Publication No. 14-03-073

DEPARTMENT OF ECOLOGY State of Washington

Eyes Over Puget Sound

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

Surface Conditions Report

May 12, 2014

Start here

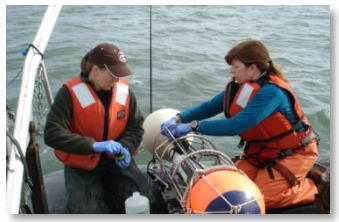
Up-to-date observations of visible water quality conditions in Puget Sound and the Strait of Juan de Fuca

Marine conditions from 5-12-2014 at a glance

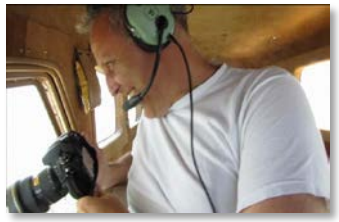
LONG-TERM MARINE MONITORING UNIT

Mya Keyzers
Laura Hermanson
Joe Leatherman

Skip Albertson



Julia Bos
Suzan Pool



Dr. Christopher Krembs

Guest: Dr. Brandon Sackmann, Integral

Personal field log

p. 3

Eyes Under Puget Sound: Sediment Monitoring

Weather conditions

p. 5

Cool, cloudy conditions with southerly winds transitioned on Sunday, May 11th to sunny, warm conditions with light northerly wind.

Water column

p. 6

Starting in 2014, colder, saltier conditions are developing throughout Puget Sound. Oxygen is lower in Whidbey Basin, Central and South Sound, but higher in Hood Canal.

Aerial photography

p. 10

Blooms and large debris lines present in Bellingham Bay, Padilla and Samish Bays, finger inlets of South Sound, south Hood Canal, East Sound, and the Straits. Large amounts of sediment-laden water leaving Port Susan and flowing into Central Basin. Turquoise water mixing to the surface in places around the San Juan Islands.

Ferry and satellite

p. 35

After some troubleshooting of the hardware and communication system, we will resume collecting data next week.

Eyes Under Puget Sound: Sediment Monitoring

Marine Sediment Monitoring Program, a "sister" program to the Marine Waters Program.

Sediment quality is examined each year at different locations throughout Puget Sound.

Scientists use a van Veen grab sampler to collect bottom sediments and test them for **chemical contamination** and **toxicity**, and to examine the structure of the sediment-dwelling invertebrate communities known as **benthos**.

Learn more about Puget Sound sediments from our blogs, Flickr photos, and YouTube video.

The van Veen grab being deployed

Our muddy team!

Benthos sieved from the sediment

Sediment samples for the lab

Eyes Under Puget Sound: Benthic Invertebrates

The Marine Sediment Monitoring Program looks for changes in sediment quality and communities of ***benthic***, or sediment-dwelling, *invertebrates*.

Invertebrates include species of worms, clams, snails, shrimp, crabs, sea stars, and more.

Changes in the number and types of species are influenced by the quality of the sediment and by changes occurring in the waters above.

Learn more about benthos and Puget Sound sediments from our blogs, and Flickr photos.

Sieving benthos from sediment in the field

Sorting benthos in the lab

Benthic species abundance is decreasing by 45%

Amphipods ("sand fleas") an invertebrate

Weather of the past two weeks before 5-12-2014

Meteorological conditions typically explain up to half of the variance in observed marine variables (Moore et al. 2008), particularly in shallower waters like those of south Puget Sound. I summarized the specific conditions prevalent during the past two weeks, from north to south. Source: http://www-k12.atmos.washington.edu/k12/grayskies/nw_weather.html

Two week summary:

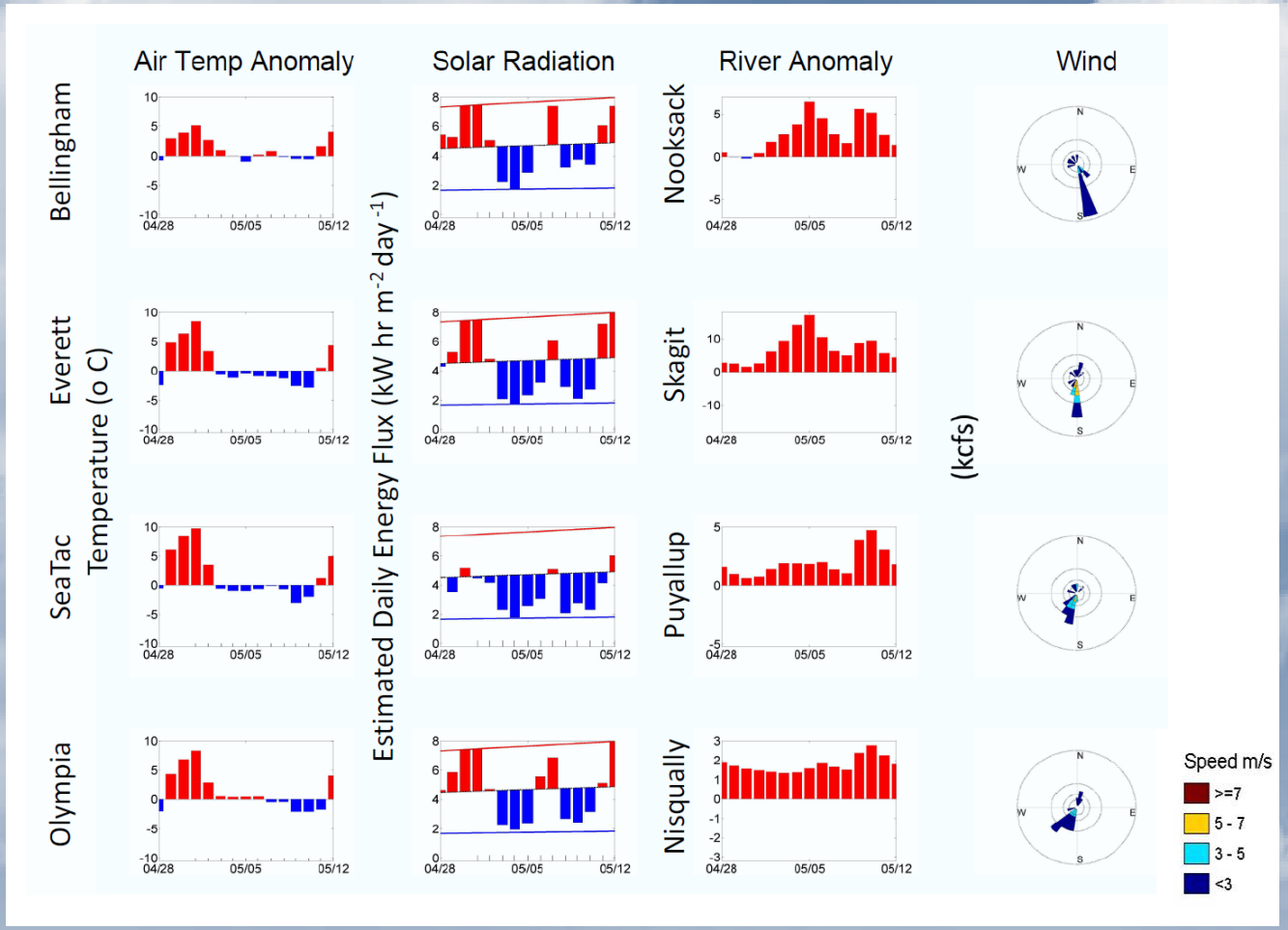
Air temperatures. The air was warm on the day of the flight, but had been slightly below average during the previous week and higher than normal two weeks prior.

Sunshine levels have increased during the past two days, but were generally low for the past week prior to that.

River flows have been above normal.

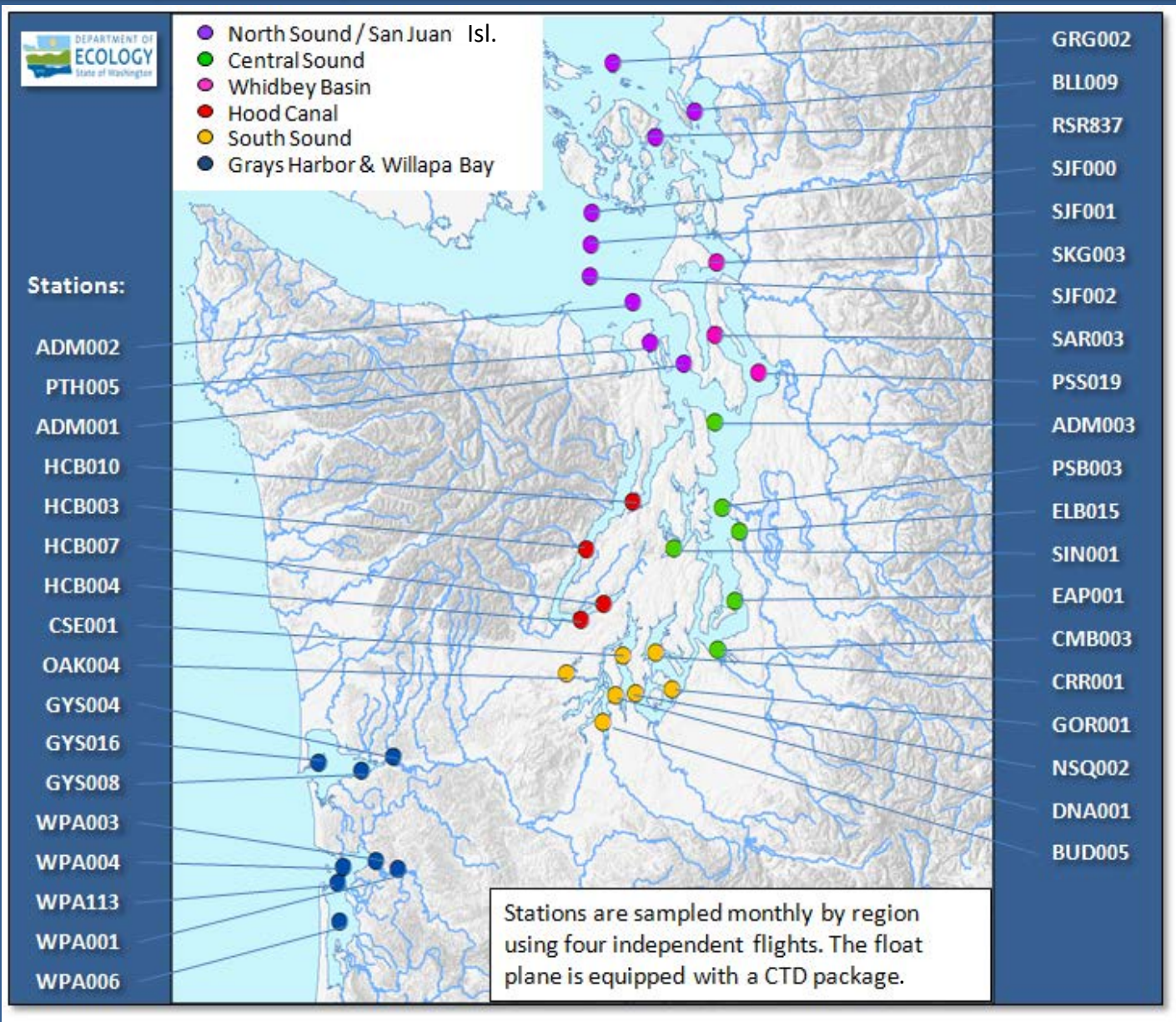
Winds have primarily been from the south up until the day of the flight.

- Higher than expected
- Lower than expected



Moore et al. 2008. Local and large-scale climate forcing of Puget Sound oceanographic properties on seasonal to interdecadal timescales. Limnol. Oceanogr., 53(5), 1746–1758

Our long-term marine monitoring stations in Washington



We use a chartered float plane to access our monthly monitoring stations most cost effectively.

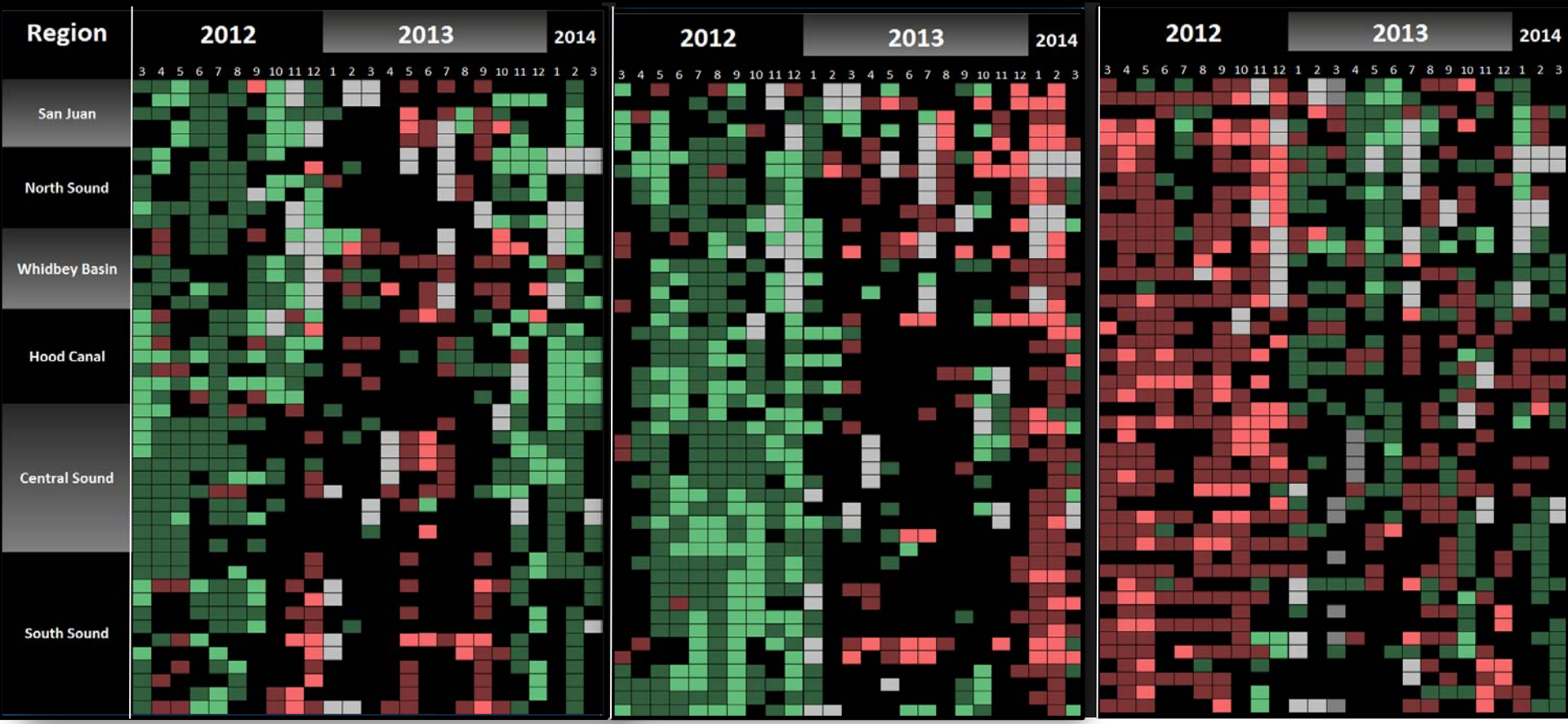
Start here

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

March 2014: Temperature expected Salinity variable Oxygen expected



= 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 2012 colder, fresher, higher oxygen conditions are gone. In 2013, Puget Sound was warmer, with normal salinity. Lower oxygen conditions appeared in the northern areas early in the year. In early 2014, colder, saltier conditions developed throughout Puget Sound with lower oxygen primarily in Whidbey Basin, Central and South Sound. Conditions are again changing in March.

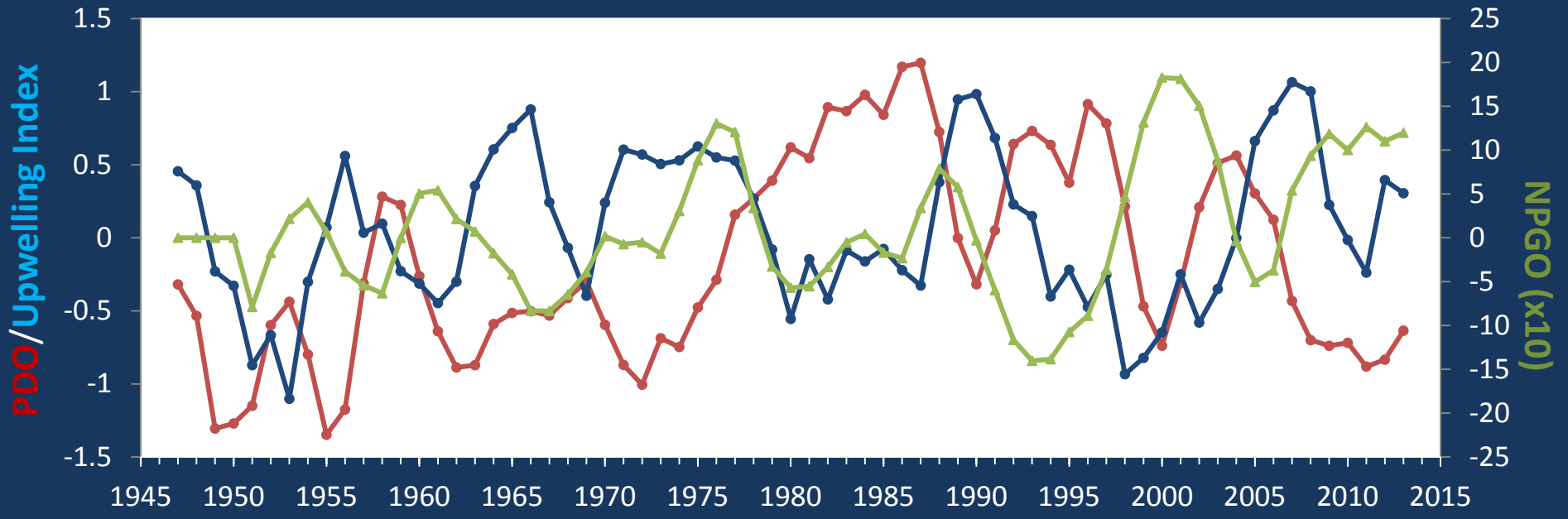
The ocean affects water quality: Ocean Climate Indices

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

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

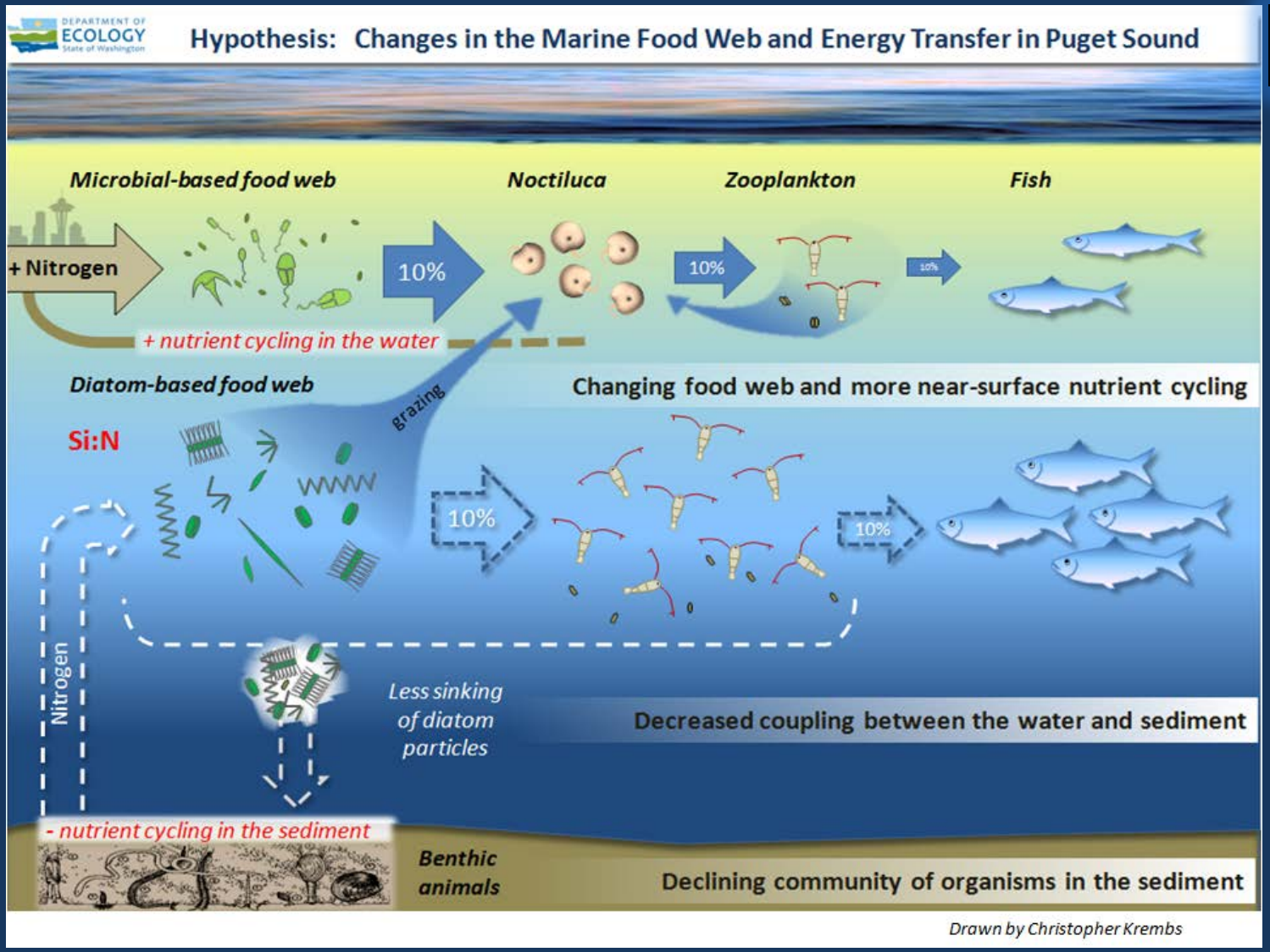
c) *North Pacific Gyre Oscillation Index (**NPGO, productivity**)* *(explanation)*

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



Ocean boundary conditions have been favorable for water quality in Puget Sound: (a) colder water (PDO), (b) less upwelled low oxygen and high nutrient ocean water reaching Puget Sound (Upwelling Index), and (c) higher surface productivity along the coast (NPGO). Where are we heading next?

Is the food web changing in Puget Sound?



Hypothesis!

Should we pay greater attention to nutrient ratios, energy transfer, and material cycling in Puget Sound?

Noctiluca blooms are a visible harbinger of a changing microbial food web in Puget Sound's waters.

[The story in 5 min]

[Explore the data]

[Follow the experts]

Summary: Aerial photography 5-12-2014

Blooms and large debris lines present in Bellingham Bay, Padilla and Samish Bays, finger inlets of South Sound, south Hood Canal, East Sound, and the Straits. Large amounts of sediment-laden water leaving Port Susan flowing into Central Basin. Turquoise water mixing to the surface in places around the San Juan Islands.

Start here

Bellingham Bay is very murky

Green bloom, Quilcene Bay, Hood Canal

Front

Mixing and Fronts: Click on numbers

Tidal fronts in Dana Passage, Admiralty Reach, Possession Sound, Rosario Strait, Boundary Pass.

1 3 6 7 8 11 15 16 20

Jellyfish: No jellyfish patches.

Plume

Suspended sediment:

Subsurface suspended sediment around San Juan Islands, Port Susan, Possession Sound, and Bellingham Bay.

1 5 6 7 8 9

Bloom

Visible blooms: 2 3 4 5 10 11 12 13 14 17

Green-brown: Southern finger inlets, Dyes Inlet, 19 20
Port Madison, Saratoga Passage, Strait of Juan de Fuca.

Red-brown: Sequim Bay, Griffin Bay.

Green-yellow: Massacre Bay, Quilcene Bay.

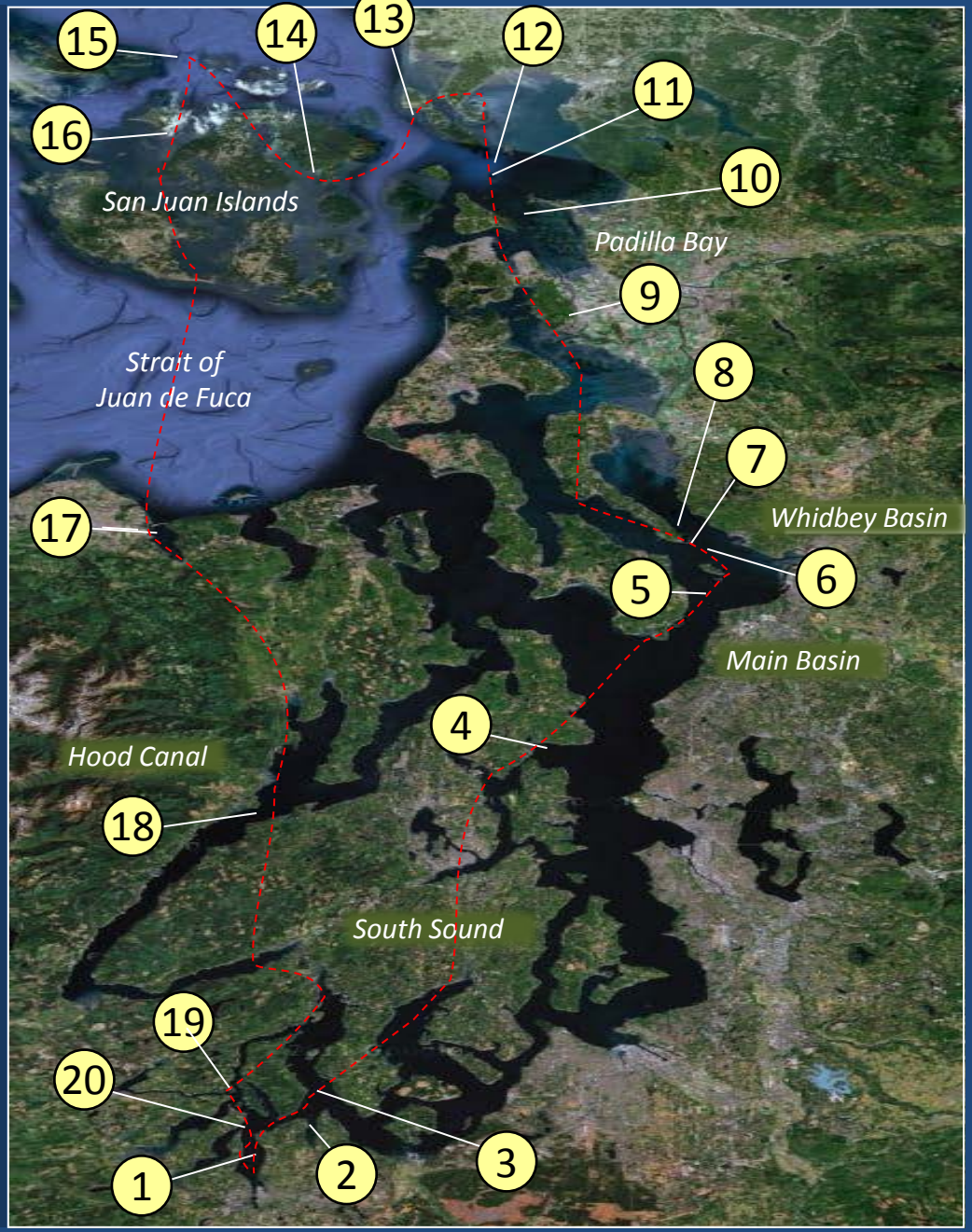
Near-shore green macro-algae abundant and increasing.

Debris

Debris: 2 3 4 5 6 8 10 11 18 19 20

Very abundant in Padilla and Samish Bays. Present in Southern finger inlets, Hood Canal, Straits, Port Madison, Possession Sound.

Seattle Tides: H. tide: 3:23 AM 4:58 PM, , L. tide: 10:12 AM,10:19 PM



Aerial photography and navigation guide

Date: 5-12-2014

Click on numbers

Flight Information:

Morning flight, photos 1-12
Good visibility

Afternoon flight, photos 13-20:
Good visibility

– – – Flight route

Observation Maps:

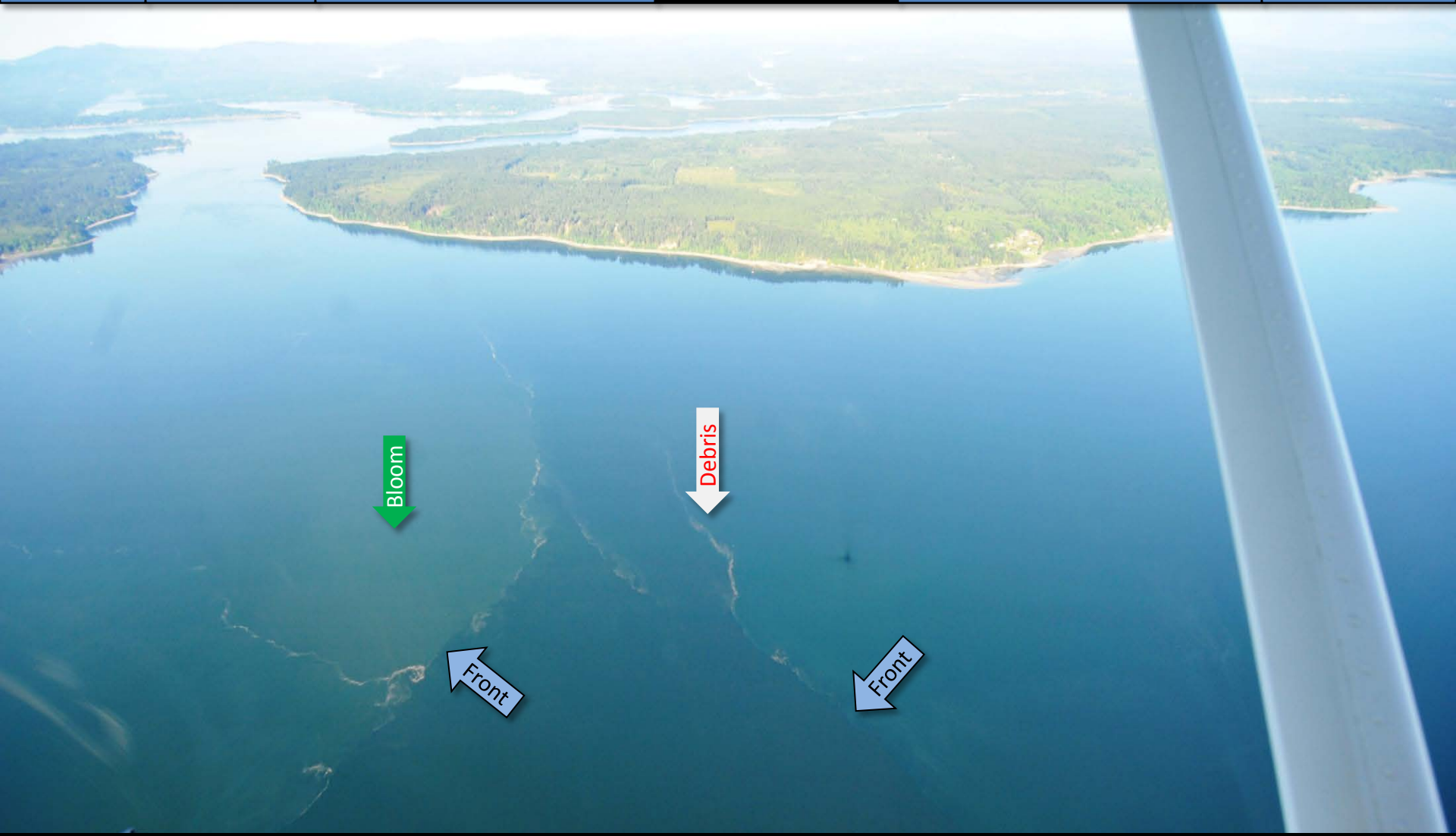
Central and North Sound

Hood Canal and South Sound

Edge of Deschutes River plume with internal wave patterns bordering water with phytoplankton bloom.

Location: Budd Inlet (South Sound), 8:28 AM.

Multiple debris lines and phytoplankton bloom.
Location: Henderson Inlet, 9:35 AM.



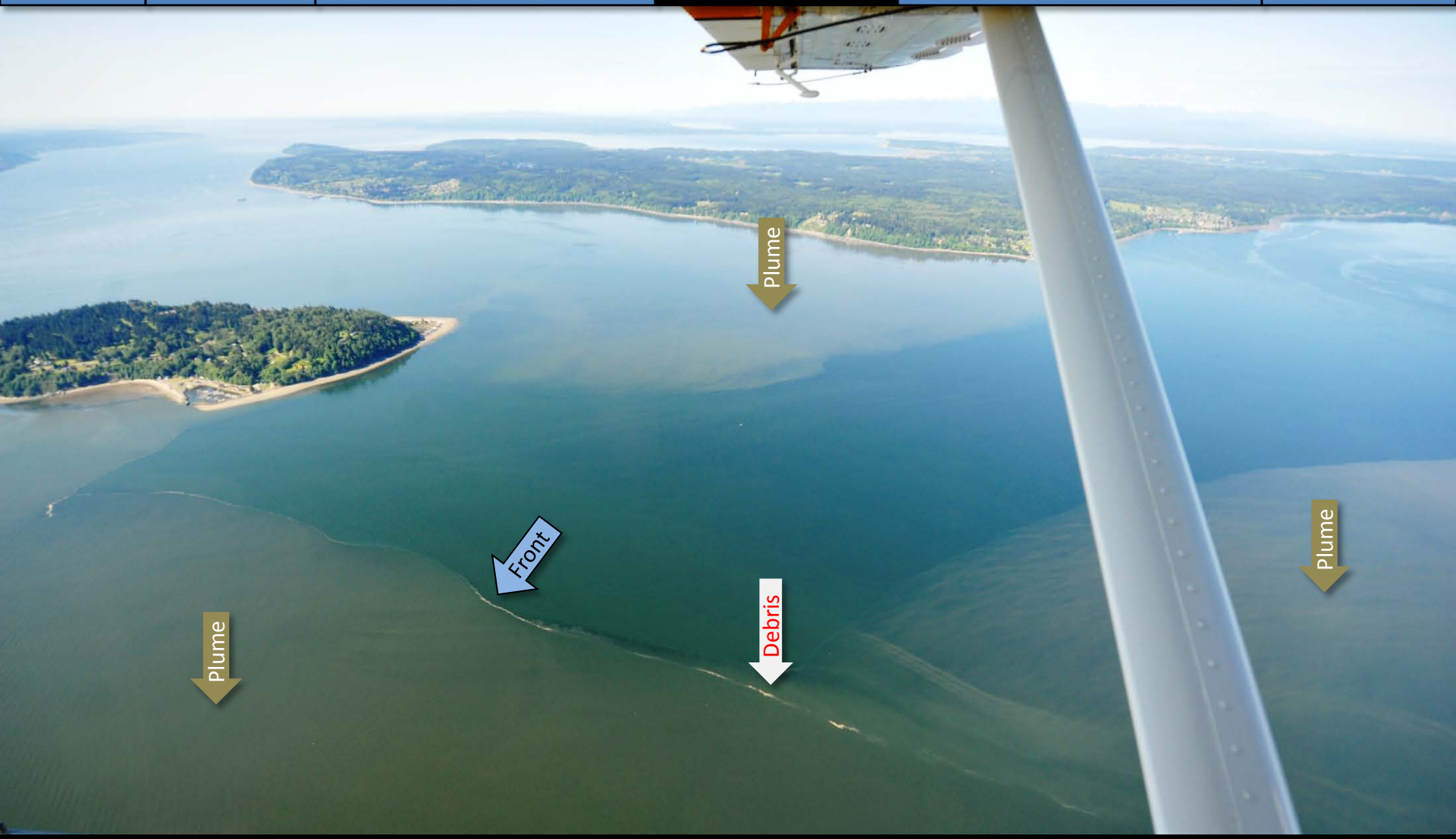
Debris lines of organic material delineating different surface water with different phytoplankton content.

Location: Nisqually Reach, Dana Passage (South Sound), 9:36 AM.

Debris line of organic material and phytoplankton bloom.
Location: Port Madison, (Central Sound), 9:58 AM.

Large eddy of suspended sediment originating from Port Susan and phytoplankton bloom.

Location: Possession Sound (Whidbey Basin), 10:09 AM.



Sediment-laden water from Port Susan and water from Saratoga Passage separated by debris line.
Location: Gedney Island, Possession Sound (Whidbey Basin), 10:11 AM.

Sediment-rich water from Port Susan meeting water from Saratoga Passage during outgoing tide.
Location: Possession Sound (Whidbey Basin), 10:12 AM.

Sediment-rich water leaving Port Susan at Camano Island during outgoing tide.

Location: Possession Sound (Whidbey Basin), 10:13 AM.

A.

B.

Sediment-rich water entering Swinomish Channel being carried southward.

Location: Swinomish Channel (La Conner), 11:32 AM.

Large and frequent mats of organic surface debris floating in strong phytoplankton bloom.
Location: Samish Island (Padilla Bay), 11:56 AM.

Strong phytoplankton bloom, debris lines bordering clearer water behind island.

Location: Vendovi Island (Samish Bay), 11:58 AM

Sediment-rich water and strong phytoplankton bloom drifting out of Bellingham Bay.

Location: Looking onto Lummi Island (Bellingham Bay), 11:58 AM

Bellingham Bay water (bloom) mixing into turquoise Rosario Strait water that is rich in silt.

Location: Lummi Island (Rosario Strait), 12:24 PM.

Red-brown phytoplankton bloom and turquoise water.

Location: East Sound, Orcas Island (San Juan Islands), 12:51 PM.

Aerial photography 5-12-2014

Water rich in phytoplankton meeting a tidal mixing zone bringing turquoise water to the surface.

Location: Off Patos Island, Saturna Island (Georgia Basin), 1:00 PM.

Turquoise water mixing to the surface displacing other water near island.
Location: Waldron Island, President Channel (San Juan Islands), 1:46 PM.

Phytoplankton bloom entering clearer bay water and flowing south along two distinct paths.
Location: Sequim Bay (Olympic Peninsula), 2:11 PM.

Aerial photography 5-12-2014

Very long debris line separating phytoplankton-rich and clearer water.

Location: Near Seabeck looking south (Hood Canal), 2:29 PM.

Aerial photography 5-12-2014

Phytoplankton bloom meeting clearer water in Pickering Passage.
Location: Hope Island (South Sound), 2:44 PM.

Aerial photography 5-12-2014

Complex pattern of surface water with different phytoplankton content separated by debris lines.

Location: Entrance to Budd and Eld Inlets (South Sound), 2:46 PM.

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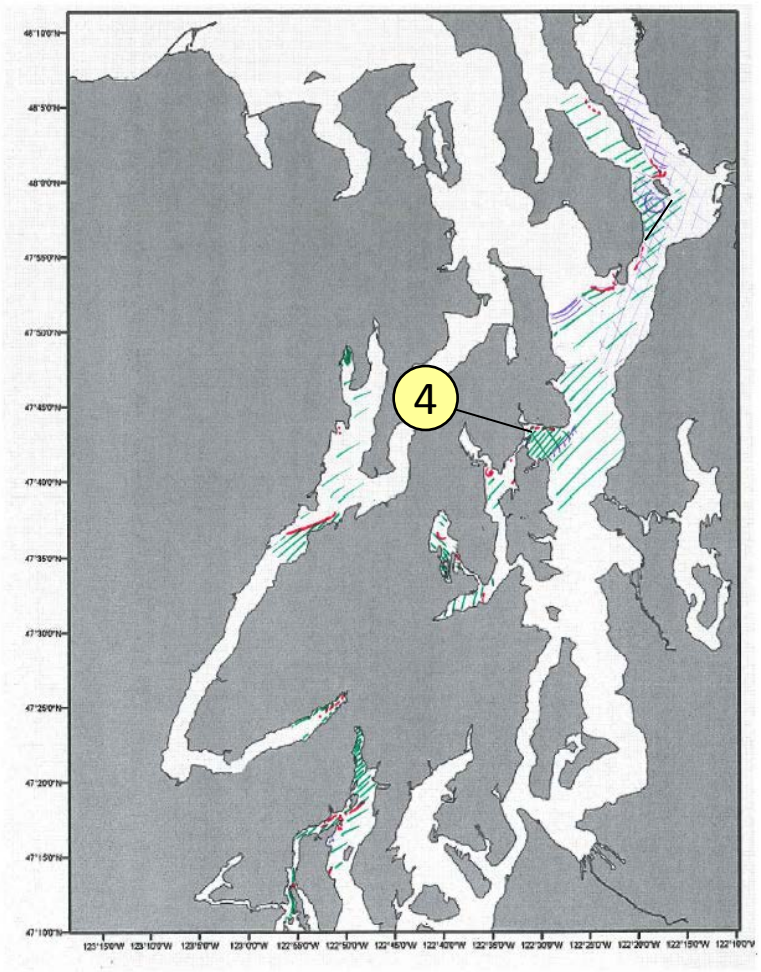
Observations in Central and North Sound

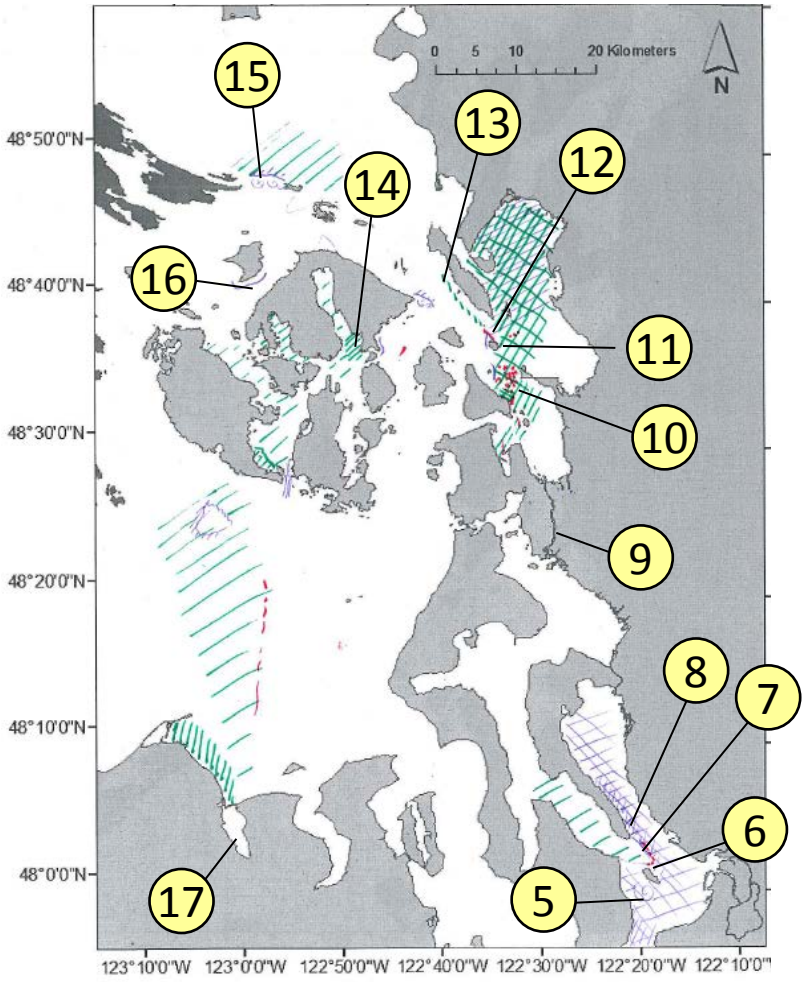
Navigate

Date: 5-12-2014

Central Sound



North Sound/San Juans



Numbers on map refer to picture numbers for spatial reference

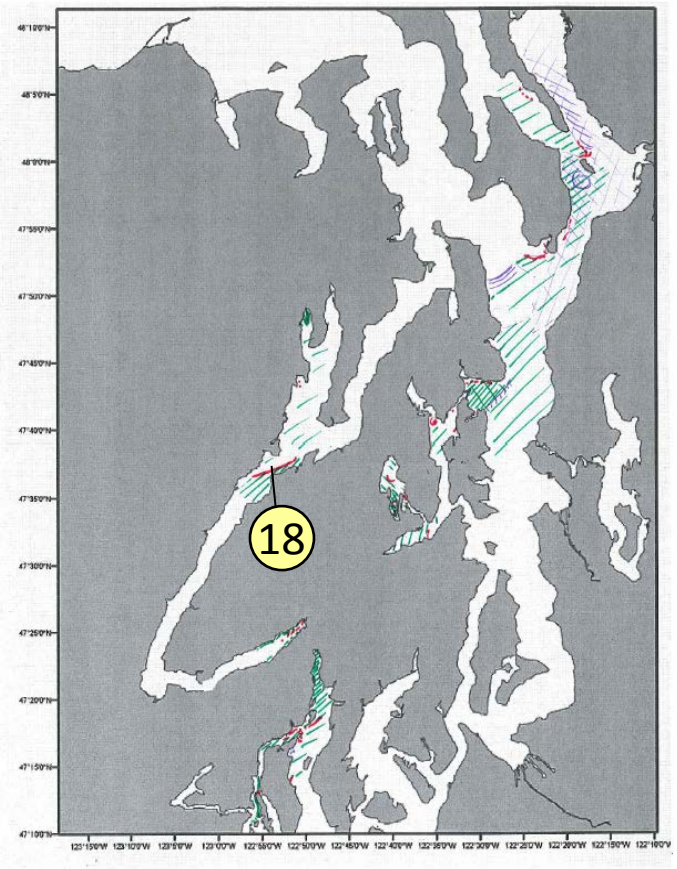
DEPARTMENT OF ECOLOGY State of Washington

Observations in Hood Canal and South Sound

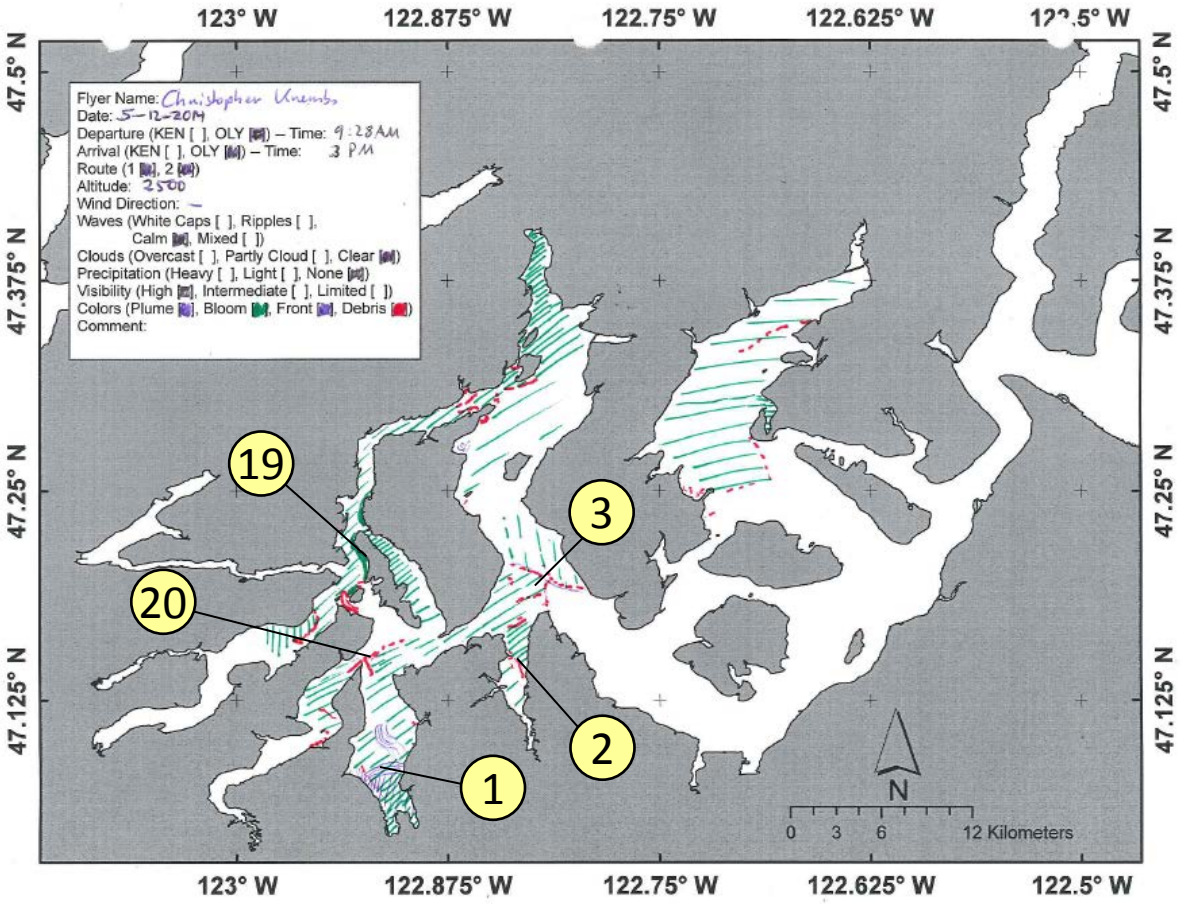
Navigate

Date: 5-12-2014

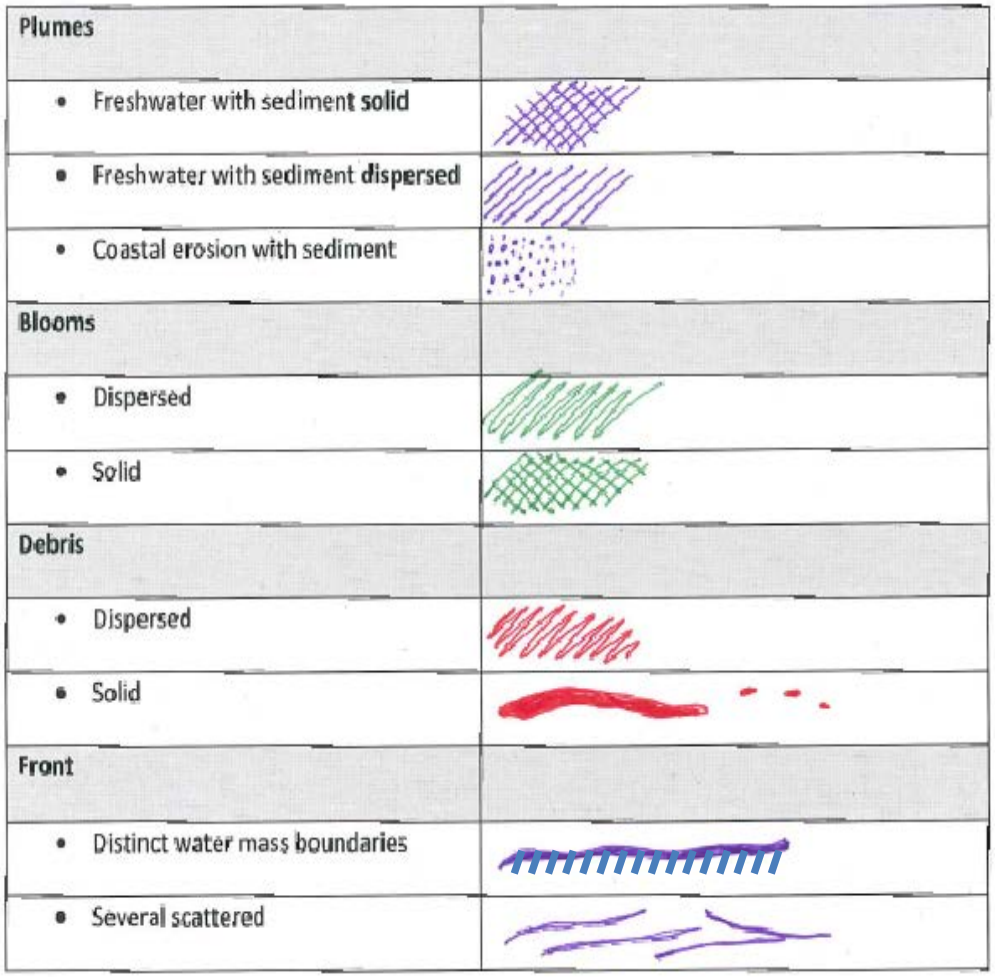
Hood Canal



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 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.

Guest: Ferry and satellite observations 5-12-2014

The *Victoria Clipper* en route ferry system received a new upgrade. After some troubleshooting of the hardware and communication system followed by a data gap, the system will resume data collection next week.

Our fluorometer is inserted through a modified cover over a sea chest strainer.

Partnership

- Ecology and Clipper Navigations, Inc. started a partnership in 2009 with the first data flow in May 2010.
- Started as a pilot project to test the proof-of-concept that we could collect time-series data across a horizontal plane.
- This public-private collaboration has been very successful for both parties involved.
- It is extremely cost effective for Ecology as the most expensive part of collecting marine water quality data is the cost of ship time.
- We plan to maintain this collaboration as long as we have agency and program support (staff support is at risk).

Guest:
Brandon Sackmann
Contact: bsackmann@integral-corp.com

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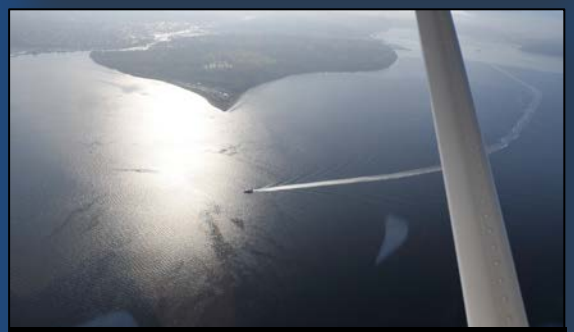


Victoria Clipper IV leaving Elliott Bay

No *Victoria Clipper IV* data available – Hardware close to completion!!!

Future Focus of Mooring Operations

Note: Due to state and federal budget reductions, our mooring program is being downscaled.

Strength through collaboration across agencies, academic institutions, and companies. We have plans to continue to collect data at our Admiralty Reach (UW Applied Physics Lab) and Mukilteo (ORCA College) moorings into the future. Operations at all other mooring locations have been suspended in order to reallocate existing resources.

We are now focusing on measuring ocean intrusions!

Why? The importance of the ocean on water quality in Puget Sound is being emphasized by Ecology's mooring at Admiralty Reach, long term monitoring data, modeling studies, and academic publications. Admiralty Reach is a challenge - it requires a team effort!

Upwelling along the coast can bring **high nutrient**, **low oxygen** and **low pH** ocean water into Puget Sound. Such intrusions explain much of the year to year variability in **water quality**.

For intrusions to enter Puget Sound, several conditions have to align:

- **Prolonged upwelling** along the Washington coast. *Driver: Northerly winds*
- **Estuarine circulation moving dense water from the coast** into the Strait of Juan de Fuca. *Driver: High Fraser River flow during summer*
- **Neap-Spring tide phase and character** favorable to intrusions along the 30 km length of Admiralty Reach. *Drivers: Neap tides and tidal harmonics*

Get data from Ecology's Monitoring Programs

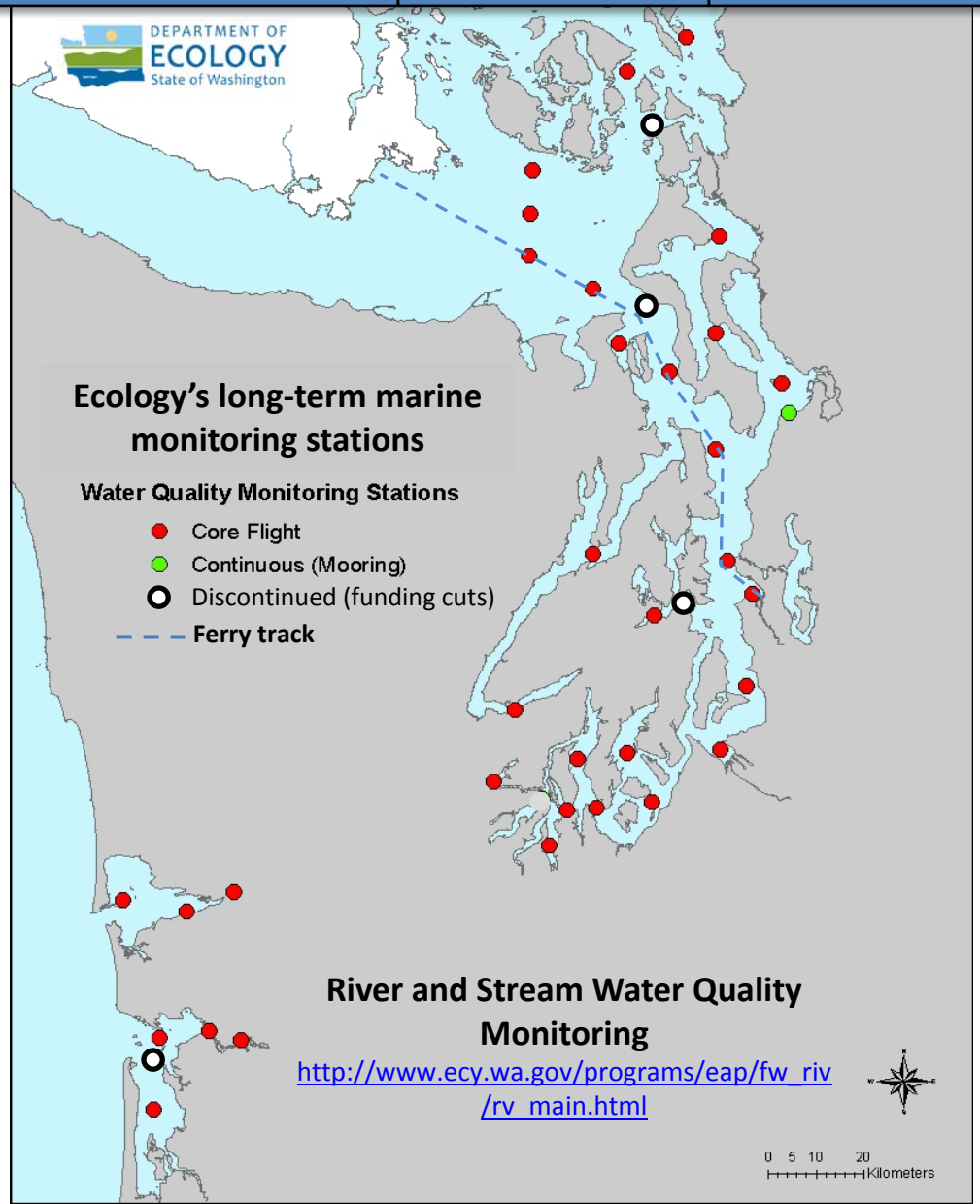
Field log	Weather	Water column	Aerial photos	Ferry and Satellite	Moorings

Long–Term Monitoring Network

christopher.krembs@ecy.wa.gov

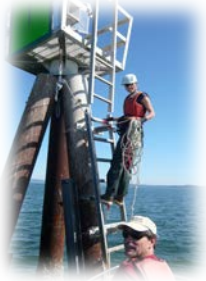
Access core monitoring data:

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.

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Marine Monitoring Unit
Environmental Assessment Program
WA Department of Ecology

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