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DEPARTMENT OF ECOLOGY State of Washington

Conditions in the Water Column - (Marine Flights)

2014

2014 - 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*

Meteorological conditions: Mean January air temperatures were slightly warmer, and precipitation was below normal. Cloudy periods alternated with clear, cold, sunny days with lighter winds out of the north.

SUMMARY GREATER PUGET SOUND REGION - Water was saltier, denser. Colder water was confined to Central Sound and Hood Canal. DO was expected with regional lows in the San Juans Islands & Whidbey Basin and highs in shallow areas. Transmission and in situ fluorescence reached new maxima.

1. **San Juan-North Sound Region:** Saltier, denser and lower DO with new minima at several sites. Unusual wide range in low and high transmission and in situ fluorescence.
2. **Central Sound Region:** Saltier, denser and colder. Both transmission and in situ fluorescence higher than expected.
3. **Whidbey Basin:** Saltier and denser, fluorescence was higher.
4. **Hood Canal:** Colder, denser and higher DO and in situ fluorescence levels.
5. **South Sound:** Saltier and denser with both transmission and in situ fluorescence higher.

SUMMARY COASTAL BAYS REGIONS – not available

1. **Grays Harbor:** not available
2. **Willapa Bay:** not available

Meteorological conditions: Temperatures were colder with a cold spell between Feb. 5th -9th . After a dry start, precipitation was above normal. The air mass changed on the 10th bringing warmer temperatures with storms. By mid-month, south winds and rain returned and several rivers recovered.

SUMMARY GREATER PUGET SOUND REGION – Denser, saltier, and colder with high DO levels confined to deeper, southern Hood Canal & San Juan sites; lower DO confined to southern Central & southeast Puget Sound.

1. **San Juan-North Sound Region:** Denser, saltier, colder with higher DO levels at shallower stations. Transmission high values in the Strait of Georgia but low at Port Townsend.
2. **Central Sound Region:** Denser, saltier, and colder with higher DO confined to surface layers of north Central stations and lower DO at southern Central stations. Fluorescence was higher.
3. **Whidbey Basin:** Denser, saltier, colder with lower DO confined to deeper layers. Fluorescence was lower.
4. **Hood Canal:** Denser, saltier, colder. Higher DO confined to deep layers in southern Hood Canal.
5. **South Sound:** Denser, saltier, colder with lower DO levels confined to the deeper, eastern inlets.

SUMMARY COASTAL BAYS REGIONS - Colder with lower DO and transmission but higher than expected in situ fluorescence for the time of the year.

1. **Grays Harbor:** Colder
2. **Willapa Bay:** Colder, denser and lower DO and transmission. In situ fluorescence was higher.

Meteorological conditions: Temperatures, precipitation and river flows were above normal. Heavy snow closed Snoqualmie Pass and SeaTac Airport received its normal amount of March precipitation. Another soggy spell occurred in the middle of the month. A tragic landslide occurred on March 22 that devastated a small community east of Oso in Snohomish County.

SUMMARY GREATER PUGET SOUND REGION – Much denser and saltier water at depth, colder pockets confined to deep water of Central Sound and Hood Canal. Seasonal super saturation of DO in Hood Canal & Whidbey Basin. Transmission was higher, especially in the South Sound.

1. **San Juan-North Sound Region:** Low density confined to Admiralty sill. High transmission.
2. **Central Sound Region:** Colder, dense. Fresher at surface, colder and saltier at depth. Transmission was higher.
3. **Whidbey Basin:** Denser water at depth in the south. Lower DO, yet super-saturation at surface. Transmission was higher.
4. **Hood Canal:** Denser with saltier water at depth. Super-saturated DO conditions at surface.
5. **South Sound:** Denser and saltier water at depth, lower DO levels and higher transmission.

SUMMARY COASTAL BAYS REGIONS – Warmer and high DO variability and high in situ fluorescence in Willapa Bay. Transmission was lower.

1. **Grays Harbor:** No data available
2. **Willapa Bay:** Warmer with variable density and salinity. Transmission was lower, in situ fluorescence was higher.

Meteorological conditions: Temperatures and precipitation were near-normal. Temperatures and rain followed the typical variability of spring.

SUMMARY GREATER PUGET SOUND REGION - Colder temperatures confined to Hood Canal, warmer temperatures confined to San Juans. Lower salinities in Whidbey basin and Southern most inlets. Saltier in the north. DO higher in Whidbey basin and lower in the Central and South basins. Transmission was higher in the northern regions.

1. **San Juan-North Sound Region:** Denser, saltier with warmer water confined to San Juan Islands. Transmission high indicative of clear water.
2. **Central Sound Region:** DO lower, especially in South Central basin.
3. **Whidbey Basin:** Lower salinity and density. DO higher especially near Skagit River. Transmission highly variable and in situ fluorescence very high.
4. **Hood Canal:** Cooler, variable DO but higher in situ fluorescence.
5. **South Sound:** Lower salinity and density confined to most southern inlets. DO lower.

SUMMARY COASTAL BAYS REGIONS - Lower salinity and density, warmer temperatures. Higher in situ fluorescence and lower transmission.

1. **Grays Harbor:** Lower salinity and density and transmission but higher in situ fluorescence.
2. **Willapa Bay:** Lower salinity and density but warmer temperatures. Higher in situ fluorescence and lower transmission.

Meteorological conditions: Warmer temperatures, with record highs at the start of the month. Higher precipitation. The wet May conditions were largely the result of a handful of very wet days. River flows were above normal, especially to the north. The Fraser river outflow is finally above normal.

SUMMARY GREATER PUGET SOUND REGION – Fresher and less dense at the surface in the south. Warmer in southwestern inlets. Low DO at depth in South Sound and western inlets. Local highs in Admiralty Reach and depth in lower Hood Canal. In situ fluorescence was higher.

1. **San Juan-North Sound Region:** Higher in situ fluorescence.
2. **Central Sound Region:** Lower salinity, lower DO at depth. Super-saturation! Both transmission and in situ fluorescence higher.
3. **Whidbey Basin:** Fresher and less dense. Lower DO at depth in at Saratoga Passage and below surface in Possession Sound. Super-saturation.
4. **Hood Canal:** Colder, higher DO near Great Bend, super-saturation at surface and in situ fluorescence is high.
5. **South Sound:** Warmer in the southwest, fresher and less dense at surface. DO lower at depth and in shallow bays. In situ fluorescence higher consistent with super-saturation of DO at the surface.

SUMMARY COASTAL BAYS REGIONS - Warmer, fresher and less dense following the Pacific Ocean SST anomalies. Lower DO in Willapa. Overall very low transmission indicative of murkier water.

1. **Grays Harbor:** Fresher less dense and warmer. Lower transmission.
2. **Willapa Bay:** Extremely fresh, low density and warm. Both transmission and DO were low while in situ fluorescence was higher.

Meteorological conditions:
Temperatures were largely expected, with precipitation below normal. River flows started out above normal, but generally decreased with the drier weather.

SUMMARY GREATER PUGET SOUND REGION - Generally lower salinities and densities. Higher densities and salinities confined to Whidbey Basin. Warmer water confined to the north. Expected DO with regional higher levels in Central Sound, and lower levels in Whidbey Basin. Transmission was lower in Central and higher in the South Puget Sound. In situ fluorescence was generally higher with the exception of Hood Canal and Whidbey Basin.

1. **San Juan-North Sound Region**: Warmer with lower salinity and density confined to Admiralty Reach region. In situ fluorescence reached new maximum values, with the exception of Bellingham which was lower.
2. **Central Sound Region:** Lower density and salinity. Warmer temperatures near surface. DO is higher and so is in situ fluorescence and transmissivity.
3. **Whidbey Basin:** Higher density and salinity and lower temperatures in northern stations. Generally lower DO.
4. **Hood Canal:** Lower salinity and density particularly at the surface. Lower temperatures at depth.
5. **South Sound:** Lower density and salinities. In situ very variable.

SUMMARY COASTAL BAYS REGIONS - Lower DO and transmission indicative of sediment content.

1. **Grays Harbor:** DO and transmission regionally variable falling outside expected values.
2. **Willapa Bay:** Transmission and DO both lower than expected.

Meteorological conditions:
Warmer and abundant sunshine. Precipitation was, on average, normal but occurred in a few very strong squalls. Rivers were mostly at or above normal, although the Fraser River was below normal for most of the month.

SUMMARY GREATER PUGET SOUND REGION - Warmer and less dense in the south, saltier cooler influence coming in from the Straits and variable DO - lower in S. Central PS; regionally higher in Hood Canal and at surface in Whidbey. Higher in situ fluorescence. High transmissivity in South Sound.

1. **San Juan-North Sound Region:** Lower temperatures but higher salinity and density in the north. Variable DO and transmissivity.
2. **Central Sound Region:** Lower salinity, lower temperature confined to surface. Lower DO levels constrained to N. Central sites.
3. **Whidbey Basin:** Higher salinity/density in the North, lower salinity and density in the South. Higher DO at the surface, lower near rivers. Fluorescence was higher.
4. **Hood Canal:** Lower temperature at depth, north warmer. Density higher at surface but lower at depth! Higher DO at sites near the Great Bend. Higher in situ fluorescence and variable transmissivity.
5. **South Sound:** Warmer and less dense. Lower DO confined to deeper, eastern basins. In situ fluorescence and transmissivity was higher.

SUMMARY COASTAL BAYS REGIONS - Warmer with lower DO higher in situ fluorescence and lower transmissivity.

1. **Grays Harbor:** n.a.
2. **Willapa Bay:** Warmer, lower DO and transmissivity.

Meteorological conditions: Warmer, sunny with event driven precipitation. The Fraser River continued to have low flow. Upwelling conditions were more prevalent than normal for the first time since January. The lack of Fraser outflow appears to have kept hypoxic intrusions to a minimum.

SUMMARY GREATER PUGET SOUND REGION – Higher temperature, lower density, lower DO. Higher DO confined to Hood Canal. Transmission was higher.

1. **San Juan-North Sound Region:** Higher salinity and density in the San Juans, consistent with low Fraser R. flow. Lower DO. Transmission reached new maximum values.
2. **Central Sound Region:** Lower salinity, density and DO. Transmission very high.
3. **Whidbey Basin:** Transmission very high.
4. **Hood Canal:** Lower salinity and density towards the south. Higher DO and transmissivity.
5. **South Sound:** Higher temperature, lower density and DO due to temperature effect.

SUMMARY COASTAL BAYS REGIONS - Lower temperature, higher salinity and density. Lower DO at sites close to the ocean. Transmission was higher, in situ fluorescence variable.

1. **Grays Harbor:** Higher salinity and density. Transmission was higher and in situ fluorescence was variable.
2. **Willapa Bay:** Lower temperature towards the ocean, generally higher salinity and density. Higher DO increasing with distance to the ocean . Transmission was higher and in situ fluorescence was variable.

Meteorological conditions: Warmer, sunny with event driven precipitation. The Fraser River continued to have low flow, the Puyallup River is running higher. Upwelling conditions were more prevalent than normal for the first time since January. The lack of Fraser outflow appears to have kept hypoxic intrusions to a minimum.

SUMMARY GREATER PUGET SOUND REGION - Warmer. Lower density confined to Central and South Sound. DO still high in Hood Canal but low in South Sound. Transmission was higher from Admiralty Inlet to the Central Sound.

1. **San Juan-North Sound Region:** Warmer water and higher transmissivity.
2. **Central Sound Region:** Warm, fresh, and less dense. High DO restricted to regions of localized blooms. Transmission was higher at depth and lower at the surface consistent with sediment and blooms. In situ fluorescence was elevated above historical values.
3. **Whidbey Basin:** Variable physical and DO conditions. Transmission was higher.
4. **Hood Canal:** Warm surface water over cold deep water increasing stratification. Higher DO in southern Hood Canal with supersaturated conditions. Transmission very high.
5. **South Sound:** Warmer and less dense. Lower DO.

SUMMARY COASTAL BAYS REGIONS - Warm and salty water caused by reduced river flow. Transmission high in Grays Harbor.

1. **Grays Harbor:** Transmission higher.
2. **Willapa Bay:** Warm and salty water due to reduced river inflow. Lower DO.

Meteorological conditions: Air temperatures above normal continuing an eight-month trend. Precipitation and river flows were also above normal, except for the Nisqually River. PDO is extremely warm phase, and downwelling conditions are stronger than normal.

SUMMARY GREATER PUGET SOUND REGION - Significantly higher temperatures, lower densities confined to Central Sound and surface in Whidbey Basin. Fluorescence generally expected, but regionally still higher than normal.

1. **San Juan-North Sound Region:** Warmer reduced density, higher transmissivity and higher in situ fluorescence.
2. **Central Sound Region:** 1-2 °C warmer and as a result less dense. Lower DO, especially at depth. Both Transmission and in situ fluorescence above normal.
3. **Whidbey Basin:** Warmer and lower density. Lower DO confined to Saratoga Passage. Transmission very high.
4. **Hood Canal:** Less dense and less salty and warmer water temperatures. Higher DO confined to surface lower DO at depth.
5. **South Sound:** Less dense and warmer and in situ fluorescence is higher.

SUMMARY COASTAL BAYS REGIONS - Colder with lower DO near the ocean,and higher DO near rivers. Transmission was higher.

1. **Grays Harbor:** Colder with higher DO confined to near-river stations. Transmission is higher.
2. **Willapa Bay:** Lower temperatures, saltier and lower DO near ocean. Higher DO near rivers,. Both transmission and in situ fluorescence are higher.

Meteorological conditions: Despite near-normal mean air temperatures, we had some large temperature swings, with two cold spells that offered plentiful sunshine. Precipitation was at or below normal, but river flows were above normal to the north. Off shore sea-surface temperatures remained warm, as did the PDO index.

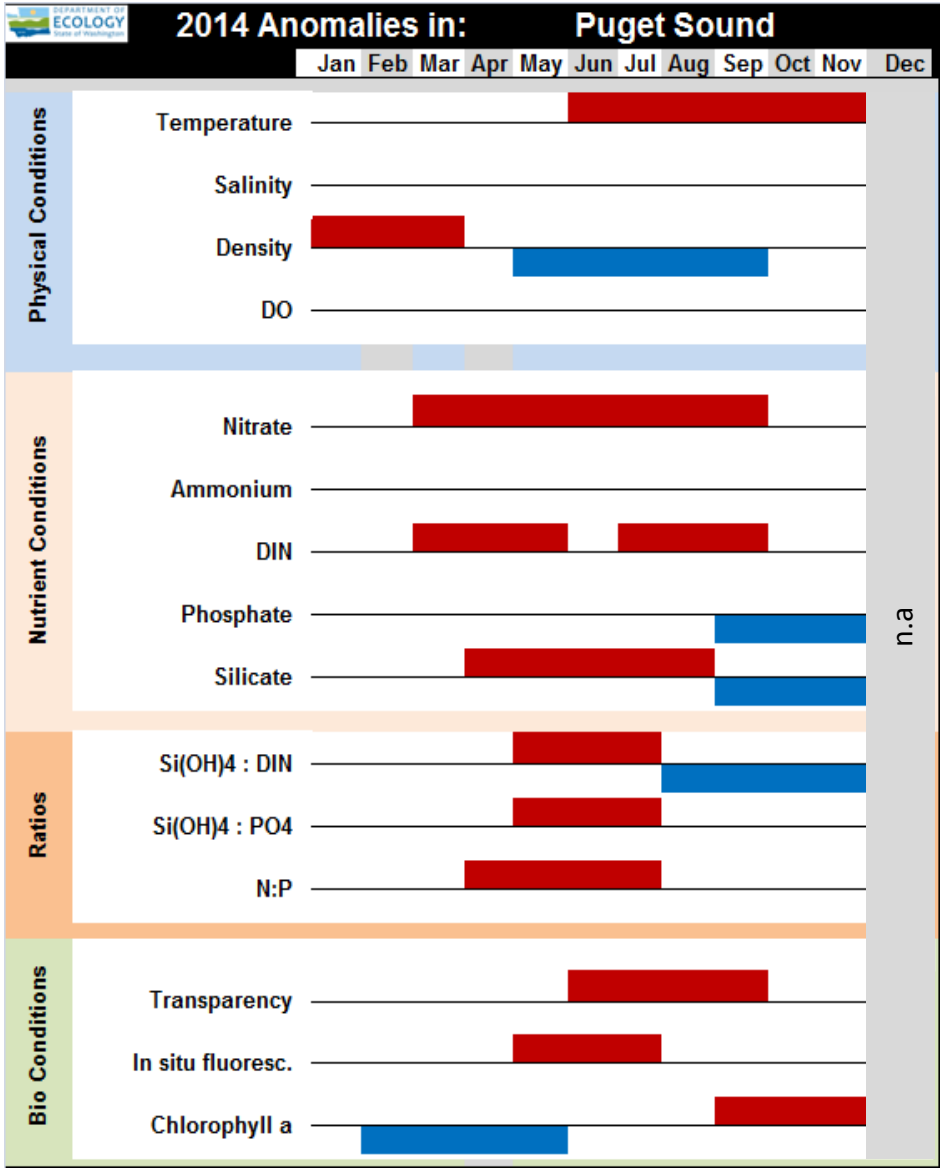
SUMMARY GREATER PUGET SOUND REGION - Much warmer and because of temperature less dense. Lower DO confined to greater depth. Higher transmission confined to North Puget Sound. In situ fluorescence generally higher.

1. **San Juan-North Sound Region:** Colder, with higher salinity and density confined to San Juan Islands.
2. **Central Sound Region:** Generally expected DO, with some higher surface layers in N. Central Sound.
3. **Whidbey Basin:** Transmissivity was higher.
4. **Hood Canal:** Expected.
5. **South Sound:** Cooler water with higher oxygen levels in western inlets. In situ fluorescence is also higher.

SUMMARY COASTAL BAYS REGIONS - Cooler with higher oxygen levels.

1. **Grays Harbor:** Cooler, denser and higher oxygen.
2. **Willapa Bay:** Cooler with variable salinity and higher oxygen.

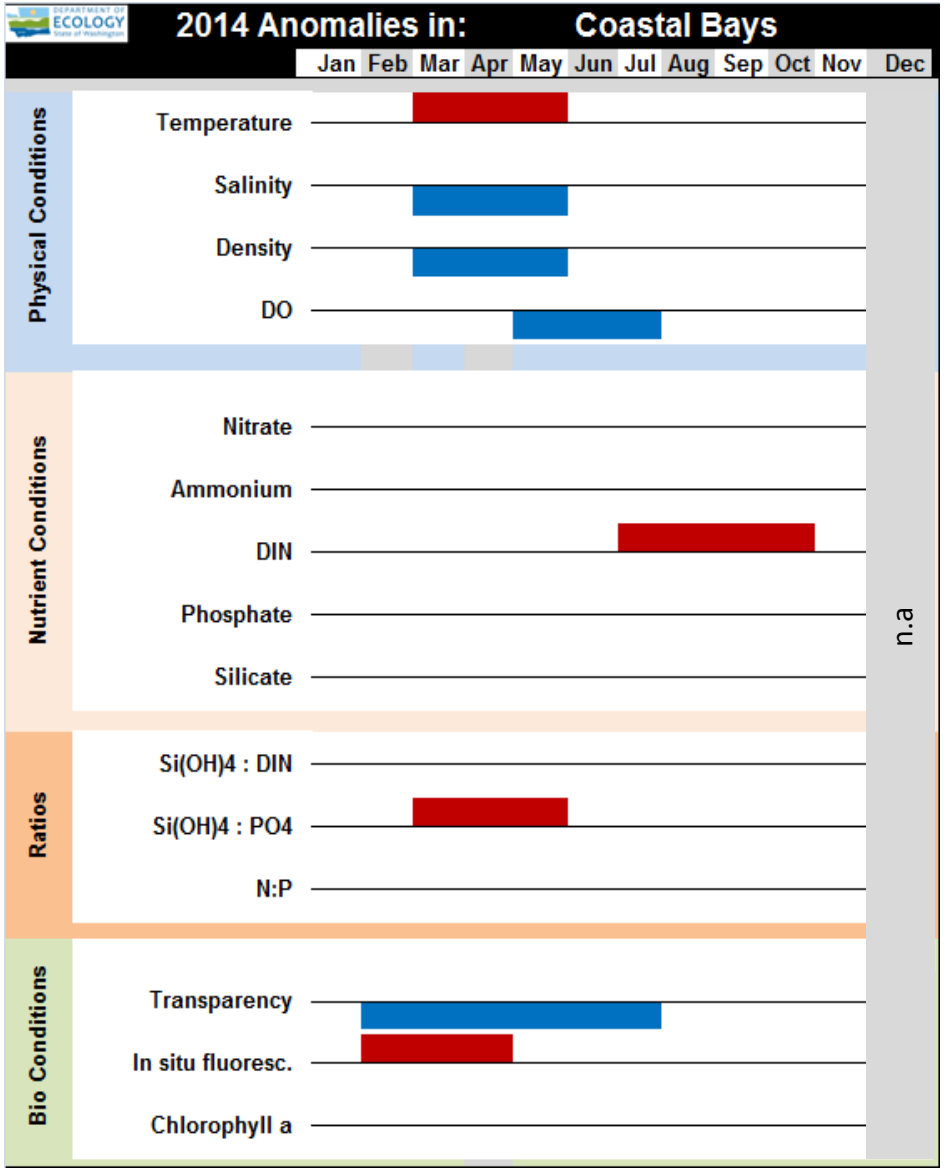
No flights were conducted in December due to airplane engine maintenance and a replacement of a bolt on the crank shaft of the entire fleet.



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: Coastal Bays

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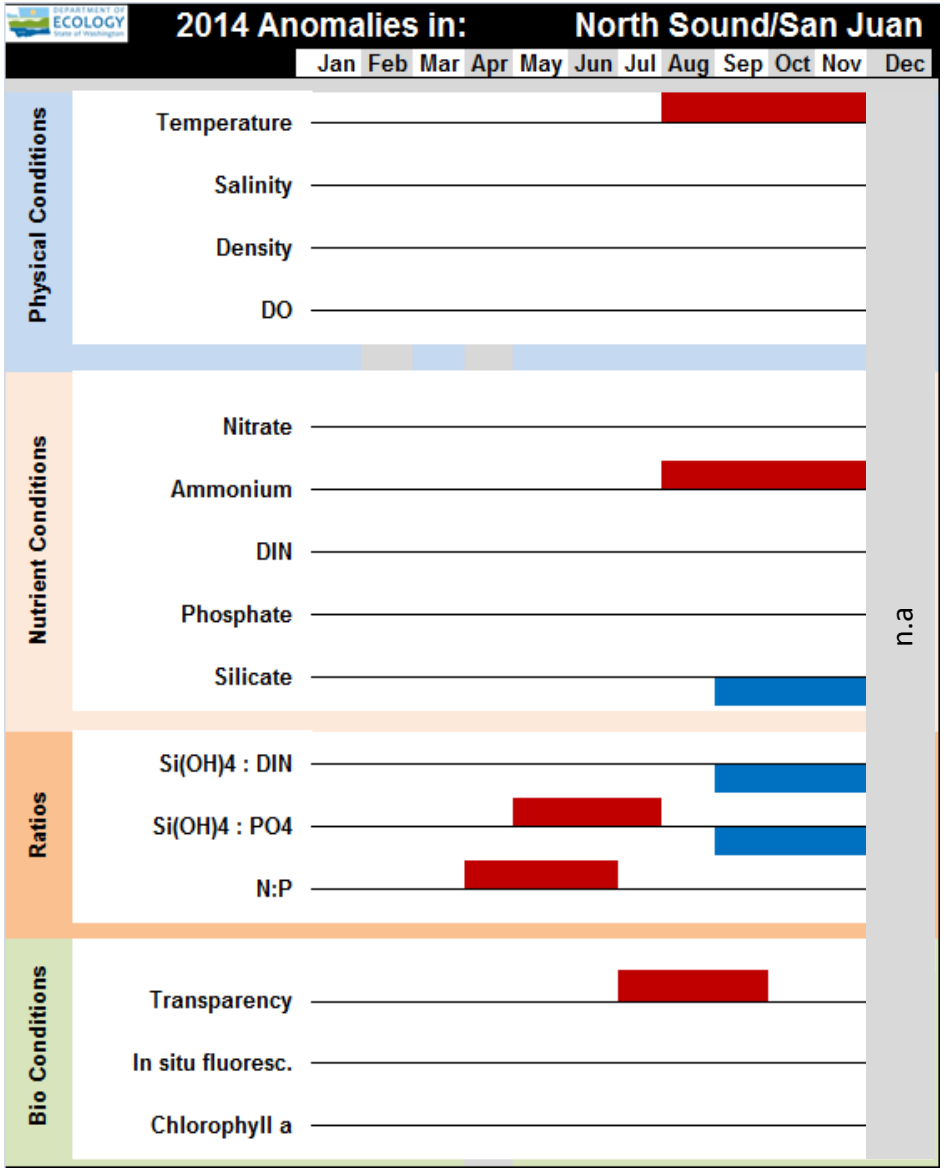
Higher water temperatures, lower salinity, and lower density occurred in spring and overlapped with a period of lower dissolved oxygen in early summer. During spring *in situ* fluorescence and Si:PO_4 ratios were also higher while water clarity was lower.

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.



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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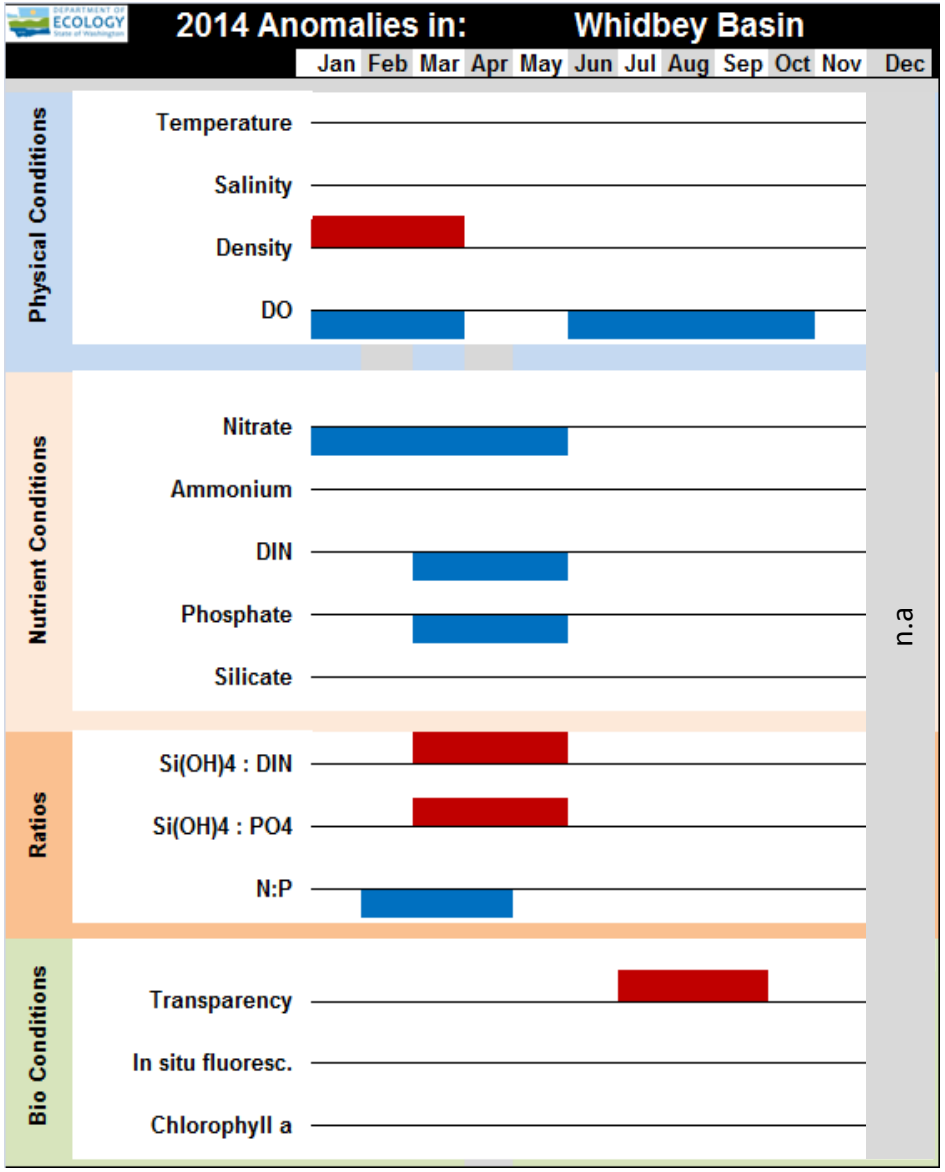

Region: Whidbey Basin

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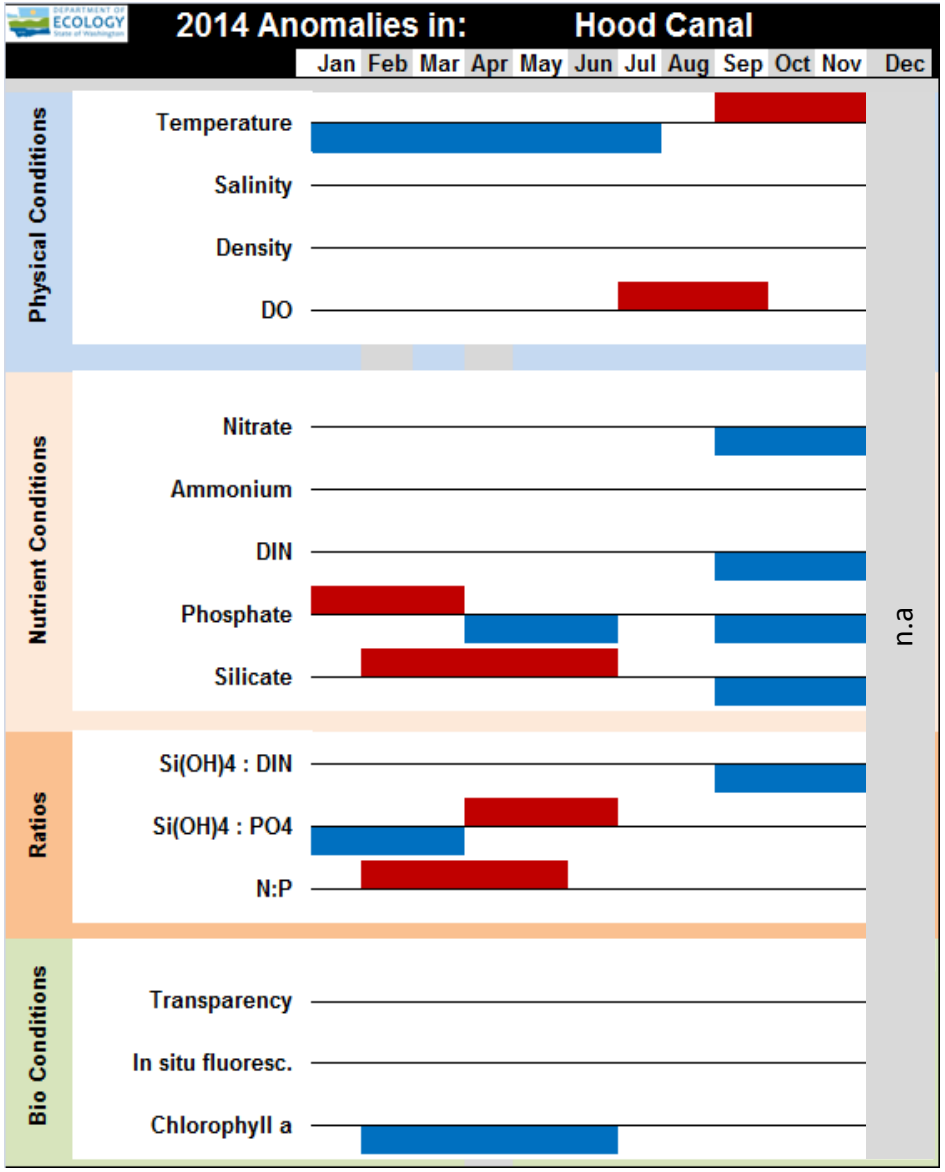
Whidbey Basin water was denser in winter. Dissolved oxygen was lower for most of the year. All nutrients except for ammonium and silicate were lower in spring affecting nutrient ratios. Water clarity (transparency) was higher in late summer.

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.



Region: Hood Canal

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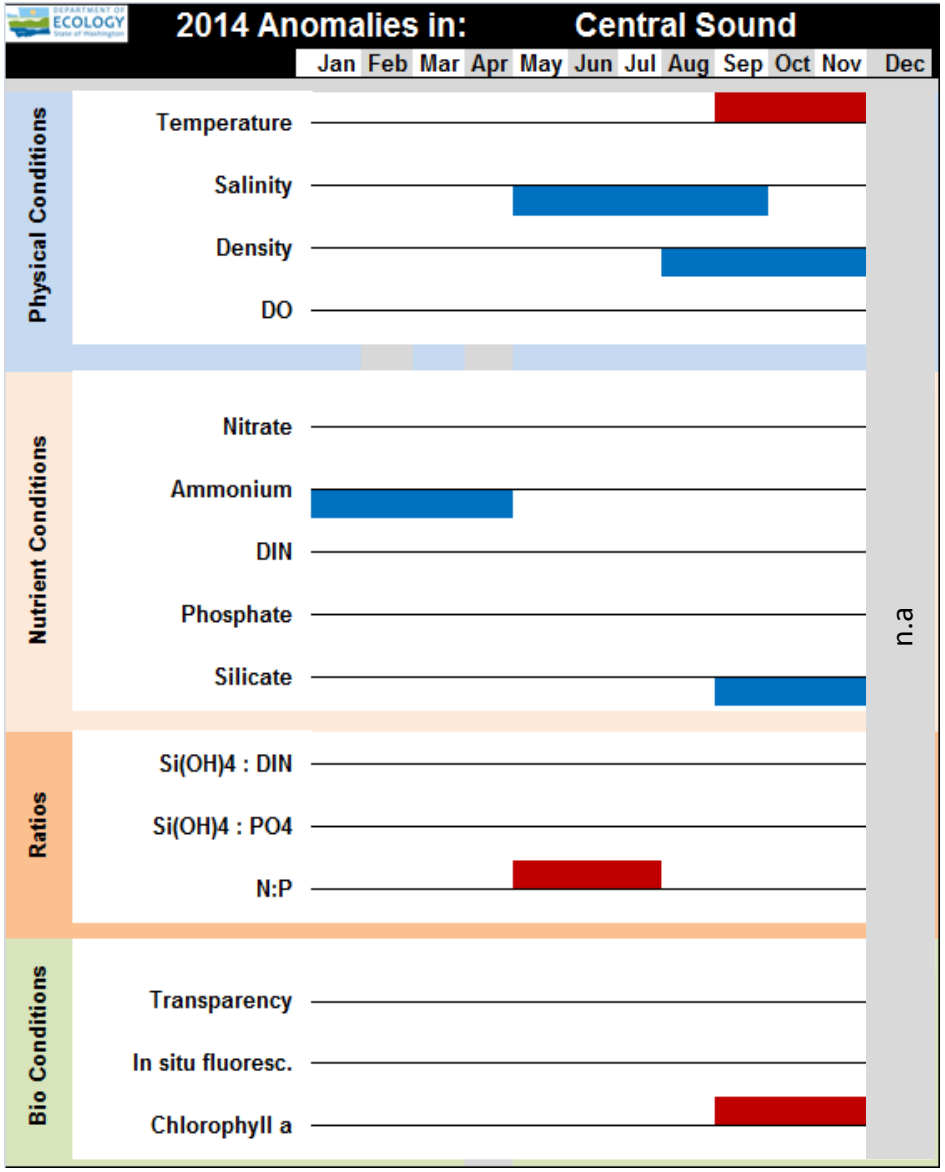
Temperature was lower the first half of the year and became higher in the fall. Dissolved oxygen was higher in late summer. Nutrient ratios were influenced by unexpected levels of phosphate and silicate in the first half of the year. In fall, nutrients were lower with the exception of ammonium. Discrete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



Region: Central Sound

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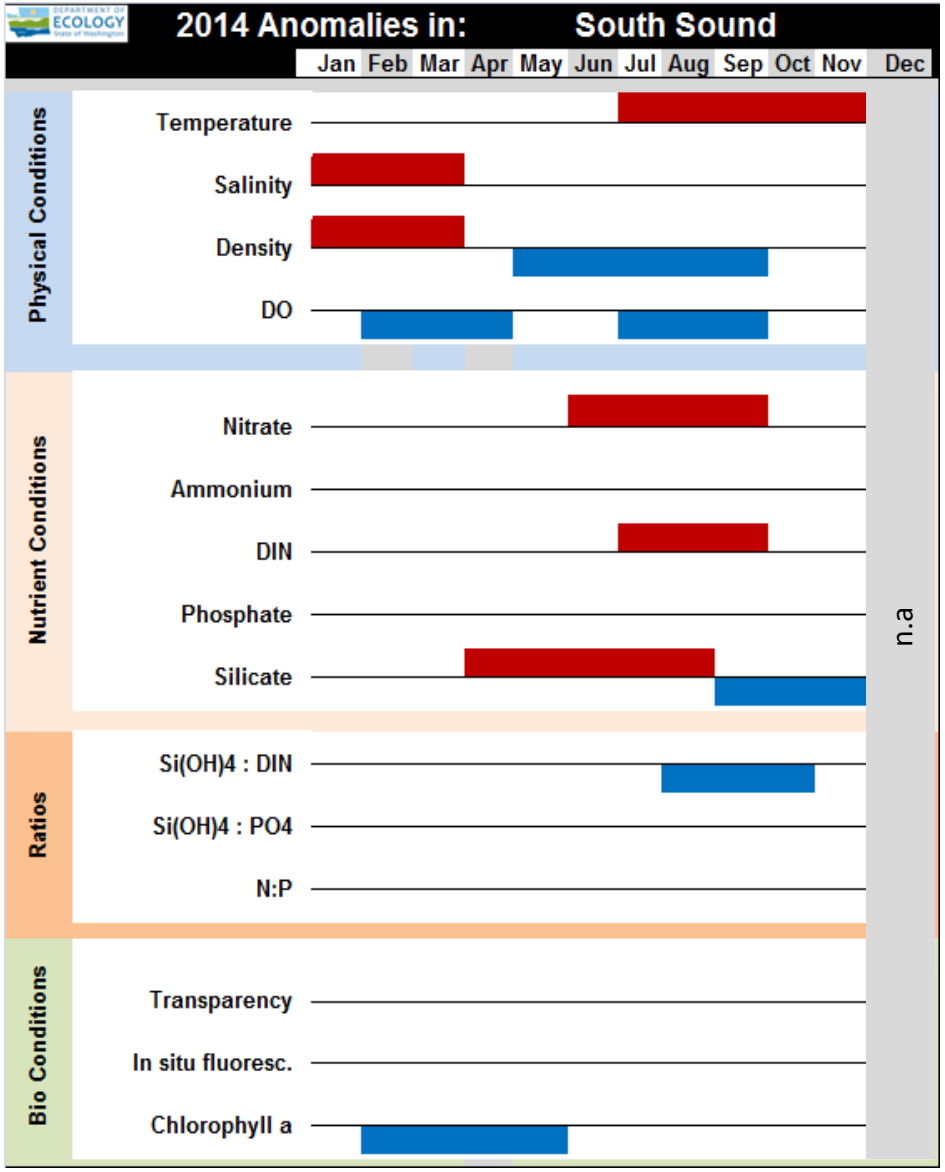
Temperature was higher in fall coinciding with lower density. Salinity was lower in summer. Ammonium was lower in the winter and silicate was lower in the fall. The N:P ratio was higher in early summer. Chlorophyll *a* was higher in the fall.

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.



Region: South Sound

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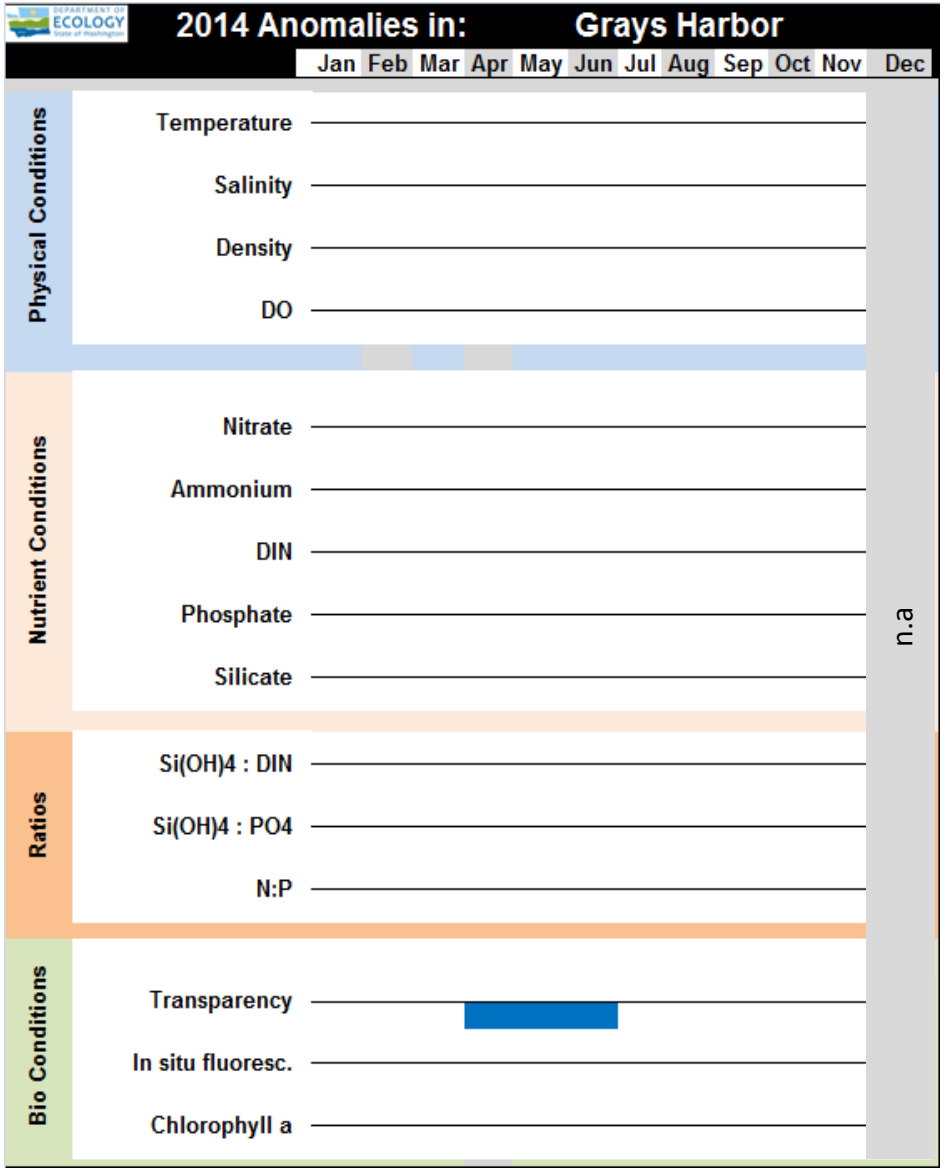
Winter had higher salinity and density. Density shifted lower in summer coinciding with higher temperatures. Dissolved oxygen was lower most of the year. Nutrients were higher in summer with the exception of ammonium and phosphate. Discrete chlorophyll *a* samples were lower early in the year.

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.



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
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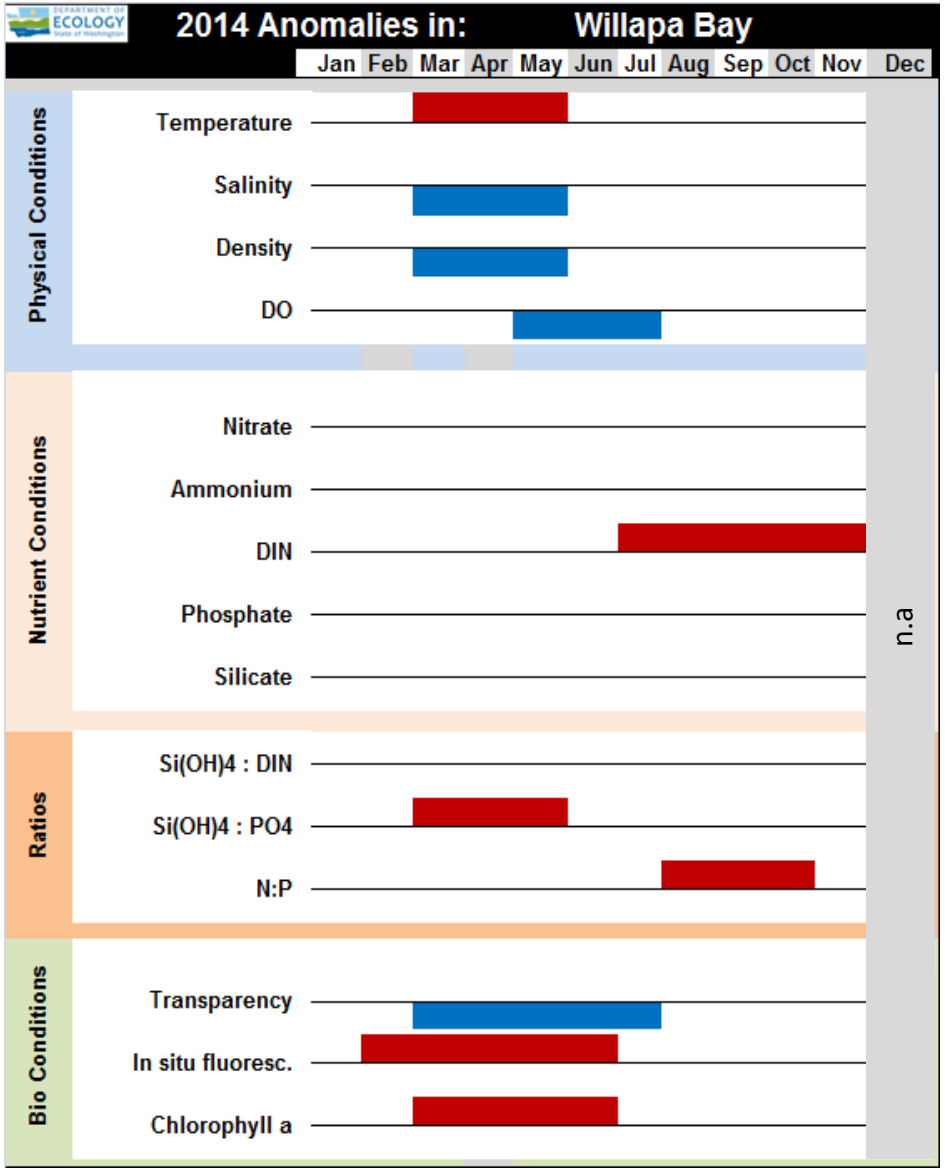

Region: Willapa Bay

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In the spring temperature was higher while salinity and density were lower. This was followed by lower dissolved oxygen. The Si:PO_4 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
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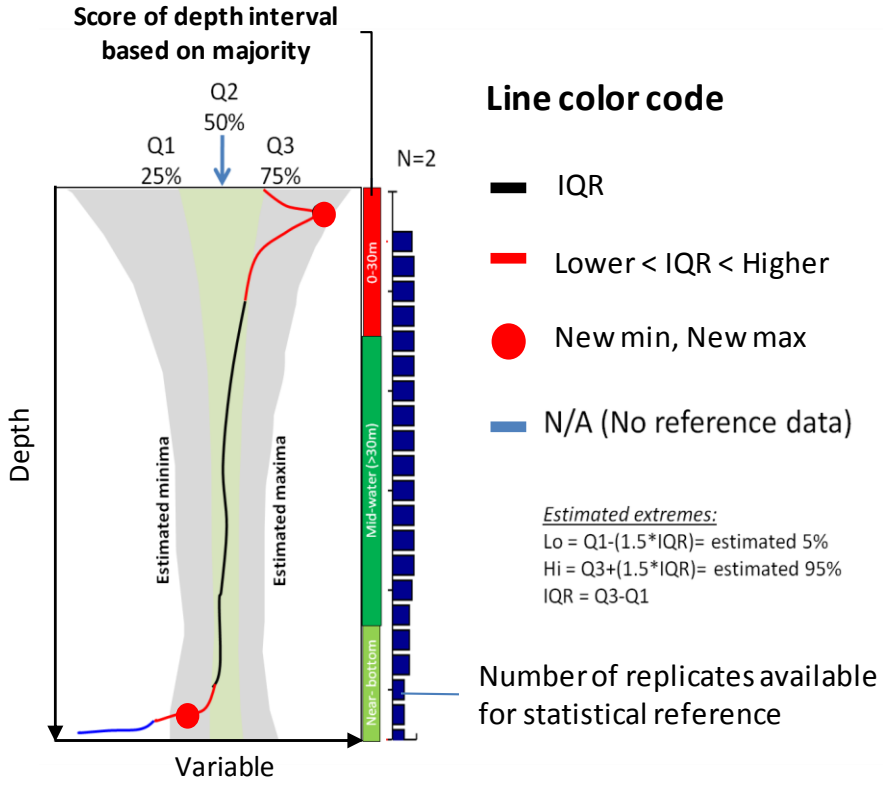


A wealth of historical data allows us to place new CTD observations into the historical context of Ecology's long-term data record.

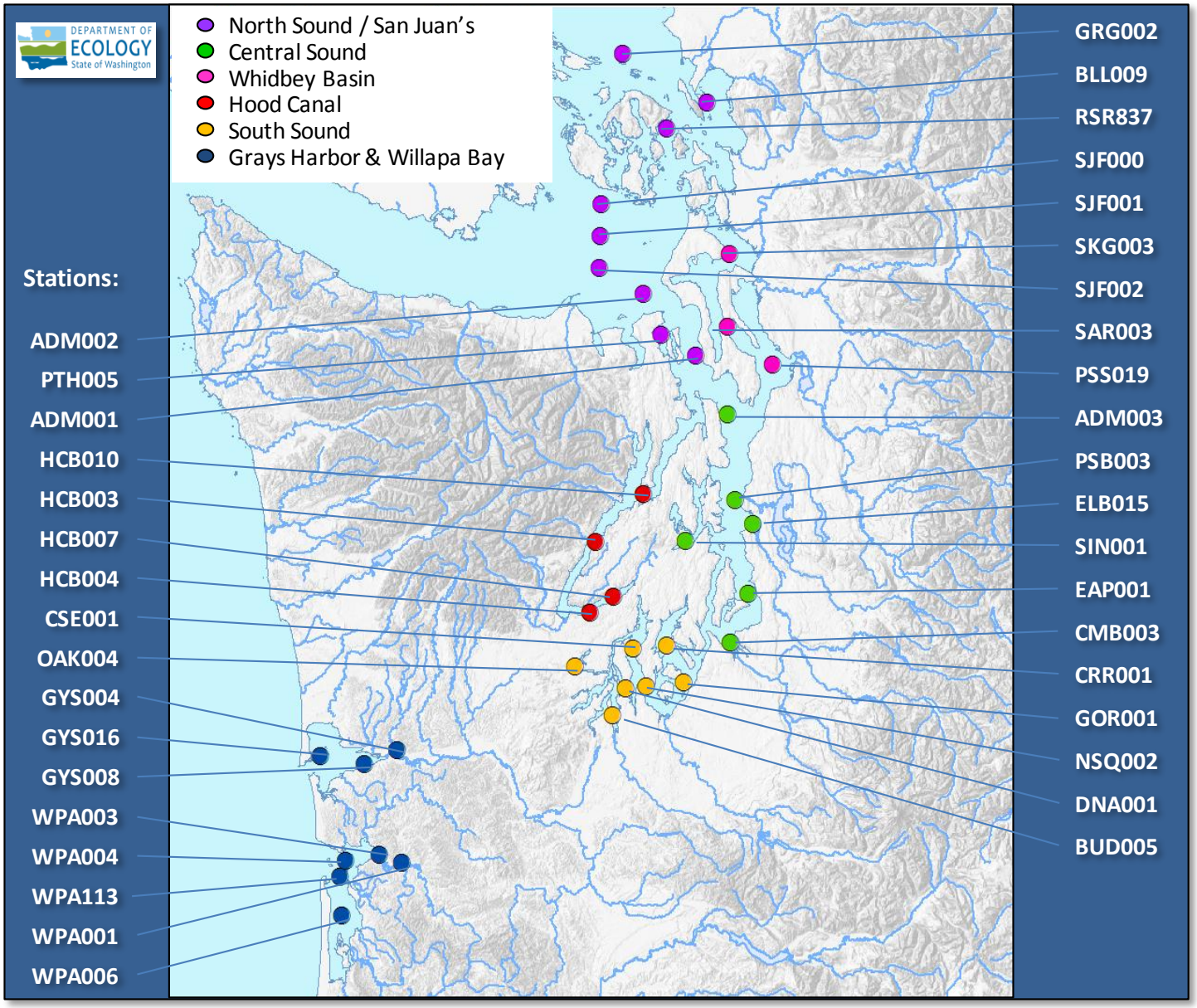
We use an increasing temporal reference framework of 1999-present to statistically define anomalies. Conditions that fall outside of a 50% observation envelope (second and third quartile) are considered "***anomalies***".

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**.



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.