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Conditions in the Water Column - (Marine Flights)

2016

2016 - Monthly

Conditions in Puget Sound and coastal bays

2014 - Summary

Previous years in summary

Anomaly Details

Monthly observations in historic context

Our Stations

Our stations in Puget Sound and coastal bays

2016 - Monthly		2014 - Summary				Anomaly Details				Our Stations				
Year 2016	Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	

Glossary:

Transmission – Beam transmission measuring how clear the water is

DO – Dissolved oxygen in the water

***In situ* fluorescence** – Concentration of photo pigments to estimate phytoplankton abundance

Higher – Higher values than a reference baseline over many years that is specific to the month and region in question

Lower – Lower values than a reference baseline over many years that is specific to the month and region in question

PDO – Pacific Decadal Oscillation

NPGO – North Pacific Gyre Oscillation


Read more here

Boundary Conditions

Boundary conditions:

Initially cold and dry and light winds from the north. Lower river flows, and a strong temperature inversion. The last several weeks were warm and wet with southerly winds. River flows higher than normal particularly to the south. Above normal precipitation.

SUMMARY GREATER PUGET SOUND REGION – Warmer and less dense. Lower salinity near large rivers. Transmission variable – lower in the North, higher in Hood Canal.

1

1. **San Juan-North Sound Region:** Warmer with lower transmissivity (water clarity).

2. **Central Sound Region:** Warmer, lower salinity, and less dense. Lower DO confined to northern and central portions of Central Sound.

3

3. **Whidbey Basin:** Warmer, lower salinity, and less dense.

4

4. **Hood Canal:** Warmer. Higher DO, *in situ* fluorescence at surface layer. Overall higher transmissivity (higher water clarity).

5

5. **South Sound:** Warmer, lower density. Lower salinity confined to northern reaches of South Sound. Higher *in situ* fluorescence.

Greater Puget Sound

SUMMARY COASTAL BAYS REGIONS – Expected.

1

1. **Grays Harbor:** Higher transmissivity (higher water clarity).

2

2. **Willapa Bay:** Expected.

Coastal Bays

Glossary (explain abbreviations and terms)

[Read more here](#)

Boundary Conditions

Boundary conditions: It was warmer and wet, with higher river flows and southerly wind. There was a notable break in the rain from the 6th through the 9th. This resulted in record maximum daily temperatures on the 9th.

SUMMARY GREATER PUGET SOUND REGION – Warmer, lower density. Lower salinity, except in Hood Canal where salinity was expected. Very low transmissivity confined to the northern reaches.

- 1. San Juan-North Sound Region:** Warmer and lower density. Lower salinity confined to southern reaches.
- 2. Central Sound Region:** Warmer, lower salinity and density. *In situ* fluorescence much higher.
- 3. Whidbey Basin:** Warmer, lower density. Transmissivity lower (lower water clarity).
- 4. Hood Canal:** Warmer, lower salinity, and density. Higher DO confined to water surface in the north whereas lower DO confined to water surface in the south. *In situ* fluorescence was higher.
- 5. South Sound:** Warmer and lower density. Lower salinity confined to the surface.

SUMMARY COASTAL BAYS REGIONS – Warmer with very low transmissivity (very low water clarity).

- 1. Grays Harbor:** Warmer.
- 2. Willapa Bay:** Warmer with lower salinity and density. Higher DO confined to water surface in the north whereas lower DO confined to water surface in the south. Very low transmissivity (low water clarity).

Glossary (explain abbreviations and terms)



[Read more here](#)

Boundary Conditions

Boundary conditions:

Air temperatures, precipitation, and river flow were above normal. Two sunny periods happened from March 15-19 and March 28-30. Ocean boundaries: Stronger downwelling and the SST temperature anomalies increasing again with PDO exceeding historical ranges.

SUMMARY GREATER PUGET SOUND REGION – Much warmer, fresher and less dense, in particular to the north. Higher in situ fluorescence particularly in extended area between Central and South Sound. Transmission highly variable particularly in Hood Canal and Central Sound.

- 1. San Juan-North Sound Region:** Much warmer with very unusual low salinity and density. Low transmission especially at depth.
- 2. Central Sound Region:** Warmer, lower salinity and density. *In situ* fluorescence was higher. Transmission was lower with areas of very low transmission at depth towards the north.
- 3. Whidbey Basin:** Warmer, lower salinity and density. Higher *in situ* fluorescence is higher.
- 4. Hood Canal:** Much warmer with lower salinity and density. Lower DO in northern and higher DO in southern Hood Canal. Transmission was unusual but variable. Higher in situ fluorescence confined to the south.
- 5. South Sound:** Warmer, lower salinity and density with lower DO, especially in western inlets. Higher in situ fluorescence in the north and Oakland Bay.

SUMMARY COASTAL BAYS REGIONS – Warmer, lower salinity and density with untypical but variable DO levels.

- 1. Grays Harbor:** Warmer, lower salinity and density with lower DO.
- 2. Willapa Bay:** Warmer, lower salinity and density. Unexpected but variable DO.

Coastal Bays

[Glossary \(explain abbreviations and terms\)](#)

[Read more here](#)

Boundary Conditions

Boundary conditions: April temperatures were above normal and ranked as one of the warmest Aprils on record, with extremely warm temperatures noted April 7-9 and April 17-20. Precipitation was below normal, but rivers fed by snowmelt ran high, mostly to the north.

SUMMARY GREATER PUGET SOUND REGION – Much warmer and very low salinity resulting in low density. Lower DO confined to HC & San Juan's. Higher transmission confined to Hood Canal and Central Sound.

- San Juan-North Sound Region:** Much warmer with lower density and salinity confined southward of Admiralty Reach, Lower DO in San Juan's and higher Do near surface in North Sound.
- Central Sound Region:** Much warmer water, much fresher and as a result of much lower density. Transmission was much higher implying clearer water.
- Whidbey Basin:** Much warmer, lower density. Lower DO confined to near rives. Transmission regionally higher.
- Hood Canal:** Much warmer, much fresher and much lower density. Lower DO, lower in situ fluorescence and lower transmissivity.
- South Sound:** Warmer, much fresher and much lower density. In situ fluorescence higher.

SUMMARY COASTAL BAYS REGIONS – Warmer, and higher *in situ* fluorescence

- Grays Harbor:** Warmer, *in situ* fluorescence higher.
- Willapa Bay:** Expected DO with unusual variable in situ fluorescence.



[Read more here](#)

Boundary Conditions

Boundary conditions: May temperatures were above, while precipitation was below normal. Warmer May air temperatures resulted in rapid melting of our mountain snowpack. However, by mid-month, all river flows fell below normal, even the Fraser after the snowpack was prematurely depleted.

SUMMARY GREATER PUGET SOUND REGION – Much warmer, fresher and very low density. Lower DO at depth except in Central Sound. Blooms at the surface causing oxygen super-saturation. Higher Transmission in Hood Canal, Central and South Sound. In situ fluorescence, was lower with higher regions confined to Central Sound.

- San Juan-North Sound Region:** Much warmer, fresher and as a result very low density. Lower DO but higher *in situ* fluorescence. Transmission variable.
- Central Sound Region:** Much warmer, fresher and as a result very low density. Locally higher DO and *in situ* fluorescence in surface waters related to blooms. Transmission was higher throughout the water column.
- Whidbey Basin:** Much warmer, fresher, lower density, and lower DO. *In situ* fluorescence regionally more variable than usual.
- Hood Canal:** Much warmer, fresher and as a result very low density. DO vertical profiles more pronounced (higher at surface lower at depth). Transmission was higher.
- South Sound:** Much warmer, fresher, low density. Lower DO and lower *in situ* fluorescence. Transmission higher fluorescence.

SUMMARY COASTAL BAYS REGIONS – Higher salinity and density, and lower DO and lower *in situ* fluorescence.

- Grays Harbor:** n.a.
- Willapa Bay:** Higher salinity and density, but lower DO and *in situ* fluorescence.



[Read more here](#)

Boundary Conditions

Boundary conditions: Air temperatures remain above normal, though less extreme. Precipitation levels are normalizing but sunshine is above and river flows are still below normal, particularly to the north. At the coast, upwelling is normal and ENSO & PDO are still above normal but beginning to return to expected ranges.

SUMMARY GREATER PUGET SOUND REGION – Much warmer less salty and much lower density. Higher in situ fluorescence, lower transmissivity confined to Hood Canal.

- 1. San Juan-North Sound Region:** n.a.
- 2. Central Sound Region:** Lower density and salinity and much warmer. *In situ* fluorescence is higher.
- 3. Whidbey Basin:** n.a.
- 4. Hood Canal:** Lower density and salinity and much warmer particularly at depth! Lower DO and *in situ* fluorescence.
- 5. South Sound:** Much less dense, lower salinity and much warmer, High *in situ* fluorescence.

Greater Puget Sound

SUMMARY COASTAL BAYS REGIONS – Saltier, denser water and lower DO. Transmission was significantly higher (water was clear).

- 1. Grays Harbor:** n.a.
- 2. Willapa Bay:** Denser and saltier with lower DO and higher transmissivity.

Coastal Bays

[Read more here](#)

Boundary Conditions

Boundary conditions:

Air temperatures in the Puget Sound lowlands were near normal - slightly cooler during the first half of the month. Precipitation was variable and river flows low particularly to the north. Cloud cover was higher than normal, especially in the first half of the month.

SUMMARY GREATER PUGET SOUND REGION – Warmer with lower dissolved oxygen confined towards the southern portions.

1. **San Juan-North Sound Region:** Regionally variable DO otherwise expected.
2. **Central Sound Region:** Warmer at depth.
3. **Whidbey Basin:** Warmer at depth with unexpected but regionally variable density. Lower Transmissivity (less clear water) and higher *in situ* fluorescence.
4. **Hood Canal:** Warmer at depth with unexpected but variable density. Lower DO and Transmission particularly in the north potentially related to large coccolithophore bloom. *In situ* fluorescence also unexpected and regionally variable.
5. **South Sound:** Warmer water with much lower dissolved oxygen.

SUMMARY COASTAL BAYS REGIONS – Warmer with unexpected but variable transmissivity (clarity) of the water.

1. **Grays Harbor:** Warmer water and lower transmissivity (less clear water).
2. **Willapa Bay:** Warmer water.



[Read more here](#)

Boundary Conditions

Boundary conditions:

Fraser River still running low, blob makes a reappearance, and La Nina neutralizes. August air temperatures were slightly above normal, after a near-normal start, and precipitation was drier than normal. Rivers were lower except for the snowmelt-fed Nisqually.

SUMMARY GREATER PUGET SOUND REGION – Warmer temperature, higher salinity confined to South Sound.

- 1. San Juan-North Sound Region:** Higher water temperature and turbidity (clearer water).
- 2. Central Sound Region:** Warmer water temperature and lower DO near surface.
- 3. Whidbey Basin:** Higher temperature and lower DO at depth, Salinity overall higher.
- 4. Hood Canal:** Warmer at depth, lower DO near surface. In situ fluorescence unexpected and variable.
- 5. South Sound:** Warm and higher salinity. DO and in situ fluorescence lower.

SUMMARY COASTAL BAYS REGIONS – Salinity higher than normal. Lower DO only in Grays Harbor.

- 1. Grays Harbor:** Salinity and density higher, DO lower.
- 2. Willapa Bay:** Salinity and density higher, *in situ* fluorescence lower.



2016 - Monthly

2014 - Summary

Anomaly Details

Our Stations



Year 2016

Month

Jan

Feb

Mar

Apr

May

Jun

Jul

Aug

Sep

Oct

Nov

Dec

2016 - Monthly

2014 - Summary

Anomaly Details

Our Stations



Year 2016

Month

Jan

Feb

Mar

Apr

May

Jun

Jul

Aug

Sep

Oct

Nov

Dec

2016 - Monthly

2014 - Summary

Anomaly Details

Our Stations



Year 2016

Month

Jan

Feb

Mar

Apr

May

Jun

Jul

Aug

Sep

Oct

Nov

Dec

2016 - Monthly

2014 - Summary

Anomaly Details

Our Stations



Year 2016

Month

Jan

Feb

Mar

Apr

May

Jun

Jul

Aug

Sep

Oct

Nov

Dec



Overview Puget Sound

Overview Coastal Bays

Central Sound

North Sound-San Juan

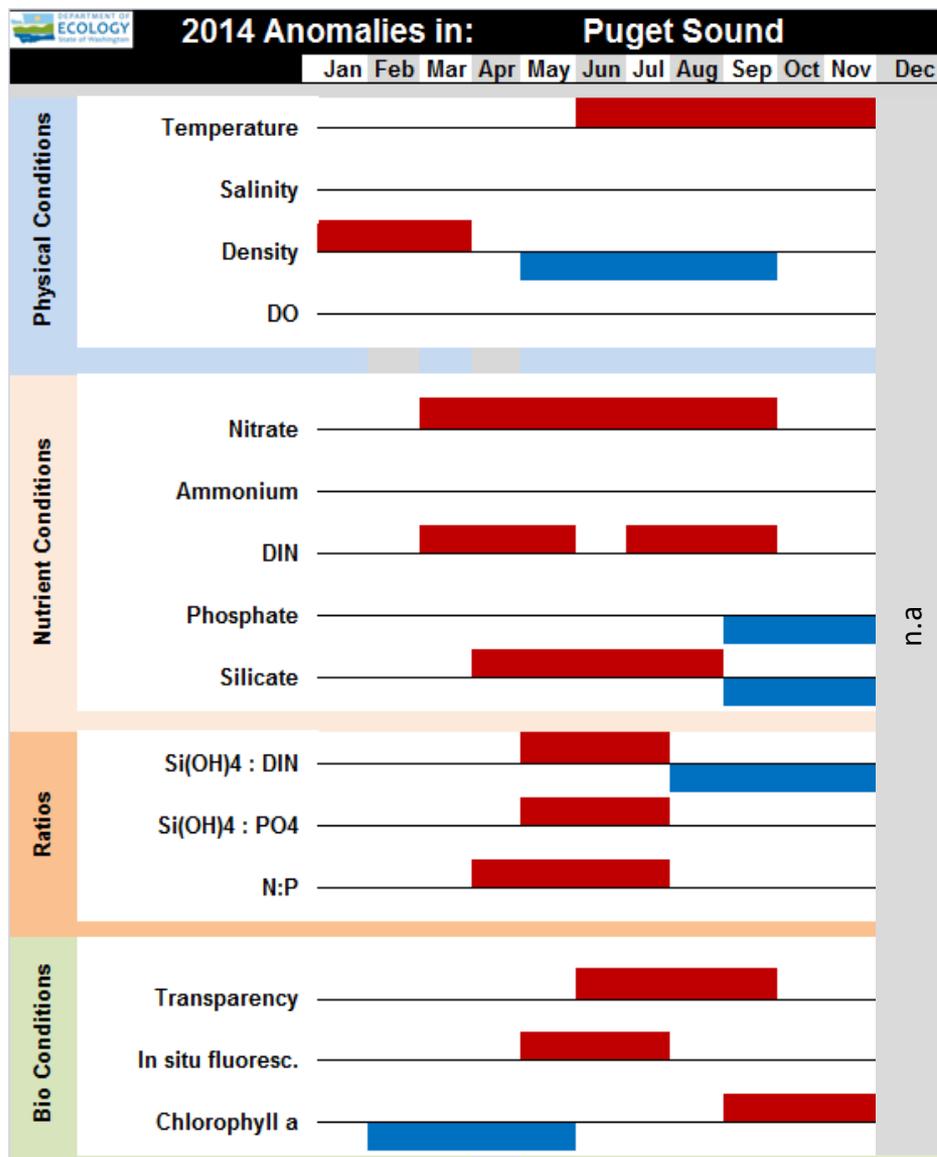
Hood Canal

Whidbey Basin

South Sound

Grays Harbor

Willapa Bay



Overview: Puget Sound



Higher water density in winter shifted to lower density coinciding with higher water temperatures in summer and fall. Nitrogen and silicate were initially higher; silicate and phosphate decreased toward the fall. Higher nutrients during the productive season also positively affected nutrient ratios. Water was clearer and *in situ* fluorescence was higher during summer.

Figure legend

Anomalies persisting for 3 months can be assumed to be real patterns above the noise level. Graphic showing the relationship of positive (red) and negative (blue) anomalies between 15 variables persisting for 3 or more months. No color shows expected conditions.



Overview Puget Sound

Overview Coastal Bays

Central Sound

North Sound-San Juan

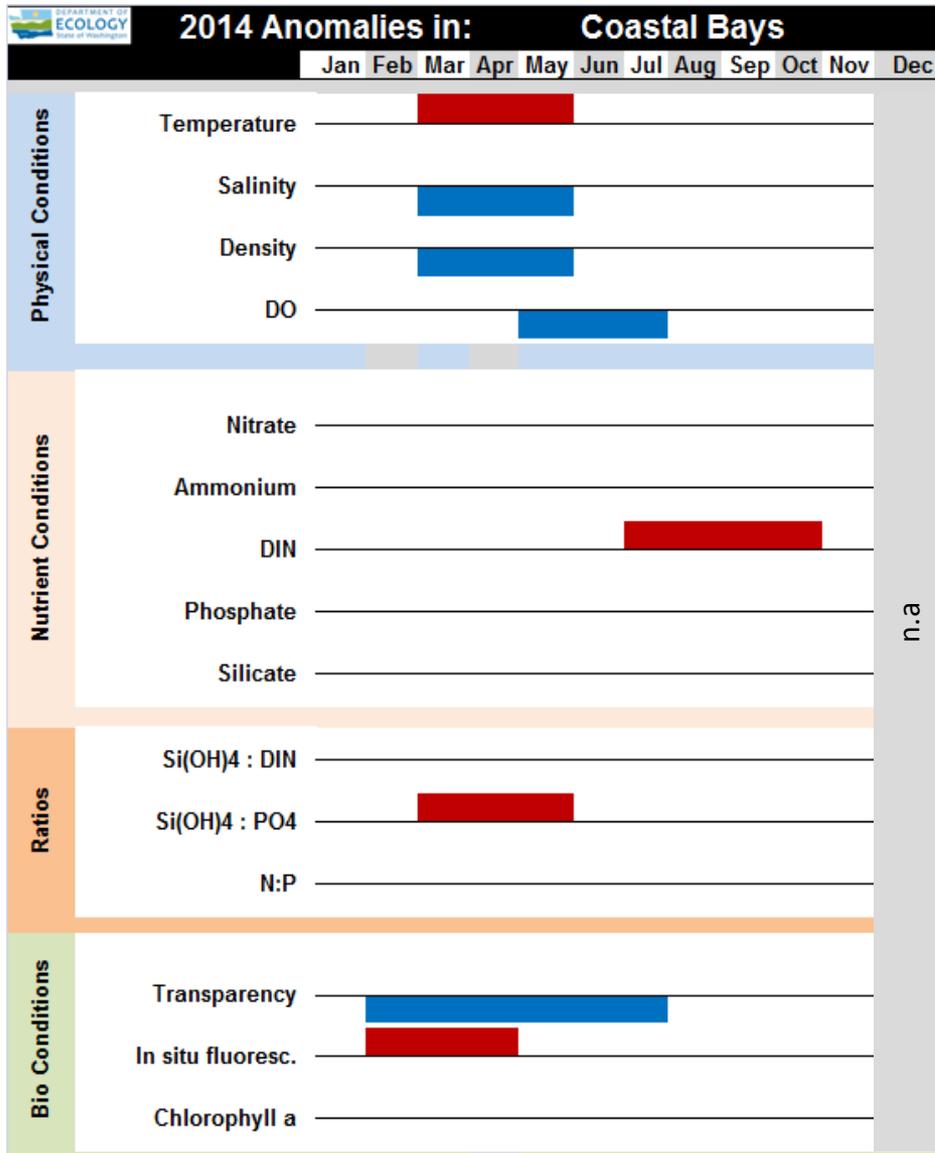
Hood Canal

Whidbey Basin

South Sound

Grays Harbor

Willapa Bay



Overview: Coastal Bays



Higher water temperatures, lower salinity, and lower density occurred in spring and overlapped with a period of lower dissolved oxygen in early summer. During spring *in situ* fluorescence and Si:PO₄ ratios were also higher while water clarity was lower.

Figure legend

Anomalies persisting for 3 months can be assumed to be real patterns above the noise level. Graphic showing the relationship of positive (**red**) and negative (**blue**) anomalies between 15 variables persisting for 3 or more months. No color shows expected conditions.



Overview Puget Sound

Overview Coastal Bays

Central Sound

North Sound-San Juan

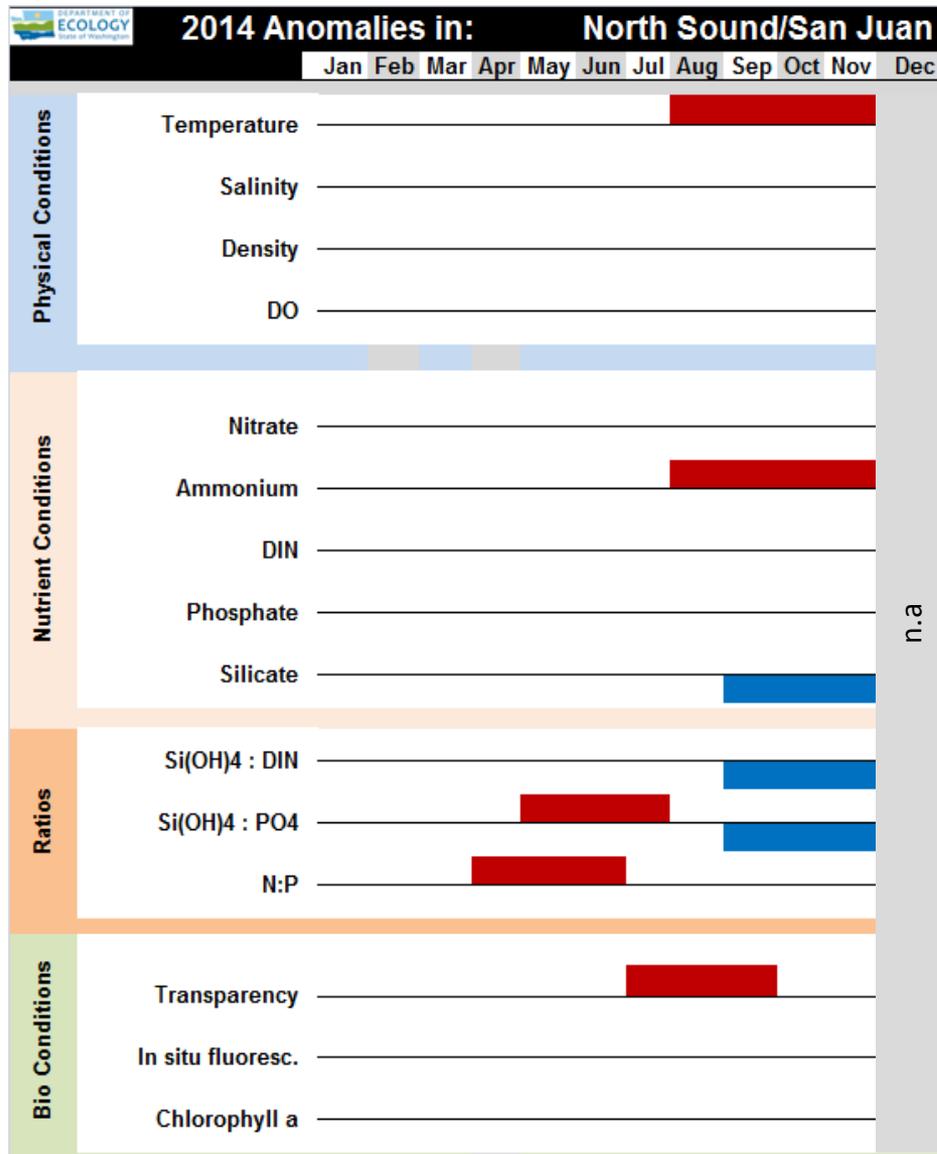
Hood Canal

Whidbey Basin

South Sound

Grays Harbor

Willapa Bay



Region: North Sound San Juan



Temperature, water clarity (transparency), and ammonium increased in late summer when the Blob entered the Strait of Juan de Fuca. In fall, silicate also became lower and affect silicate ratios.

Figure legend

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Overview Puget Sound

Overview Coastal Bays

Central Sound

North Sound-San Juan

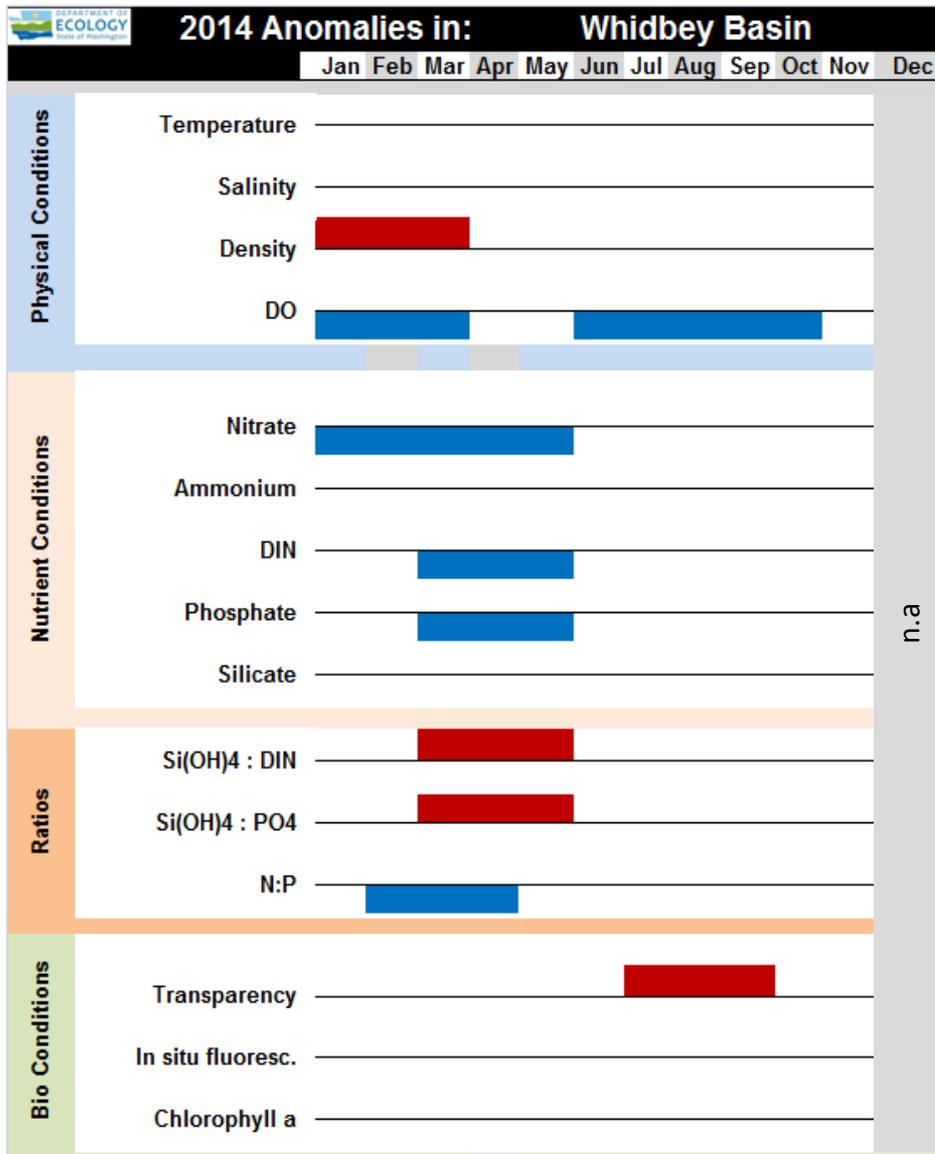
Hood Canal

Whidbey Basin

South Sound

Grays Harbor

Willapa Bay



Region: Whidbey Basin



Whidbey Basin water was denser in winter. Dissolved oxygen was lower for most of the year. All nutrients except for ammonium and silicate were lower in spring affecting nutrient ratios. Water clarity (transparency) was higher in late summer.

Figure legend

Anomalies persisting for 3 months can be assumed to be real patterns above the noise level. Graphic showing the relationship of positive (red) and negative (blue) anomalies between 15 variables persisting for 3 or more months. No color shows expected conditions.



Overview Puget Sound

Overview Coastal Bays

Central Sound

North Sound-San Juan

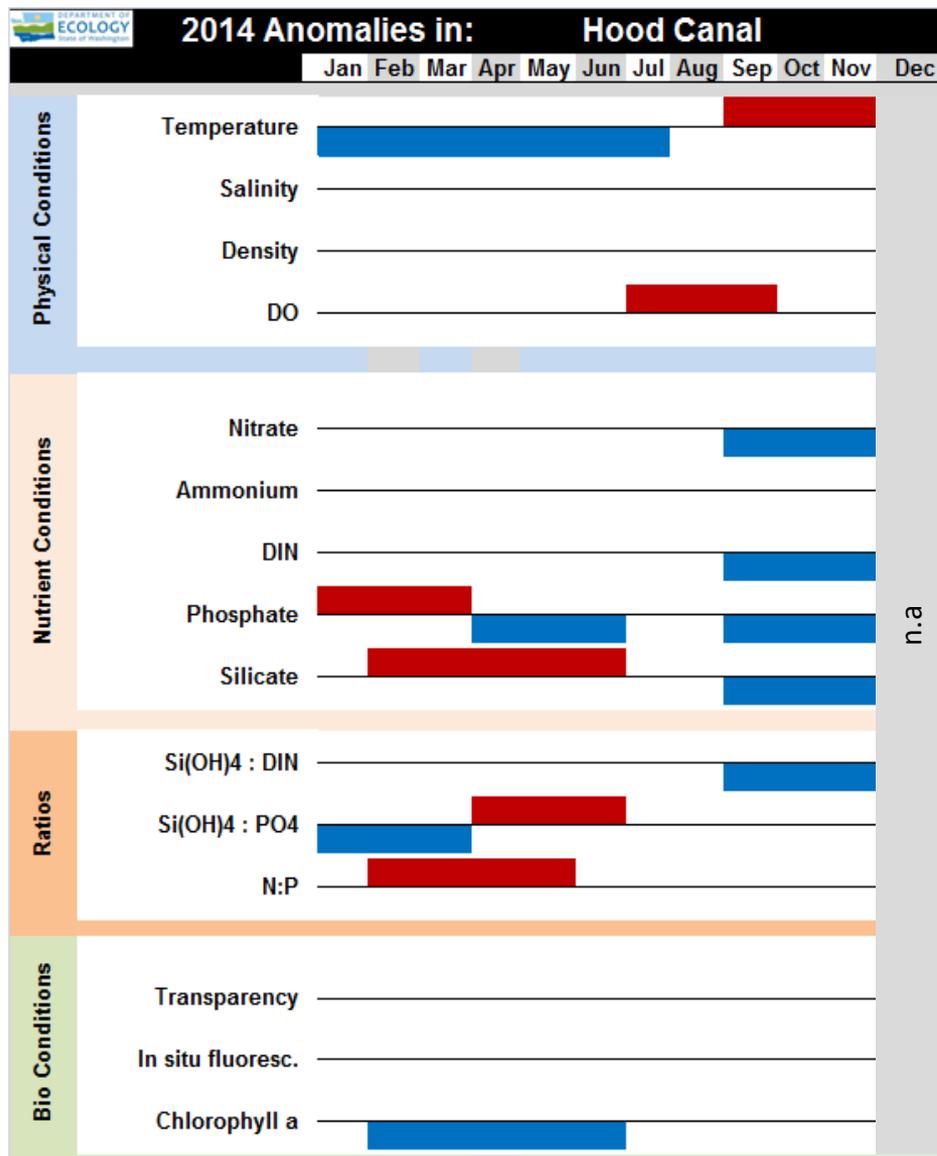
Hood Canal

Whidbey Basin

South Sound

Grays Harbor

Willapa Bay



Region: Hood Canal



Temperature was lower the first half of the year and became higher in the fall. Dissolved oxygen was higher in late summer. Nutrient ratios were influenced by unexpected levels of phosphate and silicate in the first half of the year. In fall, nutrients were lower with the exception of ammonium. Discrete chlorophyll *a* samples were lower early in the year.

Figure legend

Anomalies persisting for 3 months can be assumed to be real patterns above the noise level. Graphic showing the relationship of positive (red) and negative (blue) anomalies between 15 variables persisting for 3 or more months. No color shows expected conditions.



Overview Puget Sound

Overview Coastal Bays

Central Sound

North Sound-San Juan

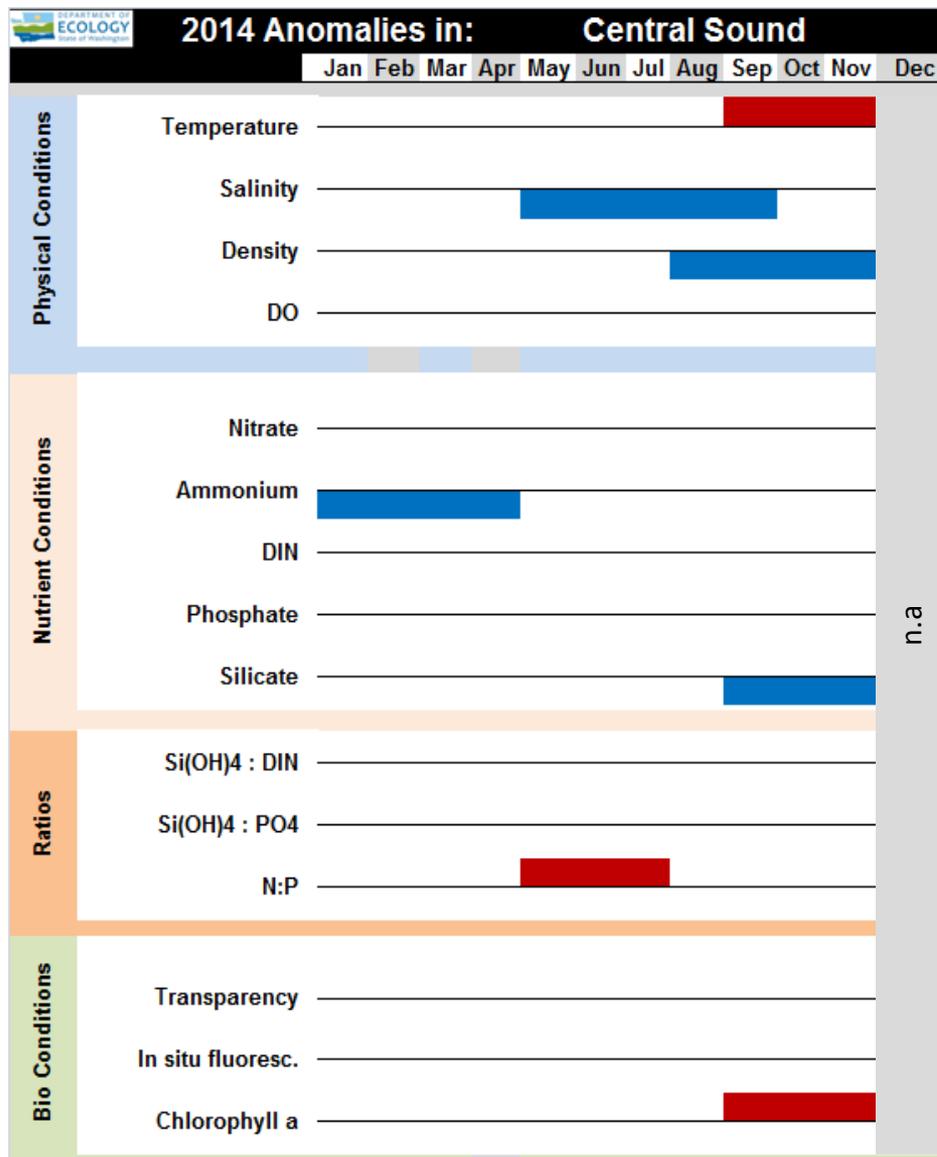
Hood Canal

Whidbey Basin

South Sound

Grays Harbor

Willapa Bay



Region: Central Sound



Temperature was higher in fall coinciding with lower density. Salinity was lower in summer. Ammonium was lower in the winter and silicate was lower in the fall. The N:P ratio was higher in early summer. Chlorophyll *a* was higher in the fall.

Figure legend

Anomalies persisting for 3 months can be assumed to be real patterns above the noise level. Graphic showing the relationship of positive (**red**) and negative (**blue**) anomalies between 15 variables persisting for 3 or more months. No color shows expected conditions.



Overview Puget Sound

Overview Coastal Bays

Central Sound

North Sound-San Juan

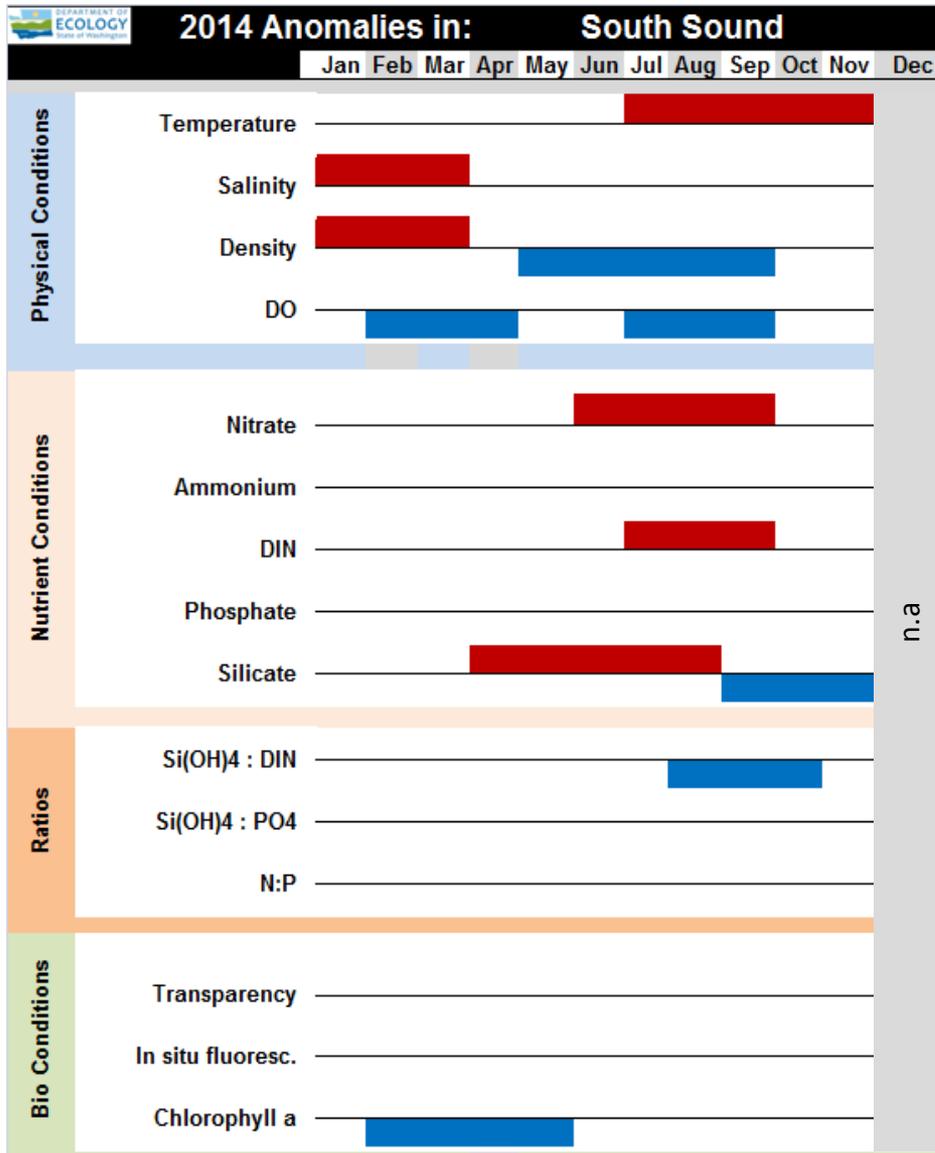
Hood Canal

Whidbey Basin

South Sound

Grays Harbor

Willapa Bay



Region: South Sound



Winter had higher salinity and density. Density shifted lower in summer coinciding with higher temperatures. Dissolved oxygen was lower most of the year. Nutrients were higher in summer with the exception of ammonium and phosphate. Discrete chlorophyll *a* samples were lower early in the year.

Figure legend

Anomalies persisting for 3 months can be assumed to be real patterns above the noise level. Graphic showing the relationship of positive (red) and negative (blue) anomalies between 15 variables persisting for 3 or more months. No color shows expected conditions.



Overview Puget Sound

Overview Coastal Bays

Central Sound

North Sound-San Juan

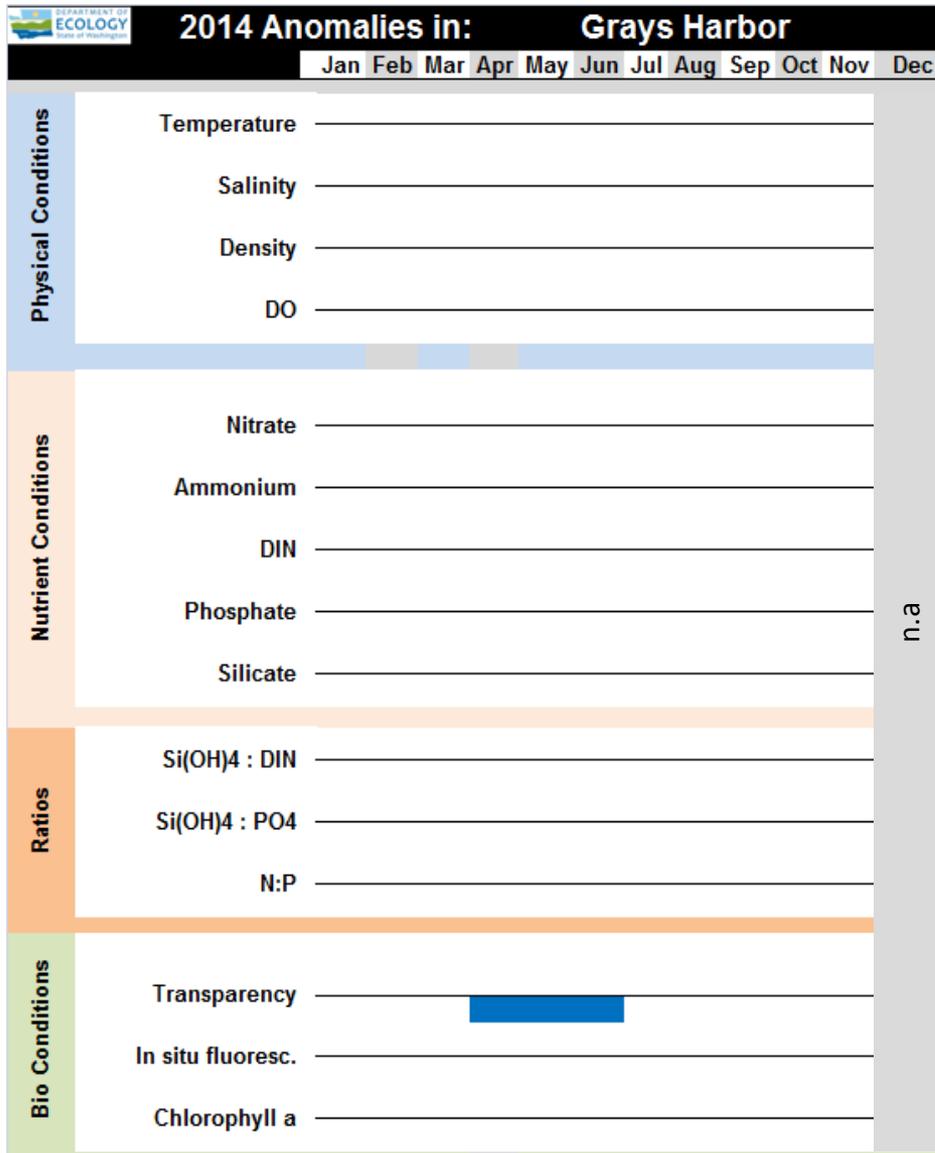
Hood Canal

Whidbey Basin

South Sound

Grays Harbor

Willapa Bay



Region: Grays Harbor



Given the limited station attainment due to the marine layer the story is incomplete.

Lower transparency in late spring matches observations in Willapa Bay.

Figure legend

Anomalies persisting for 3 months can be assumed to be real patterns above the noise level. Graphic showing the relationship of positive (**red**) and negative (**blue**) anomalies between 15 variables persisting for 3 or more months. No color shows expected conditions.



Overview Puget Sound

Overview Coastal Bays

Central Sound

North Sound-San Juan

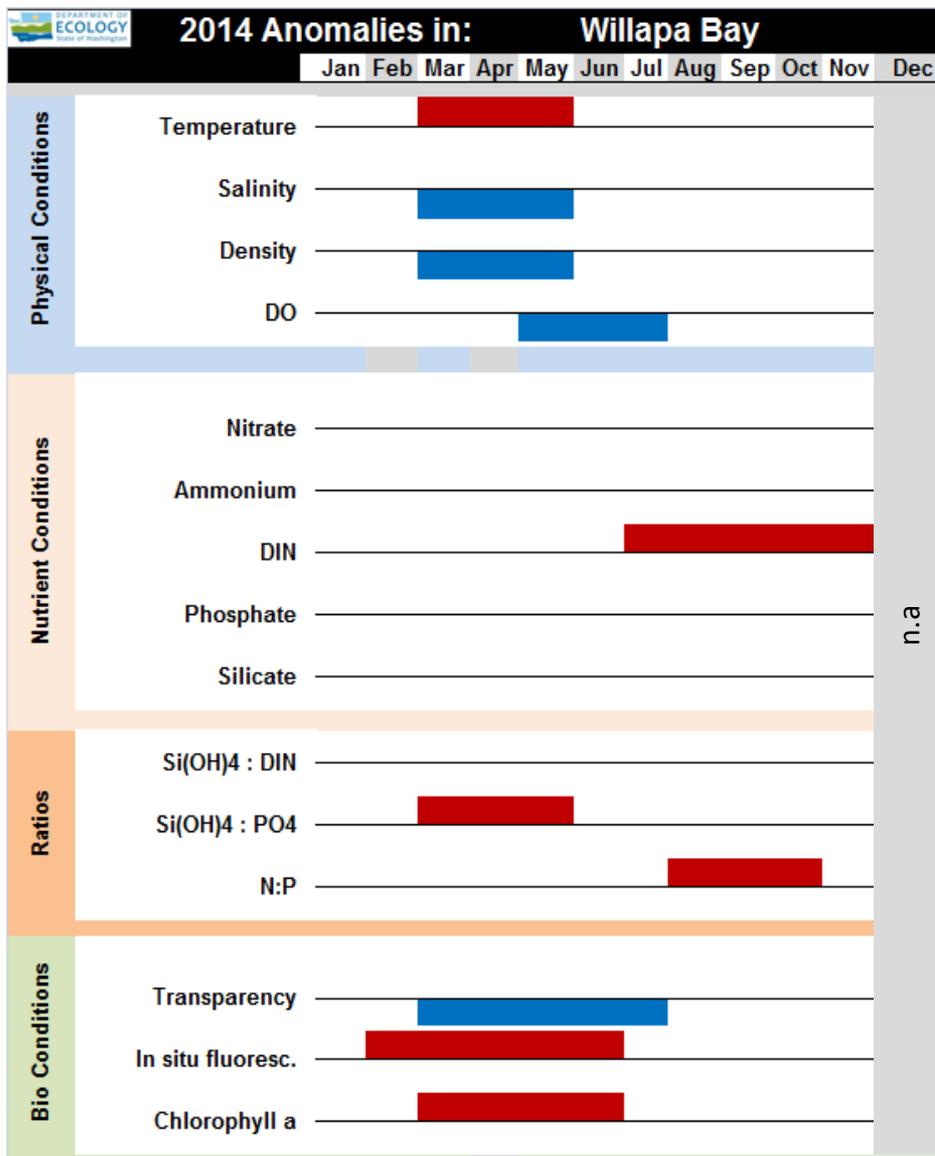
Hood Canal

Whidbey Basin

South Sound

Grays Harbor

Willapa Bay



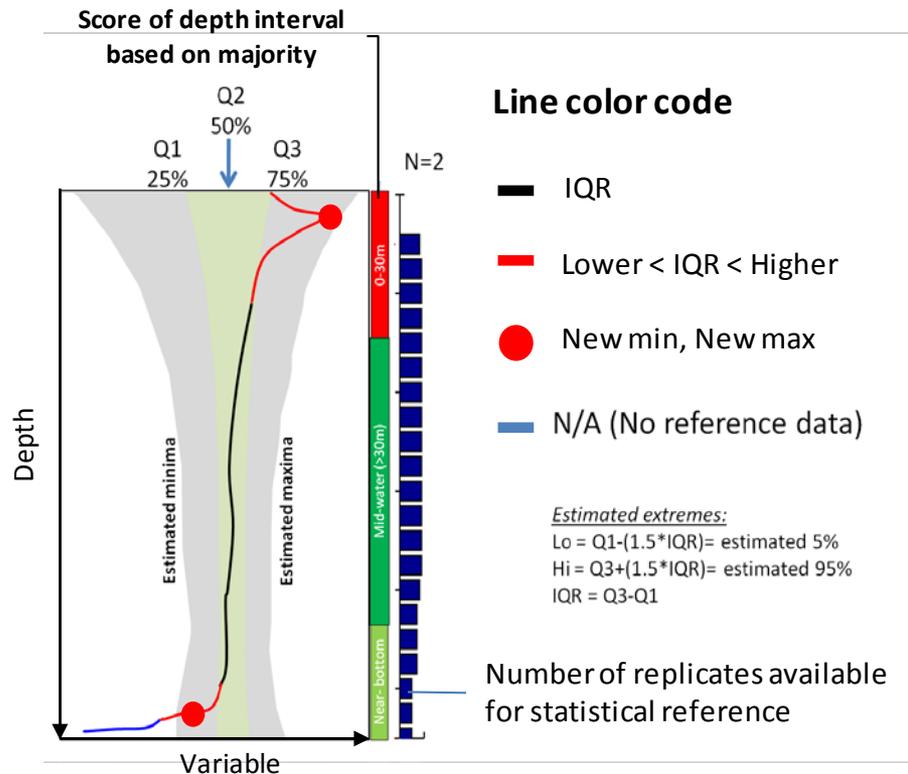
Region: Willapa Bay



In the spring temperature was higher while salinity and density were lower. This was followed by lower dissolved oxygen. The Si:PO₄ ratio, *in situ* fluorescence, and water clarity responded to physical patterns in spring. Dissolved inorganic nitrogen (DIN) and the N:P ratio were higher in fall.

Figure legend

Anomalies persisting for 3 months can be assumed to be real patterns above the noise level. Graphic showing the relationship of positive (red) and negative (blue) anomalies between 15 variables persisting for 3 or more months. No color shows expected conditions.



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.

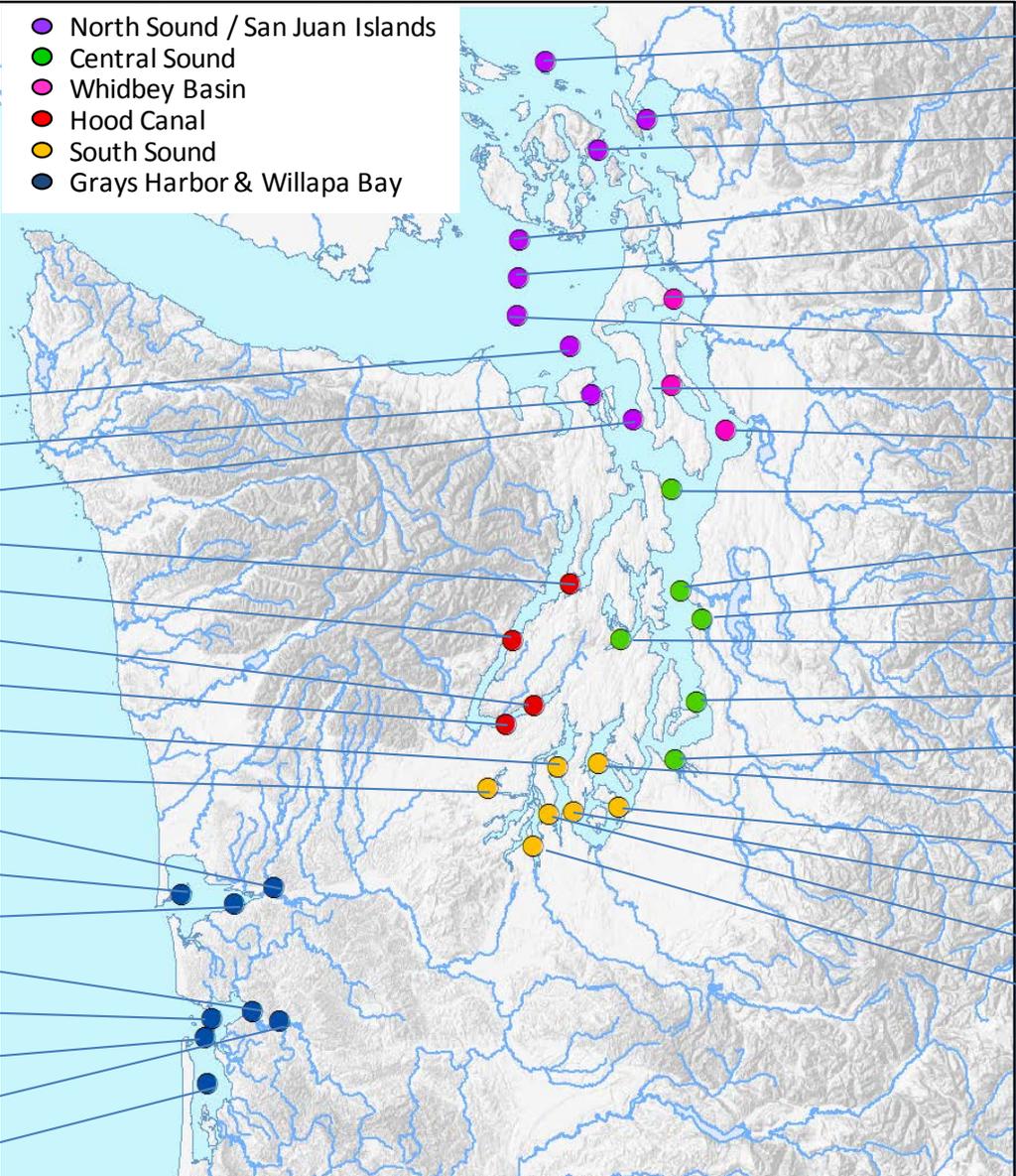
[Begin exploring anomalies, click here](#)

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 Islands
- Central Sound
- Whidbey Basin
- Hood Canal
- South Sound
- Grays Harbor & Willapa Bay

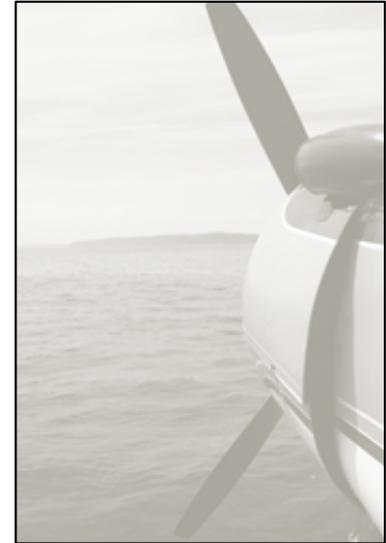


Stations:

- 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.