Publication No. 13-03-074

DEPARTMENT OF ECOLOGY State of Washington

Eyes Over Puget Sound

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

Surface Conditions Report

May 20, 2013

Visit our website (http://www.ecy.wa.gov/programs/eap/mar_wat/)

Start here

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

Marine conditions from 5-20-2013 at a glance

LONG-TERM MARINE MONITORING UNIT

Mya Keyzers
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David Mora

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Dr. Brandon Sackmann

Personal flight log p. 3

Stunning views from up high…

Weather conditions p.5

Rivers and air temperatures begin to normalize, yet sunshine has been below normal for the past week.

Water column and mooring p.6 , p.37

After 2 years of favorable conditions with colder temperatures and higher oxygen, Puget Sound water conditions are closer to expected. This year phytoplankton blooms and oxygen maxima followed a period of high freshwater inputs and milder weather conditions.

Aerial photography p. 10

Large *Noctiluca* blooms in Central Sound appeared one month early and are extending into the Straits and South Sound. Bright green blooms in some shallow bays. Fraser River sediment influence is very strong north of San Juan Islands.

Ferry and satellite p. 35

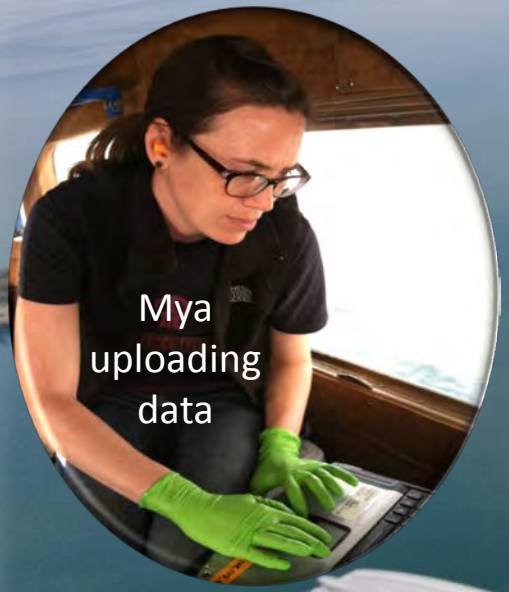
Warm, fresh water entering central Puget Sound from Whidbey Basin.

Previous Eyes Over Puget Sound reports: www.ecy.wa.gov/programs/eap/mar_wat/eops/

Personal flight log 5-20-2013

North Sound Flight

Christopher in action



Mya uploading data

Fraser River water entering the San Juans.

We now have instant air to ground bloom updates by cell phone!

Personal flight log 5-20-2013

North Sound Flight

Normally we collect our data and do no-frills flying. But when Christopher is on board taking photos for EOPS, we climb to ~2500 ft altitude between stations. That perspective is one I don't usually get to see.

It is surprising how different everything looks from that high up. I have been flying for 3 years, and I am struck by the vast horizon speckled with islands and the influence of the mighty Fraser River.

To see ribbons of brown river water layering over blue ocean water was simply stunning. Mother Nature is so vibrant and dynamic. We really do live in a special place.

Weather patterns from 5-6-2013 to 5-20-2013

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

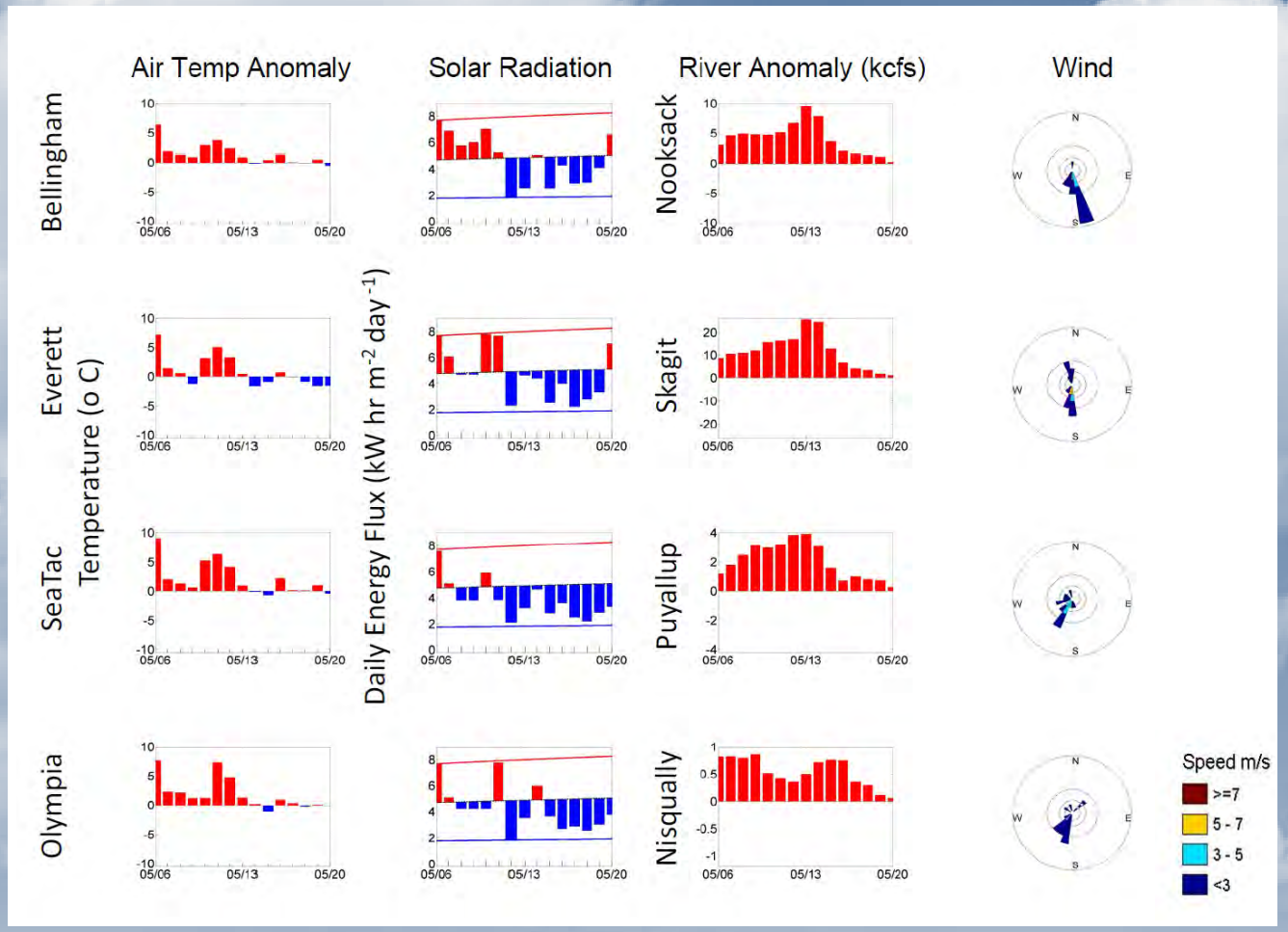
Summary:

Air temperatures were warmer at the beginning of May, except at Everett.

Sunshine levels were high at the start of May and have been below normal for the past week.

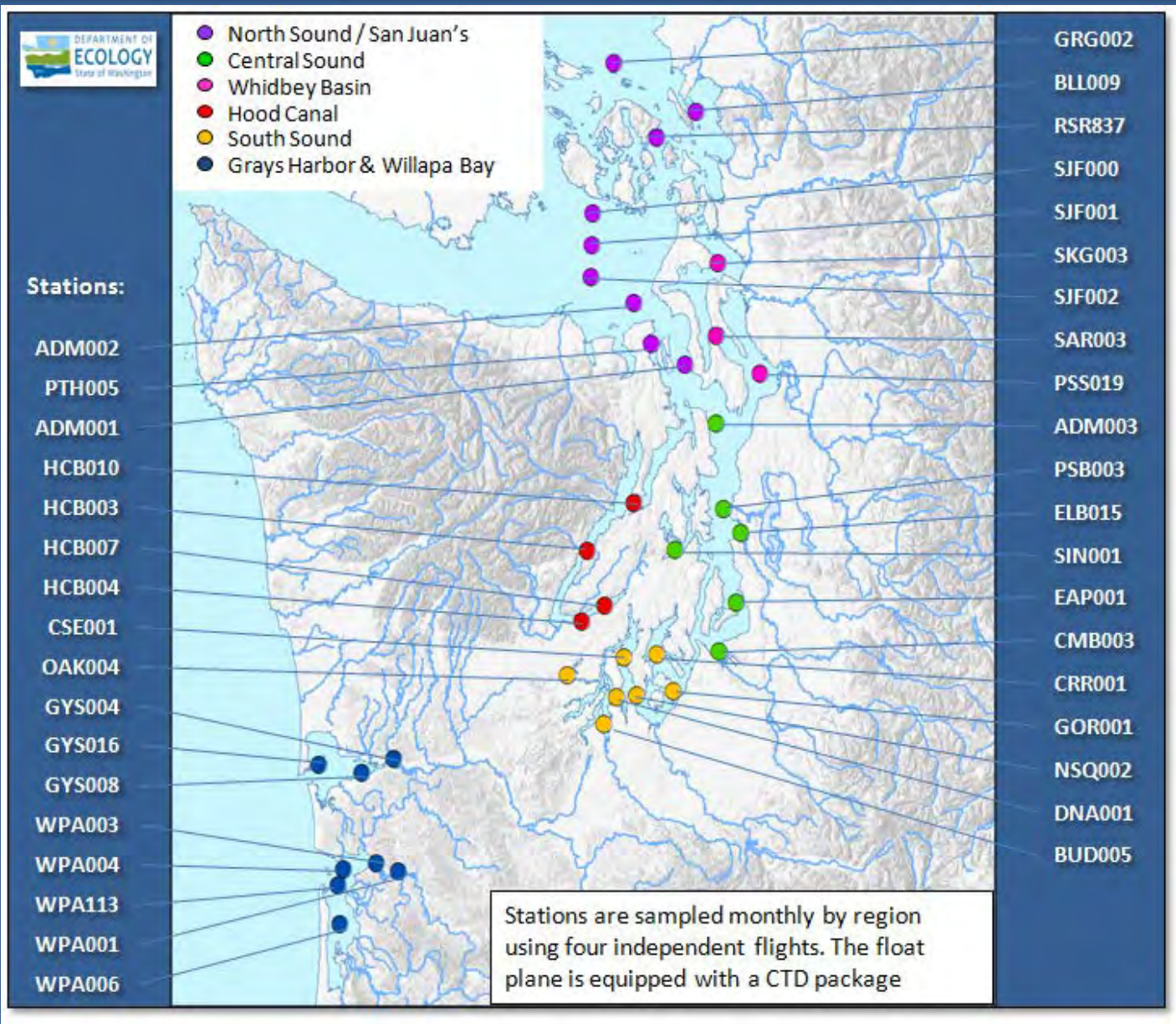
Rivers have been running above normal.

Winds have been mostly from the south, but equally out of the north around Everett.



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 Puget Sound



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

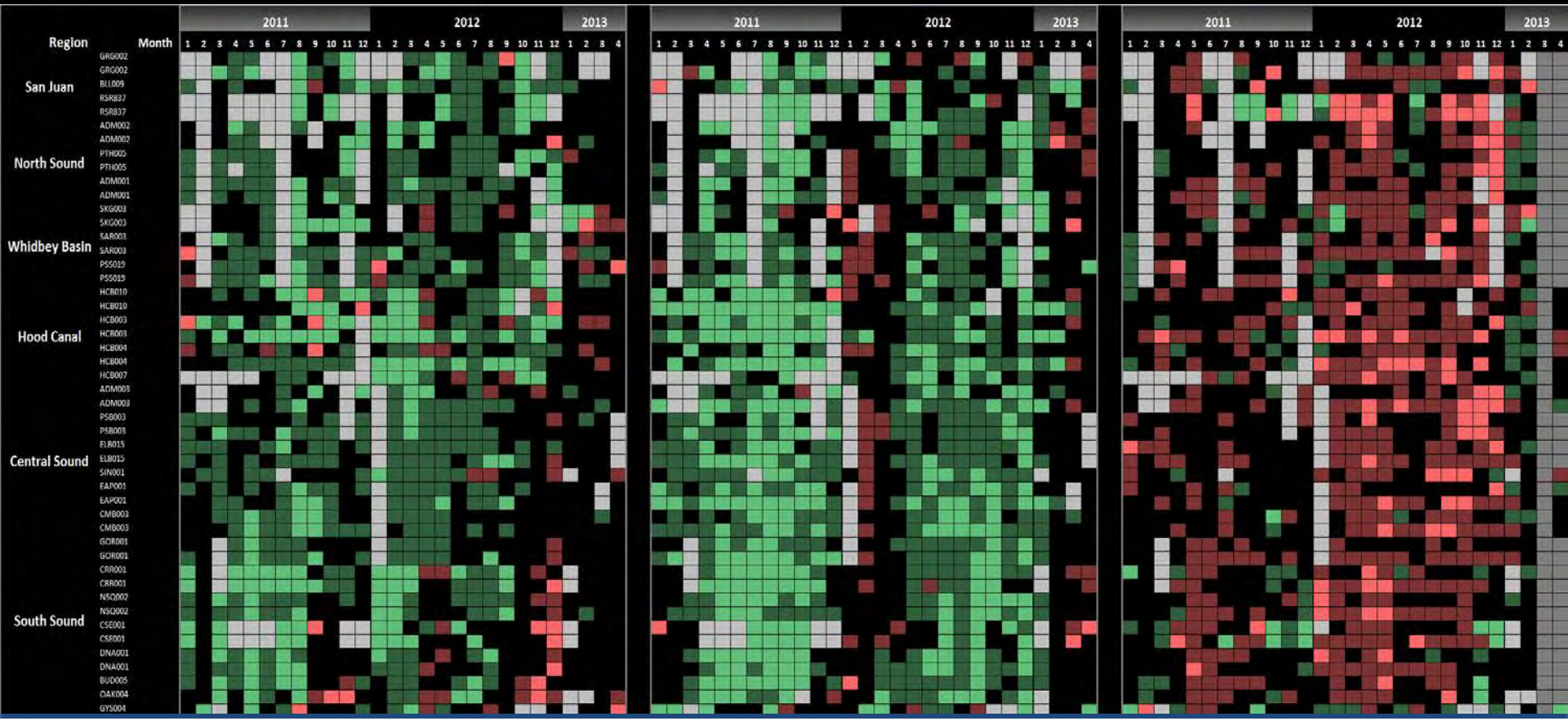
Start here

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**

Conditions of the last two years change at our stations

Temp: 2013 is warming **Salinity: Increasing?** **Oxygen: Work in progress**



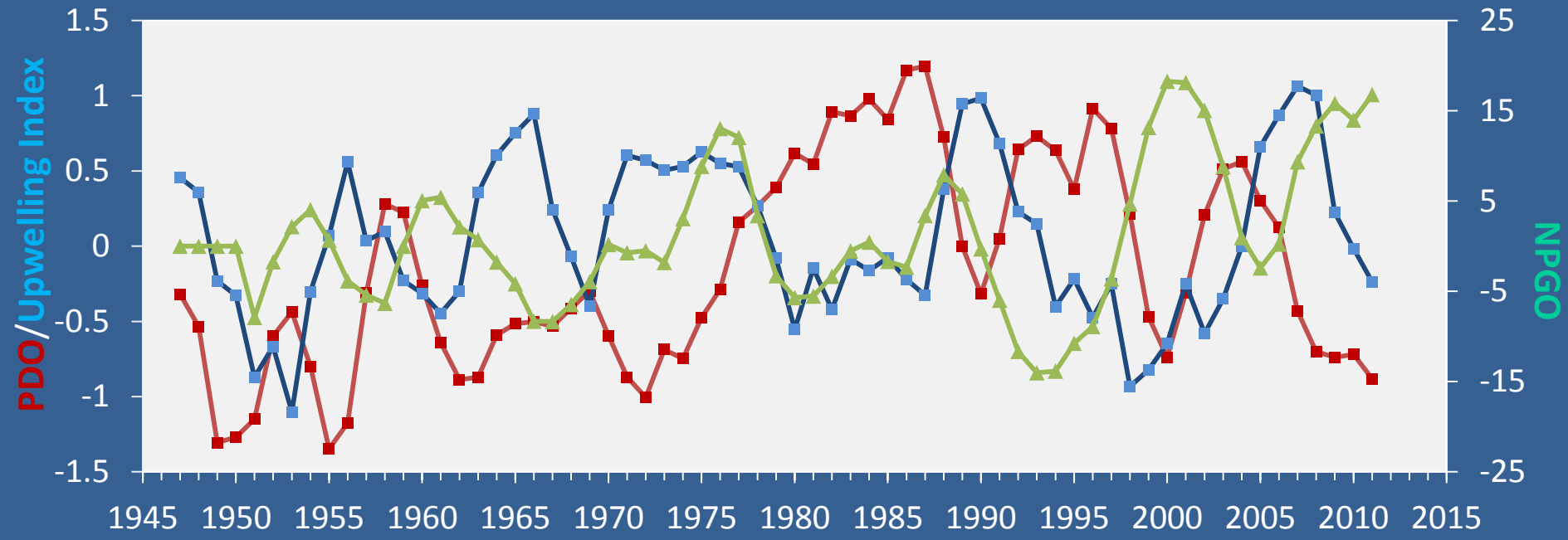
= higher than expected (>IQR, n=13)
= higher than previous measurements
= expected (=IQR, n=13)
= no data
= lower than expected (>IQR, n=13)
= lower than previous measurements

Puget Sound water conditions are changing again! Compared to 2011-2012, when waters were colder and fresher with higher oxygen, Puget Sound is more expected so far this year. A sensor check prevented Mar. and Apr. oxygen data from being available for this report. Each pixel is a monthly survey at each station.

The ocean affects water quality: Ocean Climate Indices

- Pacific Decadal Oscillation Index (**PDO**) *...(explanation)*
- Upwelling Index *(anomalies)* (**PFEL**) *...(explanation)*
- North Pacific Gyre Oscillation Index (**NPGO**) *...(explanation)*

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



Ocean boundary conditions have been favorable for water quality in Puget Sound; colder water (PDO), less upwelled, low oxygen, high nutrient ocean water reaching Puget Sound (Upwelling Index), and higher surface productivity along the coast (NPGO).

Get the data and trends from us?

We observe increasing nutrients and changing algal biomass patterns in Puget Sound:

Algae bloom, Budd Inlet 2010

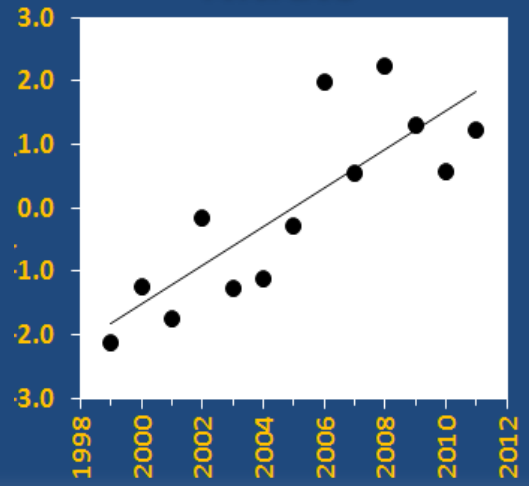
Nitrate

Phosphate

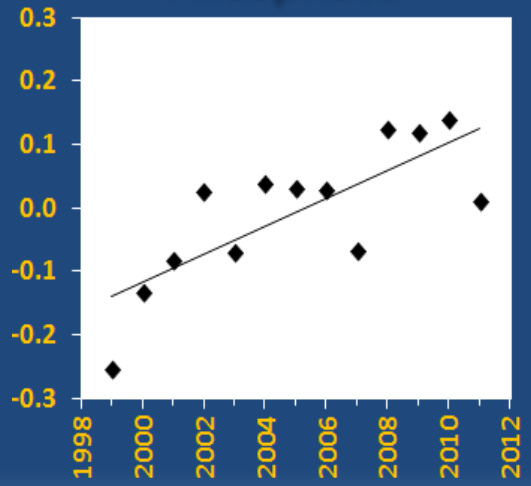
Changing Nutrient Balance

Nutrients in Puget Sound are increasing, read http://www.ecy.wa.gov/programs/eap/mar_wat/trends.html

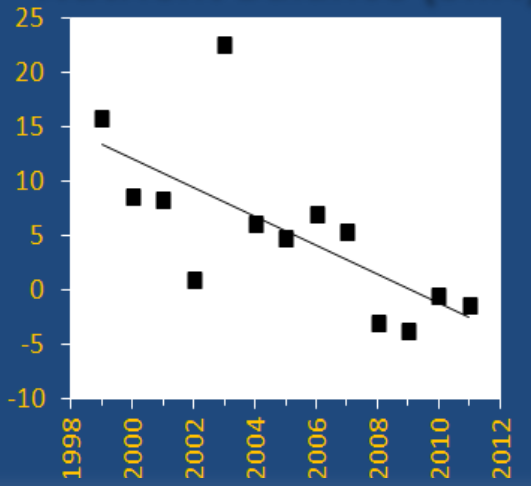
Nitrate



Phosphate



Nutrient Balance (Si:N)



Summary: Aerial photography 5-20-2013

Large *Noctiluca* bloom in Central Sound extending into the Straits and South Sound. Bright green blooms in some shallow bays. Fraser River sediment influence is very strong north of the San Juan Islands.

Start here

Internal waves in Saratoga Passage

Large mudslide on Whidbey Island

Front

Mixing and Fronts: 2 5 6 7 8 9 12 18 19

Fronts in Admiralty Reach and near Blake Island, internal waves in Saratoga Passage and north of Matia Island (north of San Juans).

Jellyfish: Present in small numbers Budd Inlet.

Plume

Suspended sediment: 6 7 8 9

High sediment loads from Fraser and Nooksack Rivers. Mud slide on Whidbey Island.

Bloom

Visible blooms: 1 2 3 4 5 10 13 14 15 16 17 18 19 20

Red: Strait of Juan de Fuca, Main Basin, Hood Canal, Padilla Bay, Henderson Inlet.

Brown: Port Townsend.

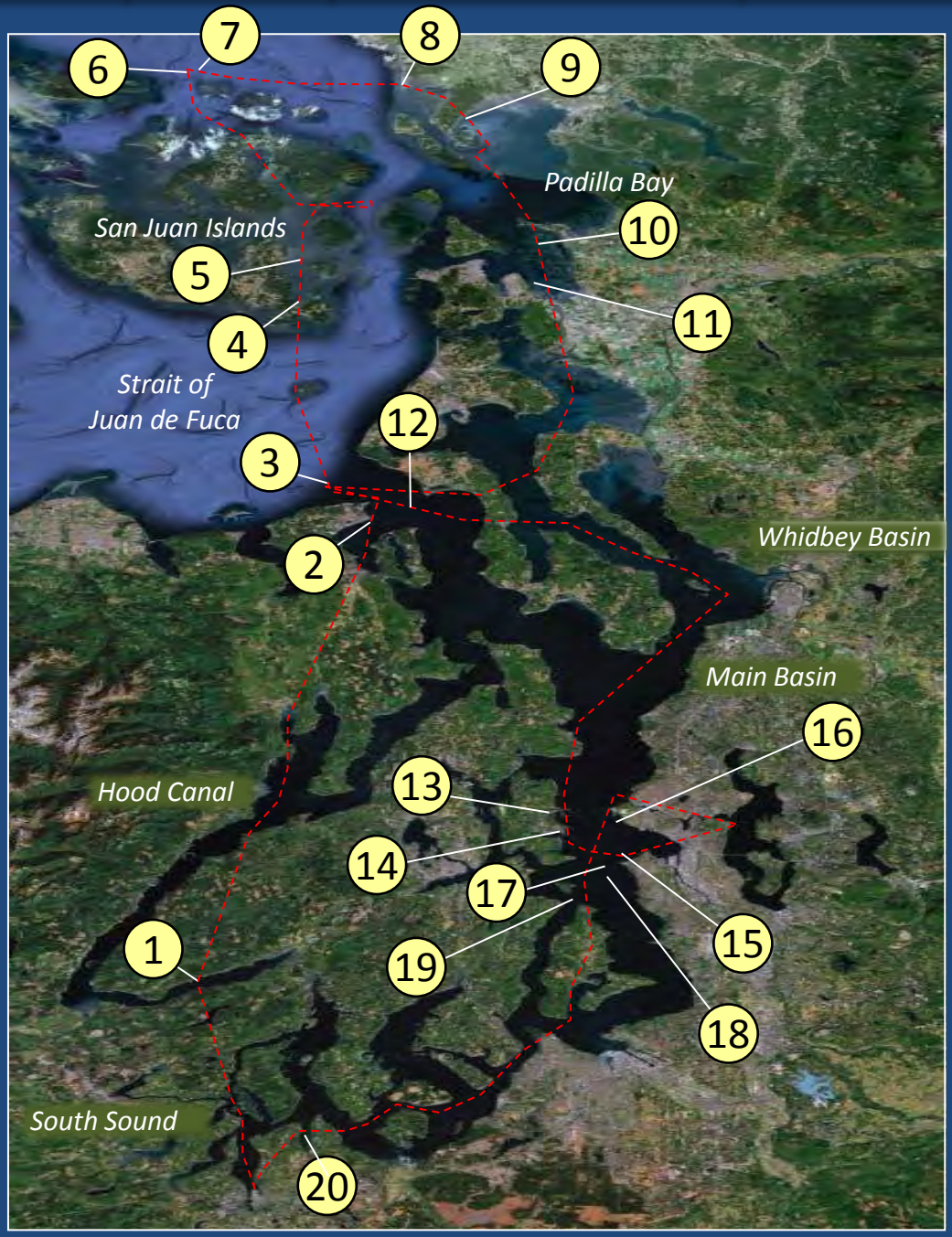
Green: Padilla Bay and Henderson Inlet.

Debris

Debris: 1 2 3 5 6 7 8 9 10 13 14 15 16 17 18 19

Mostly *Noctiluca* and foam along fronts.

Kelp rafts in the Strait of Juan de Fuca.



H. tide: 1:16 AM, 2:15 PM , L. tides: 8:11 AM, 7:33 PM

Aerial photography navigation guide, 5-20-2013

Click on numbers

Flight Information:

Morning flight, 1-5: ----
Low visibility, clouds, calm

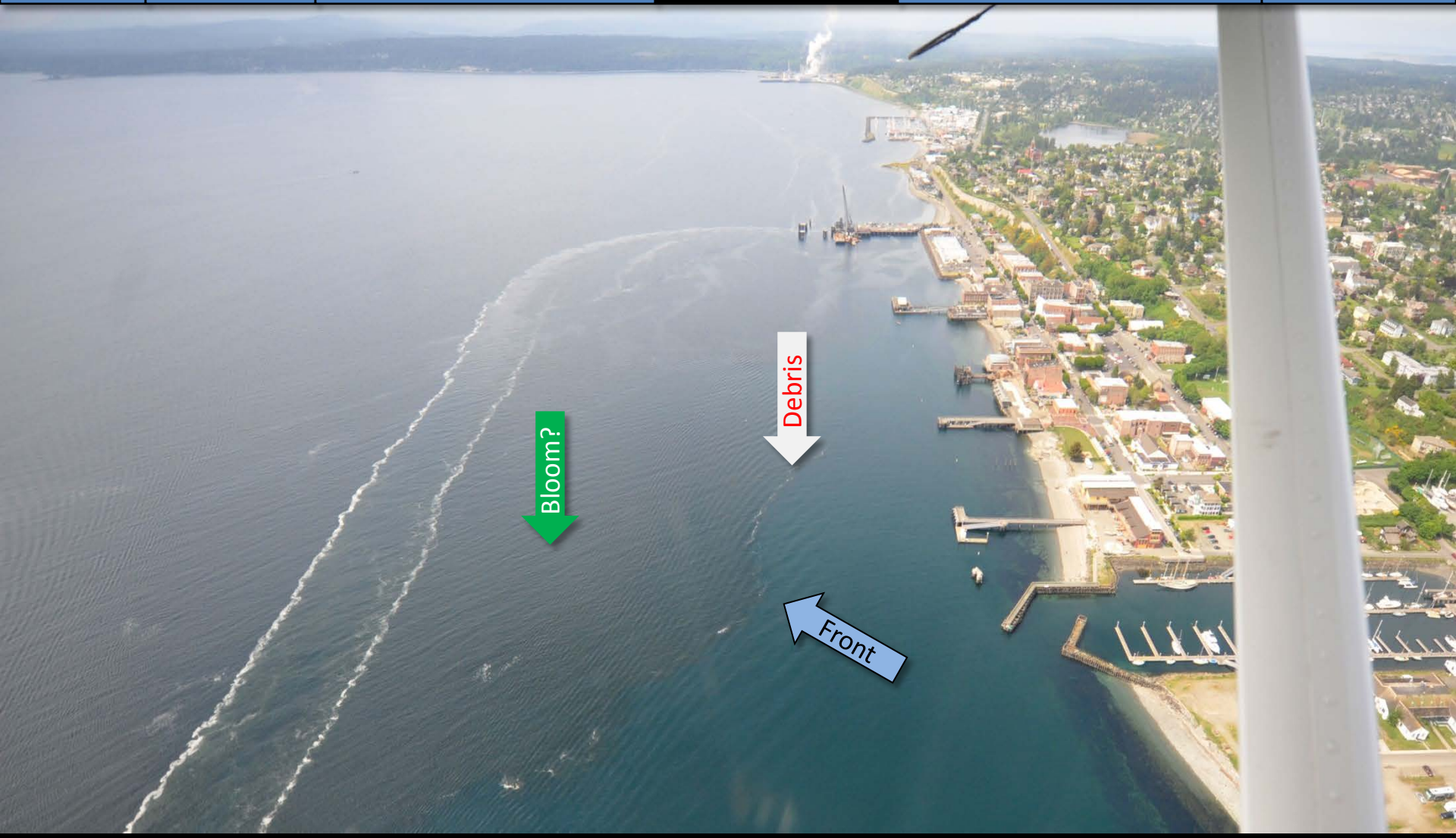
Afternoon flight, 6-20: ----
Variable visibility, some cloud reflections on water, wind increasing

Observation Maps:

Central & North Sound

South Sound

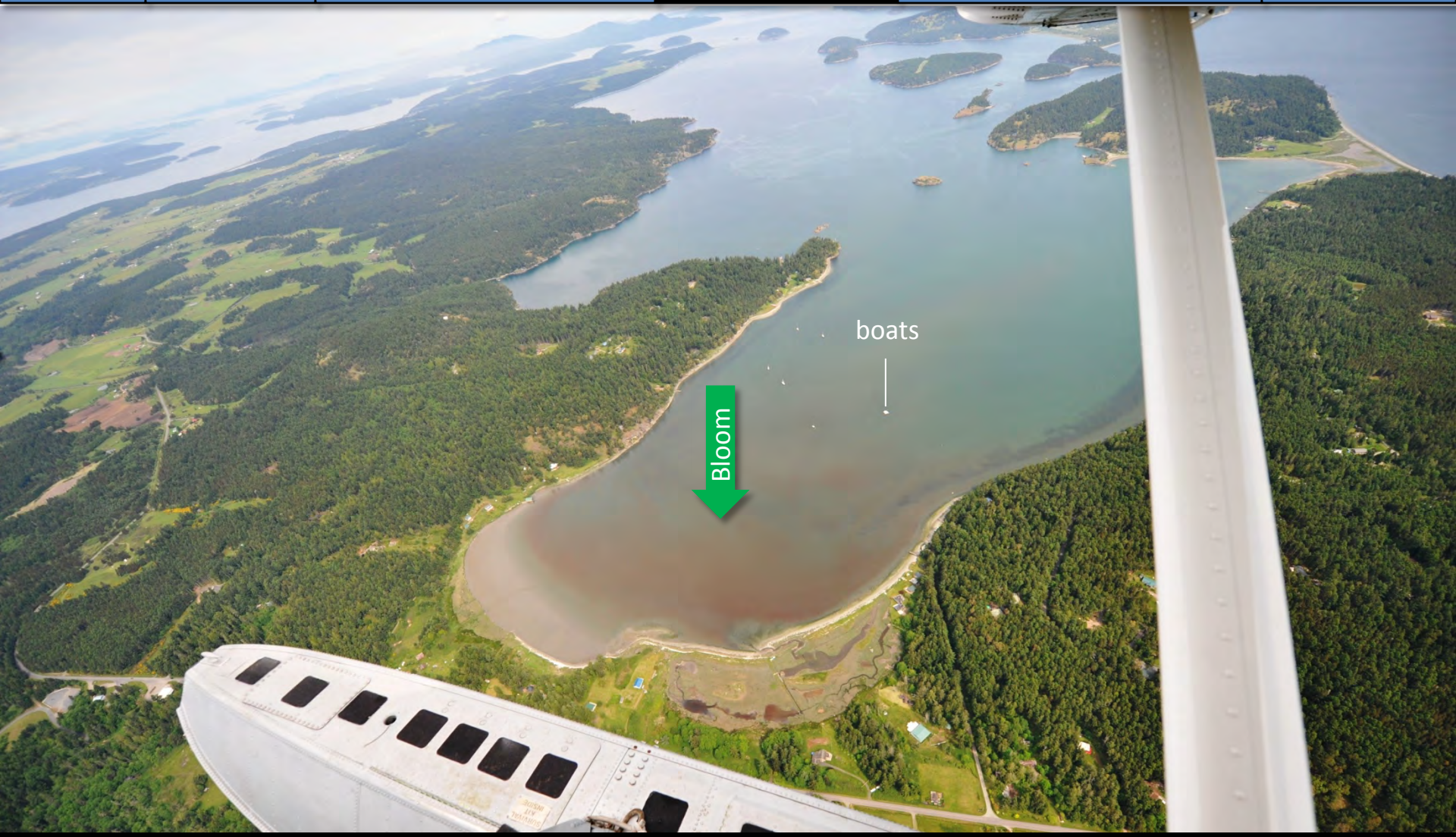
Noctiluca *bloom accumulating in long band along a convergence*.
Location: Near Twanoh State Park (Southern Hood Canal), 10:00 AM



Strong phytoplankton bloom and front.

Location: Port Townsend (Admiralty Reach), 11:15 AM

Streaks of Noctiluca *accumulating at surface in the Strait of Juan de Fuca.*
Location: Northwest of Fort Warden State Park (Admiralty Reach), 11:18 AM



Red phytoplankton bloom.

Location: Lopez Sound (San Juan Islands), 11:31 AM

Red phytoplankton bloom.

Location: Lopez Sound (San Juan Islands), 11:37 AM

The far reaches of the sediment-laden rive plume of the Fraser River

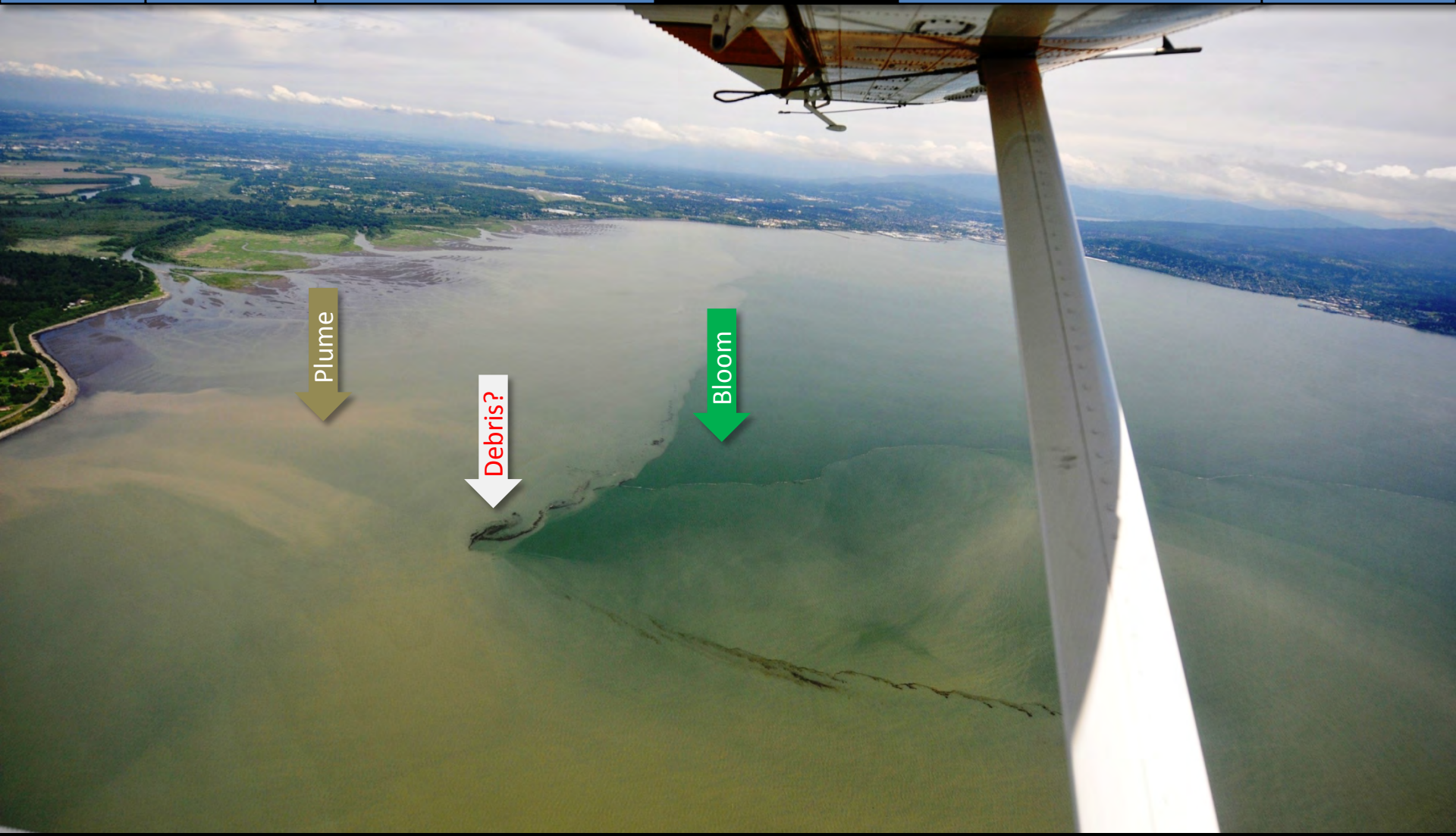
Location: Patos Island State Park (northern San Juan Islands), 12:21 PM

The far reaches of the sediment-laden river plume of the Fraser River

Location: Patos Island State Park (northern San Juan Islands), 12:22 PM

The edges of the Fraser River plume with suspended sediment.

Location: Lummi Bay (Near Bellingham), 1:15 PM



Sediment-laden river plume with black debris (kelp, plastic, oil?).

Location: Bellingham Bay, 1:19 PM

Bright green phytoplankton bloom and debris islands during high tide in shallow Padilla Bay.

Location: Padilla Bay, 2:00 PM

Oil sheen stretching for miles originating near Twin Bridge Marina.

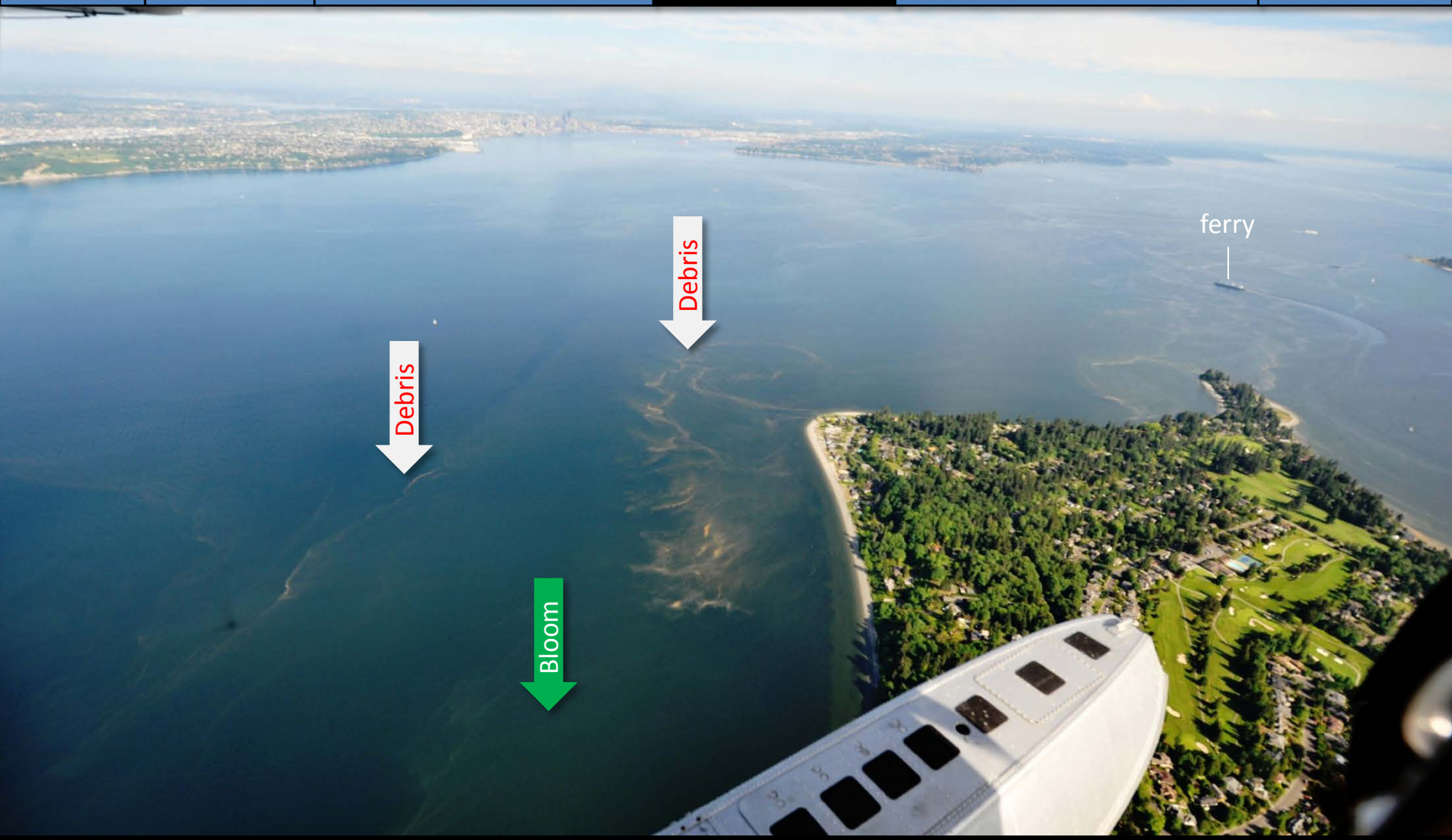
Location: Padilla Bay, 2:02 PM

Aerial photography 5-20-2013

Long tidal front in Admiralty Reach.

Location: Admiralty Reach, 2:44 PM

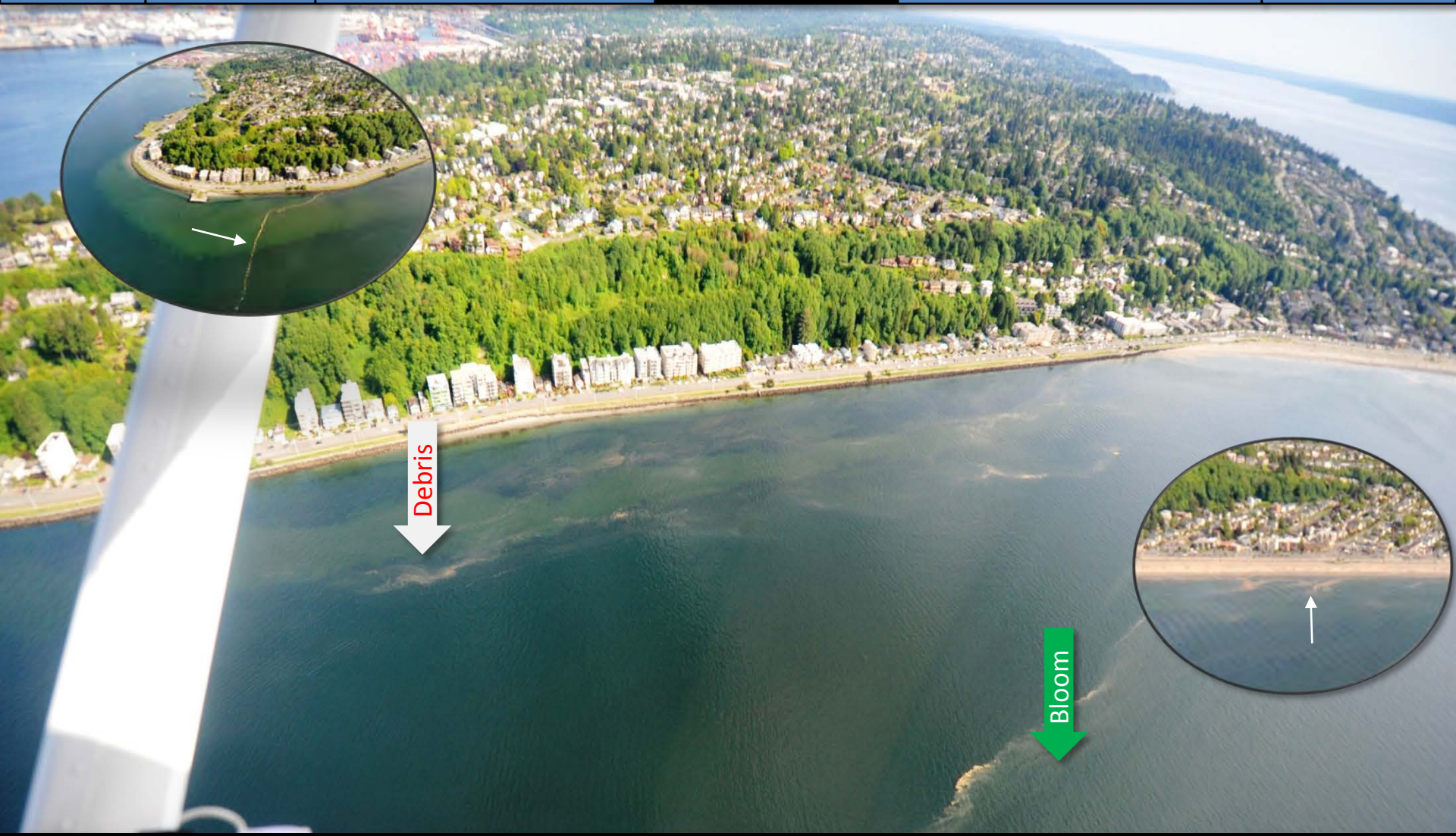
Aerial photography 5-20-2013



Noctiluca *bloom with Seattle to Bainbridge ferry in background*.
Location: Near Winslow, Bainbridge Island, 4:51 PM

A. Noctiluca *bloom with Bainbridge ferry in background. B. Blakely Harbor.*
Location: Near Winslow, Bainbridge Island, 4:52 PM

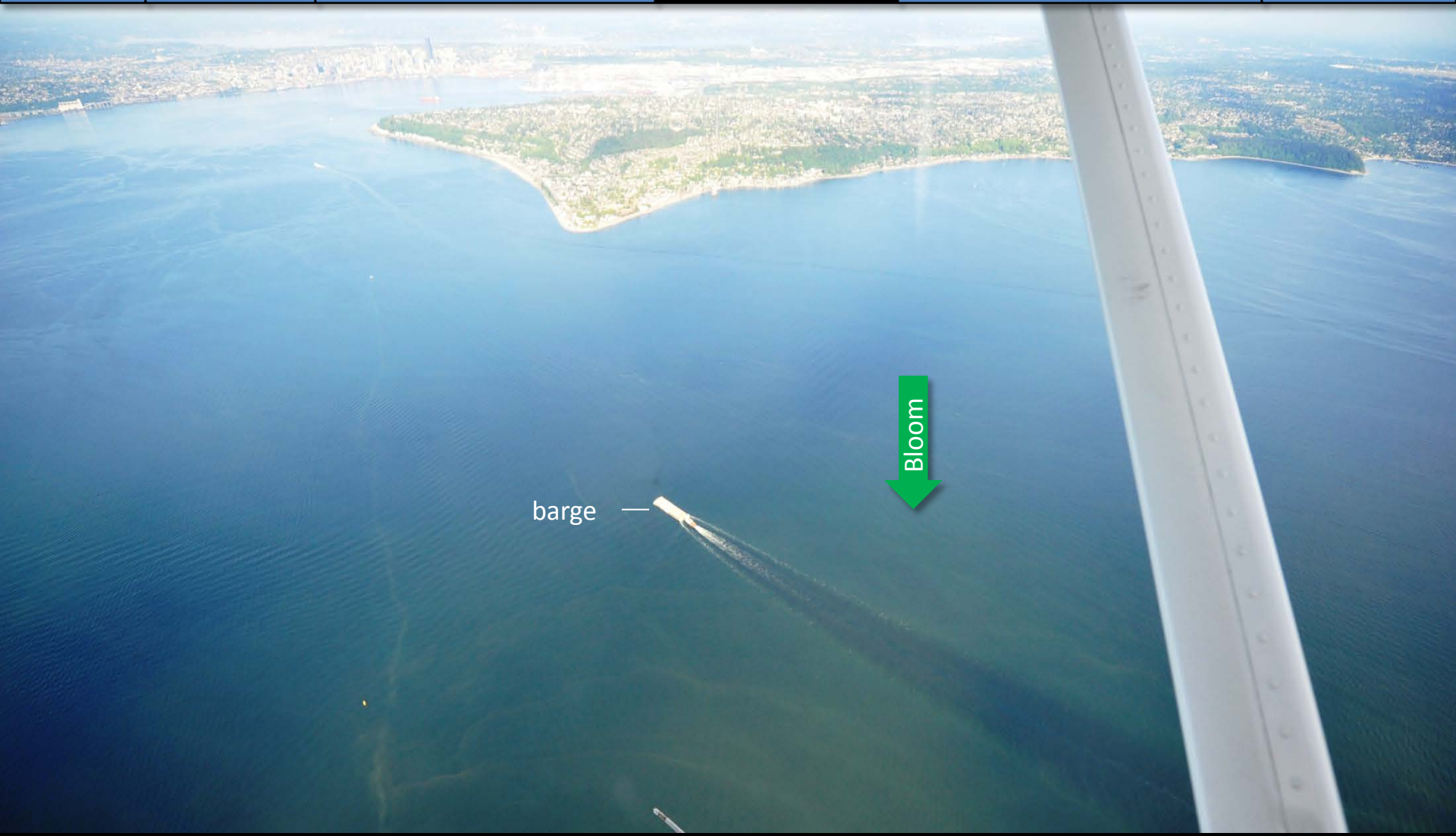
Aerial photography 5-20-2013



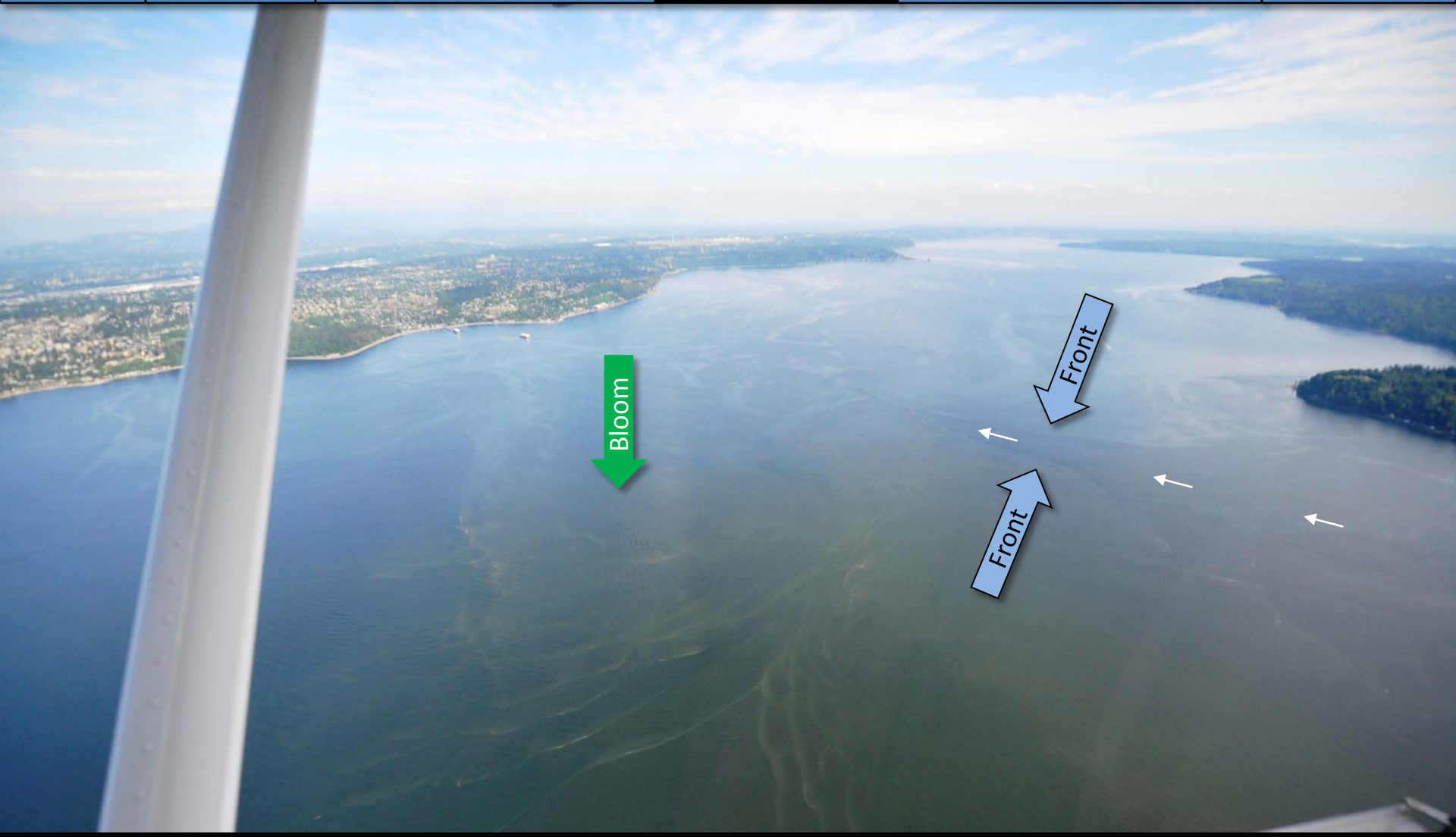
Noctiluca *bloom with West Seattle in background*.
Location: Alki Beach, Seattle, 4:58 PM

Aerial photography 5-20-2013

Noctiluca *bloom with Elliott Bay in background*.
Location: Off Magnolia Bluff, Seattle, 5:19 PM

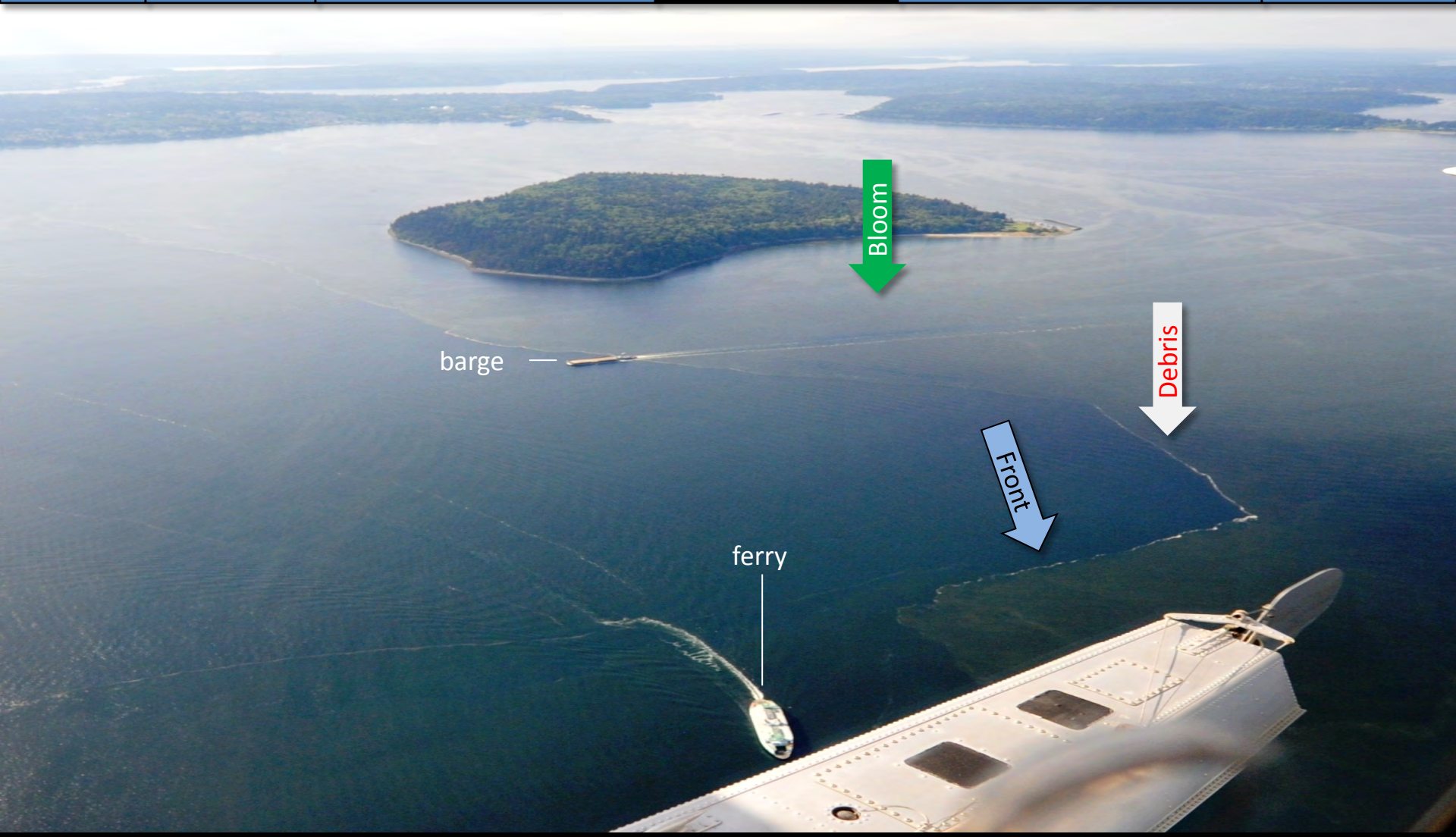


Wake of barge crossing bloom between West Seattle and Blake Island shows bloom is near the surface. Location: Main Basin, 5:22 PM



Red plankton bloom (likely Noctiluca*) covering large parts of Main Basin, with clearer water moving in from west*. Location: Between West Seattle and Vashon Island, 4:55 PM

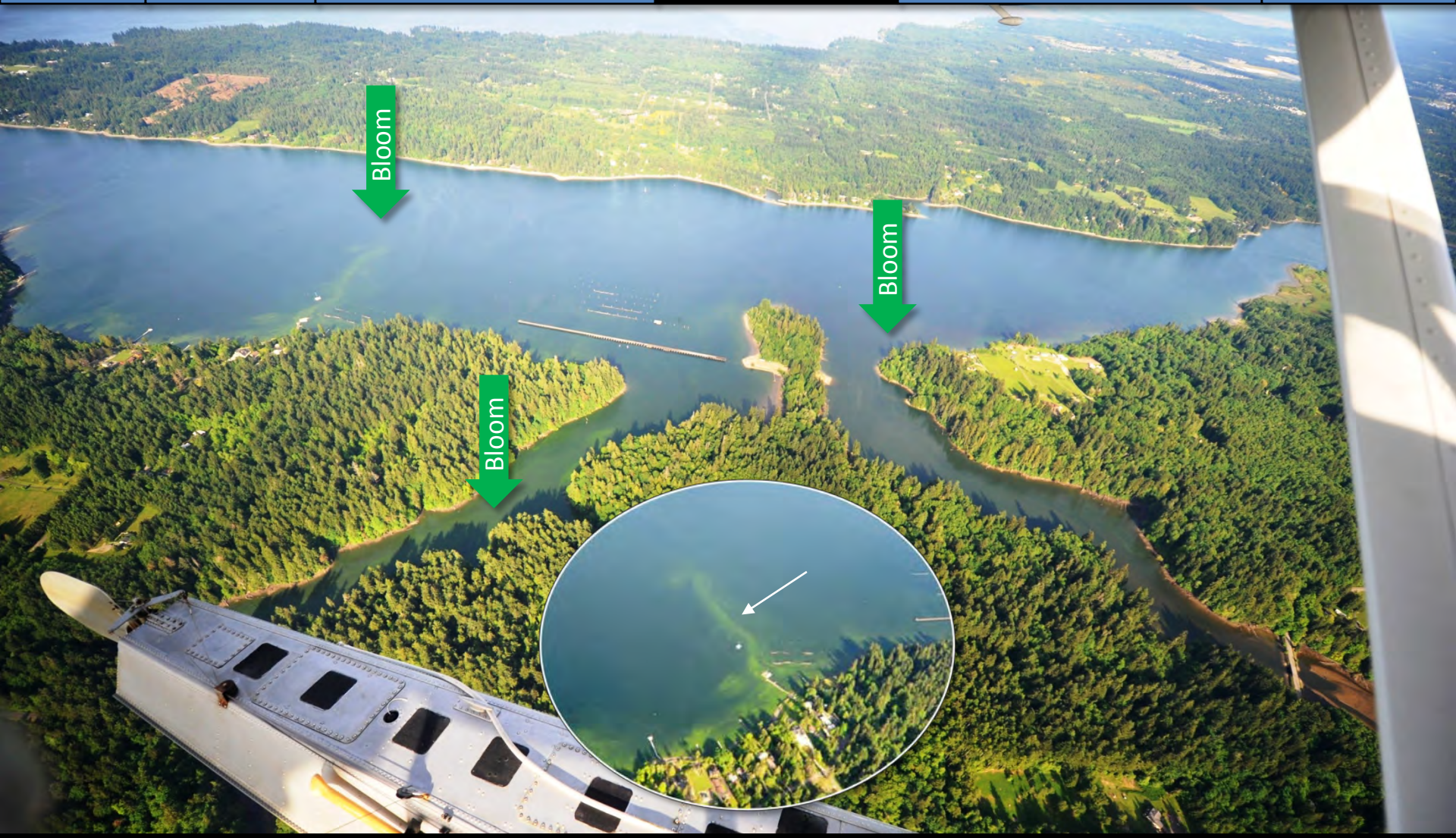
Aerial photography 5-20-2013



Plankton bloom (likely Noctiluca*) separated by sharp front and clear water*.
Location: Blake Island, Main Basin, 5:25 PM

DEPARTMENT OF ECOLOGY State of Washington

Aerial photography 5-20-2013



Green and red plankton bloom. Location: Henderson Inlet, 5:45 PM

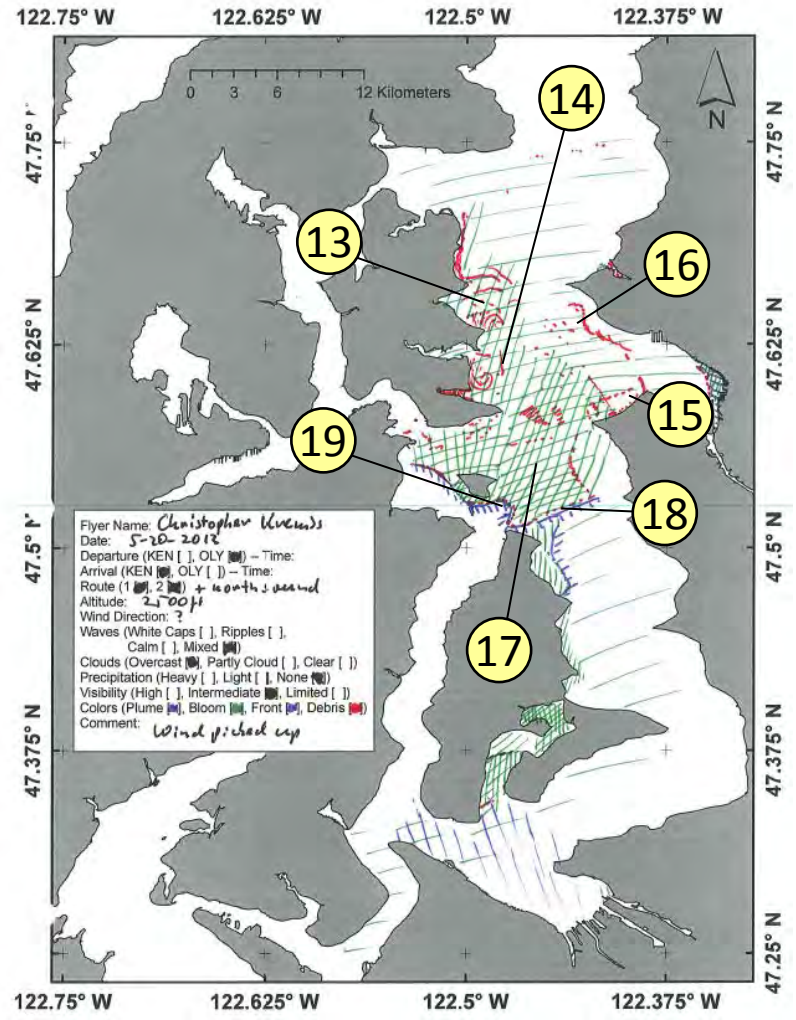
DEPARTMENT OF ECOLOGY State of Washington

Aerial photography observations in Central Sound

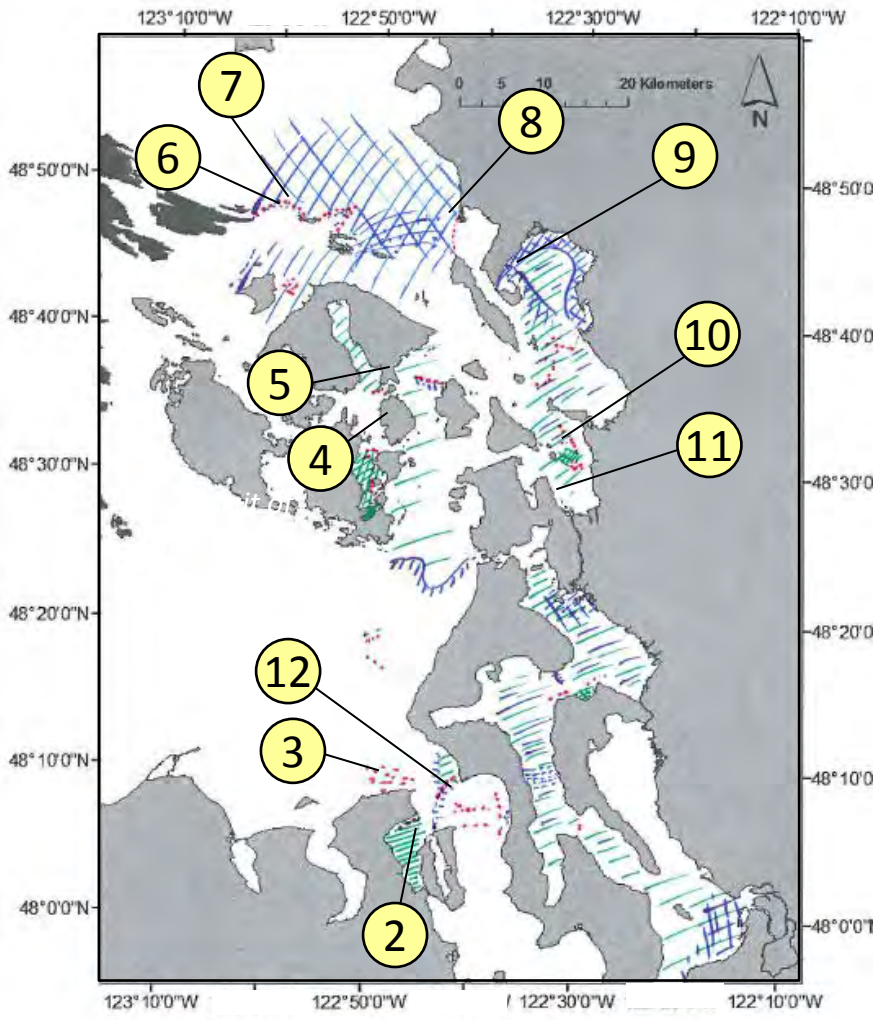
Navigate

Date: 5-20-2013

Central Sound



North Sound/San Juans



Numbers on map refer to picture numbers for spatial reference

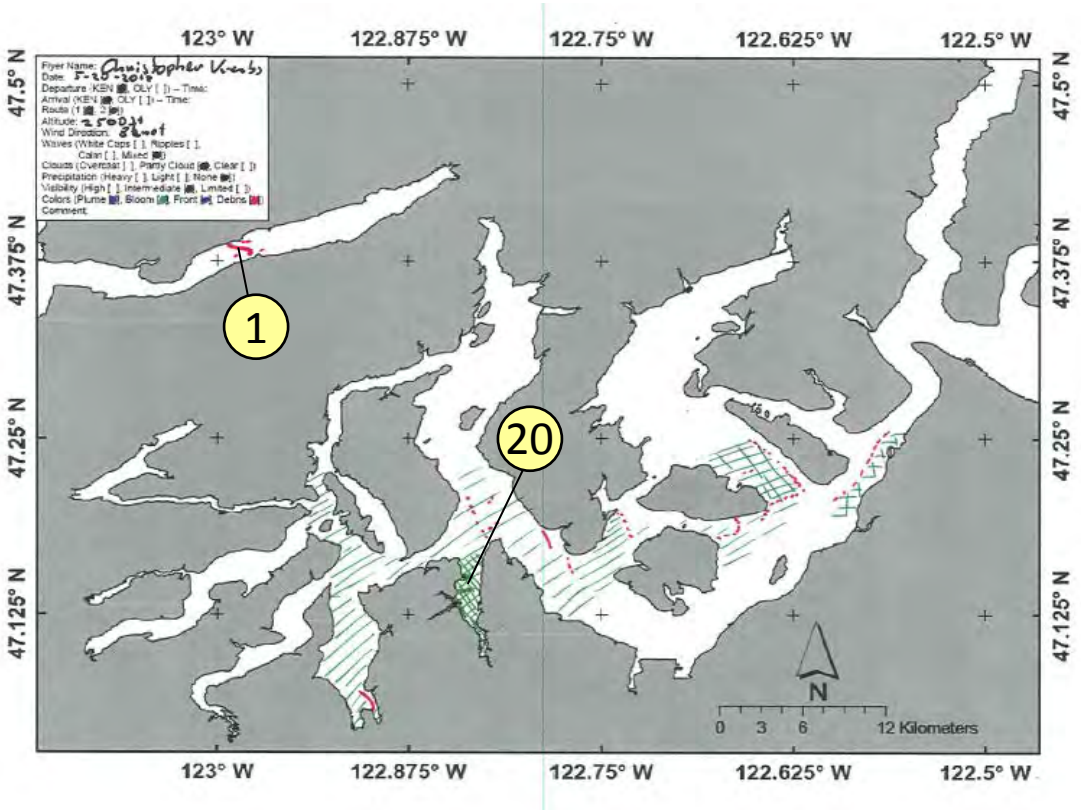
DEPARTMENT OF ECOLOGY
State of Washington

Aerial photography

Observations in South Sound: 5-20-2012

Navigate

South Sound



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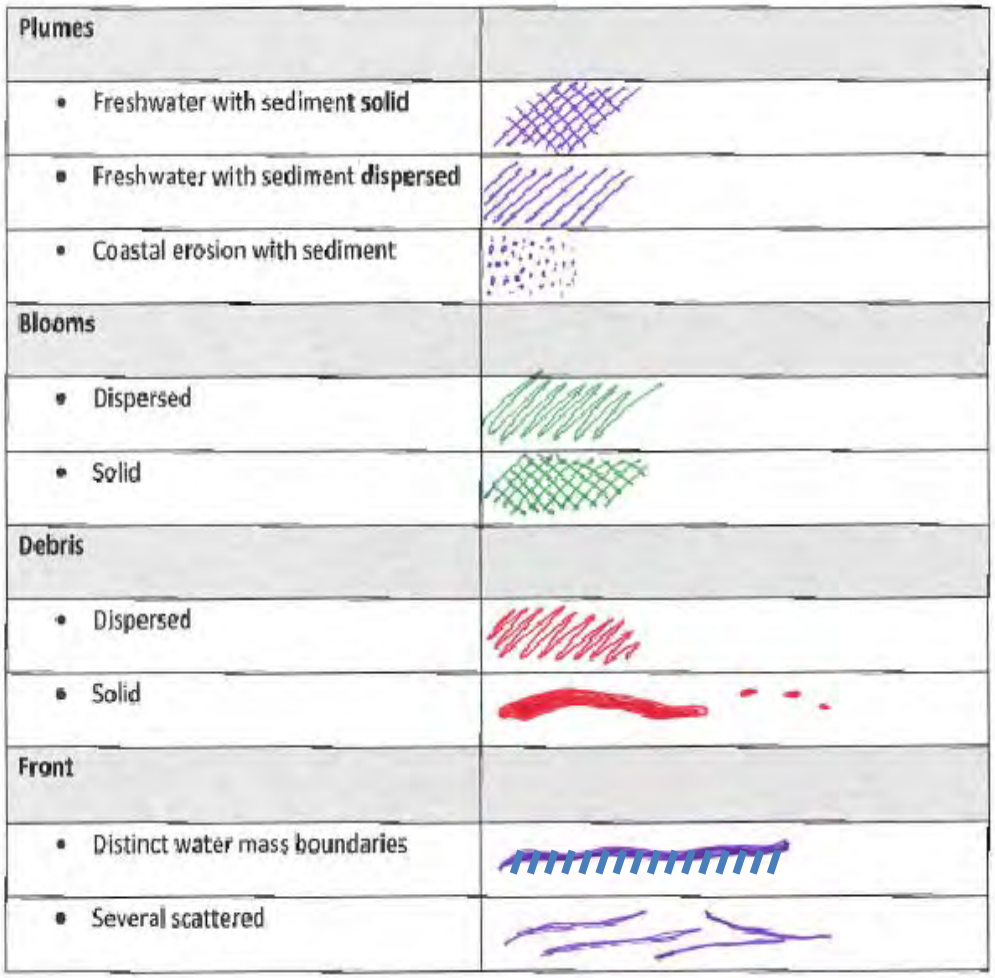
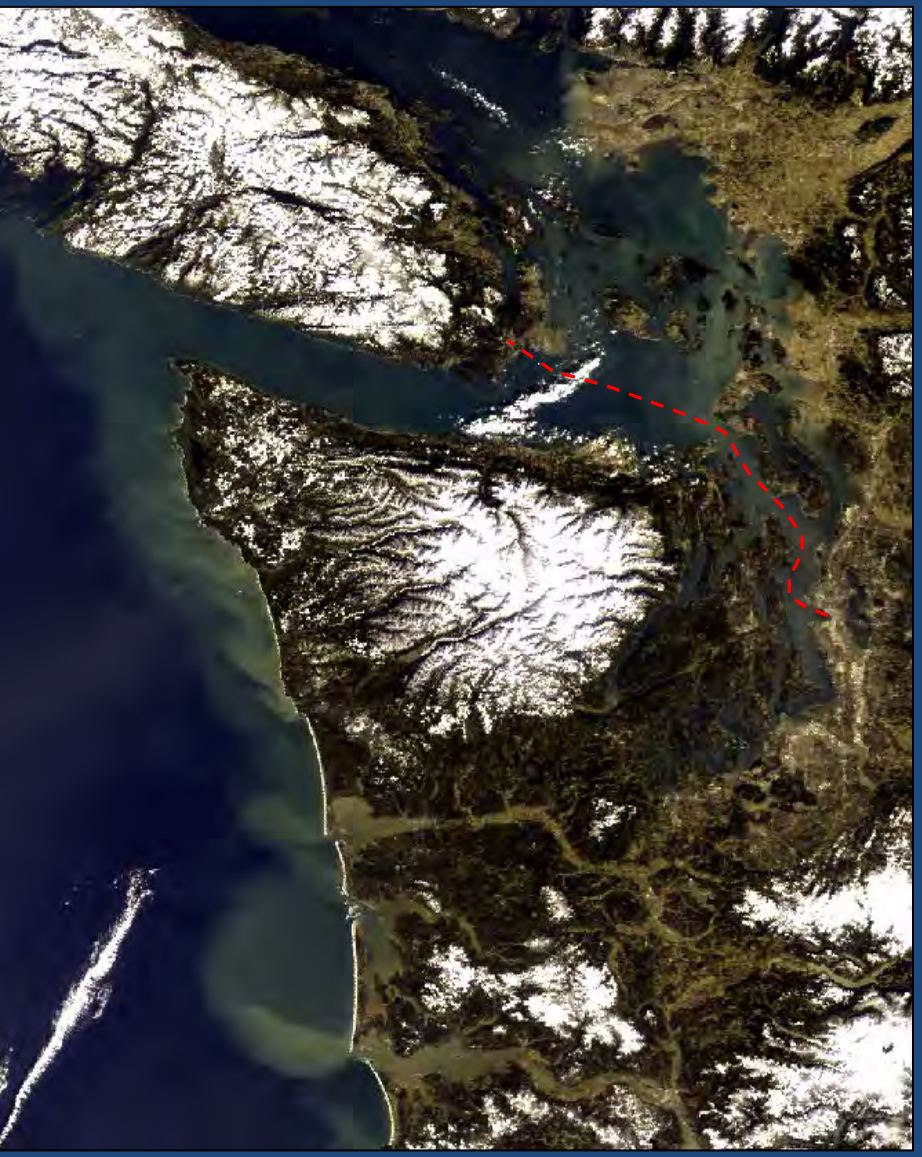


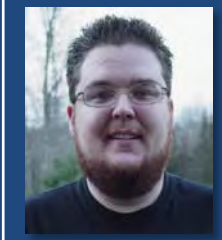
Comments:
Maps are produced by observers during and after flights. They are intended to give an approximate reconstruction of the surface conditions on scales that connect to and overlap with satellite images in the section that follows.

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.

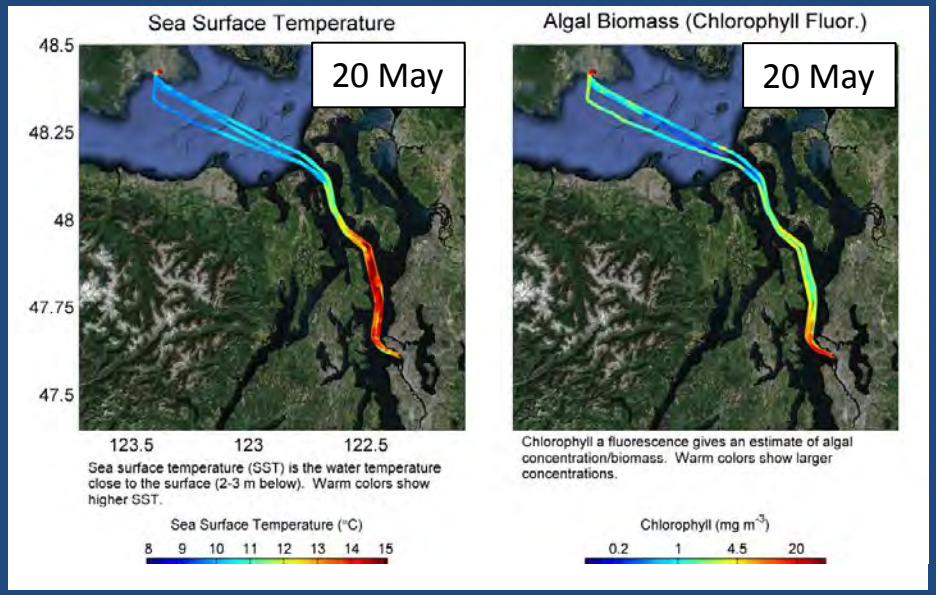
Ferry and satellite observations 5-20-2013





Brandon Sackmann
Contact:
bsackmann@integral-corp.com

Start here



Current Conditions:

Warm, fresh water entering central Puget Sound from Whidbey Basin. Sea surface temperatures > 15 °C. Moderate fluorescence in Elliott Bay, south of fresh water plume.

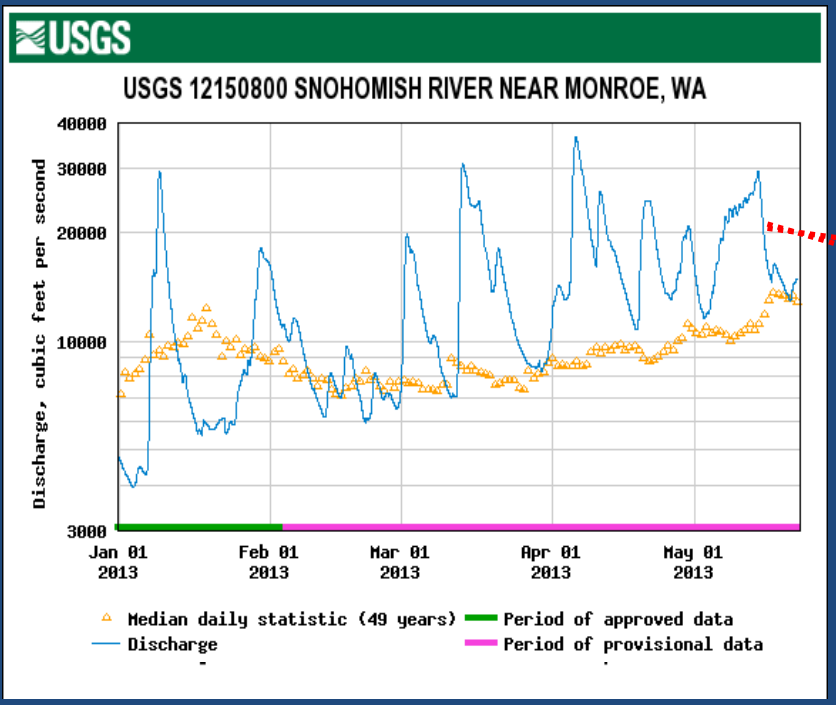
MERIS True Color image used for spatial context (19 February 2011) of the Victoria Clipper en route monitoring route (red dashes on map).

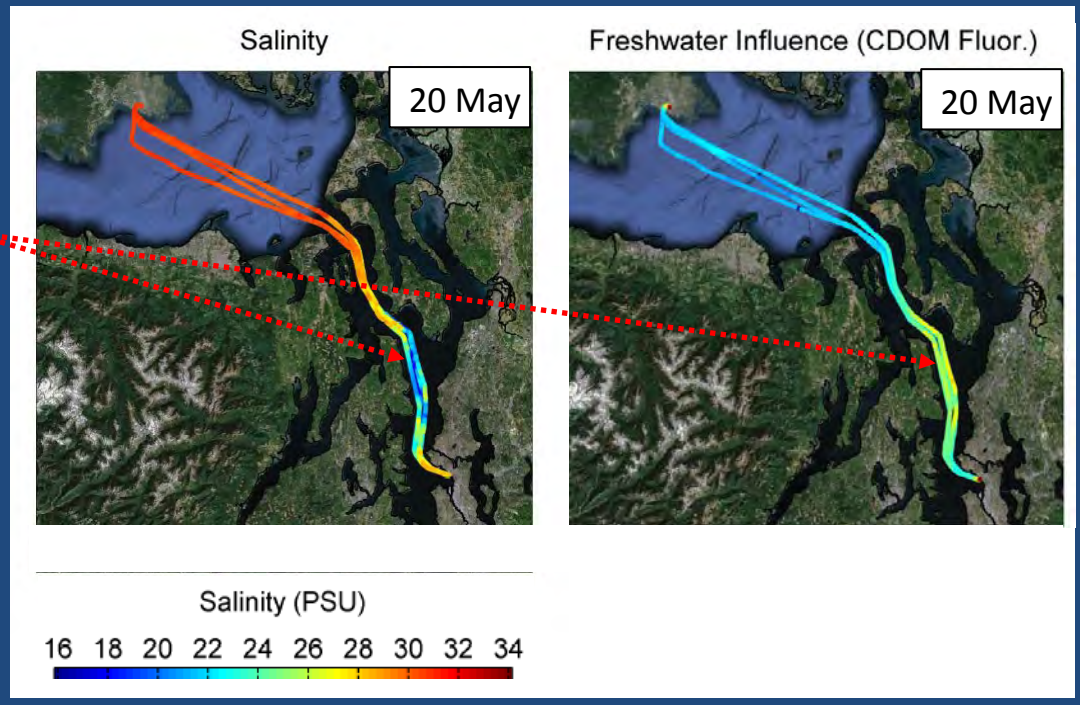
Ferry and satellite observations 5-20-2013

Warm, fresh water from Whidbey basin is associated with elevated concentrations of Colored Dissolved Organic Matter (CDOM); a useful tracer for fresh water in Puget Sound.

The higher than normal river flows experienced earlier in May are still having a noticeable effect on near-surface salinity in central Puget Sound.

- Near-surface salinity near Triple Junction ranges from 18 to 24 PSU!





Mooring observations and trends 5-6-2013 to 5-20-2013

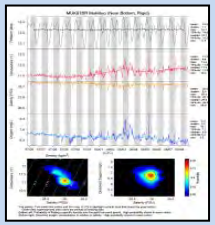
Summary: With the recent warm weather, water temperature is increasing. Dissolved oxygen is falling from expected annual maxima observed earlier in the month. Fresher water continues to have higher levels of DO.

Mukilteo, Whidbey Basin near Everett:

Dissolved Oxygen Conditions (12-16 m)

DO Max	12.2 mg/L	on 05/08	at 11.8 PSU	27.5 °C	10.4 db
DO Min	7.6 mg/L	on 05/20	at 8.1 PSU	29 °C	9.3 db

DO Avg	9.1
DO Trend	-0.9 mg/L
DO-Sal Corr	-0.81
DO-Temp Corr	0.41



Real-time data online (click)

Salinity (Sal) Conditions (12-16 m)

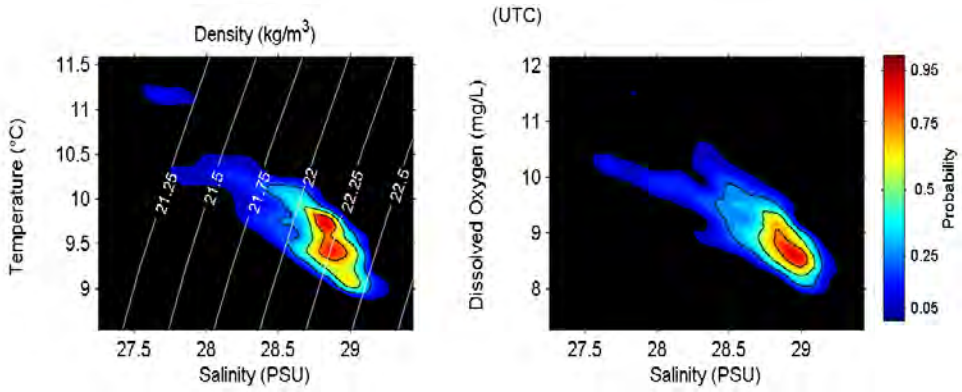
Sal Max	29.1 PSU	on 05/06	at 29.1 °C	8.9 db
Sal Min	26.9 PSU	on 05/13	at 27.4 °C	10.7 db

Sal Avg	28.7 PSU
Sal Trend	-0.1 PSU

Temperature (T) Conditions (12-16 m)

T Max	11.3 °C	on 05/14	at 10.4 PSU	11.3 db
T Min	8.9 °C	on 05/06	at 8.5 PSU	8.9 db

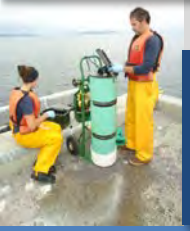
T Avg	9.6 °C
T Trend	0.7 °C



Left Panel: Probability of finding a specific density over the past two-week period. High probability shown in warm colors.

Right Panel: Dissolved oxygen concentration in relation to salinity. High probability shown in warm colors.

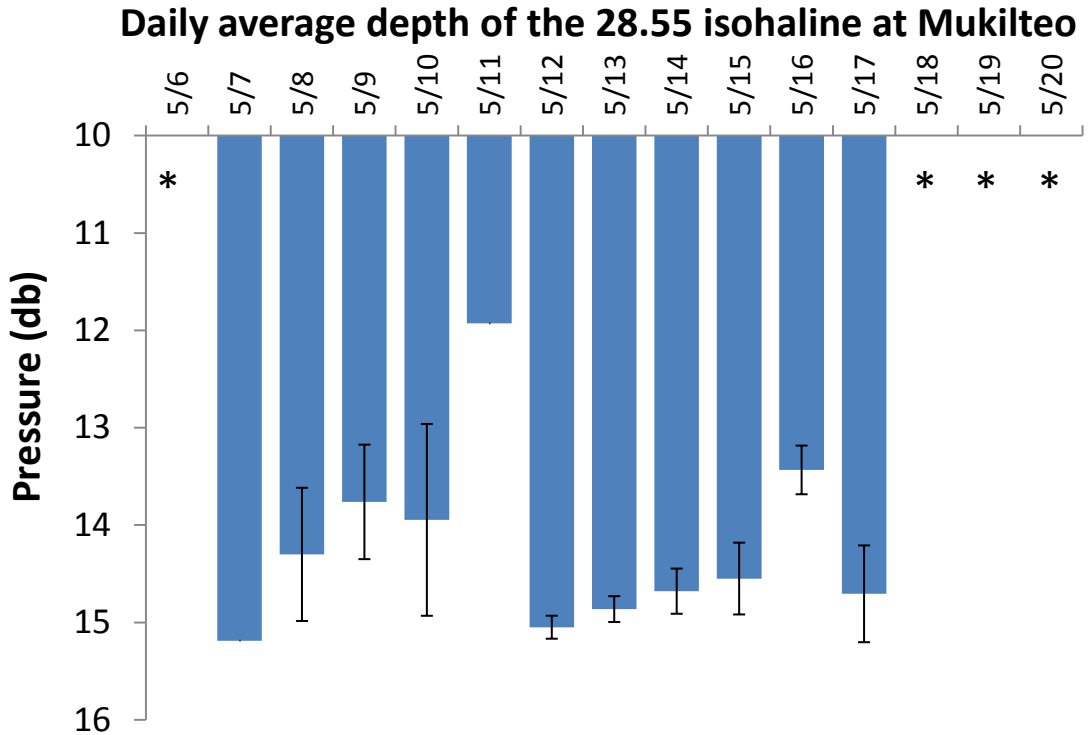
Mooring observations and trends 5-6-2013 to 5-20-2013



Go to our mooring website at: http://www.ecy.wa.gov/programs/eap/mar_wat/moorings.html

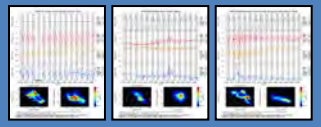
Summary: The depth of freshwater layer varies around 14 – 15 m and is about 1 – 1.5 m deeper than the previous month in response to higher than normal river flows.

We report on thickness of the freshwater layer by monitoring our near-surface sensor. This is another way to interpret the amount of freshwater entering Puget Sound.



** The pycnocline is shallower and outside our monitored depth range.*

We track the depth of the isohaline where salinity is 28.55 (±0.05) to measure the thickness of the freshwater layer at our Mukilteo station. The near-surface sensor experienced tidal pressure variations of 11.0 to 16.0 meters (or decibars).

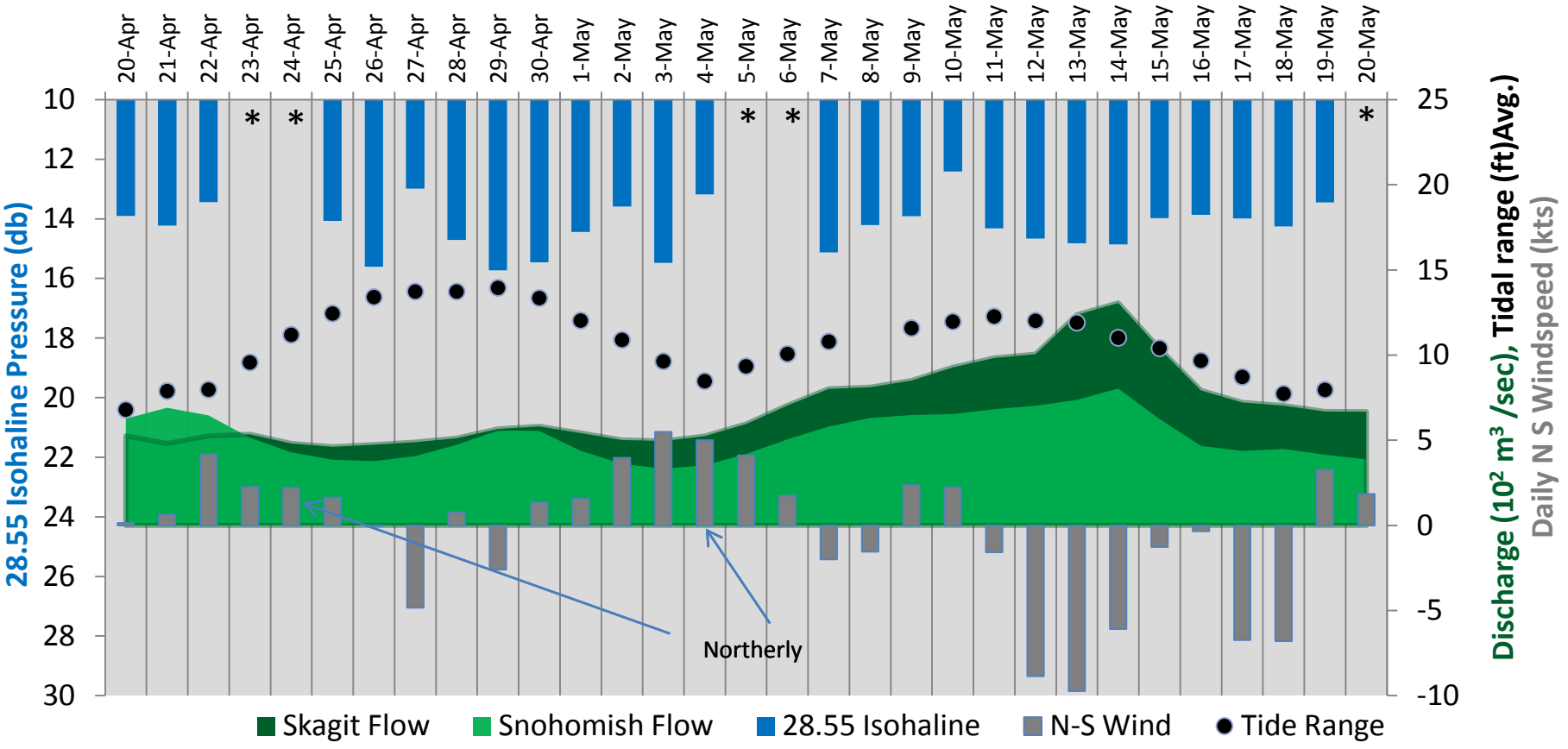


Real-time data online (click)

Mooring observations and trends 4-20-2013 to 5-20-2013

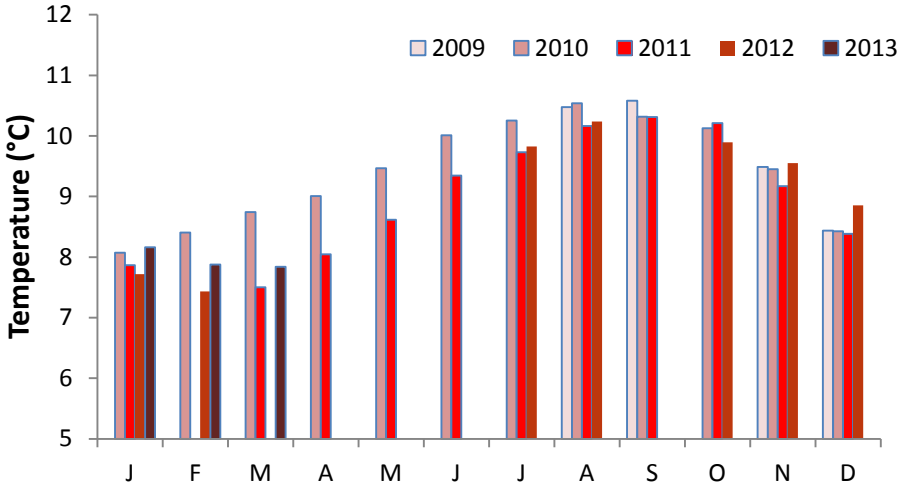
In May at Mukilteo, the thickness of the freshwater layer showed no clear response to river flows or winds. Factors influencing the thickness of the freshwater layer include: mixing with tide changes, wind (speed, duration, and direction), freshwater discharge and the fortnightly tidal cycle (tidal range).
(*) The pycnocline is shallower and outside our monitored depth range.

Thickness of freshwater layer at Mukilteo and influencing factors

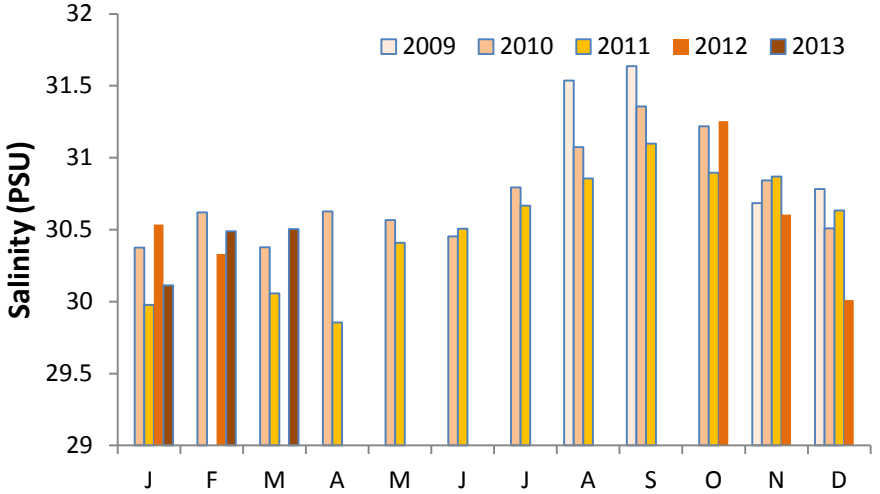


Mooring observations and trends Admiralty Inlet 2009 to 2013

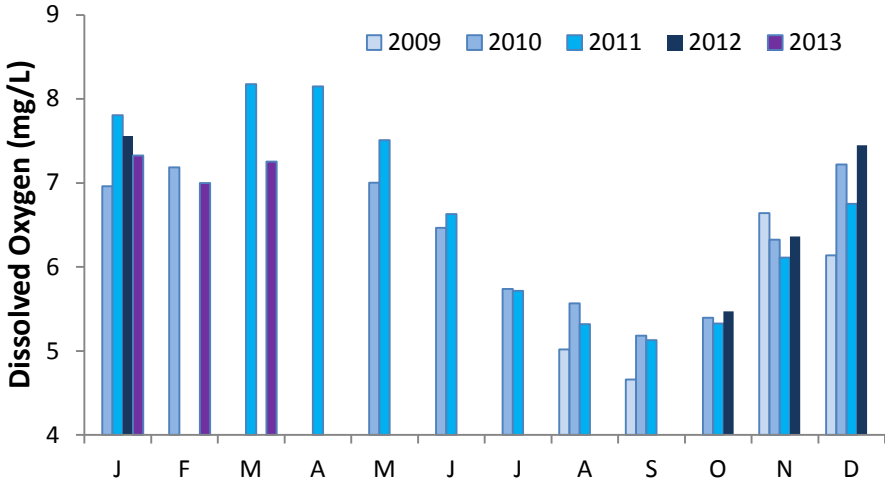
Temperature (Monthly Average)



Salinity (Monthly Average)



Dissolved Oxygen (Monthly Average)



In Admiralty Inlet (52-56 m), we measure significant inter-annual variability in temperature, salinity and dissolved oxygen.

All three variables show strong seasonality, yet are shifted in phase.

Monthly dissolved oxygen is closely tied to monthly salinity. When salinity levels are higher, dissolved oxygen tends to be lower (r^2=0.82, Spearman Rank).

Get data from Ecology's Monitoring Programs

Flight log	Weather	Water column	Aerial photos	Ferry and Satellite	Moorings

Long–Term Monitoring Network

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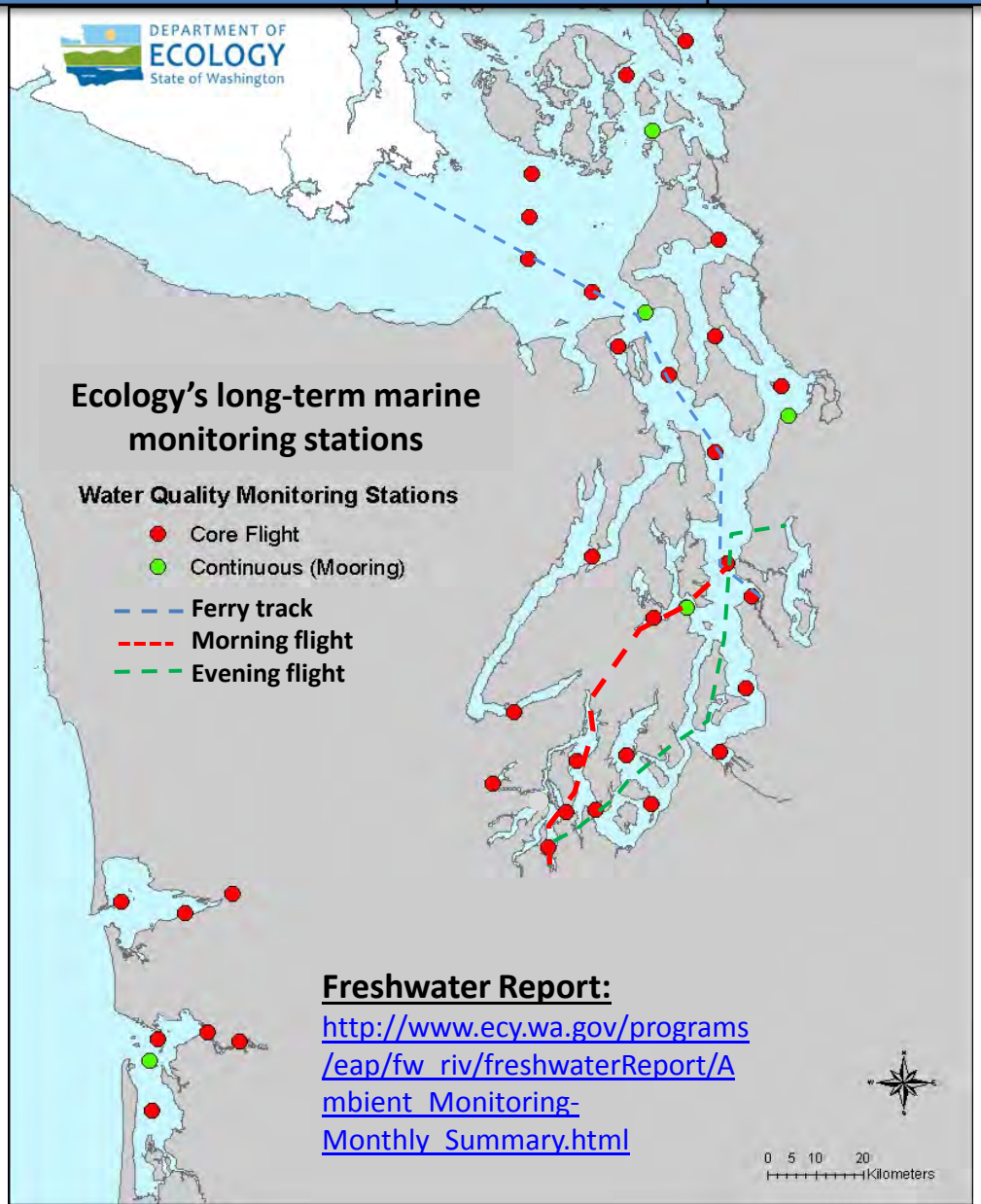
Access core monitoring data:

http://www.ecy.wa.gov/apps/eap/marinewq/mwdataset.asp



Freshwater Report:

http://www.ecy.wa.gov/programs/eap/fw_riv/freshwaterReport/Ambient_Monitoring-Monthly_Summary.html

Real–Time Sensor Network

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Access mooring data:

http://www.ecy.wa.gov/programs/eap/mar_wat/-.html

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.