



# Eyes Over Puget Sound

[Field log](#)[Climate](#)[Water column](#)[Aerial photos](#)[Continuous monitoring](#)[Streams](#)

## Surface Conditions Report, *August 24, 2016*

[Start here](#)[Scuba info](#)

*Up-to-date observations of water quality conditions in Puget Sound and coastal bays*

Field log

Climate

Water column

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Continuous monitoring

Streams

*Mya Keyzers*



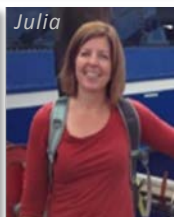
*Skip Albertson*



*Dr. Christopher Krembs (Editor)*



*Julia Bos  
Suzan Pool*



*Jim Shedd*



## Personal impressions

[p. 4](#)

Measurements to inform Ocean Acidification and Climate Change.

## Climate influences

[p. 6](#)

Conditions are normalizing, yet river flows remain lower, especially to the north.

## Water column

[p. 7](#)

Record-breaking water temperatures disappearing in July. Lower oxygen in southern Puget Sound. Water in coastal bays is warmer.

## Aerial photography

[p. 11](#)

Large jellyfish aggregations confined to Eld and Budd Inlet. *Noctiluca* in Budd and Case Inlets and Nisqually Reach. Red-brown blooms widespread in finger inlets of South Sound, including Pickering Passage and Sinclair Inlet.

## Continuous monitoring

[p. 35](#)

Surface temperature are >15 °C. Algae are abundant in central Puget Sound and temporarily increased near Victoria, BC.

## Streams

[p. 37](#)

July precipitation temporarily improved streamflows. However, August streamflows remain below normal.



## Critter of the Month – The Pea Crabs



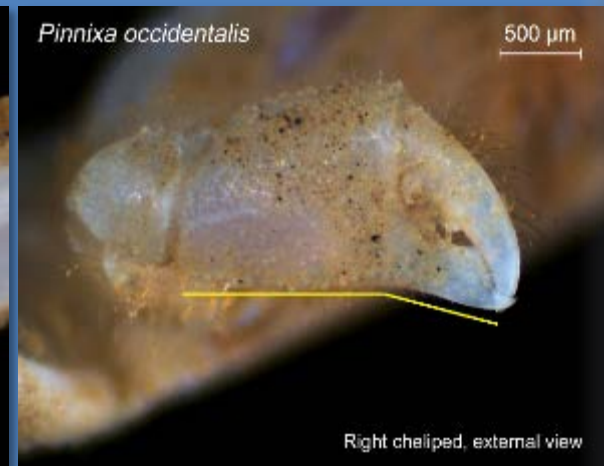
Angela Eagleston & Dany Burgess  
Marine Sediment Monitoring Team

### Family Pinnotheridae – The Pea Crabs

This month's group of critters are the ultimate unwelcome house guests! Find out how animal interactions between pea crabs and their hosts are an important part of the ecology of Puget Sound.

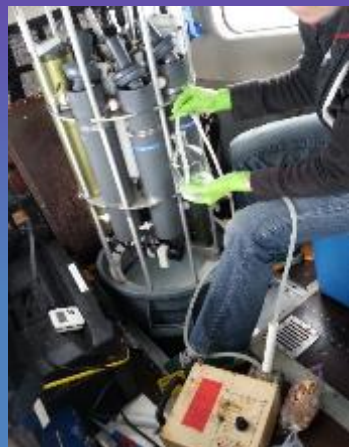
### Fun Facts!

- Inhabit the burrows, shells, and tubes of other critters
- Some are considered bivalve parasites.
- The size and shape of their carapace and claws are used to identify them.



## Measurements to Inform Ocean Acidification and Climate Change

Getting the best measurements possible for pH is becoming increasingly important as we try to understand the possible influence of ocean acidification in Puget Sound. We recently ran a pilot study on total alkalinity and dissolved inorganic carbon. See our newly published report ([click here](#)).



The main goal of the pilot study was to test the feasibility of sampling **total alkalinity** and **dissolved inorganic carbon** from the confines of a float plane.

Carbonate chemistry and pH is complex under estuarine conditions where rivers and oceans meet.

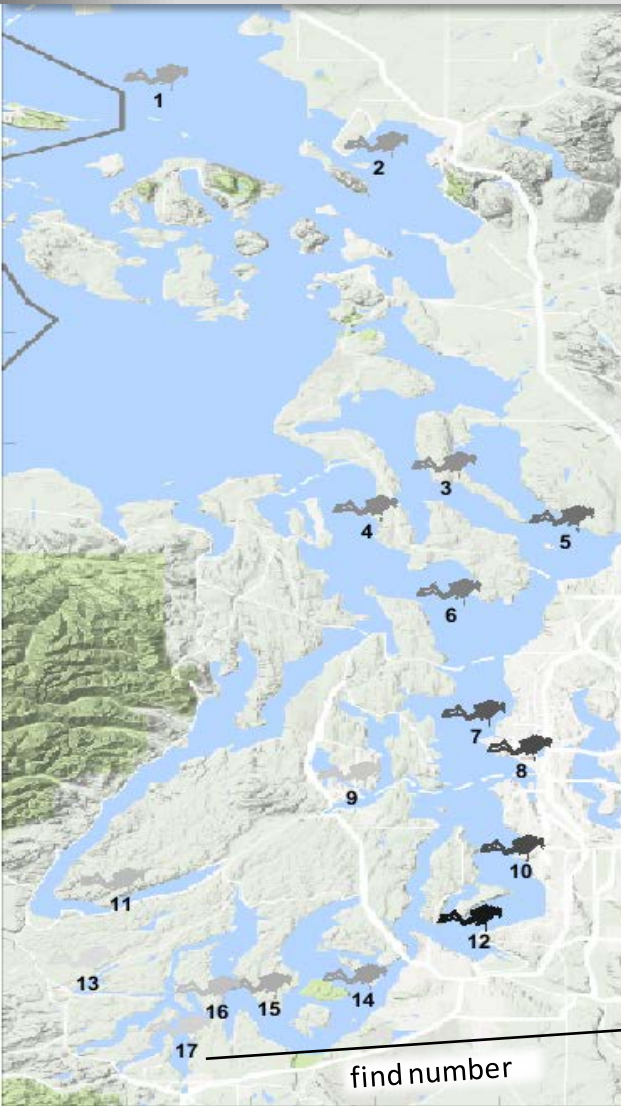
We need to understand how climate change and changing river flows affect the conditions of buffering our waters from ocean acidification.














## What is the visibility in the water for divers?



	Best /Depth		Least /Depth
1)	19 / 62		8 / 18
2)	22 / 15		14 / 5
3)	25 / 90		3 / 23
4)	26 / 94		14 / 8
5)	33 / 71		3 / 5
6)	29 / 85		8 / 15
7)	38 / 79		15 / 11
8)	42 / 97		17 / 10
9)	11 / 30		6 / 7
10)	42 / 56		9 / 3
11)	15 / 84		3 / 28
12)	54 / 82		8 / 13
13)	7 / 43		5 / 8
14)	22 / 98		16 / 5
15)	19 / 97		3 / 3
16)	14 / 87		10 / 18
17)	9 / 5		2 / 13

### Find depths with high and low visibility

- **Best visibility** was around 50 feet or more off Browns and Dash Points near Tacoma.
- **Poor visibility** occurred in many places of Puget Sound within the first 10 feet of the surface.
- In July, visibility continued to improve in Central Basin south of Seattle, along the east shore. Sinclair Inlet visibility declined.
- Elliott Bay visibility improved from 39 ft to 42 ft since June.
- We use transmissometer readings from our CTD package and convert them into horizontal visibility.



This is a new feature and we are soliciting feedback ([salb461@ecy.wa.gov](mailto:salb461@ecy.wa.gov)). Eventually we will feature the most recent data.



**Climate and natural influences**, including weather, rivers, and the adjacent ocean, can affect our marine waters. Graphics are based on provisional data and are subject to change. [http://www.ecy.wa.gov/programs/eap/mar\\_wat/weather.html](http://www.ecy.wa.gov/programs/eap/mar_wat/weather.html), page 26.

## Summary:

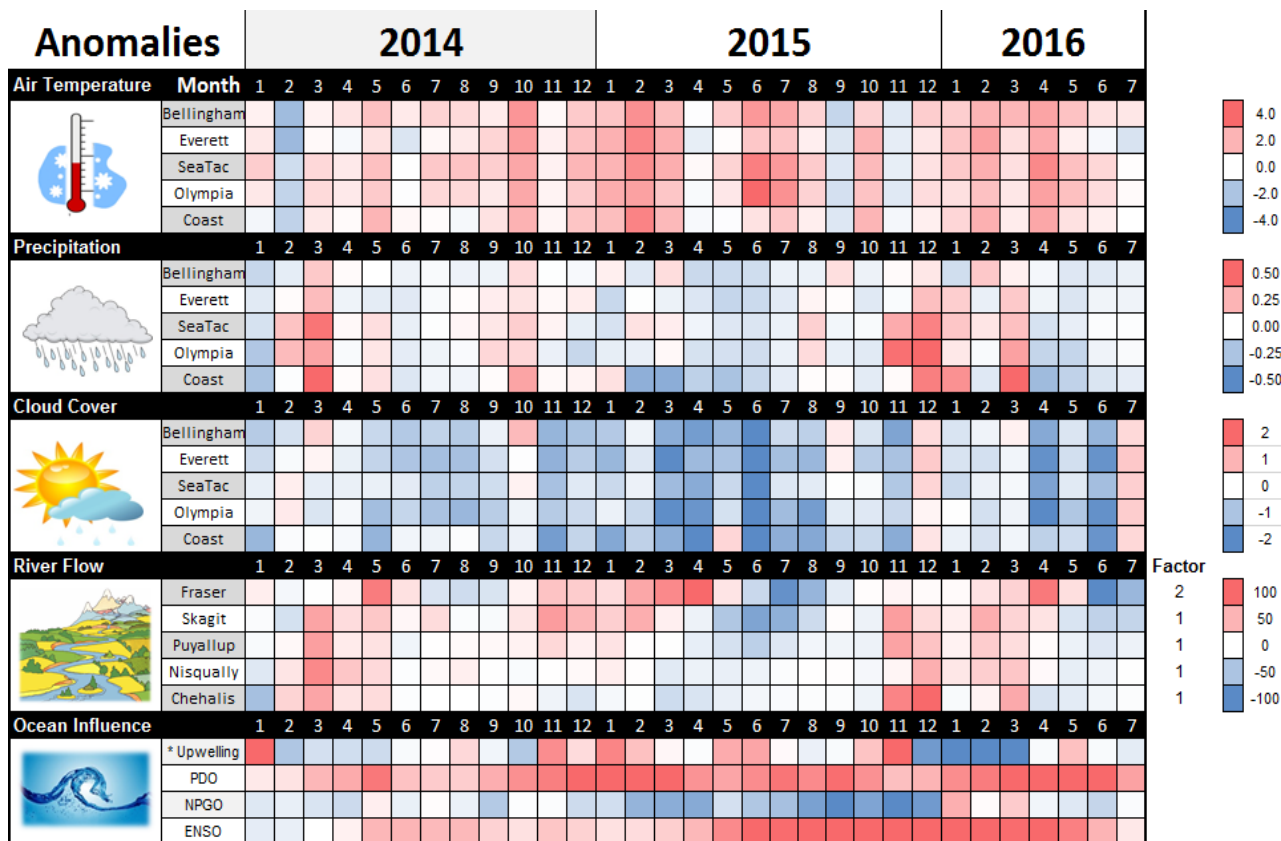
**Air temperatures** almost back to normal, except in the north.

**Precipitation** levels slightly below normal.

**Sunshine** levels below normal for July, (cloud cover was higher).

**River flows** remain below normal, particularly in the north.

**Ocean influence** returning closer to normal levels.



\*Upwelling Anomalies (PFEL)

PDO = Pacific Decadal Oscillation

NPGO = North Pacific Gyre Oscillation

ENSO = El Niño Southern Oscillation

higher | expected | lower | No data



# Our long-term marine monitoring stations in Washington

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- North Sound / San Juan Isl.
- 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

Stations are sampled monthly by region using four independent flights. The float plane is equipped with a CTD package.

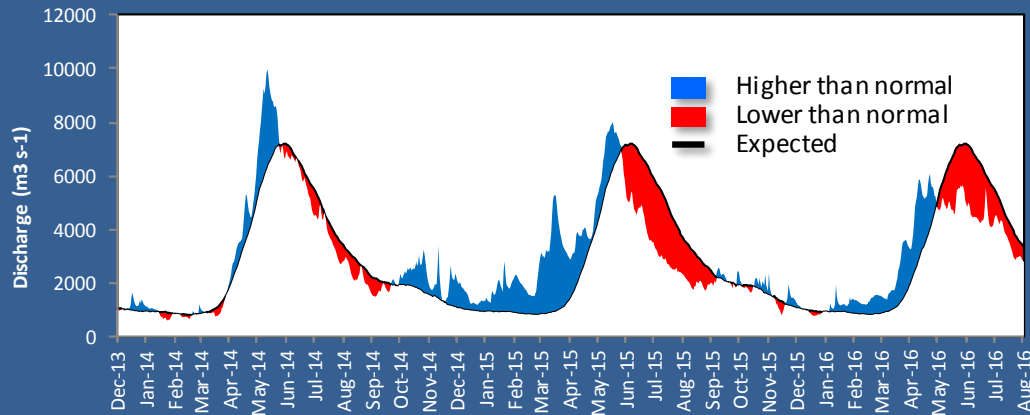
We use a boat and a chartered float plane to access our monthly monitoring stations.

Start here

We communicate data and environmental marine conditions using:

1. Marine Water Condition Index (MWCI)
2. Eyes Over Puget Sound (EOPS)
3. Anomalies and source data

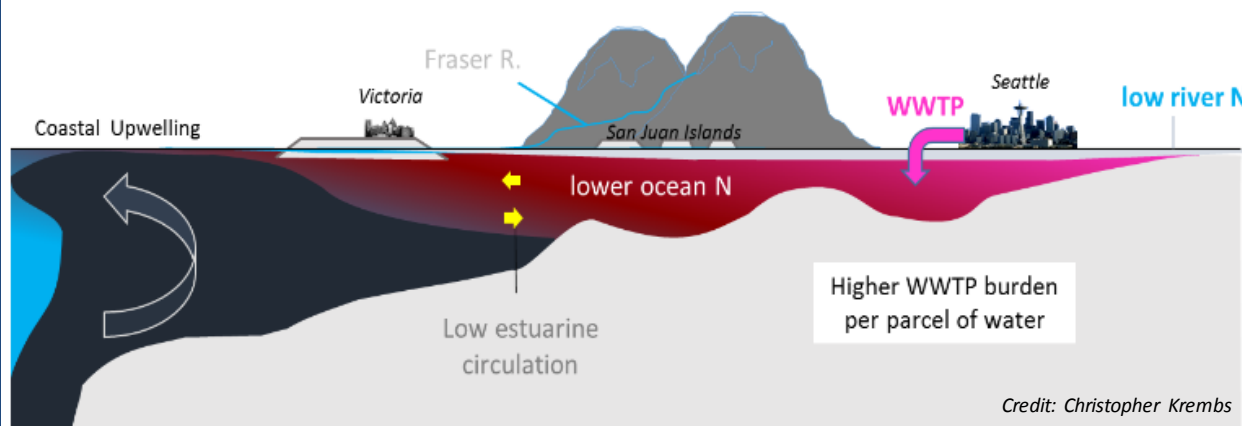
Year 2016 continues to have record-breaking global temperatures. In our region, the Fraser River flow has plummeted. **Estuarine circulation is important because water temperatures in Puget Sound are still warmer than normal! The Fraser River is the largest freshwater source for the Salish Sea, significantly affecting and driving estuarine circulation.**



In winter and spring 2016, the Fraser River and other rivers discharged prematurely. This year's Fraser River summer flow is extremely low, in response to warm winter temperatures and lack of snowpack in BC. **Very low summer flows inhibit the renewal of water in Puget Sound.**

Source: [http://wateroffice.ec.gc.ca/index\\_e.html](http://wateroffice.ec.gc.ca/index_e.html)

## Long surface water residence time reduced snowpack



Credit: Christopher Krembs

Very low Fraser River flow this summer means stagnant water in the Salish Sea and reduced exchange with the coast.

As a consequence, water warms and pollution accumulates.



Field log

Climate

Water column

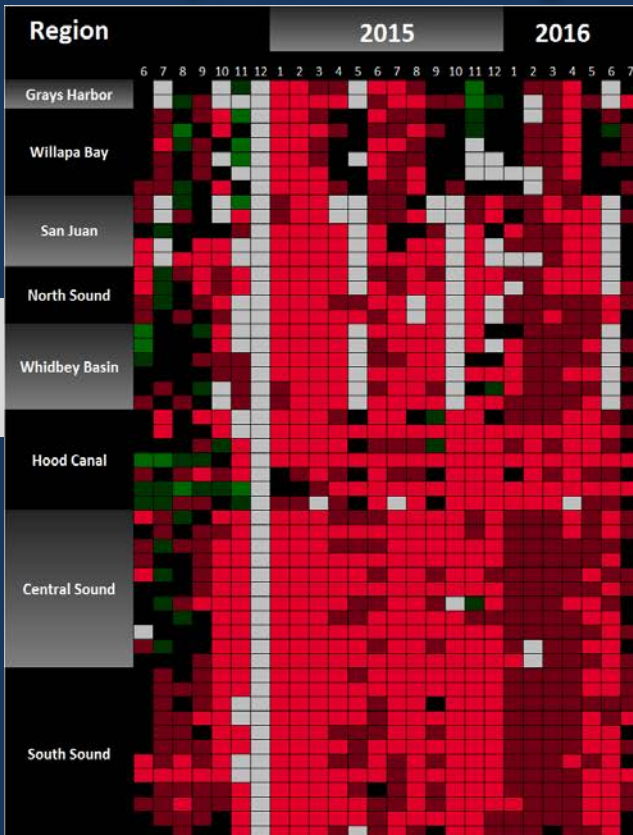
Aerial photos

Continuous monitoring

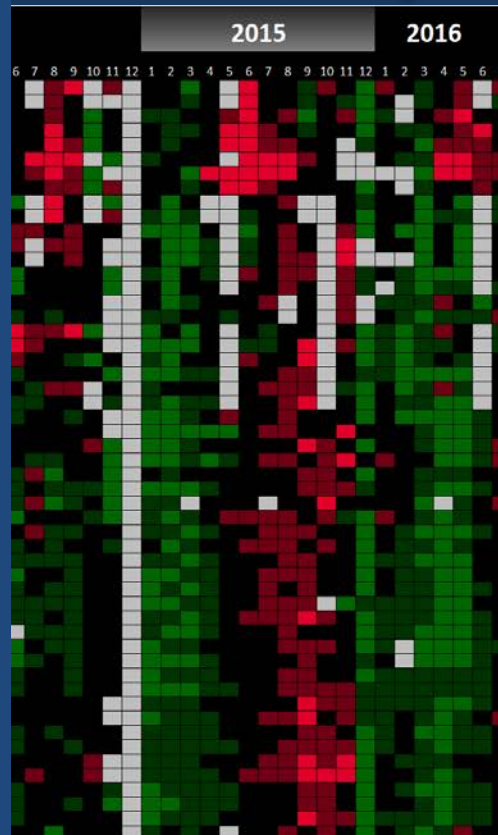
Streams

It is transition time for Puget Sound, as climate conditions are changing, while The Blob and El Niño disappear. After nearly 2 years of **record-breaking water temperatures**, Puget Sound temperatures and salinity were closer to expected ranges in July. Lower oxygen conditions appeared in southern Puget Sound. At the coast, water temperatures were warmer.

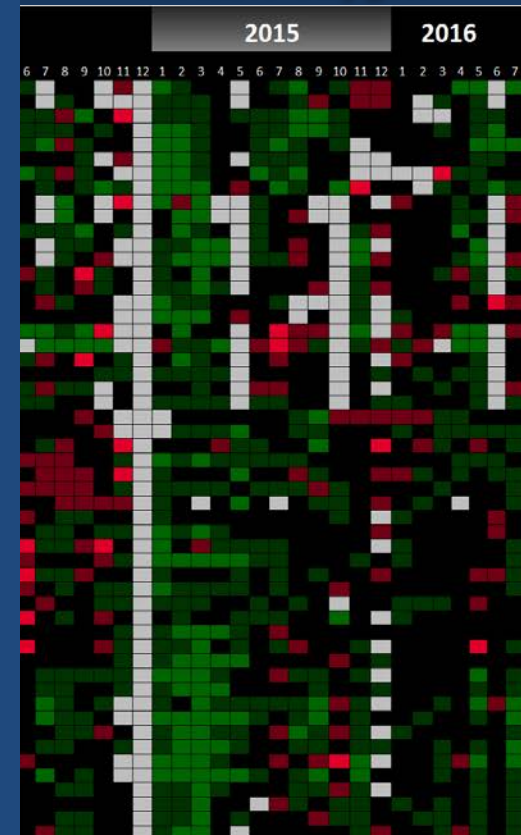
## Temperature Normalizing



## Normal Salinity



## Variable Oxygen



[Explore profiles at all stations](#)

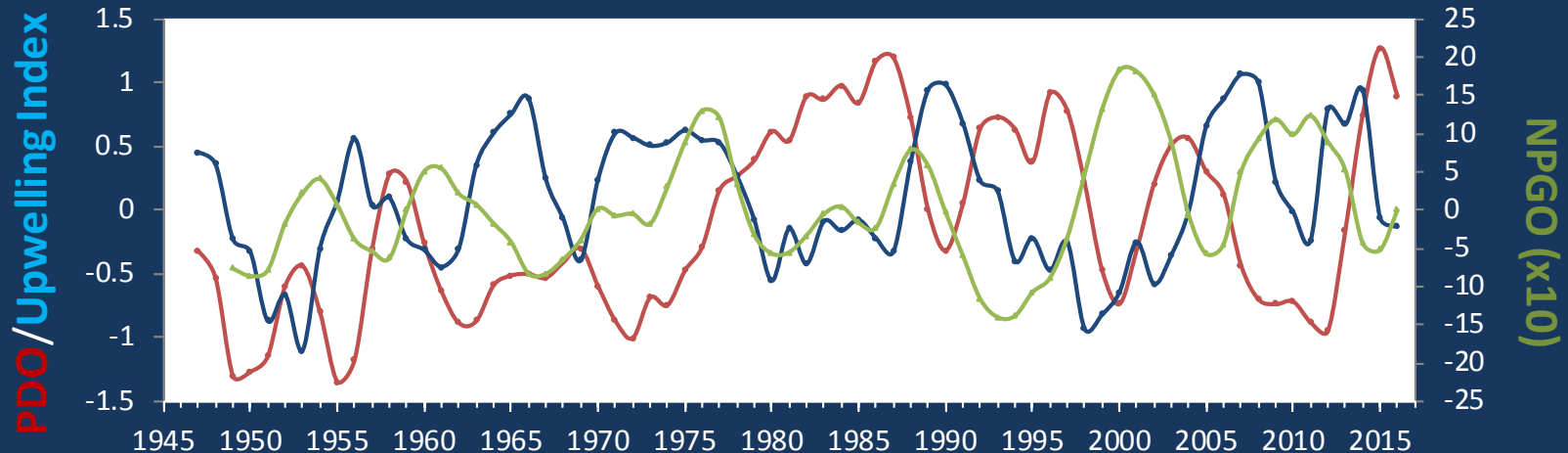
■ = higher than expected (>IQR, n=13)     
 ■ = expected (=IQR, n=13)     
 ■ = lower than expected (<IQR, n=13)  
■ = higher than previous measurements     
 ■ = no data     
 ■ = lower than previous measurements

# The ocean affects water quality: Ocean Climate Indices

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- a) Pacific Decadal Oscillation Index (**PDO, temperature**) [\(explanation\)](#)
- b) Upwelling Index (anomalies) (**Upwelling, low oxygen**) [\(explanation\)](#)
- c) North Pacific Gyre Oscillation Index (**NPGO, productivity**) [\(explanation\)](#)

**Three-year running average** of PDO, Upwelling, and NPGO indices scores



Ocean boundary conditions long-term variability: (a) water is still warm (PDO), (b) upwelling of low oxygen and high nutrient ocean water are normal (Upwelling Index anomaly), and (c) surface productivity along the coast is normalizing (NPGO).



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Large jellyfish aggregations confined to Eld and Budd Inlets. *Noctiluca* accumulating at the surface in Budd, Eld, and Case Inlets and in Nisqually Reach. Red-brown blooms widespread in finger inlets of South Sound, including Pickering Passage and Sinclair Inlet. Carr Inlet with green macro-algae developing nearshore, otherwise low activity. Port Madison with olive-brown bloom.

Start here

Mats of macro-algae, Von Geldern Cove, Carr Inlet



Bloom in Wollochet Bay, Hale Passage



## Mixing and Fronts:

Fronts in Totten Inlet Dena Passage, Case Inlet and Port Madison.



## Jellyfish:

Very numerous in Budd and Eld Inlet. Not seen in other inlets.



## Suspended sediment:

Little suspended sediment sources include local human activity around mussel rafts, tidal resuspension near shore and expected river inputs.



## Visible blooms:

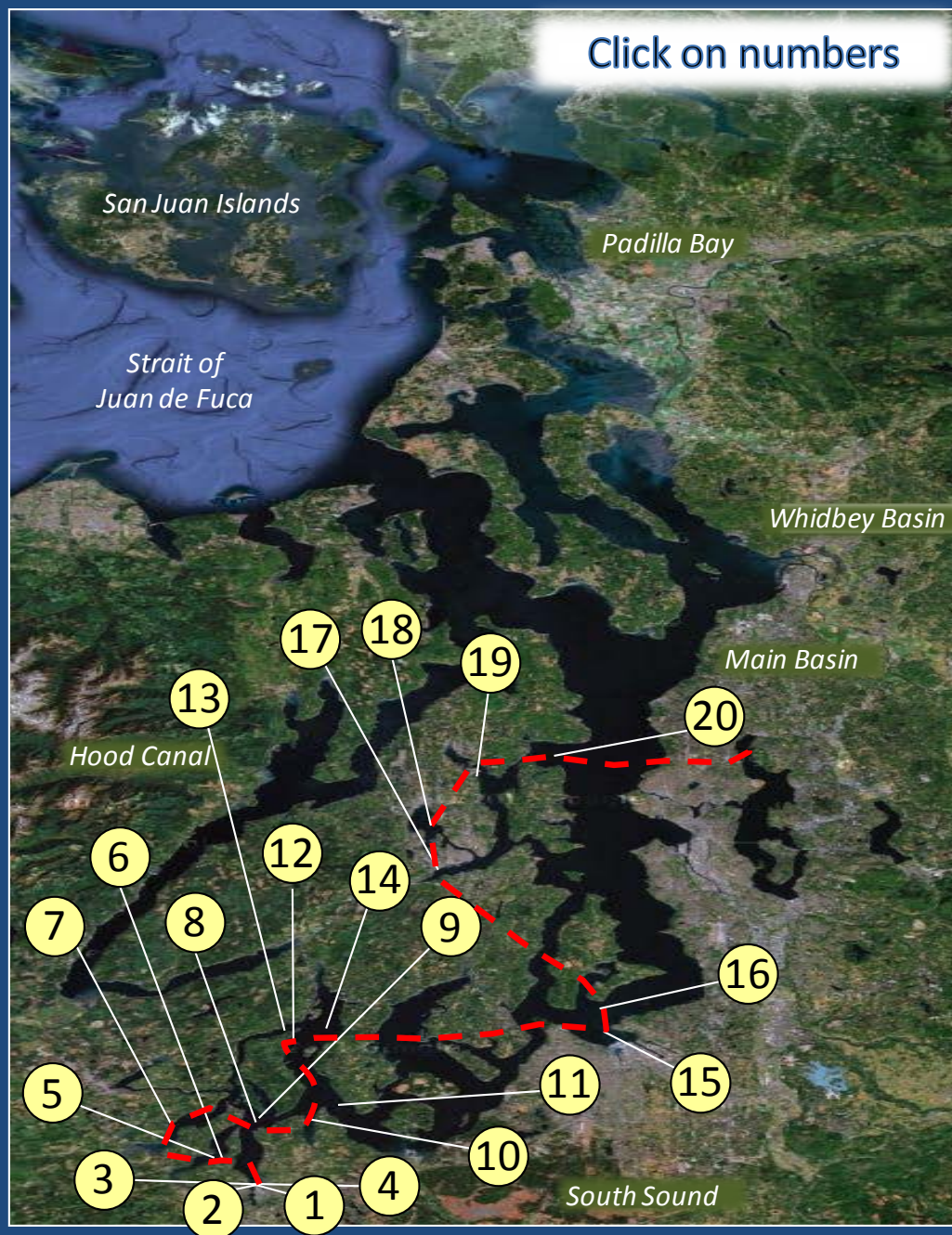
Budd, Eld, Henderson and Sinclair Inlets, Wollochet Bay and Jerrell Cove - strong red-brown blooms. Totten Inlet bloom in green and yellow. Dyes Inlet - green bloom in southern portions. Port Madison olive brown bloom.



## Debris:

Noctiluca in many places of South Sound. Macroalgae forming in Carr Inlet. Some larger organic material debris recorded east of Bainbridge island.

Click on numbers



## Aerial photography and navigation guide

**Date: 8-24-2016**

### Tide data (Seattle):

Time	Height (ft)	High/Low
04:10 AM	0.76	L
10:39 AM	9.33	H
04:14 PM	4.65	L
10:19 PM	11.23	H

### Flight Information:

Sunny, good visibility

--- Flight route

### Observation Maps:

Central Sound

South Sound



Field log

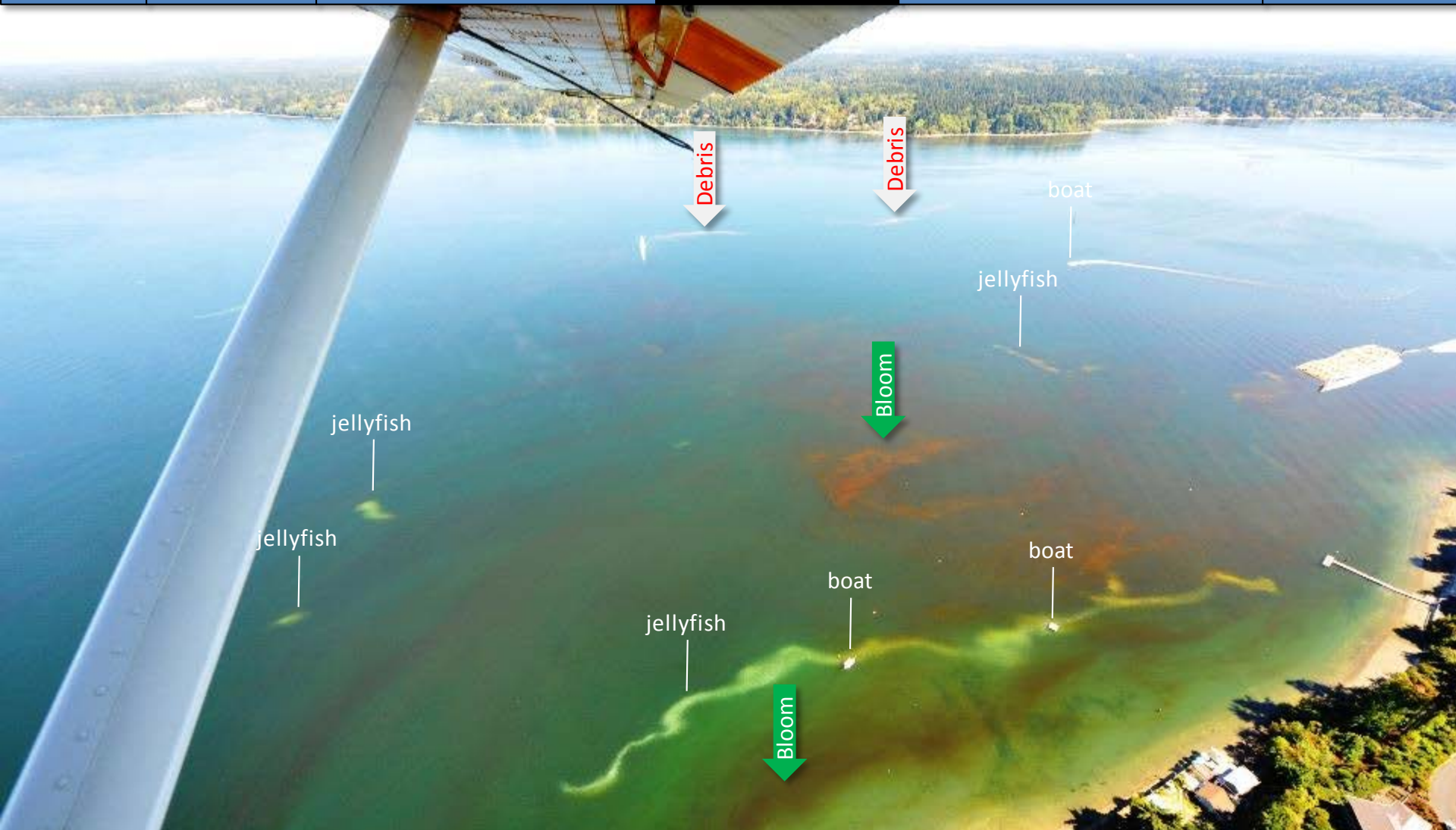
Climate

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*Strong red-brown bloom and abundant jellyfish patches and organic debris at surface.  
Location: Near Butler Cove, Budd Inlet (South Sound), 2:21 PM.*



Field log

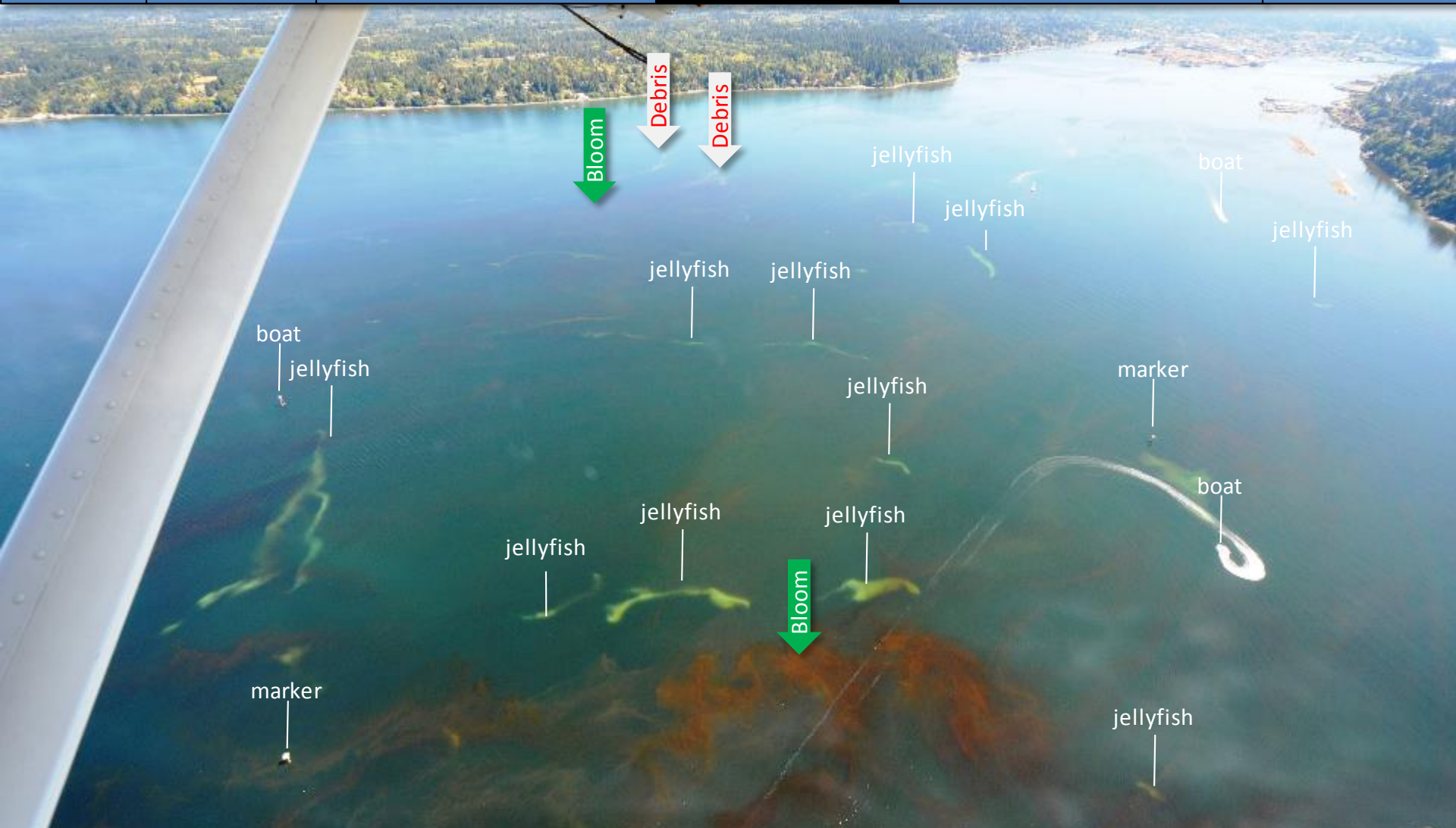
Climate

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Streams



*Strong red-brown bloom and abundant jellyfish patches and organic debris at surface.  
Location: Near Butler Cove, Budd Inlet (South Sound), 2:21 PM.*



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*Strong red-brown bloom and abundant jellyfish patches.*  
Location: *Big Tykle Cove, Budd Inlet (South Sound), 2:25 PM.*





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*Strong red-brown bloom and abundant jellyfish patches and organic debris at surface.*  
Location: Budd Inlet (South Sound), 2:25 PM.





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*Strong red-brown bloom and abundant jellyfish patches.*

Location: Eld Inlet (South Sound), 2:28 PM.





Field log

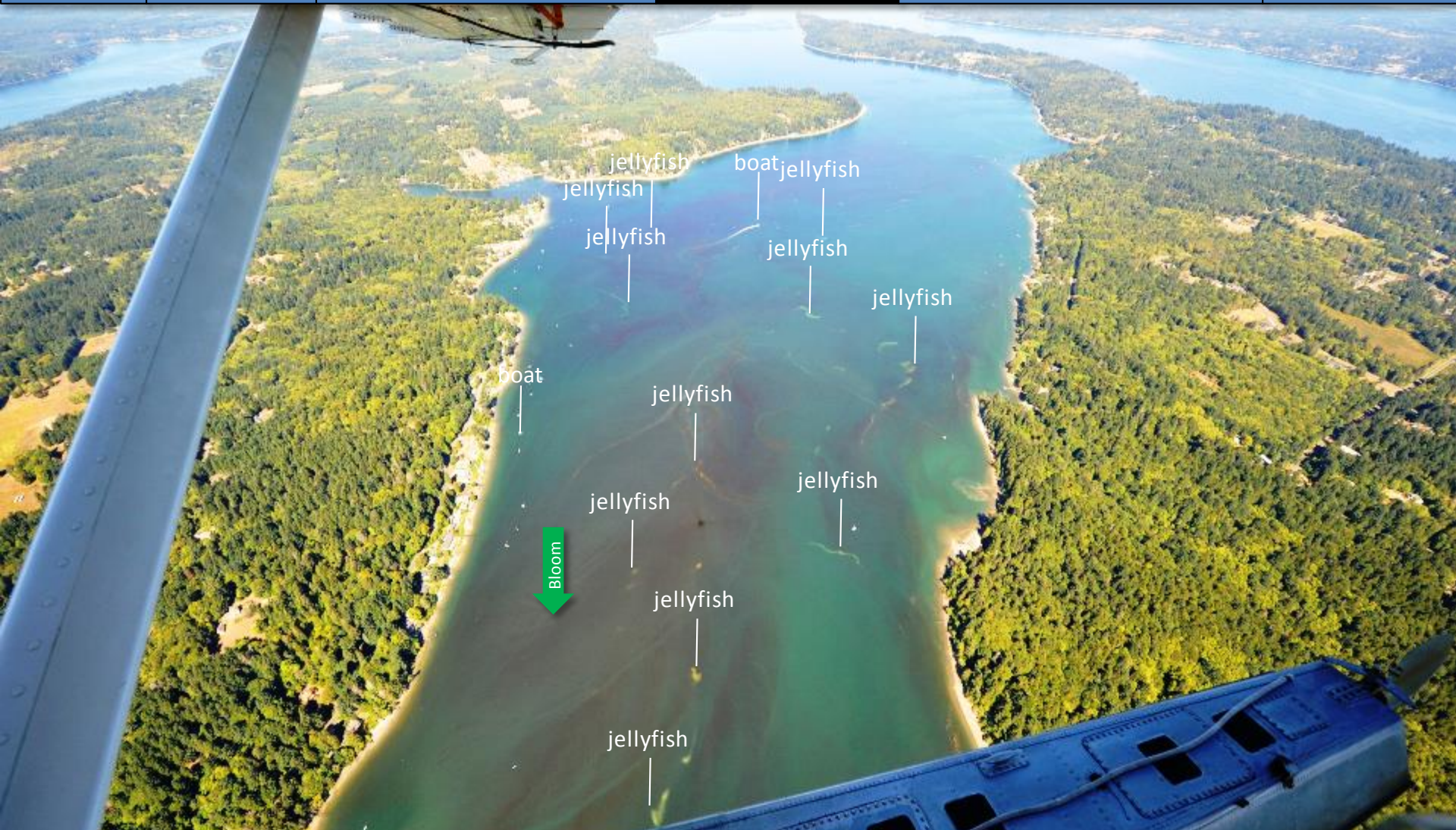
Climate

Water column

Aerial photos

Continuous monitoring

Streams



*Strong red-brown bloom and abundant jellyfish patches.*  
Location: Eld Inlet (South Sound), 2:28 PM.





Field log

Climate

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*Colorful bloom in green and red mixed in with suspended sediment flowing northward.*  
Location: Totten Inlet (South Sound), 2:30 PM.



Field log

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*Noctiluca and organic material accumulating near Boston Harbor*  
Location: Entrance to Budd Inlet (South Sound), 2:35 PM.





Field log

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*Noctiluca and organic material accumulating along tidal fronts. Green bloom in Peale Passage*  
Location: Entrance to Dana Passage (South Sound), 2:36 PM.



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*Strong bloom in brown, green and red. No jellyfish!*

Location: Above Woodland Park, Henderson Inlet (South Sound), 2:38 PM.





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*Noctiluca* accumulating as organic debris at surface.  
Location: Nisqually Reach (South Sound), 2:41 PM.



Field log

Climate

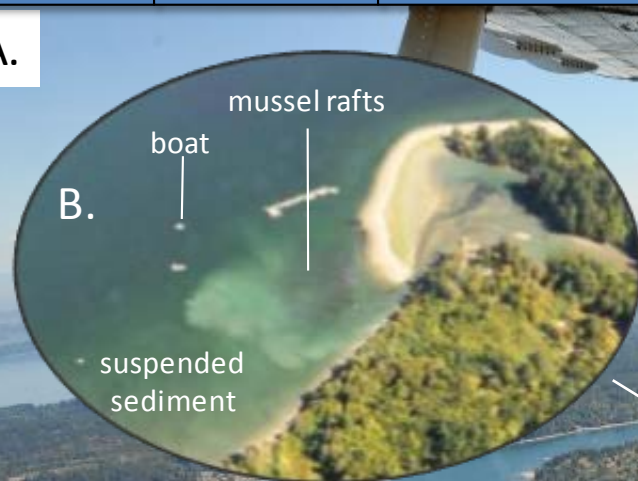
Water column

Aerial photos

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A.



*Suspended sediment plume near aquaculture structures possibly mussel rafts?*

Location: Northern Harstine Island, Case Inlet (South Sound), 2:46 PM.



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*Red-brown bloom, green bloom and reports of Noctiluca in Jarrell Cove.  
Location: Jarrell Cove, Harstine Island (South Sound), 2:46 PM.*



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*Large accumulations of a Noctiluca bloom at an unusual time of the year.*  
Location: Entrance to Pickering Passage, Case Inlet (South Sound), 2:48 PM.





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*Glacial flour in the Puyallup River plume. Flows are low in August. Fire in the background.  
Location: Commencement Bay (Central Sound), 2:58 PM.*



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*Tugboat and barge reveal narrow layer of glacial flour and freshwater originating from the Puyallup River.*  
Location: Commencement Bay (Central Sound), 2:58 PM.





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*Red-brown bloom adjacent to sediment plume from nearby creeks. No Jellyfish!*  
Location: Sinclair Inlet (Central Sound), 3:09 PM.



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*Green bloom confined to southern Dyes Inlet. Macroalgae developing off Elwood Point.*  
Location: Dyes Inlet (Central Sound), 3:12 PM.





Field log

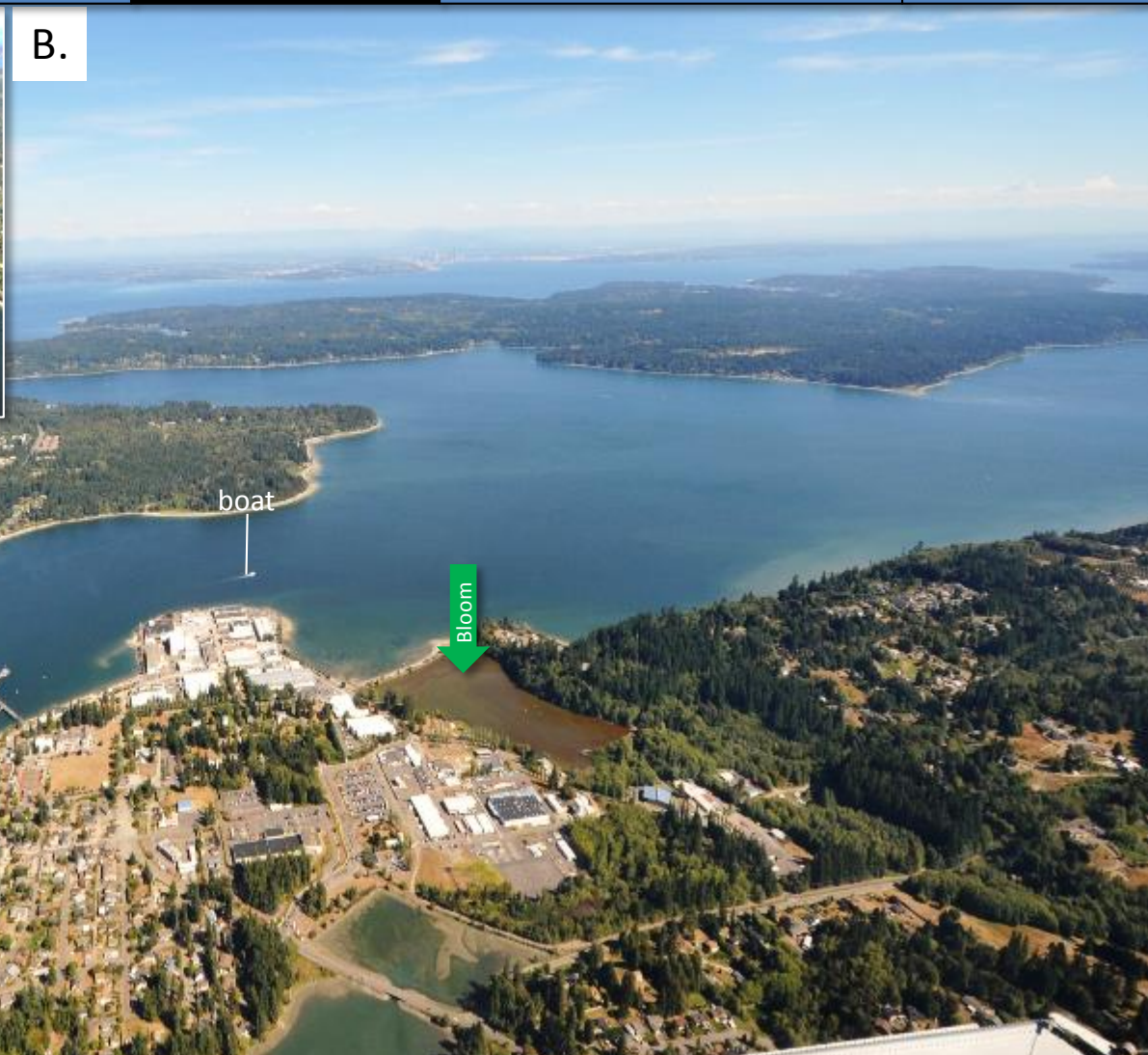
Climate

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*A. Liberty Bay with moderate green bloom, no jellyfish. B. Red-brown bloom in shallow embayment.*  
Location: Liberty Bay, Poulsbo (Central Sound), 3:17 PM.





Field log

Climate

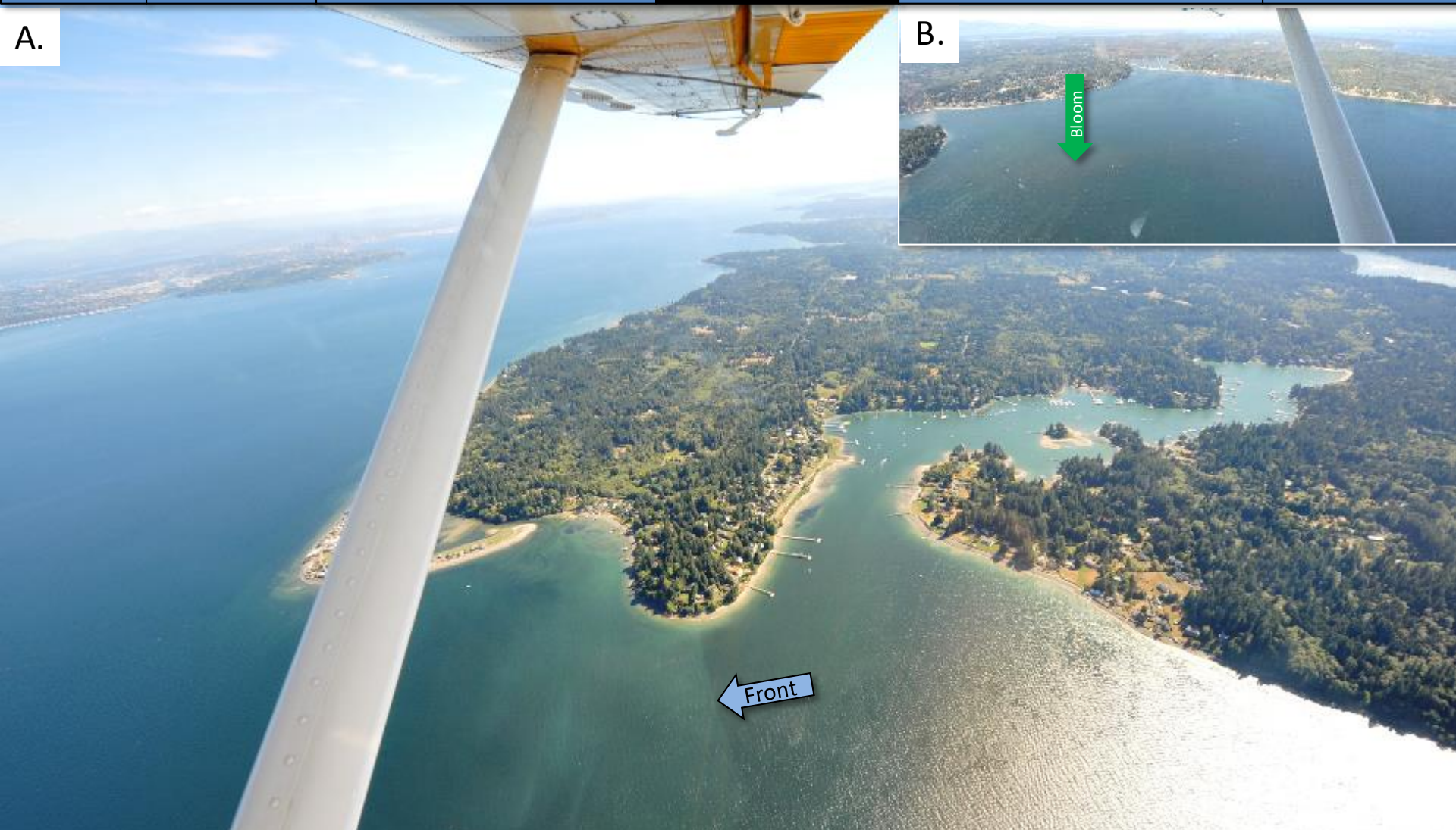
Water column

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A.



B.



*A. Front and B. localized bloom in Port Madison.*

Location: A and B near Westport, Bainbridge Island (Central Sound), 3:21 PM.



Field log

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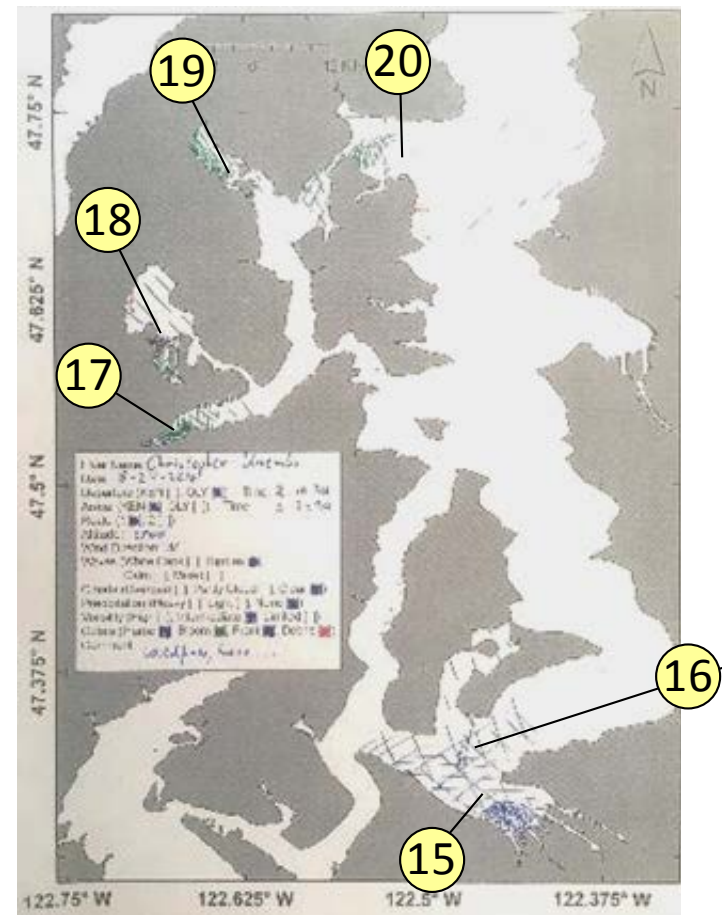
Streams

**Date: 8-24-2016**

Hood Canal

Central Sound

n.a.



*Numbers on map refer to picture numbers for spatial reference*



Field log

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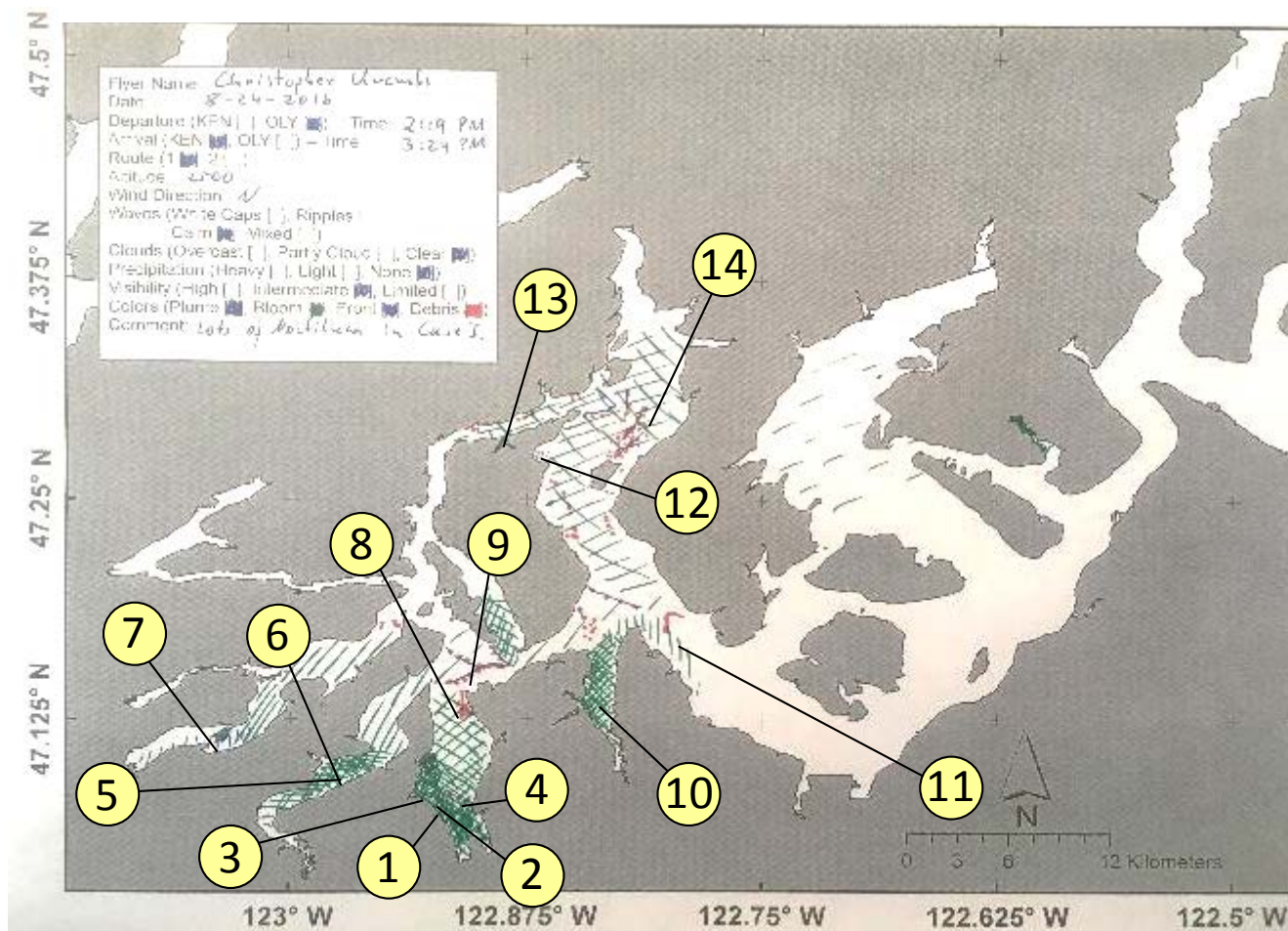
Aerial photos

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**Date: 8-24-2016**

**South Sound**



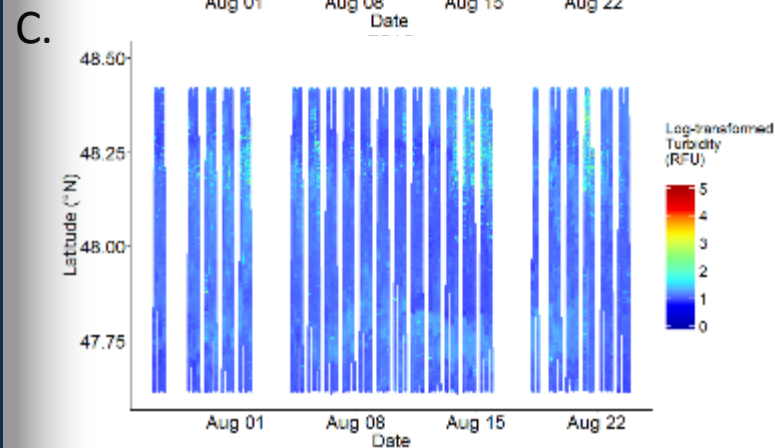
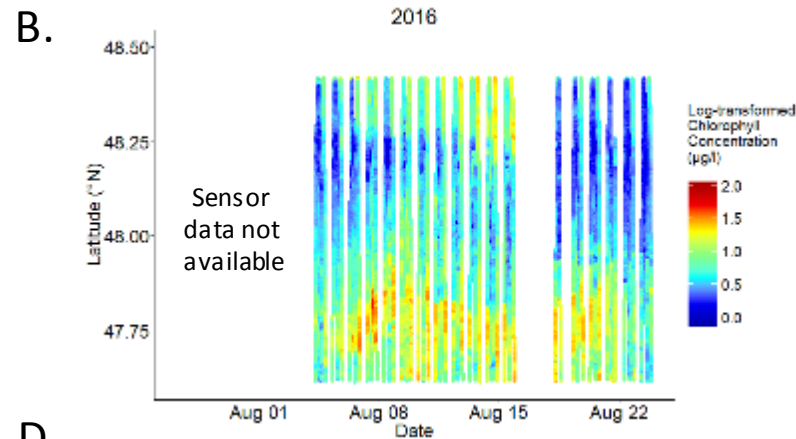
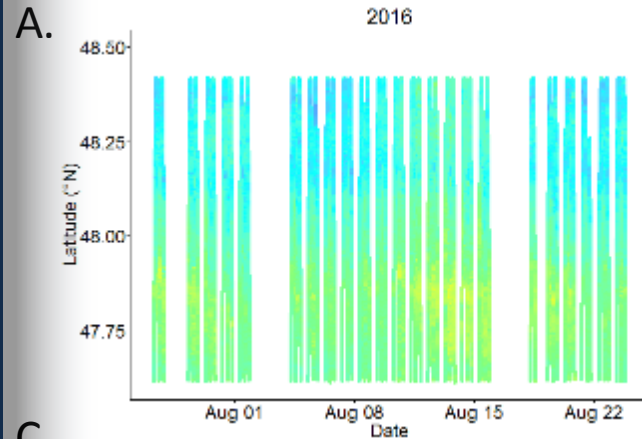
*Numbers on map refer to picture numbers for spatial reference*





## Summary of *Victoria Clipper IV* ferry data:

Summer trends of warm water and algal growth continue. Temperatures are generally  $>15^{\circ}\text{C}$  in Puget Sound. Turbidity and chlorophyll have similar patterns; thus, algae may contribute largely to turbidity. In mid-August, chlorophyll peaked in central Puget Sound and temporarily increased near Victoria, BC.



**D.**

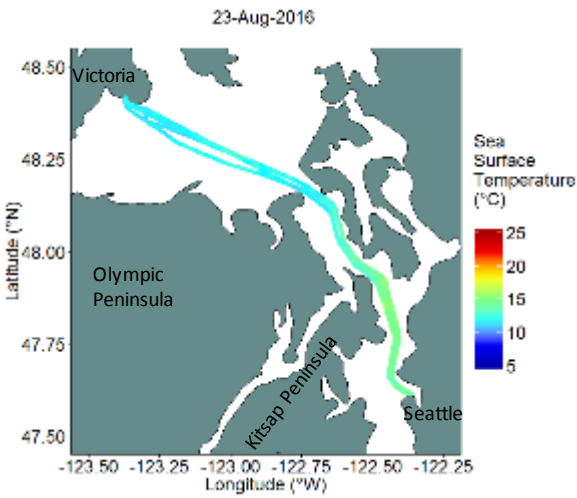
CDOM sensor is out of commission until further notice.

The *Victoria Clipper IV* carries sensors in its sea chest. The sensors allow us to plot over time transects of:

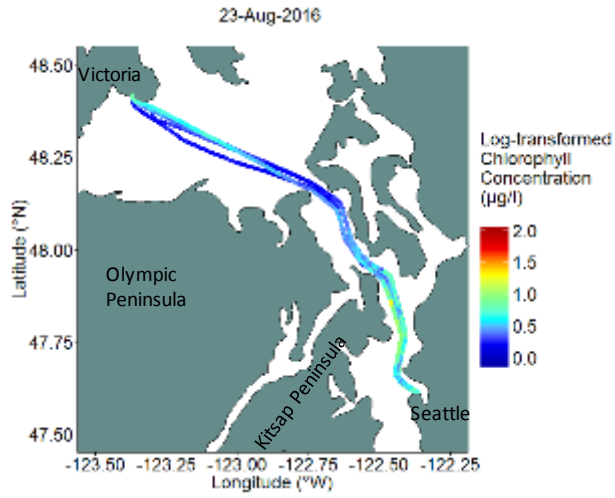
- A. Temperature
- B. Chlorophyll
- C. Turbidity
- D. CDOM = colored dissolved organic matter

Over time, we see the dynamics of these variables in surface water between Seattle and Victoria, BC.

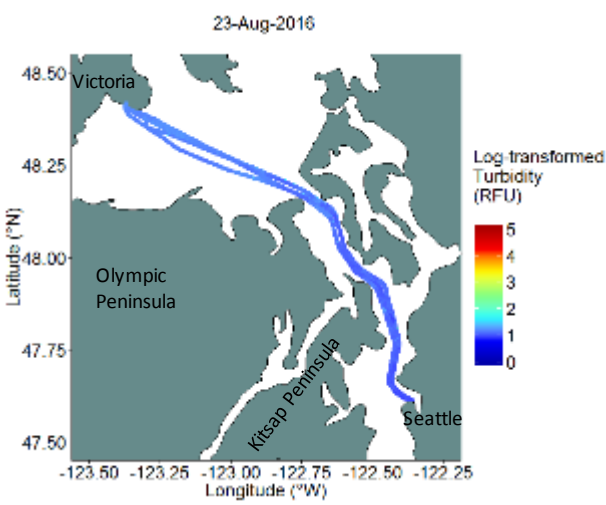
A.



B.



C.



D.

CDOM sensor is out of commission until further notice.

Figures show daily data from sensors installed on the ferry which measure near-surface waters at 5-sec intervals while the Victoria Clipper IV transits between Seattle and Victoria, BC.

- A. Sea Surface Temperature:** Water is warm in Central Basin, with temperatures over 15 °C.
- B. Chlorophyll:** Concentrations are high in Central Basin, with patchy conditions in the Strait of Juan de Fuca.
- C. Turbidity:** Turbidity was low on the entire route.
- D. Colored Dissolved Organic Matter (CDOM):** Not available.

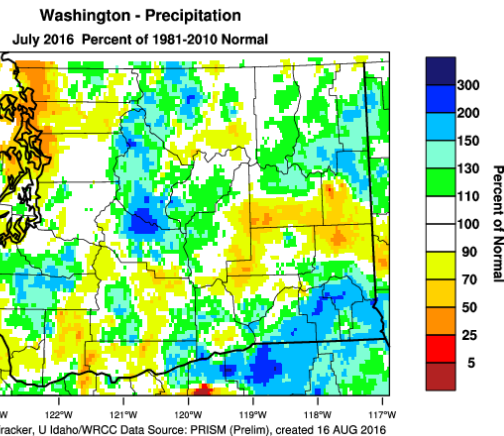




*Jim Shedd,  
Ecology*

Closer-to-usual precipitation in July improved streamflows. However, in August, many streams slipped back to below-normal or much-below-normal flows increasing water temperatures, oxygen depletion, reduction of fish habitat, and fish mortality.

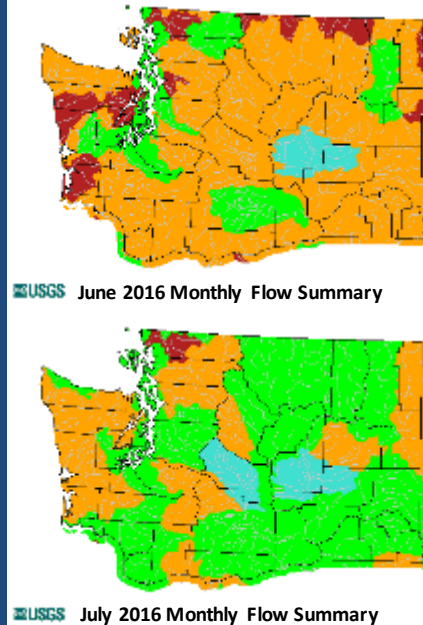
A.



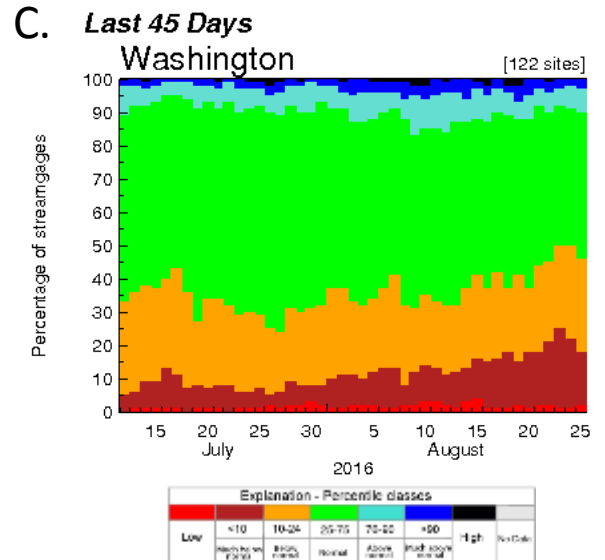
A. Precipitation in July increased to near normal in some areas of the Puget Sound Basin (above).

B. As a result, streamflows improved somewhat in July over June, particularly in the Olympics and West Central Cascades, see flow summary maps B.

B.



C.



In August, however, the percentage of streams experiencing lower-than-normal flows increased to almost 50% (C).

The increase was especially pronounced in the *already very low* ranges (flows below the 10<sup>th</sup> percentile).

# Get data from Ecology's Marine Monitoring Programs



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## Long-Term Monitoring Network

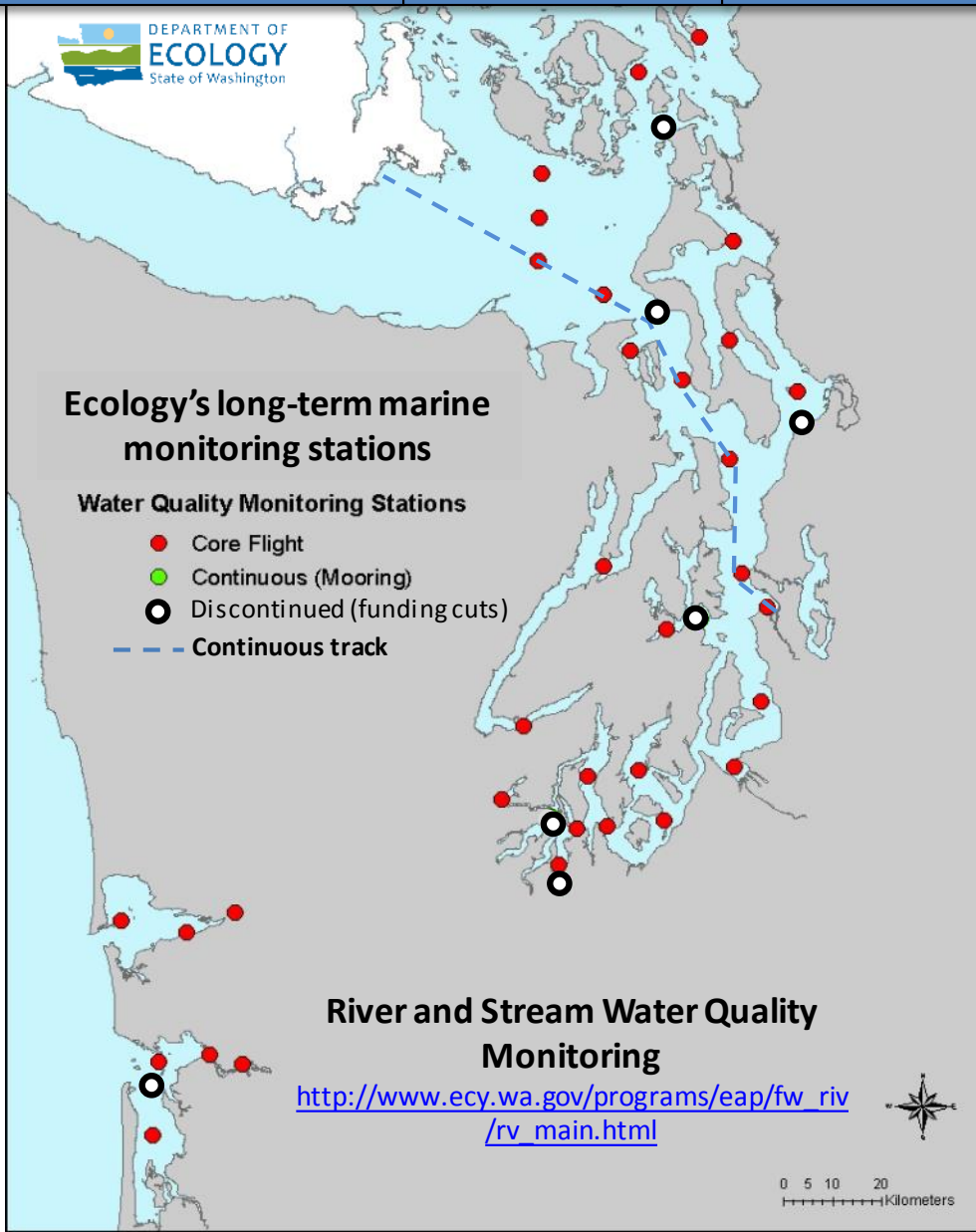


[christopher.krembs@ecy.wa.gov](mailto:christopher.krembs@ecy.wa.gov)



## Access core monitoring data:

<https://fortress.wa.gov/ecy/eap/marinewq/mwdata/set.asp>



## Real-Time Sensor Network



[Suzan.Pool@ecy.wa.gov](mailto:Suzan.Pool@ecy.wa.gov)



## Access mooring data:

[ftp://www.ecy.wa.gov/eap/Mooring\\_Raw/Puget\\_Sound/](ftp://www.ecy.wa.gov/eap/Mooring_Raw/Puget_Sound/)



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>



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**We are looking for feedback to improve our products.**

**Dr. Christopher Krembs**  
[christopher.krembs@ecy.wa.gov](mailto:christopher.krembs@ecy.wa.gov)

**Marine Monitoring Unit  
Environmental Assessment Program  
WA Department of Ecology**

