Publication No. 16-03-075

DEPARTMENT OF ECOLOGY State of Washington

Eyes Over Puget Sound

Surface Conditions Report

July 20, 2016

Start here

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

Marine conditions from 7-20-2016 at a glance

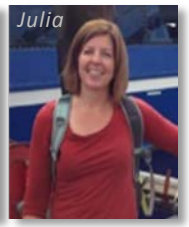
LONG-TERM MARINE MONITORING UNIT

Mattie Michalek
Washington Conservation Corps Intern

Skip Albertson

Dr. Christopher Krembs (Editor)

Julia Bos
Suzan Pool



Markus von Prause

Personal impressions p. 4

During this time of year, humans and seals hang out at the beach!

Climate conditions p. 6

In June, air temperatures and sunlight are above normal. Precipitation is near-normal, but some rivers in the north are still lower than normal.

Water column p. 7

June: salinity is still lower than normal, and record-breaking water temperatures continue; but luckily, dissolved oxygen is at expected levels. At the coast lower oxygen, higher salinities and a higher-than-normal upwelling index suggest the influence of upwelling.

Aerial photography p. 11

Jellyfish smacks in Eld and Budd Inlets. Blooms in Budd, Eld, Totten and Carr Inlets. Macro-algae on beaches in Carr Inlet and Vashon Island and adrift in Central Sound. Abundant organic debris between Port Orchard and Agate Passage.

Continuous monitoring p. 35

Surface temperature >15 °C. Algae continue to be abundant. On July 4th blooms extended into the Strait of Juan de Fuca. Windy conditions on July 9-11 temporary reduced algae biomass.

Streams p. 37

For July, river flows are improving relative to last year's levels. Glacial flour in some rivers is high because meltwater is predominantly from glaciers instead of snowpack.

Editorial assistance provided by: Carol Maloy, Valerie Partridge

Eyes Under Puget Sound 7-20-2016

Critter of the Month - The Glistenworm (*Chaetoderma argenteum*)

Angela Eagleston & Dany Burgess

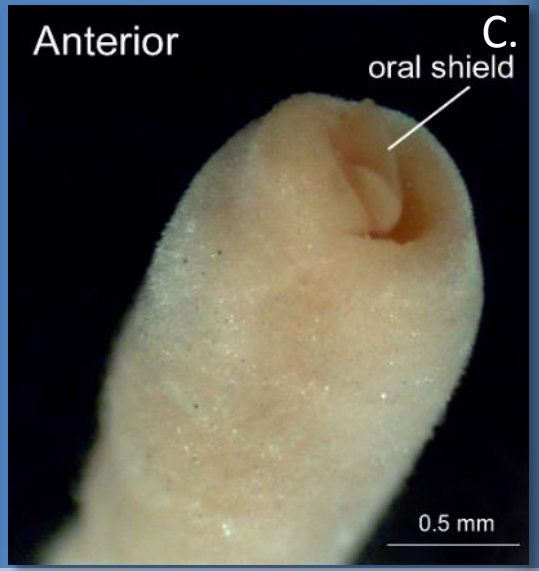
The Glistenworm

This month's critter belongs to the Phylum Mollusca, but you won't find its shell on the beach like other snails and clams. Find out how this little "naked mollusc" fits into the Puget Sound benthic community!

Fun Facts!

A. Tooth-like feeding structure.
B. Covered with microscopic spines that give it a shiny, fuzzy appearance.
C. Burrows in sediment using a shield around its mouth.

Marine Sediment Monitoring Team



Learn more about the Glistenworm and other critters on Ecology's EcoConnect blog here.

Harbor Seals of Puget Sound – *Phoca vitulina*

Mattie Michalek, Washington Conservation Corps Intern

Harbor seals are the most common marine mammal in the Puget Sound, and we often see them from the float plane while monitoring water quality. These small, spotted mammals weigh about 250-300 pounds, can dive 300 feet, and stay underwater for up to 28 minutes. During this time of year, we can see seals spending more time on beaches at lower tides, a practice known as "hauling out."

This seal pup is hanging out on shore in Padilla Bay while mom forages for food nearby. Photo Credit: Padilla Bay National Estuarine Research Reserve

Credit: Washington State Department of Fish and Wildlife

Haulout sites are important for seals. They provide a place for seals to rest, give birth, and nurse their young, and provide protection from predators. In these warmer months, we see harbor seals on shorelines and sand spits on almost every flight .

The divers' page, visibility 7-20-2016

What is the visibility in the water for divers?

	Best /Depth	Least /Depth
	(Depth is in feet)	
1)	19 / 79	6 / 5
2)	23 / 98	7 / 8
3)	19 / 49	11 / 7
4)	39 / 77	13 / 18
5)	37 / 5	8 / 38
6)	36 / 80	23 / 10
7)	23 / 61	4 / 23
8)	35 / 89	3 / 3
9)	6 / 16	5 / 3
10)	17 / 98	13 / 16
11)	24 / 95	11 / 10
12)	9 / 97	7 / 3
13)	18 / 25	4 / 5

Find depths with high and low visibility

- **Best visibility** was around 35 feet or more.
- **Poor visibility** occurred in many places of Puget Sound in the first 10 feet of the surface.
- In June, compared to May, visibility improved in Central Basin to the south of Seattle.
- Elliott Bay visibility improved from 22 feet to 39 feet.
- We use transmissometer readings from our CTD package and convert them into horizontal visibility.

visibility

good — poor

This is a new feature, and we are soliciting feedback on it (salb461@ecy.wa.gov). Eventually we will feature the most recent data.

Natural Influences leading to 7-20-2016

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 for June:

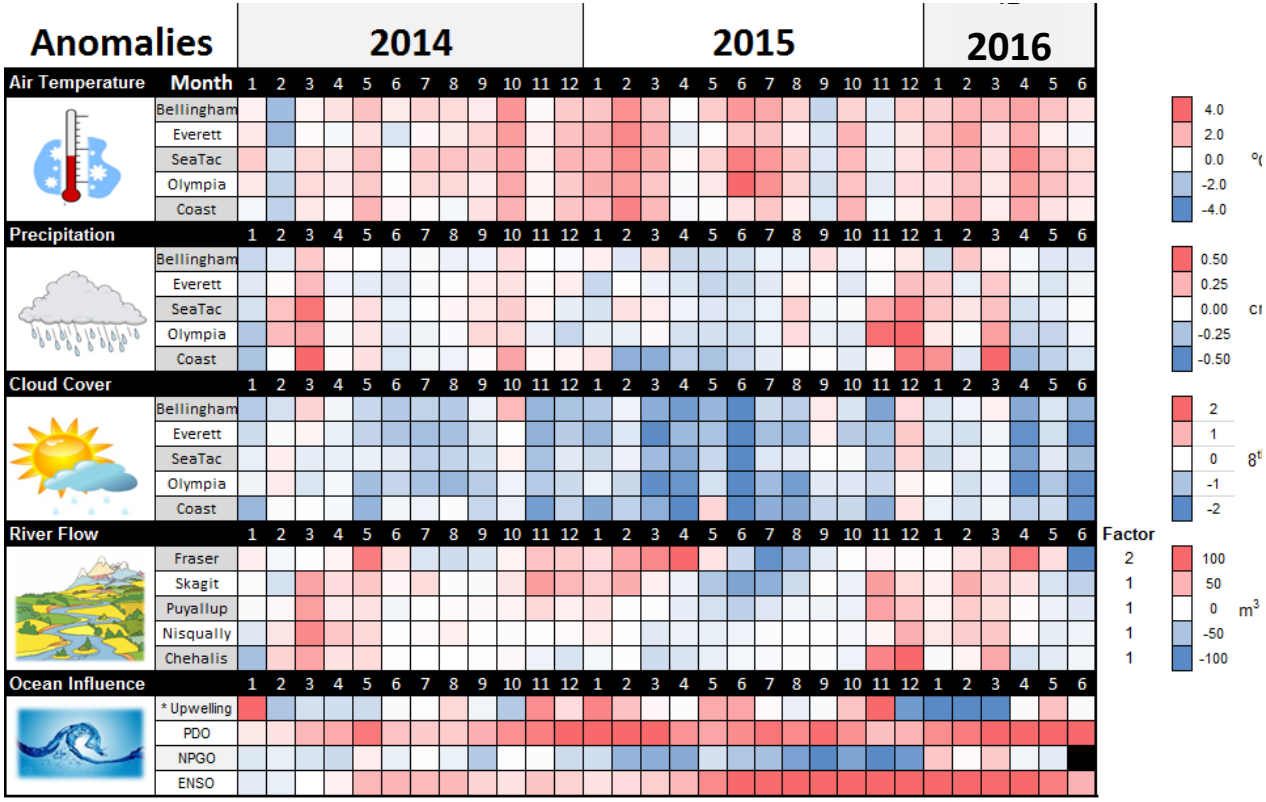
Air temperatures remain above normal in the Puget Sound lowlands, though less extreme than earlier in the year.

Precipitation levels are normal to below-normal.

Sunshine levels have been above normal.

River flows are below normal, particularly in the north.

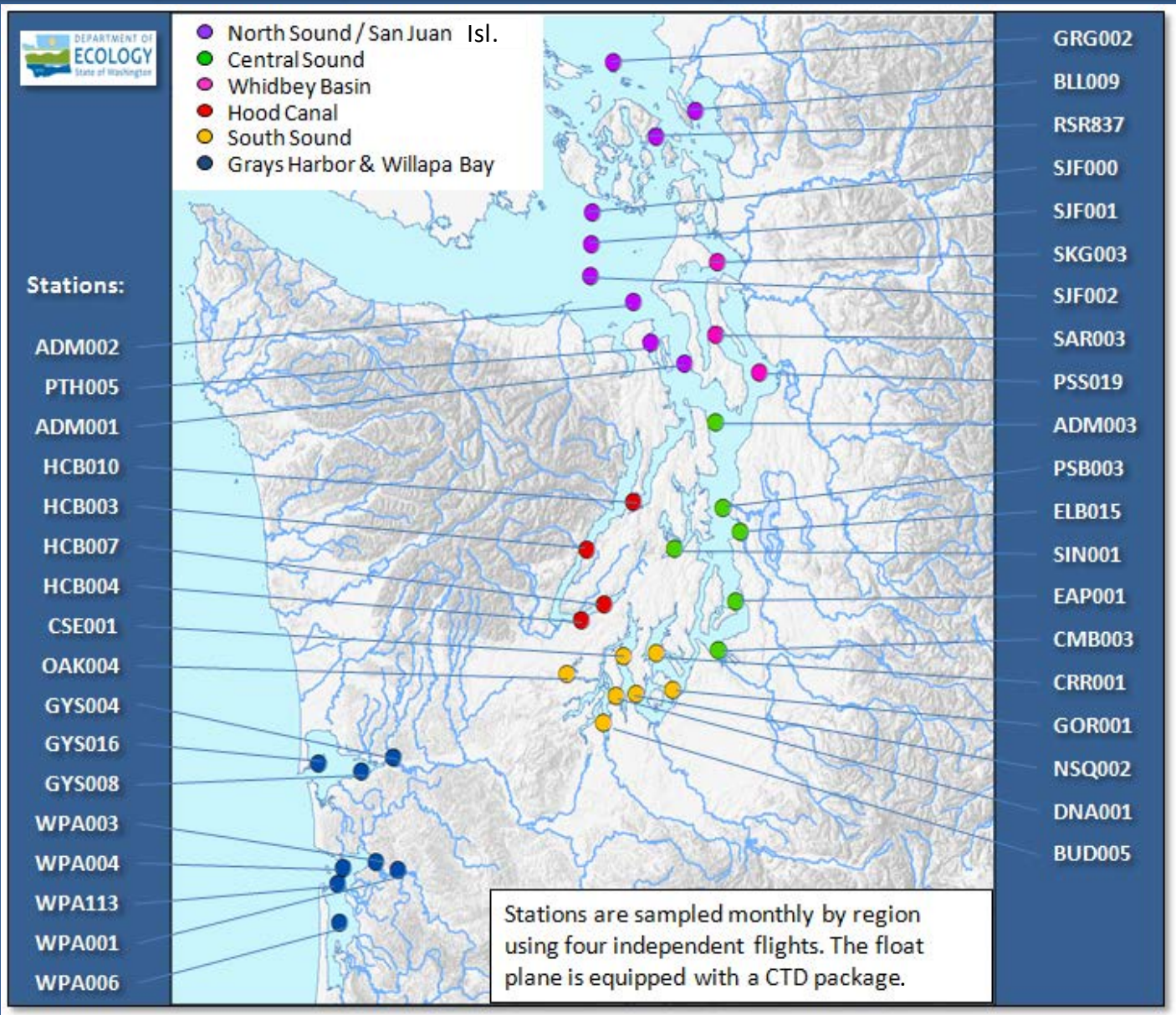
Upwelling is normal, and ENSO & PDO are above normal. (See Ocean Climate Indices page.)



Upwelling Anomalies (PFEL)
ENSO = El Niño Southern Oscillation
PDO = Pacific Decadal Oscillation

higher | expected | lower | No data

Our long-term marine monitoring stations in Washington



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

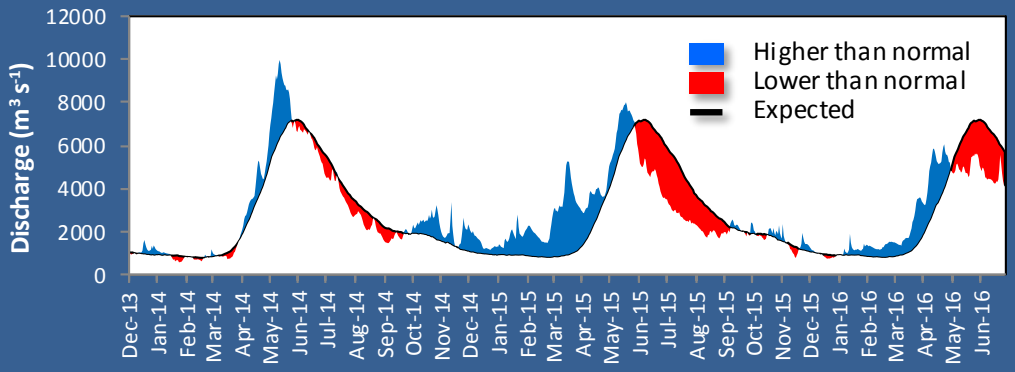
Start here

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**

How well is Puget Sound exchanging its water?

Year 2016 continues to have record-breaking global temperatures. In our region, the Fraser River has not been flowing as high as last year, and now flows have plummeted. Estuarine circulation is important because water temperatures in Puget Sound are still warmer than normal and continue to break new records! The Fraser River is the largest freshwater source for the Salish Sea, significantly affecting and driving estuarine circulation.

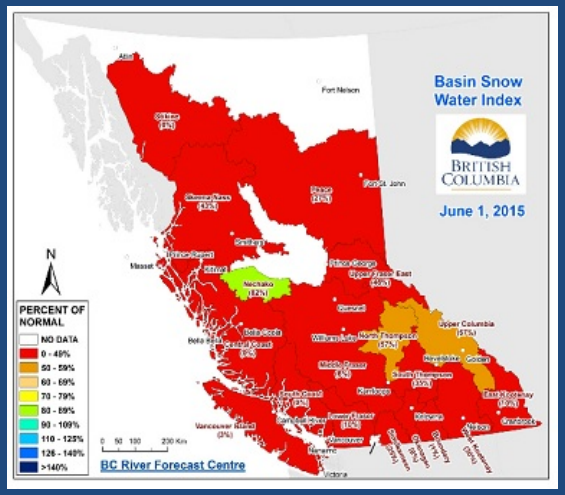


Government of Canada

In winter and spring 2016, the Fraser River and other rivers discharged prematurely. This year's Fraser 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.

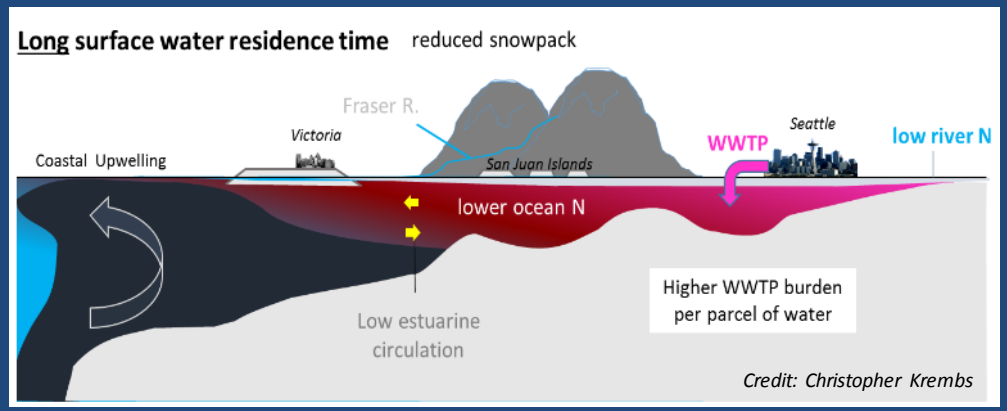
Source: http://wateroffice.ec.gc.ca/index_e.html

http://bcrfc.env.gov.bc.ca/bulletins/watersupply/SnowIndexMap.htm



BC, Canada didn't have much snow left by June 2016.

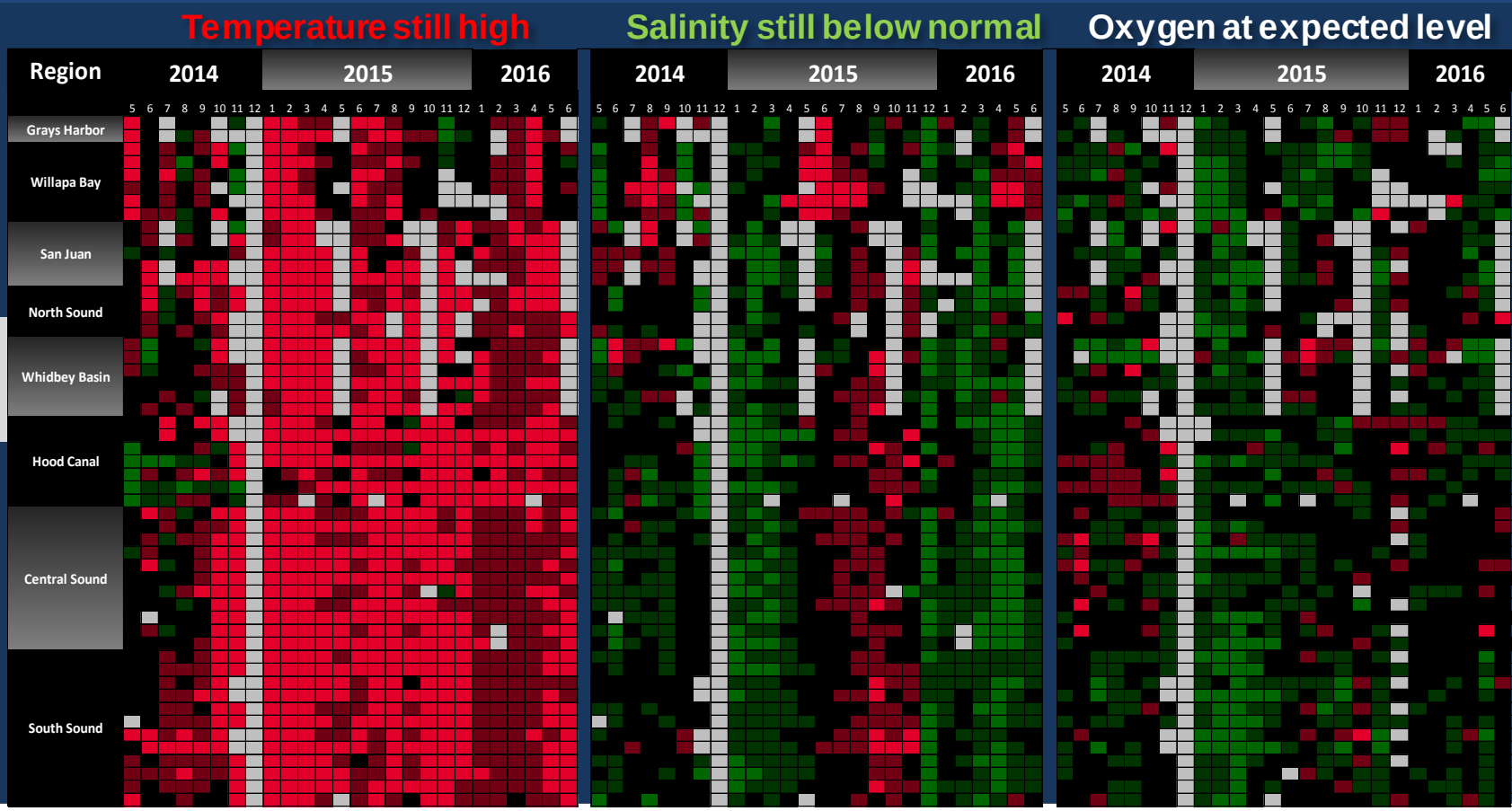
See also NOAA



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.

Physical conditions tracked in historical context

A record-warm spring brought ample meltwater to Puget Sound. Salinity is still lower than normal. Record-breaking water temperatures continue in June, and dissolved oxygen is at expected levels. At the coast (Grays Harbor and Willapa Bay), temperatures are at expected levels, salinity is higher, and oxygen is lower, suggesting upwelling effects.



[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

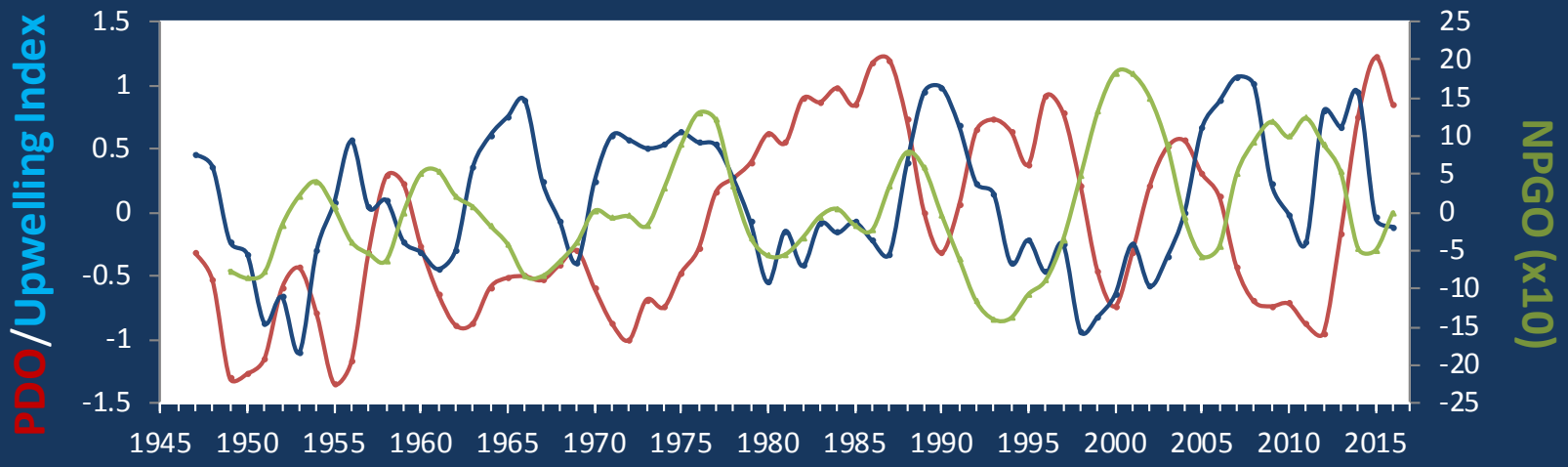
The ocean affects water quality: Ocean Climate Indices

a) *Pacific Decadal Oscillation Index (**PDO, temperature**)* *(explanation)*

b) *Upwelling Index (anomalies) (**Upwelling, low oxygen**)* *(explanation)*

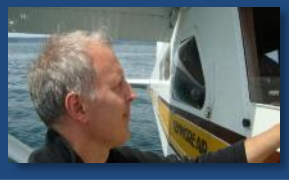
c) *North Pacific Gyre Oscillation Index (**NPGO, productivity**)* *(explanation)*

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).

Summary: Aerial photography 7-20-2016



Jellyfish in high numbers in Eld and Budd Inlets. Strong red-brown blooms in Budd, Eld, Totten, and Carr Inlets. Macro-algae on beaches in Carr Inlet and Vashon Island. Large rafts of macro-algae drifting in Central Sound. Abundant organic debris between Port Orchard and Agate Passage.

Start here

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

Mats of macro-algae, Tramp Harbor, Vashon Island

Front

Mixing and Fronts:
Tidal fronts in Totten Inlet. Tidal eddies in Hale, Pickering, and Agate Passages.

Jellyfish:
Numerous jellyfish patches in Eld and Budd Inlets.

Plume

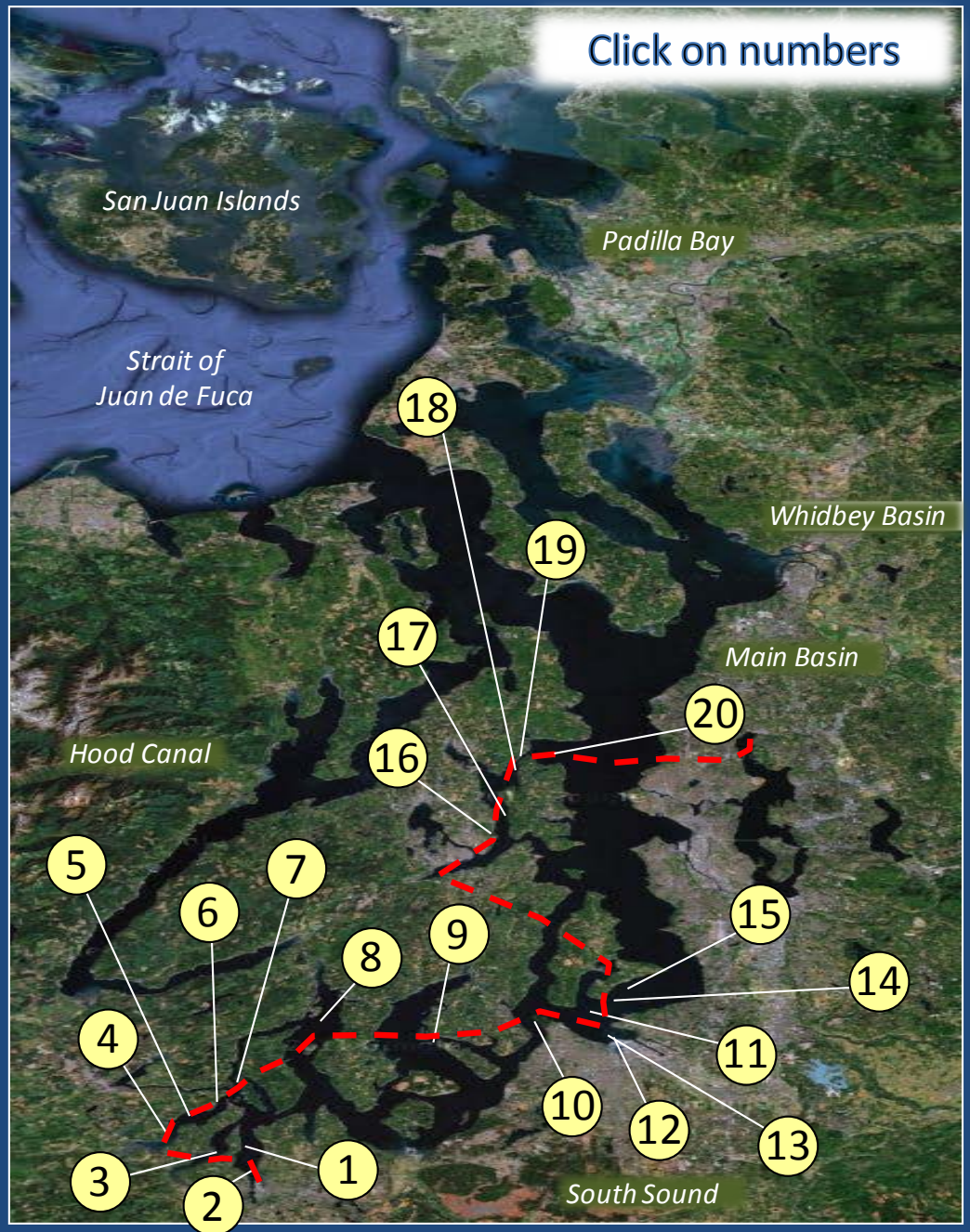
Suspended sediment:
A lot of glacial flour in the freshwater plume of the Puyallup River, extending past the Tacoma Narrows.

Bloom

Visible blooms:
Strong red-brown blooms in Budd, Eld, and Totten Inlets.
Green blooms in Carr Inlet and Port Madison.
Brown bloom in Case Inlet.

Debris

Debris:
Large green mats of macro-algae in Central Sound. Abundant reddish-white organic debris (potentially a decaying *Noctiluca* bloom) between Port Orchard and Agate Passage.



Aerial photography and navigation guide

Date: 7-20-2016

Tide data (Seattle):

Time	Height (ft.)	High/Low
12:13 AM	6.21	L
05:09 AM	9.91	H
12:05 PM	-1.74	L
07:18 PM	11.22	H

Flight Information:

Sunny, good visibility

Flight route

Observation Maps:

Central Sound

South Sound

A. Red-brown bloom and turquoise water in western Budd Inlet. B. Sailboat in an intense patch of the bloom.
Location: A. North of Big Tykle Cove. B. Butler Cove, Budd Inlet (South Sound), 3:00 PM.

PACIFIC SHELLFISH INSTITUTE

Track Budd Inlet water quality and plankton communities here

What do experts Aimee Christy and Roberta Woods say?

The dominant species on July 21 was *Ceratium fusus*.

Harmful Algal Bloom (HAB) species *Pseudo-nitzschia, Alexandrium, and Dinophysis are present.*

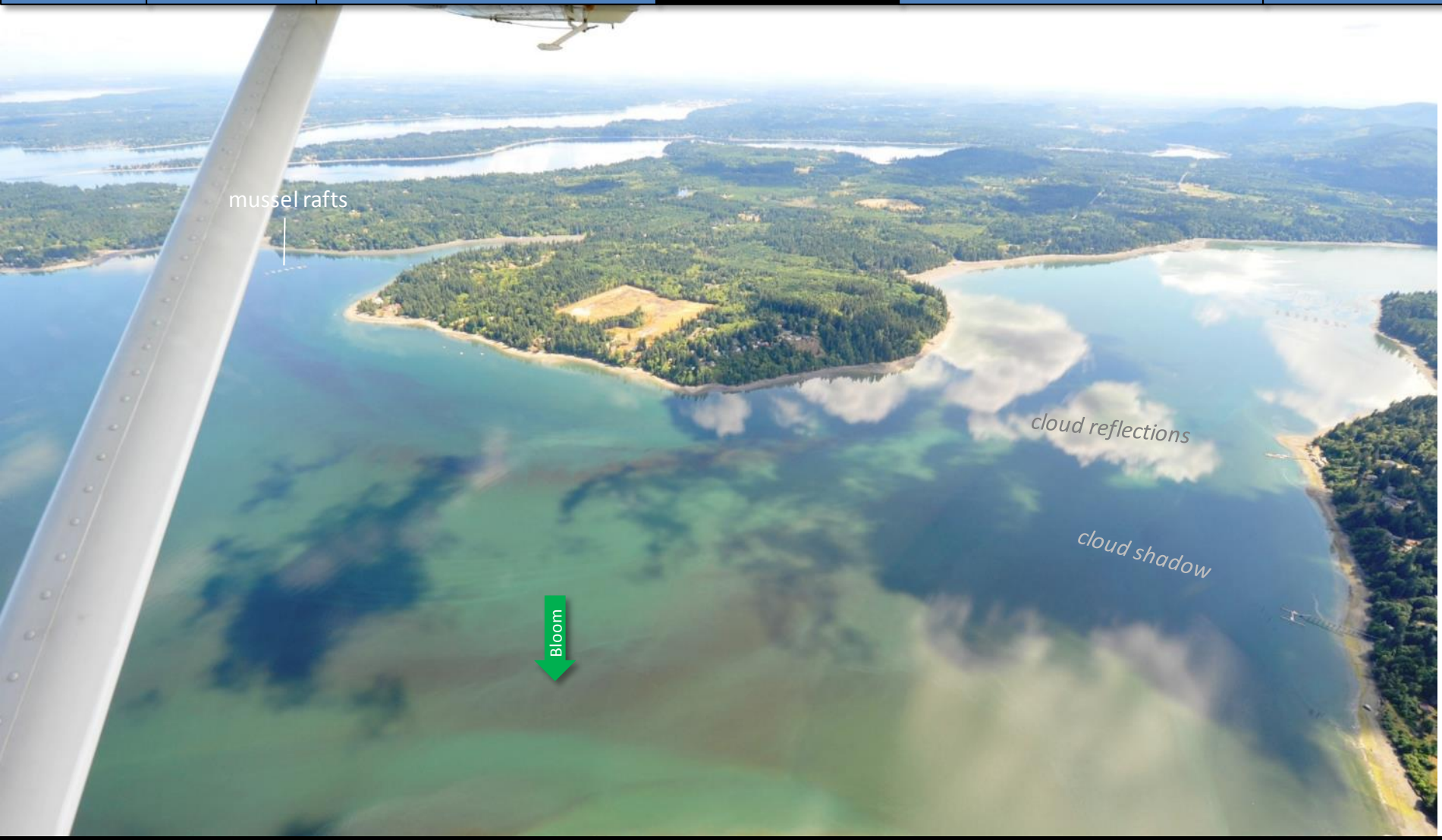
jellyfish
jellyfish
jellyfish
jellyfish
jellyfish
jellyfish
jellyfish
jellyfish
sediment
Bloom
Gull Island
boat
boat
boat

Red-brown bloom and numerous patches of jellyfish and suspended sediment. Ceratium fusus is dominating the phytoplankton species assemblage. Location: Gull Island, Budd Inlet (South Sound), 3:05 PM.

Red-brown bloom and large patches of jellyfish. Turquoise water is likely freshwater.

Location: Across from Young Cove, Eld Inlet (South Sound), 3:08 PM.

Mixing of water behind aquaculture structures in stratified water containing a bloom (incoming tide).
Location: South of Big Cove, Totten Inlet (South Sound), 3:11 PM.



Effects of a broken cloud ceiling on documenting a bloom by aerial photography.
Location: At the entrance to Gallagher Cove, Totten Inlet (South Sound), 3:12 PM.

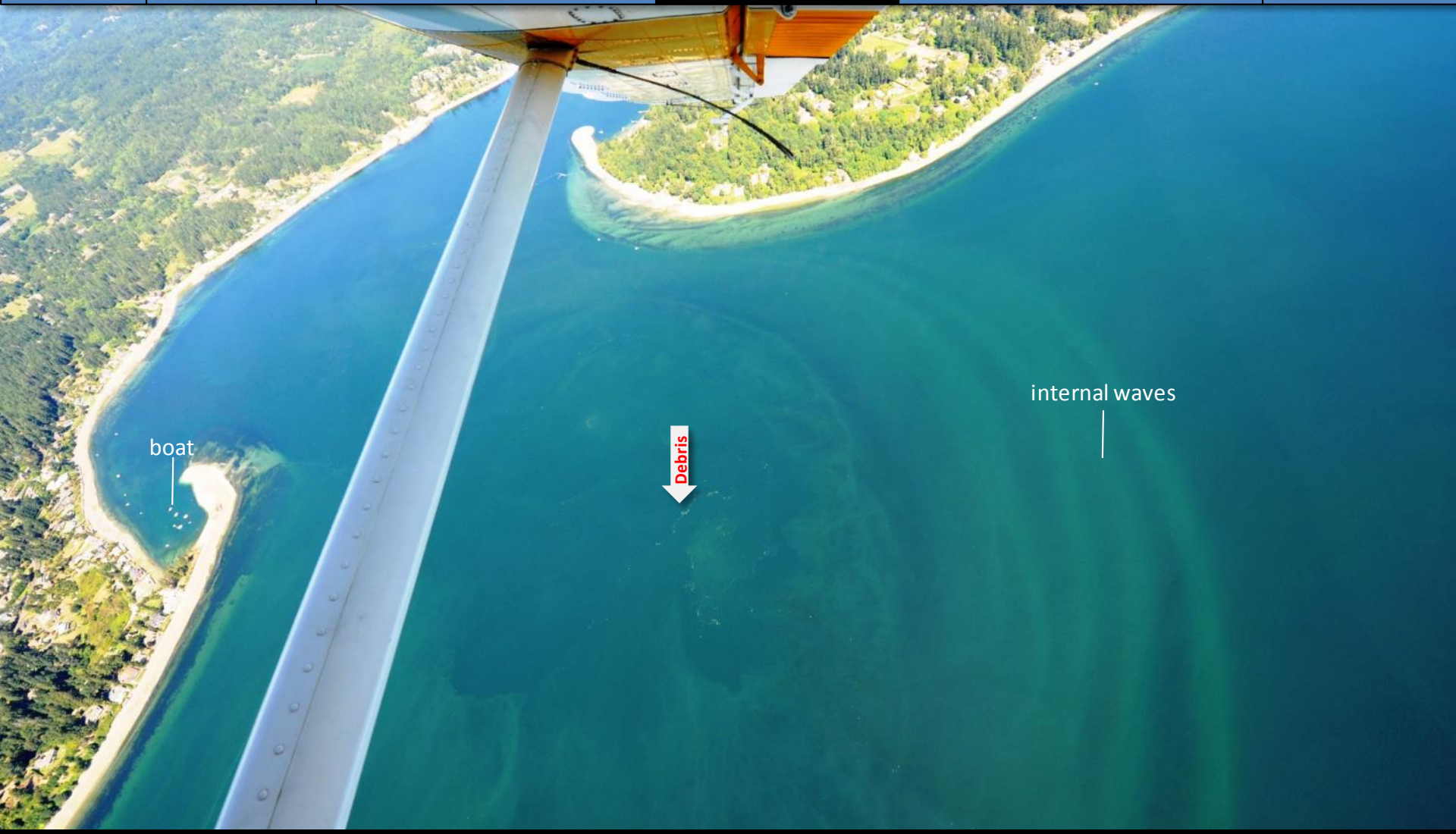
Phytoplankton blooms tend to be patchy, as seen nicely in this image.

Location: Totten Inlet (South Sound), 3:13 PM.

Mixing of water rich in phytoplankton and suspended sediment, during incoming tide.
Location: Steamboat Island, Totten Inlet (South Sound), 3:13 PM.

Large accumulation of floating organic debris at the surface of dark water.
Location: *Off Dougall Point, Case Inlet* (South Sound), 3:21 PM.

Aerial photography 7-20-2016



Large tidal eddy, stained by Puyallup glacial flour, setting off internal waves.

Location: Off Shaws Cove, Fox Island, Carr inlet (South Sound), 3:27 PM.

The Puyallup River plume, stained by glacial flour, is entrained into the Tacoma Narrows during flooding tide.

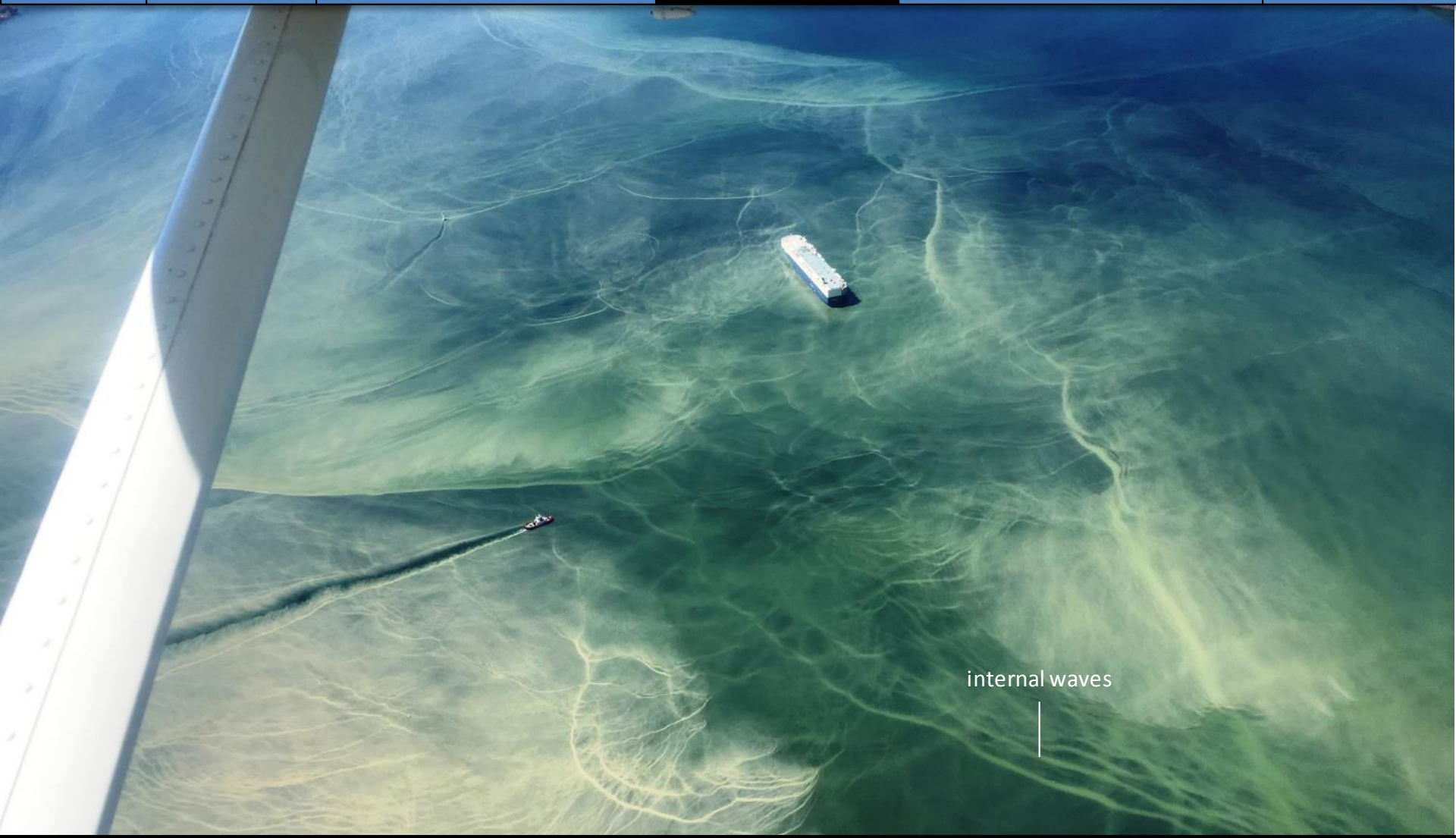
Location: Point Defiance, Tacoma Narrows (Central Sound), 3:31 PM.

Aerial photography 7-20-2016

Puyallup River plume with glacial flour being carried away by tides. Large mat of organic debris.
Location: Vashon Island (Central Sound), 3:32 PM.

The wake of a tugboat reveals that the Puyallup River plume is only a thin layer at the surface.
Location: Commencement Bay (Central Sound), 3:36 PM.

Aerial photography 7-20-2016

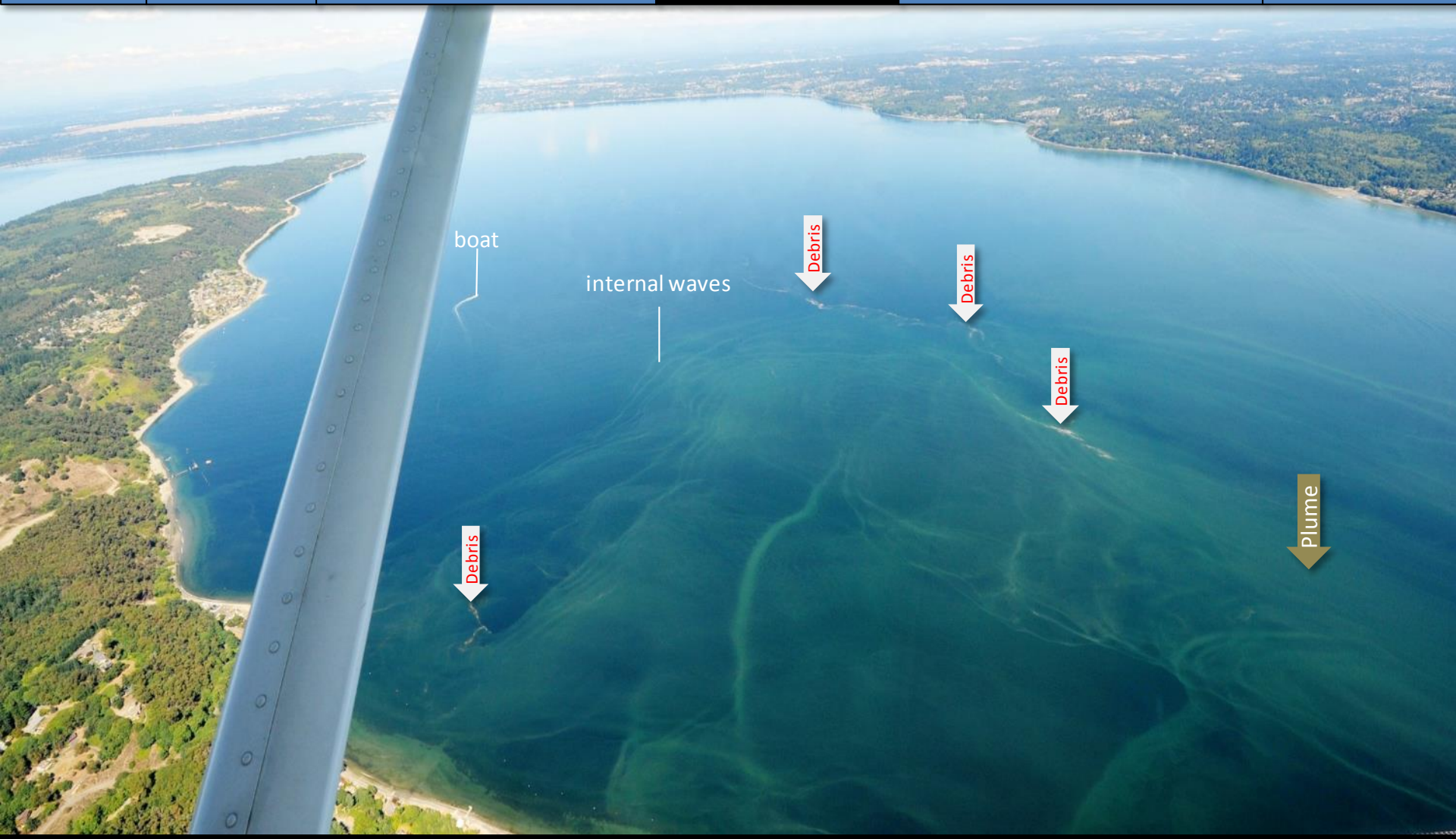


Water rich in glacial flour allows us to see how thin, complex, and far-reaching river plumes can be.

Location: Puyallup River plume in Commencement Bay (Central Sound), 3:36 PM.

Organic debris and the far-reaching influence of the Puyallup River plume.

Location: Entrance to Quartermaster Harbor, Vashon Island (Central Sound), 3:33 PM.



Organic debris and the far-reaching influence of the Puyallup River plume.
Location: Off Shore Acres, Vashon Island (Central Sound), 3:33 PM.

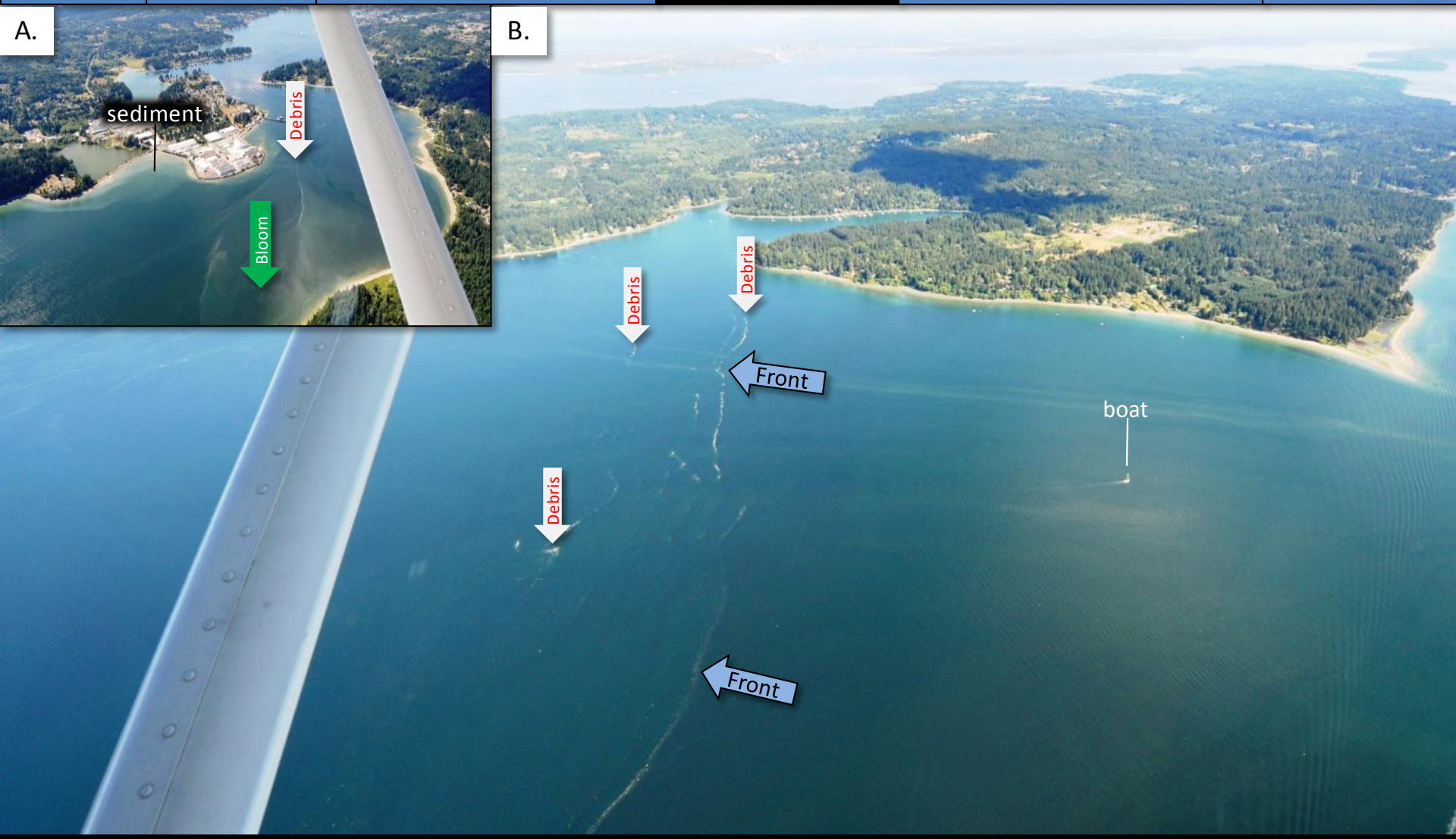
Large tidal eddy rich in suspended sediment. Boat passing through center of bloom (likely phytoplankton).

Location: Henderson Inlet (South Sound), 3:52 PM.

Large accumulations of reddish-white organic material, which could be a spent Noctiluca bloom.

Location: South of Fletcher Bay, Bainbridge Island (Central Sound), 3:53 PM.

Aerial photography 7-20-2016



A. Sediment from freshwater and bloom. B. Large accumulations of organic debris along a large tidal front.
Location: A. Entrance to Liberty Bay. B. Off Manzanita Bay, Bainbridge Island (Central Sound), 3:53 PM.

Tide moving into water that has an algal bloom and floating organic debris. Bloom reveals flow patterns.

Location: Agate Passage, Bainbridge Island (Central Sound), 3:56 PM.

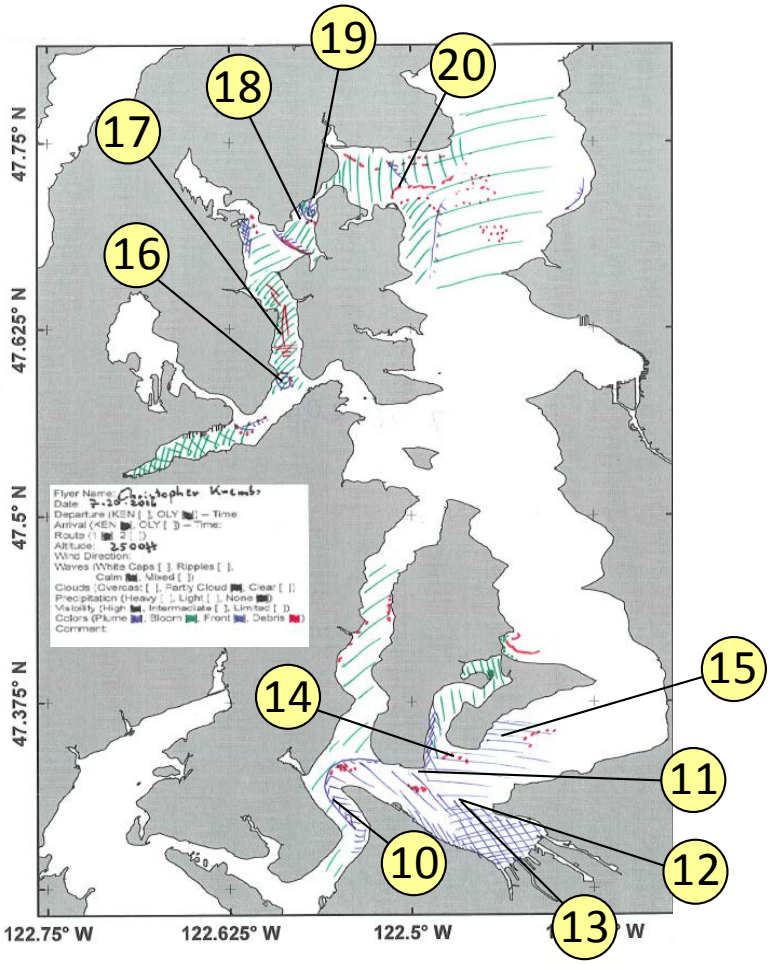
Very large mats of organic material drifting in Port Madison and adjacent parts of Central Basin.
Location: Point Monroe, Bainbridge Island (Central Sound), 3:58 PM.

Date: 7-20-2016

Hood Canal

n.a.

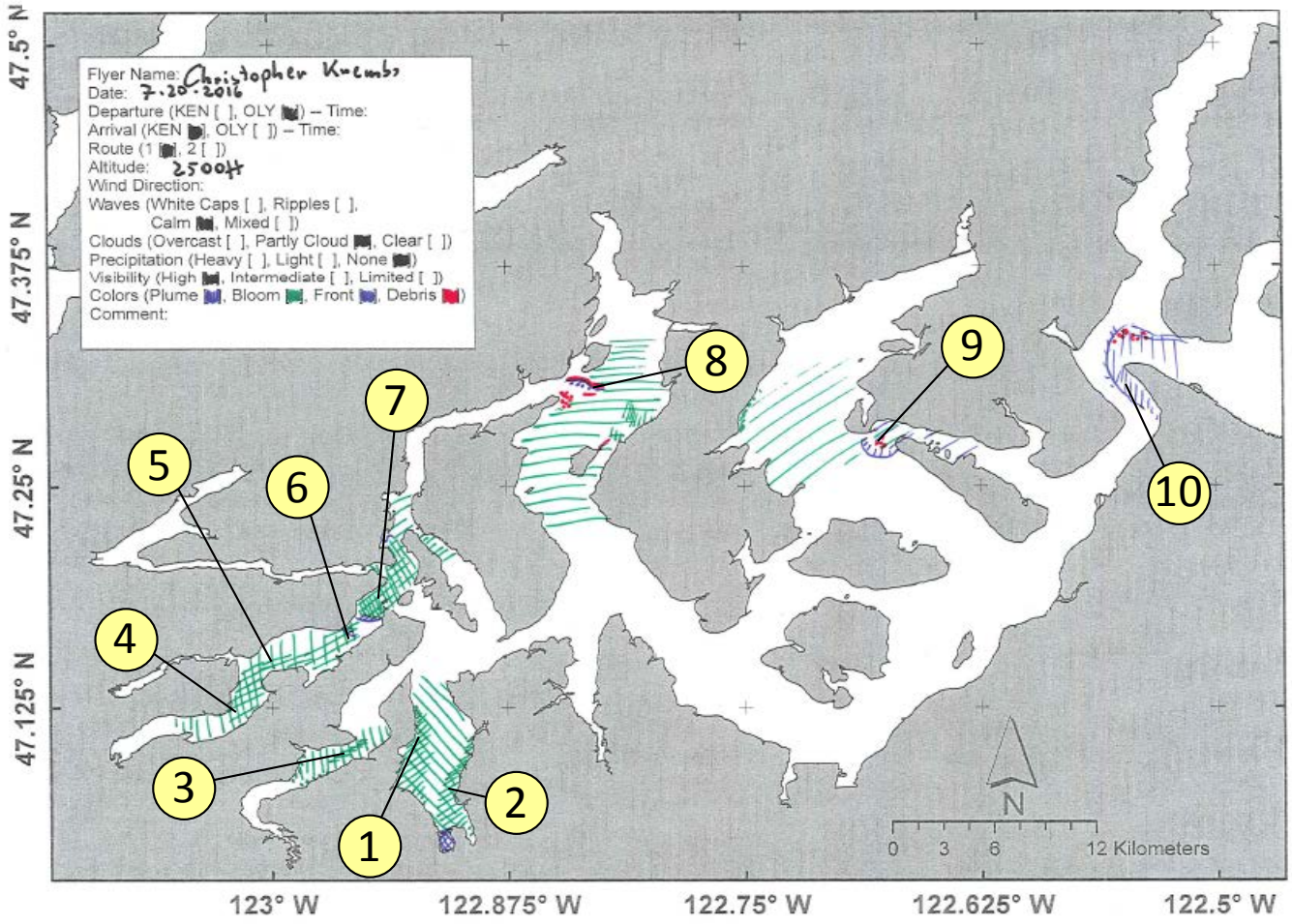
Central Sound



Numbers on map refer to picture numbers for spatial reference

Date: 7-20-2016

South Sound



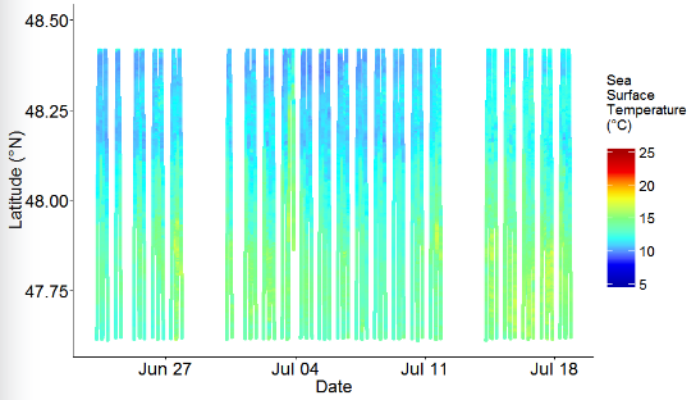
Numbers on map refer to picture numbers for spatial reference

DEPARTMENT OF ECOLOGY State of Washington

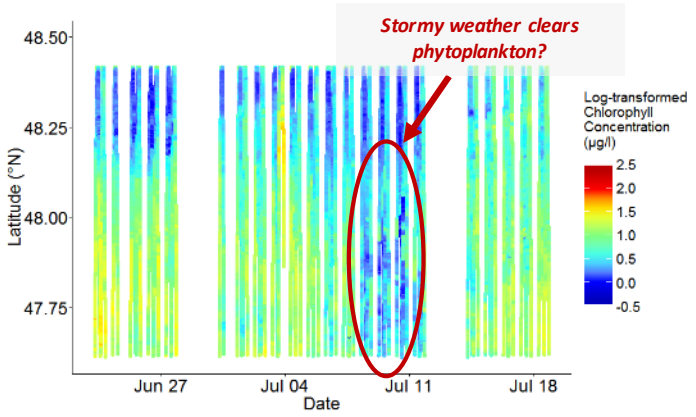
Continuous monitoring June - July

Summary of *Victoria Clipper IV* ferry data:
Summer conditions are apparent, with temperatures >15 °C in Central Sound. Algae (chlorophyll) continue to be abundant, extending into the Strait of Juan de Fuca on July 4th. Windy conditions on July 9-11 temporarily reduced algae. Turbidity and CDOM remain low, except for July 4th, when a plankton bloom spread throughout the system.

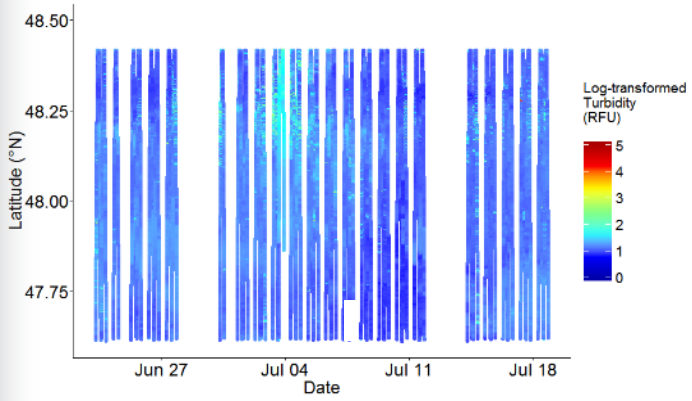
A.



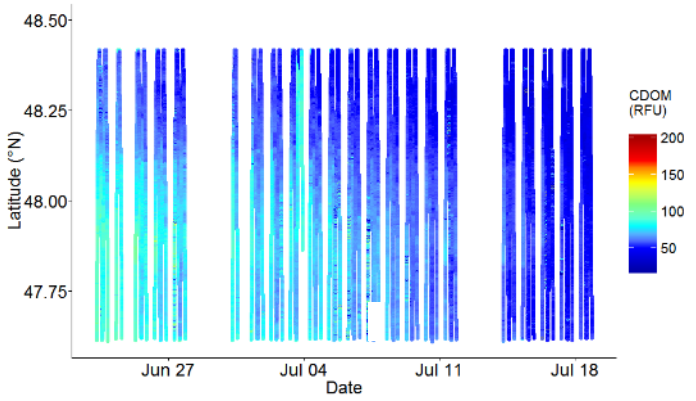
B.



C.



D.



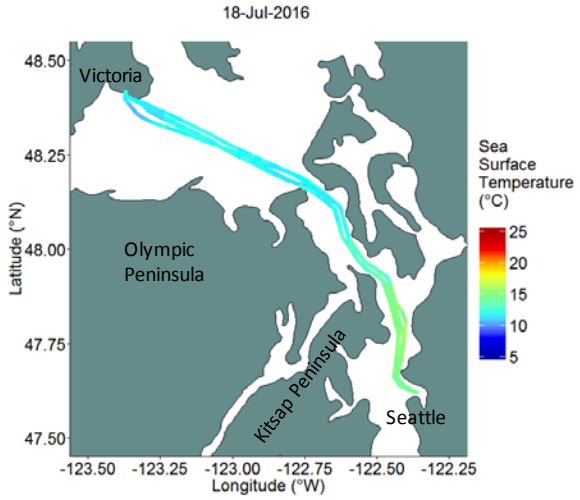
The *Victoria Clipper IV* carries sensors in its sea chest. The sensors allow us to plot over time transects of:

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

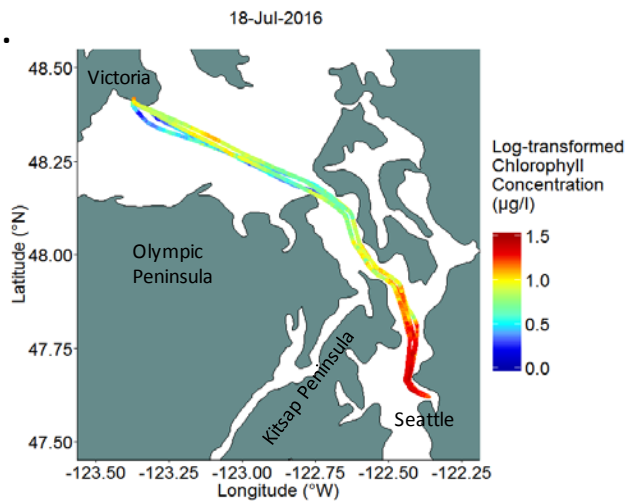
Over time, we see the dynamics of these variables in surface water between Seattle and Victoria, BC.

Continuous monitoring on 7-18-2016

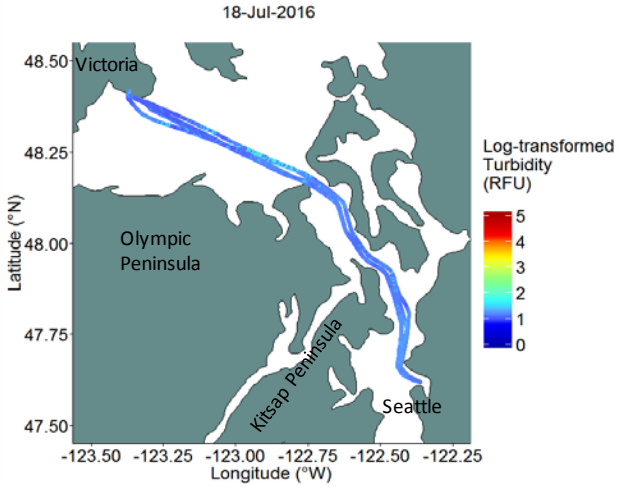
A.



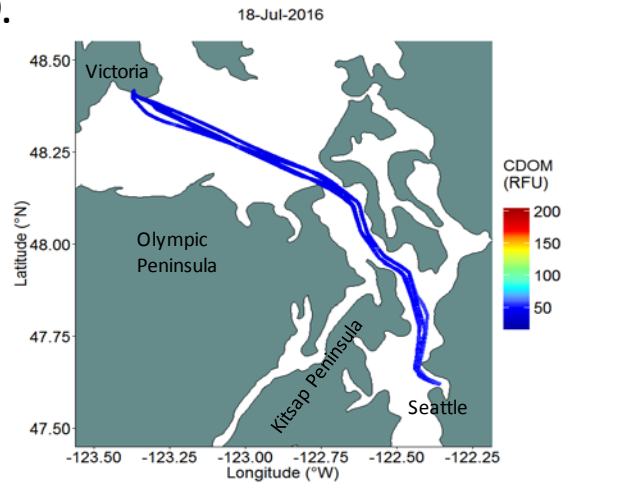
B.



C.



D.



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.

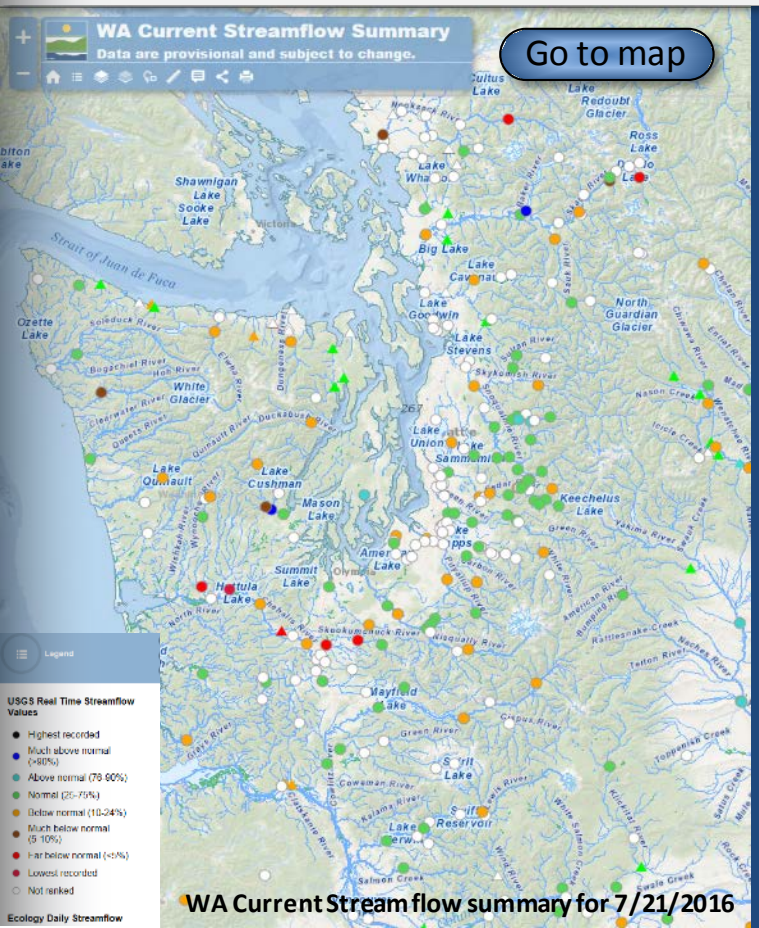
C. Turbidity: Turbidity was low on the entire route.

D. Colored Dissolved Organic Matter (CDOM): Humics (brown-yellow) from rivers are low in Central Basin and the Strait of Juan de Fuca.

Recent July rain, a short-term gain

Markus von Prause, Ecology

Flow levels for the Puget Sound Ecoregion have greatly increased in 2016, compared to the 2015 drought year. Snow water equivalents are now exhausted, and meltwater comes primarily from glaciers, as can be seen by glacial flour in the Puyallup River, for example.



WA Current Stream flow summary for 7/21/2016

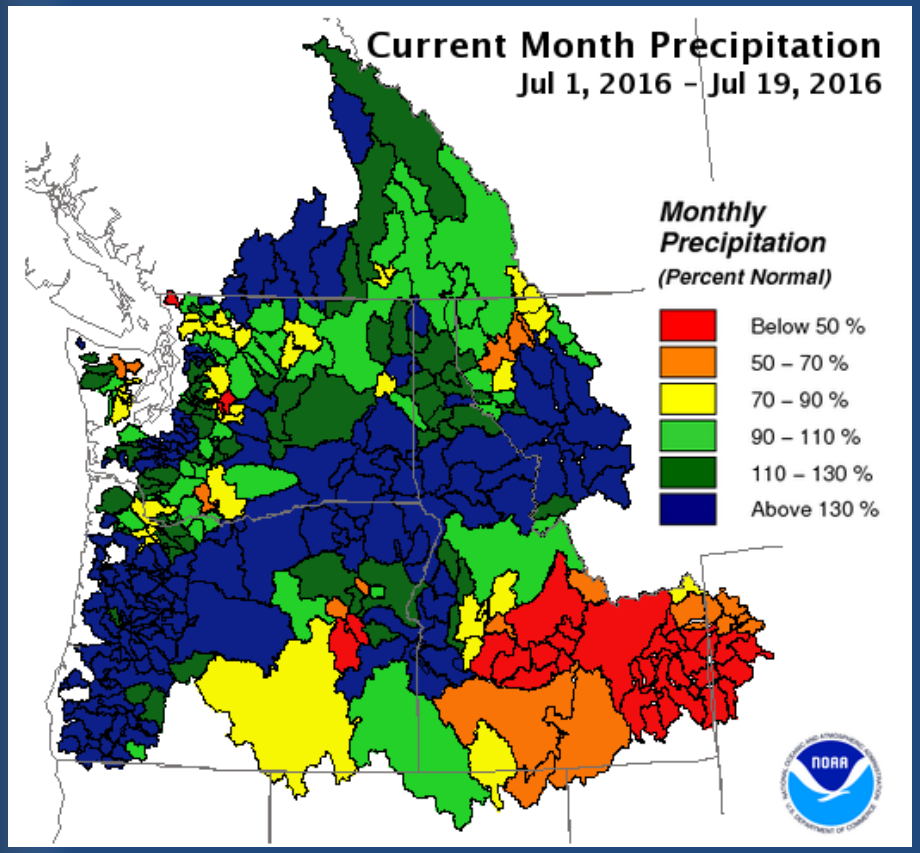
Table shows river flows in 2015 and 2016, relative to historical values for the same month (% of normal).

During July 2016, increased flows at Ecology and USGS stream monitoring sites were at normal levels as precipitation levels were well above normal.

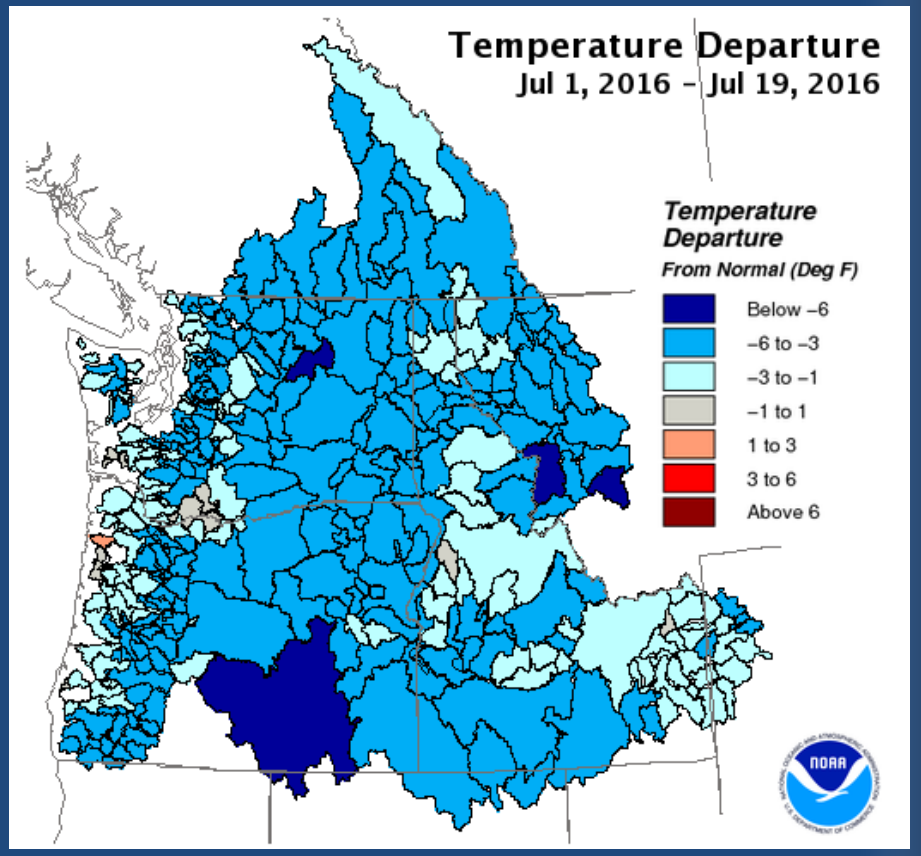
new min | less 20% | less 50% | less 80%

USGS Site Location	July 2015	July 2016
NOOKSACK RIVER AT FERNDALE, WA	new min	<50%
SF NOOKSACK RIVER AT SAXON BRIDGE, WA	new min	<50%
MF NOOKSACK RIVER NEAR DEMING, WA	<50%	<80%
NF NOOKSACK RIVER BL CASCADE CREEK NR GLACIER, WA	<20%	<20%
SAMISH RIVER NEAR BURLINGTON, WA	<20%	<50%
SKAGIT RIVER NEAR MOUNT VERNON, WA	<20%	<50%
BAKER RIVER AT HENRY THOMPSON BR AT CONCRETE, WA	<50%	<20%
SAUK RIVER NEAR SAUK, WA	new min	<50%
CASCADE RIVER AT MARBLEMOUNT, WA	<20%	<20%
NF STILLAGUAMISH RIVER NEAR ARLINGTON, WA	new min	<80%
PILCHUCK RIVER NEAR SNOHOMISH, WA	new min	> 80%
SNOHOMISH RIVER NEAR MONROE, WA	new min	<50%
TOLT RIVER NEAR CARNATION, WA	<20%	<80%
RAGING RIVER NEAR FALL CITY, WA	new min	> 80%
SF SNOQUALMIE RIVER AB ALICE CREEK NEAR GARCIA, WA	new min	<50%
NF SNOQUALMIE RIVER NEAR SNOQUALMIE FALLS, WA	new min	<80%
MIDDLE FORK SNOQUALMIE RIVER NEAR TANNER, WA	new min	<50%
SULTAN RIVER BELOW POWERPLANT NEAR SULTAN, WA	<80%	<80%
SKYKOMISH RIVER NEAR GOLD BAR, WA	new min	<20%
ISSAQUAH CREEK NEAR MOUTH NEAR ISSAQUAH, WA	<20%	> 80%
CEDAR RIVER AT RENTON, WA	<50%	<50%
ROCK CREEK NEAR MAPLE VALLEY, WA	new min	<50%
GREEN RIVER NEAR AUBURN, WA	new min	<50%
BIG SOOS CREEK ABOVE HATCHERY NEAR AUBURN, WA	<80%	<80%
NEWAUKUM CREEK NEAR BLACK DIAMOND, WA	new min	<20%

Recent July rain, a short-term gain



During July 2016, precipitation levels were well above normal in western Washington.



Temperatures were 3 to 6 degrees Fahrenheit below the historical norm for the majority of the Pacific Northwest region.

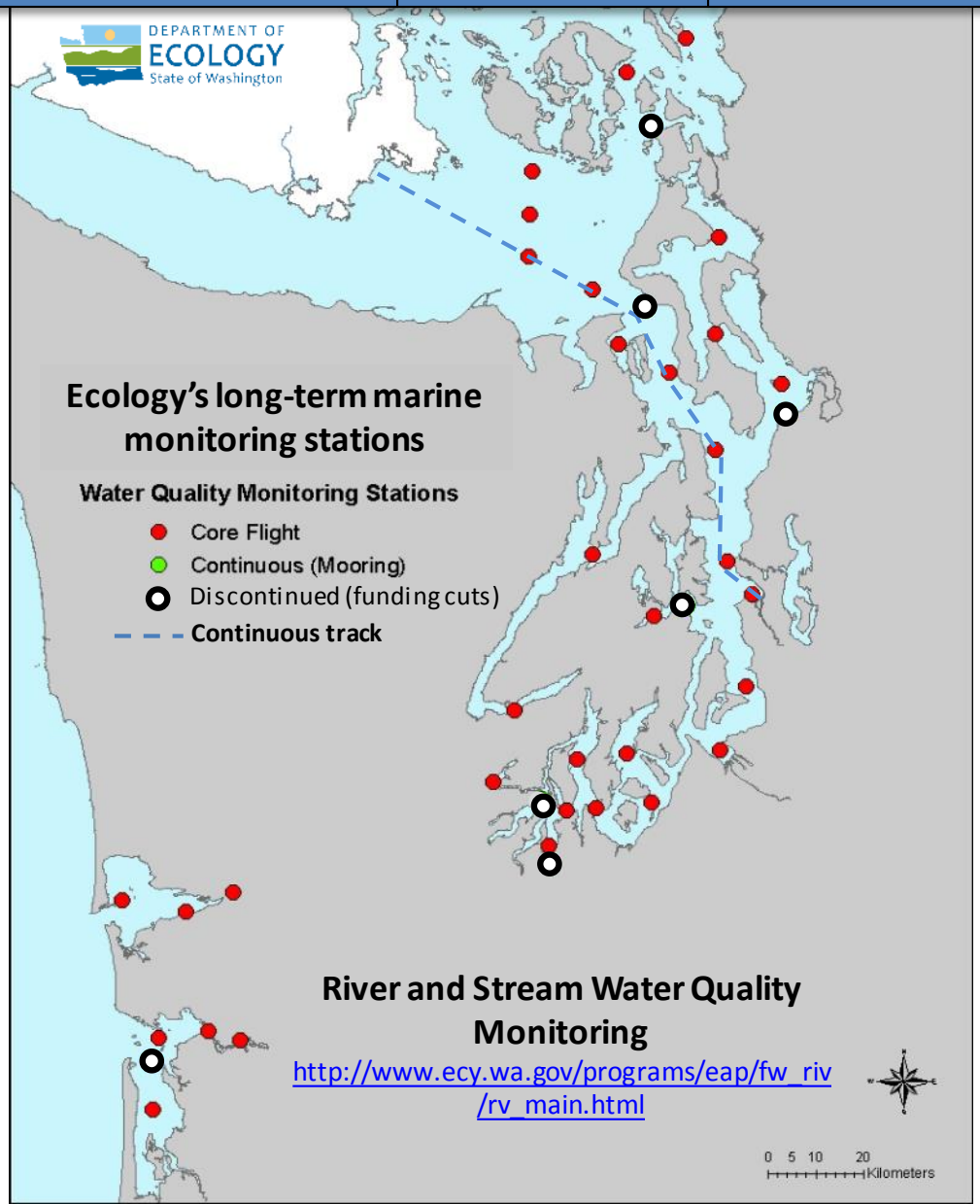
Get data from Ecology's Marine Monitoring Programs

Field log	Climate	Water column	Aerial photos	Continuous monitoring	Streams

Long–Term Monitoring Network

christopher.krembs@ecy.wa.gov

Access core monitoring data:
https://fortress.wa.gov/ecy/eap/marinewq/mwdataset.asp



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

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

Many thanks to our business partners: Clipper Navigation, Swantown Marina, and Kenmore Air.