Up-to-date observations of water quality conditions in Puget Sound and coastal bays
Guest contribution
Puget Sound Marine Waters Report.

Jeepers creepers!
Ecology scientists surprise us with the creeping pedal sea cucumber.

Water visibility for divers
Know the best and worst for October.

Climate & streams
After a dry summer we have had several months of higher precipitation, but river flows mostly remain lower than in 2018. The past summer was warmer than in 2018, but October was colder.

Water temperature and food web
South and Central Sound retained temperature ranges for spawning for anchovies. Optimum growth temperatures for herring and salmon persisted in Whidbey Basin.

Aerial photography
Sizable rafts of orange debris drift in South Sound, looking like Noctiluca. Whidbey Basin, East Sound, and Bellingham, Padilla, and Discovery Bays have sizable rafts of organic debris. By the end of October many red-brown blooms typical for fall have vanished, yet the waters of South Sound are still green.

Editorial assistance provided by: Elisa Rauschl, Julianne Ruffner, Jeanne Ponzetti, Valerie Partridge.
Psolus chitonoides

With its sticky, spiny, scaly body, the creeping pedal sea cucumber is one of the more bizarre members of the Puget Sound benthic community. It prefers to creep on rocks rather than mud, making it a rare and special find for our team!

Fun Creeping Pedal Cuke Facts

- The Latin name “chitonoides” comes from the armored mollusk it resembles: the chiton.
- Its tentacles form a cup-shaped mesh that is sticky like a spider’s web.
- Its body contains a toxin that is poisonous to some predators.

Learn more about the creeping pedal sea cucumber and other critters on Ecology’s EcoConnect blog.
What was the water visibility like for divers?

Visibility in October

Best and worst horizontal visibility at corresponding vertical depth

<table>
<thead>
<tr>
<th>Location</th>
<th>Best Visibility</th>
<th>Worst Visibility</th>
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<tbody>
<tr>
<td></td>
<td>Horizontal Distance (ft.)</td>
<td>Vertical Depth (ft.)</td>
</tr>
<tr>
<td>1</td>
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<td>2</td>
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<tr>
<td>18</td>
<td>11</td>
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</tr>
</tbody>
</table>

Find depths with high/low visibility

• **Best visibility** occurred in Hood Canal near Octopus Hole (location 11), with over 40 ft visibility at about 80 ft depth.

• **Poor visibility** occurred near the surface in Sinclair Inlet (location 10).

• The poster, “Underwater Visibility Maps — a Tool for Scuba Divers,” is available [here](http://example.com).

Visibility in October

Good | Poor

This is a new feature and we are soliciting feedback ([skip.albertson@ecy.wa.gov](mailto:skip.albertson@ecy.wa.gov)).
During the previous 30 days, Puget Sound air temperatures were below normal, while precipitation was generally below normal except for central Puget Sound (A). During the next 30 days, forecasted temperatures are projected to be warmer than normal, while precipitation is expected to be below normal (B).

**A. Northwest Climate Toolbox (previous 30 days)**

**Temperature Anomaly** from historical mean ranged from 0 to -4°F in the Puget Sound region during the past 30 days.

**Precipitation Anomaly** from historical mean ranged from -5 to +5 inches in the Puget Sound region during the past 30 days.

**B. Northwest Climate Toolbox (next 30 days)**

**Temperature Anomaly** from historical mean is forecasted to be +3°F to +7°F in the Puget Sound region during the next 30 days.

**Precipitation Anomaly** from historical mean is forecasted to be 0 to -4 inches in the Puget Sound region during the next 30 days.
Despite a strong atmospheric river precipitation event (10/21), an unusual dry spell has resulted in normal to below-normal freshwater inputs to Puget Sound (trend charts, left). Current flow distribution across the watershed is mixed (map, right), due to variable delivery of rainfall and differing rates of streamflow decline after recent precipitation.

Select Puget Sound Streamflow Trends

Current Streamflow Conditions as of 11/06/2019

USGS Real Time Streamflow Values
- Much above normal (>90%)
- Above normal (76-90%)
- Normal (25-75%)
- Below normal (10-24%)
- Much below normal (5-10%)
- Far below normal (<5%)
- Lowest recorded
- Not ranked

Ecology Daily Streamflow

Daily Streamflow
- Highest recorded
- Much above normal (>90%)
- Above normal (76-90%)
- Normal (25-75%)
- Below normal (10-24%)
- Much below normal (<10%)
- Lowest recorded
- Not ranked

USGS WaterWatch: CLICK HERE!
Current conditions: CLICK HERE!
Climate influences: How well is Puget Sound exchanging its water?

Historically, the peaks of coastal upwelling and the freshet are in sync. In 2019, the freshet was weak.

The Fraser River is the major driver of estuarine circulation and water exchange between the Salish Sea and the ocean. The Fraser River has regained expected levels. Dramatic snow melt in May resulted in well-below-normal flows in early summer.

Three-year running average of PDO, Upwelling, and NPGO Indices

How do ocean boundary conditions affect the quality of water we exchange with the ocean? Recent years’ warm water is gone (PDO). Upwelling (Upwelling Index anomaly) and NPGO, which reflects the surface productivity along the coast, are at low levels.

Pacific Decadal Oscillation Index (PDO, temperature, explanation). Upwelling Index (anomalies) (Upwelling, low oxygen, explanation). North Pacific Gyre Oscillation Index (NPGO, productivity, explanation).
In the anomaly plot, we want to connect different factors influencing water quality in the context of space and time. After a dry beginning of summer we have had several months of higher precipitation (October variable), but river flows mostly remain lower than in 2018. The past summer was warmer than in 2018, but October was colder. Early onset upwelling was a factor in both 2018 and 2019. For recent river and stream inflow, see page 7.

Conditions leading up to November:

**Air temperatures** have generally been warmer than normal this year, but October was colder.

**Precipitation** for this year has been lower than in 2018, but July through September have been wetter.

**Sunshine** (opposite of cloud cover) has been high, except in July through September.

**River flows** have been low since June of last year (2018).

**Upwelling** started early in spring in 2018 and 2019. In summer of 2019, it weakened prematurely.

All data are from public sources: UW GRAYSKIES; river flows from USGS and Environment Canada; indices from NOAA & UW (PDO).
Water temperature affects ecosystem performance

**Can organisms thrive and survive?**

The life cycles of organisms respond to temperature. To be successful, the timing of early life stages must line up with good growth conditions.

Temperature is important for growth, but also dictates if certain organisms can overwinter in Puget Sound (e.g., northern anchovy).

* Help us get these right. We scoured the literature for temperatures important to the success and survival of marine organisms.

**In October,** average surface water (0 – 30 m) temperatures were still 0.4 °C above the baseline (1999 – 2018) across all regions. South and Central Sound retained temperature ranges for spawning for anchovies. Optimum growth temperatures for herring and salmon persisted in Whidbey Basin. Expected coolest temperatures occurred in the Straits with 10.2 °C. These temperatures do not reflect nearshore conditions that can be quite different.

![Diagram showing optimal temperatures for Puget Sound organisms](diagram.png)

**Optimal temperatures for Puget Sound organisms**

- Oyster spawning range
- Max temp for bull kelp and coho and Chinook salmon
- Increase in HAB toxicity risk >15°C
- Dungeness crab egg production optimum
- Anchovy spawning optimum
- Herring and salmon growth optimum
- Herring spawning upper range 12°C
- Geoduck growth optimum
- Anchovy survival minimum

**Legend:**
- **Warmer than expected**
- **Cooler than expected**
- **Expected 18-year average**
What are the conditions at the surface?

Sizable rafts of orange debris drift in South Sound, looking like *Noctiluca*. Whidbey Basin, East Sound, and Bellingham, Padilla, and Discovery Bays have sizable rafts of organic debris. By the end of October many red-brown blooms typical for fall have vanished, yet the waters of South Sound are still green. Jellyfish and schools of fish are no longer abundant in South Sound.

**Mixing and fronts:**
Tidal fronts in Tacoma Narrows, tidal eddies in Obstruction Pass. Interesting patches of different water masses in East Sound and Sequim Bay.

**Jellyfish:**
Very few jellyfish patches in Budd Inlet. The previously reported large jellyfish patches in Quartermaster Harbor have disappeared.

**Suspended sediment:**
In Skagit Bay and along sandy spots.

**Visible blooms:**
Red-brown bloom in Henderson and Sinclair Inlets and Sequim Bay. Greenish water still persists in South Sound.

**Debris:**
**Aerial navigation guide**

**Date:** 10/30/2019

**Click on numbers**

<table>
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<tr>
<th>Time</th>
<th>Pred (ft)</th>
<th>High/Low</th>
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<tbody>
<tr>
<td>12:40 AM</td>
<td>-1.93</td>
<td>L</td>
</tr>
<tr>
<td>7:38 AM</td>
<td>11.91</td>
<td>H</td>
</tr>
<tr>
<td>1:13 PM</td>
<td>5.48</td>
<td>L</td>
</tr>
<tr>
<td>6:31 PM</td>
<td>11.24</td>
<td>H</td>
</tr>
</tbody>
</table>

**Flight Observations**

Sunny and hazy

**Tide data from 10/30/2019 (Seattle):**

- 12:40 AM: Pred = -1.93, Low (L)
- 7:38 AM: Pred = 11.91, High (H)
- 1:13 PM: Pred = 5.48, Low (L)
- 6:31 PM: Pred = 11.24, High (H)

**Citizens contributing observations**

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15
Reddish organic material (perhaps Noctiluca) drifting at surface in South Sound. Green water.
Location: A. Dana Passage, B. Entrance to Henderson Inlet, C-E. Eld Inlet (South Sound), 11:20 AM
Reddish organic material (perhaps *Noctiluca*) drifting at surface in South Sound. Green water.

Location: A. Entrance to Eld Inlet, B. Dana Passage (South Sound), 11:27 PM
Reddish organic material (perhaps Noctiluca) drifting at surface. Suspended sediment.

Location: Totten Inlet (South Sound), 11:23 AM
Green water, likely a bloom, towards the western shore.
Location: Lang Island, Case Inlet (South Sound), 11:39 AM
Dark maroon bloom.
Location: Sinclair Inlet (Central Sound), 11:50 AM
Large greenish eddy of water of very different color, surrounded by maroon-colored bloom.

Location: Sequim Bay (North Sound), 12:22 PM
Faint red-brown bloom outside Sequim Bay.
Location: Sequim Bay (North Sound), 12:23 PM
A. Green turbid water leaving Lopez Sound via Lopez Pass. B. Red-brown bloom between Reeds Bay and Center Island.

Location: Lopez Sound, San Juan Islands (North Sound), 12:42 PM
A. Large eddy, B. Patch of greener water and debris, C. Green patch.
Location: A. Off Obstruction Pass, B. East Sound, C. West Sound, Orcas Island (North Sound), 12:49 PM
A. Macroalgae rafts, B & C. Fronts between clearer and murkier water around Lummi Island.

Location: A. Eliza Island, B. Portage Island, C. Lummi Island (North Sound), 1:03 PM
A, B. Multiple rafts of organic debris accumulating at edges of tidal gullies.
Location: Padilla Bay National Estuarine Research Reserve (North Sound), 1:08 PM
A. Suspended sediment, B. Organic debris accumulating at front, C & D. Patches of organic debris.

Location: A. Skagit Bay, B. Polnell Point, C. Saratoga Passage, D. Off Langley (Whidbey Basin), 1:18 PM
Tidal front separating green water from South Sound from clearer water in Central Sound.

Location: Entrance of the Tacoma Narrows (Central Sound), 1:56 PM

Location: A. Dyes Inlet, Silverdale, B. Quartermaster Harbor, C. Hollywood Beach, Port Angeles
Red-brown bloom.
Location: Discovery Bay (North Sound)
We have published 84 editions!

Find all previous Eyes Over Puget Sound editions at the end of this document.

Recommended Citation (example for September 2018 edition):

Many thanks to our business partners:
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Environmental Assessment Program
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