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## Conditions in the Water Column - (Marine Flights)

# 2011

2011 - Monthly

*Conditions in Puget Sound and Coastal bays*

Anomaly Details

*Monthly observations in historic context*

Our Stations

*Our stations in Puget Sound and Coastal bays*



Year 2011

Month

Jan

Feb

Mar

Apr

May

Jun

Jul

Aug

Sep

Oct

Nov

Dec

[Read more here](#)

Boundary Conditions

**Meteorological conditions:** January started sunnier, drier and colder, and then became rainy and overcast with high river flows. Wind was either weak and from the north, or stronger and from the SE-SW. Air temperatures turned from colder to warmer than normal.

**SUMMARY GREATER PUGET SOUND REGION** - Water temperatures were lower. Lower salinity and density were confined to Central Basin. DO was variable, with higher values in Central Basin and lower values in Bellingham Bay and Whidbey Basin. Transmission was variable. Other variables were expected.

- 1. San Juan-North Sound Region:** Temperatures were lower. Low DO values occurred in Bellingham Bay. Other variables were expected.
- 2. Central Sound Region:** Salinity and density were low. Low temperature occurred near Seattle. DO concentrations were higher, particularly in the surface layer. Transmission was highly variable and varied regionally near rivers. Other variables were expected.
- 3. Whidbey Basin:** Temperatures were higher at depth. DO concentrations were lower. Transmission was high and other variables were expected.
- 4. Hood Canal:** Water temperatures varied regionally, while salinity and density were lower in the northern stations. Lower DO occurred at the surface in the north and at depth in the south. Transmission reached new maxima. Other variables were expected.
- 5. South Sound:** Temperatures were lower. Lower surface DO concentrations were seen in the surface layer of Carr Inlet. Other variables were expected.

**SUMMARY COASTAL BAYS REGIONS** - Water temperatures were lower and salinity and density were variable near rivers. DO near rivers was significantly lower. Transmission was spatially variable. Other variables were expected.

- 1. Grays Harbor:** Salinity and density were variable. Lower DO concentration occurred at stations near rivers. Transmission was high. Other variables were expected.
- 2. Willapa Bay: Water:** Temperatures were higher. Low DO concentrations were seen at the river stations and near Oysterville. Other variables were expected.



Greater Puget Sound



Coastal Bays



Year 2011

Month

Jan

Feb

Mar

Apr

May

Jun

Jul

Aug

Sep

Oct

Nov

Dec

[Read more here](#)

Boundary Conditions

**Meteorological conditions:** February started warm, dry, and cloudy with some rain in north. Mid February became cold. A snowstorm began on the 23rd. River flow dropped. South Sound and the Coast flights occurred during sunny periods; Central Sound flight was after a cloudy period.

**SUMMARY GREATER PUGET SOUND REGION** - Lower salinity and density. Dissolved oxygen conditions had local variations in Elliott Bay, Oakland Bay, Budd Inlet and the south of Hood Canal. Transmission was generally higher, especially in Central Sound. Other variables were within expected ranges.

- 1. San Juan-North Sound Region:** Region was not sampled due to high winds.
- 2. Central Sound Region:** We measured significantly lower salinity and density, but higher transmission. Other variables fell into expected ranges.
- 3. Whidbey Basin:** Whidbey Basin was not sampled due to high winds.
- 4. Hood Canal:** Significantly lower salinity, density and transmission. DO showed complex layers yet were within expected ranges. Other variables were expected.
- 5. South Sound:** Expected conditions for most variables. DO concentrations in Budd Inlet & Oakland Bay were lower than expected.

**SUMMARY COASTAL BAYS REGIONS** - Significantly lower salinity and density yet dissolved oxygen conditions were high. Transmission was generally expected yet higher in Grays Harbor.

- 1. Grays Harbor:** Lower than expected temperatures, salinity and density. Transmission and dissolved oxygen were high.
- 2. Willapa Bay: Water:** Significantly lower salinity and density, but higher dissolved oxygen levels. Other variables fell into expected ranges.





Year 2011

Month

Jan

Feb

Mar

Apr

May

Jun

Jul

Aug

Sep

Oct

Nov

Dec

[Read more here](#)

Boundary Conditions

**Meteorological conditions:** Cloudy and wet everywhere around Western Washington, except toward the extreme north. Heavy rain accompanied strong southerly winds after mid month. River flows were above normal in the south and on the coast, but below normal to the north.

**SUMMARY GREATER PUGET SOUND REGION** - Lower temperature and salinity. DO high in Central Basin (Elliott Bay, W. Point, East Passage) and low at Pt. Townsend and Budd Inlet. High and supersaturated DO levels confined to surface waters in Whidbey Basin and Hood Canal. Transmission more variable than expected. Fluorescence in the South Sound was low and or more variable. In situ fluorescence was high in the north.

- San Juan-North Sound Region:** Lower temperatures in the south across Admiralty Reach. DO conditions near Pt. Townsend were low. Transmission was often higher. Fluorescence was more variable than expected.
- Central Sound Region:** Significantly lower temperatures, salinity and density nearly everywhere. DO levels only higher in Elliott Bay and deep waters at West Point and East Passage. Fluorescence was more variable than expected. Other variables were expected.
- Whidbey Basin:** Low temperatures, salinity and density were confined to the south. High surface DO levels that were often supersaturated. Transmission was more variable than expected; in situ fluorescence was high.
- Hood Canal:** Low temperatures, salinity and density were more variable. DO levels were high in the south but confined to the surface in the north. Transmission and fluorescence were high.
- South Sound:** Significantly lower temperatures and salinity. Lower DO confined to Budd Inlet. High transmission was confined to Dana Passage. Fluorescence in South Sound was low.

### SUMMARY COASTAL BAYS REGIONS – Not Available

- Grays Harbor:** Not Available
- Willapa Bay: Water:** Not Available



[Read more here](#)

Boundary Conditions

**Meteorological conditions:** April was cold, cloudy and wet. Predominantly southerly winds with numerous storms. A few breaks in the weather occurred the 12th and the 22-24th. Solar radiation was generally low. River flows were higher towards the south.

**SUMMARY GREATER PUGET SOUND REGION** - Low temperature, salinity, and density with expected temperatures confined to northern portions of Central Sound and Hood Canal. DO conditions were expected with vertical and regional exceptions of high observations in eastern bays. Transmission was low in the North Sound, but higher towards the south. Fluorescence was expected in northern Puget Sound but was otherwise variable.

- San Juan-North Sound Region:** Low temperature, salinity and density. Expected DO conditions and in situ fluorescence. Transmission was low.
- Central Sound Region:** Low temperatures were confined to southern parts. Salinity and density were uniformly low. DO conditions were expected, but occasionally were higher at greater depths. Transmission was high and in situ fluorescence was low.
- Whidbey Basin:** Lower temperatures, salinity and density. Other variables were expected.
- Hood Canal:** Lower salinity and density. Low temperature in the southern parts. DO concentrations and in situ fluorescence were expected. Transmission was high.
- South Sound:** Low temperatures were confined to the southern portion. Lower salinity and density occurred ubiquitously. Transmission was low; in situ fluorescence was expected.

**SUMMARY COASTAL BAYS REGIONS** – Low salinity and density at the coast. DO concentrations were variable and transmission was low. Fluorescence in Grays Harbor was low yet higher in Willapa Bay.

- Grays Harbor:** Uniformly low salinity and density and variable DO levels, (low in river, high in mid-bay). Both Transmission and in situ Fluorescence were also low.
- Willapa Bay: Water:** Low salinity and density, but variable DO levels (low near ocean, high rivers and mid bay). Transmission was low, yet in situ Fluorescence was high.



[Read more here](#)[Boundary Conditions](#)

**Meteorological conditions:** May was unusually cool and wet and sunny days were numbered. River flow was above normal during the second half of the month, except on the Skagit that remained below normal.

**SUMMARY GREATER PUGET SOUND REGION** - Temperature, salinity and density were much lower, while oxygen conditions were generally higher than expected throughout the entire Puget Sound region. Since in situ algae biomass was mostly expected and transmission higher in the northern regions, the oxygen increase can be attributed to physical conditions. Lower transparency in the southern regions is consistent with high river discharge due to a lot of rain.

1. **San Juan-North Sound Region:** Temperature, salinity and density was low while oxygen conditions were high. Both transmission and in situ fluorescence were low.
2. **Central Sound Region:** Temperature, salinity and density were low while oxygen conditions were high in Admiralty and East Passage at depth. Other variables were expected.
3. **Whidbey Basin:** Temperature, salinity and density were low while oxygen conditions were high near the surface. Transmission was variable. Other variables were expected.
4. **Hood Canal:** Temperature, salinity and density were low while oxygen conditions were high at depth in the south. Transmission was high.
5. **South Sound:** Temperature, salinity and density were very low while oxygen conditions were high.

**SUMMARY COASTAL BAYS REGIONS** – Temperature, salinity and density were low while oxygen conditions were higher than expected. Since algal biomass was lower and transmission expected (Willapa Bay) or higher (Grays Harbor), increased oxygen is attributed to physical conditions.

1. **Grays Harbor:** Temperature, salinity and density were very low while oxygen conditions were high. While transmission was high, in situ fluorescence was low.
2. **Willapa Bay: Water:** Temperature, salinity and density were very low while oxygen conditions were high. In situ fluorescence was low.





Year 2011

Month

Jan

Feb

Mar

Apr

May

Jun

Jul

Aug

Sep

Oct

Nov

Dec

[Read more here](#)

Boundary Conditions

**Meteorological conditions:** After a cool stormy start, we enjoyed a warm and sunny weather break near June 4th. The remainder of the month was cooler and wetter in the central regions. Winds were predominantly from the WSW on the coast, SW in Olympia, and S and SE in the north.

**SUMMARY GREATER PUGET SOUND REGION** - Lower temperature, lower salinity and lower density in particular in South Sound. DO conditions were expected. Transmission was higher in the north while fluorescence was lower. Fluorescence in Hood Canal fell outside both the high and low end expected ranges.

- 1. San Juan-North Sound Region:** Lower temperature across Admiralty Reach. Lower salinity and lower density in Bellingham Bay. Variable DO conditions in Bellingham and in Admiralty Inlet. Transmission was higher and in situ fluorescence was lower.
- 2. Central Sound Region:** Lower salinity and density throughout the central sound. DO conditions were expected with evidence of supersaturation at surface and in shallow bays. Transmission was higher. Fluorescence was inconsistent and lower.
- 3. Whidbey Basin:** Lower temperature, salinity and density. DO conditions were expected with seasonal supersaturation at all shallow layers. Transmission was mostly expected with occasional higher values. Fluorescence was largely expected.
- 4. Hood Canal:** Lower salinity and density. DO conditions were expected with seasonal supersaturation everywhere. Transmission was high but in situ fluorescence was variable and inconsistent.
- 5. South Sound:** Ubiquitously lower temperatures, salinity and density. DO conditions were higher with seasonal supersaturation.

**SUMMARY COASTAL BAYS REGIONS** – Lower salinity and density occurred in both coastal Bays. DO conditions and transmission were expected and in situ fluorescence was lower.

- 1. Grays Harbor:** Lower salinity and density but higher DO concentrations. Seasonal supersaturation absent. In situ fluorescence was lower.
- 2. Willapa Bay: Water:** Lower salinity and density and expected DO conditions. Seasonal supersaturation limited to river sites. Fluorescence was low.





Year 2011

Month

Jan

Feb

Mar

Apr

May

Jun

Jul

Aug

Sep

Oct

Nov

Dec

[Read more here](#)

Boundary Conditions

**Meteorological conditions:** After a few days of warmer boundary conditions, we reverted to cooler than normal (and cloudy) conditions. Rainfall was below average in South Sound and north of Everett, and above normal at the end of July on the Coast and in Central Sound.

**SUMMARY GREATER PUGET SOUND REGION -** Colder, fresher and less dense conditions implying that freshwater influence dominated low density. DO conditions were in the upper range of observations. Transmission was lower with the exception of Hood Canal where levels were higher.

- 1. San Juan-North Sound Region:** Not sampled due to technical issue
- 2. Central Sound Region:** Colder, fresher and less dense. Higher DO levels throughout Central Sound except at South Admiralty Inlet. Lower transmission in deeper layers of northern Central Basin.
- 3. Whidbey Basin:** Not sampled due to technical issue
- 4. Hood Canal:** Colder, fresher and less dense conditions. DO was mostly expected. Transmission was higher except in the locally lower deep layers in the north. Fluorescence was variable, falling both above and below expected ranges.
- 5. South Sound:** Colder, fresher and less dense conditions. Higher DO levels at western shallow stations and at depth in Nisqually Reach. Expected levels in eastern sites (Dana Passage, Carr) and at surface. Transmission and in situ fluorescence were mostly expected.

**SUMMARY COASTAL BAYS REGIONS –** Colder than expected with DO conditions and transmission within the expected ranges. In situ Fluorescence was lower.

- 1. Grays Harbor:** Significantly colder and with lower in situ fluorescence.
- 2. Willapa Bay: Water:** Expected physical, DO and transmission conditions. Fluorescence was lower.



[Read more here](#)

Boundary Conditions

**Meteorological conditions:** Cooler conditions persisted until later in the month. It was dryer in Central and North Sound and wet in the South Sound and the coast. With decreasing precipitation, high River flows returned to normal by the end of August. Unusual southerly winds persisted.

**SUMMARY GREATER PUGET SOUND REGION - Colder, fresher and less dense as a result of wet and cold conditions earlier this summer. DO levels were high but expected. Transmission was high and fluorescence was low suggesting low algae biomass.**

- San Juan-North Sound Region:** Colder, fresher and less dense conditions. Variable DO levels (high in the surface/shallow layer, low at depth). Transmission was outside expected values and variable. In situ fluorescence was low.
- Central Sound Region:** Colder, fresher and less dens. Transmission was high, fluorescence was low and DO was expected.
- Whidbey Basin:** Colder, fresher and less dense. Higher levels of DO, especially at depth. Transmission was high and in situ fluorescence was outside expected ranges yet variable.
- Hood Canal:** Colder, fresher and less dense. Higher DO levels in the main stem of Hood Canal. Transmission outside expected ranges yet variable. In situ fluorescence, however, was low suggesting suspended sediment.
- South Sound:** Colder, fresher and less dense. Higher levels of DO and supersaturation in Carr, Case and shallow stations. In situ fluorescence was low and transmission was expected.

**SUMMARY COASTAL BAYS REGIONS – Warmer, fresher and less dense. Low levels of DO, and no seasonal supersaturation. Both transmission and fluorescence were low as a result of high sediment levels.**

- Grays Harbor:** Expected physical and DO conditions. Transmission and in situ fluorescence was low.
- Willapa Bay: Water:** Warmer, fresher and less dense. Lower levels of DO, transmission and in situ fluorescence.



Greater Puget Sound



Coastal Bays



Year 2011

Month

Jan

Feb

Mar

Apr

May

Jun

Jul

Aug

Sep

Oct

Nov

Dec

[Read more here](#)

Boundary Conditions

**Meteorological conditions:** Air temperatures were higher and cooler at the Coast. Sunny earlier in the month with river flows trending low (except those in Central Sound). Winds from the north during the first half of the month and from the south during the second half of the month.

### **SUMMARY GREATER PUGET SOUND REGION - Low salinity, density and temperatures confined to Central and Whidbey Basin. Transmission was expected and in situ fluorescence was low.**

- 1. San Juan-North Sound Region:** Expected temperatures, but low salinity and density. Variable DO levels, but transmission reached new maximum values. Fluorescence, however, was low.
- 2. Central Sound Region:** Lower temperatures, salinity and density. Expected DO levels. High transmission and variable in situ fluorescence that had a tendency to be low.
- 3. Whidbey Basin:** Lower temperatures, salinity and density towards the south of Whidbey Basin. DO levels were higher in deep waters. Transmission was expected while in situ fluorescence was outside of expected ranges yet variable.
- 4. Hood Canal:** Highly variable temperatures and lower salinity and density. Variable DO levels - higher at depth in the southern canal, lower at depth in the main canal. In situ fluorescence low.
- 5. South Sound:** Low salinity and density and variable in situ fluorescence outside expected ranges.

### **SUMMARY COASTAL BAYS REGIONS – New extremes in physical conditions likely driven by ocean source water. Transmission was outside expected ranges yet variable; in situ fluorescence was low.**

- 1. Grays Harbor:** Higher salinity and density and very low DO levels (upwelled ocean water). In situ fluorescence low.
- 2. Willapa Bay: Water:** Variable temperature and transmission falling outside expected ranges. In situ fluorescence was low.



  
[Read more here](#)[Boundary Conditions](#)

**Meteorological conditions:** Geographically variable conditions in October. Increasingly cooler and wetter in the north, while South Sound enjoyed benign conditions. River flows increased above normal in the middle of October.

**SUMMARY GREATER PUGET SOUND REGION** - Generally lower salinity and density, with the exception of Whidbey Basin. Lower temperatures confined to Central Sound and Hood Canal, including Whidbey Basin. Generally expected DO concentrations, yet elevated at depth in Whidbey, N. Hood Canal and Georgia Strait while lower in Commencement Bay, Carr & Case Inlets & Oakland Bay. Fluorescence was low, yet transmission was expected.

- 1. San Juan-North Sound Region:** Largely expected physical and optical conditions. DO was only higher in Georgia Strait at depth. In situ fluorescence was low.
- 2. Central Sound Region:** Lower temperatures, salinity and density. Largely expected DO conditions with concentrations confined to Commencement Bay at depth and near the surface. Fluorescence differed from expected values but was highly variable.
- 3. Whidbey Basin:** Lower temperatures but expected salinity, density and DO. Higher DO concentrations confined to greater depths. Other variables were expected.
- 4. Hood Canal:** Lower temperatures, salinity and density, but largely expected DO concentrations and transmissivity. In situ fluorescence differed from expected values but was spatially variable.
- 5. South Sound:** Lower salinity and density. Unexpected low DO concentrations confined to Carr and Case Inlets and Oakland Bay. In situ fluorescence was low.

**SUMMARY COASTAL BAYS REGIONS** – Expected conditions for most variables. Only in situ fluorescence was low.

- 1. Grays Harbor: Expected conditions.** In situ fluorescence lower than expected.
- 2. Willapa Bay: Water:** In situ fluorescence lower than expected.

1

2

3

4

5

Greater Puget Sound

1

2

Coastal Bays

[Read more here](#)

Boundary Conditions

**Meteorological conditions:** The first 20 days were drier with low river flows throughout Western Washington followed by wetter conditions. Olympia and the Coast were sunnier than areas to the north. Air temperatures alternated weekly between warm and cold.

**SUMMARY GREATER PUGET SOUND REGION** - Lower temperatures in the north and variable in the south which showed warmer temperatures in the bays. Persistent lower salinity and density in most regions. Elevated DO levels in Hood Canal and select South Sound sites. Untypically variable in situ fluorescence, yet other optical conditions were expected.

1. **San Juan-North Sound Region:** Lower temperature and lower salinity. Otherwise expected conditions.
2. **Central Sound Region:** Lower salinity and density and higher than expected water transmissivity.
3. **Whidbey Basin:** n.a.
4. **Hood Canal:** Lower temperature, salinity and density. Unexpected stronger vertical DO gradients and variable in situ fluorescence.
5. **South Sound:** Variable temperatures (colder in Carr Inlet and Nisqually; warmer in shallow bays). Lower salinity and density. Otherwise expected conditions.

**SUMMARY COASTAL BAYS REGIONS** – Expected physical conditions yet water transmissivity was high and in situ fluorescence was lower than expected.

1. **Grays Harbor:** Expected physical conditions with higher water transmissivity and lower in situ fluorescence.
2. **Willapa Bay:** Unexpected but highly variable density and salinity. Higher transmissivity and lower in situ fluorescence.



[Read more here](#)

Boundary Conditions

**Meteorological conditions:** Air temperatures were colder followed by a warmer period during the second half of the month. Solar radiation was generally low, with sporadic sunny days. Precipitation was low except in Central Sound. Rivers were running low until the end of the month when the wind picked up.

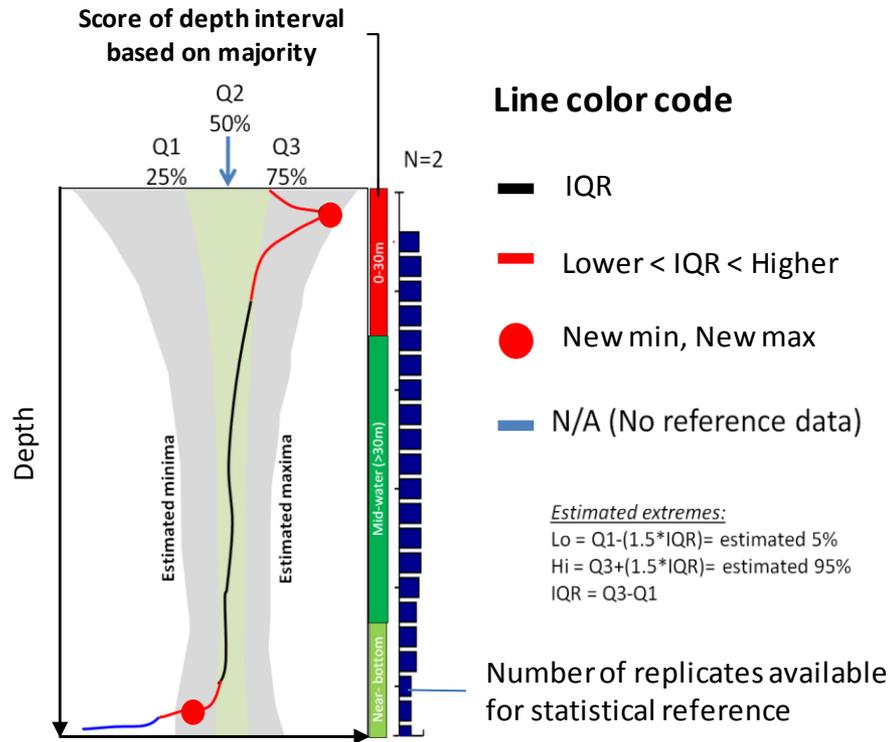
**SUMMARY GREATER PUGET SOUND REGION** - Generally lower temperatures with the exception of South Sound. Low salinity and density limited to Central Sound. Water transmissivity was high. Other variable ranges were expected.

- San Juan-North Sound Region:** Lower temperatures and higher water transmissivity measured at a limited number of stations that were collected.
- Central Sound Region:** Higher DO concentrations restricted to northern stations. Transmissivity was higher than expected.
- Whidbey Basin:** Lower temperatures, variable DO levels near the surface. Water transmissivity was generally elevated and in situ fluorescence fell outside expected ranges but was locally variable.
- Hood Canal:** Statement limited to one station: Stronger vertical gradients in temperature salinity and density at HCB010. Water transmissivity was variable falling outside expected ranges.
- South Sound:** Largely expected conditions. Lower DO levels restricted to Dana Passage through Nisqually Reach and Carr Inlet. Water transmissivity was high.

**SUMMARY COASTAL BAYS REGIONS** – Ubiquitously lower temperatures. Higher salinity and density limited to Willapa Bay. In situ fluorescence was outside expected ranges but geographically variable. Transmissivity was higher than expected.

- Grays Harbor:** Lower temperatures and lower DO concentrations restricted to mid-bay. Water transmissivity was variable.
- Willapa Bay: Water:** Lower temperatures, higher salinity and density. Transmissivity was high and in situ fluorescence lower than expected





A wealth of historical data allows us to place new CTD observations into the historical context of Ecology's long-term data record.

We use an increasing temporal reference framework of 1999-present to statistically define anomalies. Conditions that fall outside of a 50% observation envelope (second and third quartile) are considered "**anomalies**".

Graphically you can explore current anomalies in our monthly data updates.

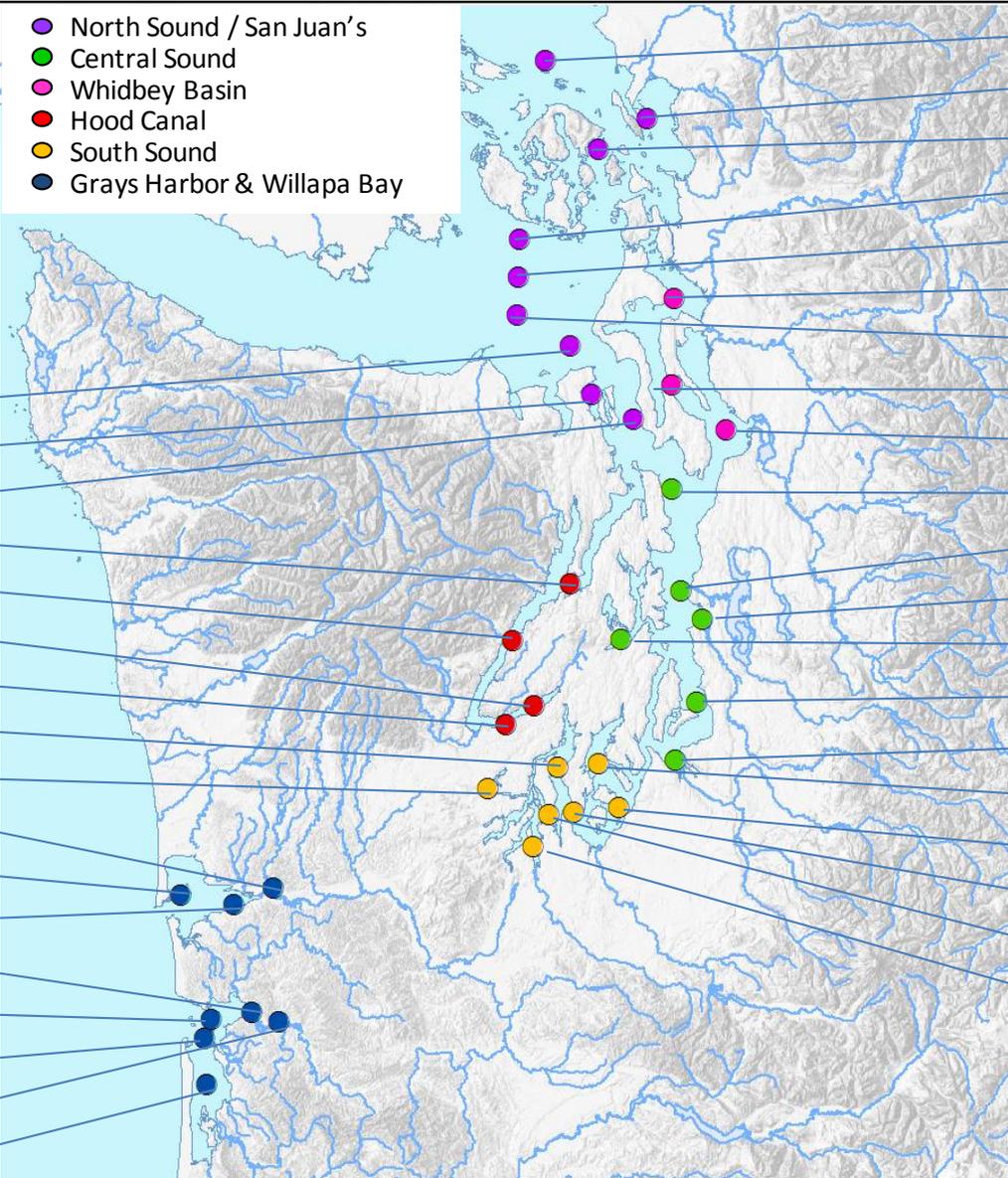
[Begin exploring anomalies, click here](#)

## How to read our graphics:

A **green background** describes the range into which 50% of our historical recorded data fall. Grey shows the 99% data envelope that we estimate from the interquartile range multiplied by 1.5. Pieces of the data line falling within the 50% envelope are colored **black**, data falling outside the 50% envelope are colored **red**. New extrema are emphasized with a red dot. If we sample a depth deeper than previously sampled we give the data line the color **blue**. Bars (dark blue) on the right indicate the number of observations (e.g. N=2). To illustrate if the entire water column section (<10m, 10-30m, >30m) is on average a "normal" or "**anomalous**" condition, we included a color coded vertical line. **Red** indicates on **average anomalous conditions**; **green** indicates on **average normal conditions**.



- North Sound / San Juan's
- Central Sound
- Whidbey Basin
- Hood Canal
- South Sound
- Grays Harbor & Willapa Bay

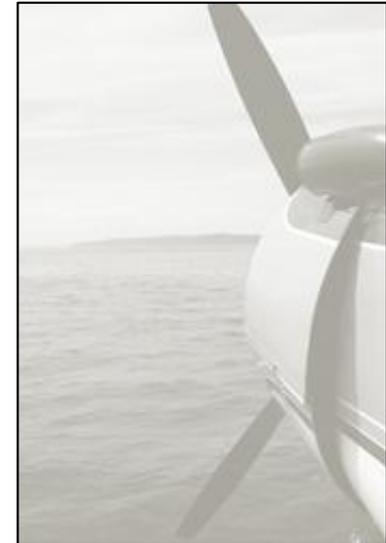


Stations:

- ADM002
- PTH005
- ADM001
- HCB010
- HCB003
- HCB007
- HCB004
- CSE001
- OAK004
- GYS004
- GYS016
- GYS008
- WPA003
- WPA004
- WPA113
- WPA001
- WPA006

- GRG002
- BLL009
- RSR837
- SJF000
- SJF001
- SKG003
- SJF002
- SAR003
- PSS019
- ADM003
- PSB003
- ELB015
- SIN001
- EAP001
- CMB003
- CRR001
- GOR001
- NSQ002
- DNA001
- BUD005

For detailed station information [click here](#)



We use a float plane as a cost-effective means to collect marine samples throughout Washington's extensive marine waters.