Publication No. 15-03-071

DEPARTMENT OF ECOLOGY State of Washington

Eyes Over Puget Sound

Field log | Climate | Water column | Aerial photos | Ferry and Satellite | Moorings

Surface Conditions Report, February 17, 2015

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

Marine conditions from 2-17-2015 at a glance

LONG-TERM MARINE MONITORING UNIT

Mya Keyzers
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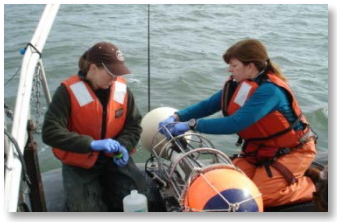
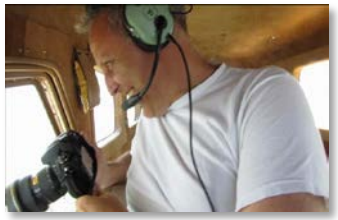


Dr. Christopher Krembs



Guest:
Dr. Brandon Sackmann, Integral

Please give us feedback

Editorial assistance provided by: Suzan Pool, Carol Maloy

South Sound Estuary Association in Olympia

Expanded services and programs

A larger location at 309 State Ave. NE hosts classes, citizen science projects, interpretive displays, and larger aquariums.

The Estuarium is more visible this summer; a new mural on the east-facing wall, and new eye-catching art at the entrance.

Learn about the fundraising concert featuring blues pianist Scott Cossu on May 1st, and other exciting events.

A larger location this summer

Visit us on the web at: http://www.sseacenter.org

I ♥ Puget Sound

What do you love the most about Puget Sound?

People that are curious and care

Wondrous marine life

Islands and hidden bays

Charismatic marine mammals

Personal Field Impression 2-15-15

Miles of diverse coastline

Sea anemones in orange and white

Glacial flour and river plumes

Unique geological features

Climate and natural influences before 2-17-2015

New section! **Climate and natural influences** are conditions that influence our marine waters, including weather, rivers, and the adjacent ocean (previously called Weather). For an explanation of the figure, see: http://www.ecy.wa.gov/programs/eap/mar_wat/weather.html, page 26.

Summary:

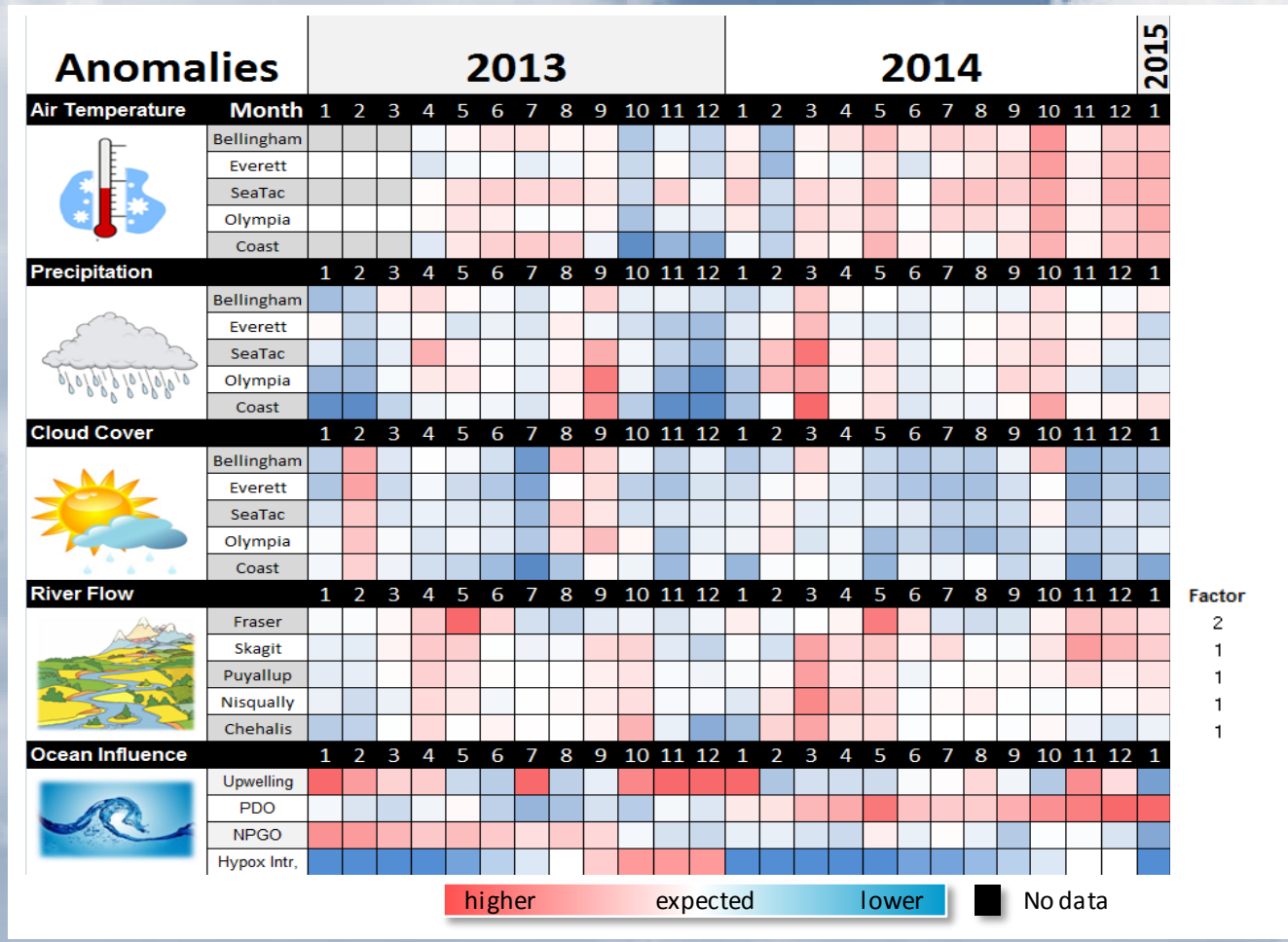
Air temperatures remain above normal, continuing a 10-month trend.

Precipitation has been below normal for the past week and month in the Central Puget Sound region.

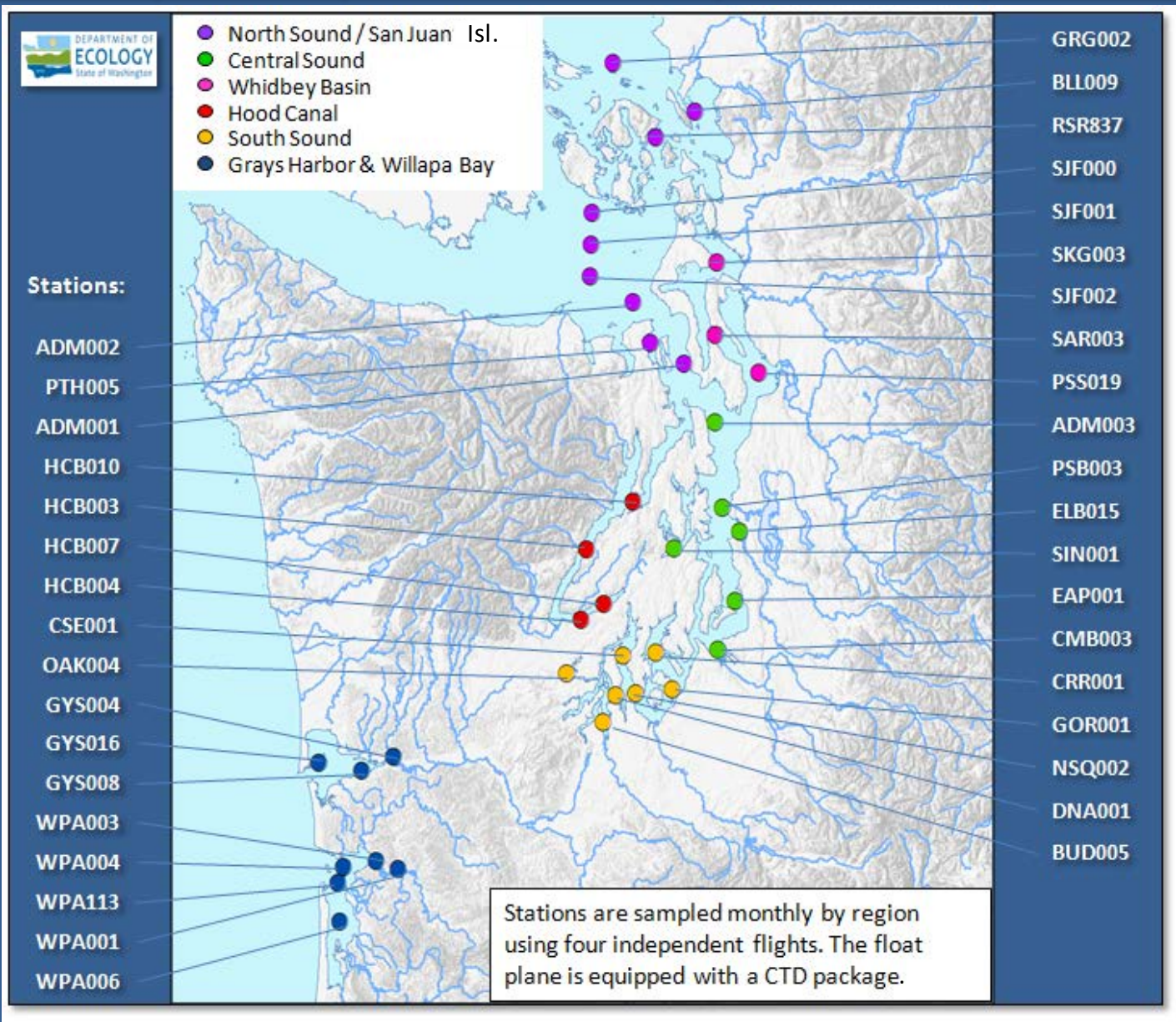
Sunshine has been abundant for the past five days and above normal for the winter.

River flows are above normal across the Puget Sound region, but below normal at the coast (Chehalis River).

PDO remains in the warm phase, and upwelling is below normal.



Our long-term marine monitoring stations in Washington



We use 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**

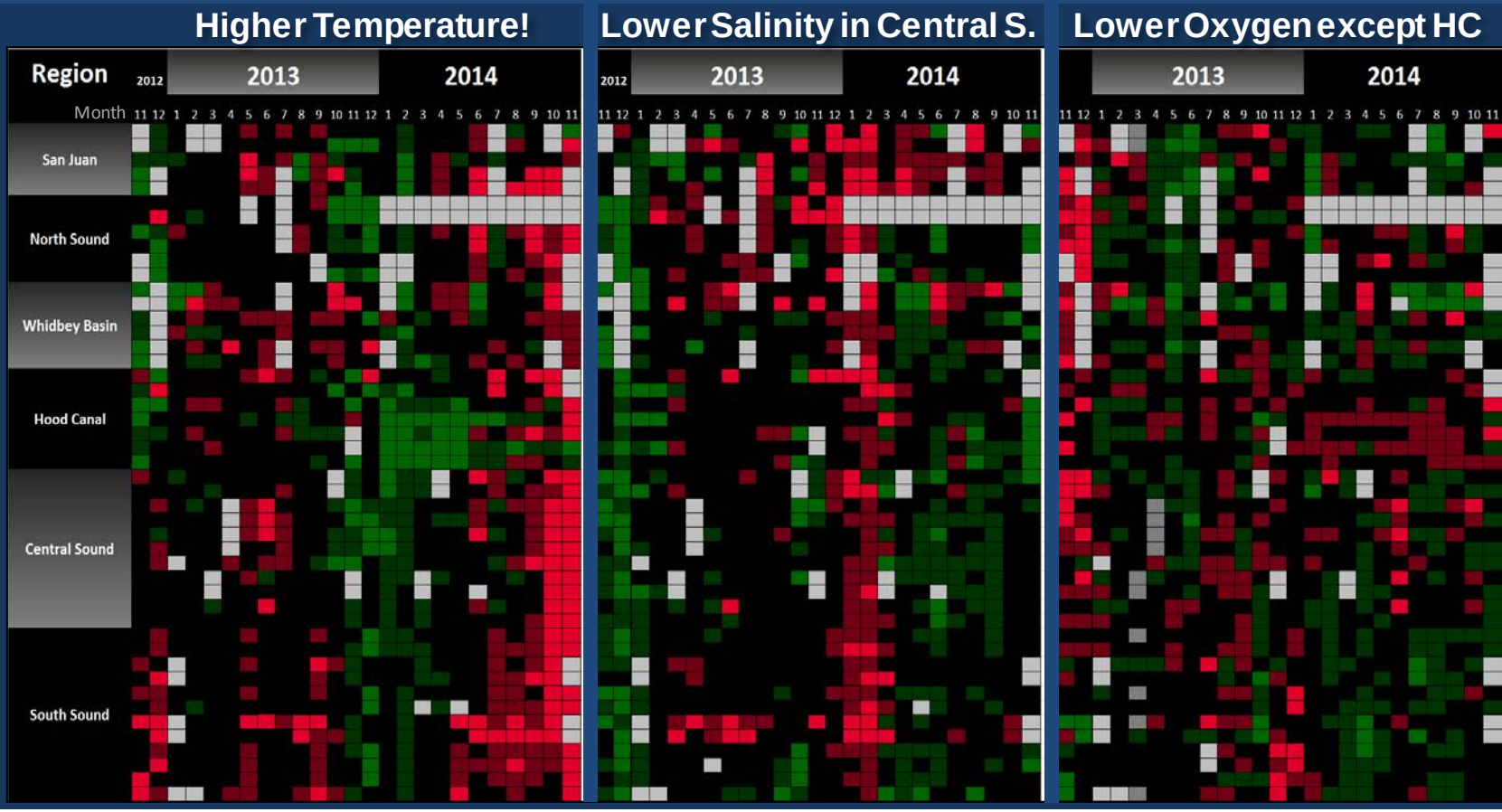
Physical conditions tracked in statistically historic context

In 2014, conditions were dominated by **warm water** during summer and fall, associated with the NE Pacific Ocean warm surface anomaly. In October and November, temperatures were the highest on our record since 1989. In 2014, salinity was higher and later, waters south of Admiralty Reach became fresher. Oxygen was mostly lower except in Hood Canal where a high anomaly persisted into the fall.

Nov. 2014:

Red boxes show that the water measured in fall 2014 is warmer than any of our measurements since 1999

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

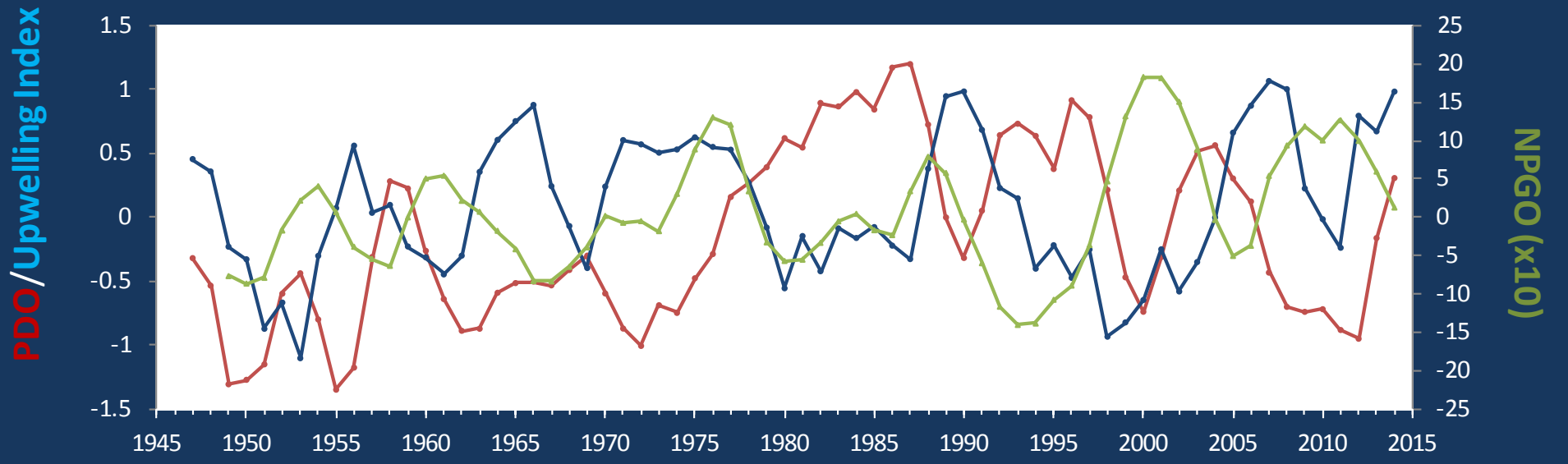
The ocean affects water quality: Ocean Climate Indices

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

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

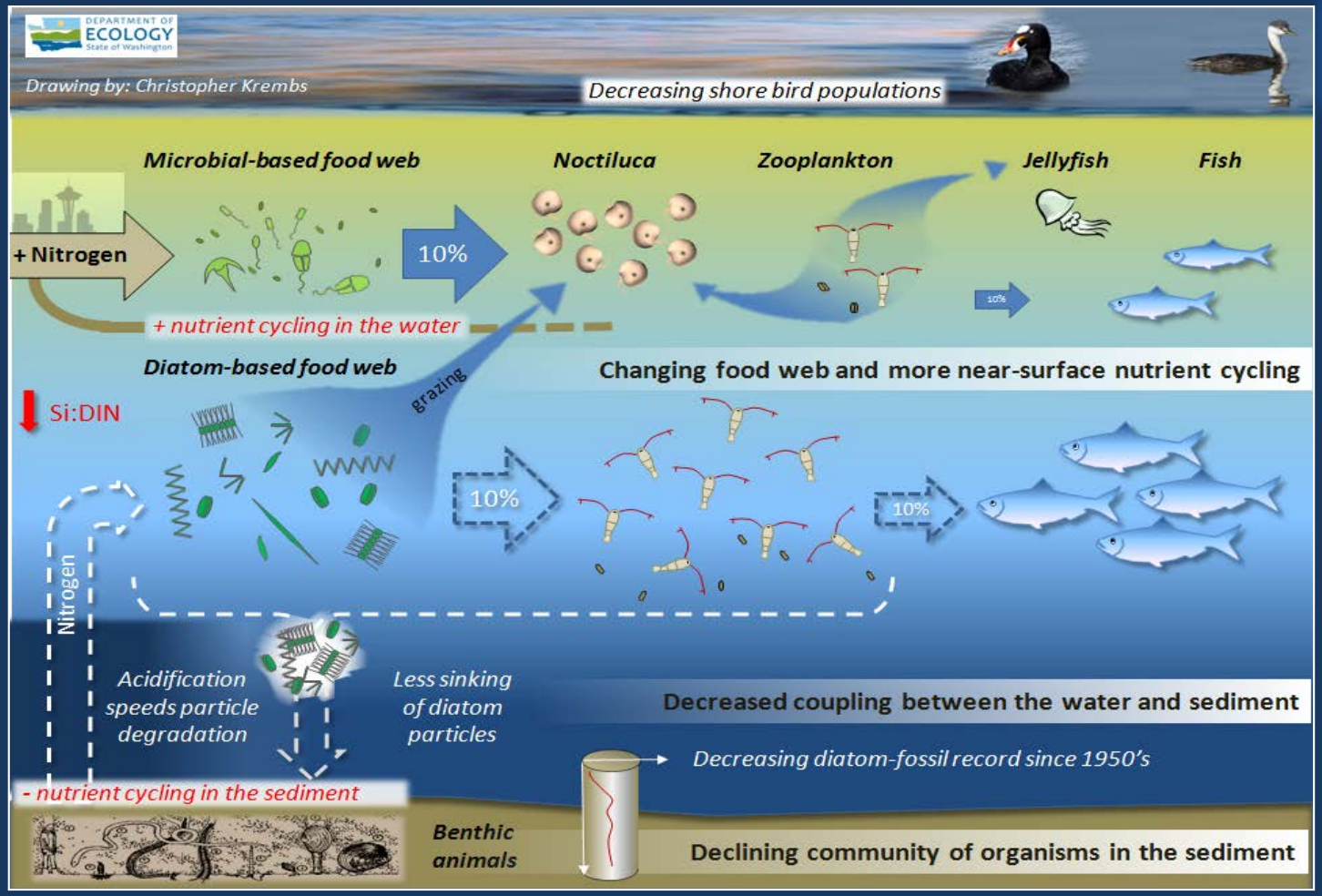
c) *North Pacific Gyre Oscillation Index (**NPGO, productivity**)* *(explanation)*

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



Ocean boundary conditions are no longer favorable for water quality in Puget Sound: (a) water is warming (PDO), (b) upwelling of low oxygen and high nutrient ocean water is again increasing (Upwelling Index), and (c) higher surface productivity along the coast (NPGO) is falling. Where are we heading next?

Hypothesis for combining a series of recent observations affecting energy and material transfer to higher trophic levels



Hypothesis!

Increases in nitrate concentrations could be caused by a top-down control on phytoplankton biomass.

Is *Noctiluca* a visible harbinger of a food web change?

Are changes in higher tropic levels part of a story of the low food web?

[Follow the experts WebEx]

Summary: Aerial photography 2-17-2015

Patches of jellyfish persist in finger inlets of South Sound. First signs of growing phytoplankton appear where water is turning green. Otherwise, the surface waters are in nice shades of blue and green and, as expected, carry sediment near rivers. High tides are mobilizing driftwood.

Start here

Reflections on the propeller of the plane

Picture credit: Joe Leatherman

Big sea anemones growing on flotsam

Front

Mixing and Fronts: 1 3 5 6 9 11 12 13 14 15 19

Tidal fronts and a high tide mobilizing driftwood. Several sizable tidal eddies as a result of strong tides.

Jellyfish: 1 2 3 Click on numbers

Jellyfish patches still persist in southern inlets of South Sound (Totten, Eld, and Budd Inlets).

Plume

Suspended sediment: 4 5 9 11 12 17 18 19 20

Large suspended sediment plume confined to region around Rosario Strait. How does this work?

Bloom

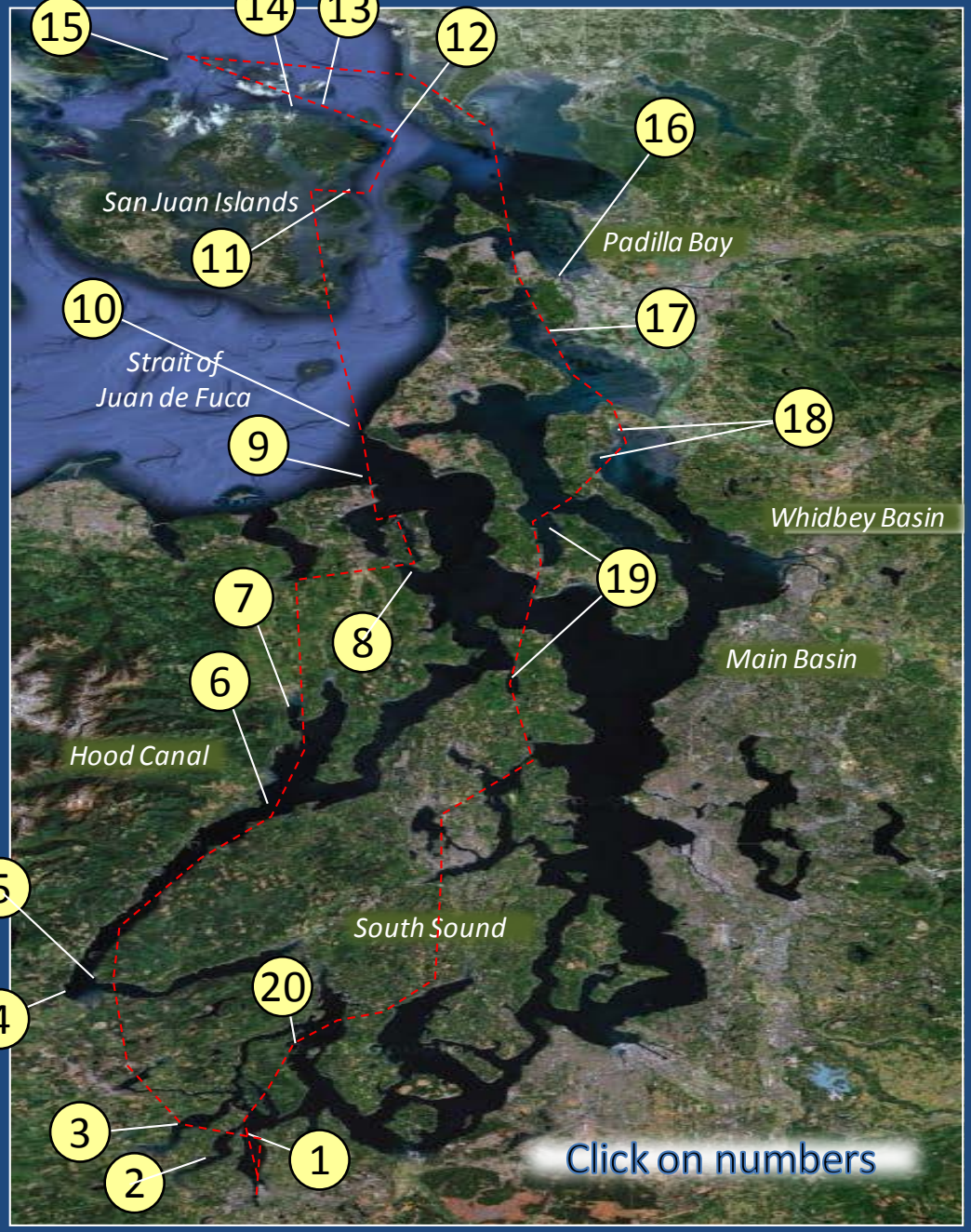
Visible blooms:

Green-brown: First signs of growing phytoplankton biomass in response to sunny weather across the Sound. No blooms.

Debris

Debris: 1 2 3 5 6 11 12 13 14 15 18 19

Large lines and patches of organic debris in South Sound (Budd and Totten Inlets).



Aerial photography and navigation guide

Date: 2-17-2015

Tides	Feet	(Seattle)
4:08 AM	11.65	H
9:38 AM	6.05	L
2:54 PM	11.31	H
9:43 PM	-1.56	L

Flight Information:

Morning flight, photos 1-12
Sunny, cold, high visibility

Afternoon flight, photos 13-20
Sunny, high visibility, winds

Flight route and fueling stop

Observation Maps:

Central and North Sound

South Sound

Aerial photography 2-17-2015

Jellyfish patches and strong organic debris lines.

Location: Off Burfoot Park, Budd Inlet (South Sound), 9:32 AM.

Numerous jellyfish patches lasting through the warm winter.

Location: Near Young Cove, Budd Inlet (South Sound), 9:34 AM.

Long organic debris line along front.

Location: Off Baron Point, Totten Inlet (South Sound), 9:51 AM.

Aerial photography 2-17-2015

Skokomish River plume entering Hood Canal between tidally submerged flats.

Location: Off Union (Hood Canal), 11:18 AM.

Fronts delineating the flow of Skokomish River water.

Location: Across from Union, Great Bend (Hood Canal), 9:48 AM.

Long front and organic debris line at entrance to Dabob Bay.

Location: Across from Seabeck (Hood Canal), 10:03 AM.

Aerial photography 2-17-2015

Quilcene Bay appears to be clear of algal blooms

Location: Dabob Bay (Hood Canal), 10:10 AM.

Tidal eddies form as water flows southward through Portage Canal.

Location: Indian Island (North Sound), 10:22 AM.

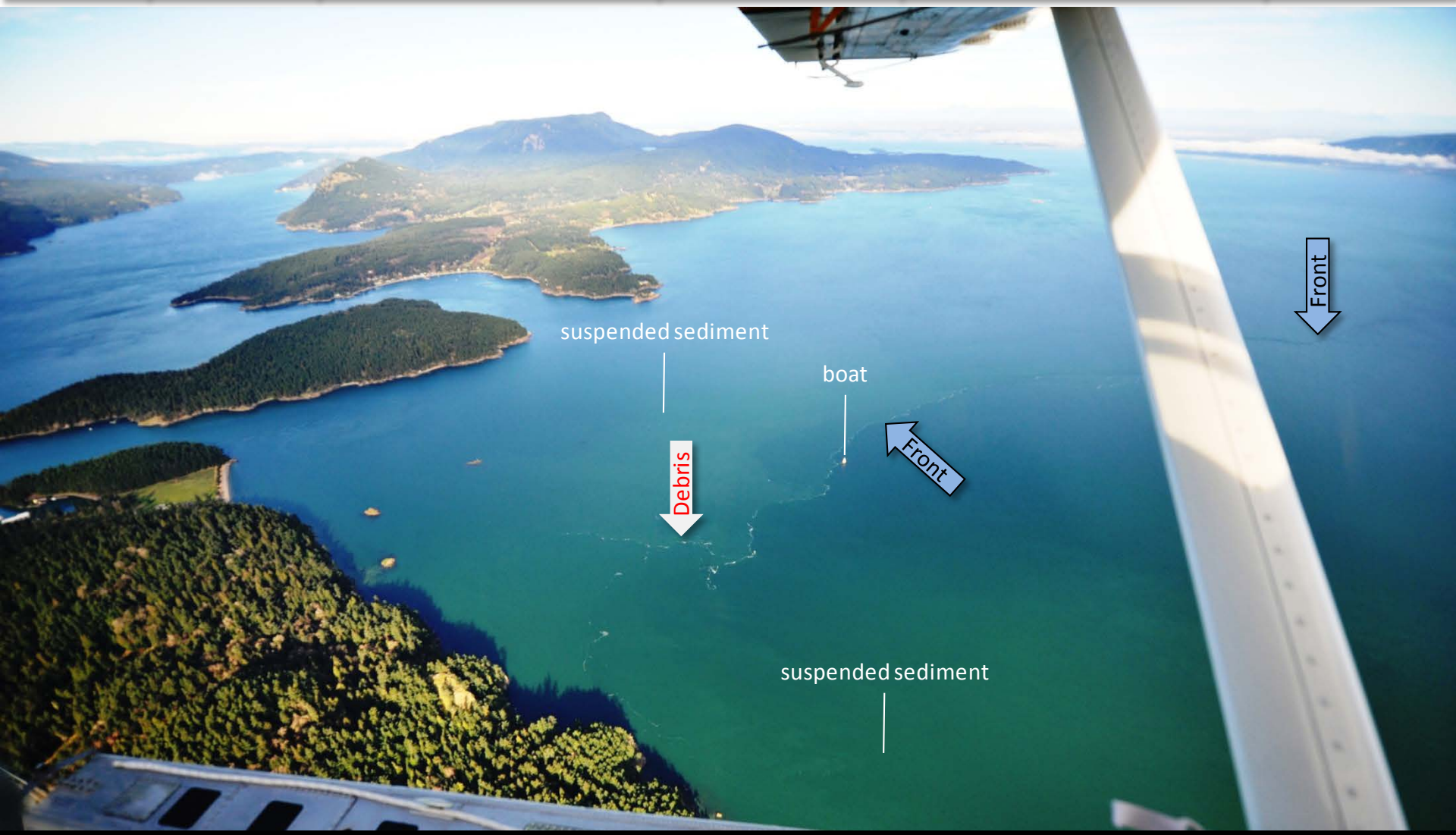
Aerial photography 2-17-2015

Strong tidal currents (flood) and fine suspended sediments show structures of turbulence and shear.

Location: Fort Worden State Park (North Sound), 11:04 AM.

Panorama shot of Fort Ebey State Park and Penn Cove.
Location: Strait of Juan de Fuca (North Sound), 11:07 AM.

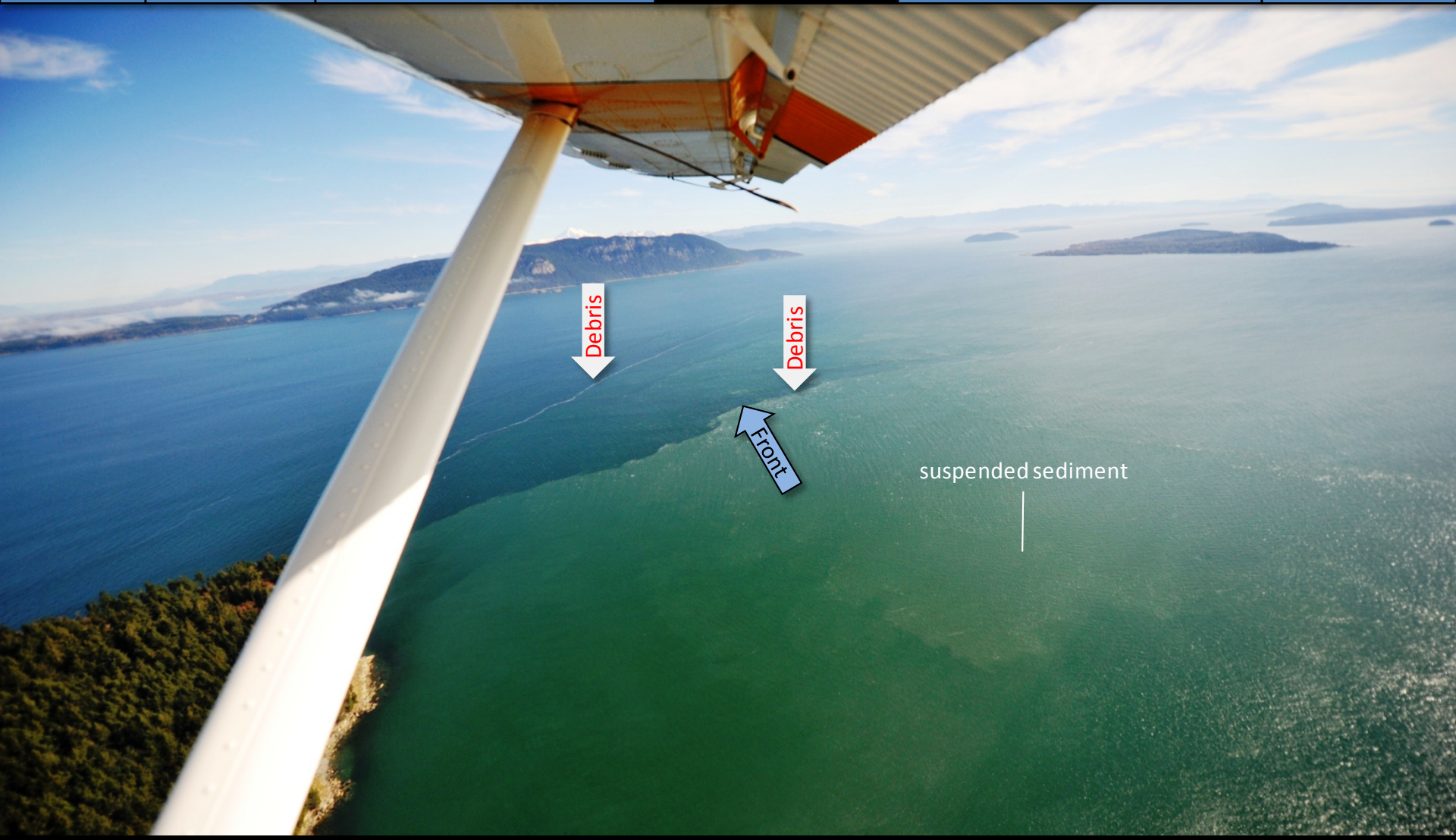
Aerial photography 2-17-2015



Strong front with debris line retaining sediment-rich surface water in Rosario Strait.

Location: Entrance to Obstruction Pass (San Juan Islands), 11:22 AM.

Aerial photography 2-17-2015



Strong front with debris line retaining sediment-rich surface water in Rosario Strait.

Location: Entrance to Obstruction Pass (San Juan Islands), 11:58 AM.

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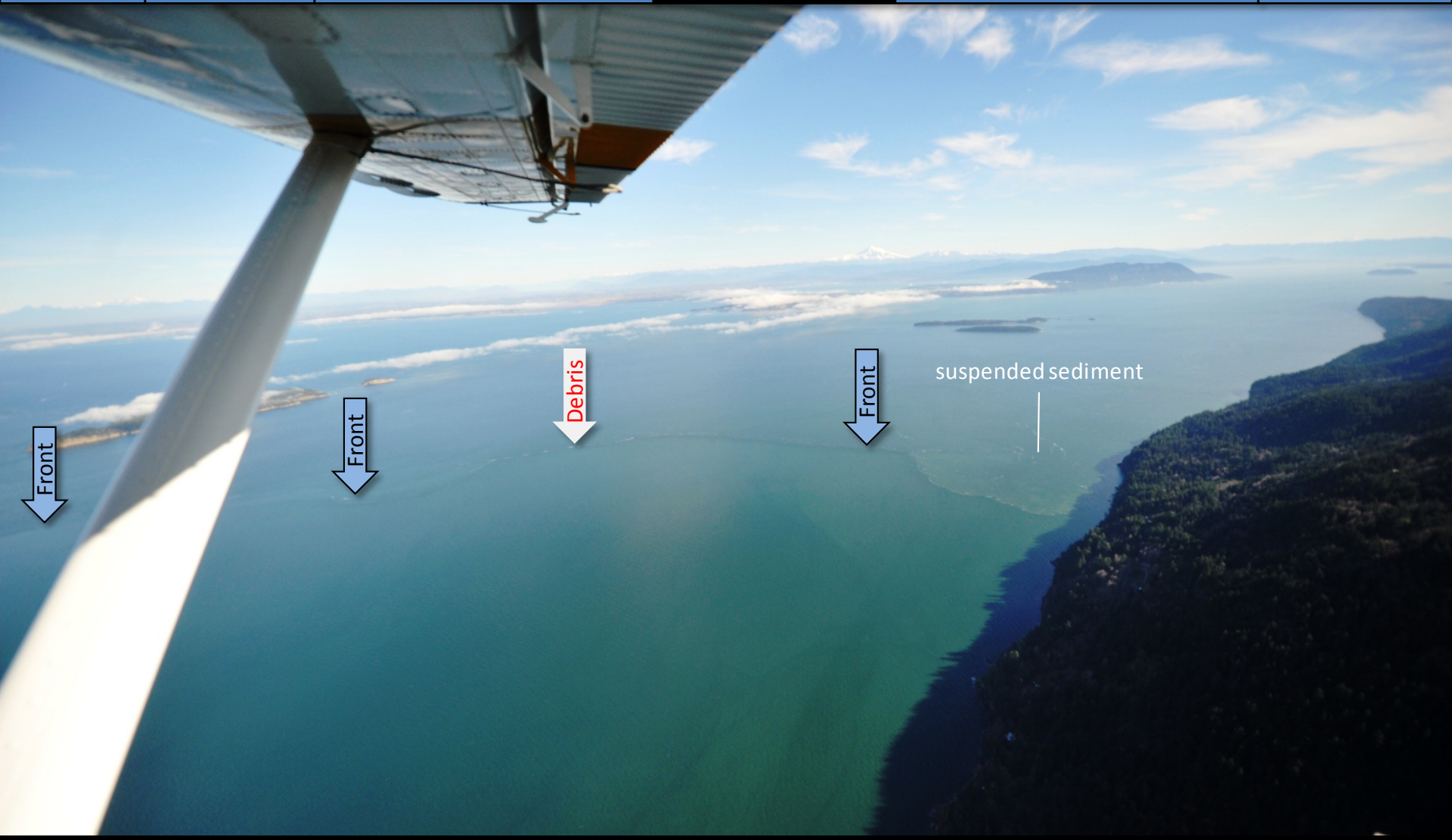
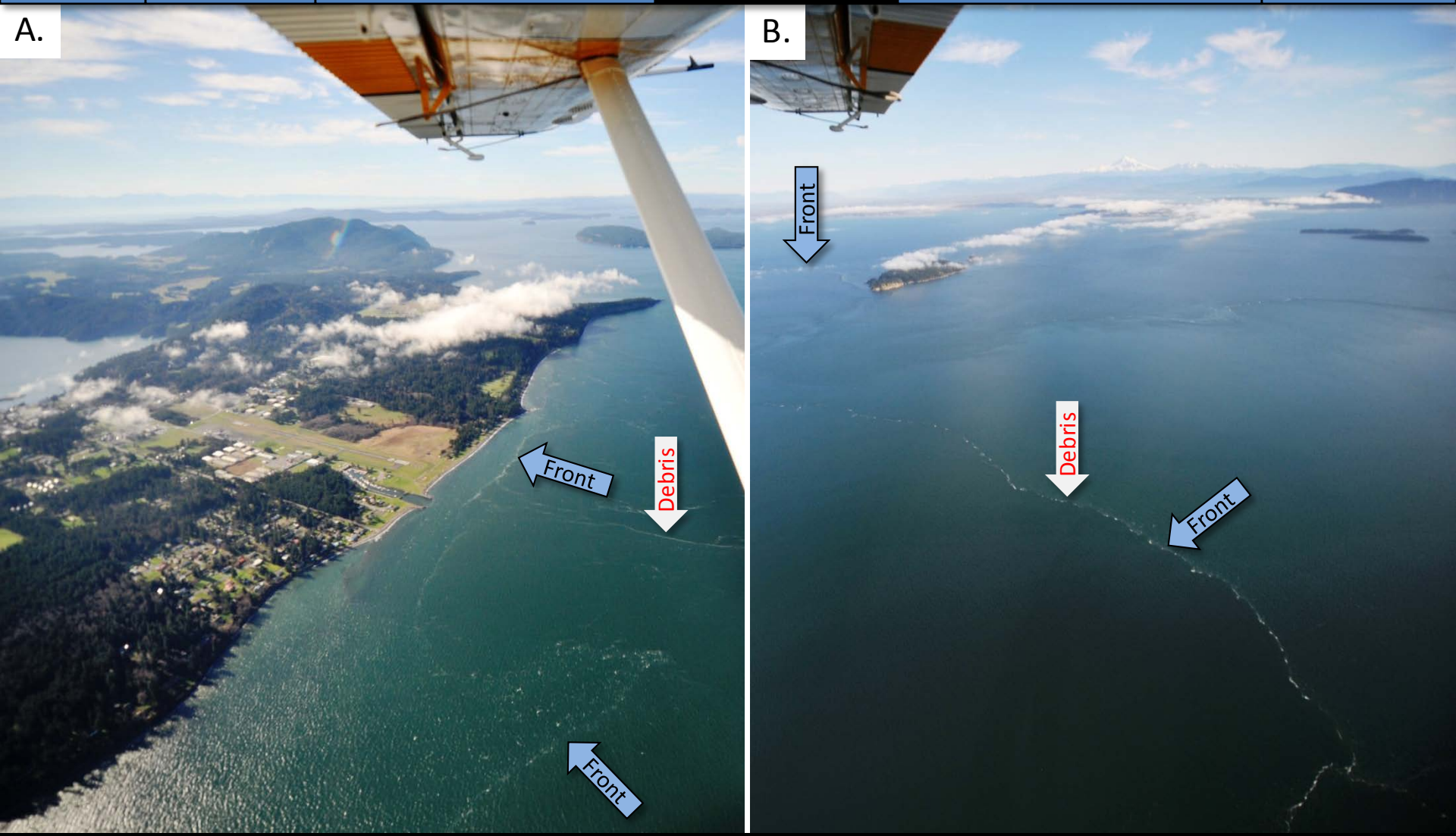
Aerial photography 2-17-2015



Strong front with debris line with sediment-rich surface water to the east.

Location: Across from San Juan Islands National Wildlife Refuge (San Juan Islands), 12:03 PM.

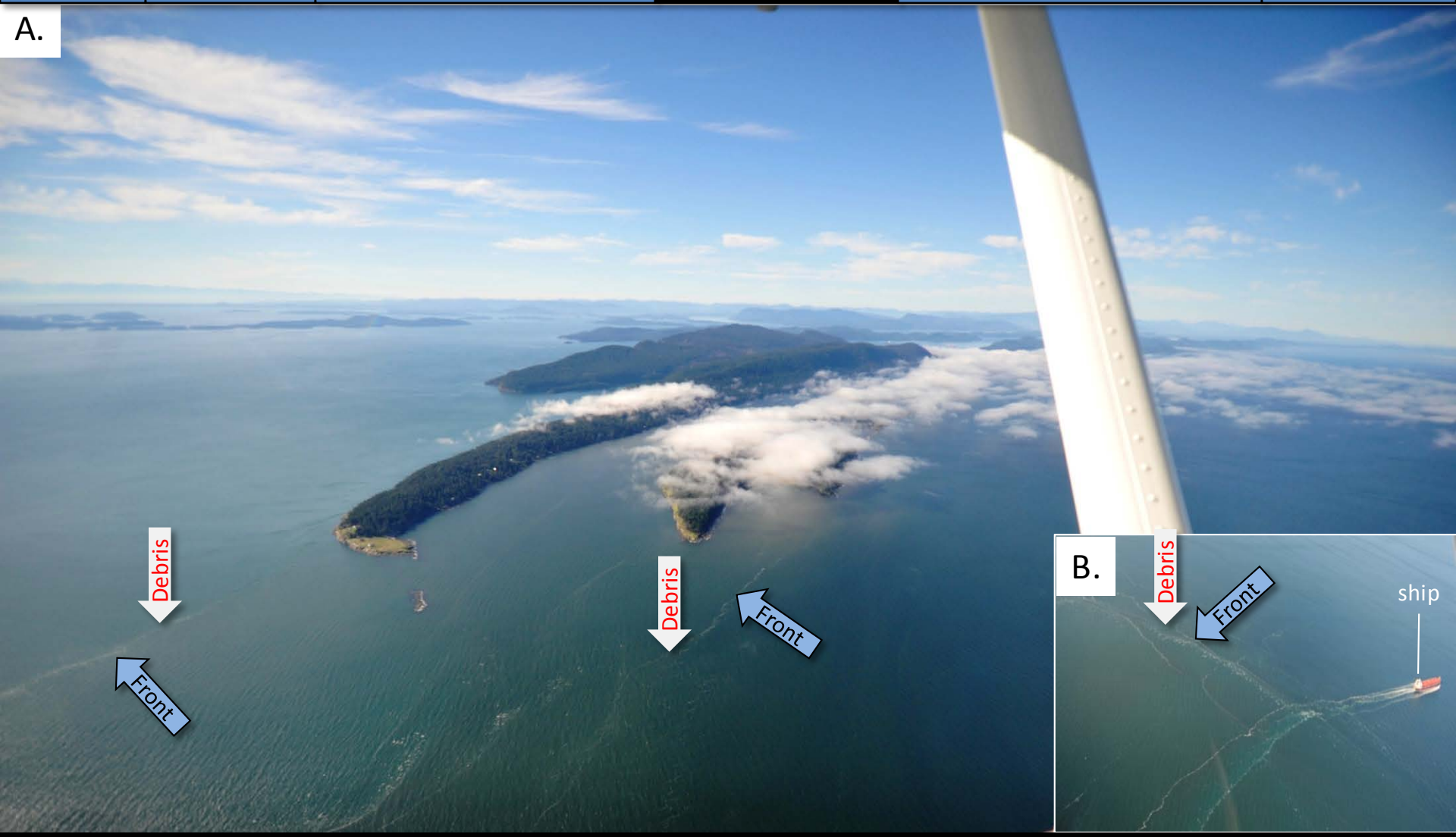
Aerial photography 2-17-2015



Very structured surface water with fronts and debris lines.

Location: A. Eastsound, B. San Juan Islands National Wildlife Refuge (Orcas Island), 12:04 PM.

Aerial photography 2-17-2015



Front with near-surface phytoplankton-rich layer and debris lines.

Location: A. Tumbo Island looking across US-Canada border, B. Ship wake (Georgia Basin), 12:08 PM.

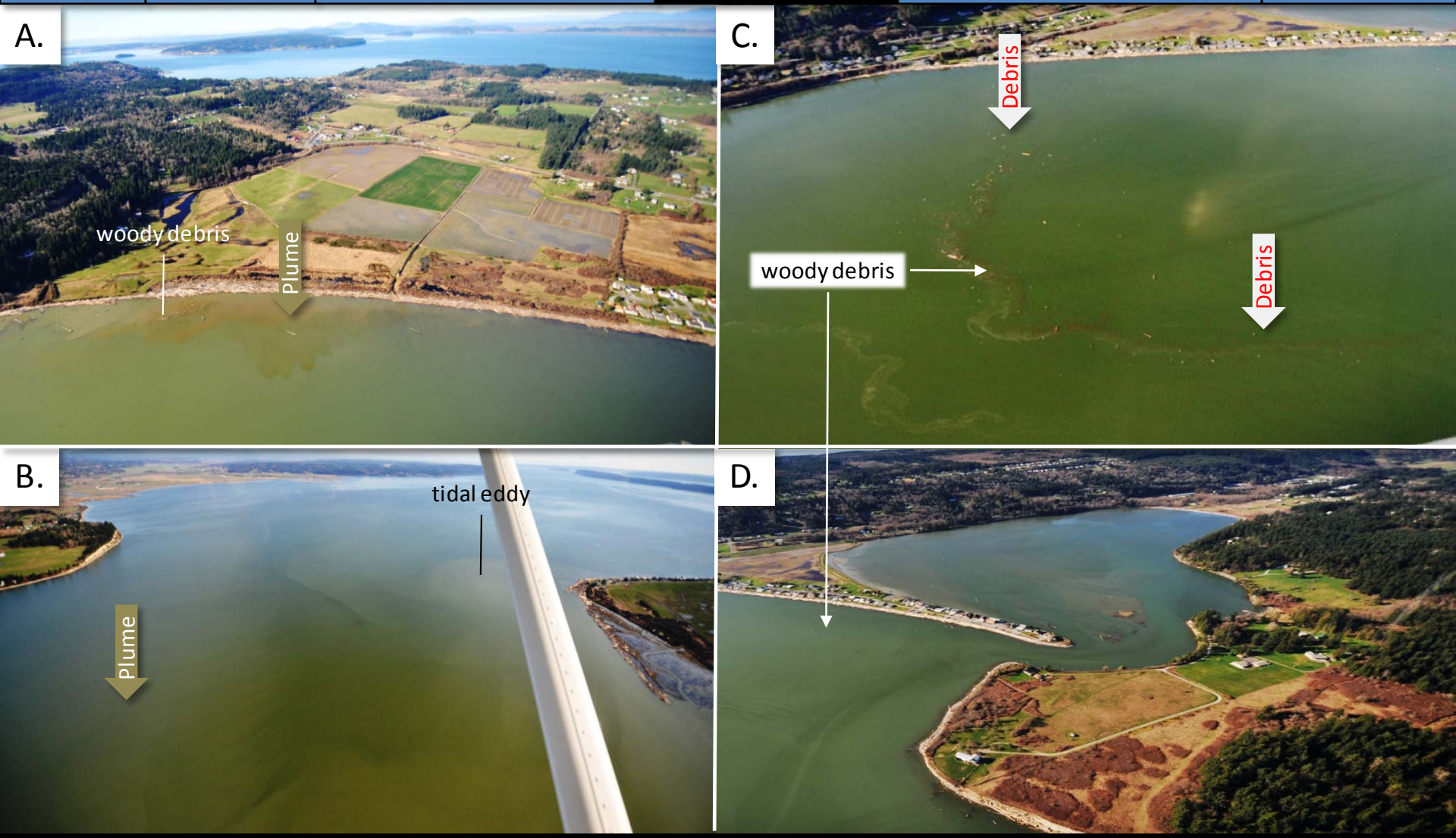
Aerial photography 2-17-2015

South Padilla Bay during high tide.

Location: North entrance of Swinomish Channel (North Sound), 1:47 PM.

Suspended sediment of the Skagit River carrying woody debris into Skagit Bay.

Location: Near La Conner, Skagit Bay (Whidbey Basin), 1:50 PM.



Plumes of a murky creek (A), turbid and green water (B), patches of organic debris and driftwood (C, D)
Location: A-B. Livingston Bay, C-D. Outside Triangle Cove, Port Susan (Whidbey Basin), 2:27 PM.

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Aerial photography 2-17-2015

Smaller bays prone to water quality issues are appearing relatively clear (A-B, D). Small eddy (C).

Location: A-C. Holmes Harbor (Whidbey Basin), D. Port Gamble (Hood Canal), 3:50 PM.

Aerial photography 2-17-2015

Ongoing suspended sediment from human activity.

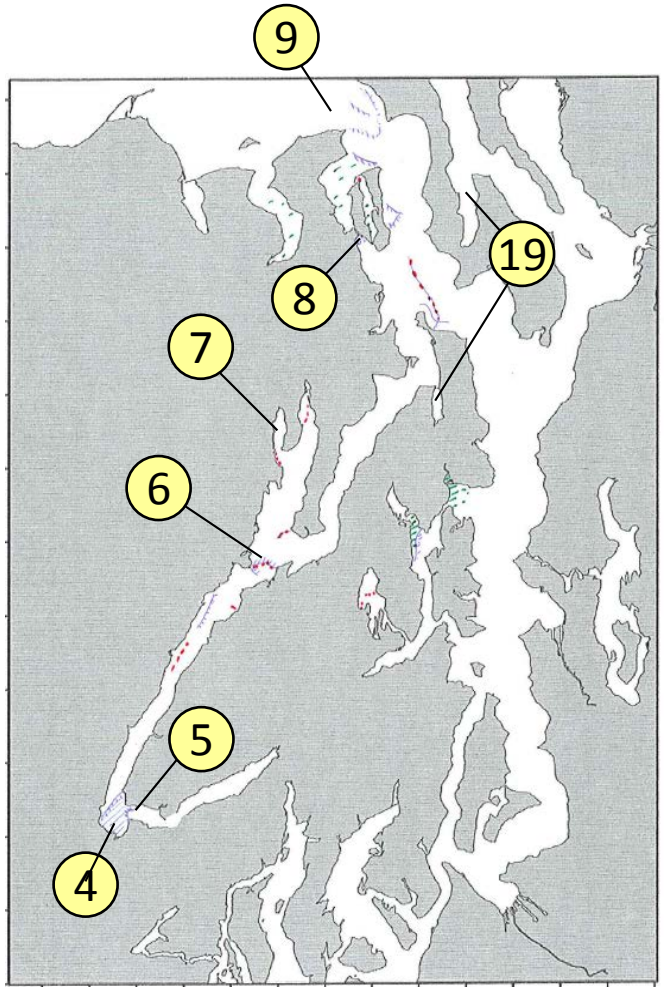
Location: Northeastern bay of Harstine Island, Case Inlet (South Sound), 4:27 PM.

Qualitative aerial observer map during transit

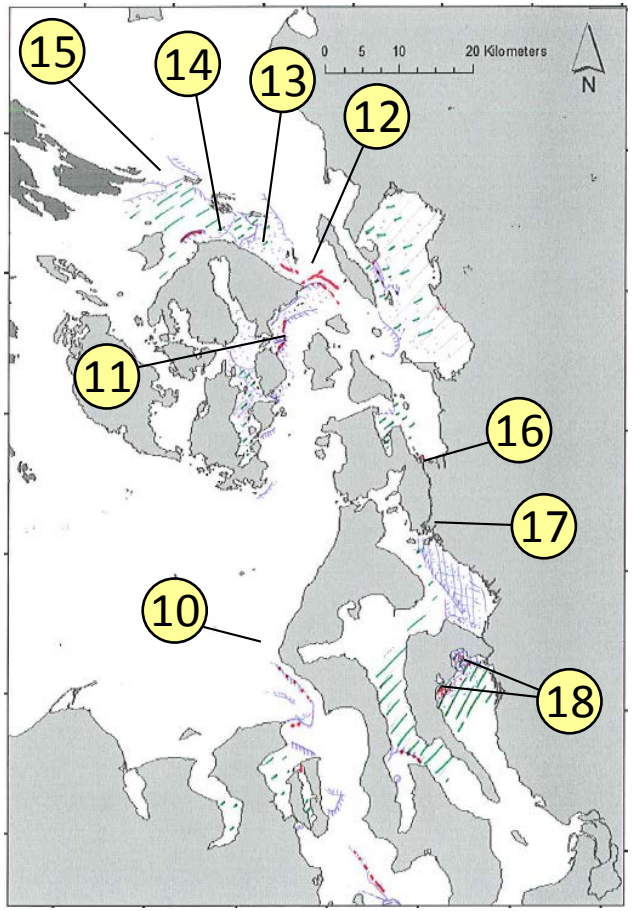
Navigate

Date: 2-17-2015

Central Sound



North Sound/San Juan Islands



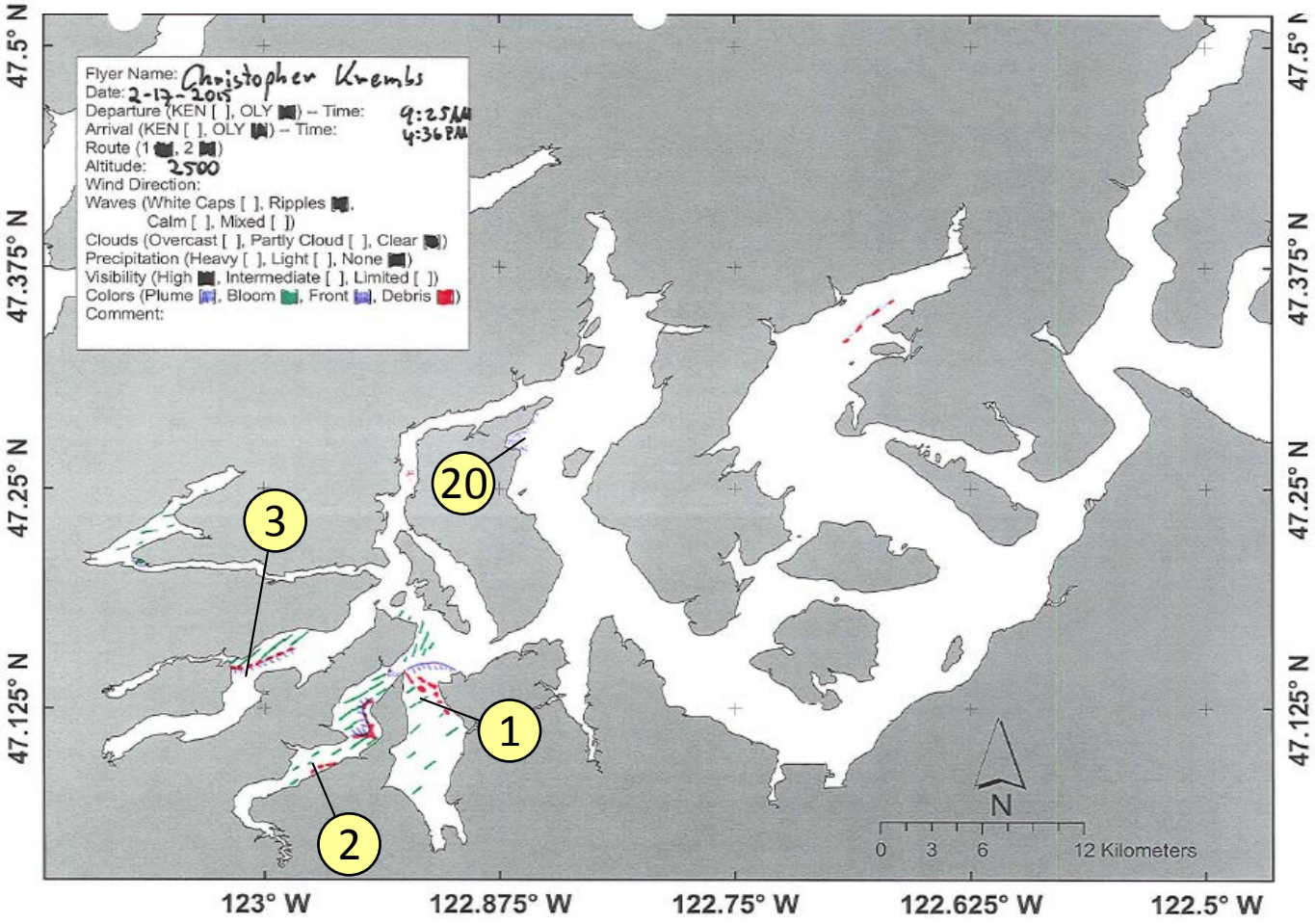
Numbers on map refer to picture numbers for spatial reference

Qualitative aerial observer map during transit

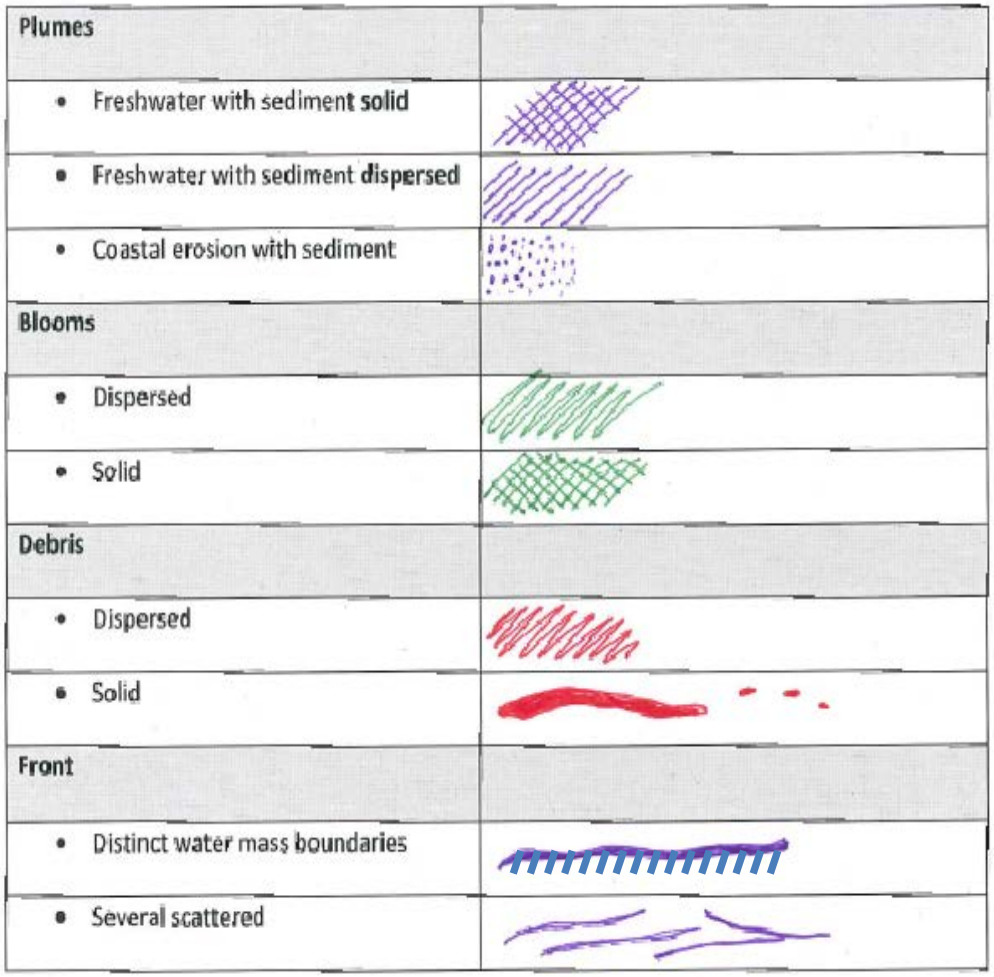
Navigate

Date: 2-17-2015

South Sound



Numbers on map refer to picture numbers for spatial reference

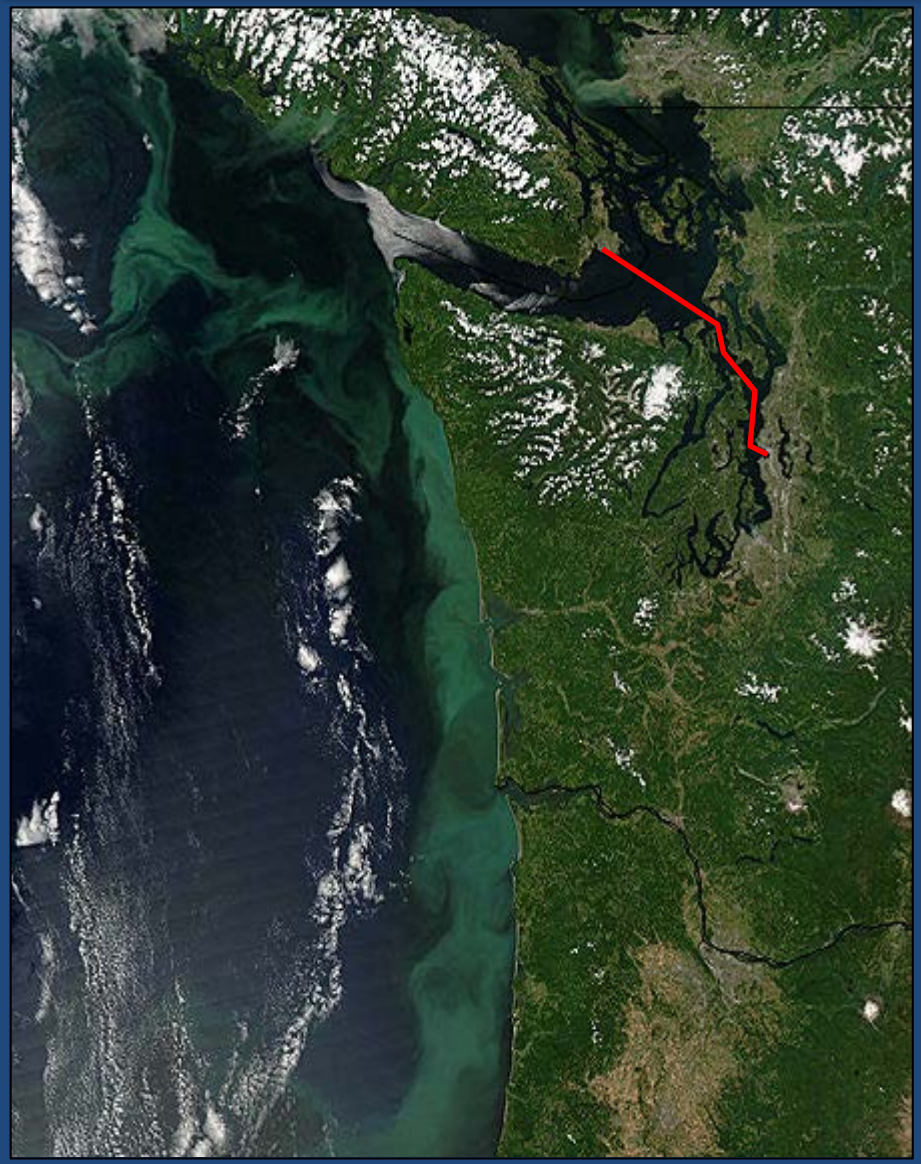


Comments:
Maps are produced by observers during and after flights. They are intended to give an approximate reconstruction of the surface conditions on scales that connect to and overlap with satellite images in the section that follows.

Debris:
Debris can be distinguished into natural and anthropogenic debris floating at the surface *sensu* Moore and Allen (2000). The majority of organic debris in Puget Sound is natural and mixed with discarded man-made pieces of plastic, wood, etc. From the plane, we cannot differentiate the quality of debris at the surface and therefore, call it for reasons of practicality just “debris”.

S.L. Moore, M. J. Allen. 2000. Distribution of Anthropogenic and Natural Debris on the Mainland Shelf of the Southern California Bight. Marine Pollution Bulletin, 40(1): 83–88.

Ferry and satellite observations 2-17-2015



Brandon Sackmann
Contact: bsackmann@integral-corp.com

Start here

The *Victoria Clipper IV* carries sensors in its sea chest. The sensors allow us to get surface transects of temperature, chlorophyll, salinity, and other bio-optical measurements between Seattle and Victoria, BC twice per day.

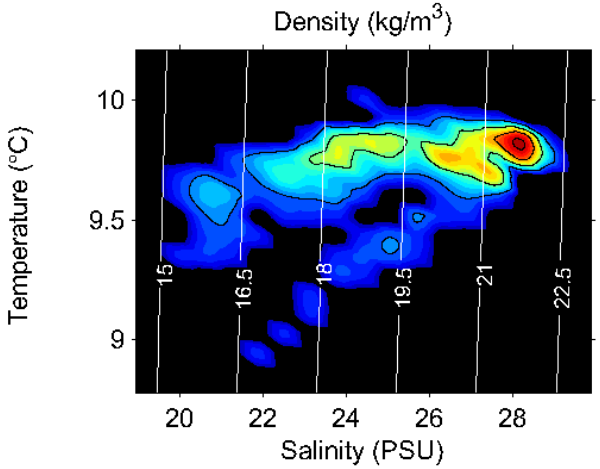
Current Conditions:

Victoria Clipper in the shipyard this month.
No data.

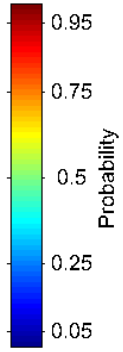
Mooring observations and trends 02-04-2015 to 02-17-2015

At Mukilteo, recent observations indicate continuation of decreasing water temperature and increasing dissolved oxygen. In the upper mooring, water mixing appears influenced by tides. In early February, the deeper mooring detected decreasing salinity and increasing temperature that coincides with river flows.

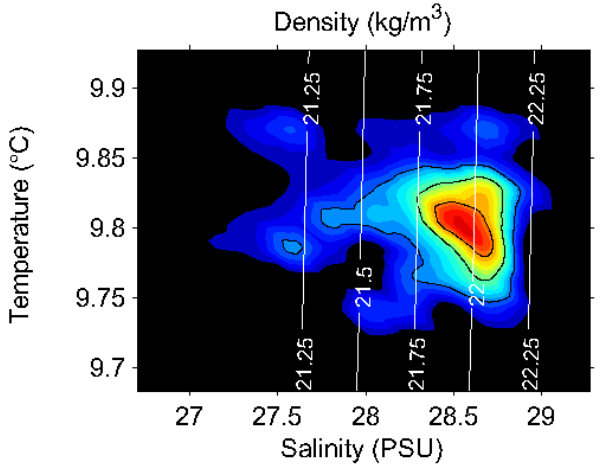
2-6 m depth

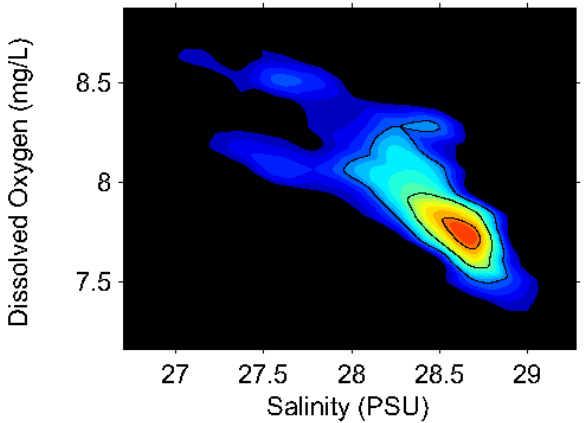


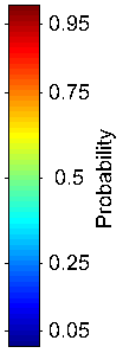
Dissolved oxygen not measured



12-16 m depth







These plots show the probability of observations over the past two-week period. High probability shown in warm colors.

Left Panels: Density is defined by salinity and temperature.

Right Panel: Dissolved oxygen concentration in relation to salinity.

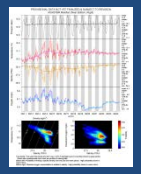
Mooring observations and trends 01-18-2015 to 02-17-2015

Our mooring station in Mukilteo is located in Whidbey Basin near Everett. It is also located at the transition between Possession and Central Sounds at a depth that is influenced by the Skagit and Snohomish river discharges, prevailing winds, and tidal mixing.

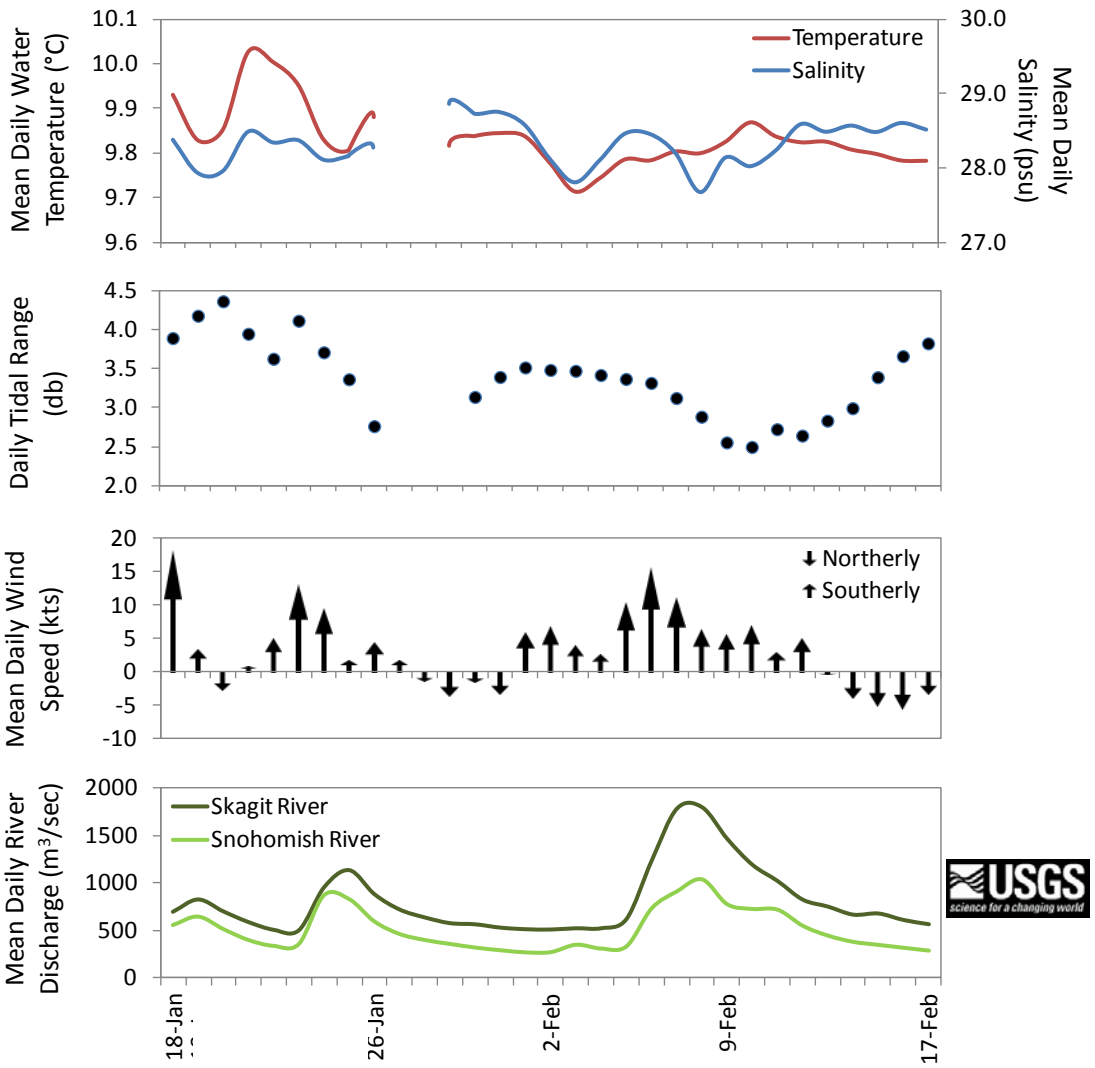
As the largest regional contributor of freshwater to Puget Sound, understanding the timing and magnitude of the Skagit River flow is important.

We present data of daily means for the past 31 days. Data are plotted in Pacific Standard Time. Wind data are from Paine Field in Everett. River flow data are from USGS.

Click on icon to view real-time data of the moorings



Near-bottom sensor and associated environmental data at Mukilteo



Mooring observations and trends Mukilteo 2010 to 2015

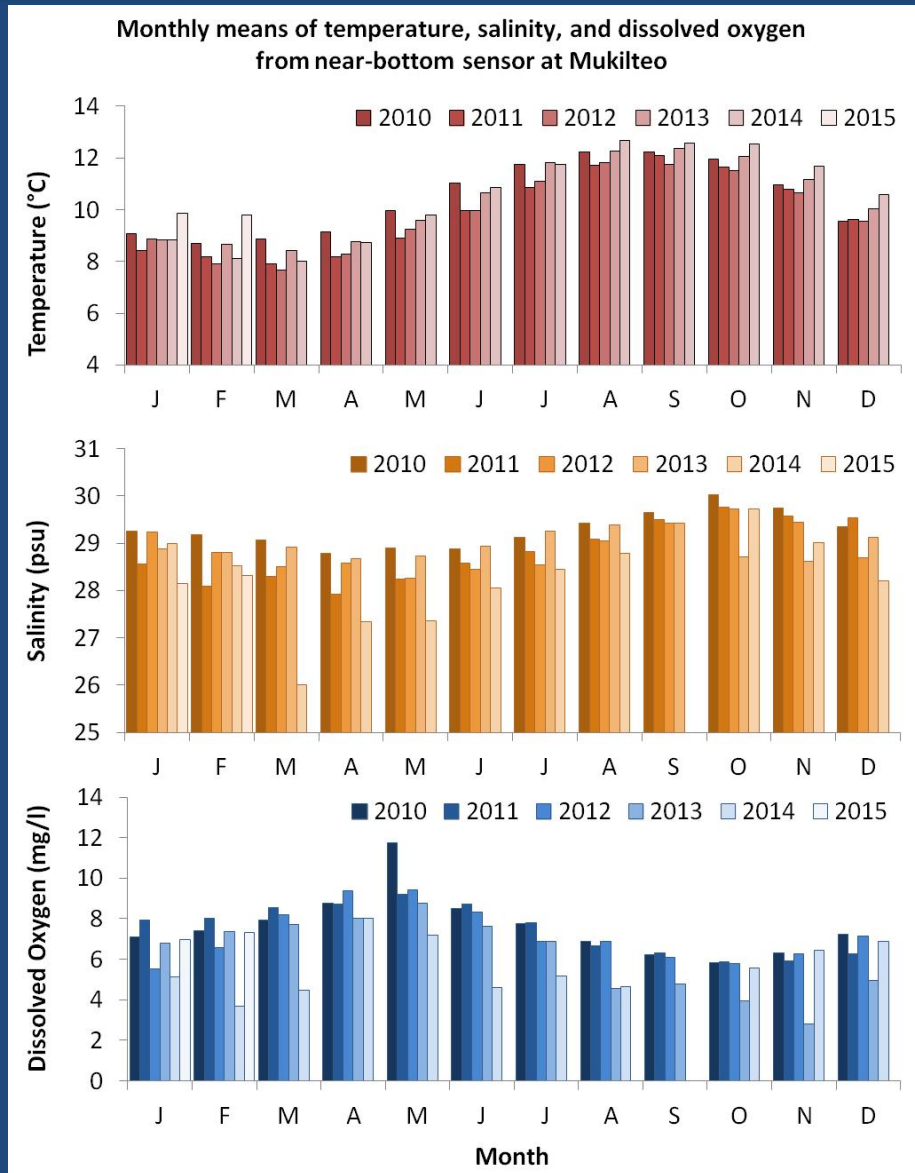
At the Mukilteo mooring, we use the near-bottom sensor (12-16 m deep) to measure significant inter-annual variability in temperature, salinity, and dissolved oxygen.

Inter-annual variability is shown over a 5-year period. All three variables show strong seasonality.

As compared to past years, the start of 2015 is showing that water temperature is warmer and salinity is lower. Dissolved oxygen is roughly similar to 2010, 2011, and 2013.

Seasonally, there is an increase in water temperature, decrease in salinity, and little change in dissolved oxygen.

Please note that data are provisional. Data are in GMT.



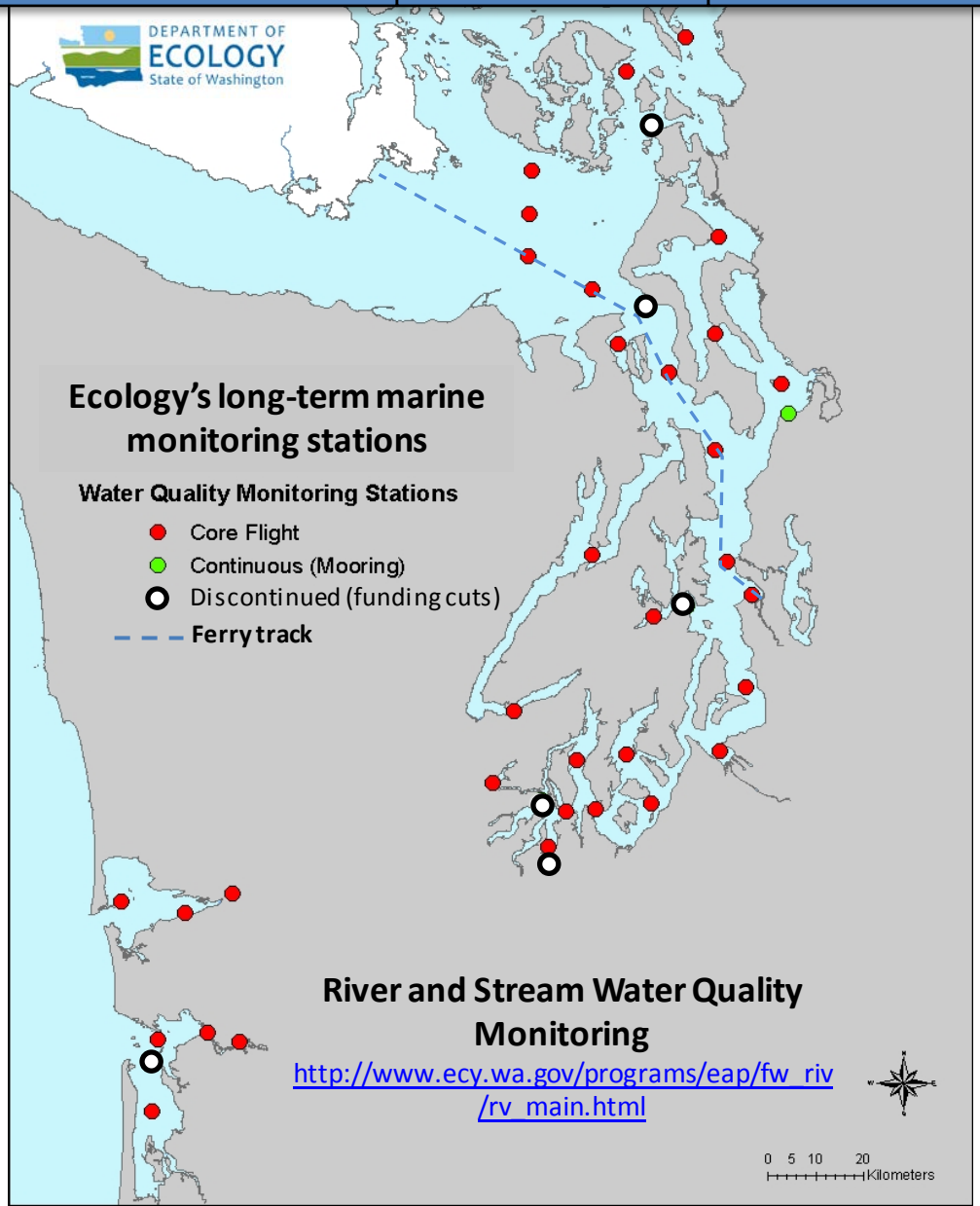
Get data from Ecology's Marine Monitoring Programs

Field log	Climate	Water column	Aerial photos	Ferry and Satellite	Moorings

Long–Term Monitoring Network

christopher.krembs@ecy.wa.gov

Access core monitoring data:
http://www.ecy.wa.gov/apps/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 Navigations, Swantown Marina, and Kenmore Air.