Publication No. 13-03-070

DEPARTMENT OF ECOLOGY State of Washington

Eyes Over Puget Sound

Guest Contribution:
Brandon Sackmann

Surface Conditions Report

January 15, 2013

We have a new 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 1-15-2013 at a glance

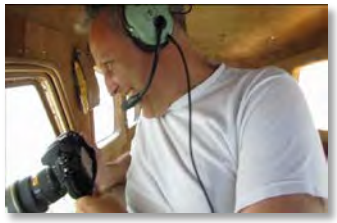
LONG-TERM MARINE MONITORING UNIT

Mya Keyzers
Laura Friedenberg

Skip Albertson

Julia Bos
Suzan Pool
David Mora

Dr. Christopher Krembs



Guest: Dr. Brandon Sackmann

Previous Eyes Over Puget Sound reports:

Personal flight log p. 4

Has herring spawning begun?

Weather conditions p. 5

The weather has been cool with some sun and light winds. River flows have fallen below normal.

Water column and mooring p. 6 , p.31

A pattern of colder and fresher Puget Sound water persists since 2011. Oxygen levels at mooring locations are currently increasing as part of the seasonal cycle.

Aerial photography p. 7-26

Jellyfish aggregations continue to go strong in Budd inlet. Debris lines numerous and long. Multiple oil sheens in Seattle waterways.

Ferry and satellite p. 27-30

In 2012 warm temperatures in Central Puget Sound occurred a few weeks earlier than 2011 and stimulated an earlier but weak spring bloom. CDOM continues to provide an important tracer for freshwater entering Puget Sound from Whidbey Basin.

www.ecy.wa.gov/programs/eap/mar_wat/eops/

Why Eyes Over Puget Sound?

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

Algae bloom Budd Inlet 2010

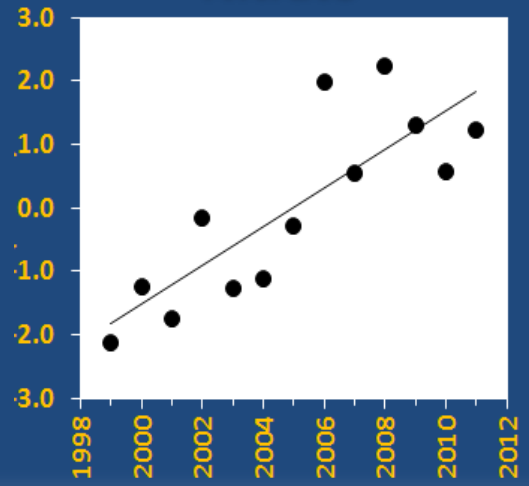
Nitrate

Phosphate

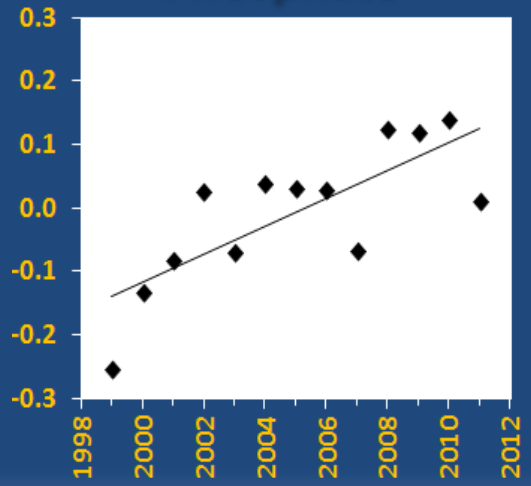
Changing Nutrient Balance

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

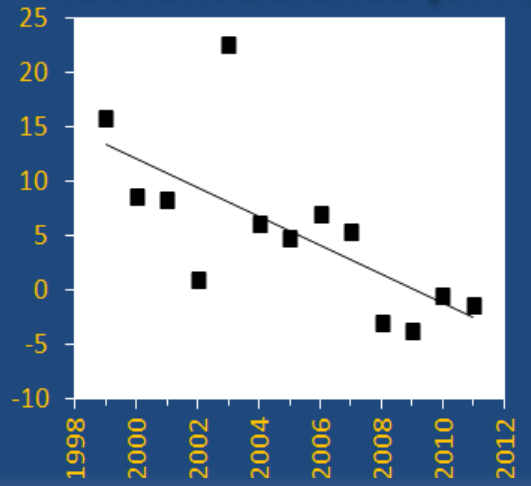
Nitrate



Phosphate



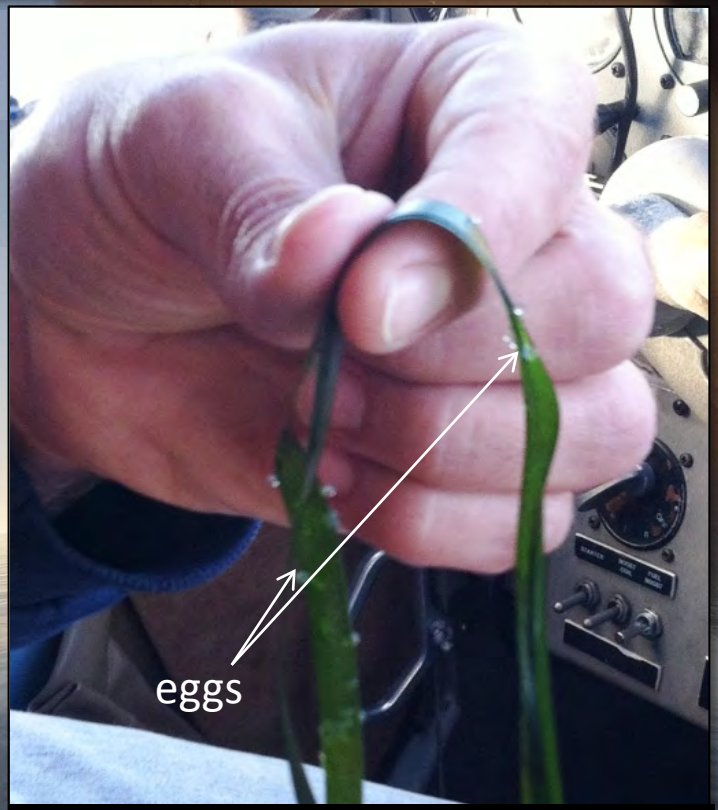
Nutrient Balance (Si:N)



Personal flight log 1-15-2013

North Sound Flight

Have herring started spawning?



Foamy tide line containing debris and eelgrass

Herring eggs on eelgrass

Our team recently learned what herring spawning habitats look like from the air, so we have been keeping an eye out for them. Herring start spawning in Puget Sound around this time in the winter and into the spring. While we didn't see any near shore spawning areas from the air, we were lucky to get up close with some eggs that could be from herring. At our Possession Sound station we were sampling in a very foamy tide line that had debris and eelgrass in it. When we pulled up the CTD, some eelgrass was caught on the frame and there were small, transparent eggs on it. These eggs are so small they can fit on the tip of a ballpoint pen. We were excited to see that herring could already be spawning in this area.

Weather patterns from 1-1-2013 to 1-15-2013

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

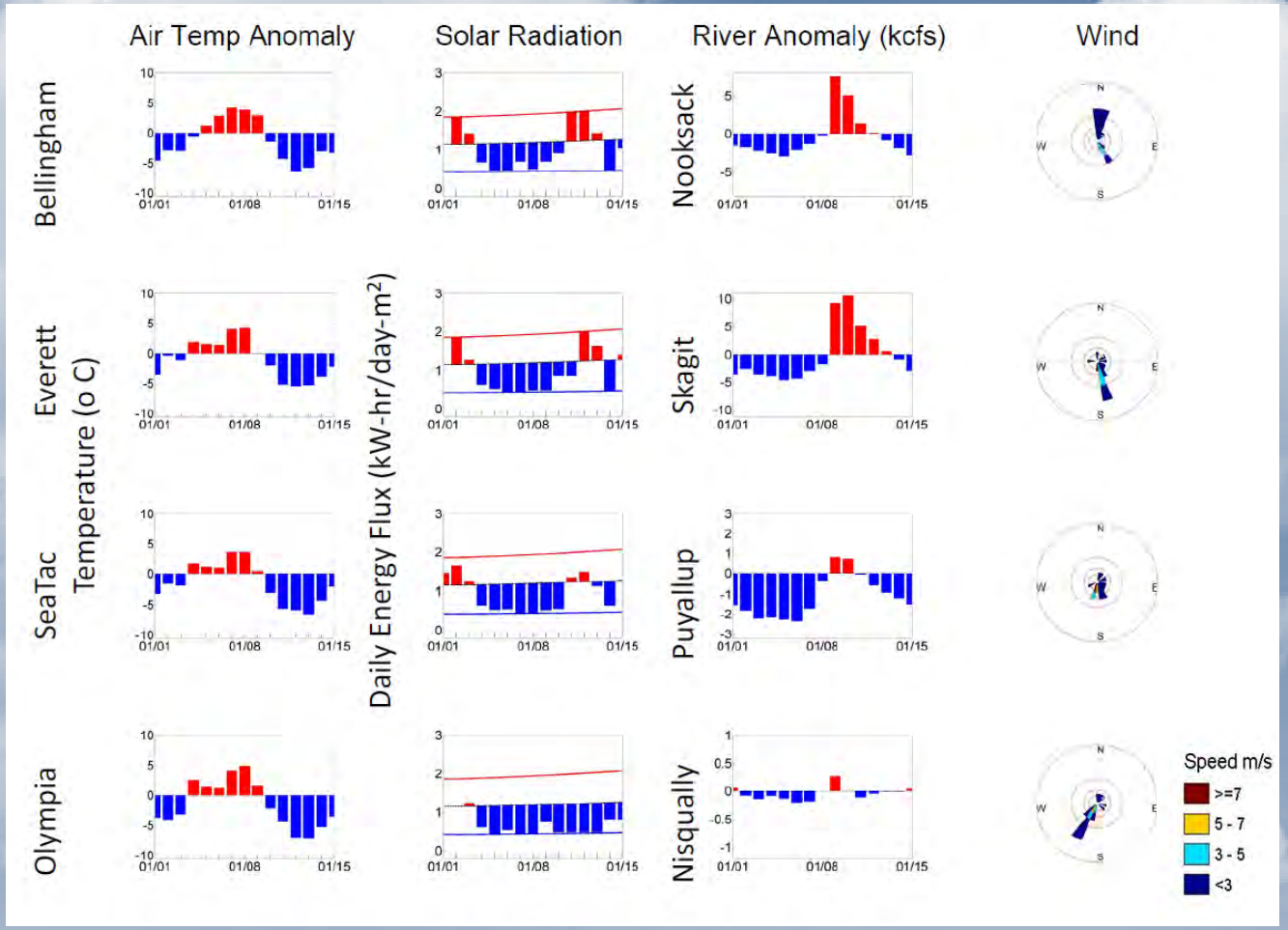
Summary:

Air temperatures have been below normal for the past five days.

Sunshine has been slightly above normal the past few days except for the day before the flight (Jan. 14) and along the coast.

Rivers had been running above normal early this month, but have dropped since air temperature fell last week.

Winds have been light and variable.



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

2011-2012 Temperature, salinity are down and oxygen is up

Colder water

Fresher water

More oxygen

Each horizontal line is a station in Puget Sound. Each color dot is 1 out of 12 sampling event per year

- = 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

Summary: Aerial photography 1-15-2013

Jellyfish aggregations continue to go strong in Budd inlet. Debris lines numerous and long. Multiple oil sheens in Seattle waterways.

Start here

Cloud banks over Dana Passage

Multiple oil sheens in Seattle's Salmon Bay

Front

Mixing and Fronts:
Large fronts in Central Basin, Budd Inlets, Pickering Passage and Case Inlet. 9 10 11

Jellyfish: 5 6 7
Abundant in Budd and Eld Inlets.

Plume

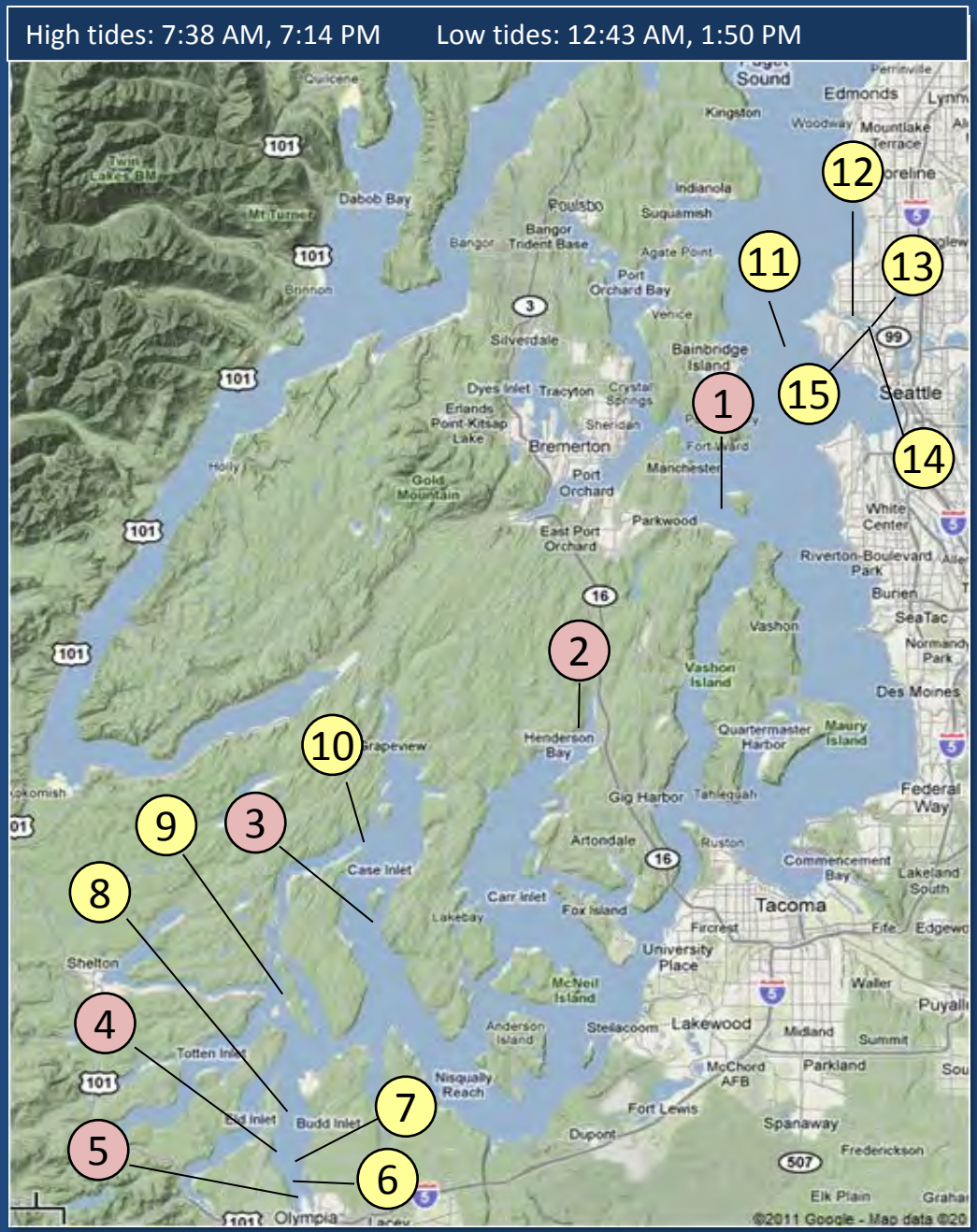
Suspended sediment: 13 14
In waterway due to vessel activity.

Bloom

Visible blooms:
No apparent blooms.

Debris

Debris: 1 2 3 4 6 7 8 9 10 11
Long debris lines in many locations often associated with fronts or river plumes.



Aerial photography navigation guide, **1-15-2013**

Click on numbers

Flight Information:

Morning flight:
Good visibility, cloud banks, calm

Evening flight:
Good visibility, cloud banks, calm low sun angle

Observation Maps:

Central Sound

South Sound

Surface debris. Location: Southworth/Yukon Harbor (Central Sound), 10:27 AM

Debris line and fish pens in Burley-Minter Lagoon. Location: Carr Inlet, 10:34 AM

Aerial photography 1-15-2013

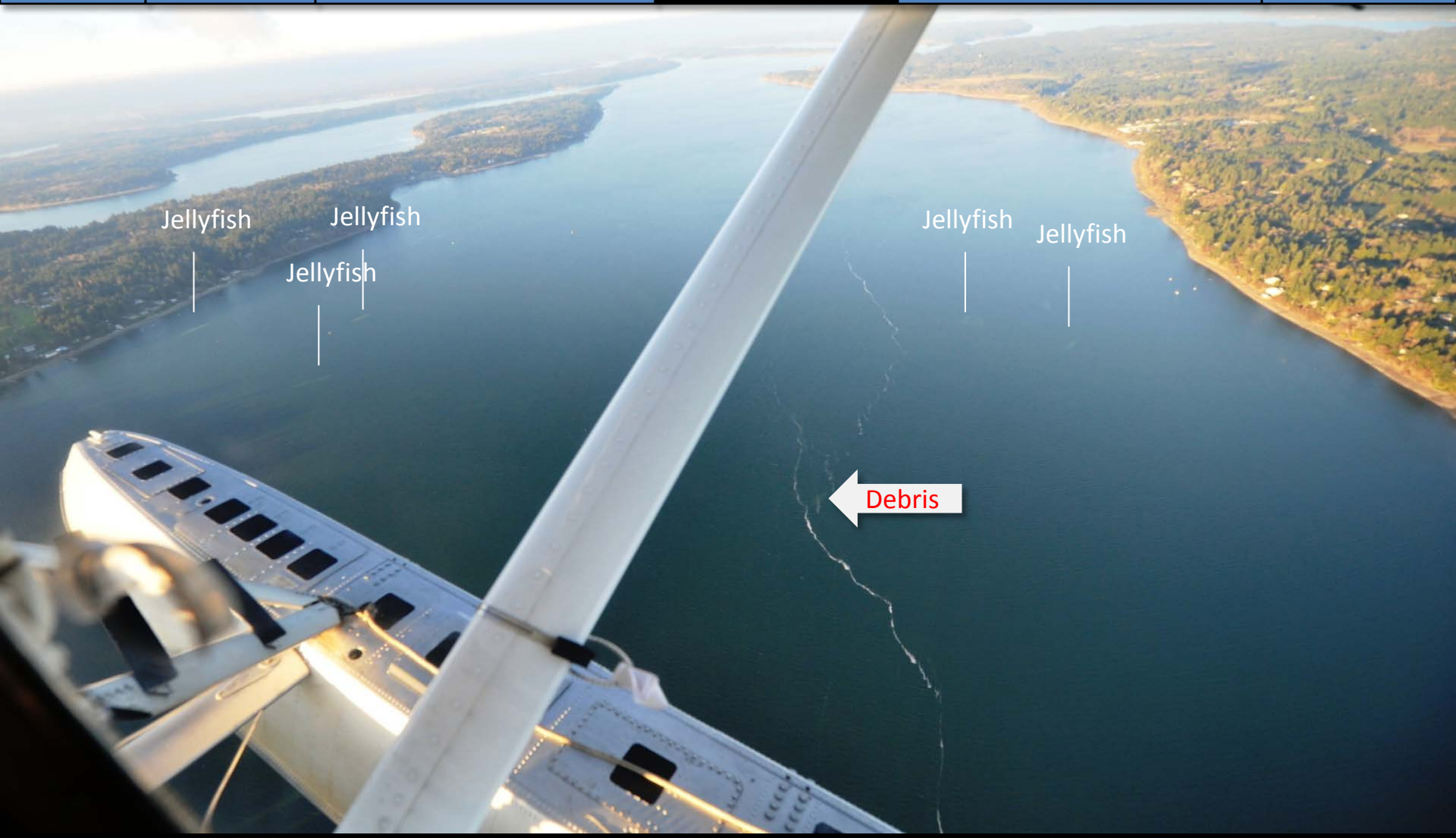
One of multiple debris lines east of Herron Island. Location: Case Inlet, 10:40 AM

Aerial photography 1-15-2013

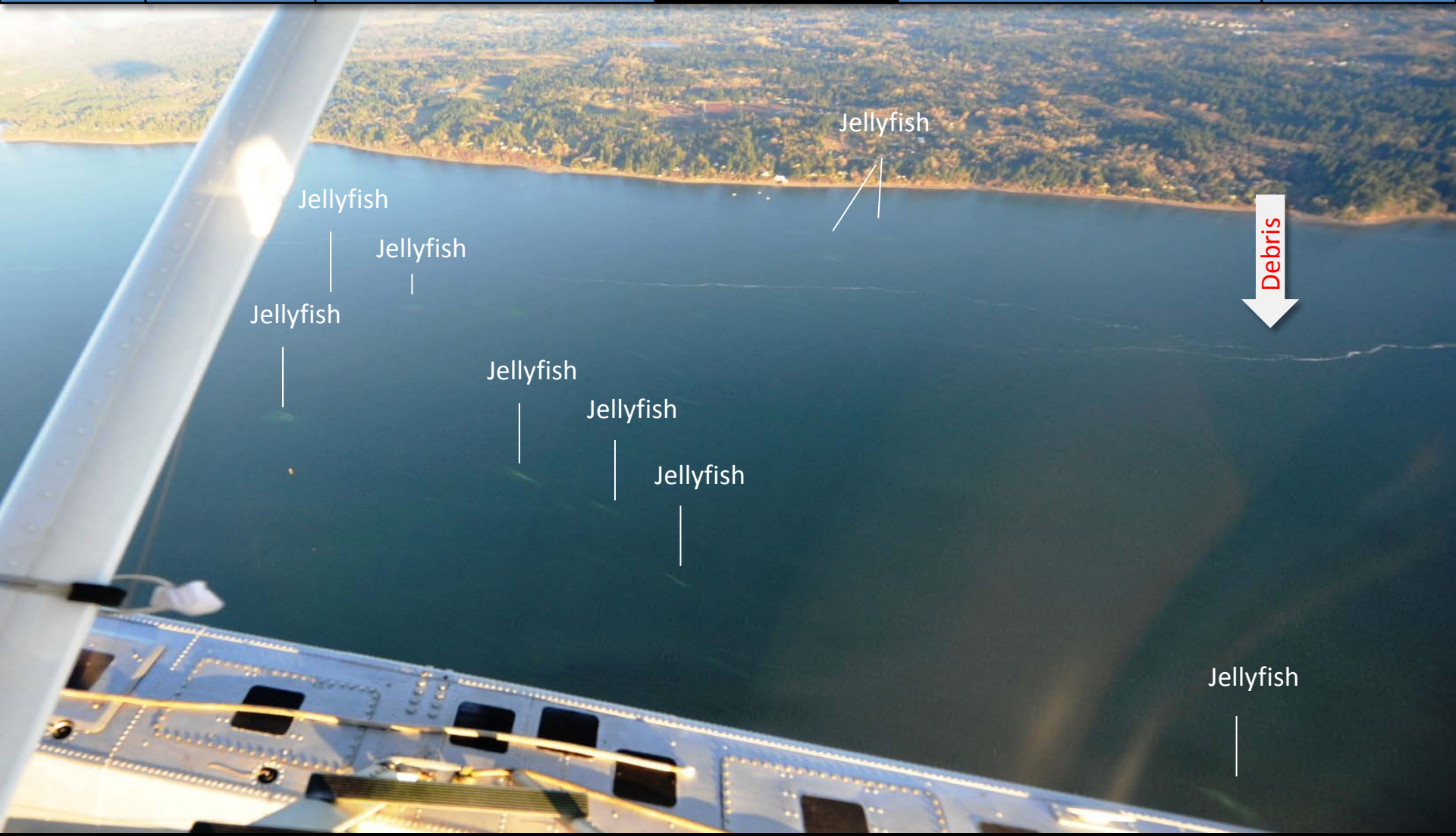
Surface slick during landing approach. Location: Budd Inlet (South Sound), 10:47 AM

Sizable and numerous jellyfish (approx. 10 cm diameter). Location: Swantown Marina (Budd Inlet), 10:55 AM

Aerial photography 1-15-2013



Jellyfish aggregations and long debris line. Location: Budd Inlet (South Sound), 4:00 PM



Jelly fish patches and debris line. Location: Budd Inlet (South Sound), 4:01 PM

Very long debris line extending across Budd Inlet.

Location: Gull Harbor, Budd Inlet, (South Sound), 4:02 PM

Aerial photography 1-15-2013

Dynamic environment and two tidal eddies and front .

Location: Squaxin Island/Hope Island (South Sound), 4:05 PM

Front and debris line as water from Pickering Passage connects to Case Inlet.

Location: Northern tip of Harstine Island (South Sound), 4:11 PM

Long debris line separating surface waters running north-south in Central Sound .

Location: West of Elliott Bay/Alki Point (Central Sound), 4:28 PM

DEPARTMENT OF ECOLOGY State of Washington

Aerial photography 1-15-2013

Oil sheen, extending deep into waterways. Location: Salmon Bay (Seattle), 4:32 PM

Aerial photography 1-15-2013

Suspended bottom sediment resulting from vessel activities.

Location: Salmon Bay (Seattle), 4:33 PM

Oil sheen between vessels. Location: Salmon Bay (Seattle), 4:33 PM

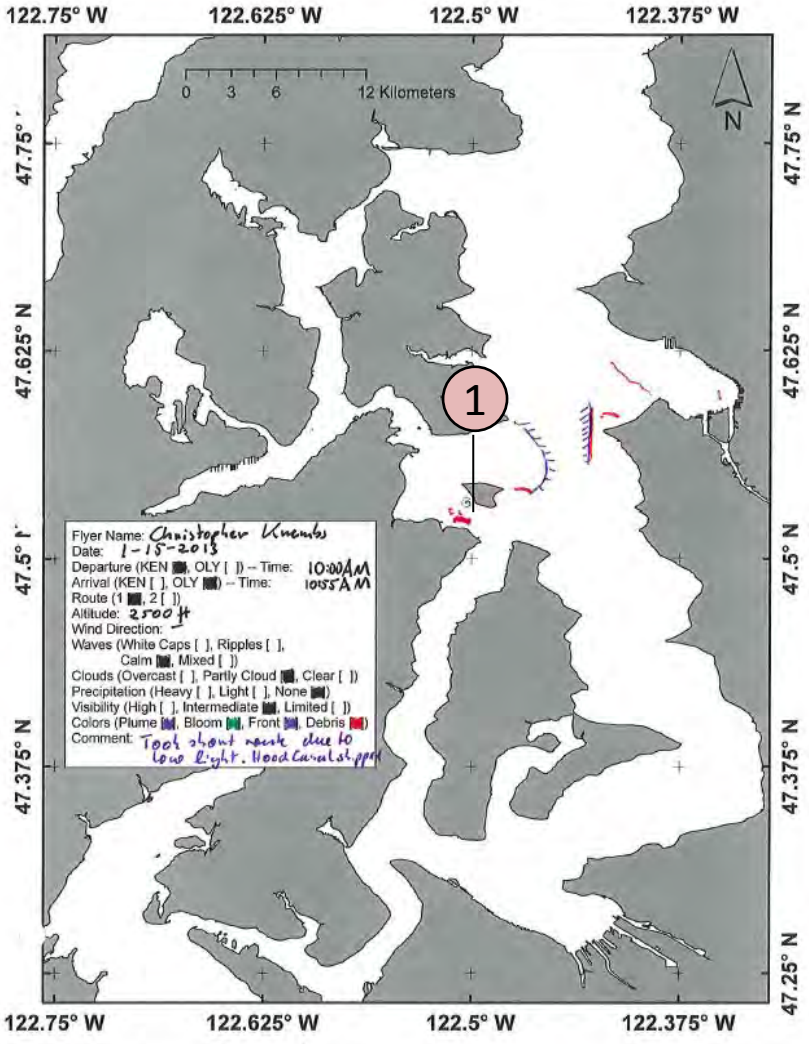
Oil sheens between vessels. Location: Salmon Bay (Seattle), 4:33 PM

Aerial photography observations in Central Sound

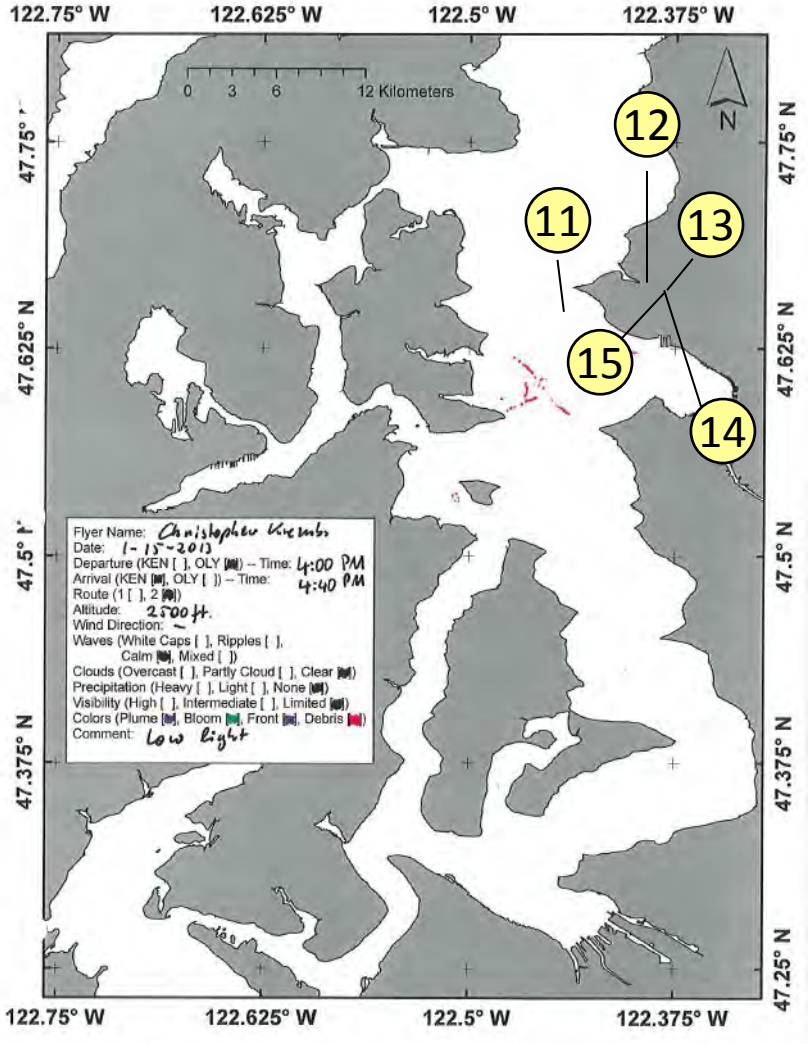
Navigate

Date: 1-15-2013

Morning



Evening



Numbers on map refer to picture numbers for spatial reference

Navigate

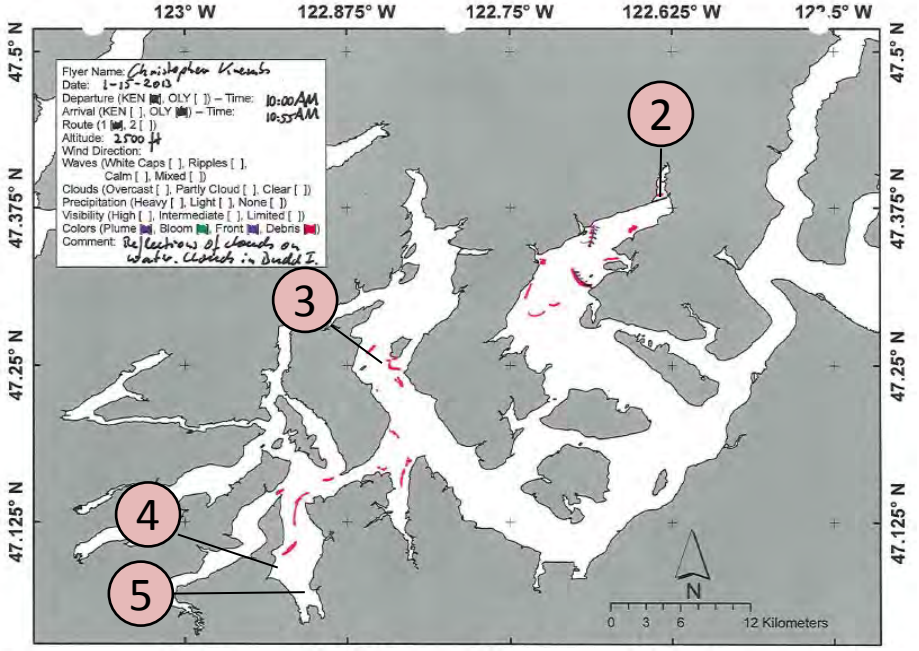
Aerial photography

Observations in South Sound: 1-15-2013

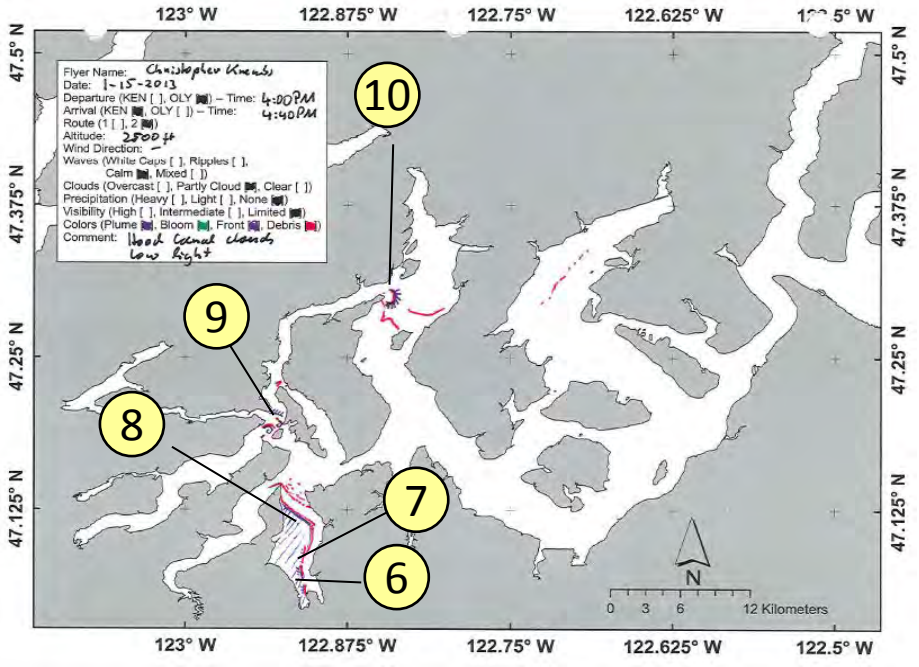
DEPARTMENT OF ECOLOGY State of Washington

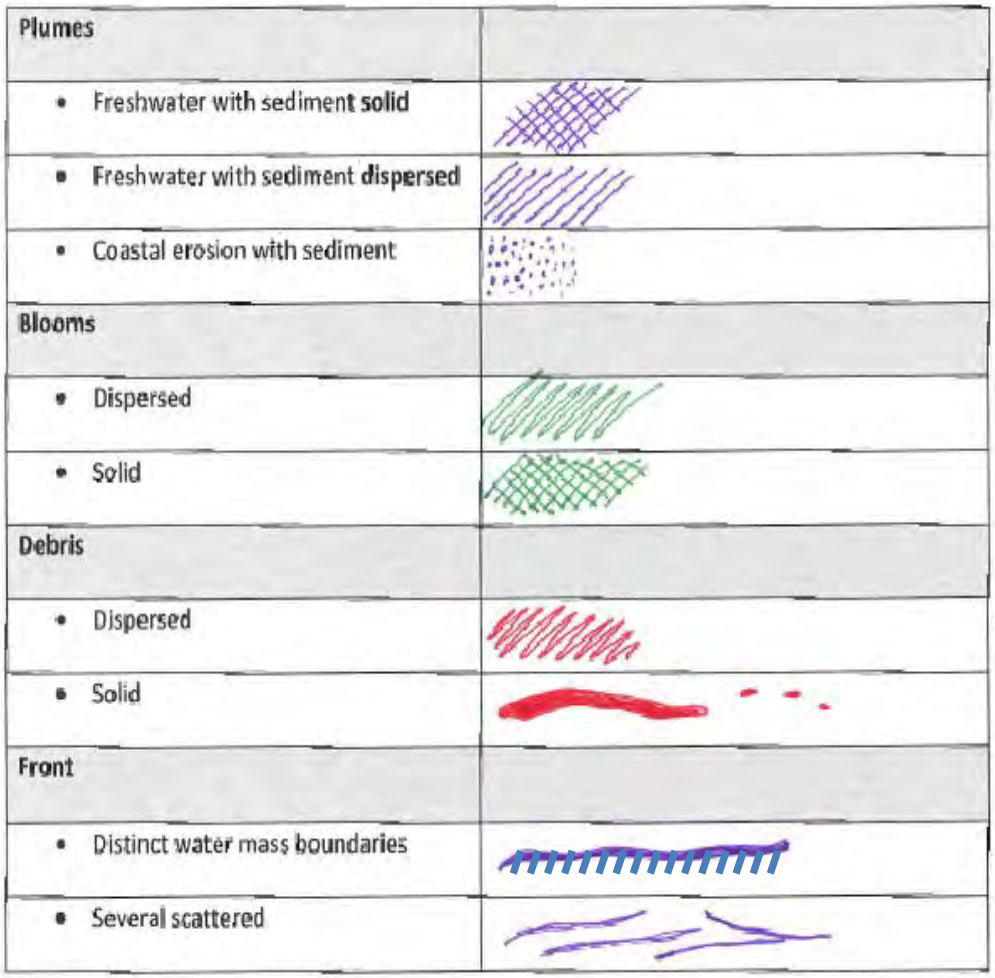
Numbers on map refer to picture numbers for spatial reference

Morning



Evening



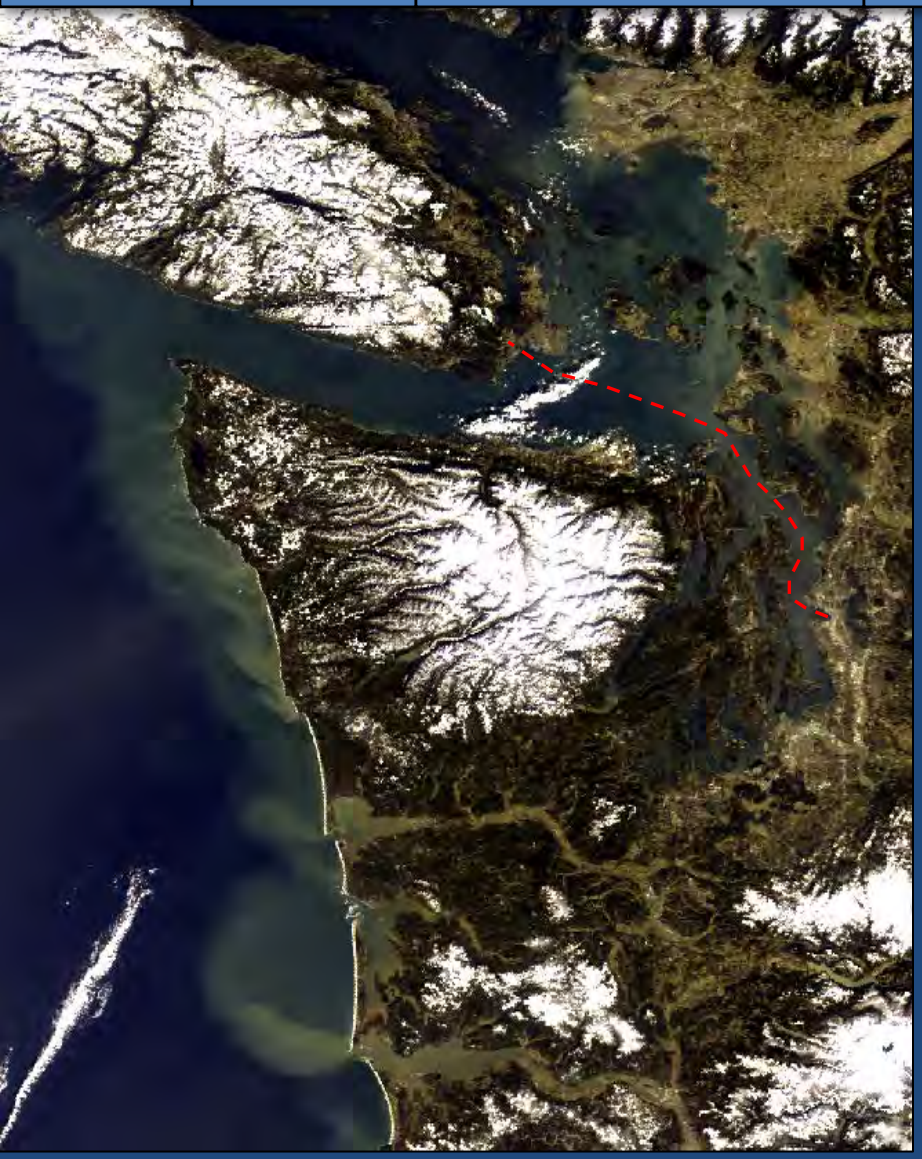


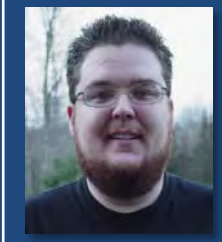
Comments:
Maps are produced by observers during and after flights. They are intended to give an approximate reconstruction of the surface conditions on scales that connect to and overlap with satellite images in the section that follows.

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 can't 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: 2012 in review





Brandon Sackmann
Contact: bsackmann@integral-corp.com

January 2013:

Clipper undergoing maintenance. Service to resume next week.

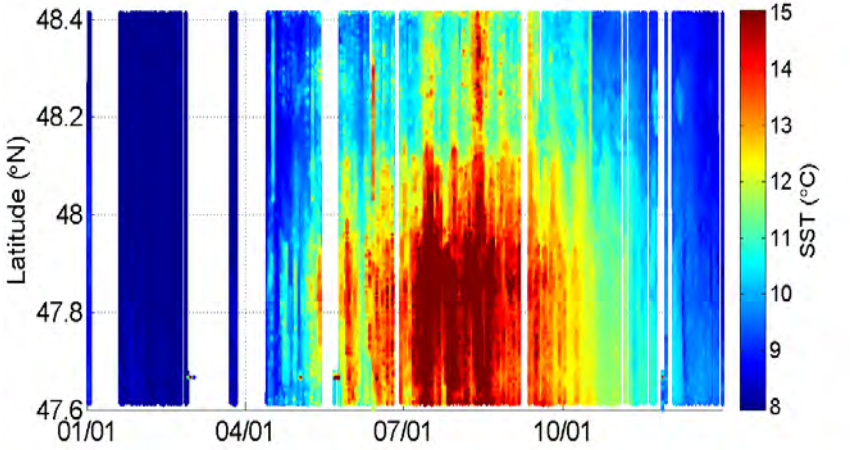
2012 in Review:

A new thermosalinograph added temperature and salinity measurements to the suite of optical parameters already being measured by the Victoria Clipper. Dual temperature sensors provide redundancy and data from 2012 suggest that the new sensor is performing well!

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

Ferry and satellite observations: 2012 in review

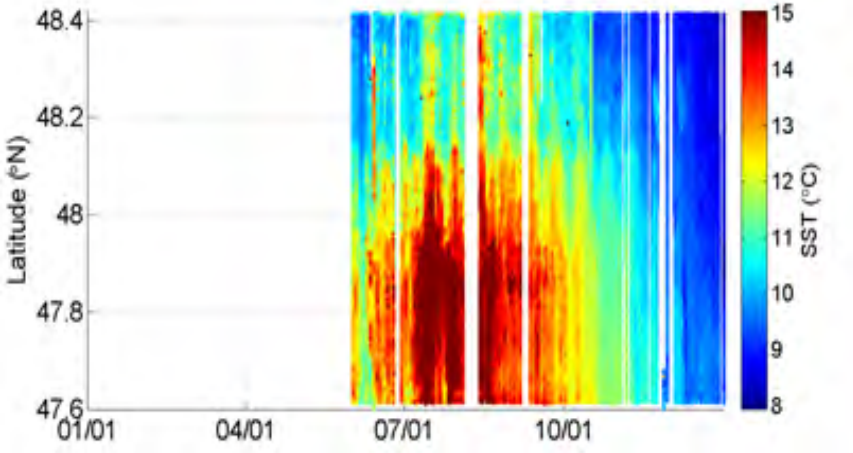
Turner Designs, C3 Thermistor

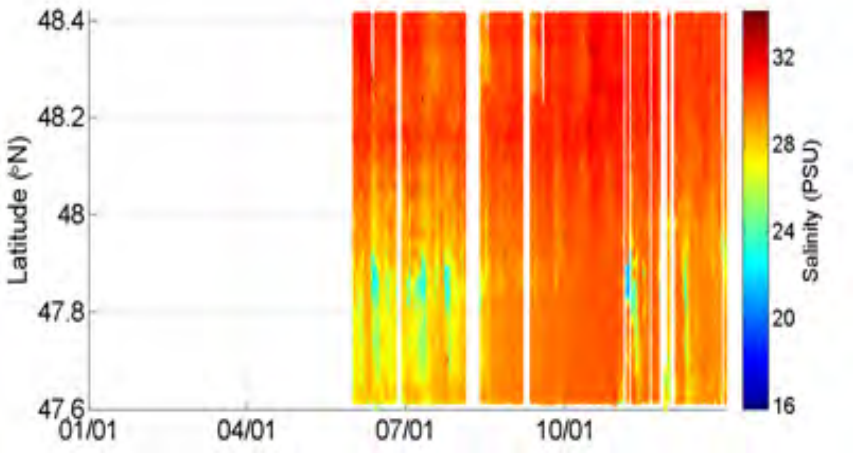


Temperature from Turner Designs, C3 vs. Temperature from new Citadel thermosalinograph showing overall good agreement

Thermosalinograph adds salinity measurements to the suite of optical parameters already being measured by the Victoria Clipper

Citadel Thermosalinograph *(started June 2012)*

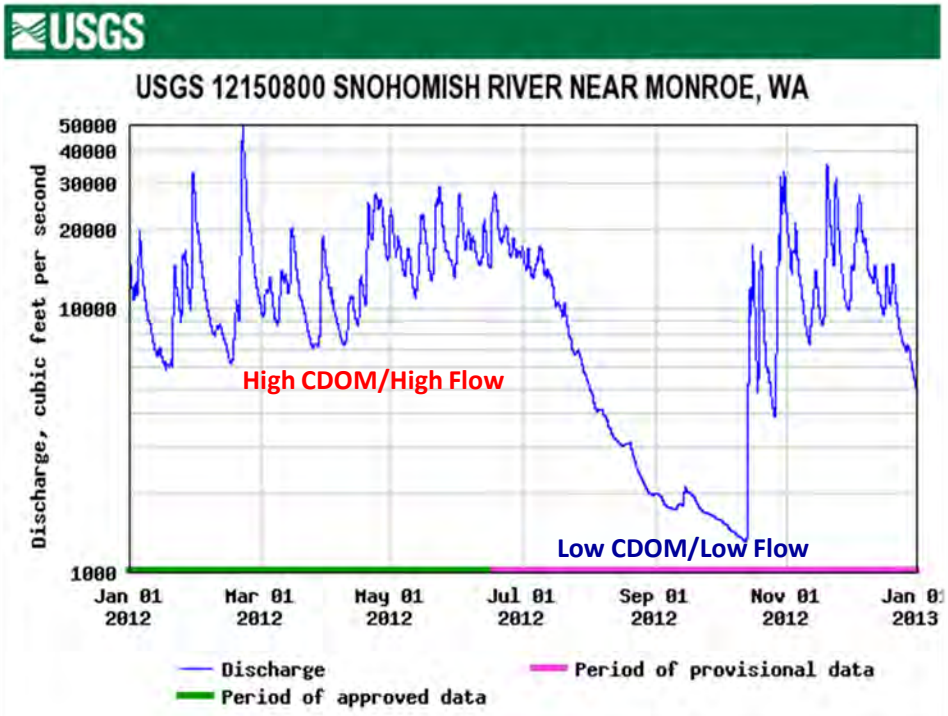


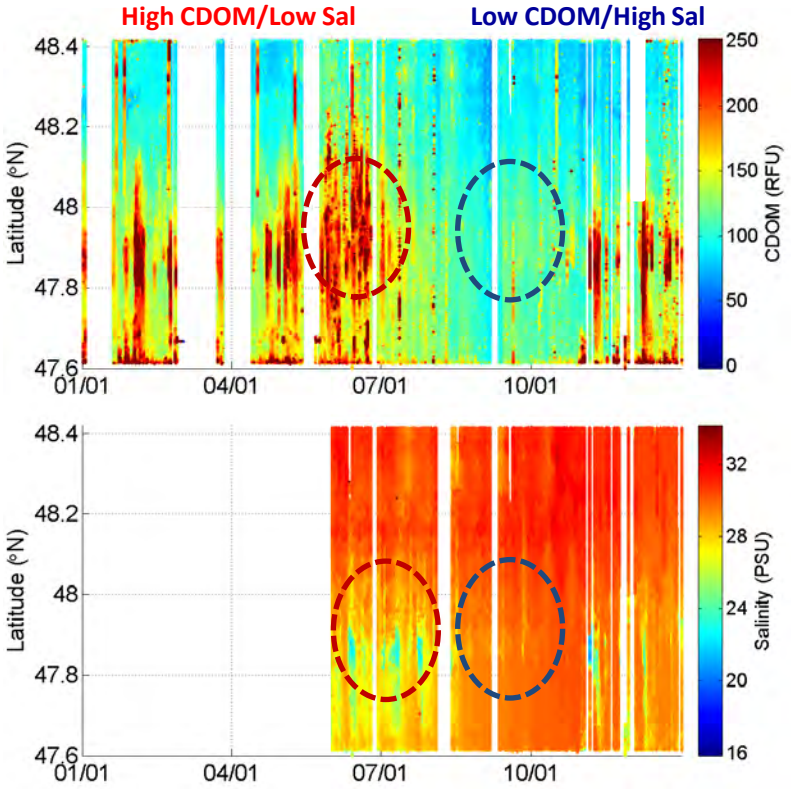


Ferry and satellite observations: 2012 in review

2012 in Review:

CDOM continues to provide an important tracer for freshwater entering Puget Sound from Whidbey Basin. High CDOM concentrations are associated with increased river flows and low near-surface salinity.



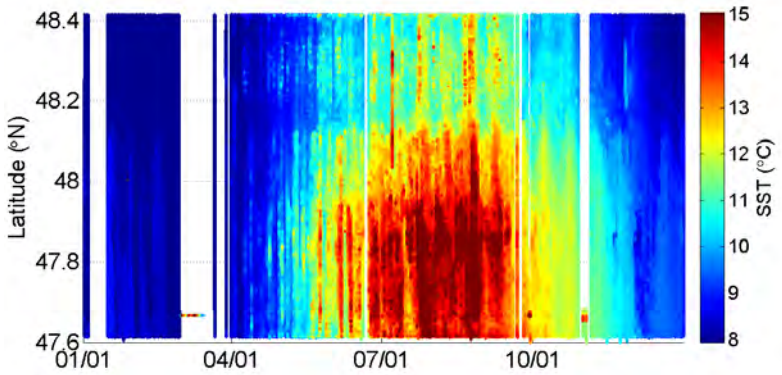


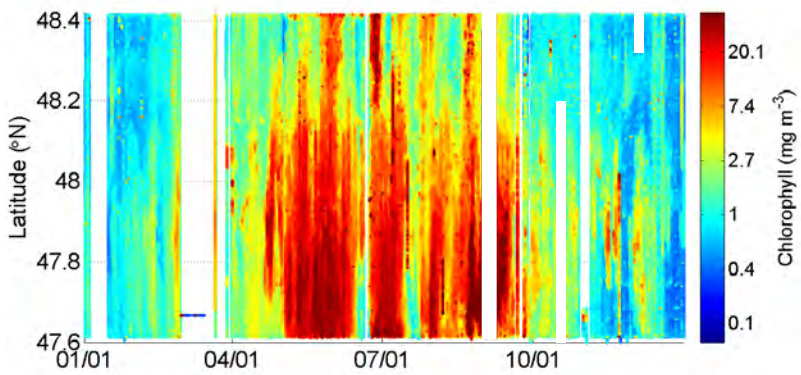
Ferry and satellite observations: 2012 in review

2012 in Review:

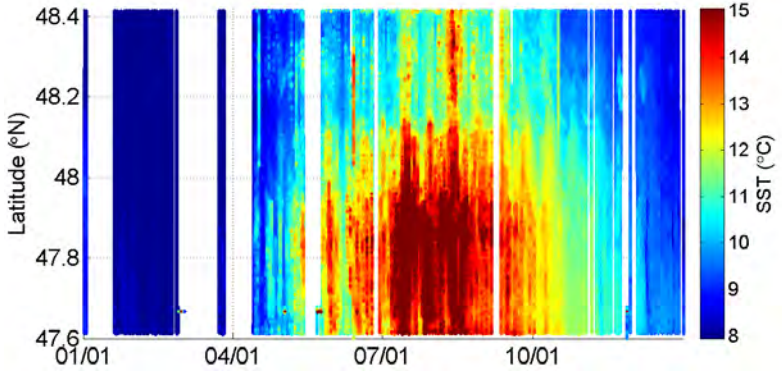
Warm temperatures in Central Puget Sound occurred a few weeks earlier in 2012 vs. 2011 and stimulated an earlier, yet somewhat weaker, spring phytoplankton bloom. Phytoplankton blooms in the Strait of Juan de Fuca appeared weaker in 2012 compared with 2011.

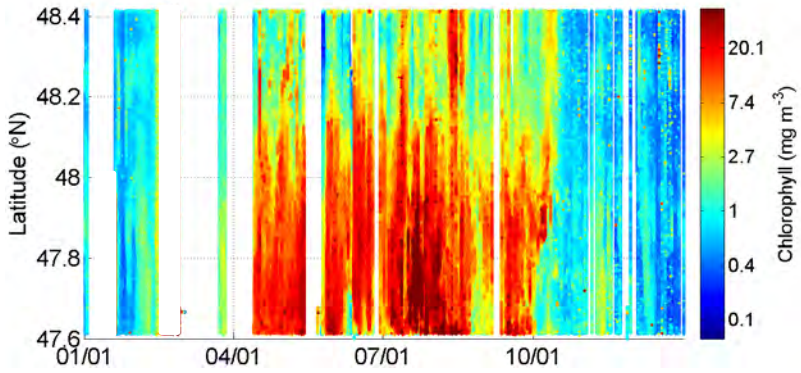
2011





2012





Mooring observations and trends 1-1-2013 to 1-14-2013

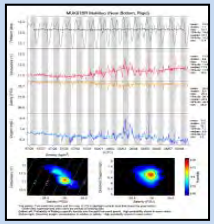
Summary: Dissolved oxygen increasing as water temperature declines. Lowest dissolved oxygen occurs with highest salinity and water temperature. Warmest temperatures occurs with highest salinity. During the winter, freshwater entering Puget Sound is colder than saltwater. (Only 1 week of Manchester data from 1/1/2013 – 1/7/2013)

Mukilteo, Whidbey Basin near Everett:

Dissolved Oxygen Conditions (12-16 m)

DO Max	8.4 mg/L	on 1/7	at 27.8 PSU	8.2 C	11.8 db
DO Min	6.9 mg/L	on 12/31	at 29.2 PSU	9.4 C	13.6 db

DO Avg	7.3 mg/L
DO Trend	+1.2 mg/L
DO-Sal Corr	-0.70
DO-Temp Corr	-0.97



Real-time data online (click)

Salinity (Sal) Conditions (12-16 m)

Sal Max	29.3 PSU	on 1/12	at 9.4 C	15.4 db
Sal Min	26.9 PSU	on 1/13	at 8.3 C	11.9 db

Sal Avg	28.9 PSU
Sal Trend	-0.32 PSU

Temperature (T) Conditions (12-16 m)

T Max	9.4 C	on 12/31	at 29.2 PSU	13.6 db
T Min	8.2 C	on 1/7	at 27.8 PSU	11.8 db

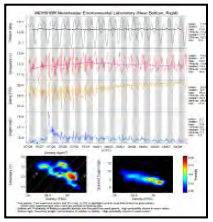
T Avg	9.0 C
T Trend	-0.4 C

Manchester, near Clam Bay:

Dissolved Oxygen Conditions (8.6-12.7 m)

Max	7.0 mg/L	on 1/5	at 29.0 PSU	9.0 C	10.1 db
Min	6.1 mg/L	on 1/7	at 29.0 PSU	9.0 C	10.2 db

Avg	6.7 mg/L
Trend	no trend
DO-Sal Corr	-0.71
DO-Temp Corr	0.71



Real-time data online (click)

Salinity (Sal) Conditions (8.6-12.7 m)

Max	29.3 PSU	on 1/1	at 9.5 C	12.8 db
Min	28.9 PSU	on 1/5	at 9.0 C	10.5 db

Avg	29.4
Trend	No trend

Temperature (T) Conditions (8.6-12.7 m)

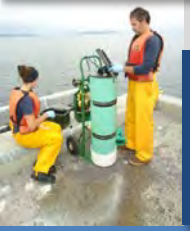
Max	9.5 C	on 12/31	at 29.3 PSU	11.1 db
Min	9.0 C	on 1/3	at 28.9 PSU	10.2 db

Avg	10.2 C
Trend	-0.4 C

Mooring observations and trends 1-1-2013 to 1-14-2013

DEPARTMENT OF ECOLOGY State of Washington

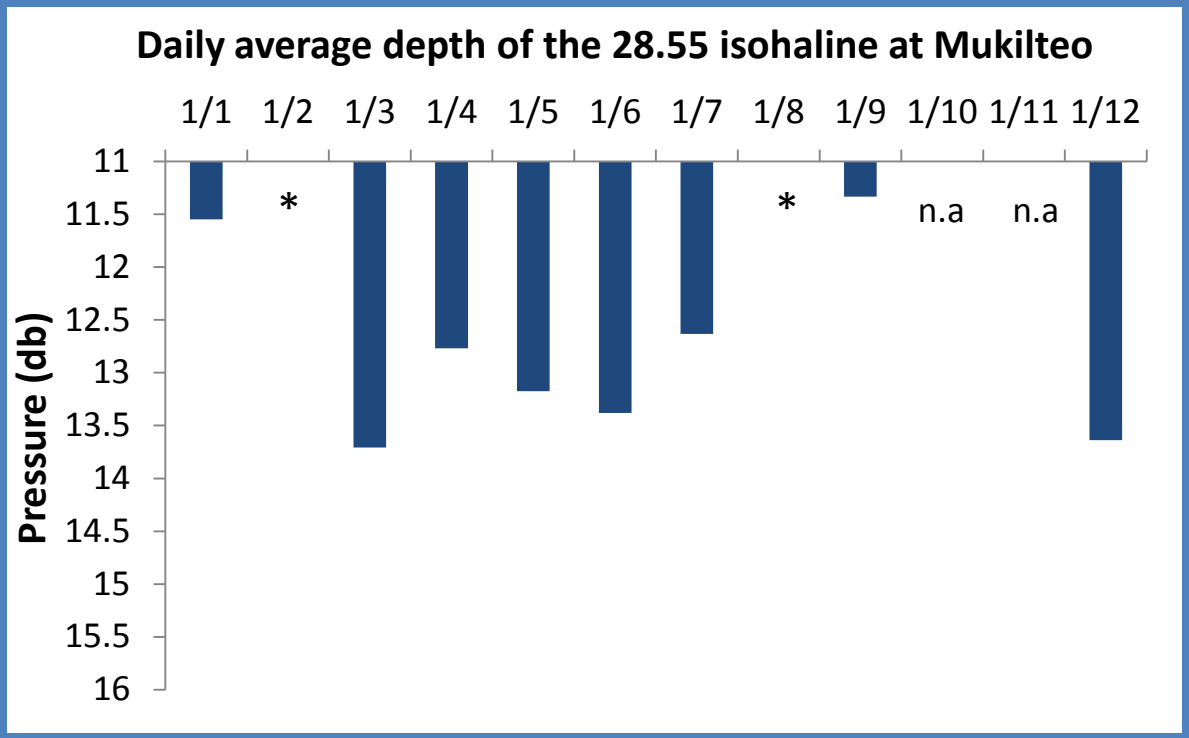
NANOOS



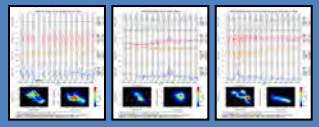
Go to our mooring site at: http://www.ecy.wa.gov/programs/eap/mar_wat/moorings.html

Summary: Freshwater inputs into Whidbey Basin are increasing, river plumes are extending further into Puget Sound and are thicker indicated by the deepening of pycnocline layer compared to previous months.

This month we report on thickness of the fresh water layer by monitoring our near-surface sensor. The pycnocline is often near the surface sensor (*).

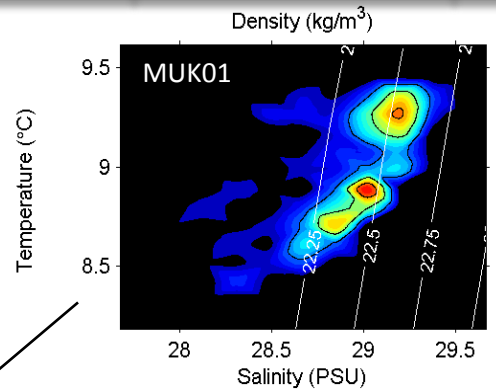


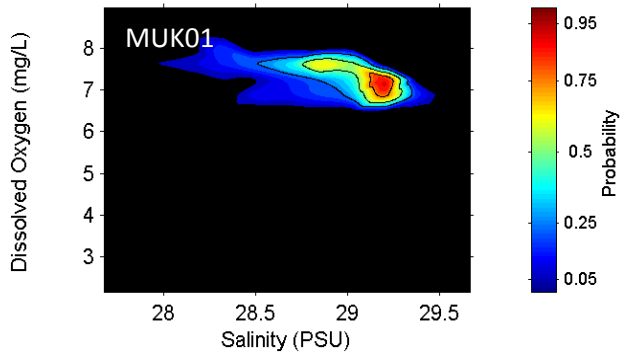
We track the depth of the isohaline where salinity is 28.55 (±0.05) to measure the thickness of the freshwater layer at our Mukilteo station. The near-surface sensor experienced tidal pressure variations of 11.0 to 16.0 meters (or dbar).



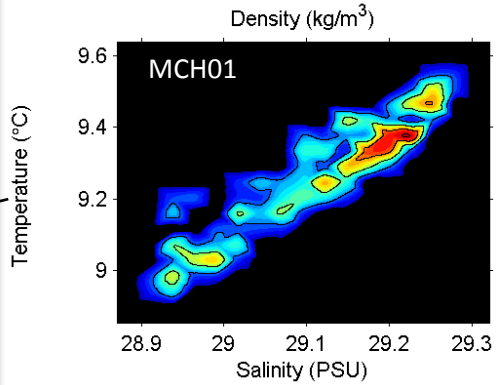
Real-time data online (click)

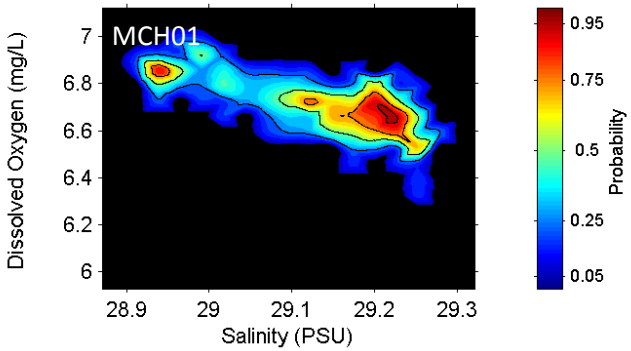
Mooring observations and trends 1-1-2013 to 1-14-2013





At Mukilteo, two principal water masses are observed. Lowest dissolved oxygen concentrations were associated with the water mass of highest salinity.





At both stations, highest salinity and warmest temperatures are observed together, showing that the saltiest waters are keeping Puget Sound warmer.

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.

Get data from Ecology's Monitoring Programs

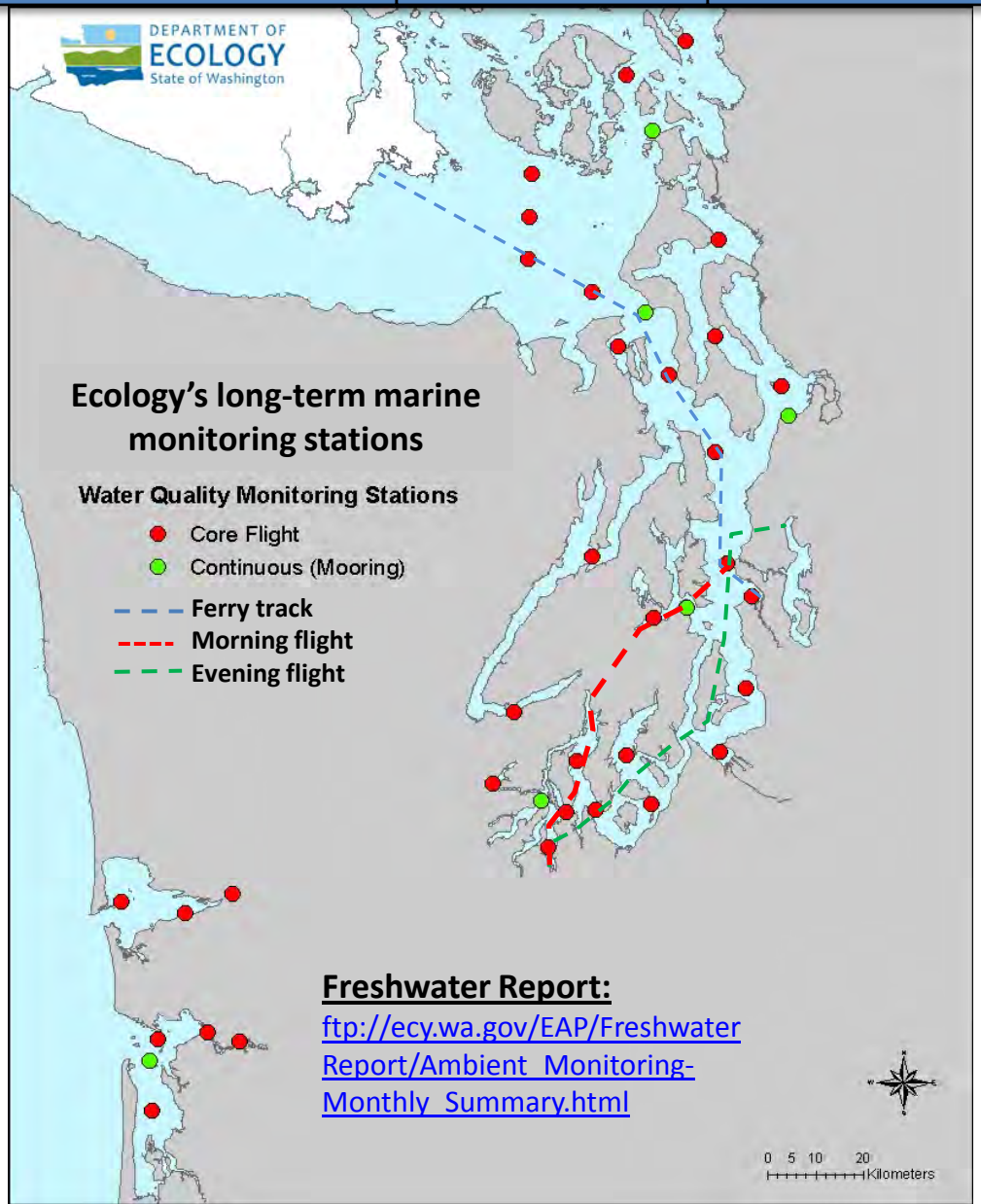
Flight log	Weather	Water column	Aerial photos	Ferry and Satellite	Moorings

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

brandon.sackmann@ecy.wa.gov

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

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