Eyes Over Puget Sound (EOPS)
3. Anomalies and source data

Station network of ambient water quality monitoring stations
How well is Puget Sound exchanging its water?

Year 2016 had record-breaking global temperatures. Peak river flows are moving earlier in the year, into the springtime. This will affect the estuarine circulation and increase the water residence time, therefore increasing the relative burden of waste water discharge during the summer months (with lower flows).

2016 Fraser River summer flow was extremely low in response to warm winter temperatures and lack of snowpack in BC. Very low summer flows inhibited the renewal of water in Puget Sound. November flow is above normal.

Source: http://wateroffice.ec.gc.ca/index_e.html

Climate Change Impacts in the United States, 2014


Puget Sound October conditions are normalizing with the transition to La Niña. Record-breaking water temperatures anomalies are weakening with Hood Canal and South Sound still lagging behind. Rain normalized higher salinities and oxygen is now mostly normal. At the coast, conditions are normalizing.
**The ocean affects water quality: Ocean Climate Indices**

- **a)** Pacific Decadal Oscillation Index ($PDO$, temperature)  
- **b)** Upwelling Index (anomalies) ($Upwelling$, low oxygen) 
- **c)** North Pacific Gyre Oscillation Index ($NPGO$, productivity)

---

**Three-year running average** of PDO, Upwelling, and NPGO indices scores

---

Ocean boundary conditions long-term variability:  
(a) water is still warm ($PDO$),  
(b) upwelling of low oxygen and high nutrient ocean water are normal ($Upwelling$ Index anomaly),  
and (c) surface productivity along the coast is normalizing ($NPGO$).
Summary: Aerial photography 11-22-2016

Large jellyfish aggregations in finger Inlets of South Sound. Slowly fading red-brown blooms in Eld and Budd Inlets. Otherwise, water is very clear. A lot of suspended sediment east of Steamboat Island and south of Squaxin Island.

### Field log

- **Climate**
  - El Niño is now gone (January 2016)
  - La Niña is here (September 2016)

- **Water column**
  - **Mixing and Fronts:** Some tidal eddies in South Sound which is otherwise calm.
  - **Jellyfish:** Very numerous in Budd, Eld, Totten, and Henderson Inlets.
  - **Suspended sediment:** Strong near shore suspended sediments east of Steamboat Island.
  - **Visible blooms:** Red-brown blooms in Eld and Budd Inlets which have clear water otherwise.
  - **Debris:** Occasional organic debris mostly near Vashon Island.

### Climate

- Continuous monitoring
- Streams
Aerial photography and navigation guide
Date: 11-22-2016

Tide data (Seattle):
<table>
<thead>
<tr>
<th>Time</th>
<th>Height (ft)</th>
<th>High/Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>04:38 AM</td>
<td>2.4</td>
<td>L</td>
</tr>
<tr>
<td>11:55 AM</td>
<td>11.65</td>
<td>H</td>
</tr>
<tr>
<td>06:51 PM</td>
<td>3.74</td>
<td>L</td>
</tr>
</tbody>
</table>

Flight Information:
Overcast fair visibility, had to turn around because of visibility.

Observation Maps:
Central and North Sound
South Sound
Jellyfish patches still very numerous, a fading bloom, and organic debris on the eastern side of the inlet.

Location: Budd Inlet (South Sound), 12:17 PM.
Suspended sediment from prop wash along path of ship. Jellyfish and fading bloom in red-brown.

Location: Budd Inlet (South Sound), 12:19 PM.
Abundant jellyfish patches.
Location: Budd Inlet (South Sound), 12:18 PM.
Long ribbon of jellyfish, red-brown bloom, and river plume.

Location: Eld Inlet (South Sound), 12:21 PM.
Long patches of jellyfish, red-brown bloom, and river plume.
Location: Eld Inlet (South Sound), 12:21 PM.
River plume with lots of suspended sediment from recent rains.
Location: Totten Inlet (South Sound), 12:23 PM.
River plume hugging western shores.
Location: Totten Inlet (South Sound), 12:26 PM.
Jellyfish patches and suspended sediment surrounded by organic debris.
Location: Totten Inlet (South Sound), 12:27 PM.
Incoming tidal wedge with clearer water coming from Dana Passage.
Location: Hope Island (South Sound), 12:29 PM.
Large quantities of suspended sediment and eddies off eastern shores of Steamboat Island.
Location: Totten Inlet (South Sound), 12:31 PM.
Large quantities of suspended sediment and eddies off eastern shores of Steamboat Island.
Location: Totten Inlet (South Sound), 12:31 PM.
Large quantities of suspended sediment off the tip of Squaxin Island.

Location: Squaxin Island from two perspectives, A. and B. (South Sound), 12:32 PM.
A. Organic debris. B. Organic debris with faint orange color which could be Noctiluca?
Location: A. Dockton Park, Quartermaster Harbor, B. Vashon Island (Central Sound), 12:47 PM.
Puyallup River plume not visible. Debris line in Blair Waterway.
Location: Port of Tacoma, Commencement Bay (Central Sound), 12:51 PM.
Puyallup River plume not visible likely due to recent precipitation as snow in the mountains.
Location: Port of Tacoma, Commencement Bay (Central Sound), 12:51 PM.
Puyallup River plume not visible likely due to recent precipitation as snow in the mountains.

Location: Port of Tacoma, Commencement Bay (Central Sound), 12:51 PM.
Calm and uneventful in Gig Harbor at the entrance to the Tacoma Narrows.
Location: Gig Harbor (Central Sound), 12:57 PM.
Front across Pitt Passage. Many little fishing vessels with nets.
Location: McNeil Island (South Sound), 1:03 PM.
Greenish water with numerous jellyfish patches.
Location: Henderson Inlet (South Sound), 1:09 PM.
Greenish water with numerous jellyfish patches.
Location: Henderson Inlet (South Sound), 1:09 PM.
Date: 11-22-2016

North Sound

Central Sound

n.a.
Qualitative aerial observer map during transit

Date: 11-22-2016

South Sound

Numbers on map refer to picture numbers for spatial reference
Summary of *Victoria Clipper IV* ferry data:
The water in late October and November has cooled and become well mixed. Decrease in chlorophyll fluorescence coincided with increase in turbidity, most likely from rain and winds. Recently, water was more turbid in the Juan de Fuca Strait (higher latitude) than in Puget Sound.

The *Victoria Clipper IV* carries sensors in its sea chest. The sensors allow us to plot over time transects of:

A. Temperature  
B. Chlorophyll  
C. Turbidity  
D. CDOM

Over time, we see the dynamic of these variables in surface water between Seattle and Victoria, BC.

The CDOM sensor is out of commission until further notice.
Figures show daily data from sensors installed on the ferry which measure near-surface water at 5-sec intervals while the Victoria Clipper IV transits between Seattle and Victoria, BC.

A. **Sea Surface Temperature**: Water is still warmer in Puget Sound than the Strait.

B. **Chlorophyll**: Concentrations are low throughout the transect with a small detection in Central Sound.

C. **Turbidity**: Turbidity is low on the entire route.

D. **Colored Dissolved Organic Matter (CDOM)**: Not available.

CDOM sensor is out of commission until further notice.
Strong precipitation in October greatly improved Puget Sound streamflows and officially removed any drought conditions from the U.S. Drought Monitor statewide. Many streams recovered dramatically, quickly transitioning from “much below normal” to “above normal.” Along with the rain, salmon have returned to Puget Sound tributaries to spawn.

A. Precipitation was well above normal in the Puget Sound basin throughout October resulting in a dramatic increase in streamflow for the month. Much of western Washington saw precipitation in excess of 200% of normal.

B. Streamflows changed from September, with most streams at or below normal, to flows much above normal in October.

In October, streamflows increased over the second half of the month following the remnant of Typhoon Songda. Currently, about 70% of the state’s streamflows are above the normal range.
Get data from Ecology’s Marine Monitoring Programs

### Long-Term Monitoring Network


christopher.krembs@ecy.wa.gov

Access mooring data: [ftp://www.ecy.wa.gov/eap/Mooring_Raw/Puget_Sound/](ftp://www.ecy.wa.gov/eap/Mooring_Raw/Puget_Sound/)

Suzan.Pool@ecy.wa.gov

---

### Water column

Ecology’s long-term marine monitoring stations

Water Quality Monitoring Stations
- Core Flight
- Continuous (Mooring)
- Discontinued (funding cuts)
- Continuous track

River and Stream Water Quality Monitoring

---

### Real-Time Sensor Network


christopher.krembs@ecy.wa.gov

Access mooring data: [ftp://www.ecy.wa.gov/eap/Mooring_Raw/Puget_Sound/](ftp://www.ecy.wa.gov/eap/Mooring_Raw/Puget_Sound/)

Suzan.Pool@ecy.wa.gov
We are looking for feedback to improve our products.

Dr. Christopher Krembs
christopher.krembs@ecy.wa.gov

Marine Monitoring Unit
Environmental Assessment Program
WA Department of Ecology

Many thanks to our business partners: Clipper Navigation, Swantown Marina, and Kenmore Air.