Publication No. 16-03-072

DEPARTMENT OF ECOLOGY State of Washington

Eyes Over Puget Sound

Surface Conditions Report, April 6, 2016

Critter of the Month

Start here

Up-to-date observations of visible water quality conditions in Puget Sound and the Strait of Juan de Fuca

Marine conditions from 4-6-2016 at a glance

LONG-TERM MARINE MONITORING UNIT

Mattie Michalek

Skip Albertson

Dr. Christopher Krembs (Editor)

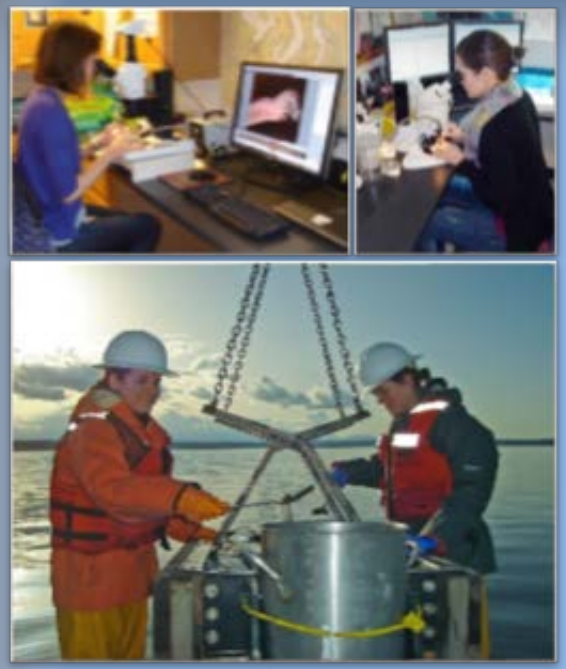
Julia Bos
Suzan Pool

Jim Shedd

Editorial assistance provided by: Suzan Pool, Carol Maloy

Eyes Under Puget Sound 4-6-2016

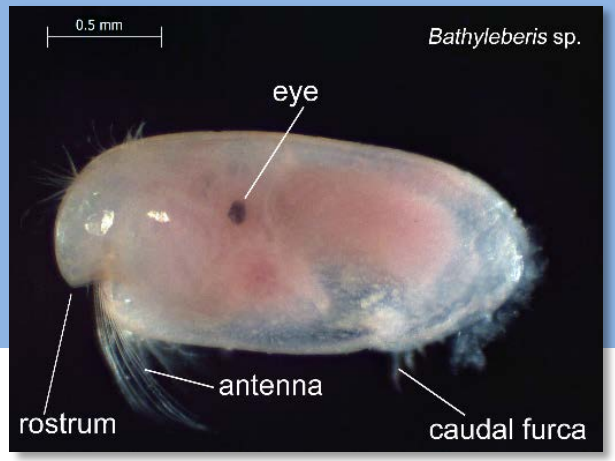
Critter of the Month – Ostracods, a common species in Puget Sound



Dany Burgess & Angela Eagleston
Marine Sediment Monitoring Team

Ostracods - The Seed Shrimp

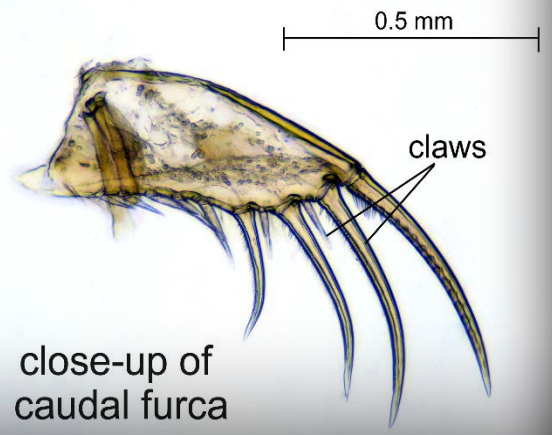
This month's Critter is a fascinating crustacean that conceals its appendages inside a bivalve-like shell.



Fun Ostracod Facts!

- Most are tiny - the size of a sesame seed.
- They use their antennae and other appendages (like the caudal furca pictured below) to capture food particles and burrow into the mud.
- They can live in extreme environments like the deep sea and caves.

Because their shells fossilize well, ostracods have the most complete fossil record of any animal, dating back 425 million years! Scientists use them to understand how the earth and its climate have changed through time.



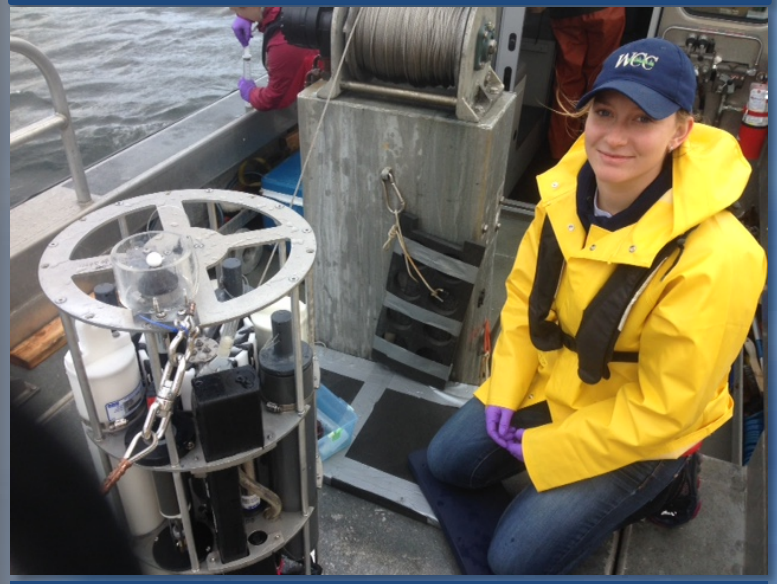
Learn more about ostracods and other critters on Ecology's EcoConnect blog

Personal Field Impression 4-6-2016

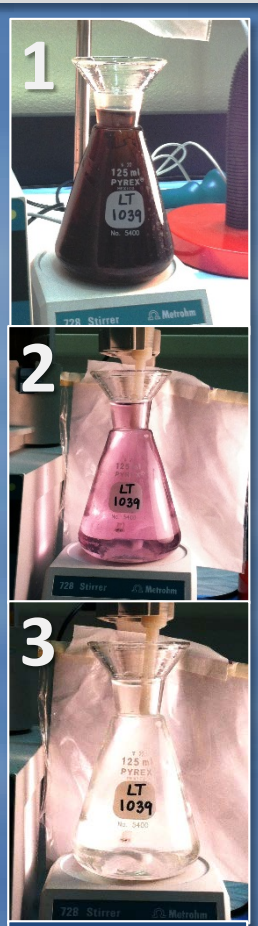
Sampling and Analyzing Dissolved Oxygen

Mattie Michalek –Washington Conservation Corps Intern

When we sample Puget Sound by sea plane or boat, we measure dissolved oxygen (DO) in the water with an instrument. To check that our DO sensor is working, we also collect water samples for laboratory analysis. In the field, we add two chemicals that cause the oxygen to bind to manganese to form a solid.



Ready to collect a water sample in the field.



The phases of a titration. The 3rd phase is called the "endpoint."

Mattie performing a Winkler titration on a DO sample

Back at the lab, additional chemicals are added to the sample to break up the bound oxygen. We then titrate the sample by adding very small, precise amounts of a solution to the sample until it turns from a deep purple (1) to clear (3). I enjoy running DO samples because the analyst must use their best judgment and trained eye to gauge whether a sample is at its endpoint.

Natural Influence, not updated for March

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.

Putting the puzzle pieces of influencing factors together…

Summary for February 2016:

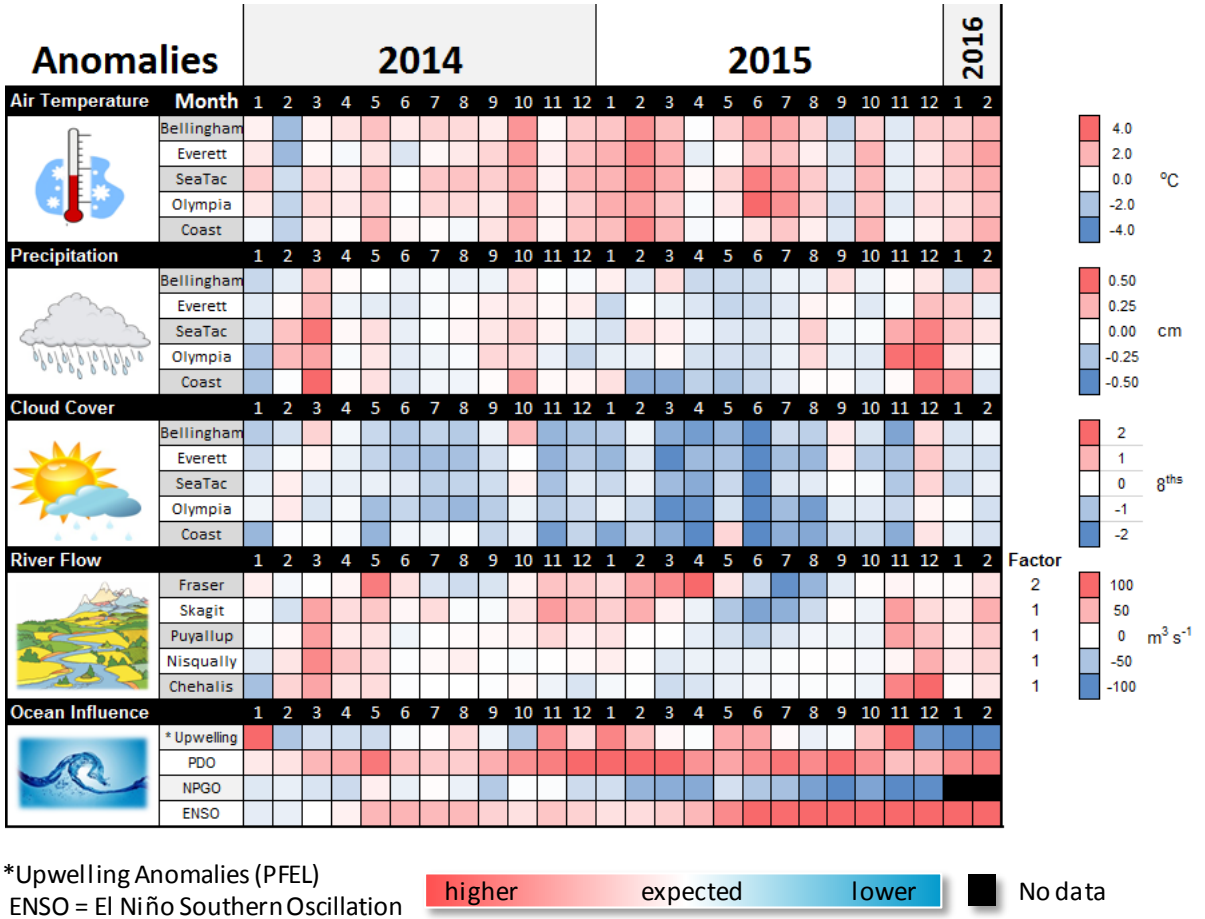
Air temperatures remained above normal in the Puget Sound lowlands.

Precipitation levels were above normal overall.

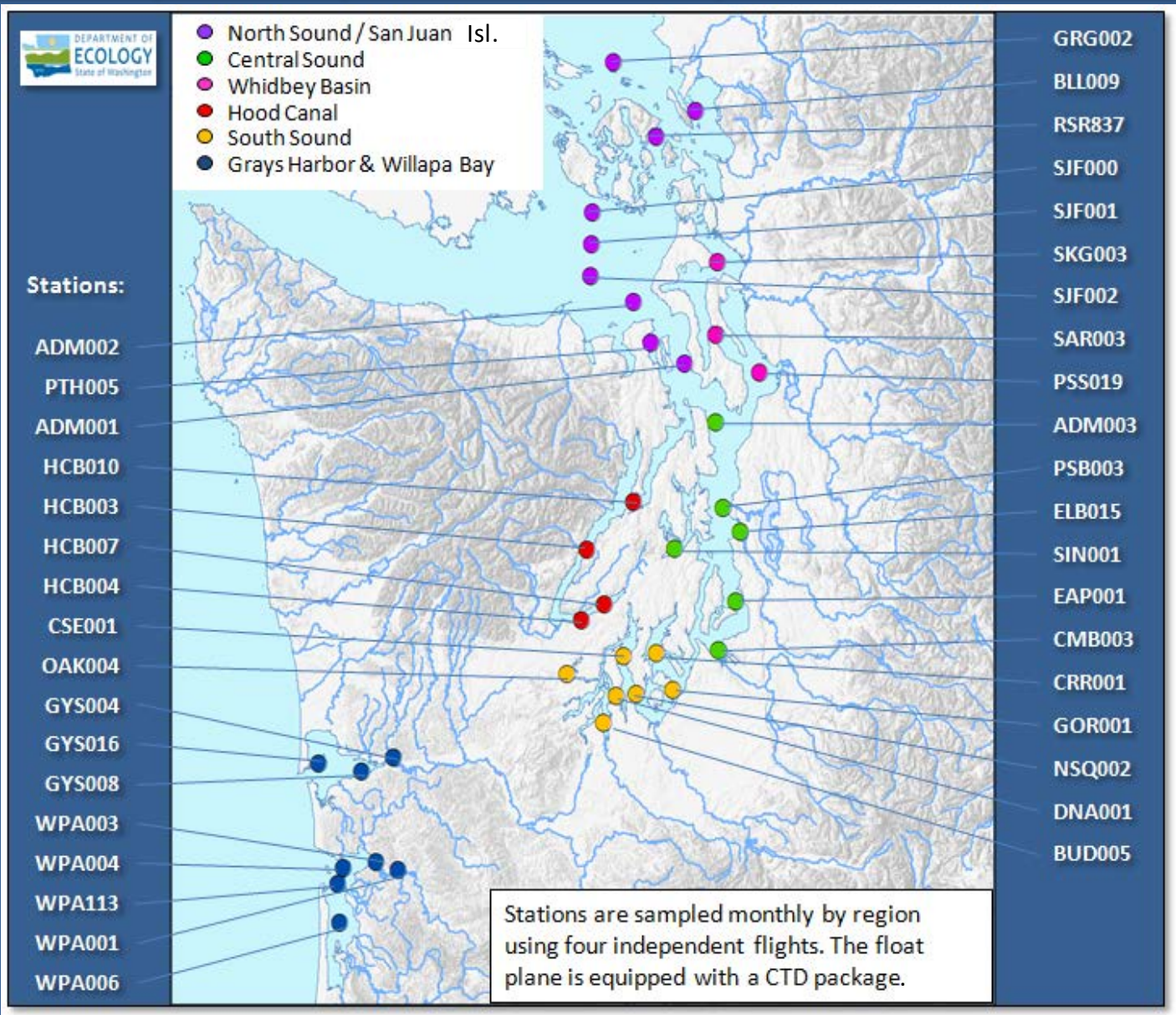
Sunshine levels were generally above normal, but alternated with cloudy periods.

River flows continued above normal.

Downwelling was strong, and ENSO and PDO remained in their warm phase (El Niño).



Our long-term marine monitoring stations in Washington



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

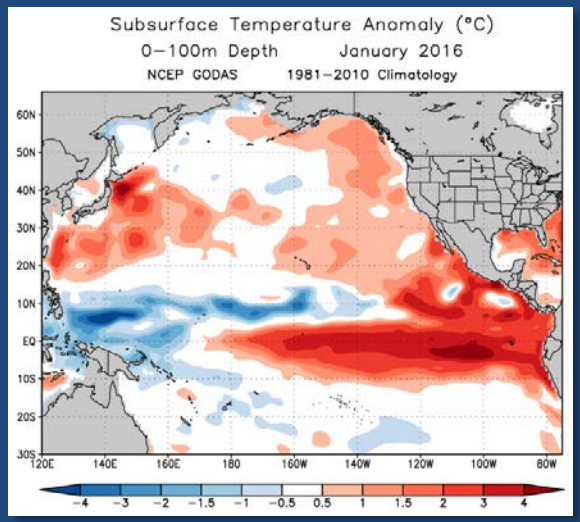
Start here

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**

Are Puget Sound conditions normalizing?

Year 2015 was a record breaker for water temperature in Puget Sound and for global temperatures. Premature melting of the snowpack in early summer caused initially fresh conditions. This year looks better. The winter brought record-breaking rain and, as a result, estuarine circulation has increased to renew the water within Puget Sound. **Yet, water temperatures are still high!**

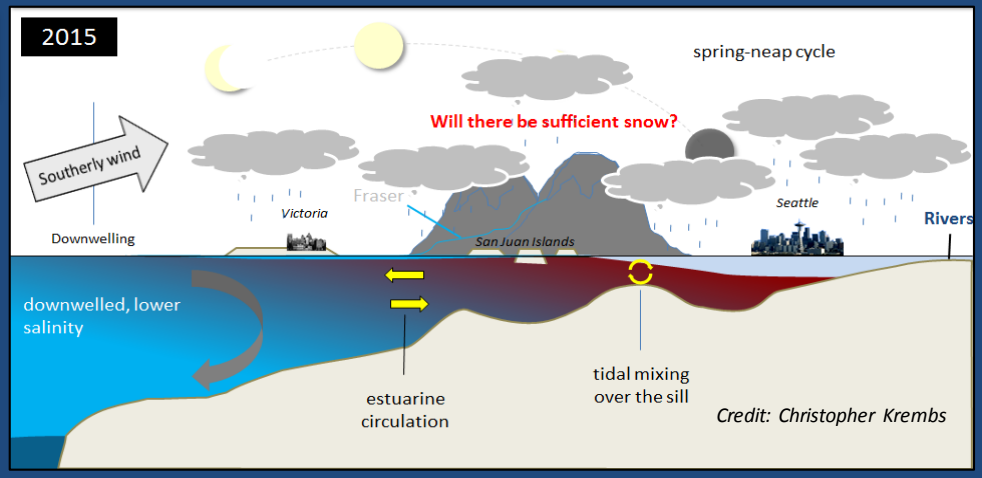


AOOS
Alaska Ocean Observing System

Alaska "Blob" Tracker

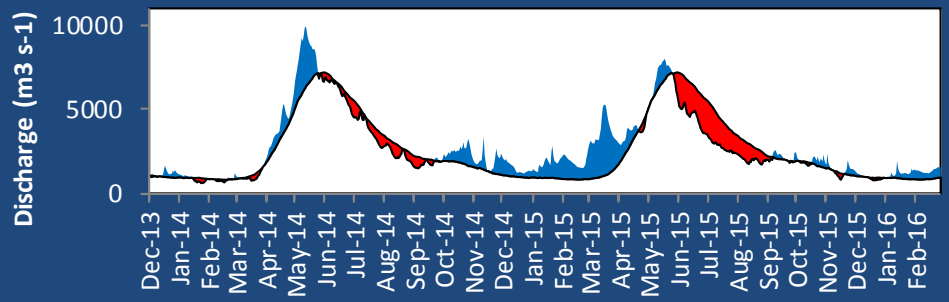
As of January 2016 (left), the Blob below the surface is still alive!

Read here



Rivers are flowing higher and increasing water exchange. This is an opportunity to bring cooler ocean water into Puget Sound.

The Fraser River is the largest freshwater source for the Salish Sea, significantly affecting estuarine circulation.



Government of Canada

In winter and spring 2015, the Fraser River and other rivers discharged prematurely. Very low summer flows followed and inhibited the renewal of water in Puget Sound. Rivers are now normal or running higher, but not like last year. Estuarine circulation is as expected.

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

Physical conditions tracked in historical context

With record high precipitation, salinity is notably lower than normal. **Temperatures** remain high in Puget Sound. Record warm water from last year persists much longer in Hood Canal. Oxygen in Puget Sound is expected. Conditions are comparable, but less pronounced at the Coast.

Still higher temperature in P. Sound

Salinity below normal

Expected 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

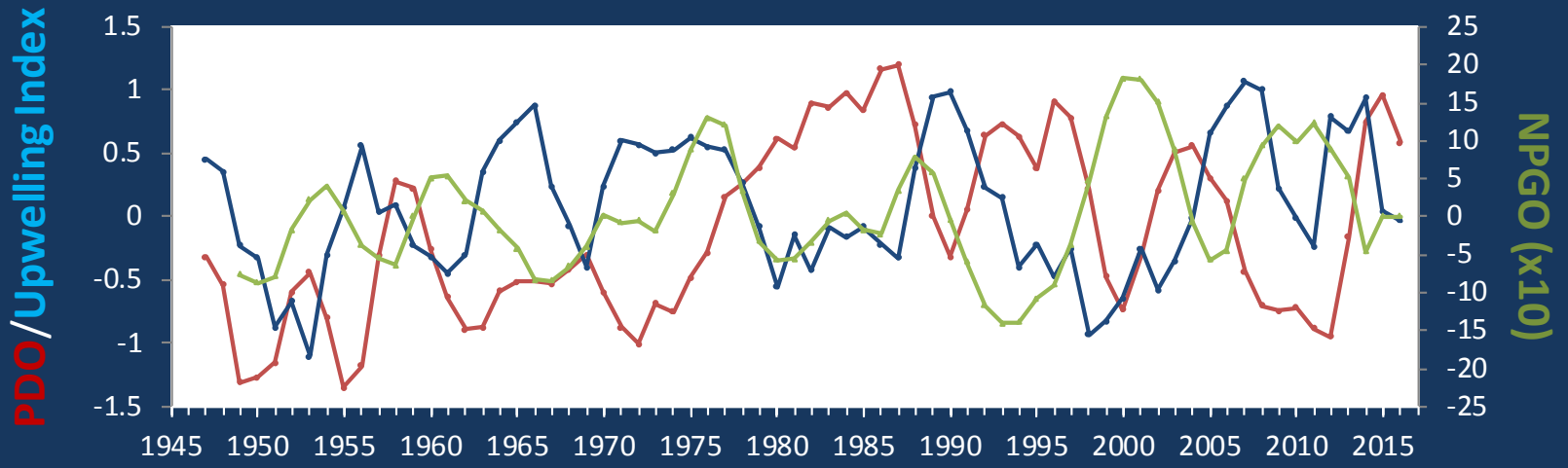
The ocean affects water quality: Ocean Climate Indices

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 are in transition: (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 normalizing (NPGO).

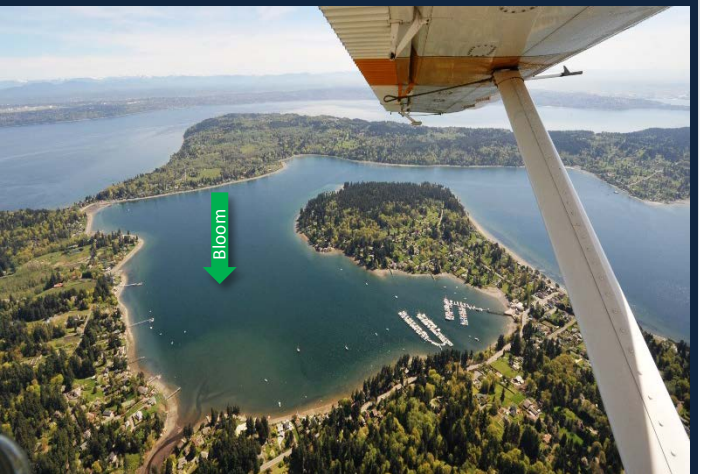
Summary: Aerial photography 4-6-2016

Jellyfish increasing and in very high numbers in Southern and Sinclair Inlets. Spring phytoplankton bloom across South and Central Sound. Fish aggregations and spawning around Vashon Island. Several large tidal eddies documented.

Start here

Spring phytoplankton bloom in Henderson Inlet

Phytoplankton bloom in Quartermaster Harbor



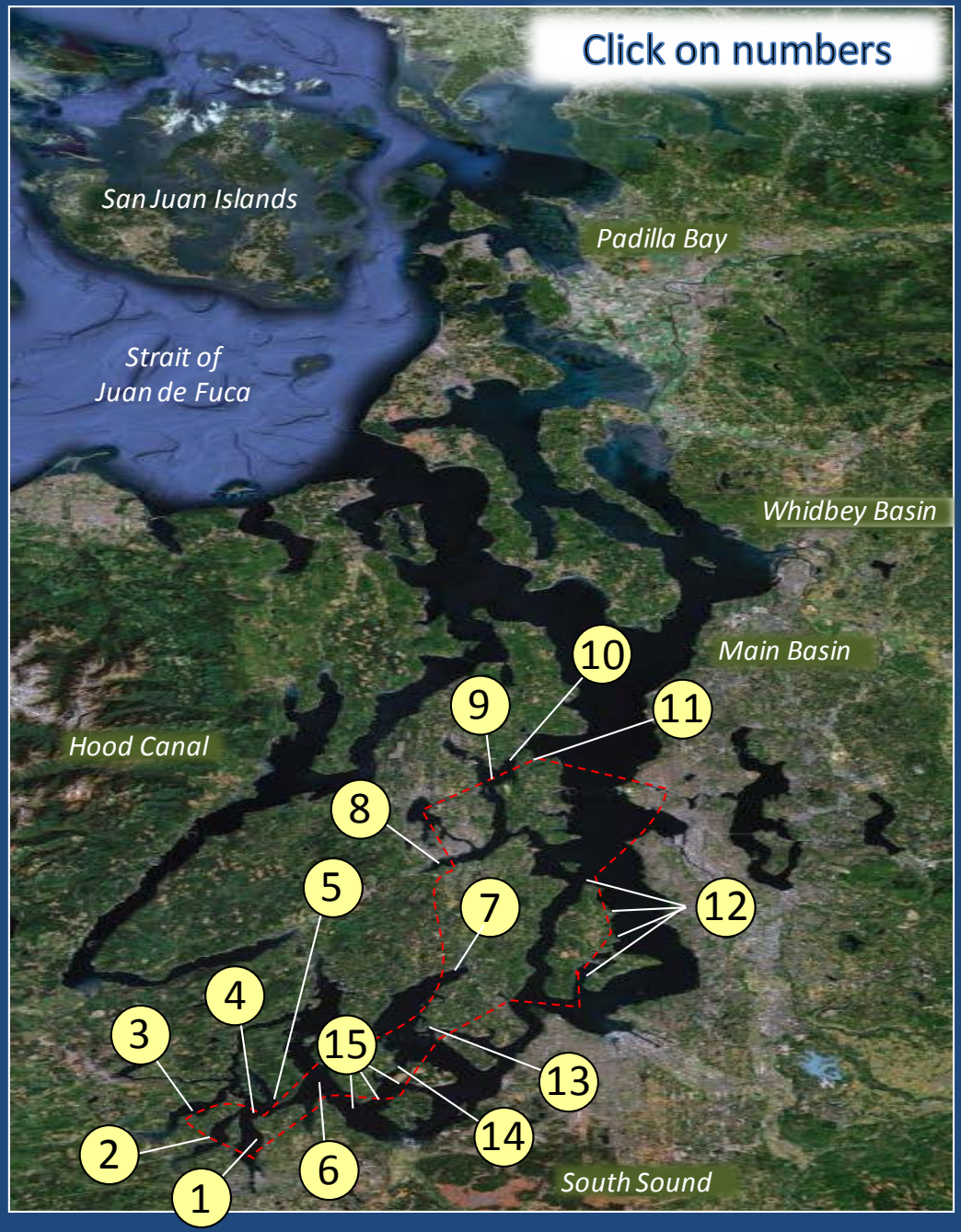
Mixing and Fronts:
Tidal fronts and eddies in Pitt and Agate Passages.

Jellyfish:
Numerous jellyfish patches in Budd, Led, Henderson, and Sinclair Inlets.

Suspended sediment:
Very little suspended sediment, some around tidally exposed points.

Visible blooms:
Spring phytoplankton bloom in fully swing in all places across South and Central Sound.

Debris:
Debris in Dana Passage and Carr Inlet, otherwise low occurrence.



Aerial photography and navigation guide

Date: 4-6-2016

Tide data (Seattle):

Time	Pred	High/Low
04:40 AM	11.81	H
10:58 AM	1.58	L
05:03 PM	11.04	H
11:08 PM	1.54	L

Flight Information:

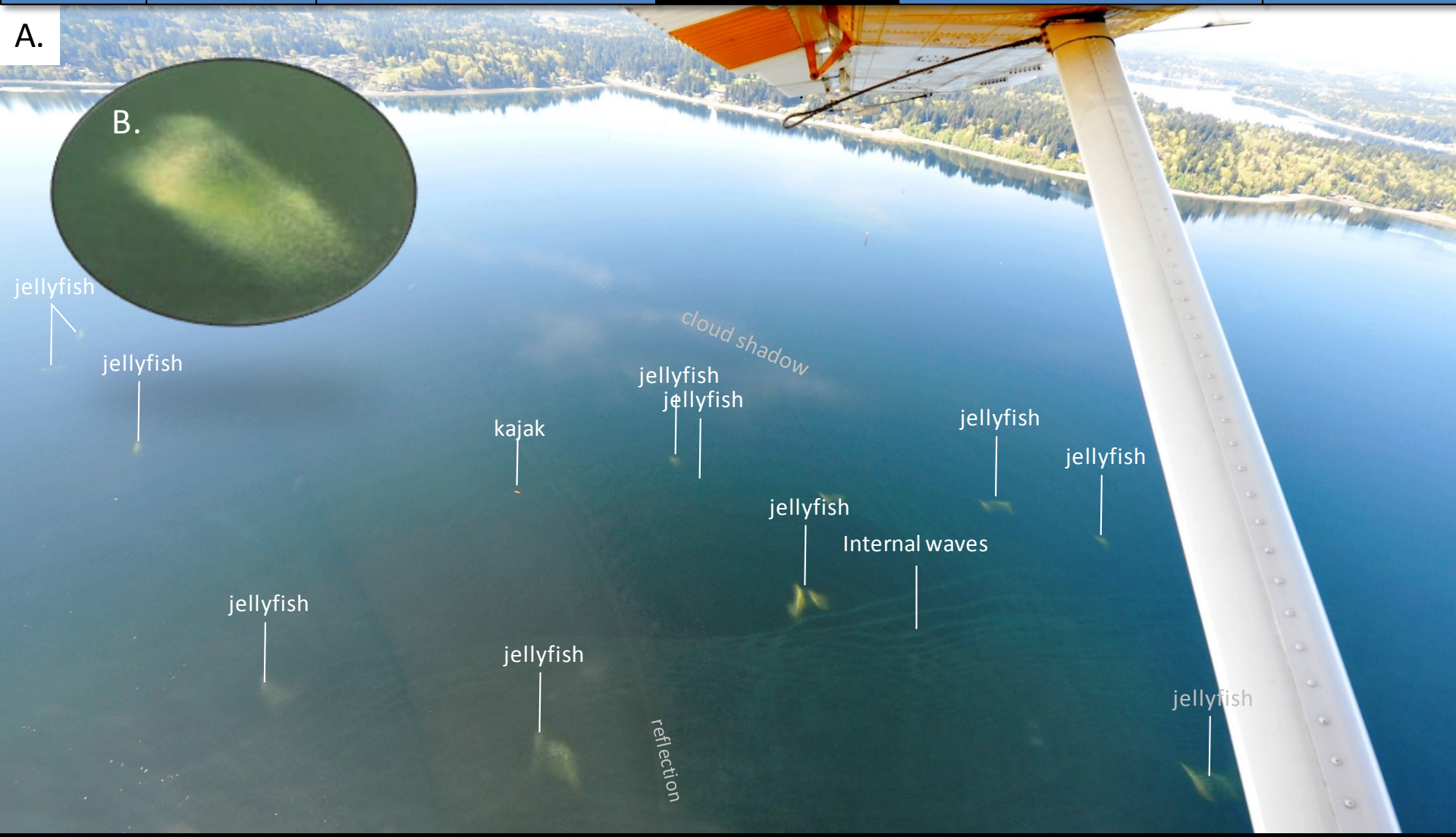
Sunny, broken ceiling near Bremerton

Flight route

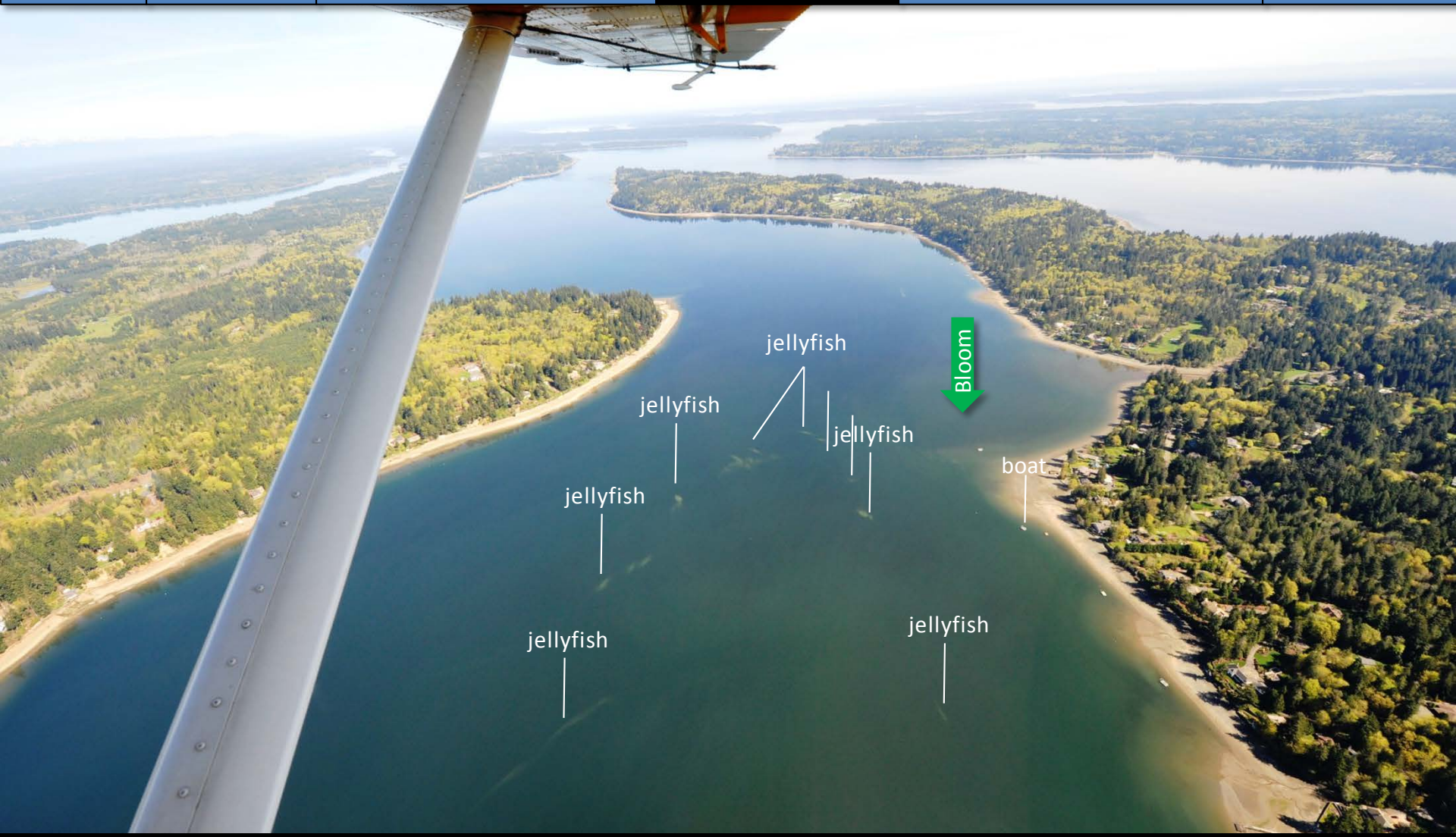
Observation Maps:

Central Sound

South Sound



A. Jellyfish patches are already very numerous in Southern Inlets. B. The granularity confirms that we see jellyfish. Location: Budd Inlet across Butler Cove (South Sound), 12:23PM.



Jellyfish patches are already very numerous in Southern Inlets.

Location: Led Inlet (South Sound), 2:29 PM.

Mussel rafts have visible impact on water flowing past them.
Location: Totten Inlet, Gallagher Cove (South Sound), 12:31 PM.

Water rich in phytoplankton from Peale Passage flowing past Boston Harbor.
Location: *Off Dover Point,* near Dana Passage (South Sound), 12:33 PM.

Water rich in phytoplankton from Peale Passage flowing dowards Boston Harbor.
Location: *Squaxin Island,* near Dana Passage (South Sound), 12:33 PM.

Aerial photography 4-6-2016

Phytoplankton rich water from finger inlets meet less colored water from Case Inlet at entrance to Dana Passage. Location: Across Henderson Inlet (South Sound), 12:36 PM.

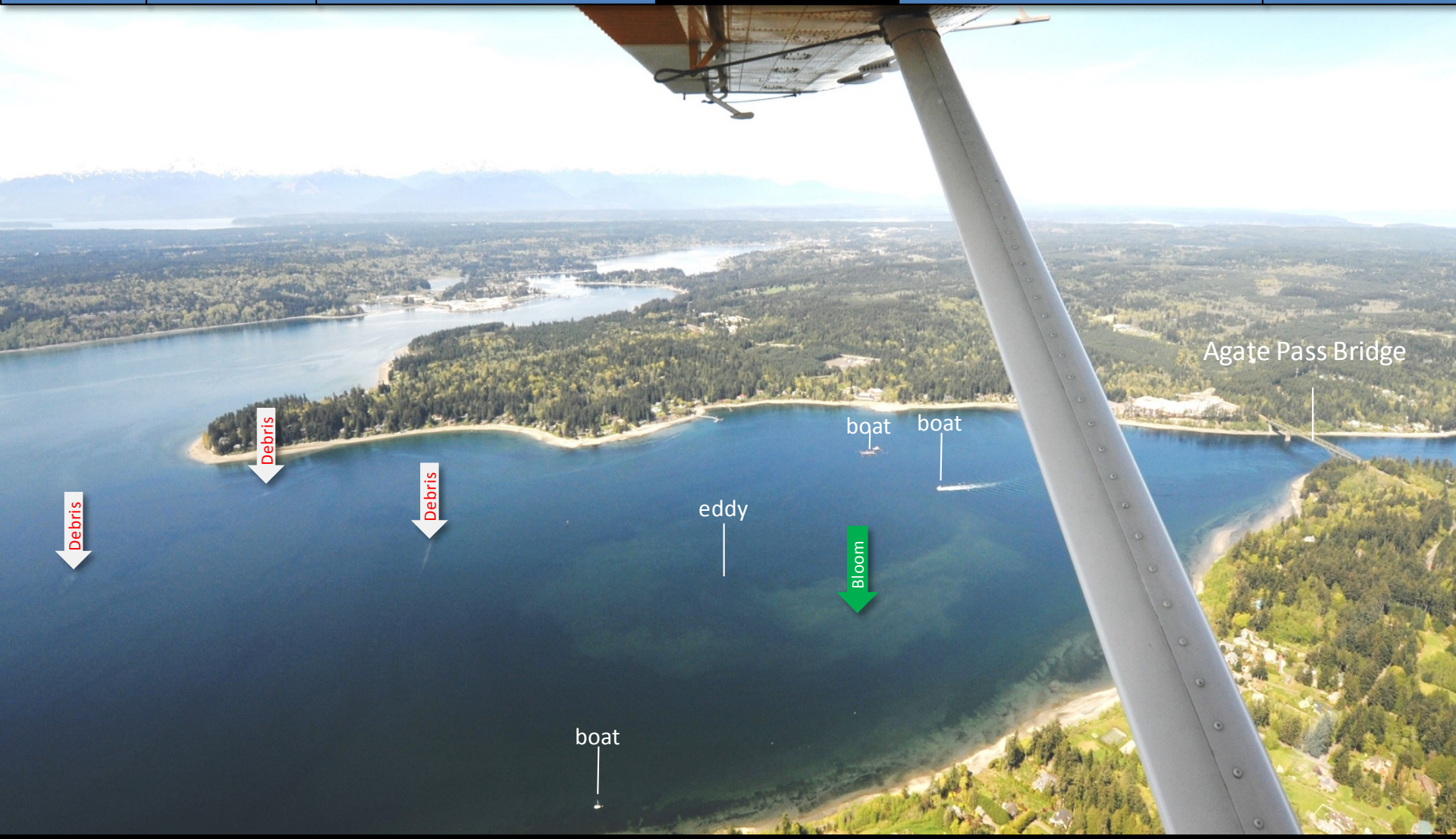
A. Long streaks of organic material. B. Schools of fish aggregating near McCormick Creek.
Location: Henderson Bay, Carr Inlet (South Sound), 12:46 PM.

Patches of jellyfish amongst more dispersed patches (not shown).

Location: Sinclair Inlet, (Central Sound), 12:54 PM.

A. Schooling fish or eelgrass, keeping them apart remains a guessing game! B. Internal waves in Bay.
Location: A. Battle Point, B. Manzanita Bay, Bainbridge Island (Central Sound), 1:01 PM.

Aerial photography 4-6-2016



Eddy rich in phytoplankton in Agate Pass.

Location: Near Agate Pass Bridge, Bainbridge Island (Central Sound), 1:02 PM.

Phytoplankton bloom staining water green.
Location: *Treasure Island,* Port Madison (Central Sound), 1:03 PM.

Suspended sediment or spawning herring. A challenge from 2500 feet around Vashon Island!

Location: A. Point Vashon, B. off SW 127th St ,C. Point Heyer, D. off SW 268th St (Central Sound), 1:19 PM.

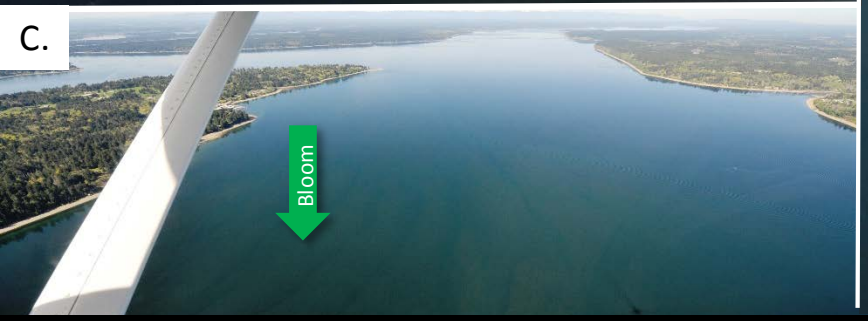
Large eddy rich in phytoplankton.

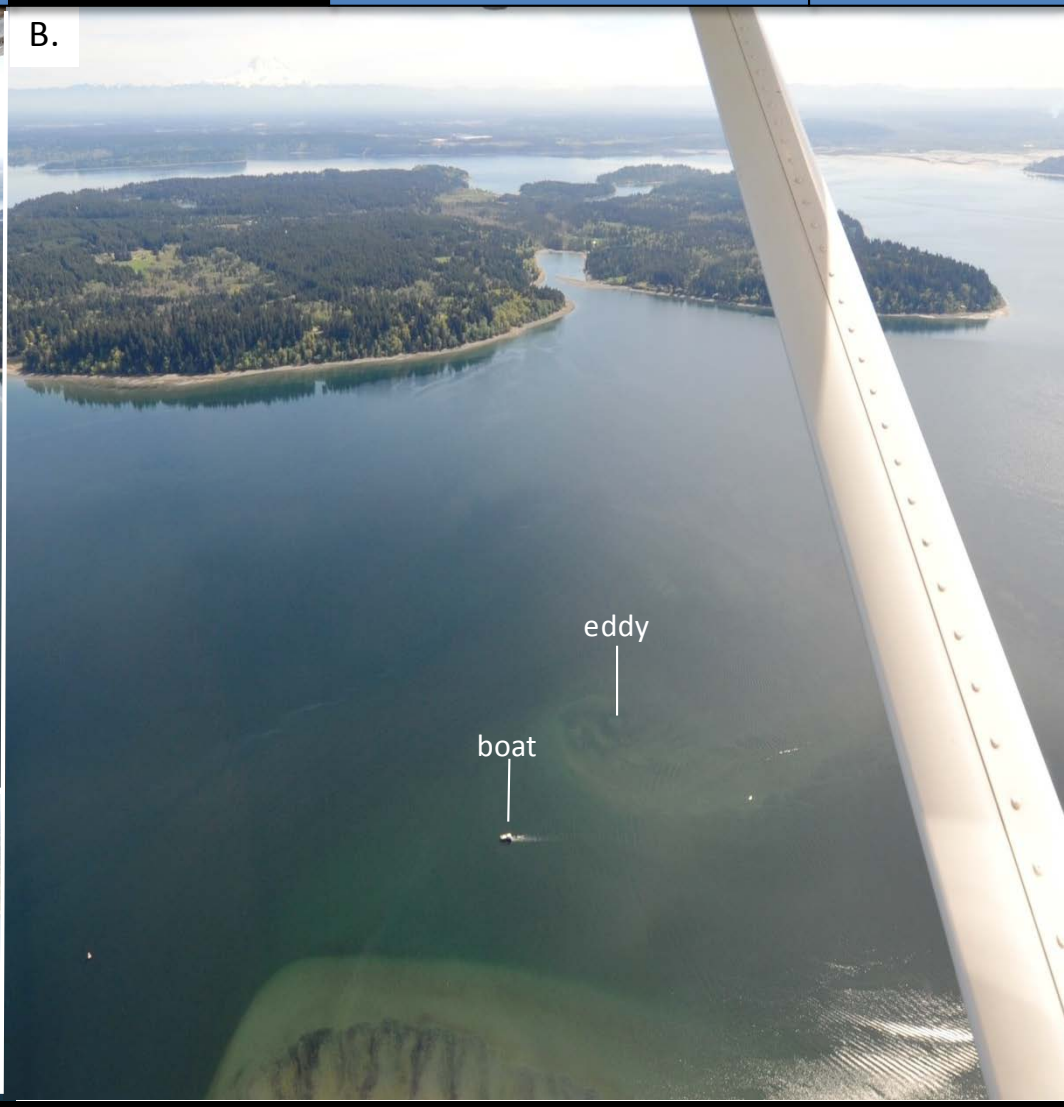
Location: Across Shaws Cove, Carr Inlet, (South Sound), 1:25 PM.

Aerial photography 4-6-2016

Tidal exchange and phytoplankton-rich water in Pitt Passage.

Location: Pitt Passage (South Sound), 1:27 PM.



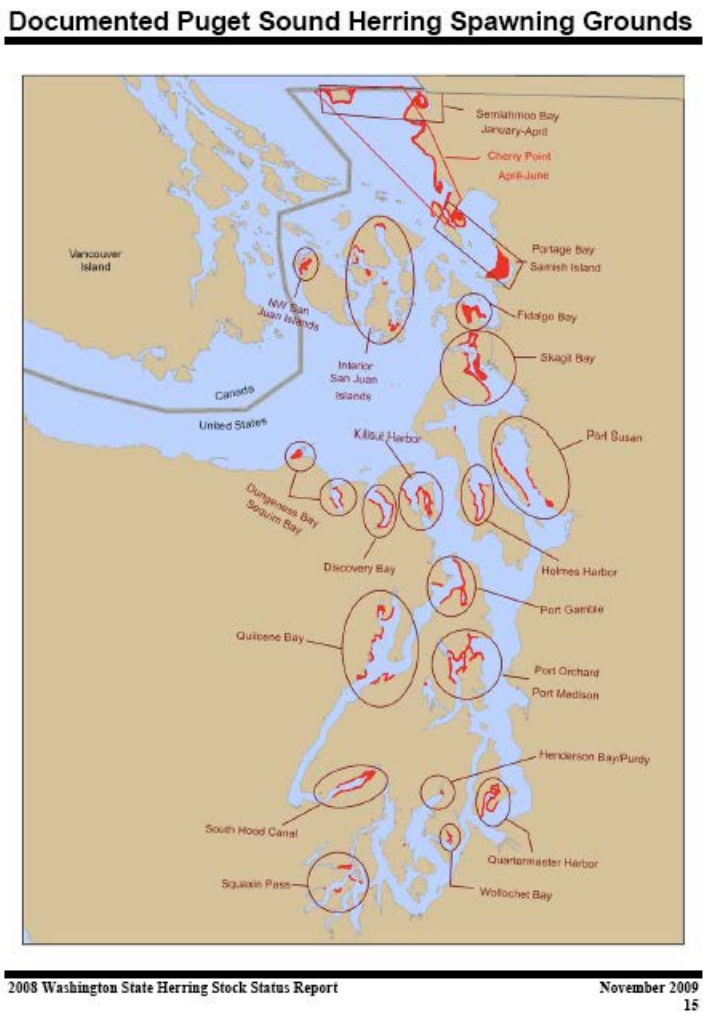


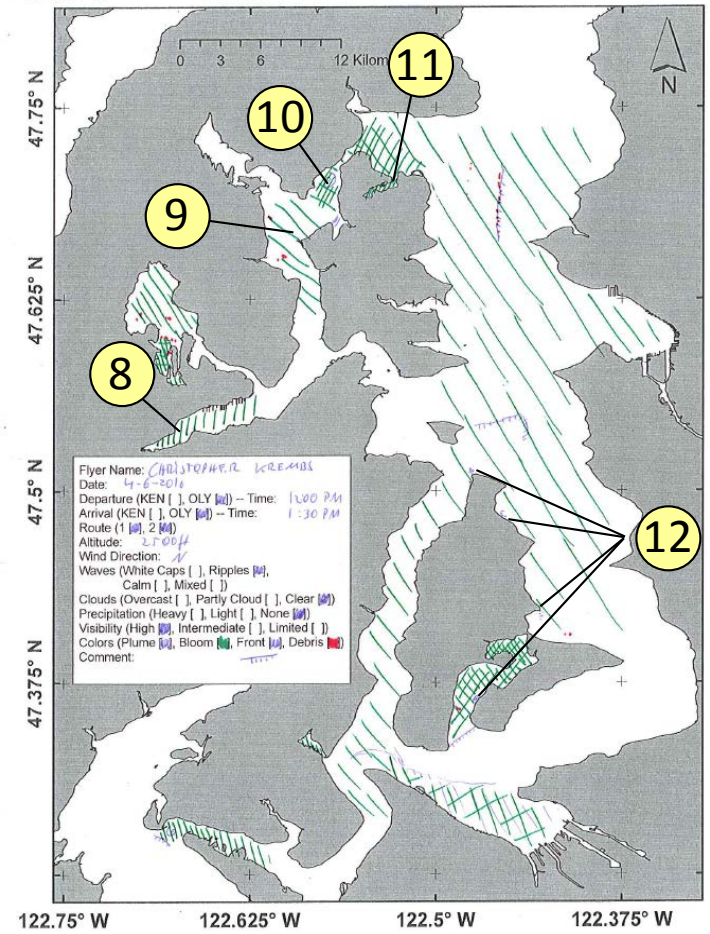
Phytoplankton-rich water in A. Pitt Passage B. Across Anderson Island with large eddy, C. Nisqually Reach

Location: Around McNeil and Anderson Island (South Sound), 1:30 PM.

Date: 4-6-2016

Central Sound

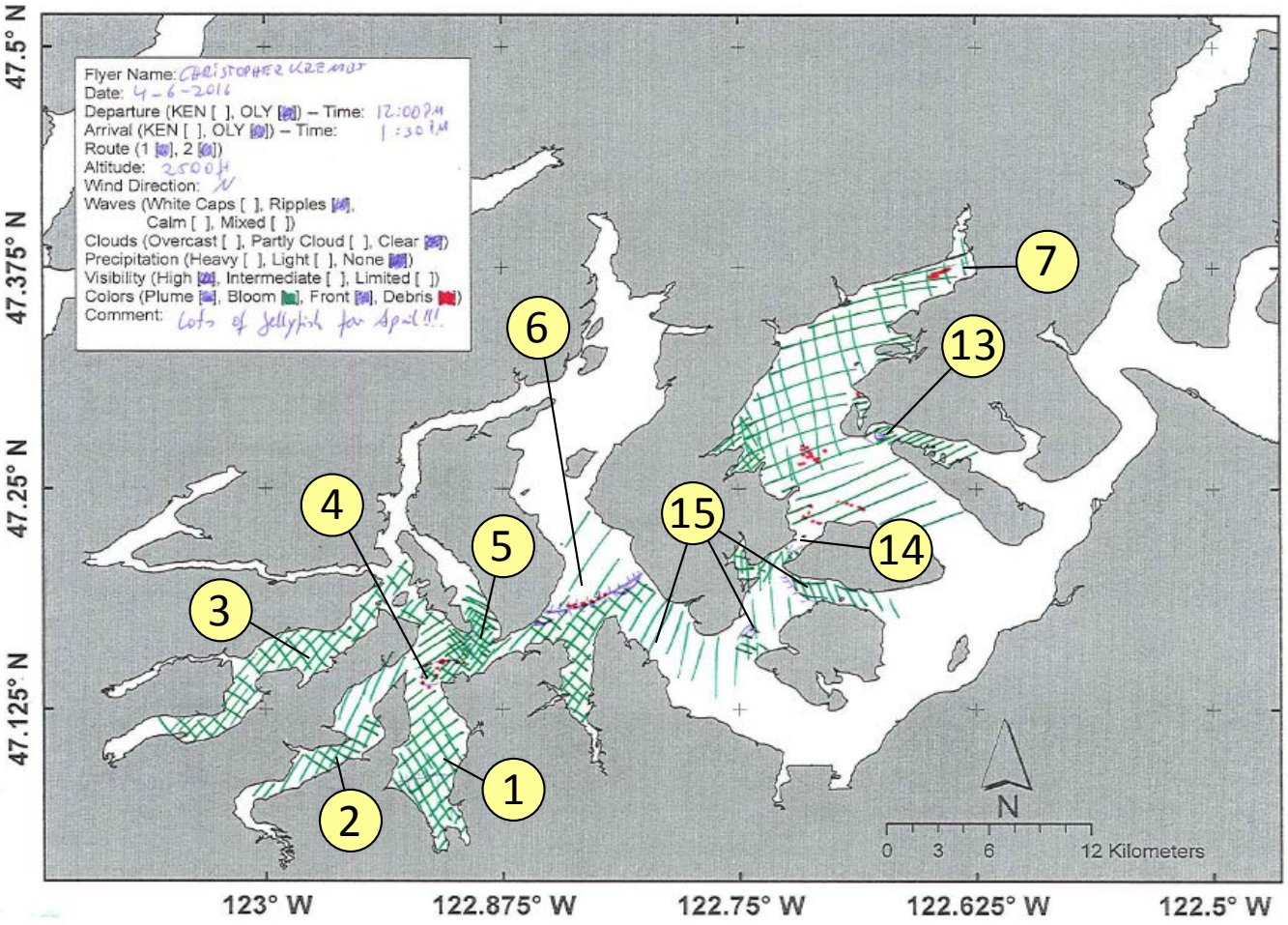




Numbers on map refer to picture numbers for spatial reference

Date: 4-6-2016

South Sound

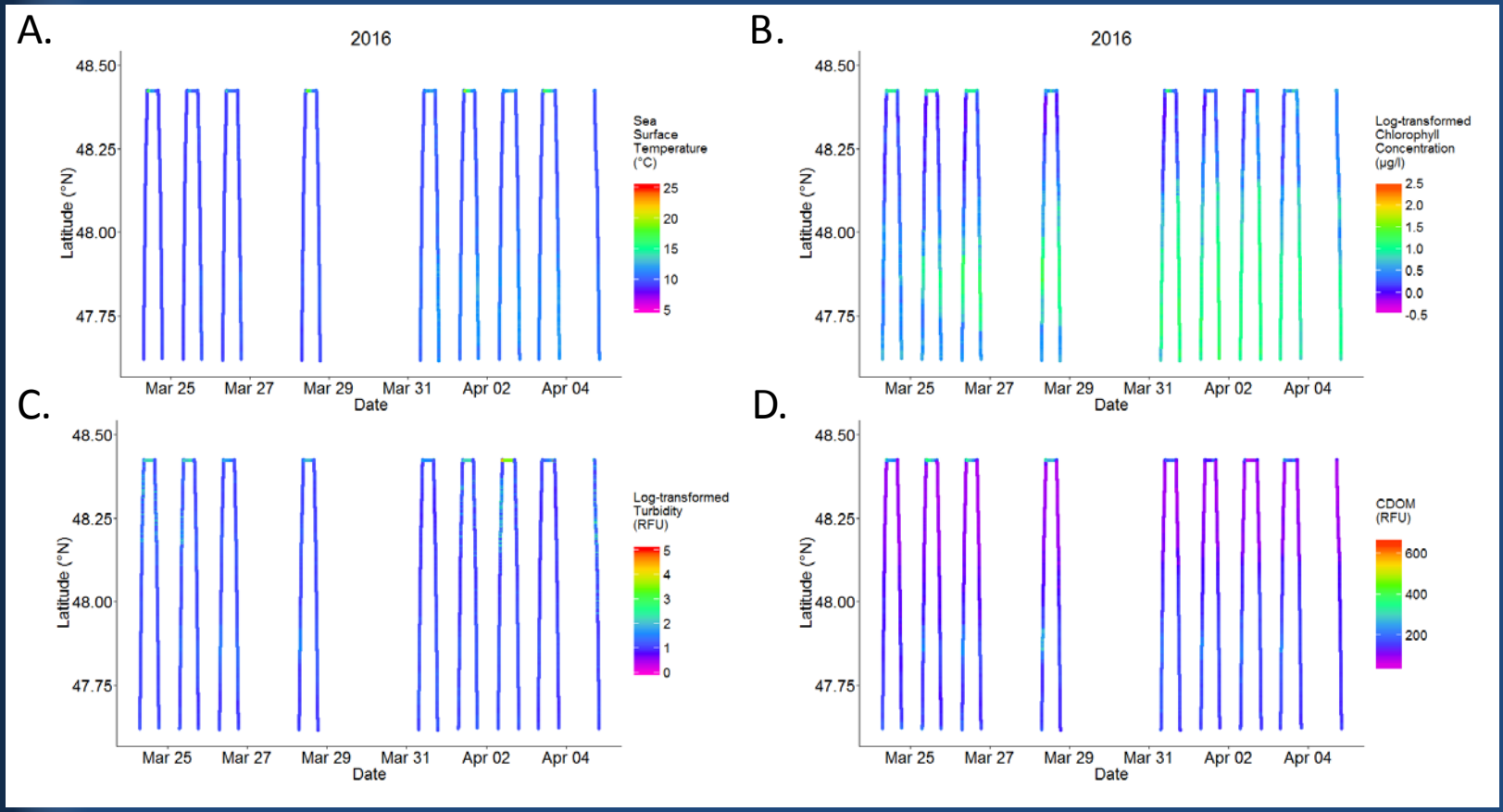


Numbers on map refer to picture numbers for spatial reference

Continuous monitoring 4-6-2016

Suzan Pool

Summary of *Victoria Clipper IV* ferry data:
The ferry was in dry-dock until mid-March when it resumed sailing. Spatial plots (next page) show data from Tuesday, April 3rd. Over the last two weeks, near-surface water on the ferry route was near 10 °C. Within Puget Sound, chlorophyll concentrations increased.



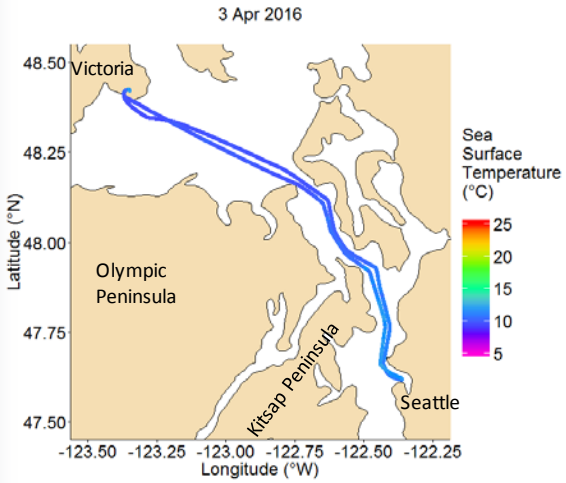
The *Victoria Clipper IV* carries sensors in its sea chest. The sensors allow us to plot over time transects of:

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

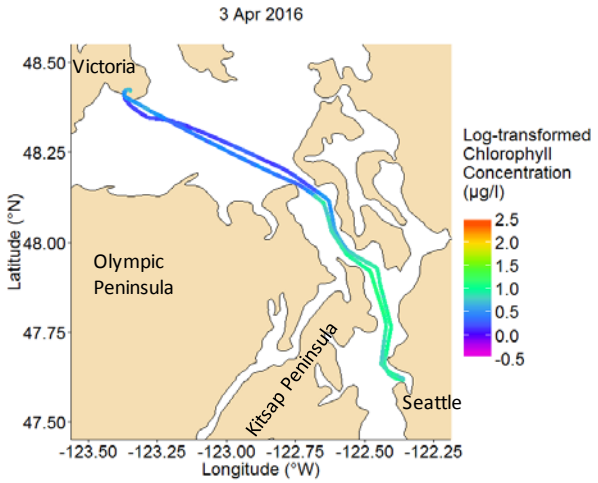
Over time, we see the dynamic of these variables in surface water between Seattle and Victoria, BC.

Continuous monitoring 4-6-2016

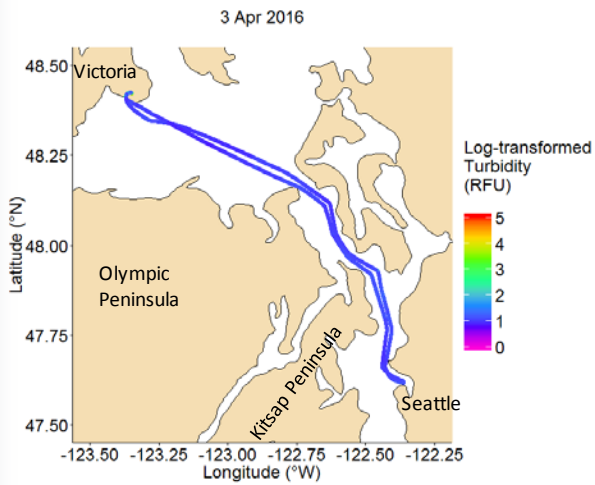
A.



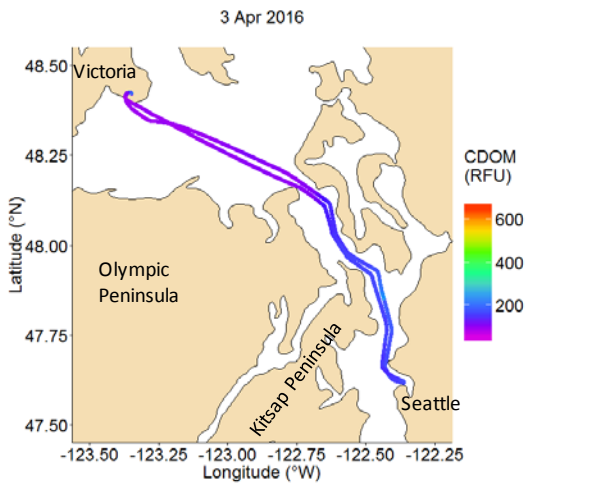
B.



C.



D.



Figures show daily sensor data 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 was isothermal on entire route.

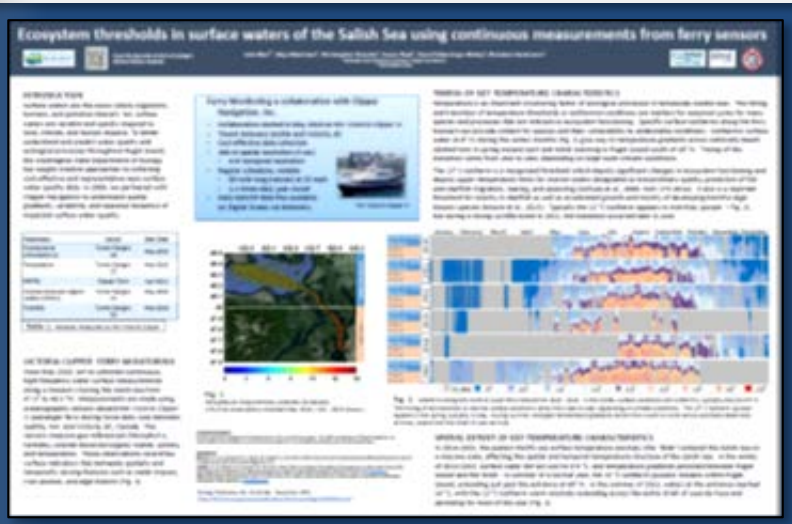
B. Chlorophyll: Concentrations were low in the Strait and increased in Puget Sound.

C. Turbidity: Turbidity was low on entire route.

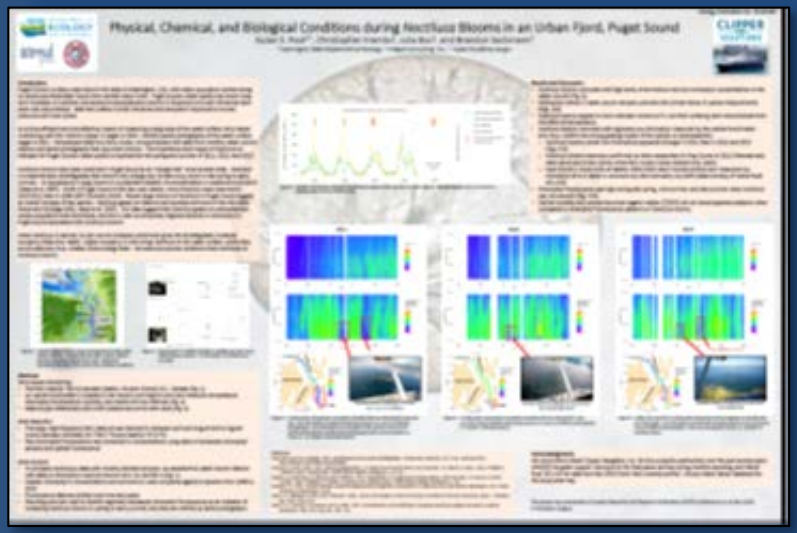
D. Colored Dissolved Organic Matter (CDOM): Particulates in the water were low in Central Basin and nearly absent in the Strait of Juan de Fuca.

Continuous monitoring 4-6-2016

Check out our posters that we presented at the Coastal and Estuarine Research Federation conference in Portland, Oregon during November 2015.

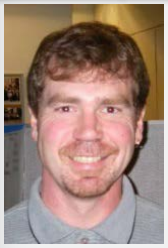


Bos, J., S. Albertson, C. Krembs, S. Pool, C. Falkenhayn Maloy, and B. Sackmann. 2015. Ecosystem Thresholds in Surface Waters of the Salish Sea using Continuous Measurements from Ferry Sensors. Poster presented at Coastal Estuarine and Research Federation 2015 Conference, Portland, Oregon. Washington State Department of Ecology Publication No. 15-03-041. https://fortress.wa.gov/ecy/publications/documents/1503041.pdf



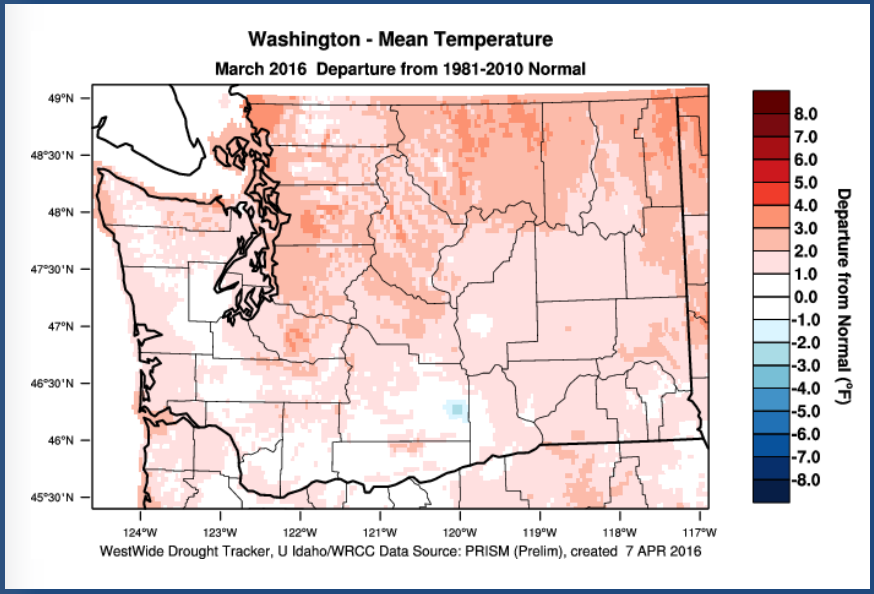
Pool, S.S., C. Krembs, J. Bos, and B. Sackmann. 2015. Physical, Chemical, and Biological Conditions during *Noctiluca* Blooms in an Urban Fjord, Puget Sound. Poster presented at Coastal Estuarine and Research Federation 2015 Conference, Portland, Oregon. Washington State Department of Ecology Publication No. 15-03-040. https://fortress.wa.gov/ecy/publications/documents/1503040.pdf

Wet and warm weather keep rivers flowing

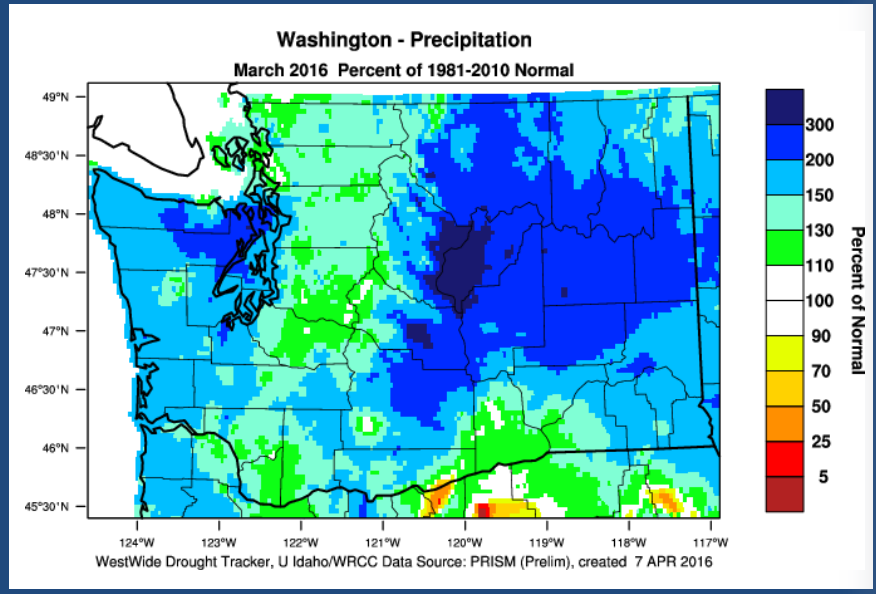


Jim Shedd, Ecology

Puget Sound Basin streamflows remained higher than normal in March. Many mountain streams reported much above normal flows (>90th percentile) responding to high snow fall and warm air. Despite warmer temperatures, snow water equivalence remains near normal, which is good news for snowpack.

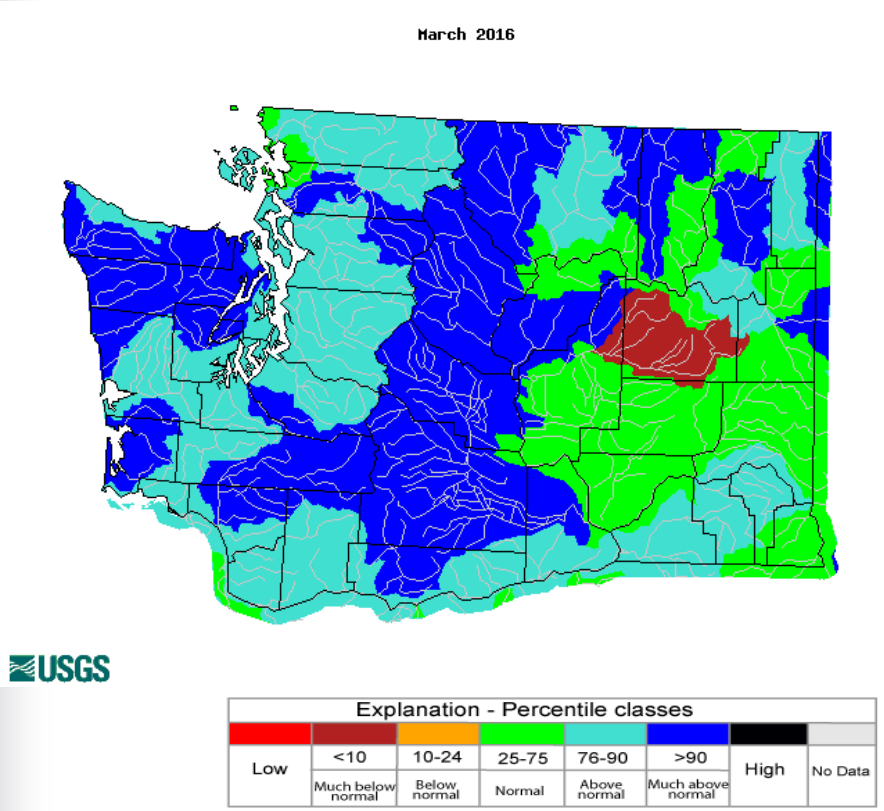


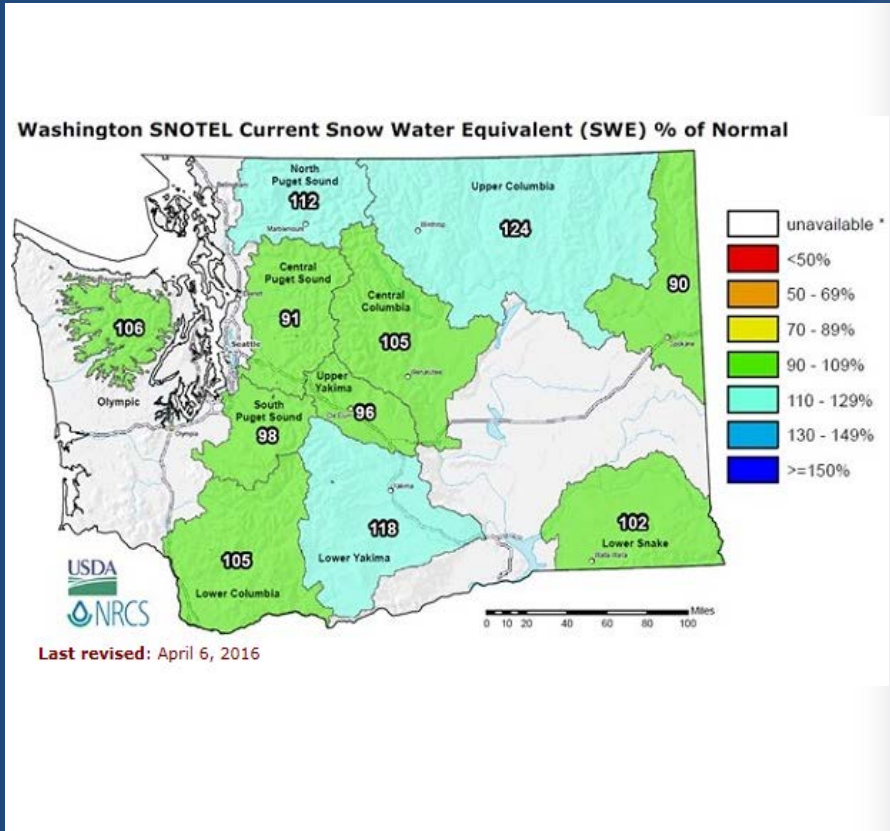
Temperatures were about 2 to 3 degrees (F) higher than normal throughout much of the Puget Sound Region in March.



Precipitation remained higher than normal in March, reporting up to 150% of normal in the Puget Sound lowlands. Upward of 200% normal precipitation was reported in the northeast Olympics and Hood Canal basin.

Wet and warm weather keep rivers flowing





Puget Sound Basin streamflows remained higher than normal in March. Many mountain streams in both the Olympics and Cascades reported much above normal flow conditions (>90th percentile).

Snow Water Equivalence remains near normal throughout the Puget Sound Basin, good news for retaining snowpack. Last year at this time snow water equivalence was 20 percent or less in some areas of the Puget Sound Basin.

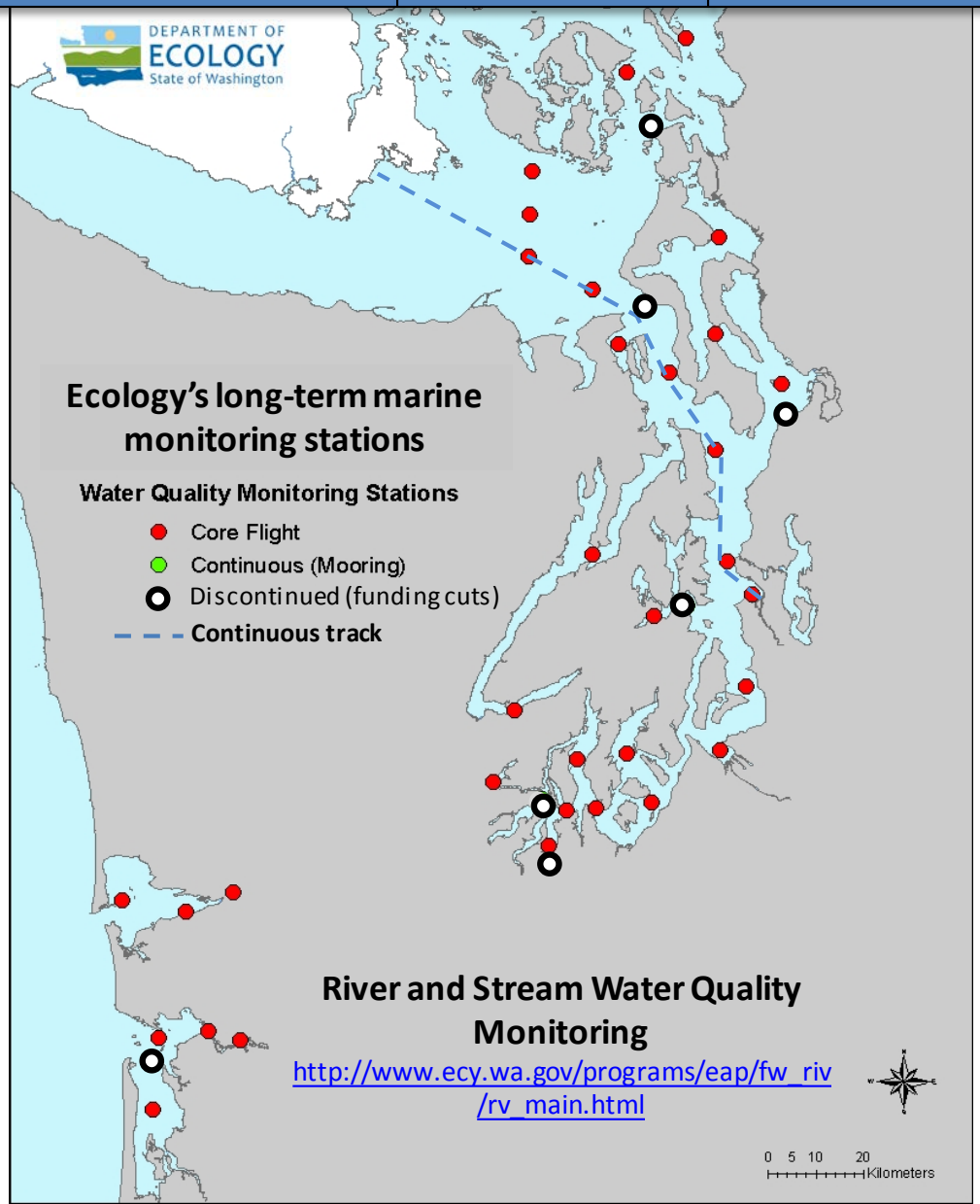
Get data from Ecology's Marine Monitoring Programs

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.