Guest Contribution:
Brandon Sackmann

Surface Conditions Report
January 15, 2013

We have a new website (http://www.ecy.wa.gov/programs/eap/mar_wat/)

Up-to-date observations of visible water quality conditions in Puget Sound and the Strait of Juan de Fuca
## Marine conditions from 1-15-2013 at a glance

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<th>Flight log</th>
<th>Weather</th>
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<td><strong>Personal flight log</strong></td>
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<td>Has herring spawning begun?</td>
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<td><strong>Weather conditions</strong></td>
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<td>The weather has been cool with some sun and light winds. River flows have fallen below normal.</td>
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<td><strong>Water column and mooring</strong></td>
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<td>A pattern of colder and fresher Puget Sound water persists since 2011. Oxygen levels at mooring locations are currently increasing as part of the seasonal cycle.</td>
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<td><strong>Aerial photography</strong></td>
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<td>Jellyfish aggregations continue to go strong in Budd inlet. Debris lines numerous and long. Multiple oil sheens in Seattle waterways.</td>
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<td>In 2012 warm temperatures in Central Puget Sound occurred a few weeks earlier than 2011 and stimulated an earlier but weak spring bloom. CDOM continues to provide an important tracer for freshwater entering Puget Sound from Whidbey Basin.</td>
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**Mya Keyzers**  
Laura Friedenberg

**Skip Albertson**

**Julia Bos**  
Suzan Pool  
David Mora

**Dr. Christopher Krembs**

**Guest: Dr. Brandon Sackmann**

Previous Eyes Over Puget Sound reports:  
Why Eyes Over Puget Sound?

We observe increasing nutrients and changing algal biomass patterns in Puget Sound:


Algae bloom Budd Inlet 2010

Nutrient Balance (Si:N)
Our team recently learned what herring spawning habitats look like from the air, so we have been keeping an eye out for them. Herring start spawning in Puget Sound around this time in the winter and into the spring. While we didn’t see any near shore spawning areas from the air, we were lucky to get up close with some eggs that could be from herring. At our Possession Sound station we were sampling in a very foamy tide line that had debris and eelgrass in it. When we pulled up the CTD, some eelgrass was caught on the frame and there were small, transparent eggs on it. These eggs are so small they can fit on the tip of a ballpoint pen. We were excited to see that herring could already be spawning in this area.
Meteorological conditions typically explain up to half of the variance in observed marine variables (Moore et al. 2008), particularly in shallower waters like those of South Puget Sound. I summarized the specific conditions prevalent during the past two weeks, from north to south. Source: [http://www-k12.atmos.washington.edu/k12/grayskies/nw_weather.html](http://www-k12.atmos.washington.edu/k12/grayskies/nw_weather.html)

**Summary:**

**Air temperatures** have been below normal for the past five days.

**Sunshine** has been slightly above normal the past few days except for the day before the flight (Jan. 14) and along the coast.

**Rivers** had been running above normal early this month, but have dropped since air temperature fell last week.

**Winds** have been light and variable.

2011-2012 Temperature, salinity are down and oxygen is up

Each horizontal line is a station in Puget Sound. Each color dot is 1 out of 12 sampling event per year.

- Dark red = higher than expected (>IQR, n=13)
- Dark blue = expected (=IQR, n=13)
- Dark green = lower than expected (>IQR, n=13)
- Light red = higher than previous measurements
- Light blue = no data
- Light green = lower than previous measurements

Flight log | Weather | Water column | Aerial photos | Ferry and Satellite | Moorings
Jellyfish aggregations continue to go strong in Budd inlet. Debris lines numerous and long. Multiple oil sheens in Seattle waterways.

**Mixing and Fronts:**
Large fronts in Central Basin, Budd Inlets, Pickering Passage and Case Inlet. 9 10 11

**Jellyfish:** 5 6 7
Abundant in Budd and Eld Inlets.

**Suspended sediment:** 13 14
In waterway due to vessel activity.

**Visible blooms:**
No apparent blooms.

**Debris:** 1 2 3 4 6 7 8 9 10 11
Long debris lines in many locations often associated with fronts or river plumes.
Aerial photography navigation guide, 1-15-2013

Flight Information:

- **Morning flight:**
  Good visibility, cloud banks, calm

- **Evening flight:**
  Good visibility, cloud banks, calm
  low sun angle

Observation Maps:

- Central Sound
- South Sound
Surface debris. Location: Southworth/Yukon Harbor (Central Sound), 10:27 AM
Debris line and fish pens in Burley-Minter Lagoon. Location: Carr Inlet, 10:34 AM
One of multiple debris lines east of Herron Island. Location: Case Inlet, 10:40 AM
Surface slick during landing approach. Location: Budd Inlet (South Sound), 10:47 AM
Sizable and numerous jellyfish (approx. 10 cm diameter). Location: Swantown Marina (Budd Inlet), 10:55 AM
Jellyfish aggregations and long debris line. Location: Budd Inlet (South Sound), 4:00 PM
**Jelly fish patches and debris line.** Location: Budd Inlet (South Sound), 4:01 PM
Very long debris line extending across Budd Inlet.
Location: Gull Harbor, Budd Inlet, (South Sound), 4:02 PM
Dynamic environment and two tidal eddies and front.

Location: Squaxin Island/Hope Island (South Sound), 4:05 PM
Front and debris line as water from Pickering Passage connects to Case Inlet.
Location: Northern tip of Harstine Island (South Sound), 4:11 PM
Long debris line separating surface waters running north-south in Central Sound.
Location: West of Elliott Bay/Alki Point (Central Sound), 4:28 PM
Oil sheen, extending deep into waterways. Location: Salmon Bay (Seattle), 4:32 PM
Suspended bottom sediment resulting from vessel activities.

Location: Salmon Bay (Seattle), 4:33 PM
Oil sheen between vessels. Location: Salmon Bay (Seattle), 4:33 PM
Oil sheens between vessels. Location: Salmon Bay (Seattle), 4:33 PM
Aerial photography observations in Central Sound

Date: 1-15-2013

Morning

Evening

Numbers on map refer to picture numbers for spatial reference.
Aerial photography

Observations in South Sound: 1-15-2013

Numbers on map refer to picture numbers for spatial reference
**Comments:**
Maps are produced by observers during and after flights. They are intended to give an approximate reconstruction of the surface conditions on scales that connect to and overlap with satellite images in the section that follows.

**Debris:** Debris can be distinguished into natural and anthropogenic debris floating at the surface sensu Moore and Allen 2000. The majority of organic debris in Puget Sound is natural mixed with discarded man made pieces of plastic, wood etc. From the plane we can’t differentiate the quality of debris at the surface and therefore call it for reasons of practicality just “debris”.

Brandon Sackmann
Contact: bsackmann@integral-corp.com

January 2013:
Clipper undergoing maintenance. Service to resume next week.

2012 in Review:
A new thermosalinograph added temperature and salinity measurements to the suite of optical parameters already being measured by the Victoria Clipper. Dual temperature sensors provide redundancy and data from 2012 suggest that the new sensor is performing well!
Turner Designs, C3 Thermistor

Temperature from Turner Designs, C3 vs. Temperature from new Citadel thermosalinograph showing overall good agreement

Thermosalinograph adds salinity measurements to the suite of optical parameters already being measured by the Victoria Clipper

Citadel Thermosalinograph \((\text{started June 2012})\)
2012 in Review:

CDOM continues to provide an important tracer for freshwater entering Puget Sound from Whidbey Basin. High CDOM concentrations are associated with increased river flows and low near-surface salinity.
2012 in Review:

Warm temperatures in Central Puget Sound occurred a few weeks earlier in 2012 vs. 2011 and stimulated an earlier, yet somewhat weaker, spring phytoplankton bloom. Phytoplankton blooms in the Strait of Juan de Fuca appeared weaker in 2012 compared with 2011.
**Summary:** Dissolved oxygen increasing as water temperature declines. Lowest dissolved oxygen occurs with highest salinity and water temperature. Warmest temperatures occur with highest salinity. During the winter, freshwater entering Puget Sound is colder than saltwater. (Only 1 week of Manchester data from 1/1/2013 – 1/7/2013)

**Mukilteo, Whidbey Basin near Everett:**

**Dissolved Oxygen Conditions (12-16 m)**

| DO Max | 8.4 mg/L on 1/7 at 27.8 PSU 8.2 C 11.8 db |
| DO Min | 6.9 mg/L on 12/31 at 29.2 PSU 9.4 C 13.6 db |
| DO Avg | 7.3 mg/L |
| DO Trend | +1.2 mg/L |
| DO-Sal Corr | -0.70 |
| DO-Temp Corr | -0.97 |

**Salinity (Sal) Conditions (12-16 m)**

| Sal Max | 29.3 PSU on 1/12 at 9.4 C 15.4 db |
| Sal Min | 26.9 PSU on 1/13 at 8.3 C 11.9 db |
| Sal Avg | 28.9 PSU |
| Sal Trend | -0.32 PSU |

**Temperature (T) Conditions (12-16 m)**

| T Max | 9.4 C on 12/31 at 29.2 PSU 13.6 db |
| T Min | 8.2 C on 1/7 at 27.8 PSU 11.8 db |
| T Avg | 9.0 C |
| T Trend | -0.4 C |

**Manchester, near Clam Bay:**

**Dissolved Oxygen Conditions (8.6-12.7 m)**

| Max | 7.0 mg/L on 1/5 at 29.0 PSU 9.0 C 10.1 db |
| Min | 6.1 mg/L on 1/7 at 29.0 PSU 9.0 C 10.2 db |
| Avg | 6.7 mg/L |
| Trend | no trend |
| DO-Sal Corr | -0.71 |
| DO-Temp Corr | 0.71 |

**Salinity (Sal) Conditions (8.6-12.7 m)**

| Max | 29.3 PSU on 1/1 at 9.5 C 12.8 db |
| Min | 28.9 PSU on 1/5 at 9.0 C 10.5 db |
| Avg | 29.4 |
| Trend | No trend |

**Temperature (T) Conditions (8.6-12.7 m)**

| Max | 9.5 C on 12/31 at 29.3 PSU 11.1 db |
| Min | 9.0 C on 1/3 at 28.9 PSU 10.2 db |
| Avg | 10.2 C |
| Trend | -0.4 C |
Mooring observations and trends
1-1-2013 to 1-14-2013

Summary: Freshwater inputs into Whidbey Basin are increasing, river plumes are extending further into Puget Sound and are thicker indicated by the deepening of pycnocline layer compared to previous months.

This month we report on thickness of the fresh water layer by monitoring our near-surface sensor. The pycnocline is often near the surface sensor (*).

We track the depth of the isohaline where salinity is 28.55 (±0.05) to measure the thickness of the freshwater layer at our Mukilteo station. The near-surface sensor experienced tidal pressure variations of 11.0 to 16.0 meters (or dbar).
Mooring observations and trends
1-1-2013 to 1-14-2013

At Mukilteo, two principal water masses are observed. Lowest dissolved oxygen concentrations were associated with the water mass of highest salinity.

At both stations, highest salinity and warmest temperatures are observed together, showing that the saltiest waters are keeping Puget Sound warmer.

**Left Panel:** Probability of finding a specific density over the past two-week period. High probability shown in warm colors.

**Right Panel:** Dissolved oxygen concentration in relation to salinity. High probability shown in warm colors.
## Get data from Ecology’s Monitoring Programs

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### Long–Term Monitoring Network

- **Access core monitoring data:**

- **christopher.krembs@ecy.wa.gov**

### Real–Time Sensor Network

- **Access mooring data:**

- **brandonsackmann@ecy.wa.gov**

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**Ecology’s long-term marine monitoring stations**

- **Water Quality Monitoring Stations**
  - Core Flight
  - Continuous (Mooring)
  - Ferry track
  - Morning flight
  - Evening flight

**Freshwater Report:**

You may subscribe or unsubscribe to the Eyes Over Puget Sound email listserv by going to:
http://listserv.wa.gov/cgi-bin/wa?A0=ECOLOGY-EYES-OVER-PUGET-SOUND

We are looking for feedback to improve our products.

Dr. Christopher Krembs
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Marine Monitoring Unit
Environmental Assessment Program
WA Department of Ecology

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