Publication No. 20-03-071

DEPARTMENT OF ECOLOGY
State of Washington

Eyes Over Puget Sound

Surface Conditions Report: *March 16, 2020*

Critter of the month: The humpback shrimp

Up-to-date observations of water quality conditions in Puget Sound and coastal bays

LONG-TERM MARINE MONITORING UNIT

Dany Burgess
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The kelp Humpback shrimp

p. 4

The kelp humpback shrimp is a master of camouflage.

Water visibility for divers

p. 5

Now would be the time to go diving, the water is clear.

Climate & streams

p. 6-10

After a wet January, precipitation currently is low. Most of the winter has been normal but currently its cooler. As a result rivers presently run lower than expected. Rivers in general have been flowing low since last year.

Water temperature and food web

p. 12

While low temperatures allow herring to spawn, we are now in March approaching the survival threshold for anchovies, around 8 °C.

Aerial photography

p. 13-29

First spring blooms develop in response to sunnier conditions and stain the water of finger inlets in South Sound green. Jellyfish patches are numerous only in Eld Inlet. Herring are reported to be spawning in the northern regions of Puget Sound, but not yet in South Sound. Northerly winds and waves resuspended sediment in exposed north-facing beaches of South Sound.

Editorial assistance provided by: Elisa Rauschl, Julianne Ruffner, Valerie Partridge.

My Experience so far as the Marine Monitoring Intern with the MMU

Tyler Ransier – Washington Conservation Corps Intern

My name is Tyler Ransier, and I am the marine monitoring intern for the year of 2020. Although I've only been a part of the MMU team for five months now, I have gotten the opportunity to assist with a huge variety of exceptional projects, programs and people. Here is a snapshot of some of the awesome work I've been helping out with so far!

Above: I help collect water samples using a CTD
Below: We also collect CTD data via float plane

Above: I sort invertebrates into phyla
Below: I filter water samples for chlorophyll-a

Critter of the month – The Kelp Humpback Shrimp

Dany Burgess
Marine Sediment monitoring Team

Hippolytes clarki

The kelp humpback shrimp is a master of camouflage – with its green or brown color, it blends in perfectly with its eelgrass (or kelp) home. It may be tiny, but it is a big player in the Puget Sound food web!

Kelp Humpback Shrimp Facts

- Important food source for juvenile rockfish and other predators
- May be distinguished from similar species by counting the tiny points at the end of its "snout"

Learn more about the kelp humpback shrimp and other critters on Ecology's EcoConnect blog here

What was the water visibility like for divers?

February: Imagine you can better see the diver underwater water at good visibility, darker contour.

(only best visibility shown)

Best and poor horizontal visibility at corresponding vertical depth

Location	Best Visibility		Worst Visibility	
	Horizontal Distance (ft.)	Vertical Depth (ft.)	Horizontal Distance (ft.)	Vertical Depth (ft.)
1	15	49	14	5
2	11	44	7	7
3	-2	3	15	34
4	22	38	10	5
5	16	3	16	97
6	20	46	5	3
7	18	46	7	11
8	21	95	13	8
9	22	39	11	5
10	17	10	11	48
11	37	90	13	11
12	22	69	19	20
13	22	98	10	11
14	5	5	5	23
15	12	43	8	7
16	13	7	10	44
17	12	21	8	51

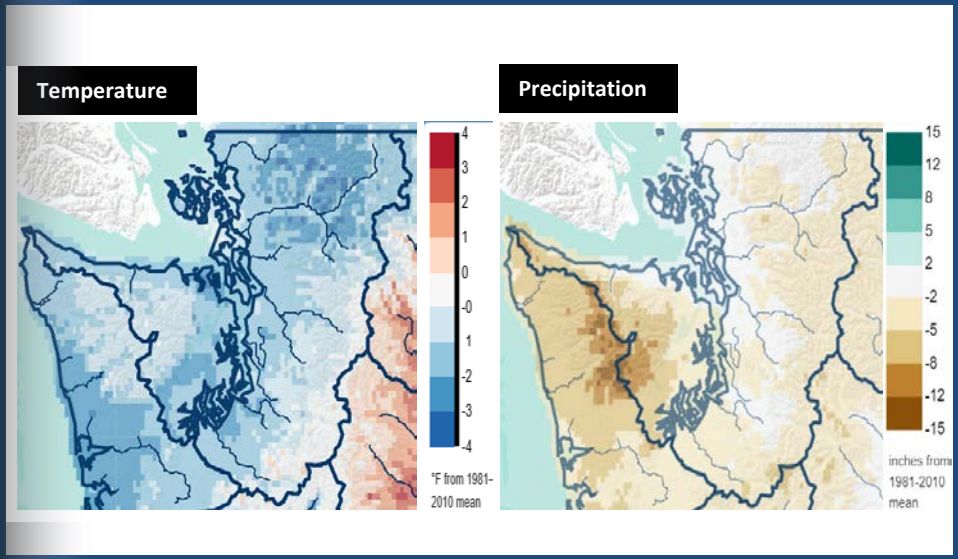
Find depths with high/low visibility

- **Best visibility** occurred in Hood Canal near Octopus Hole (location 11), with almost 40 ft visibility at about 90 ft depth.
- **Poor visibility (no diver icon)** occurred near the surface in Mukilteo (location 6) and in Oakland Bay near Shelton (location 14).
- Explanation: "Underwater Visibility Maps — a Tool for Scuba Divers," is available here.

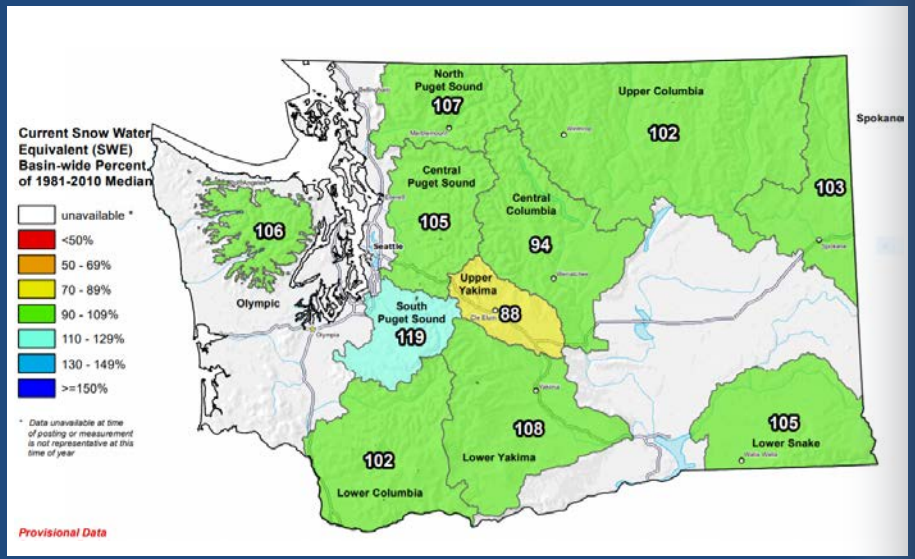
How much water did we get and what can we expect?

In March, Puget Sound air temperatures were below normal while precipitation was near to below normal (A). Nearing the seasonal peak of snowpack accumulation, watersheds that drain to Puget Sound hold near-normal volumes (B). Monitoring snowmelt rates and timing will be critical as we transition to spring and summer. Will trends in early snowmelt runoff peaks continue?

A. Northwest Climate Toolbox



B. Washington SNOTEL, USDA/NRCS



Temperature Anomaly from historical mean daily ranged from +1 to -4 °F in the Puget Sound region during the past 30 days.

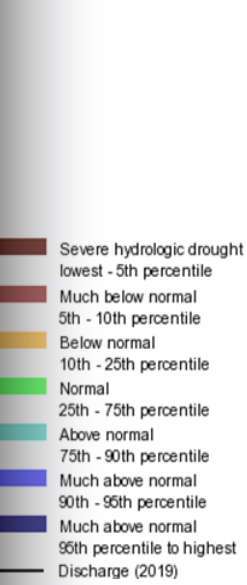
Precipitation Anomaly from historical mean ranged from 0 to -12 inches in the Puget Sound region during the past 30 days.

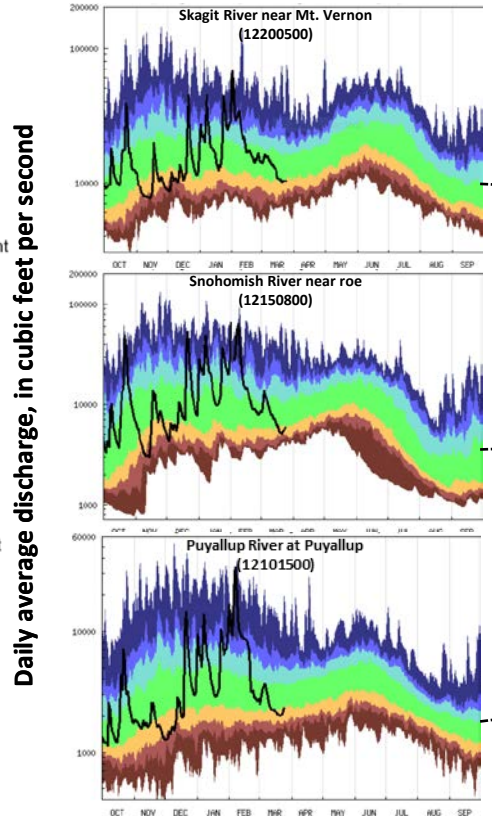
Snow water equivalent percent of median for watersheds draining to Puget Sound are just above normal. Nearing the typical peak of seasonal snowpack accumulation, April 1st, snow water equivalents are at 109% of the historical median.

How much water flows into Puget Sound?

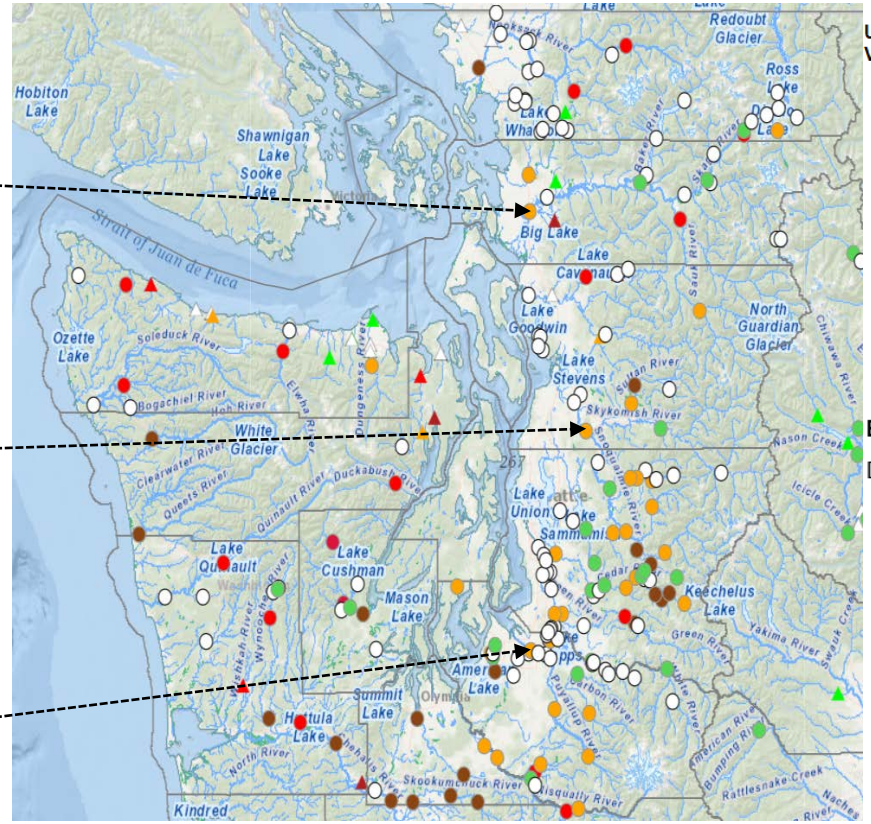
Cool and dry conditions during March have resulted in below normal flows in larger, snow-dominated watersheds (see trend charts). Most stream gages are reporting normal to far-below-normal flows, especially those that are in rain-dominated watersheds (see map). With a normal snowpack this year, temperature will be the main driver of a sustained freshwater supply to Puget Sound.

Select Puget Sound Streamflow Trends





Current Streamflow Conditions as of 3/26/2020

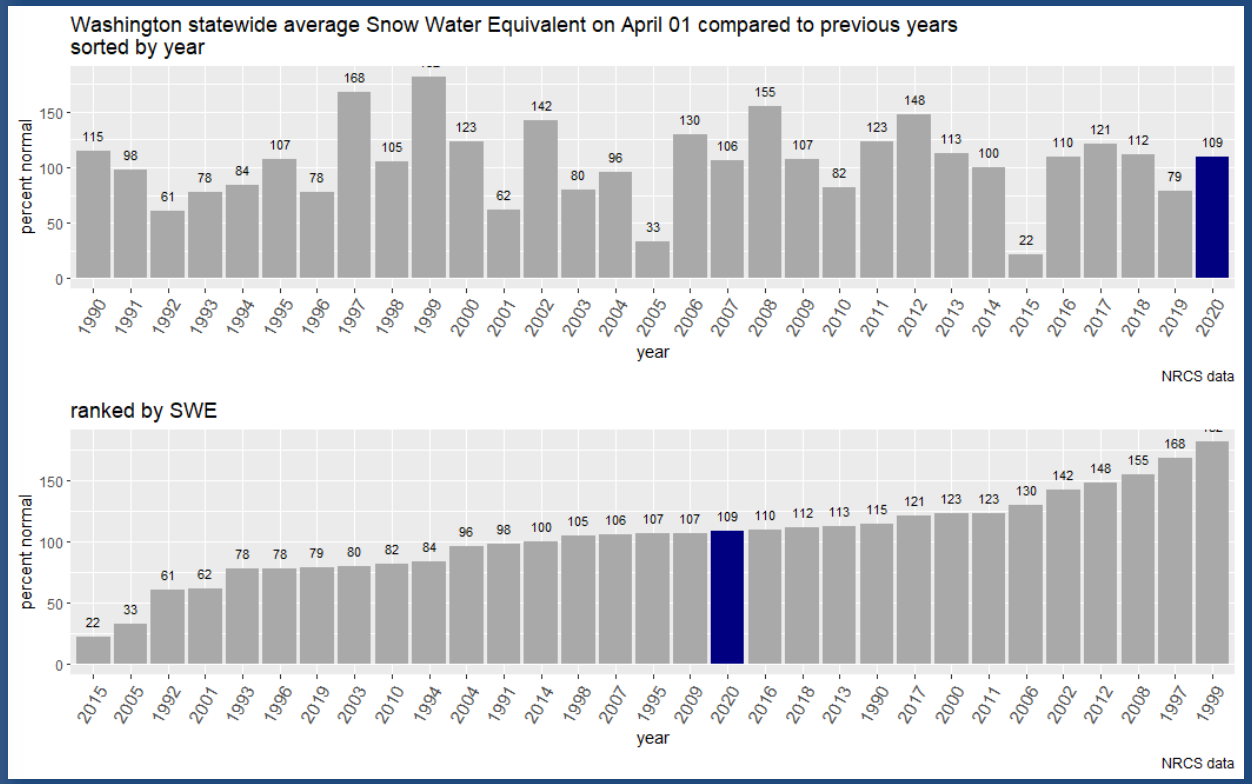


USGS WaterWatch: CLICK HERE!

Current conditions: CLICK HERE!

How much water did we get and what can we expect?

Statewide snowpack measured 109 percent of normal on April 1st. This is a tremendous comeback from where it was on January 1st: 50 percent of normal. Ample snowpack at higher elevations means that mainstream rivers like the Skagit, Nooksack, Snohomish, Stillaguamish in snowpack-dominated basins are forecasted to experience normal to above normal runoff from April through September.



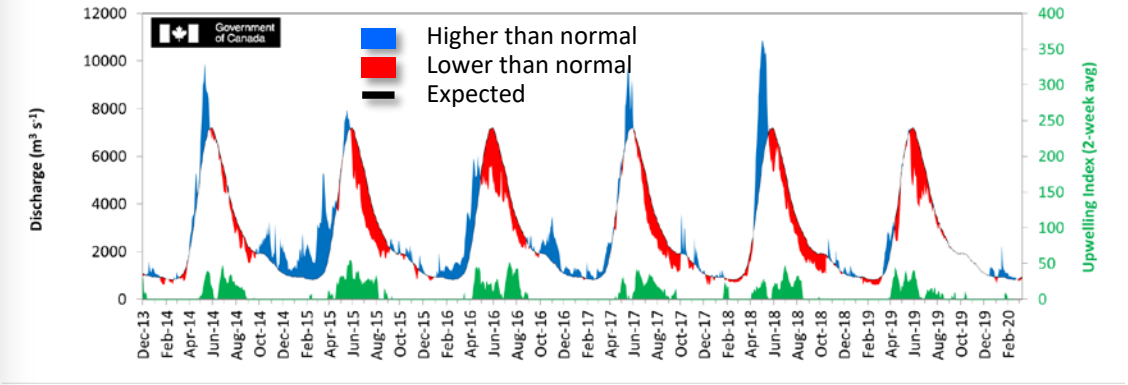
Snowpack fed basins are in good shape, but lower elevation basins and non-snowpack fed tributaries need precipitation.

Many rain-dominated, lower-elevation basins – like the Chehalis -- are forecasted to experience below-normal runoff from April to September. This includes the Samish, Deschutes, Skokomish, Dungeness, Elwha and Wynoochee Rivers.

Climate : How well is the Salish Sea exchanging its water?

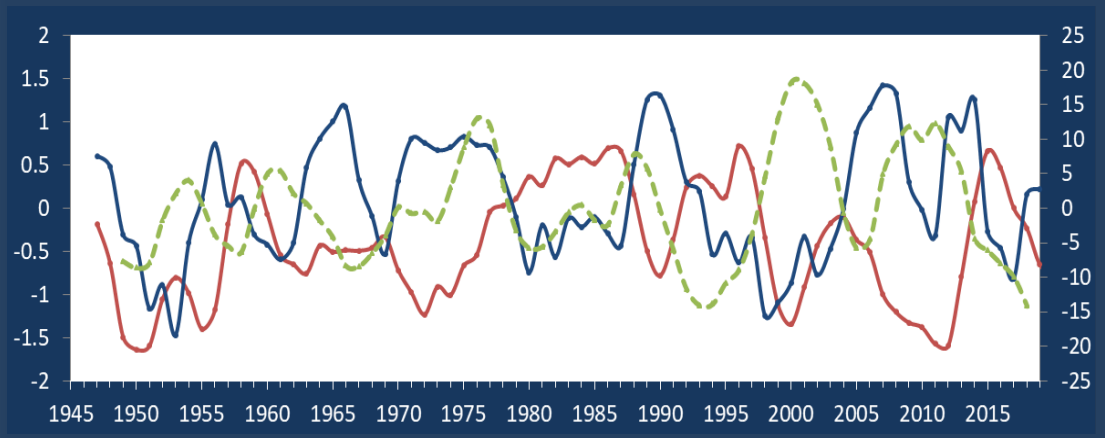
Historically, the peaks of coastal upwelling and the freshet are in sync. In early 2020 Fraser R. flows are expected.

Fraser River (at midnight)



The Fraser River is the major driver of estuarine circulation and water exchange between the Salish Sea and the ocean. The Fraser River has regained expected levels. The **Canadian snow basin index** for the Fraser River is at 117%, predicting a strong freshet — click here

Three-year running average of PDO, Upwelling, and NPGO Indices



How do ocean boundary conditions affect the quality of water we exchange with the ocean?

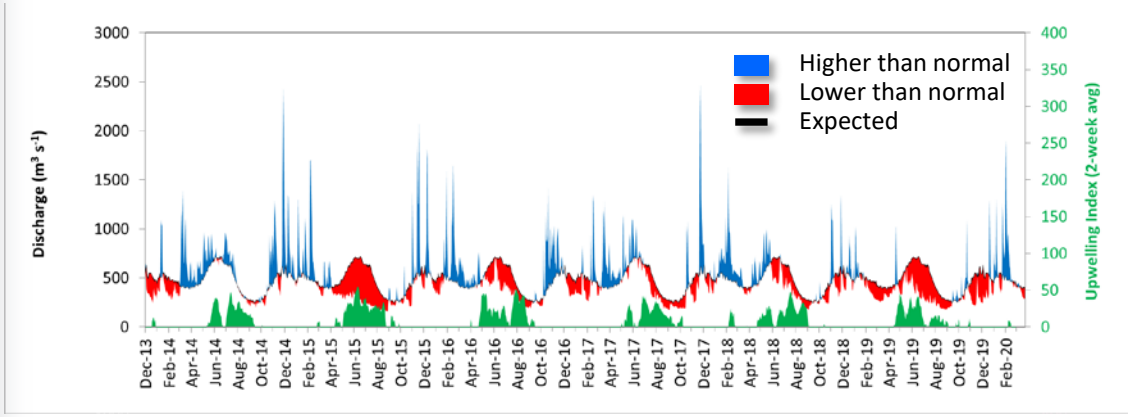
Recent years' warm water is mostly gone (PDO). Upwelling (Upwelling Index anomaly) is relative expected. NPGO, which reflects the surface productivity along the coast, has not been updated since July 2019.

*Pacific Decadal Oscillation Index (**PDO, temperature**, explanation). Upwelling Index (anomalies) (**Upwelling, low oxygen**, explanation). North Pacific Gyre Oscillation Index (**NPGO, productivity**, explanation).*

Climate: How well is Puget Sound exchanging its water?

The Skagit River is the largest freshwater source for Puget Sound. It is a river that is regulated.

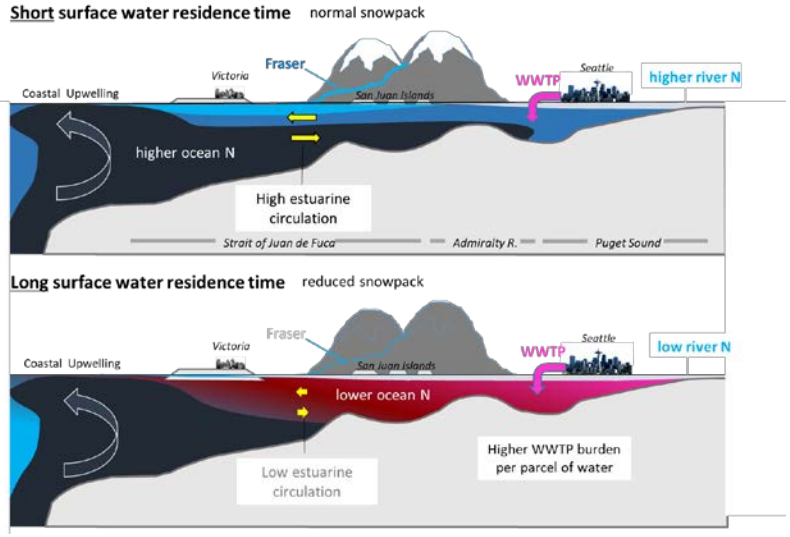
Skagit River (at midnight)



The Skagit River freshet is no longer clearly pronounced, because it is a regulated system. However, drought years and low flows can be seen in the river's discharge data. Freshwater is an important component determining the stratification of surface water in Puget Sound. Drought years weaken the extent of stratification.

Normal river flows drive **"natural"** nutrient inputs and keep the **water cool**.

Low river flows change the **nutrient balance and makes water warmer**.



River flows and upwelling in the summer influence our water quality.

Rivers strengthen estuarine circulation in the Salish Sea. This is important in the summer.

Upwelled ocean water provides cool, nutrient-rich water.

For that to happen, we need northerly winds and good river flows (a good snowpack) during periods of water exchange through Admiralty Reach (neap tides).

What influences Puget Sound's water quality?

In the anomaly plot, we want to connect different factors influencing water quality in the context of space and time. Air temperatures in the past year have generally been warmer, and the overall amount of rain has been low (note anomalies relative to a baseline in summer over-emphasize a weak summer rain). 2020 fortunately started out with high precipitation, and rivers are responding. For recent river and stream inflow, see pages 6-7.

Conditions leading up to March:

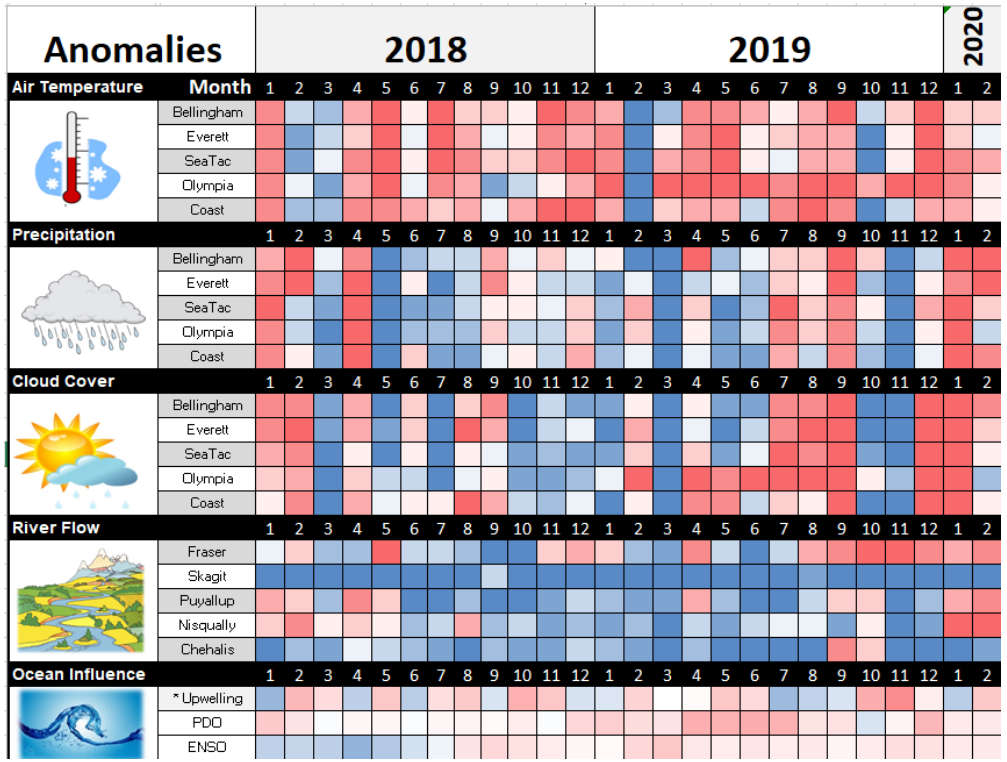
Air temperatures have been warmer this winter, with a cold period only in October.

Precipitation for fall was low, but January was the 4th-wettest on record.

Sunshine (opposite of cloud cover) has been cycling between higher and lower values.

River flows have mostly been low since last year, June 2018, but now regained strength in some places.

Upwelling started to be less predictable, as in the previous year.



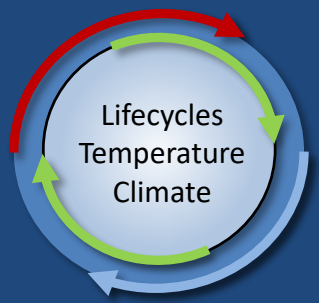
All data are from public sources: UW GRAYSKIES; river flows from USGS and Environment Canada; indices from NOAA & UW (PDO).

*Upwelling/downwelling Anomalies (PFEL)
PDO = Pacific Decadal Oscillation
ENSO = El Niño Southern Oscillation

higher — expected — lower

No data

Water temperature affects ecosystem performance



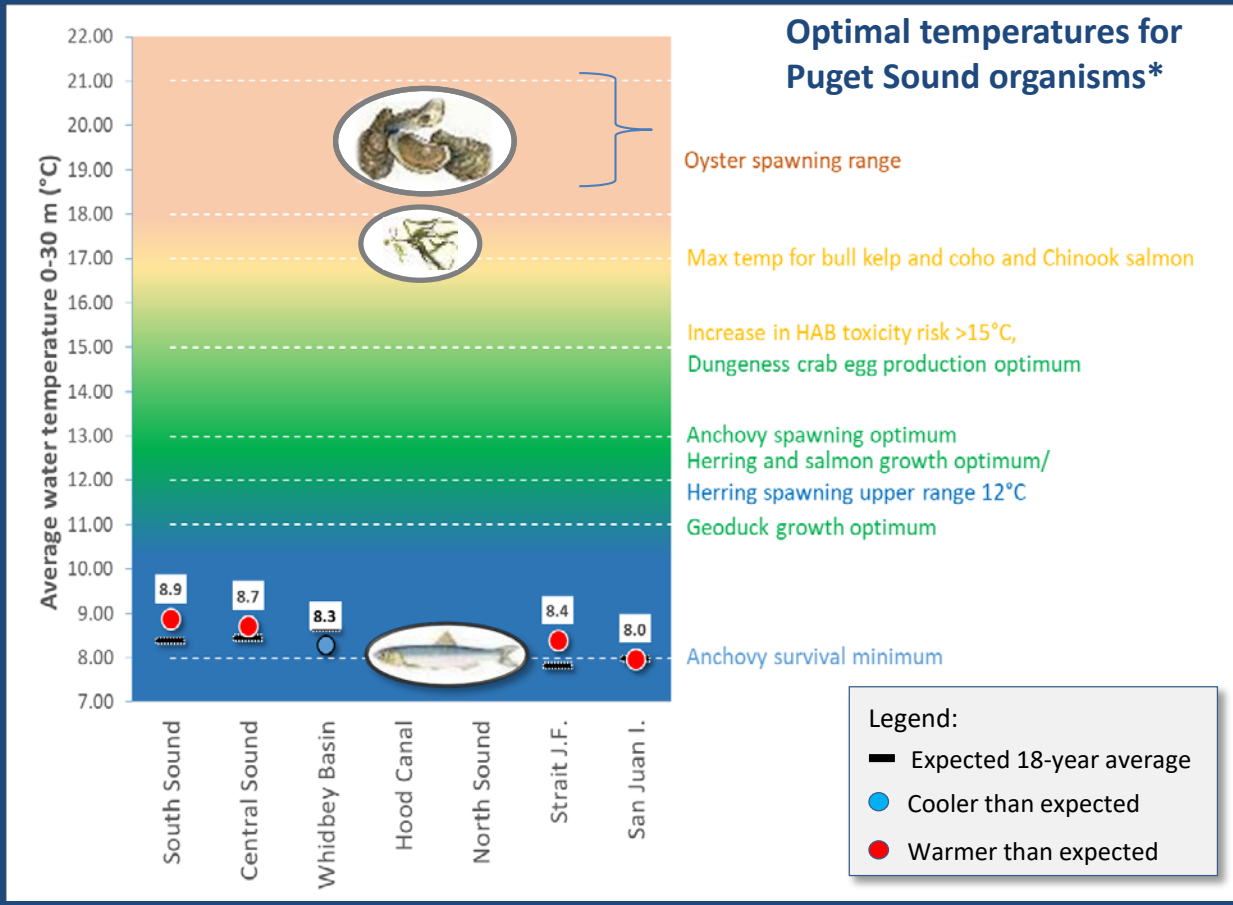
Can organisms thrive and survive?

The life cycles of organisms respond to temperature. To be successful, the timing of early life stages must line up with good growth conditions.

Temperature is important for growth, but also dictates if certain organisms can overwinter in Puget Sound (e.g., northern anchovy).

* Help us get these right. We scoured the literature for temperatures important to the success and survival of marine organisms.

In February, average surface water (0 – 30 m) temperatures were still slightly above the baseline (1999 – 2018) across many regions. Water temperatures were in ranges for spawning for herring, but gradually approaching the minimum survival temperature for anchovies of about 8.2 °C. Coldest water temperatures currently occur in Puget Sound right now, in March (data not available yet). Temperatures do not reflect nearshore conditions that can be quite different.



What are the conditions at the surface?

First spring blooms develop in response to sunnier conditions and stain the water of finger inlets in South Sound green. Jellyfish patches are numerous only in Eld Inlet. Herring are reported to be spawning in the northern regions of Puget Sound (click here), but not yet in South Sound. Northerly winds and waves re-suspended sediment in exposed north-facing beaches of South Sound.

Large ships come all the way into South Sound.

The de Havilland Beaver float plane, a great workhorse.

Watch video

Start here

Front

Mixing and fronts:
Tidal eddy off McNeil Island nicely visible through resuspended nearshore sediment.

Jellyfish:
Numerous only in Eld Inlet but present in Totten and Budd Inlets in few and small patches.

Plume

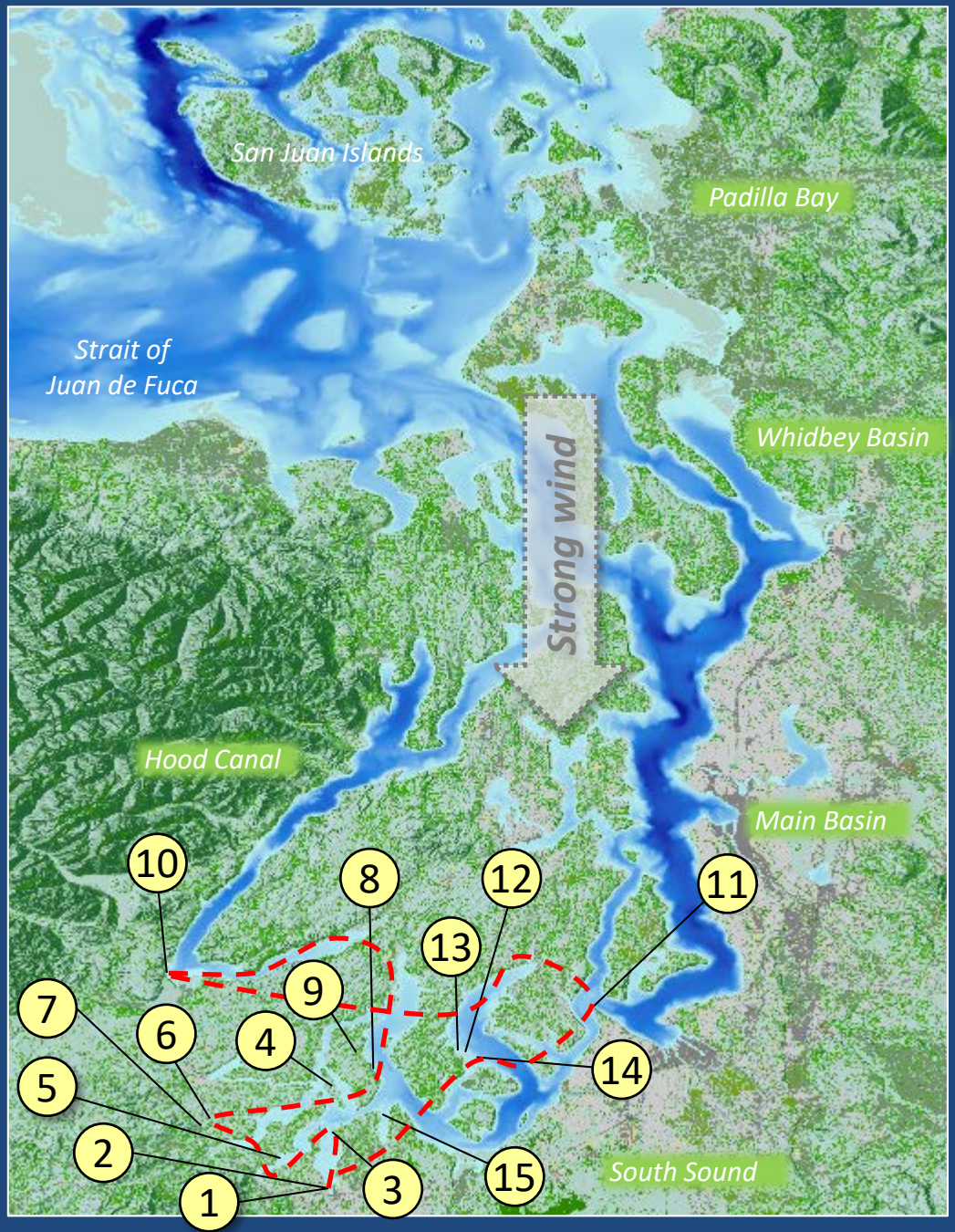
Suspended sediment:
Sediment suspended by waves on many beaches facing north. Both ship traffic and shellfish-harvesting create local sediment disturbances.

Bloom

Visible blooms:
First signs of a spring bloom developing in all Finger Inlets of South Sound.

Debris

Debris:
Low levels restricted in South Sound to only Dana Passage.



DEPARTMENT OF ECOLOGY
State of Washington

Aerial navigation guide

Date: 3/16/2020

Click on numbers

Tide data from 3/16/2020 (Seattle):

Time	Pred (ft)	High/Low
05:11 AM	7.02	L
10:28 AM	10.26	H
05:37 PM	0.24	L

Flight Observations

Sunny and hazy, moderate wind south of Tacoma Narrows, >20 knots winds out of the North past the Tacoma Narrows.

Note: Flight route was changed due to strong winds north of the Tacoma Narrows.

No wind at the Port of Olympia. Little did we know that winds would pick up past the Tacoma Narrows.

Location: Port of Olympia, Budd Inlet (South Sound), 11:26 AM

Aerial photography 3-16-2020

Large ship approaching the Port of Olympia and stirring up sediment.

Location: Budd Inlet (South Sound), 11:27 AM

Aerial photography 3-16-2020

Water flowing past Boston Harbor reveals a spring bloom in Budd Inlet.
Location: Dana Passage (South Sound), 11:20 AM

Aerial photography 3-16-2020

South Sound has beautiful islands and waterways.
Location: Squaxin Island (South Sound), 11:22 AM

Aerial photography 3-16-2020

Patches of jellyfish are present in Eld Inlet, but otherwise almost absent in other South Sound Inlets.

Location: Eld Inlet (South Sound), 11:32 AM

Aerial photography 3-16-2020

Surface water in finger inlets of South Sound are stratified. A boat mixing the surface layer in Oyster Bay.

Location: Totten Inlet (South Sound), 11:35 AM

Aerial photography 3-16-2020

All finger inlets of South Sound have river inputs; like the Skookum Creek, most currently carry little sediment.

Location: Little Skookum Inlet (South Sound), 11:37 AM

Aerial photography 3-16-2020

Sediment resuspension by underwater shellfish extraction (see boat) and at wave-exposed beaches.

Location: McMciken Island, Case Inlet (South Sound), 11:47 AM

Aerial photography 3-16-2020

Sediment resuspension on wave-exposed beaches.

Location: Harstine Island, Case Inlet (South Sound), 11:48 AM

Aerial photography 3-16-2020

Clear freshwater of the Skokomish entering Hood Canal at Union.

Location: Union (Hood Canal), 12:02 PM

Aerial photography 3-16-2020

Strong winds meet tidal current passing the Tacoma Narrows in opposite direction, causing high waves.

Location: Point Defiance (Central Sound), 12:20 PM

Aerial photography 3-16-2020

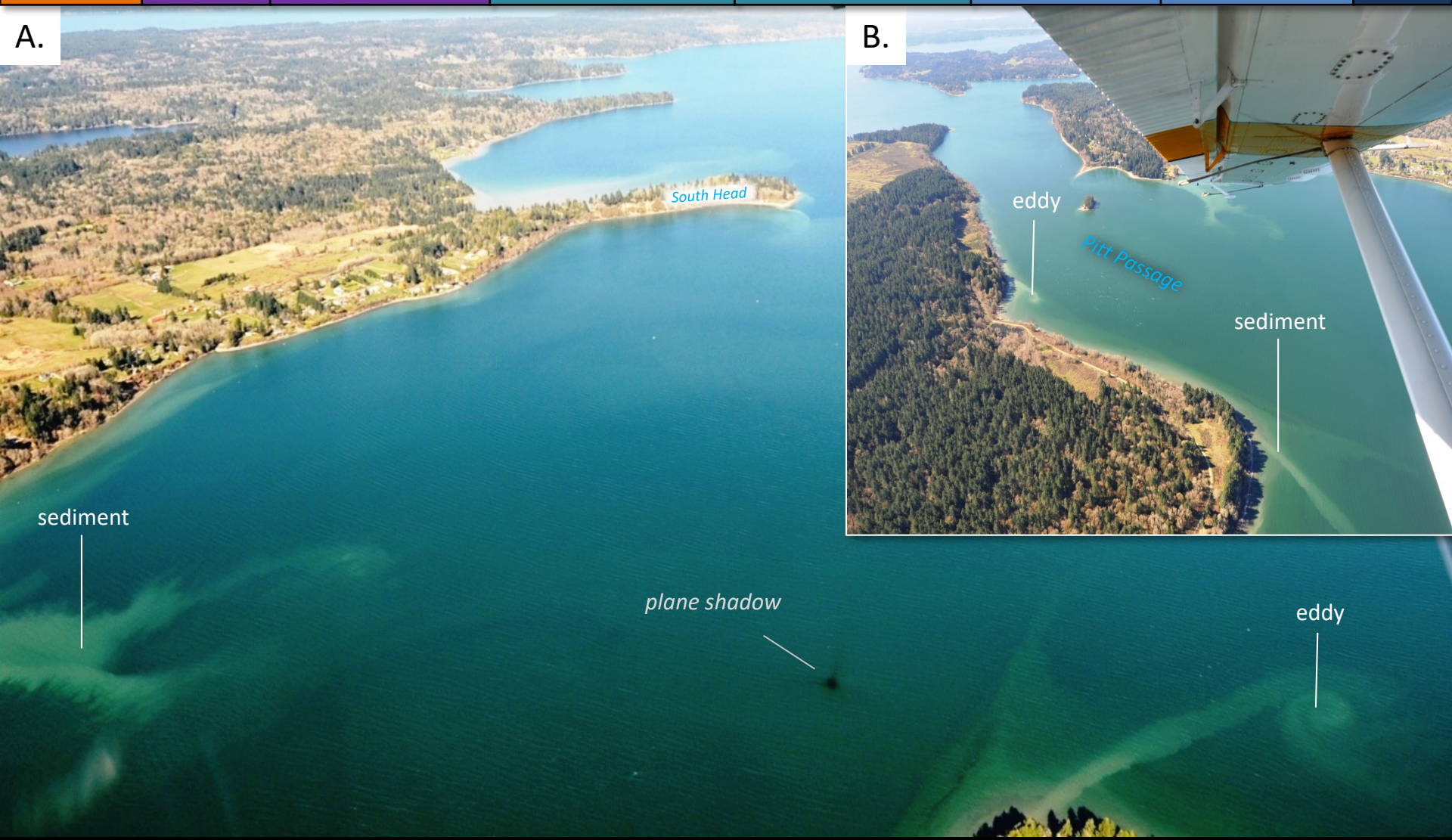
Strong northerly winds cause sediment resuspension on wave-exposed north-facing beaches.

Location: Carr Inlet (South Sound), 12:25 PM

Aerial photography 3-16-2020

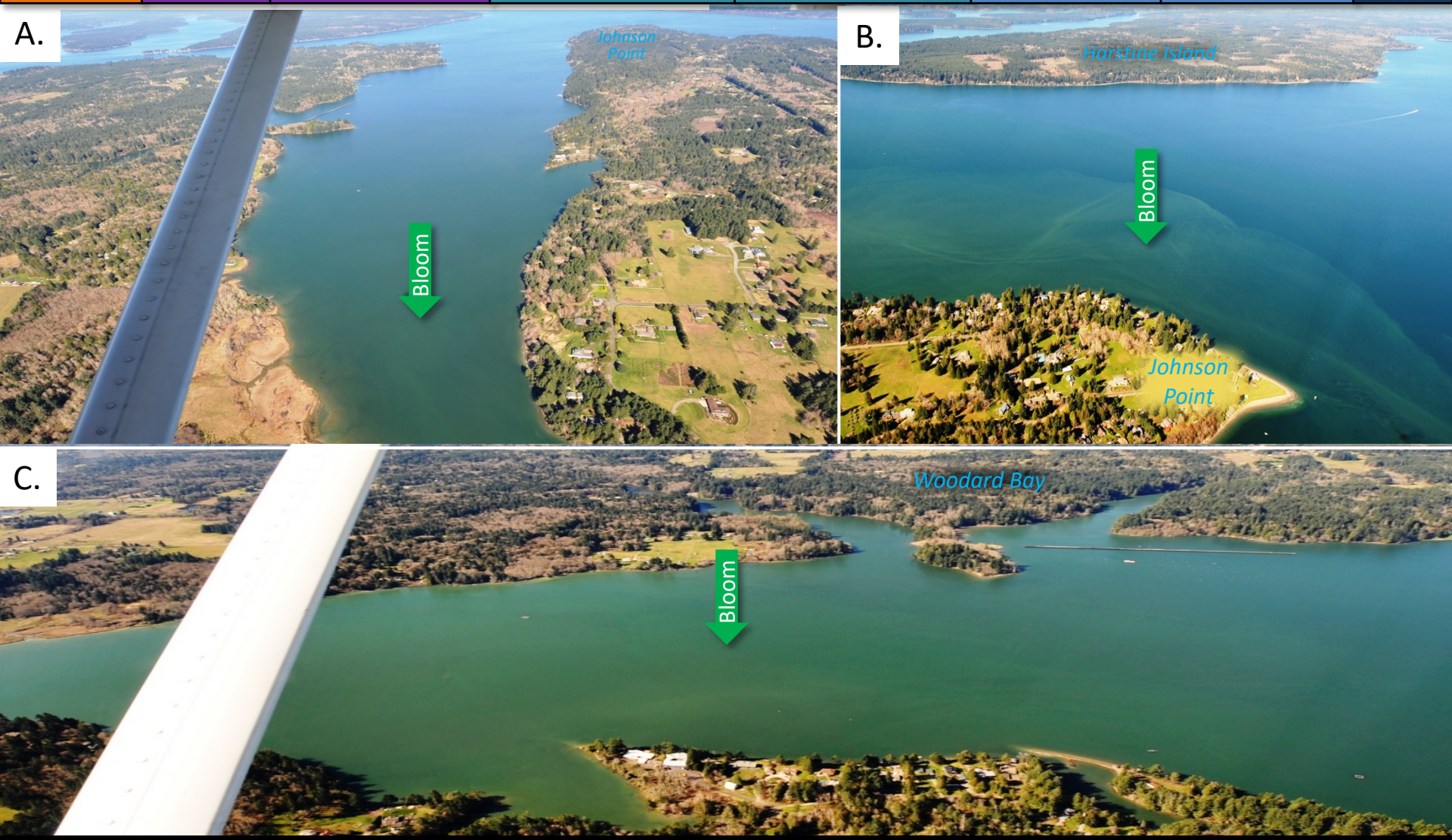
Resuspended sediment can travel along shore to be redeposited elsewhere.

Location: Carr Inlet (South Sound), 12:26 PM



Resuspended sediment makes nearshore tidal eddies visible. A. looking north, B. looking south.
Location: Pitt Passage, McNeil Island Carr Inlet (South Sound), 12:28 PM

Aerial photography 3-16-2020



Spring bloom in Henderson Inlet has started. A. Looking West, B. Flowing into Dana Passage. C. Looking south.

Location: Henderson Inlet (South Sound) 12:32 PM

We have published 86 editions!

Find all previous Eyes Over Puget Sound editions at the end of this document.

Recommended Citation (example for September 2018 edition):

Washington State Department of Ecology. 2018. Eyes Over Puget Sound: Surface Conditions Report, September 17, 2018. Publication No. 18-03-075. Olympia, WA. https://fortress.wa.gov/ecy/publications/documents/1803075.pdf.

Many thanks to our business partners: Shannon Point Marine Lab (WWU), Swantown Marina, and Kenmore Air.

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March_16_2020,
Publication No. 20-03-071

Jan_10_2020,
Publication No. 20-03-070

October_30_2019,
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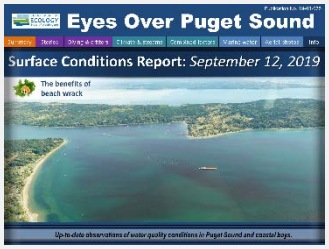

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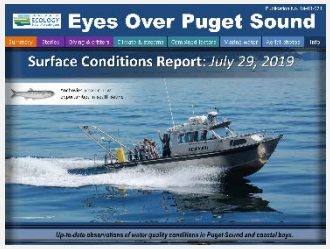

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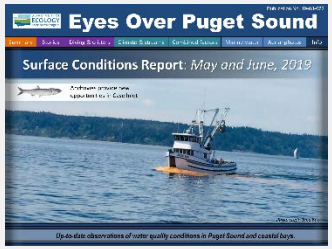

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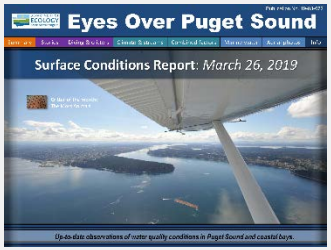

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Publication No. 19-03-071

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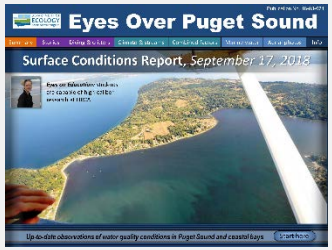

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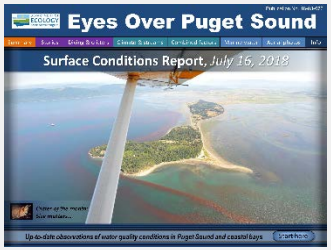

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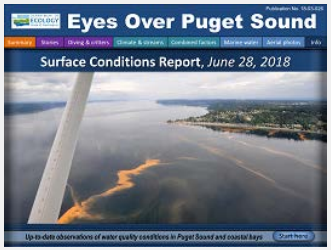

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Publication No. 18-03-072

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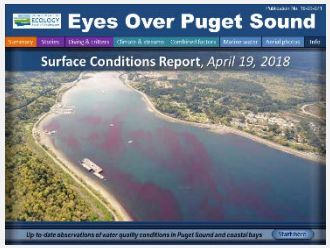

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Publication No. 18-03-071

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Publication No. 17-03-073

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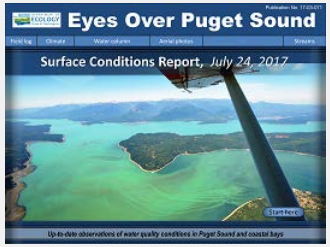

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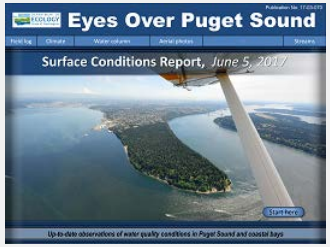

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Publication No. 17-03-070

December_31_2016,
Publication No. 16-03-079

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Publication No. 16-03-078

September_26_2016,
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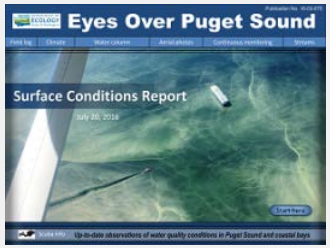

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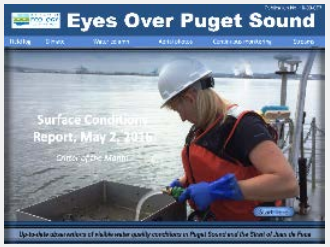

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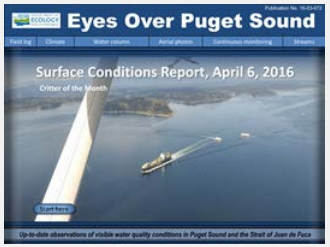

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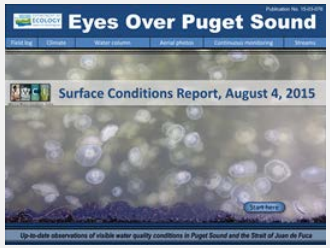

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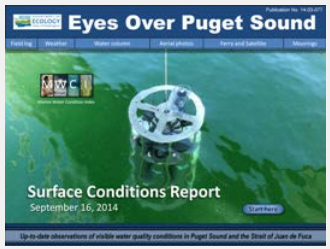

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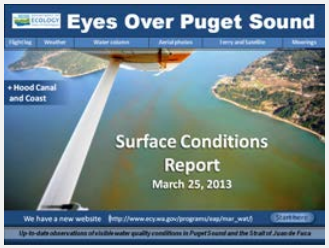

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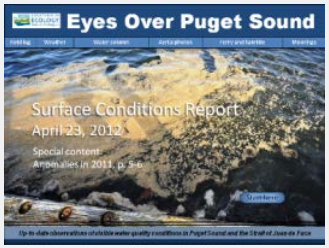

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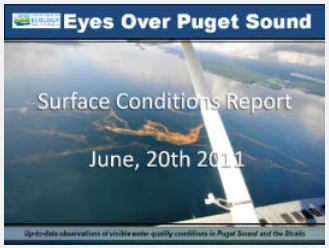

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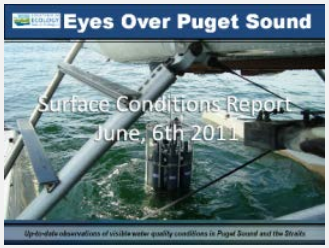

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