

# South Puget Sound – 2011 and 2012 in review. Aerial and water column observations from Ecology's long-term monitoring program.



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## Abstract:

Marine water in South Puget Sound has been the focus of ongoing water quality concerns. Concentrated, frequent, vast **algal bloom** and **jellyfish** patches at the surface and **low oxygen water** at depth have been persistent features for years. South Puget Sound's remoteness from the ocean and its disproportionately long shoreline make it particularly vulnerable to land-based influences.

We documented extensive **dinoflagellate blooms** and **jellyfish** aggregations in all finger inlets of South Sound during 2011 and currently in 2012. These features align with a 13-year **increase in macronutrients** in surface waters.

In **2012 the water column** was unusually **cold** and significantly **fresher**. As a result **oxygen** levels at depth noticeably **recovered**.

Our observations illustrate the importance of climate variability and distant oceanic influences for the South Puget Sound oxygen budget despite persistent high algal biomass at the surface.

## Eyes Over Puget Sound



## Conclusion

Following Puget Sound-wide trends, **South Sound has seen a decline in phytoplankton biomass** in the water column since 1999. During the same time, **nutrient concentrations have steadily increased** and nutrient ratios have shifted. The conditions give smaller opportunistic algal species ideal growth conditions. Starting in 2011 we have documented large and lasting blooms at the surface. A recent coordination with the **Squaxin Tribe** and the **Sound Toxins Program** (NOAA) confirmed the high abundance of motile **dinoflagellates**. Often red-brown blooms are accompanied by **extensive jellyfish** aggregations. 2011 and 12 have been unusually cold and wet which has **cooled and freshened marine waters** Puget Sound-wide. A positive side effect is a **system-wide increase in oxygen levels**, in particular after the cold snap in January 2012.

## Cold spell

"Colder air temperatures and reduced freshwater input from land cause shallow Puget Sound water to cool, partially over-turn, and entrain oxygen."

Cold spell affects Puget Sound water!  
"A monster Pacific Northwest storm coated Washington with freezing rain on Thursday January 19<sup>th</sup>, 2012 and brought much of Washington State to a standstill." [USA Today]

January 19<sup>th</sup>, 2012

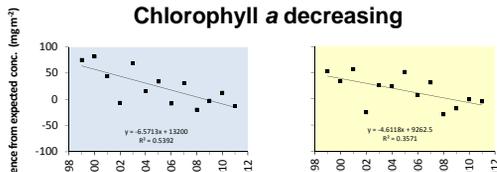


## Historic trends (1999 - 2011)

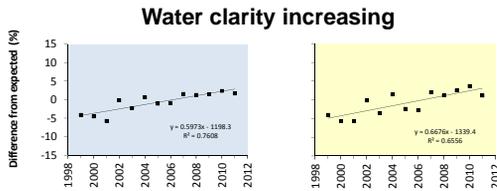
### Puget Sound

### South Sound

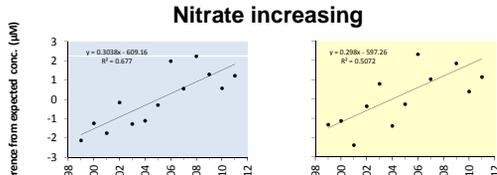
#### Chlorophyll a decreasing



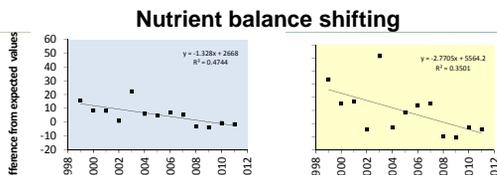
#### Water clarity increasing



#### Nitrate increasing



#### Nutrient balance shifting

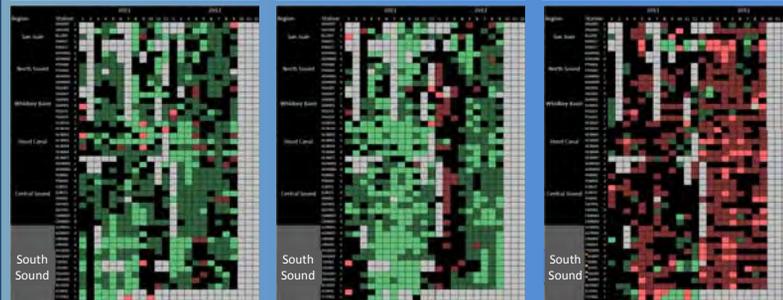


## Two years in review (2011 and 2012)

### Colder

### Fresher

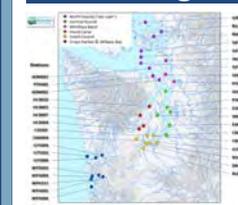
### More O<sub>2</sub>



Heat maps show the anomalies of temperature, salinity and dissolved oxygen in color. Anomalies are generated relative to 13 years of historic data. Temperature and salinity are lower and dissolved oxygen is higher than expected conditions in Puget Sound. The cold spell in January 2012 had a strong Puget Sound-wide effect on salinity (water retained as snow). The profound and lasting ventilation of Puget Sound in January 2012 is remarkable.

Legend:  
 ■ = higher than expected (>IQR, n=13)  
 ■ = expected (=IQR, n=13)  
 ■ = lower than expected (<IQR, n=13)  
 ■ = higher than previous measurements  
 ■ = no data  
 ■ = lower than previous measurements

## Marine Flights



We use a float plane as a cost-effective means to collect marine samples monthly throughout Washington's extensive marine waters. We lower a CTD package carrying 4 Niskin bottles and 9 in situ sensors to full depth.

## Moorings



We deployed a mooring package off the Carlyon Beach dock floating at 5.3 m depth. The mooring package (model SBE 16+ and SBE 43) measures temperature, conductivity, density, salinity, and dissolved oxygen. (Decommissioned 3/1/11)

## Cold spell



During the week of January 14-21, 2012 **water temperature** dropped rapidly (-1.0 °C), **salinity** values temporarily increased (retention of frozen water on land), and **dissolved oxygen** conc. rose (0.4 mg/L). Arrow shows the period of the cold snap followed by snow melt.

Method: We integrate Chl a values over depth from 0-60m, we take average depth values for transparency and for nutrients we take median conc. from 0, 10 and 30m. For each variable we subtract a time-averaged seasonal cycle (13 yrs) from the dataset that is specific to each station. From these monthly collected de-seasonalized data we calculated yearly averages for larger regions (e.g., South Sound).