



Eyes Over Puget Sound

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

Surface Conditions Report, *November 22, 2016*

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

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

Field log

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Water column

Aerial photos

Continuous monitoring

Streams

*Mya Keyzers
Laura Hermanson*



Skip Albertson



*Dr. Christopher
Krembs (Editor)*



*Julia Bos
Suzan Pool*



Tyler Burks



Personal impressions

[p. 3](#)

Particulate organic matter is important.

Climate influences

[p. 5](#)

Wet and warm conditions prevail, with above-normal downwelling and cold phase ENSO present (La Niña).

Water column

[p. 6](#)

Record-breaking water temperatures, salinities, and oxygen are returning to mostly normal.

Aerial photography

[p. 10](#)

Large jellyfish aggregations in finger Inlets of South Sound. Slowly fading red-brown blooms in Eld and Budd Inlets. Masses of suspended sediment east of Steamboat Island.

Continuous monitoring

[p. 34](#)

The water has cooled but Puget Sound is still a little warmer. Decrease in chlorophyll fluorescence coincided with increase in turbidity, most likely from rain and winds.

Streams

[p. 36](#)

Strong precipitation in October greatly improved Puget Sound streamflows. In October, many streams recovered dramatically.

Editorial assistance provided by:

Suzan Pool, Carol Maloy

Nutrients in the form of particulate material in the water

Why do we care?

- There could be a big difference how organic material and energy is cycling through the marine food web of Puget Sound in recent years.
- Near the surface, roughly 30% of nutrients are in the particulate phase. When and how quickly particulate material sinks is important to understand the release of nutrients back into the water at depth and when nutrients become again available for algae growth at the surface.
- If you have buoyant or ballasted organic material (e.g. ballasted by silicate from diatoms), organic material sinks at different rates. Because of difference in sinking speed particles are broken down by microbes and remineralize either in the watercolumn or in the sediment.



The study requires us to take on more samples in the confined space of the plane. But it works well.



Collection of total organic carbon, total nitrogen, particulate organic carbon, and dissolved inorganic nutrients from 10-m depth and near bottom.

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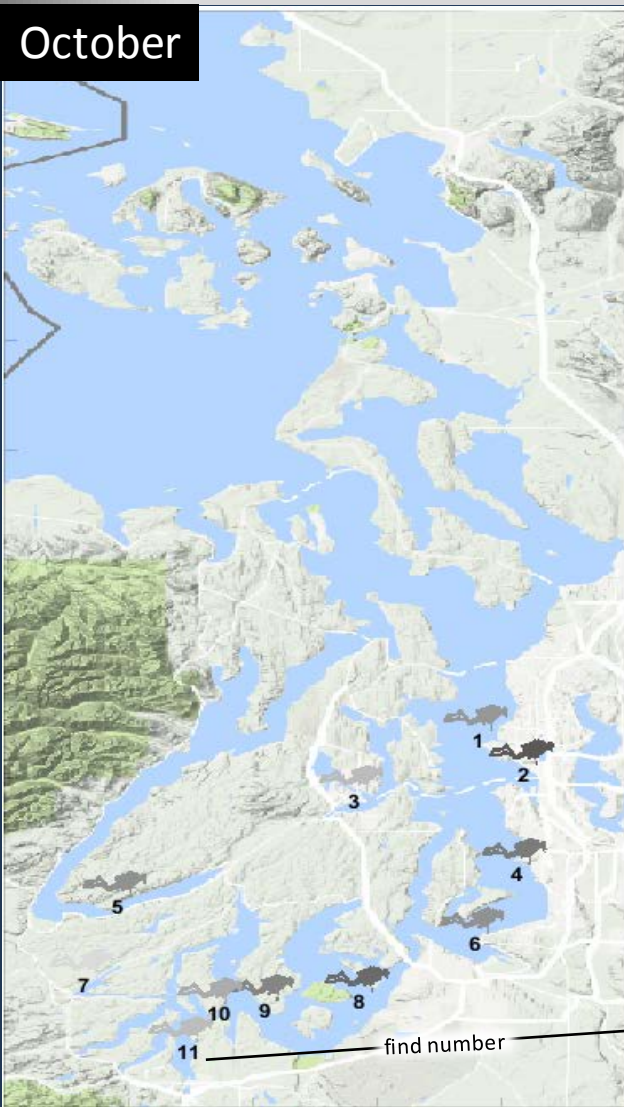
Continuous monitoring

Streams














What was the visibility in the water for divers?

October



Best /Depth Least /Depth

1)	23 / 98		21 / 3
2)	38 / 80		10 / 3
3)	15 / 8		13 / 33
4)	30 / 92		15 / 3
5)	25 / 26		2 / 3
6)	25 / 69		7 / 3
7)	7 / 11		3 / 5
8)	34 / 79		19 / 11
9)	28 / 5		22 / 72
10)	19 / 52		16 / 97
11)	15 / 28		6 / 7

Find depths with high and low visibility

- Best visibility** was 35 feet around Seacrest Park (2), but South Puget Sound (8-10) and Hood Canal (5) below 20 ft are better than normal.
- Poor visibility** occurred in many places within the upper 20 feet of the water.
- South Puget Sound visibility is better than normal except by Shelton (7) and Olympia (11).
- 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).
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, page 26.

Summary:

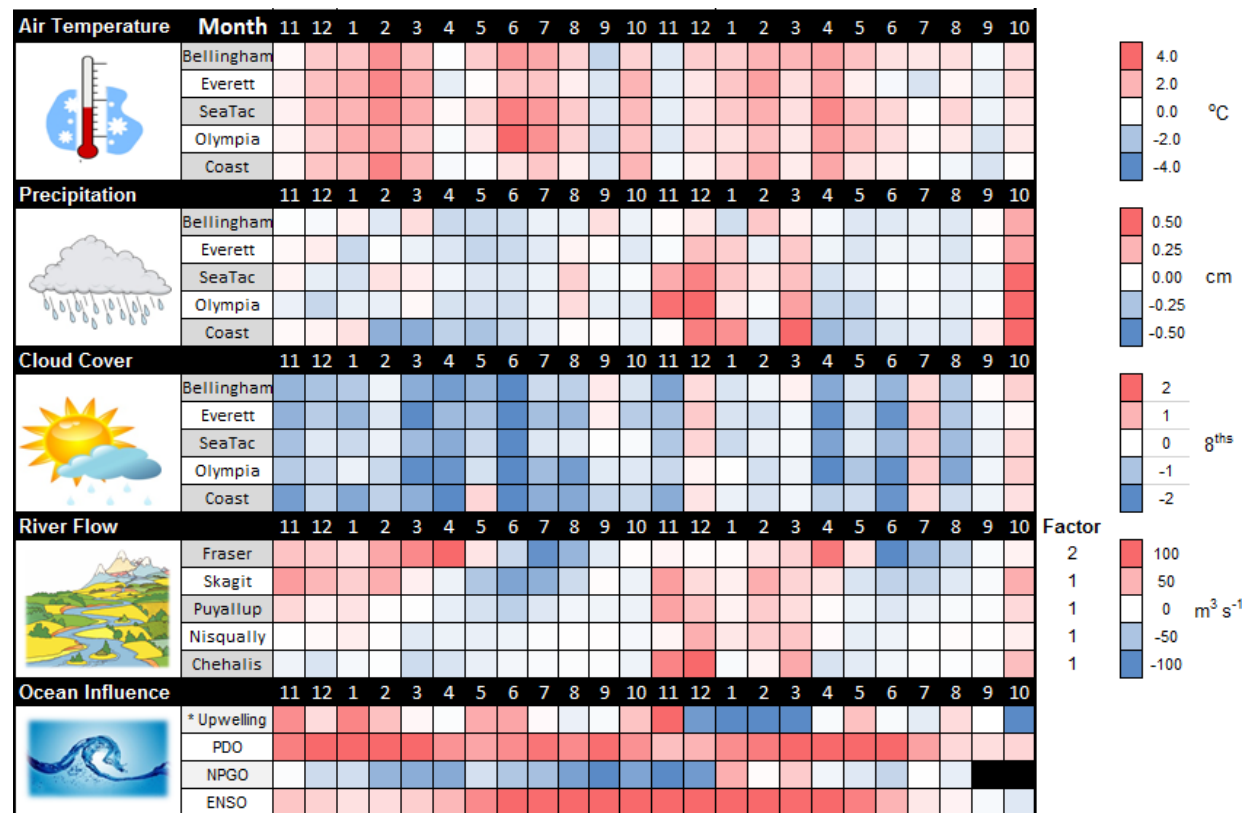
Air temperatures in October have been above normal, after a cool spell in September.

Precipitation levels have been very high.

Sunshine levels were generally low (higher cloud cover).

River flows were all above normal.

Downwelling was very strong. ENSO has entered the La Niña phase and PDO is trending towards neutral.



*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

Station network of ambient
water quality monitoring stations

We use a boat and a chartered float plane equipped with a CTD package 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

Field log

Climate

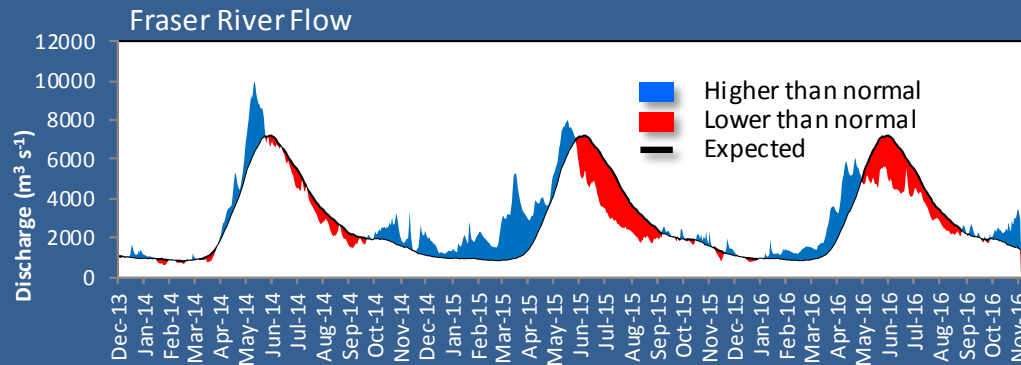
Water column

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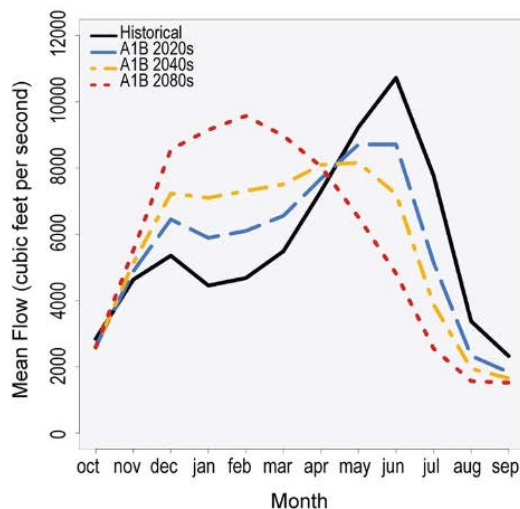
Year 2016 had record-breaking global temperatures. Peak river flows are moving earlier in the year, into the springtime. This will affect the estuarine circulation and increase the water residence time, therefore increasing the relative burden of waste water discharge during the summer months (with lower flows).



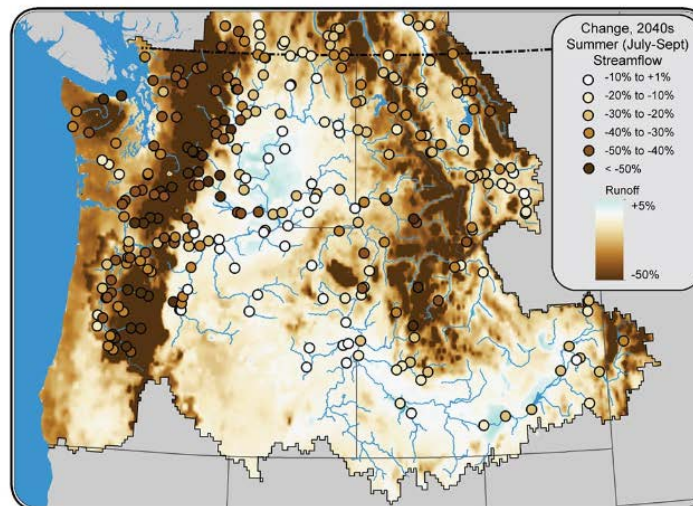
2016 Fraser River summer flow was extremely low in response to warm winter temperatures and lack of snowpack in BC. Very low summer flows inhibited the renewal of water in Puget Sound. November flow is above normal.

Source: http://wateroffice.ec.gc.ca/index_e.html

Future Shift in Timing of Stream Flows



Reduced Summer Flows



Climate Change Impacts in the United States, 2014

Mote et al., Eds., U.S. Global Change Research Program, 487-513.
doi:10.7930/J04Q7RWX.

On the Web:

<http://nca2014.globalchange.gov/report/regions/northwest>:

Field log

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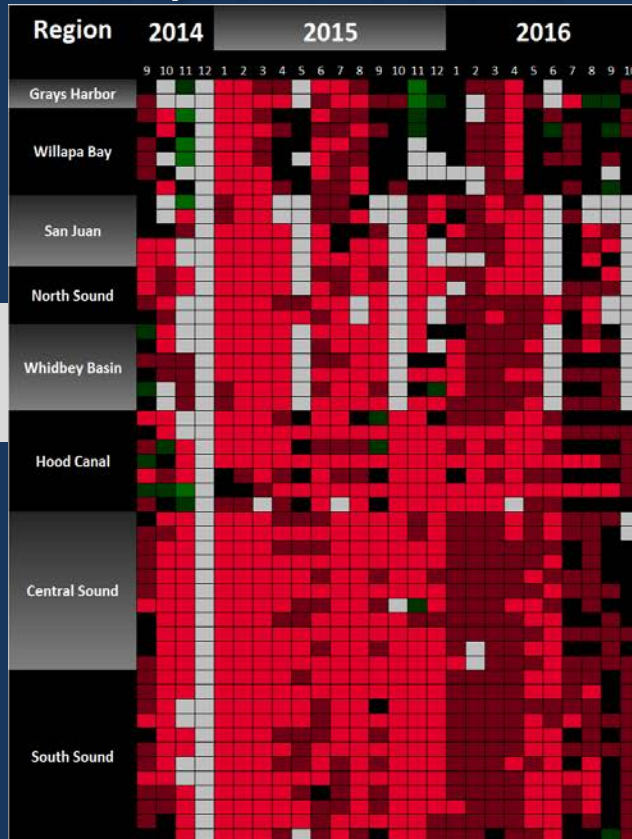
Aerial photos

Continuous monitoring

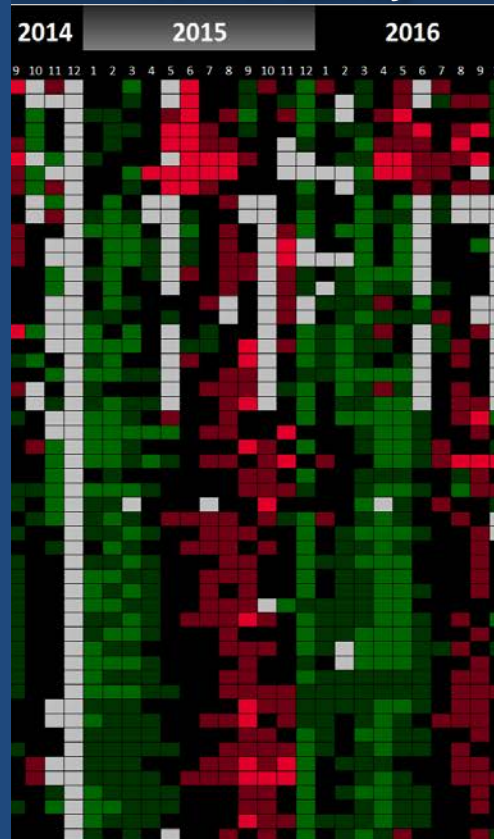
Streams

Puget Sound October conditions are normalizing with the transition to La Niña. Record-breaking water temperatures anomalies are weakening with Hood Canal and South Sound still lagging behind. Rain normalized higher salinities and oxygen is now mostly normal. At the coast, conditions are normalizing.

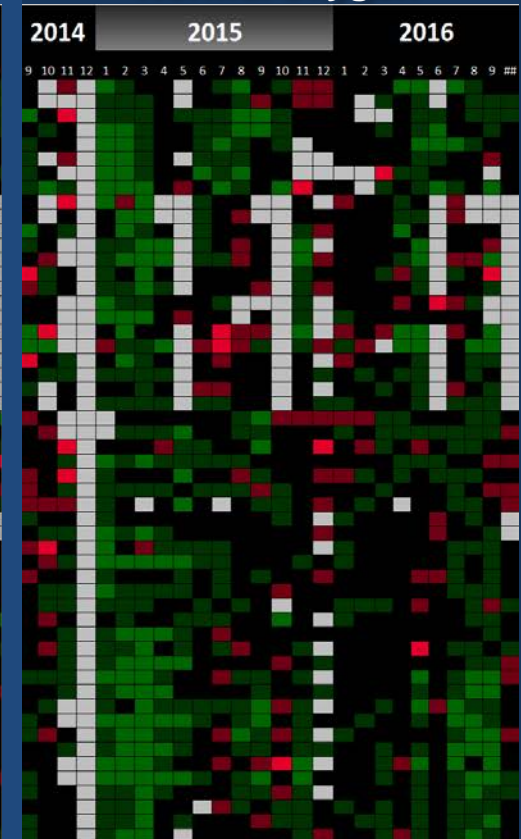
Temperature more Normal



Normal Salinity



Normal Oxygen



[Explore profiles at all stations](#)

■ = higher than expected (>IQR, n=13)
■ = higher than previous measurements

■ = expected (=IQR, n=13)
■ = no data

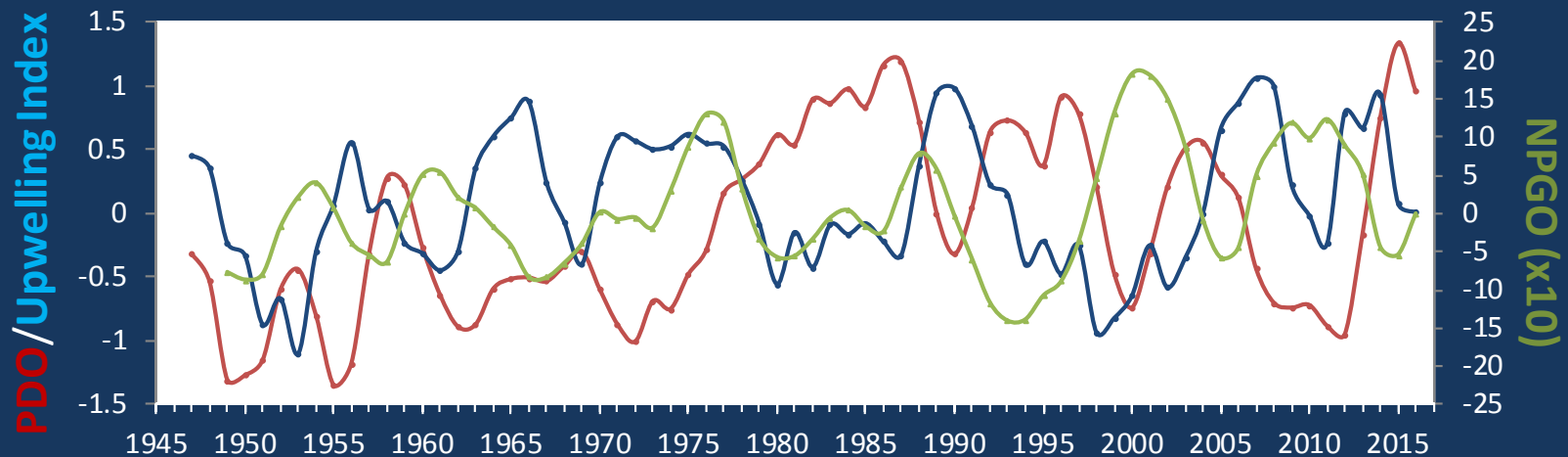
■ = lower than expected (<IQR, n=13)
■ = lower than previous measurements

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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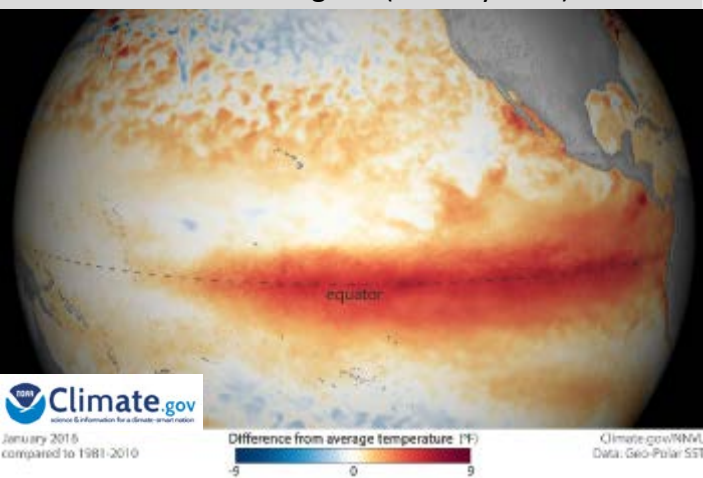
Streams



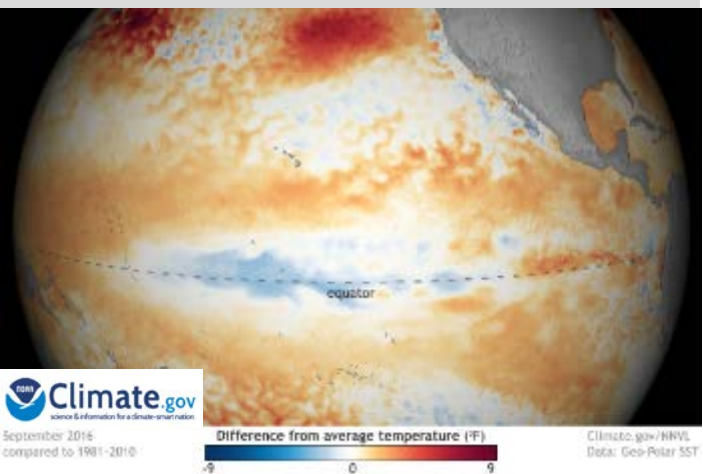
Large jellyfish aggregations in finger Inlets of South Sound. Slowly fading red-brown blooms in Eld and Budd Inlets. Otherwise, water is very clear. A lot of suspended sediment east of Steamboat Island and south of Squaxin Island.

Start here

El Niño is now gone (January 2016)



La Niña is here (September 2016)



Front

Mixing and Fronts:

Some tidal eddies in South Sound which is otherwise calm.



Jellyfish:

Very numerous in Budd, Eld, Totten, and Henderson Inlets.

Plume

Suspended sediment:

Strong near shore suspended sediments east of Steamboat Island.

Bloom

Visible blooms:

Red-brown blooms in Eld and Budd Inlets which have clear water otherwise.

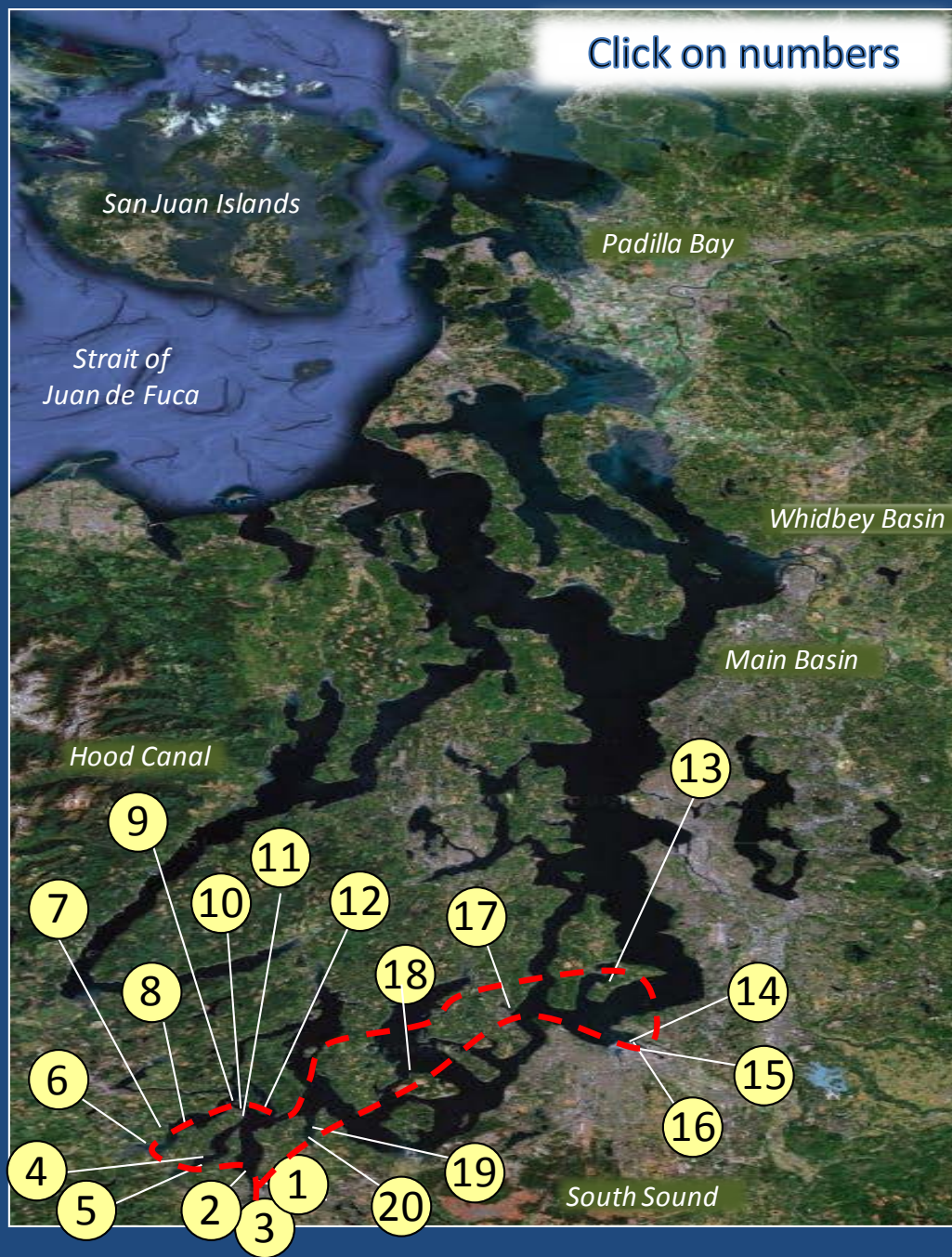
Debris

Debris:

Occasional organic debris mostly near Vashon Island.



Click on numbers



Aerial photography and navigation guide

Date: 11-22-2016

Tide data (Seattle):

Time	Height (ft)	High/Low
04:38 AM	2.4	L
11:55 AM	11.65	H
06:51 PM	3.74	L

Flight Information:

Overcast fair visibility, had to turn around because of visibility.

--- Flight route

Observation Maps:

Central and North Sound

South Sound



Field log

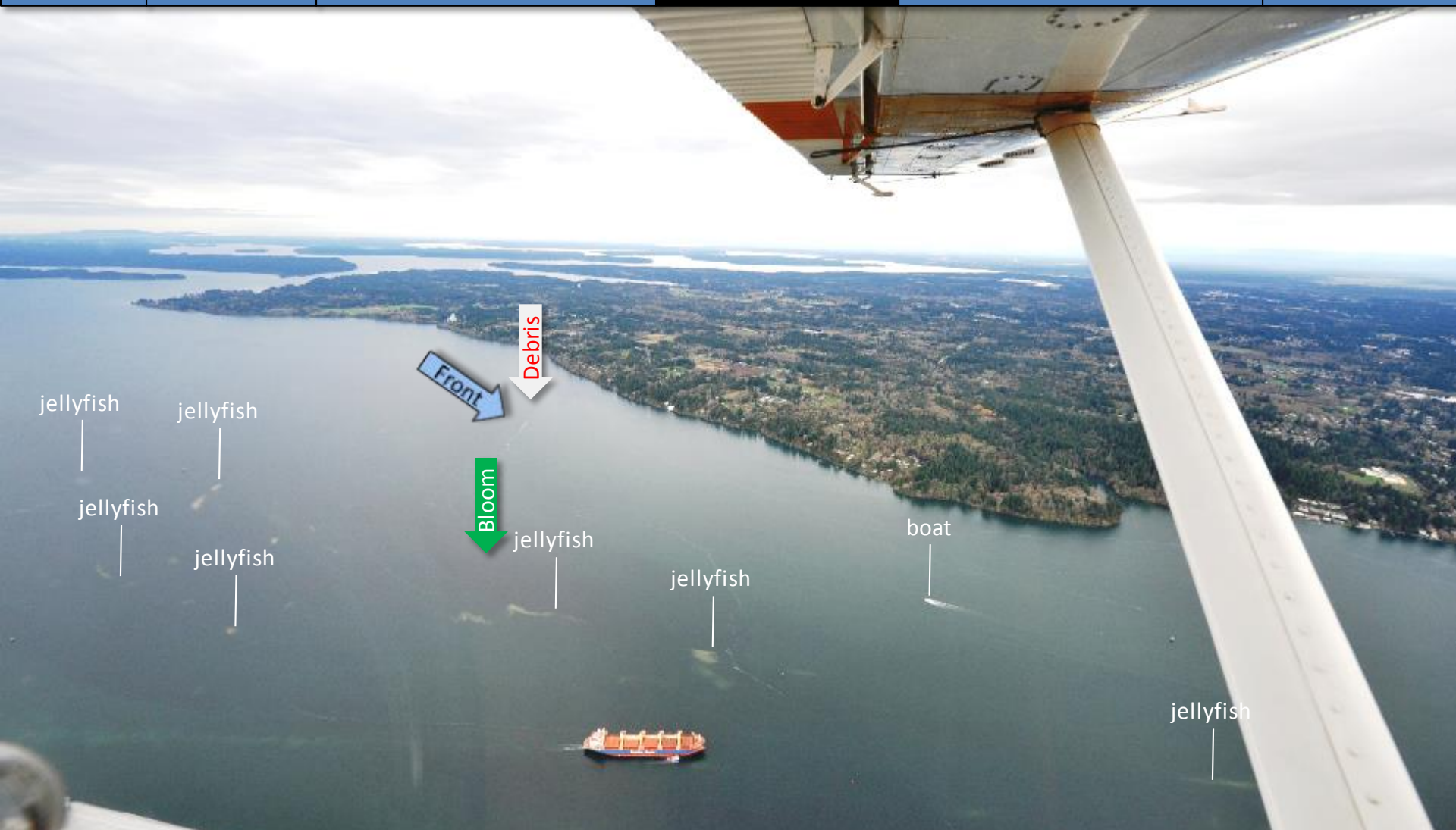
Climate

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Jellyfish patches still very numerous, a fading bloom, and organic debris on the eastern side of the inlet.
Location: Budd Inlet (South Sound), 12:17 PM.

Field log

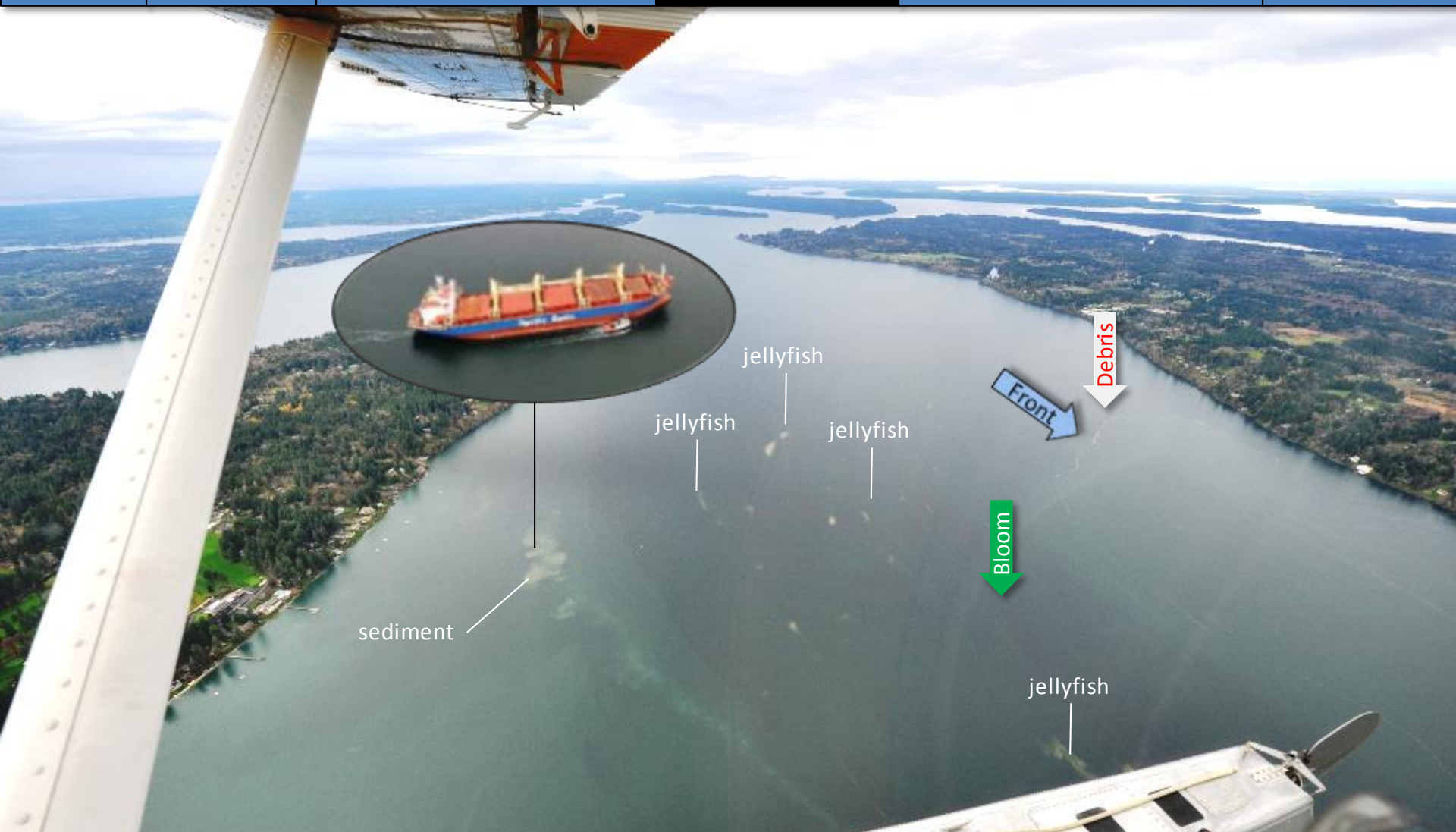
Climate

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Suspended sediment from prop wash along path of ship. Jellyfish and fading bloom in red-brown.
Location: Budd Inlet (South Sound), 12:19 PM.

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Abundant jellyfish patches.

Location: Budd Inlet (South Sound), 12:18 PM.

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Long ribbon of jellyfish, red-brown bloom, and river plume.

Location: Eld Inlet (South Sound), 12:21 PM.

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Long patches of jellyfish, red-brown bloom, and river plume.

Location: Eld Inlet (South Sound), 12:21 PM.

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River plume with lots of suspended sediment from recent rains.
Location: Totten Inlet (South Sound), 12:23 PM.

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River plume hugging western shores.
Location: Totten Inlet (South Sound), 12:26 PM.



Field log

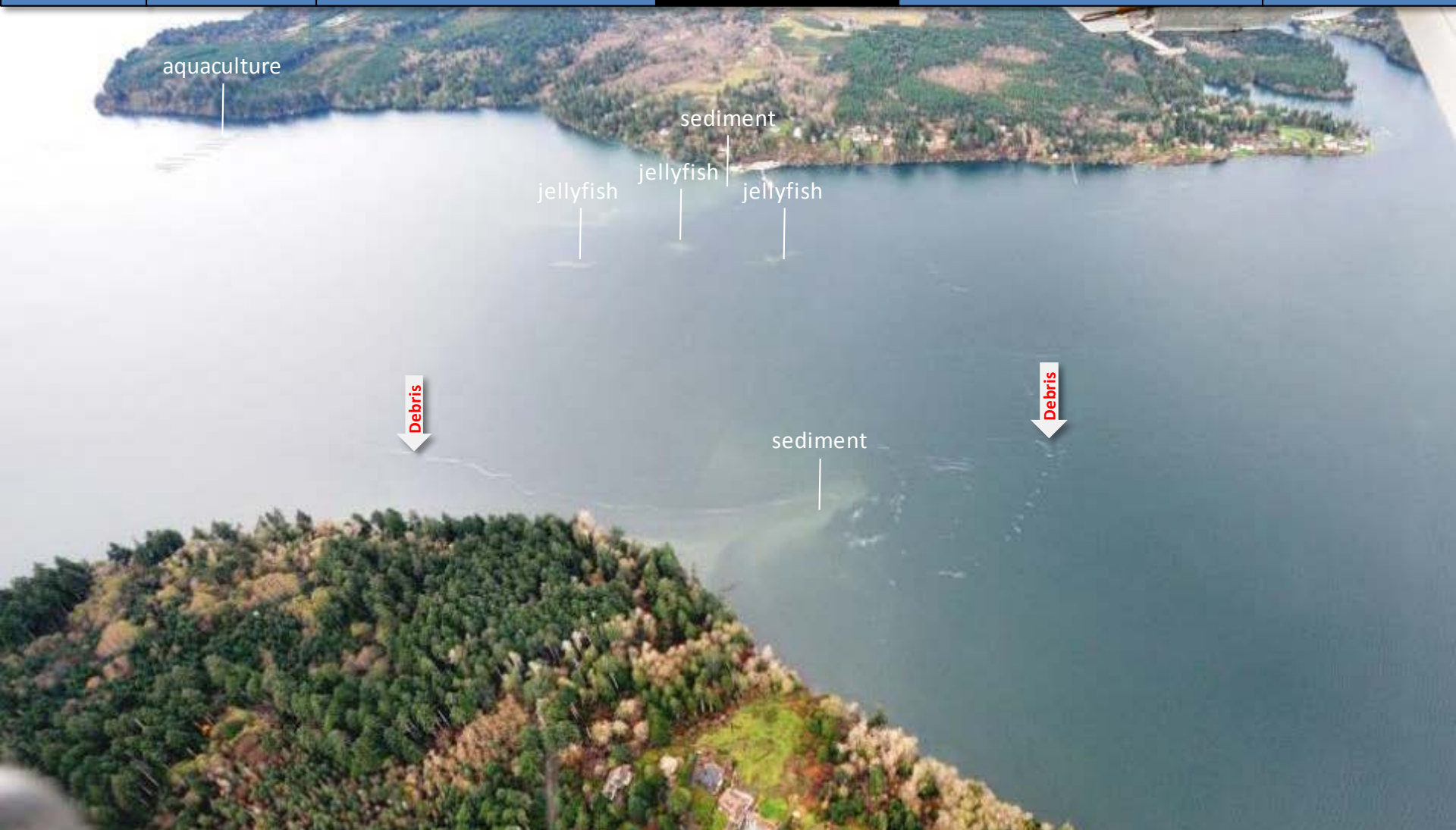
Climate

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Jellyfish patches and suspended sediment surrounded by organic debris.

Location: Totten Inlet (South Sound), 12:27 PM.

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Incoming tidal wedge with clearer water coming from Dana Passage.

Location: Hope Island (South Sound), 12:29 PM.

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Large quantities of suspended sediment and eddies off eastern shores of Steamboat Island.
Location: Totten Inlet (South Sound), 12:31 PM.



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Large quantities of suspended sediment and eddies off eastern shores of Steamboat Island.
Location: Totten Inlet (South Sound), 12:31 PM.



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Large quantities of suspended sediment off the tip of Squaxin Island.
Location: Squaxin Island from two perspectives, A. and B. (South Sound), 12:32 PM.

Field log

Climate

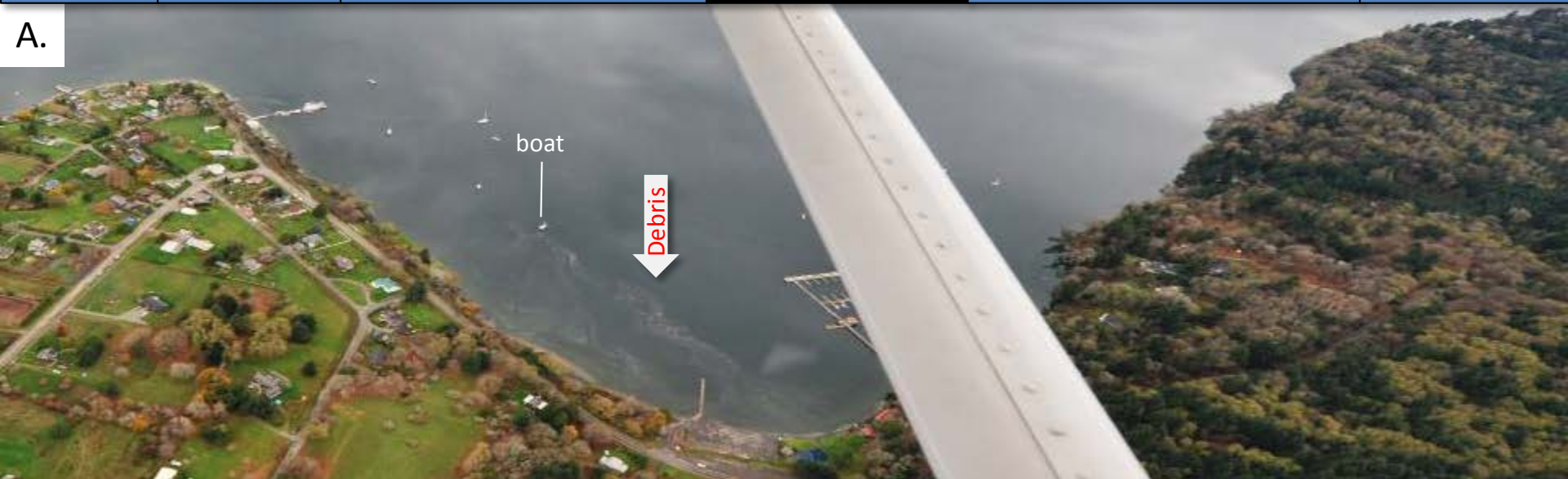
Water column

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A.



B.



A. Organic debris. B. Organic debris with faint orange color which could be Noctiluca?

Location: A. Dockton Park, Quartermaster Harbor, B. Vashon Island (Central Sound), 12:47 PM.



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Puyallup River plume not visible. Debris line in Blair Waterway.
Location: Port of Tacoma, Commencement Bay (Central Sound), 12:51 PM.

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Puyallup River plume not visible likely due to recent precipitation as snow in the mountains.
Location: Port of Tacoma, Commencement Bay (Central Sound), 12:51 PM.

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Puyallup River plume not visible likely due to recent precipitation as snow in the mountains.
Location: Port of Tacoma, Commencement Bay (Central Sound), 12:51 PM.

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Calm and uneventful in Gig Harbor at the entrance to the Tacoma Narrows.
Location: Gig Harbor (Central Sound), 12:57 PM.

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Front across Pitt Passage. Many little fishing vessels with nets.
Location: McNeil Island (South Sound), 1:03 PM.



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Greenish water with numerous jellyfish patches.
Location: Henderson Inlet (South Sound), 1:09 PM.

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Greenish water with numerous jellyfish patches.
Location: Henderson Inlet (South Sound), 1:09 PM.

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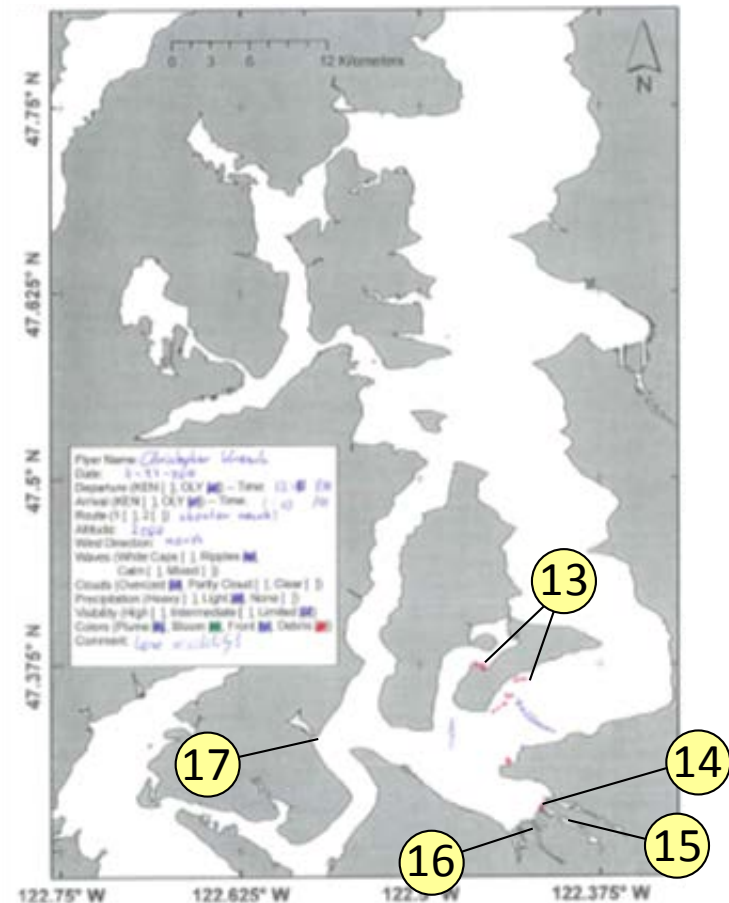
Streams

Date: 11-22-2016

North Sound

Central Sound

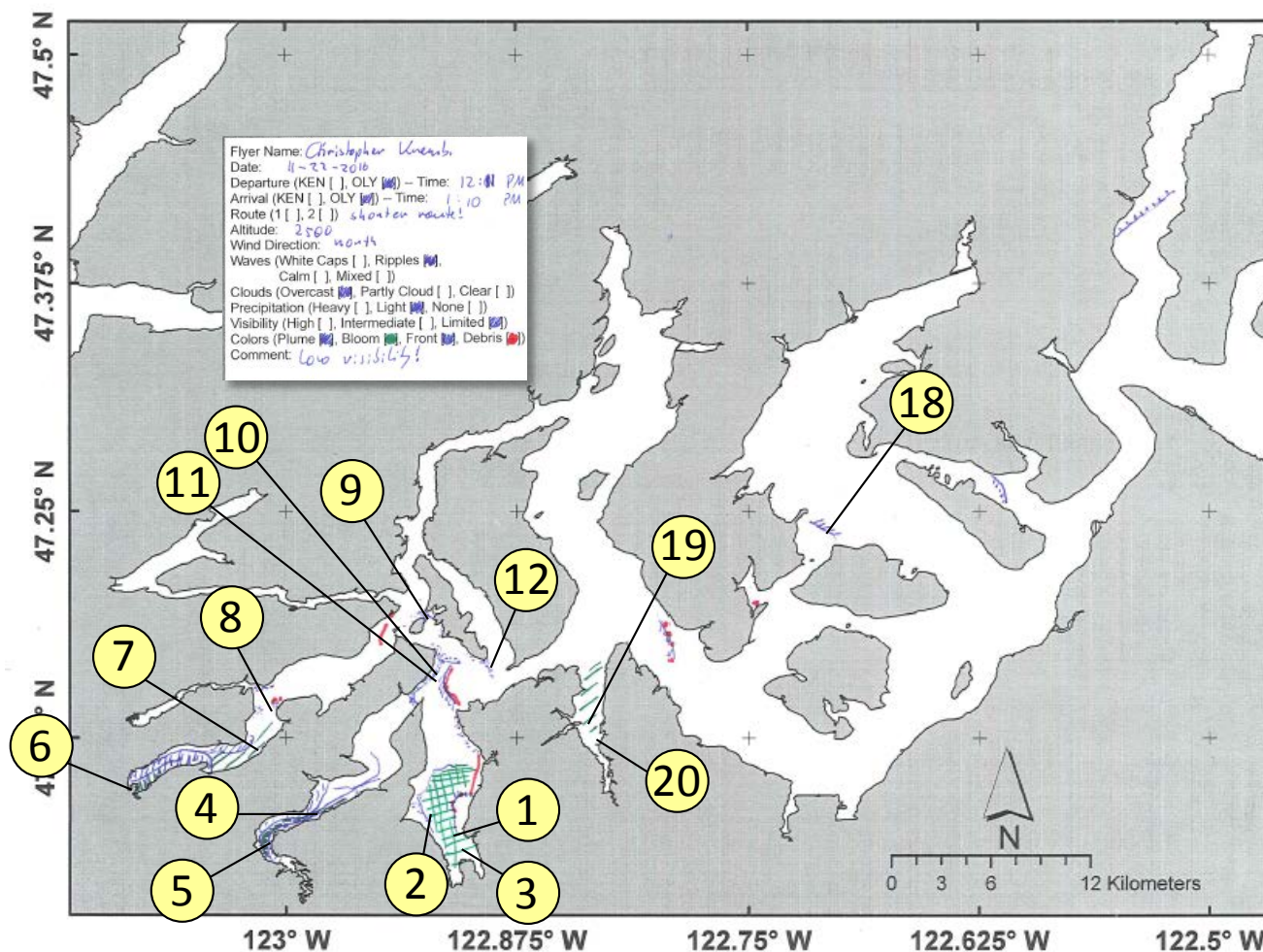
n.a.



Numbers on map refer to picture numbers for spatial reference

Date: 11-22-2016

South Sound

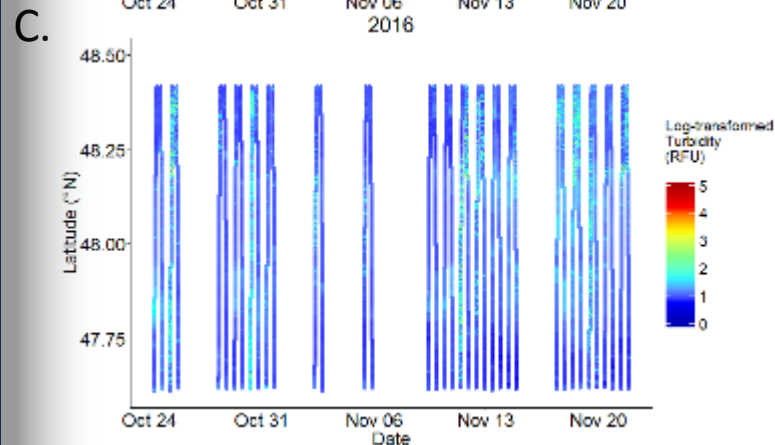
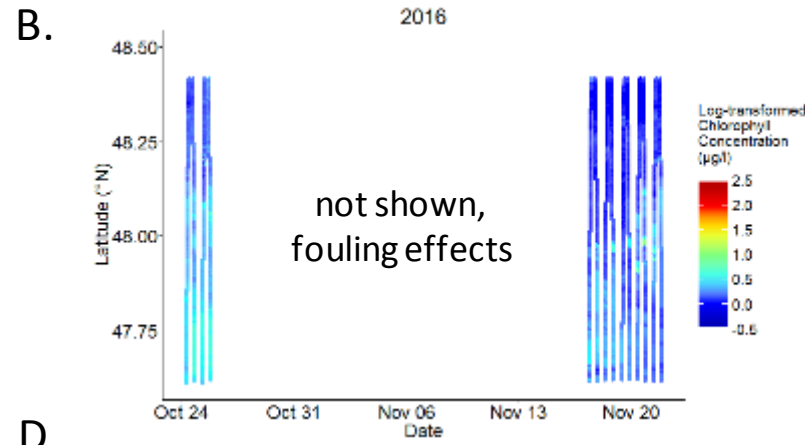
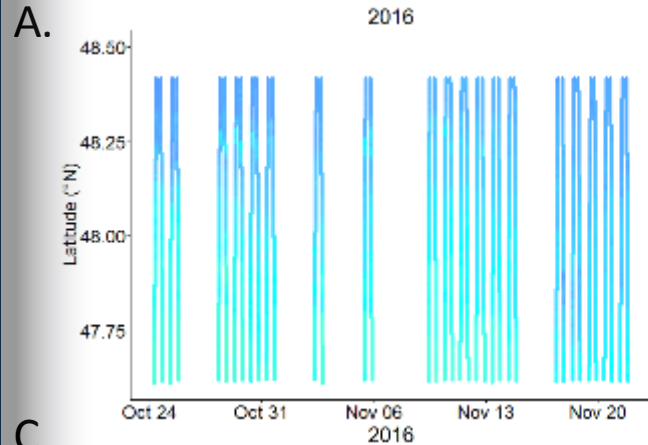


Numbers on map refer to picture numbers for spatial reference



Summary of *Victoria Clipper IV* ferry data:

The water in late October and November has cooled and become well mixed. Decrease in chlorophyll fluorescence coincided with increase in turbidity, most likely from rain and winds. Recently, water was more turbid in the Juan de Fuca Strait (higher latitude) than in Puget Sound.



D.

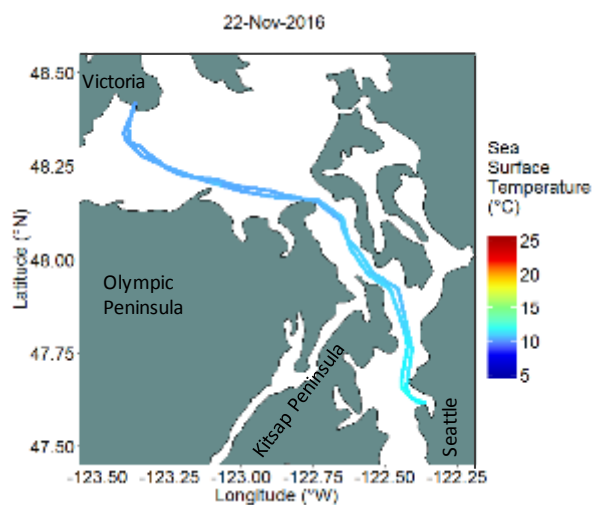
CDOM sensor is out of commission until further notice.

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

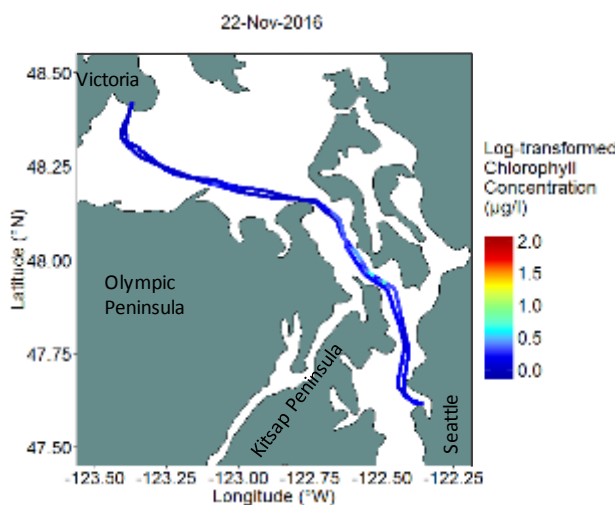
- A. Temperature
- B. Chlorophyll
- C. Turbidity
- D. CDOM

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

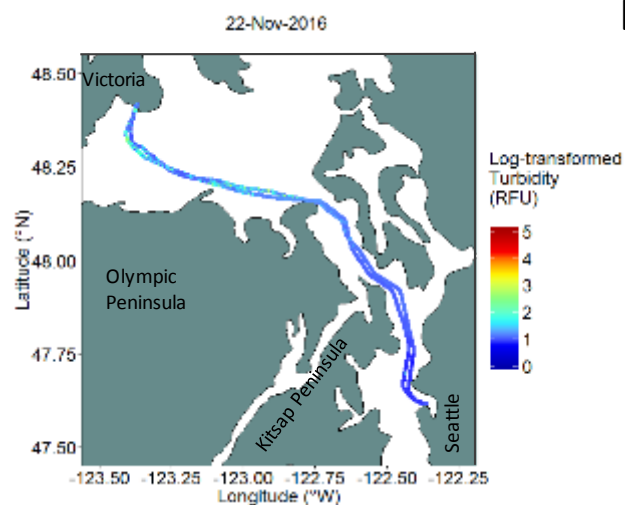
A.



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 water at 5-sec intervals while the *Victoria Clipper IV* transits between Seattle and Victoria, BC.

A. Sea Surface Temperature: Water is still warmer in Puget Sound than the Strait.

B. Chlorophyll: Concentrations are low throughout the transect with a small detection in Central Sound.

C. Turbidity: Turbidity is low on the entire route.

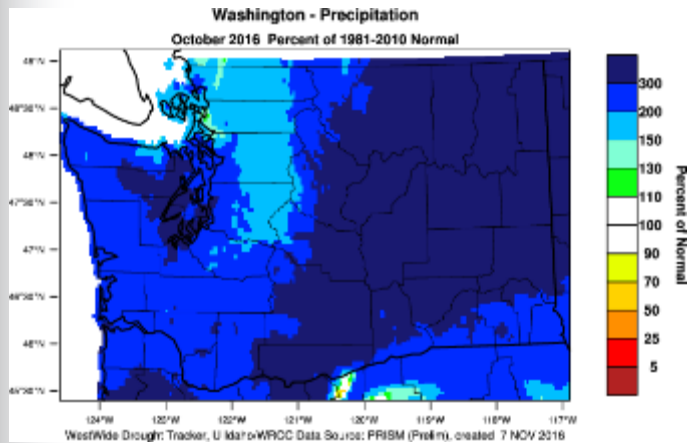
D. Colored Dissolved Organic Matter (CDOM): Not available.



*Tyler Burks,
Ecology*

Strong precipitation in October greatly improved Puget Sound streamflows and officially removed any drought conditions from the U.S. Drought Monitor statewide. Many streams recovered dramatically, quickly transitioning from “much below normal” to “above normal.” Along with the rain, salmon have returned to Puget Sound tributaries to spawn.

A.

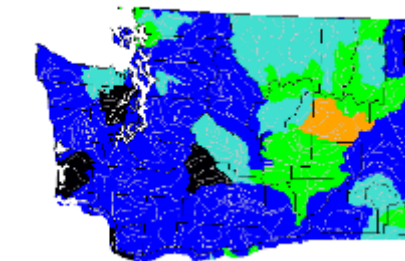


A. Precipitation was well above normal in the Puget Sound basin throughout October resulting in a dramatic increase in streamflow for the month. Much of western Washington saw precipitation in excess of 200% of normal.

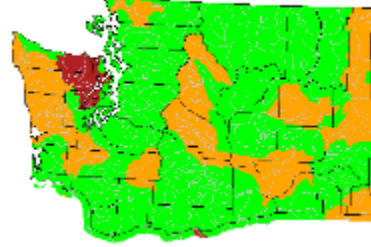
B. Streamflows changed from September, with most streams at or below normal, to flows much above normal in October.

B.

October 2016

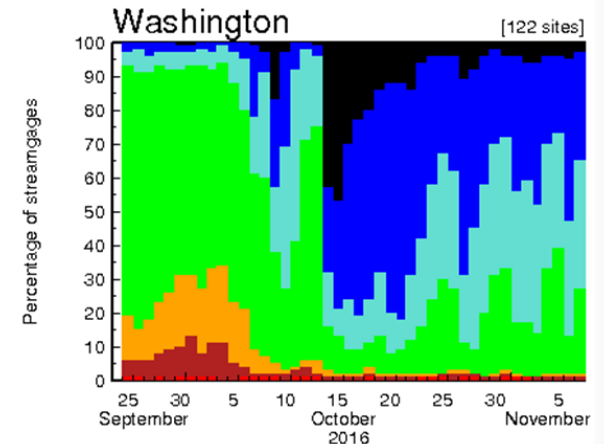


September 2016



Explanation - Percentile classes						
●	●	●	●	●	●	○
Low	<10	10-24	25-75	76-90	>90	High
	Much below normal	Below normal	Normal	Above normal	Much above normal	Not-ranked

C.



Explanation - Percentile classes						
Low	<10	10-24	25-75	76-90	>90	High
	Much below normal	Below normal	Normal	Above normal	Much above normal	Not-ranked

In October, streamflows increased over the second half of the month following the remnant of Typhoon Songda. Currently, about 70% of the state's streamflows are above the normal range.

Get data from Ecology's Marine Monitoring Programs



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Long-Term Monitoring Network



christopher.krembs@ecy.wa.gov



Access core monitoring data:

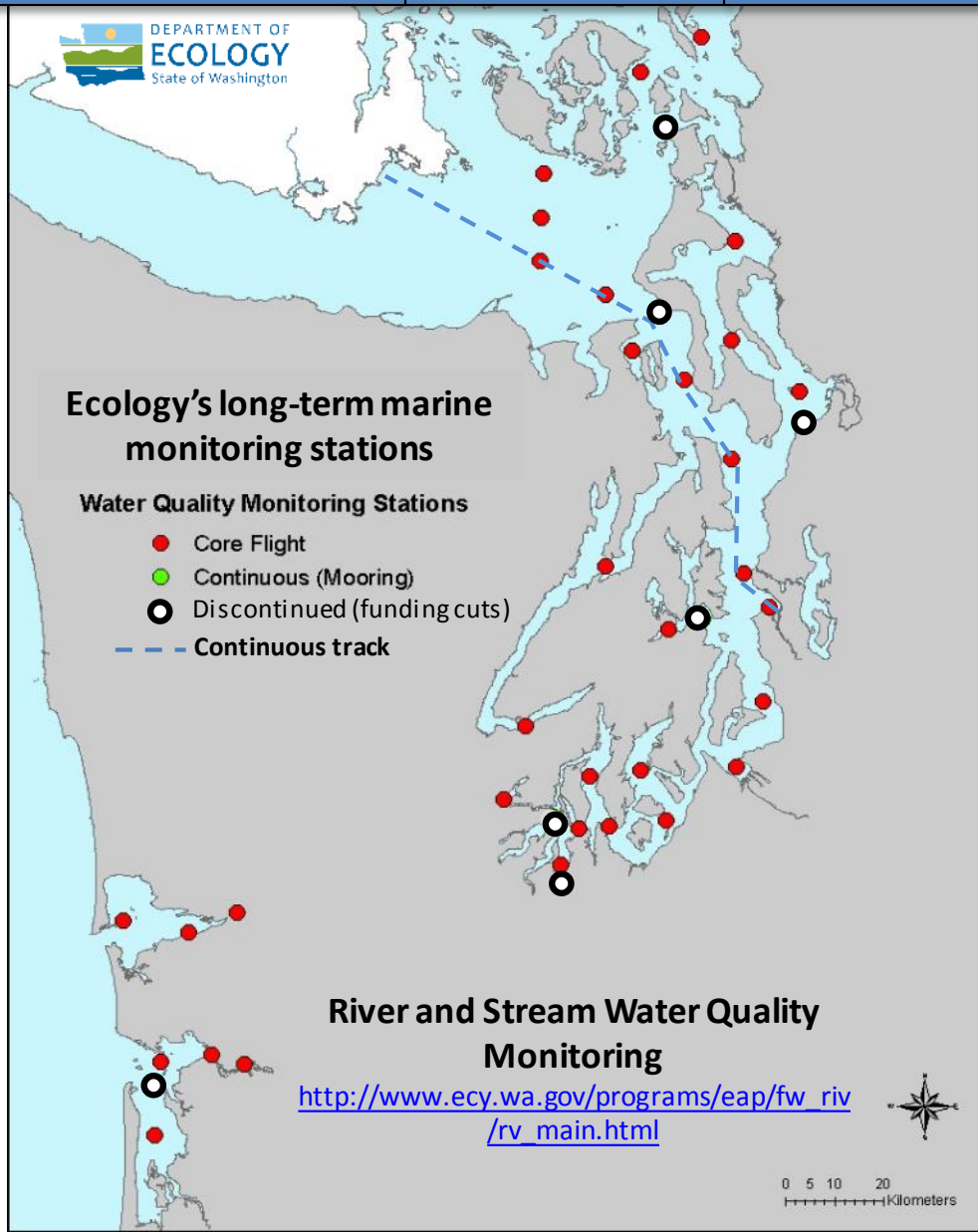
<https://fortress.wa.gov/ecy/eap/marinewq/mwdata/set.asp>



Ecology's long-term marine monitoring stations

Water Quality Monitoring Stations

- Core Flight
- Continuous (Mooring)
- Discontinued (funding cuts)
- Continuous track



River and Stream Water Quality Monitoring

http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html

Real-Time Sensor Network



Suzan.Pool@ecy.wa.gov



Access mooring data:

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>



Field log	Climate	Water column	Aerial photos	Continuous monitoring	Streams
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We are looking for feedback to improve our products.

Dr. Christopher Krembs
christopher.krembs@ecy.wa.gov

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

