



Eyes Over Puget Sound

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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A decade in review...



Edition no. 100

A place where observations, people, adventure, art, and science meet

Times are changing...

Summary People 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 Data

We have reached 100 editions!

EOPS successfully helped us overcome a **dilemma of long-term monitoring programs**.

[Presentation](#)

Times are changing. We will be switching to a web integrated camera platform to inform you faster and more effectively on present surface conditions in Puget Sound.

A time capsule. The 100 published EOPS reports are in PDF format visually documenting conditions in the time period of 2011 to 2022.

We hope you will continue to make use of our images to inspire students, research, and environmental protection.



We thank you for your interest and positive feedback over the years, which enabled us to create this unique perspective in your own backyard.

I hope we see you on a new platform in the future under the same name: **“Eyes Over Puget Sound”**

Dr. Christopher Krembs (photographer of EOPS)

The story and future of Eyes Over Puget Sound report will be different



Our field teams see amazing things on the water that we wanted to share.

“It all started over lunch with Brandon and Christopher envisioning what would be possible if one could marry satellite images with aerial photos taken during Ecology’s routine monitoring flights. Later they expanded on these ideas and figured out how to add one additional piece to the puzzle by adding en route ferry data to the program – many thanks to our partners at the Victoria Clipper!”



S. Pool, using ferry data, Read poster



Brandon Sackmann

[Read book chapter](#)

Supporting a vision...

Summary People 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 Data



A new idea needs support to bring it to life.



Creative communication

Advocacy & Management support

Agency support

Sandy Howard

Carol Maloy

Rob Duff

Thank you to great leadership that fostered innovative approaches to marine monitoring

Public Attention...

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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ECOS Award	Washington's Ferries for Science and Eyes over Puget Sound
Encyclopedia of Puget Sound	About the Eyes Over Puget Sound monitoring program
Encyclopedia of Puget Sound	Eyes Over Puget Sound: An interview with Christopher Krembs
Book Chapter	Strategies to increase the impact and effectiveness of long-term marine monitoring programs
King 5 News	Is that algae safe? How to identify blooms in Washington waters
King 5 News	Ecologists find rare algae bloom in Chuckanut Bay near Bellingham
Kiro 7 News	Booming anchovy population helps salmon, orcas
Kiro 7 News	Red algae blooms in Puget Sound not "red tide"
Kitsap Sun	Water quality is defined by its effect on sea life
Kitsap Sun	Plankton blooms observed throughout Puget Sound
Kitsap Sun	Orange plankton bloom is not a good sign for ecological health
KOMO News	Noctiluca bloom in Chuckanut Bay may be a first
KUOW	Noctiluca bloom in Chuckanut Bay may be a first
KUOW	Puget Sound Salmon Losing, Jellyfish Winning
Seattle Times	Prime fish give way to hordes of jellyfish in Puget Sound
Ecology blog	Puget Sound Nutrient Watch: Algal Blooms
Journal of Olympia	Outdated Sewage Treatment Is Suffocating Fish In Puget Sound
KGMI	Anchovies flourish in the Puget Sound

Giving Puget Sound water quality a face while sharing outreach material

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Monitoring is a long-term commitment carried by many.

As the decades go by, it is time to reflect upon the evolution of the marine monitoring program. We would like to acknowledge and thank the marine monitoring staff that have built the foundation for marine flights and moorings since 1973. Many good times have been had, and we have come a long way. The data speak a story!



Brad Hopkins



Skip Albertson,
Bernie Strong



Carol Falkenhayn Maloy



Jan Newton



Casey Clishe, John Summers

1973 1999

*Dale Norton
Joe Joy
Brad Hopkins
Eric Egbers
Greg Cloud*

*Gerald McDonald
Will Abercrombie
Dale Clark
Sharon Chase
Ann Haines
Shirley Prescott*

*Carol Janzen
Wayne Heath
Bernie Strong
Lisa Eisner
Sharon Bell
Mark Golliet
Skip Albertson*

*Angie Thomson
Casey Clishe
Margaret Edie
Carol Maloy
Jan Newton
Chris Moore*

*Sandra Weakland
Julia Bos
Eric Siegel
Kara Van Voorhis
John Summers
Anne Petrenko*

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Julia Bos,
Stephanie Jaeger



Ingredients to success:

Consistent data quality comes with a commitment to detail, supporting staff, detailed documentation, transparency, ongoing data and method scrutiny, and a passion to improve.



Zack Holt

Jessica Archer



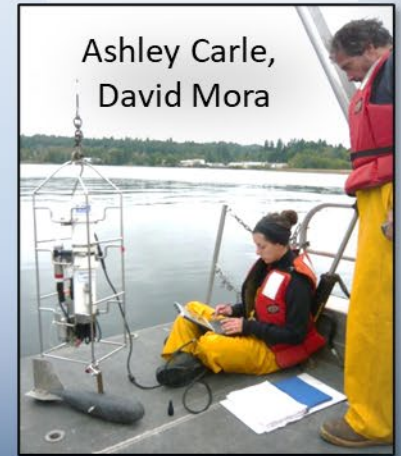
Simone Hoffer,
Ryan McEliece



Lynn Schneider



Ashley Carle,
David Mora



2000  2014

*Judah Goldberg
Rick Reynolds
Katherine Cox
Noel Larson
Brion Dolan
Brian Grantham*

*Stephanie Jaeger
Jessica Archer
Lynn Schneider
Ryan McEliece
Adrienne Stutes
Simone Hoffer*

*Jessica Bennett
Marissa Jones
Mya Keyzers
Zack Holt
Christopher Krembs
Brandon Sackmann
David Mora*

*Ashley Carle
Laura Hermanson
Suzan Pool
Julianne Ruffner
Christopher Clinton
Clifton Herrmann
Brooke McIntyre*

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A maturing program:

As monitoring datasets continue to grow in value and volume, the continued investment into data management, documentation, and relentless scrutiny of data quality become increasingly important and complex.



Mya Keyzers



Laura Hermanson



Stephen Gonski



Allison Brownlee



Elisa Rauschl



Suzan Pool



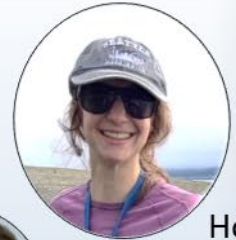
Christopher Krembs



Micah Horwith



Natalie Coleman



Holly Young



Chris Jendrey



*Mattie Michalek
Nichole Marks
Allison Brownlee
Juhi LaFuente*

*Stephen Gonski
Tyler Ransier
Grace McKenney
Ventus Pearce*

*Elisa Rauschl
Natalie Coleman
Micah Horwith*

*Chris Jendrey
Holly Young
Suzan Pool*

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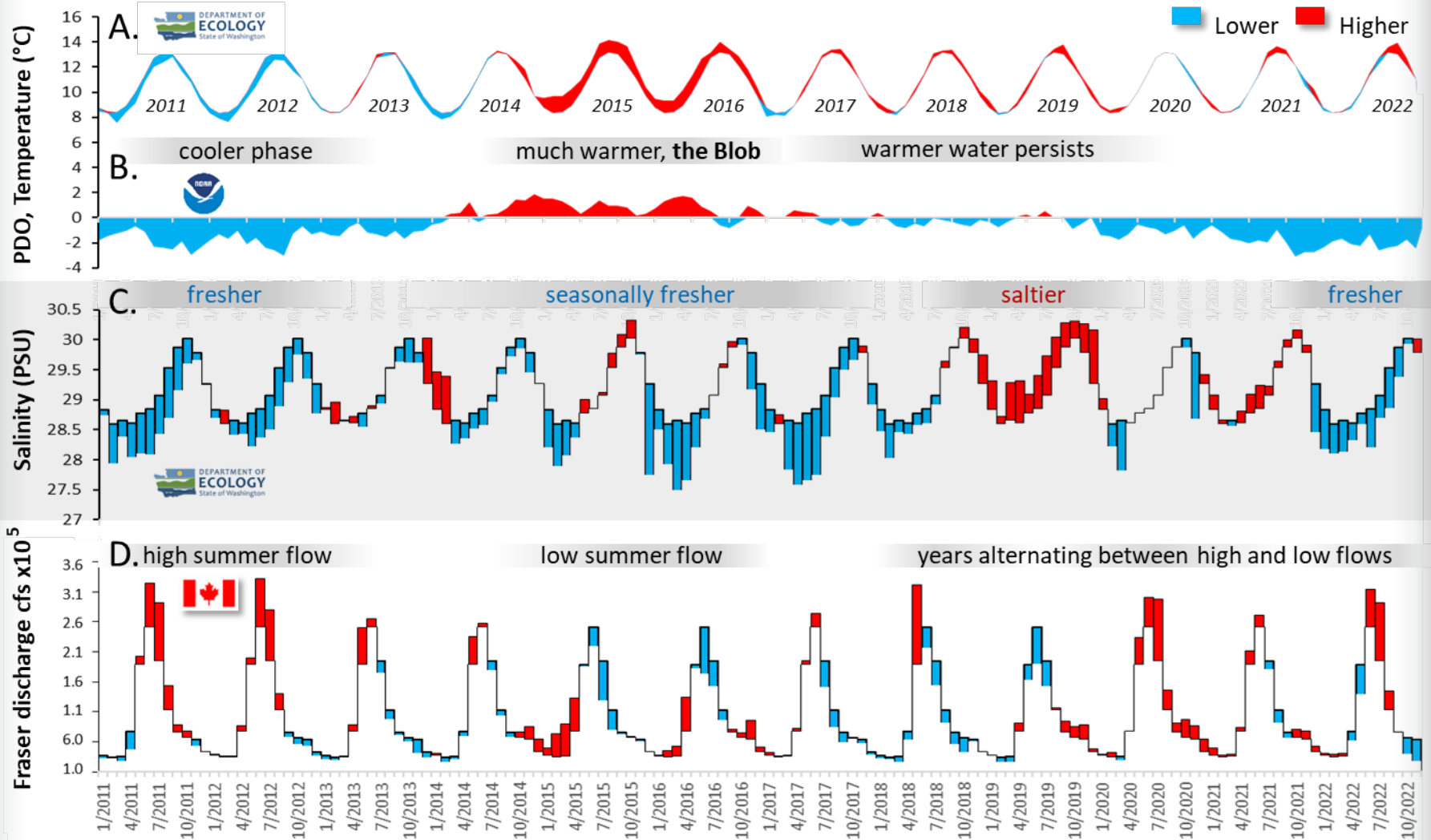
LONG-TERM MARINE MONITORING UNIT



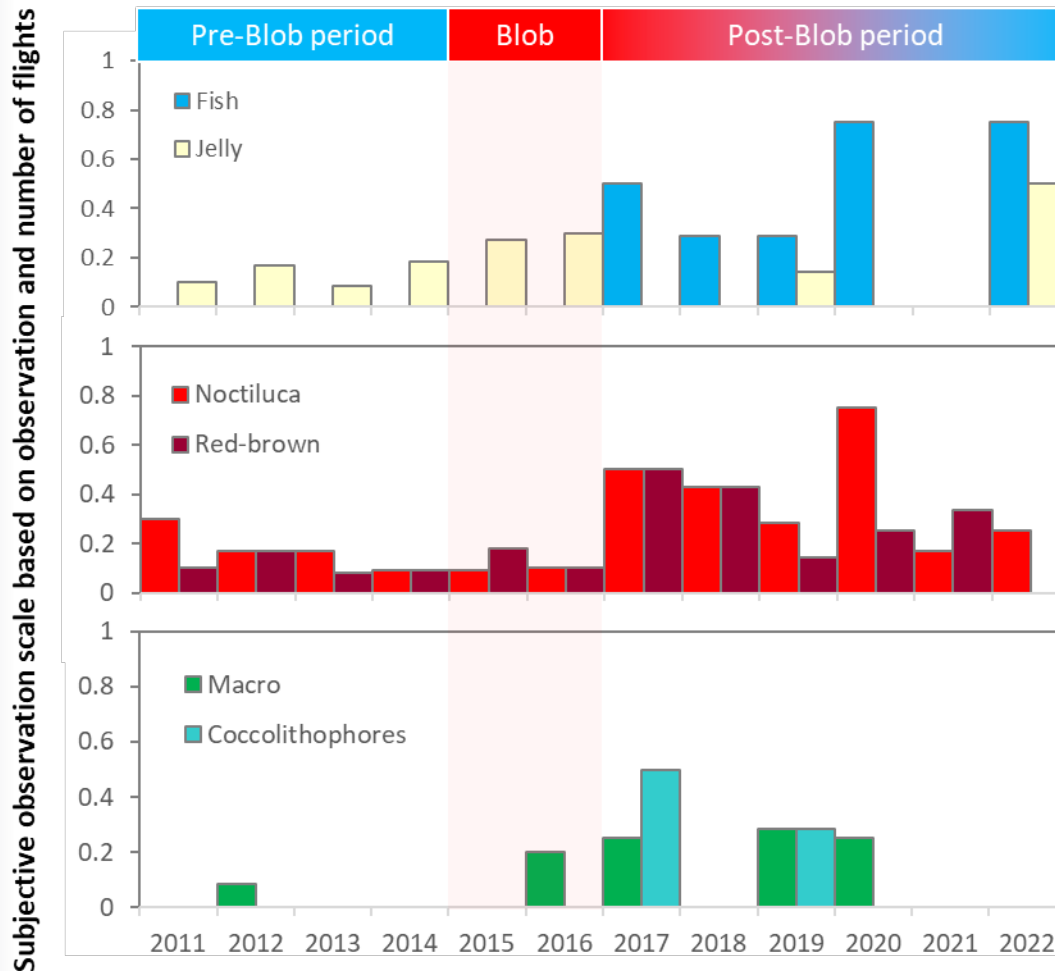
The Blob, a marine heatwave in the Pacific Ocean, go to next page

2011-22	Puget Sound before, during, and after the Blob
2011	Noctiluca abundant, we see our first jellyfish smacks
2012	Noctiluca and its grazing impact, red blooms, jellyfish
2013	Noctiluca in masses and diverse places
2014	Sediment from Oso landslide , jellyfish on the rise
2015	Jellyfish masses, Noctiluca, blooms, and sediment
2016	Jellyfish masses, Noctiluca, macroalgae, and blooms
2017	After the blob, diverse big blooms, macroalgae, fish
2018	Bright red blooms, Noctiluca, macroalgae, and fish
2019	Coccolithophore, Noctiluca, macroalgae, and fish
2020	Abundant fish, people contributing amazing pictures
2021	Noctiluca, and many blooms in bright colors, geese
2022	Abundant fish, jellies are back, and sediment

Snow and rivers respond to periods of increased temperatures. The Blob B. from 2015 to 2016 seen as high Pacific Decadal Oscillation Index values (PDO) raised water temperatures A., changed the Fraser River discharge D., and lowered surface salinities C. in Puget Sound, followed by a saltier period two years later in 2018-19.



Marine Monitoring programs are in a position to use an abundance of observations and formulate hypotheses to further engage science on pressing climate related issues. In the following decadal review, we illustrate the effect of a two-year climate disturbance, the Blob, on surface observations in the larger Puget Sound region



A decade of aerial documentary can reveal patterns despite limited observations over space and time. For example, it appears that Puget Sound responds to a large disturbance characterized by a period of warm water: the Blob.

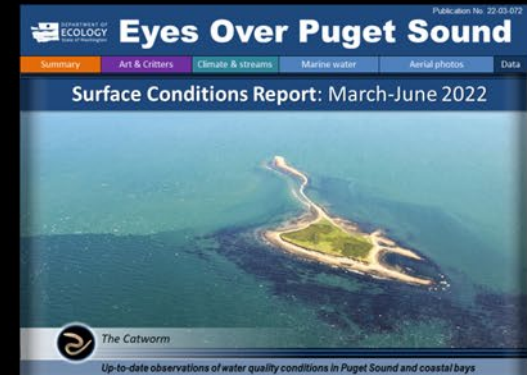
We noted a transition from abundant jellyfish to schools of anchovies for many terminal inlets. Likewise, the frequency and extent of Noctiluca and other red colored blooms increased temporarily after 2016. Likewise, so did macroalgae and coccolithophore blooms. While subjective, this is an interesting ecosystem response.

What we presented at the 2018 Salish Sea Ecosystem Conference, [read here](#)

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2022

A third year of La Niña weather and changes at Kenmore Air made flying for aerial photography challenging. Due to the La Niña, the winter of 2022 was especially cold and wet, resulting in a good snowpack. Low air temperatures, rain, and late snow accumulation in the mountains pushed back the discharge of meltwater to Puget Sound in stark contrast to the Blob years, where snow melted and discharged into Puget Sound prematurely. Jellyfish patches were small in South Sound. Central Sound saw more oxygenated conditions. By June, a high number of schooling fish appeared in South Sound and Whidbey Basin. By late summer, weak upwelling off the coast meant likely less nutrient-rich upwelled water to Puget Sound and could be a possible explanation of low productivity and clearer water. By October, smoky air from forest fires confined our flight to southern and central Puget Sound where we documented some remnant blooms as well as jellyfish.



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Patches of jellyfish and a red-brown and turquoise blooms. Location: Budd Inlet (South Sound), 11:57 AM

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Puyallup River plume seen from the river side.
Location: Commencement Bay (Central Sound), 12:47 PM

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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*High number of schooling fish. On the image, we count more than 85 schools (marked with white vertical lines).
Location: Case Inlet (South Sound), 12:05 PM*

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Strong discoloration of water in Port Susan by bloom and sediment. Fronts surrounding the Stillaguamish River plume. Location: Port Susan (Whidbey Basin), 12:46 PM

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Green bloom mixed with nearshore suspended sediment.
Location: Similk Bay (Whidbey Basin), 12:56 PM



Eddy and suspended sediment in Outer Bay. Greener water in Inner Bay.

Location: Lopez Sound (San Juan Islands), 1:13 PM



People contribute their observations



Summary People 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 Data

A.



B.



Tomato soup on the waterfront (Russel Barsh for KWIAHT, May 11, 2022)
theorcasonian.com/tomato-soup-on-the-waterfront/

Photo courtesy of Anita Holliday


A repeating observation of Noctiluca blooms in East Sound, Orcas Island.

A. Mya Keyzers, 7/14/2021. B. Anita Holliday, 5/11/2022.

2021

The year 2021 was generally drier and warmer including a heat wave in June. Higher river flows followed a rainy and cloudy fall. In 2021, EOPS aerial images continued to capture the diversity of phenomena on the water, with support from its wonderful contributors who documented visible water quality issues across the larger Puget Sound region. With our Artists Corner and story maps on critters in the mud, we hope to continue to inspire, educate, and motivate our community to keep curious and watchful eyes over the environment.

Publication No. 22-03-070



Eyes Over Puget Sound

Overview | Art & Critters | Awesome people | **New tools** | Combined factors | Aerial photos | Data

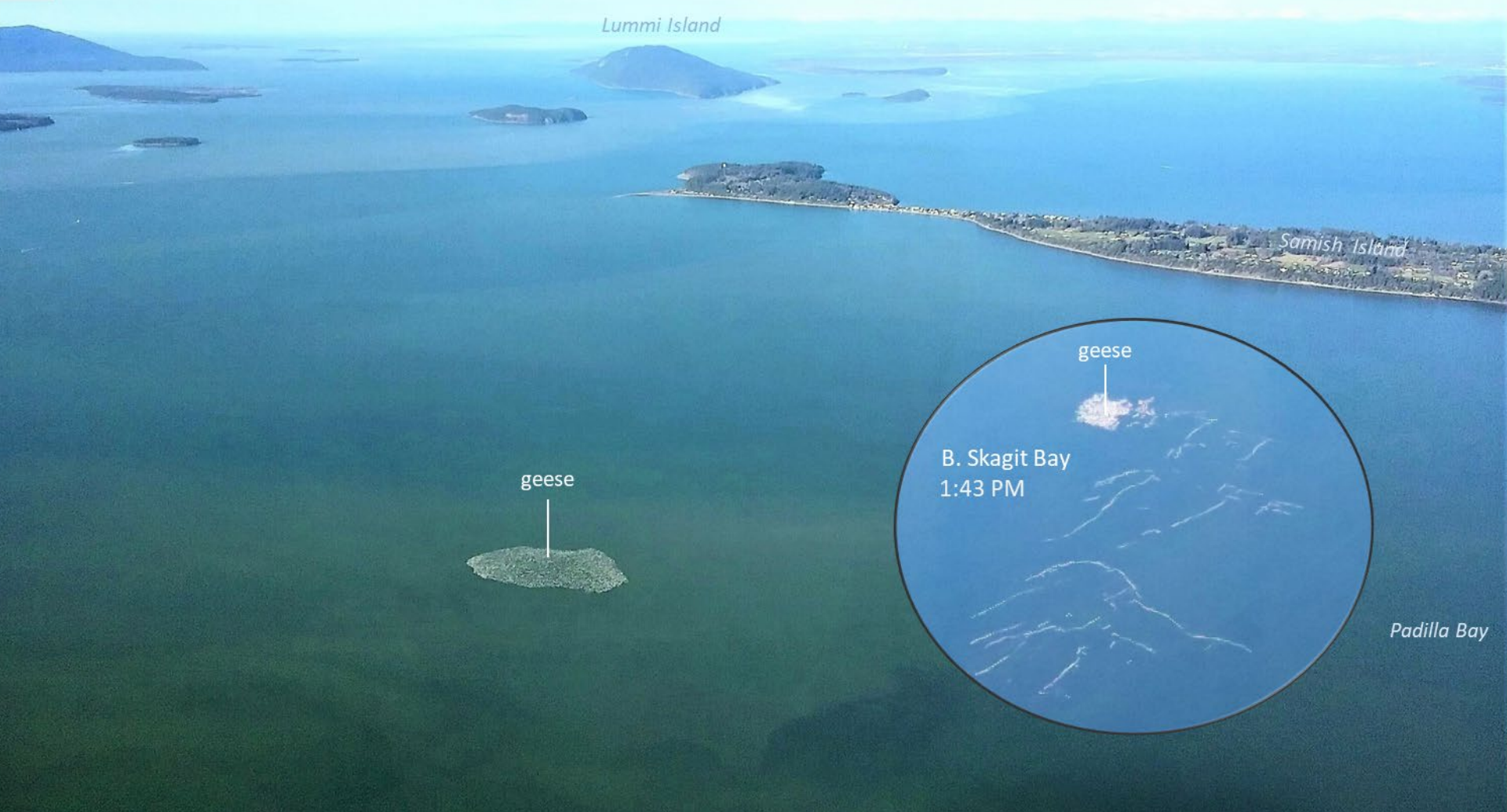
Surface Conditions Report: 2021 in review

[Surface Conditions Report: February 3, 2021](#)
[Surface Conditions Report: March 13, 2021](#)
[Surface Conditions Report: April 1, 2021](#)
[Surface Conditions Report: June 17, 2021](#)
[Surface Conditions Report: Sept 8, 2021](#)

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

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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A.



A. Large flock of geese floating in open water. B. Geese landing in formation in open water. Read more
Location: A. Padilla Bay, B. Skagit Bay (North Sound), 1:35 PM

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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*Bloom along front in Mosquito Bay originating in Horseshoe and Mitchell Bays.
Location: San Juan Island (San Juan Islands), 1:24 PM*

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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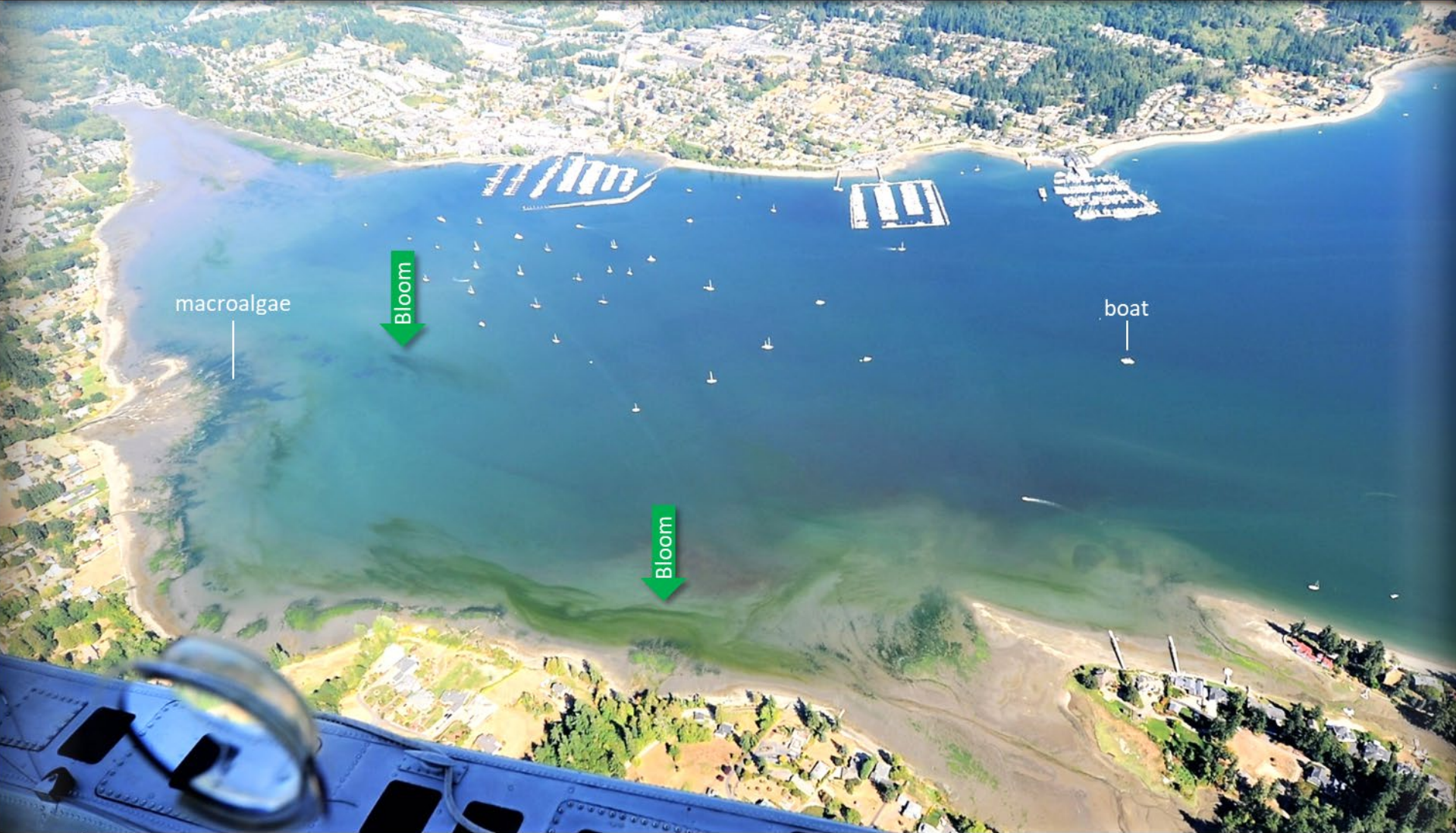
Strong red-brown bloom.
Location: Budd Inlet (South Sound), 11:34 AM

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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*Very red-brown bloom spanning the entire length of Kilisut Harbor, from the entrance of the bay to Scow Bay.
Location: Marrowstone Island (Central Sound), 1:50 PM*

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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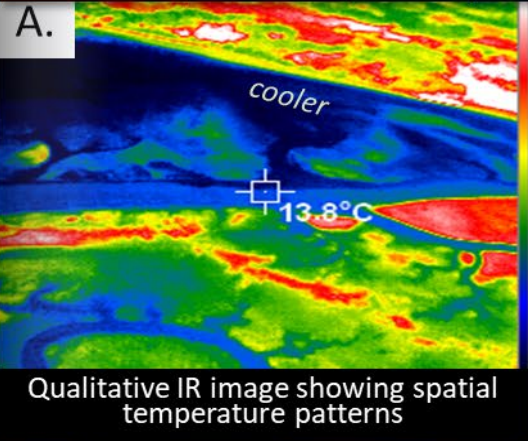
*Bright-green bloom patches in shallow portions of Liberty Bay.
Location: Liberty Bay (Central Sound), 2:02 PM*

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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*Strong red-brown bloom with turquoise water mixing in from Chapman bay.
Location: Henderson Inlet (South Sound), 2:30 PM*

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Padilla Bay seagrass experiences much cooler temperatures north of the tidal gully. Sediment from south of the gully discolors the water. Location: Padilla Bay (North Sound), 12:35 PM

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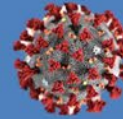
Noctiluca reported on 7/2/2021 near Alki Point (ERTS #707751)



Puyallup River plume with glacial flour, bloom, and orange organic debris (likely Noctiluca) accumulating at front. Location: East of Maury Island (Central Sound), 2:22 PM

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2020



The COVID-19 pandemic of 2020 resulted in an information gap in our work between March and September. Our field crew restored full capacity and data collection, and aerial photography resumed in September.

Critters in the sediment and water are a testament that life continues in beautiful ways, and it's worth going for a dive in Puget Sound when the water is clear. Despite wildfires and a lot of smoke during a dry late summer, precipitation and flows of major rivers were as expected, or even above normal, for most of the year. With volunteers sending in images on the water we can say that 2020 was a productive year for Puget Sound. Schools of herring were abundant, Noctiluca blooms were big and numerous, and large amounts of decaying organic material washed onto beaches.

Publication No. 21-03-070



Eyes Over Puget Sound

Summary
Stay connected
COVID Stories
Critters & Divers
Climate and streams
Aerial photos
Info




Picture by:  JESSIE MILLER



2020 in Review




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



People contribute their observations



Summary People 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 Data

Des Moines Marina, 6/7/20 (Robin Beck)



Three Tree Point, 6/7/2020 (Elisa Rauschl)



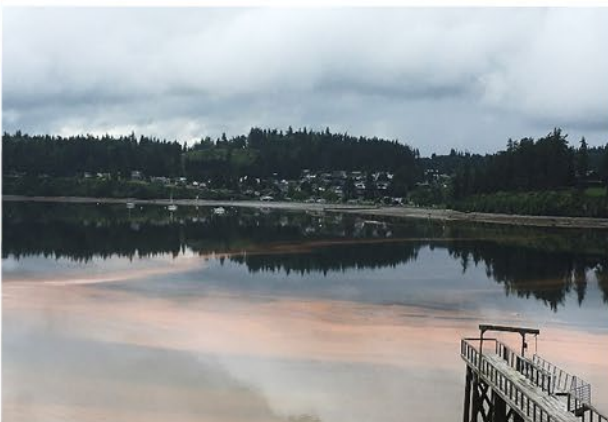
Lincoln Park 6/10/2020 (Ben Budka)



Chuckanut Bay, Bellingham Bay, 8/4/2020
(Steve Tuckerman)



Holmes Harbor, 6/16/2020 (Christine Goodwin)



Saddlebag Island, 8/11/2020 (Kathryn Sobocinski)



Noctiluca is a putative eutrophication indicator that thrives when excess organic material is present.



People contribute their observations



Summary People 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 Data

A.

Bowman Bay, 7/16/2020 (Julie Morse)



B.

Allyn-Grapeview, Case Inlet, 7/29/2020 (Michael Joffe)



Algae blooms can come in all colors, sometimes bright yellow-green as in A. Bowman Bay, or B. brown-red such as the *Protoceratium reticulatum* bloom in Case Inlet which persisted for several months.



People contribute their observations



Summary People 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 Data

Redondo, 9/1/2020 (Cliff Coomber)



Dash Point State Park, 8/30/2020 (Katharine Ellingson)



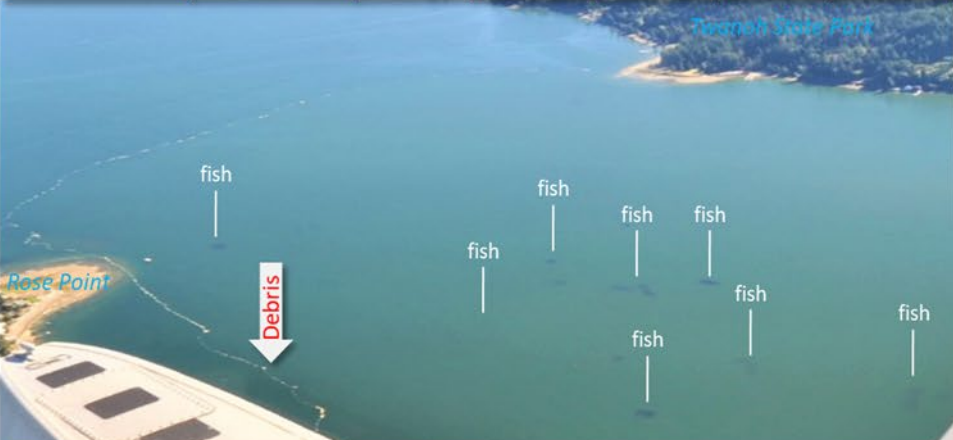
Tramp Harbor Docton, 8/27/2020 (Karlista Rickerson)



Tramp Harbor, *Protoceratium reticulatum* bloom in August (Karlista Rickerson)

When organic material and debris from excessive amounts of algae die, it washes onshore as mucus.

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Schools of fish near the surface.
Location: Twanoh State Park, (Hood Canal)



Several large schools of fish around Point Jefferson.
Location: Port Madison (Central Sound)



Isolated red-brown bloom surrounded by schools of fish.
Location: North Bay, Case inlet (South Sound)

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A. A dozen fishing vessels harvest the annual chum salmon run south of the bridge, B. while others are waiting north of the bridge. Location: Hood Canal Bridge, (Hood Canal)

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2019

2019 started with snow, and a summer drought kept river flows low. As a result, salinities in Puget Sound were elevated year-round. Warmer surface water temperatures in spring gradually extended to greater depth by late summer. The spring bloom was strong, and South Sound provided optimal conditions for anchovies that showed up in high numbers. A coccolithophore bloom stained Hood Canal turquoise, and Port Angeles and Discovery Bay were colored red-brown by strong blooms. Noctiluca and macroalgae, both known eutrophication indicators in coastal regions, were abundant in Central Sound, and extended into South Sound and Whidbey Basin. Large numbers of jellyfish occurred in Quartermaster Harbor, Sinclair Inlet, and parts of Orcas Island.



Publication No. 20-03-070

Eyes Over Puget Sound

DEPARTMENT OF ECOLOGY

Critters | Climate and streams | Fish and food | Aerial photos | Info

Eyes Over Puget Sound Surface Conditions Report: February 21, 2019

Eyes Over Puget Sound Surface Conditions Report: March 26, 2019

Eyes Over Puget Sound Surface Conditions Report: May and June 2019

2019 in Review

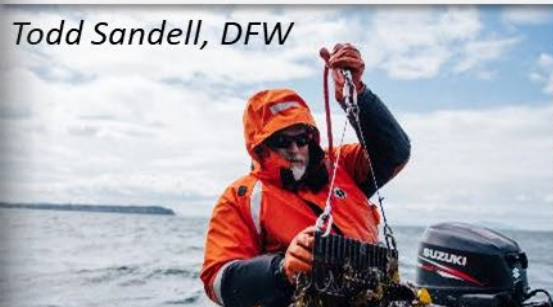
Eyes Over Puget Sound Surface Conditions Report: July 29, 2019

Eyes Over Puget Sound Surface Conditions Report: September 12, 2019

Eyes Over Puget Sound Surface Conditions Report: October 30, 2019

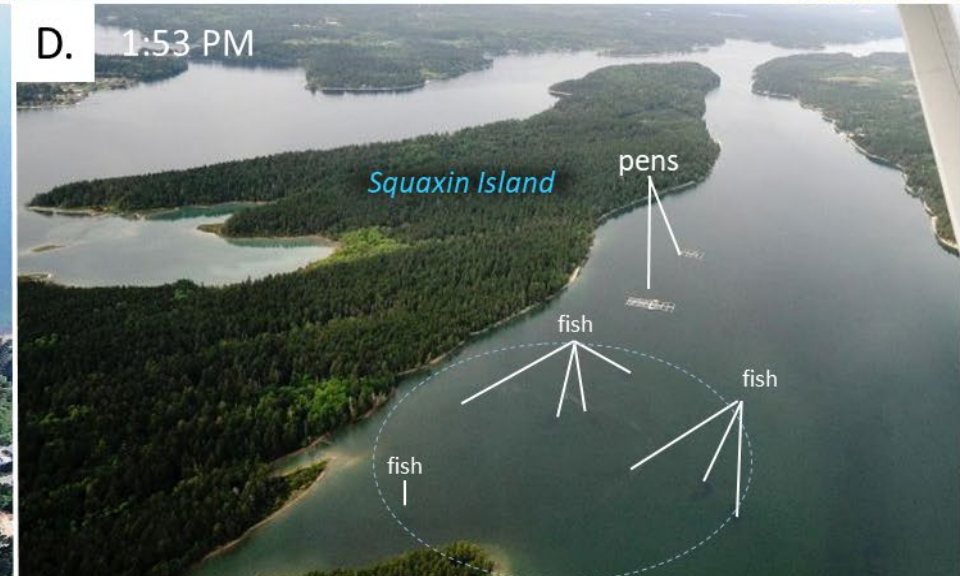
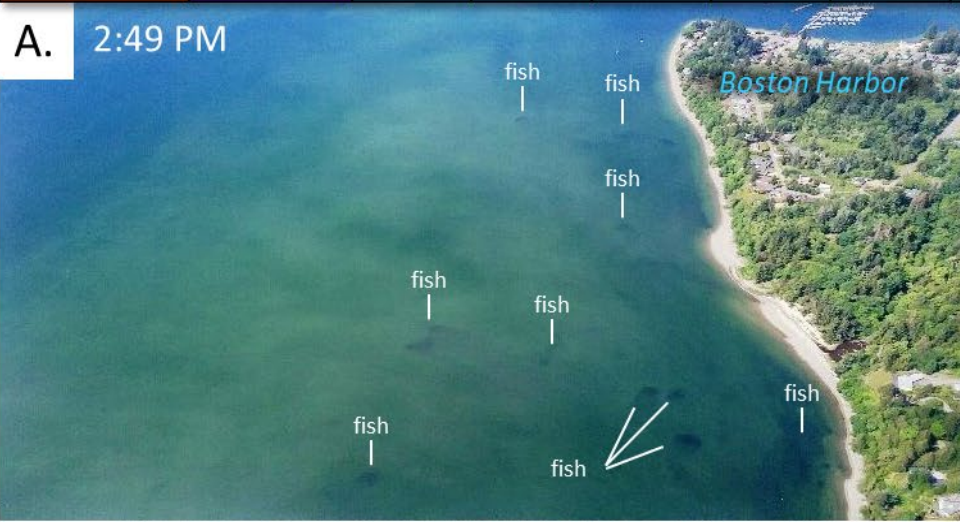
Up-to-date observations of visible water quality conditions in Puget Sound and the Strait of Juan de Fuca

Scientists catch anchovies in shallow and deep water of Case Inlet



Large numbers of juvenile anchovy began to appear in South Sound with warmer water in the fall of 2015 and have been present in annual fall surveys since then. Here is an example of 250K juvenile anchovies caught with only one net set.

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Schools of fish in shallow regions of South Sound.

Location: A. Budd Inlet, B. Eld Inlet, C. Case Inlet (North Bay), D. Peale Passage (South Sound)

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We share people's experiences with Noctiluca on the water. Thank you for the great contributions.
Location: A. Des Moines Marina, B. Holmes Harbor, C. Edmonds, D. Port Blakely, E. Central Sound



*Large Noctiluca bloom stretching from Poverty Bay to West Point.
Location: Shorewood (Central Sound), 2:15 PM*

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Large rafts of macroalgae stretching along the shores of Manchester.
Location: Manchester (Central Sound), 2:41 PM

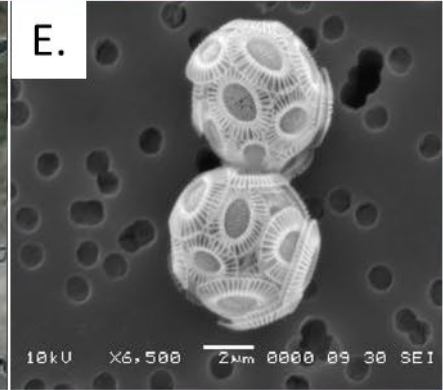
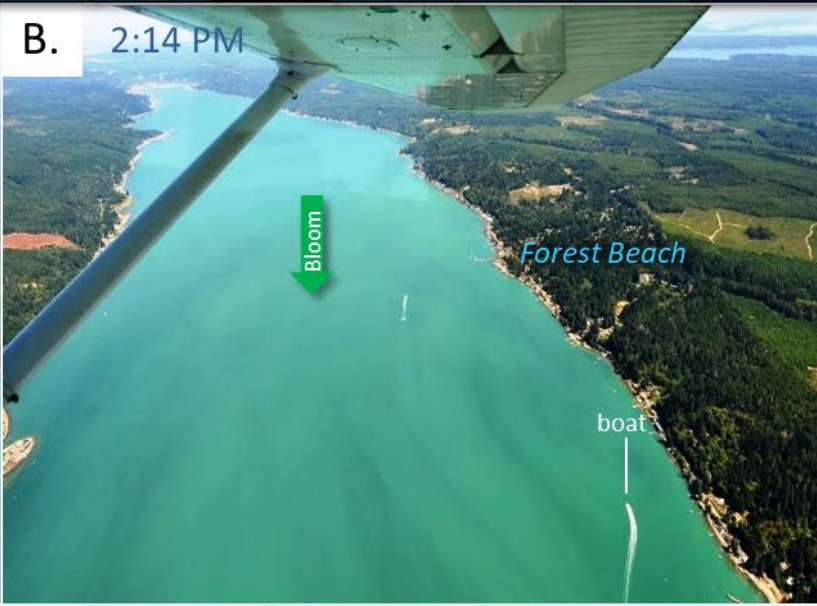
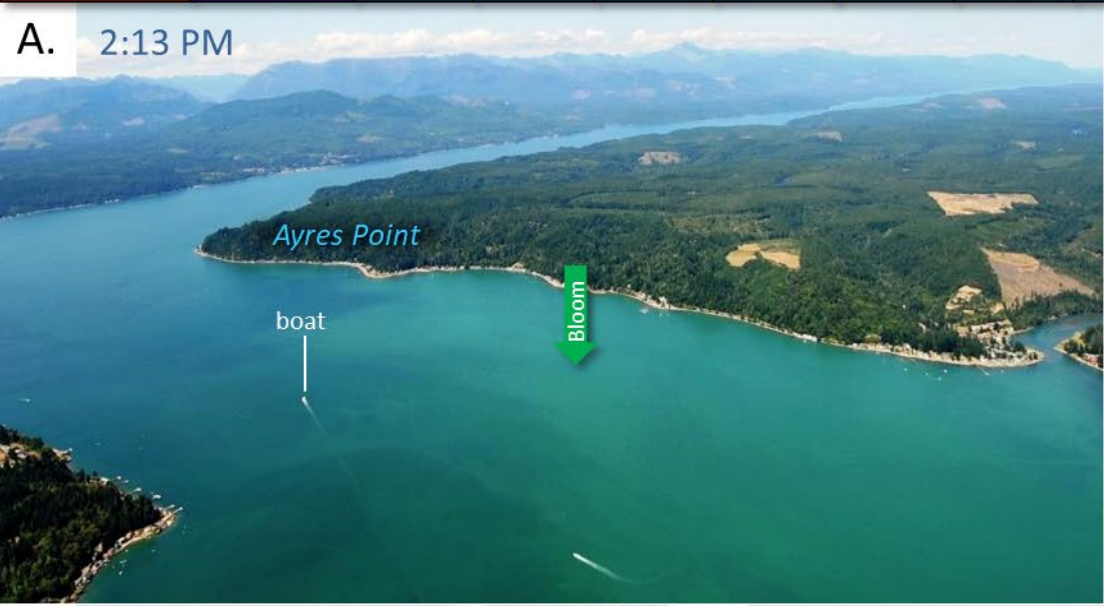
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A. & B. Large rafts of macroalgae. C. Macroalgae washing onto beaches. D. Beachgoers touching macroalgae.

Location: A. Across Discovery Park, B. Blakely Harbor, C. Burien, D. Dash Point (Central Sound), 2:39 PM

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D. NASA satellite image southern Hood Canal

E. Microscopic coccolithophore

*Strong coccolithophore bloom stretching from Union (A) to Lynch Cove (B). C. Twanoh State Park.
Location: A–D. Southern Hood Canal (Hood Canal)*

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*Red-brown bloom, schooling fish, and a patch of jellyfish.
Location: Eld Inlet (South Sound), 1:49 PM*

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Red-brown bloom and very turbid water.
Location: Quartermaster Harbor (Central Sound), 2:20 PM

2018

In 2018, water temperatures were slightly warmer than normal. Aerial photos revealed many spawning herring and baitfish as well as algal blooms. We also saw abundant macroalgae, a persistent Noctiluca bloom, and countless red blooms. Were these observations related to the cool, wet spring followed by a warm, dry, and sunny summer? Or did the neutral boundary conditions in the Pacific Ocean also play a role? A full summary is available in the report.

Publication No. 19-03-070



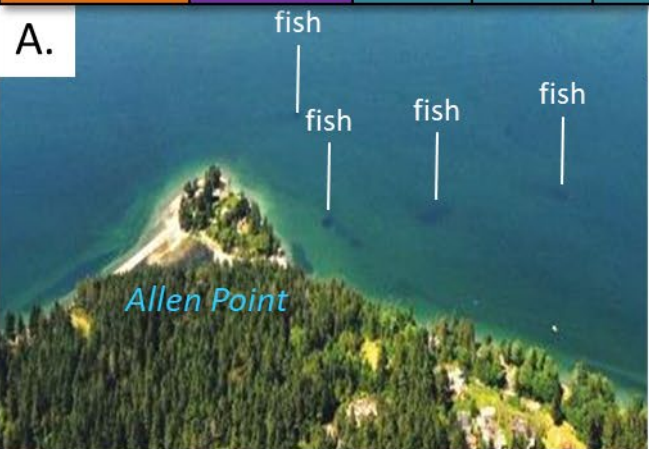
The image shows the cover of the 'Eyes Over Puget Sound' 2018 Review report. The cover features a central photograph of two people, a man and a woman, looking through binoculars over the water. The title 'Eyes Over Puget Sound' is prominently displayed at the top, with '2018 Review' in the center. Below the title, there are navigation tabs for 'Food for thought', 'Climate and streams', 'Fish and food', 'Aerial photos', and 'Info'. The cover is decorated with a grid of smaller thumbnail images showing various water quality observations, including aerial views of the water and close-ups of water conditions. At the bottom, a caption reads: 'Up-to-date observations of visible water quality conditions in Puget Sound and the Strait of Juan de Fuca'.



Bright red-brown-purple bloom with an occasional jellyfish patch.

Location: Sinclair Inlet (Central Sound), 1:49 PM

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Many patches of schooling fish.

Location: A. Near Allen Point. B. Near Purdy Sand Spit (South Sound), 12:00 PM



Large ribbons of Noctiluca and macroalgae accumulating at the surface.
Location: Poverty Bay (Central Sound), 1:34 PM

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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*Large mats of macroalgae accumulating off beaches in southwestern portions of Carr Inlet.
Location: Carr Inlet (South Sound), 1:03 PM*

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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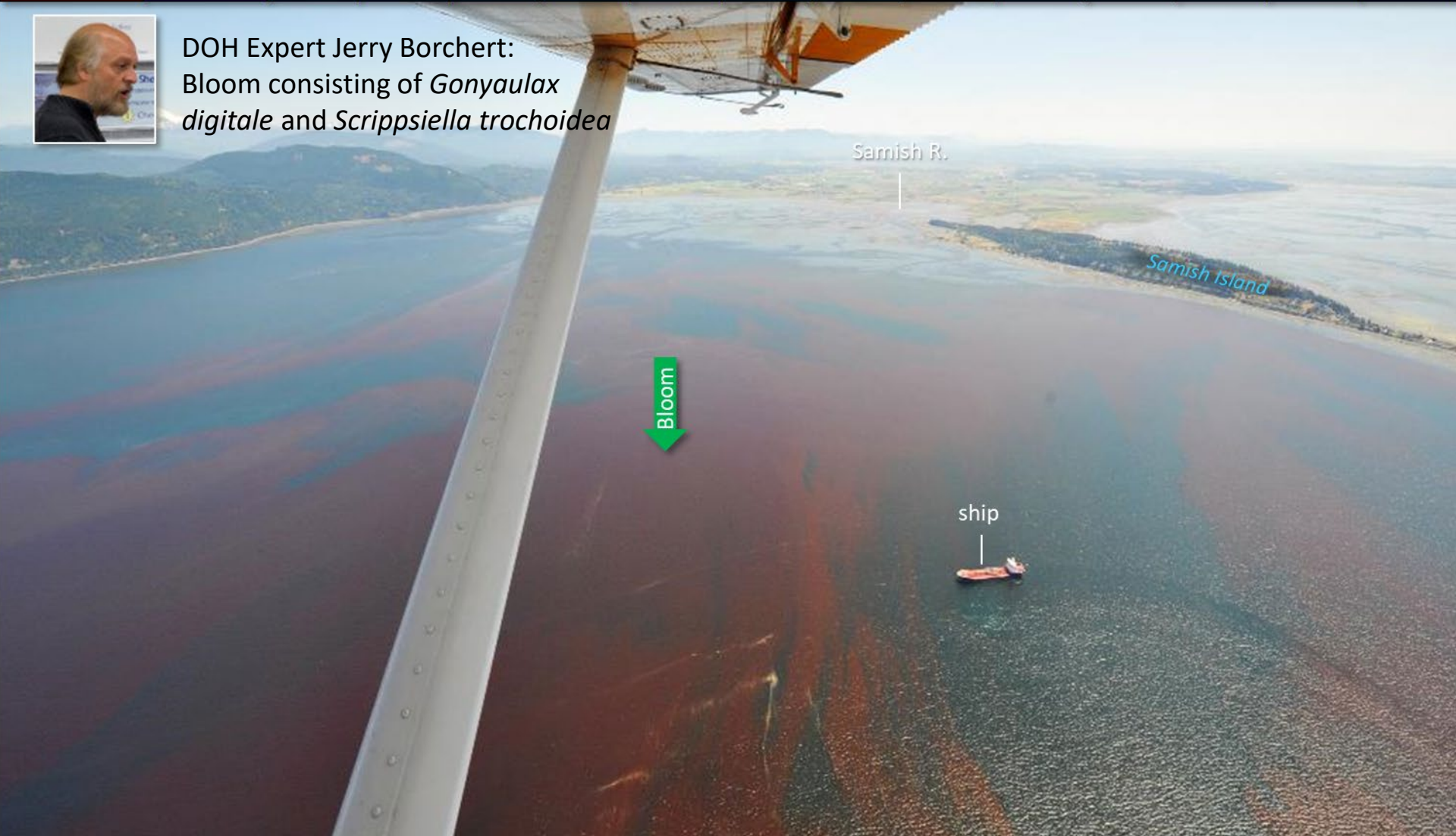


*Red-brown bloom extending in long ribbons from Samish Bay into Padilla Bay.
Location: Samish Island (North Sound), 2:01 PM*

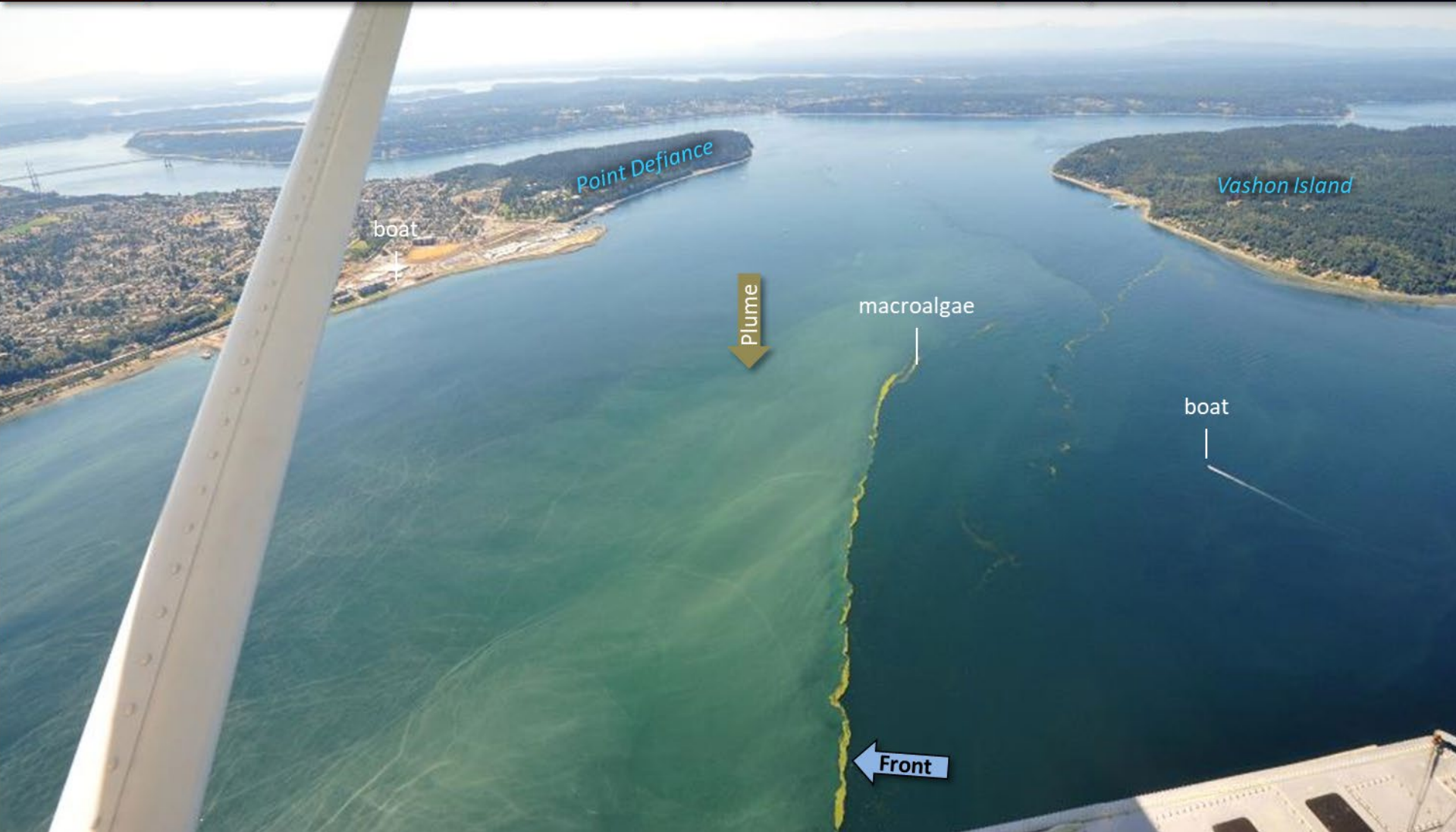
Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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DOH Expert Jerry Borchert:
Bloom consisting of *Gonyaulax digitale* and *Scrippsiella trochoidea*



Large and very patchy red-brown bloom.
Location: Samish Island (North Sound), 2:03 PM



*Large mats of macroalgae accumulating along edges of Puyallup River plume.
Location: Commencement Bay (Central Sound), 3:12 PM*

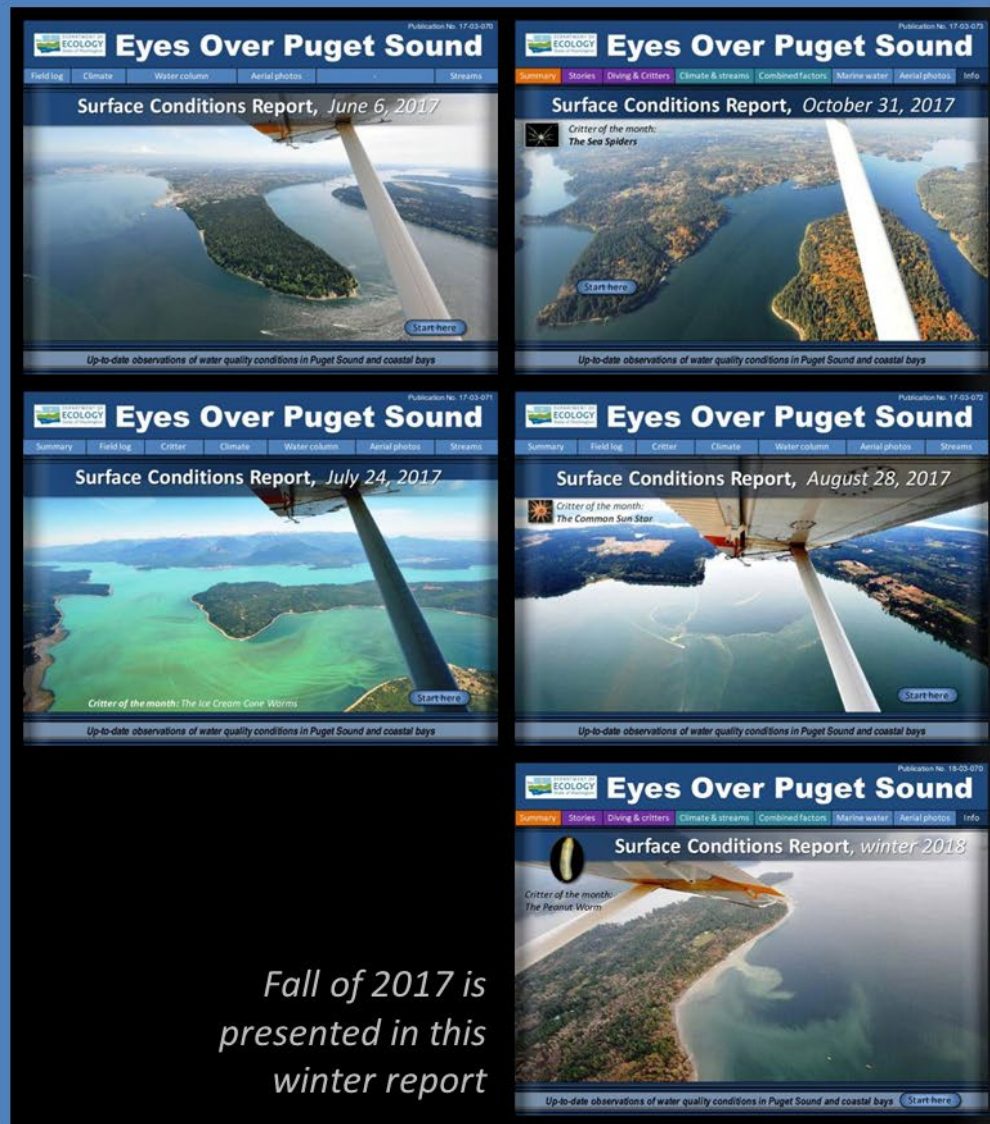
Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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*Vivid red-brown bloom covering large portions of Sequim Bay north to Pitship Point.
Location: Sequim Bay (Strait of Juan de Fuca), 1:26 PM*

2017

In early 2017, cooler and wetter conditions combined with high river flows set the stage for a favorable supply of freshwater, creating significantly fresher marine conditions in Puget Sound. By July, above normal sunshine resulted in intense and unusual blooms in Hood Canal (coccolithophores) and South Sound inlets. Large mats of macroalgae drift at the surface. Many schools of fish are visible, yet jellyfish are remarkably absent. By August, despite a dry summer, water is still fresher than in the past 17 years, lasting well into October. By the end of 2017, large-scale climate, weather patterns, and stream flows finally returned to normal.



Fall of 2017 is presented in this winter report

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Bright yellow-green bloom.

Location: Oyster Bay/Dyes Inlet (Central Sound), 1:27 PM.



A train of internal waves traveling towards Skagit Bay.
Location: Entrance to Skagit Bay (Whidbey Basin), 1:59 PM.

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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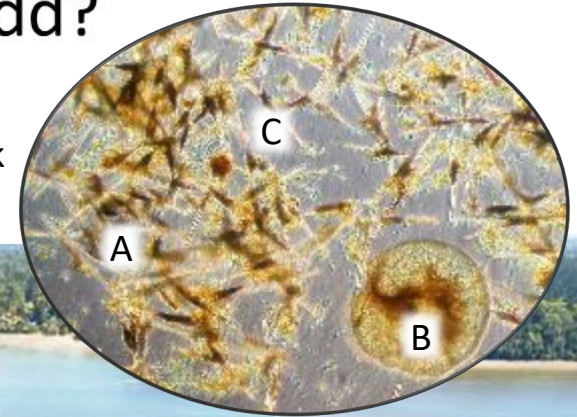


*Sediment plume from the Puyallup River and red-brown bloom entering the Tacoma Narrows.
Location: Gig Harbor (Central Sound), 2:38 PM.*



What's Blooming in Budd?

Aimee Christy collected a 3m net tow sample from 2 lower Budd Inlet locations during the bloom and observed a thick tangle of *Ceratium fusus* (100X magnification).



Ceratium fusus (A) and one *Noctiluca* (B), and *Hypophysis* (C) under the microscope



Large, very patchy orange-brown bloom.
Location: Budd Inlet (South Sound), 11:56 AM.

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Red-brown bloom and schools of fish off Young Cove.

Location: Eld Inlet (South Sound), 12:04 PM.

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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*Coccolithophore bloom, extending to Bangor. Other red-brown and brown purple bloom near surface.
Location: Near Dabob Bay (Hood Canal), 12:38 PM.*

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Large mats of macroalgae near Puyallup River plume.
Location: Commencement Bay (Central Sound), 1:07 PM.

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Schools of fish and macroalgae in shallow water.
Location: Mayo Cove, Carr Inlet (South Sound), 1:17 PM.

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Schools of fish in red-brown bloom.
Location: Henderson Inlet (South Sound), 1:27 PM.



Large red-brown bloom and front.

Location: Elwood Point, Dyes Inlet (Central Sound), 12:49 PM.

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Red-brown bloom mixed in with water colored in green-ochre.

Location: Sinclair Inlet (Central Sound), 12:52 PM.

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Green bloom.

Location: North Bay, Case Inlet (South Sound), 12:59 PM.

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Noctiluca bloom mixed in with green bloom along tidal front.
Location: Off Stretch Island, Case Inlet (South Sound), 1:03 PM.



*Organic material accumulating at tidal front next to intense green and orange bloom.
Location: Off Samego Point, McNeil Island, Carr Inlet (South Sound), 1:32 PM.*

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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*Large rafts of macroalgae accumulating along front. Plume of Puyallup River extending north.
Location: Off Maury Island (Central Sound), 1:45 PM.*

2016

The year 2016 in pictures: After two years of very warm air and record high water temperatures starting with the Blob (2015) and followed by El Niño (2016), temperatures have fallen and remain slightly warmer than normal in Puget Sound. Very low summer river flows (e.g., Fraser River) reflect climatic predictions for the NW. Record temperatures and low salinities occurred alongside observations of abundant jellyfish, floating macroalgae, and *Noctiluca* blooms. Surprisingly, only South Sound developed very low summer oxygen levels in 2016. In the fall, La Niña came with a punch, rain increased, and air temperatures dropped. Will this be an unusual La Niña?

Publication No. 16-03-079



EYES OVER PUGET SOUND

EOPS | Weather | Climate | Species Respond | Water column | Aerial photos

2016 Review

El Niño, January 2016 | La Niña, September 2016

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

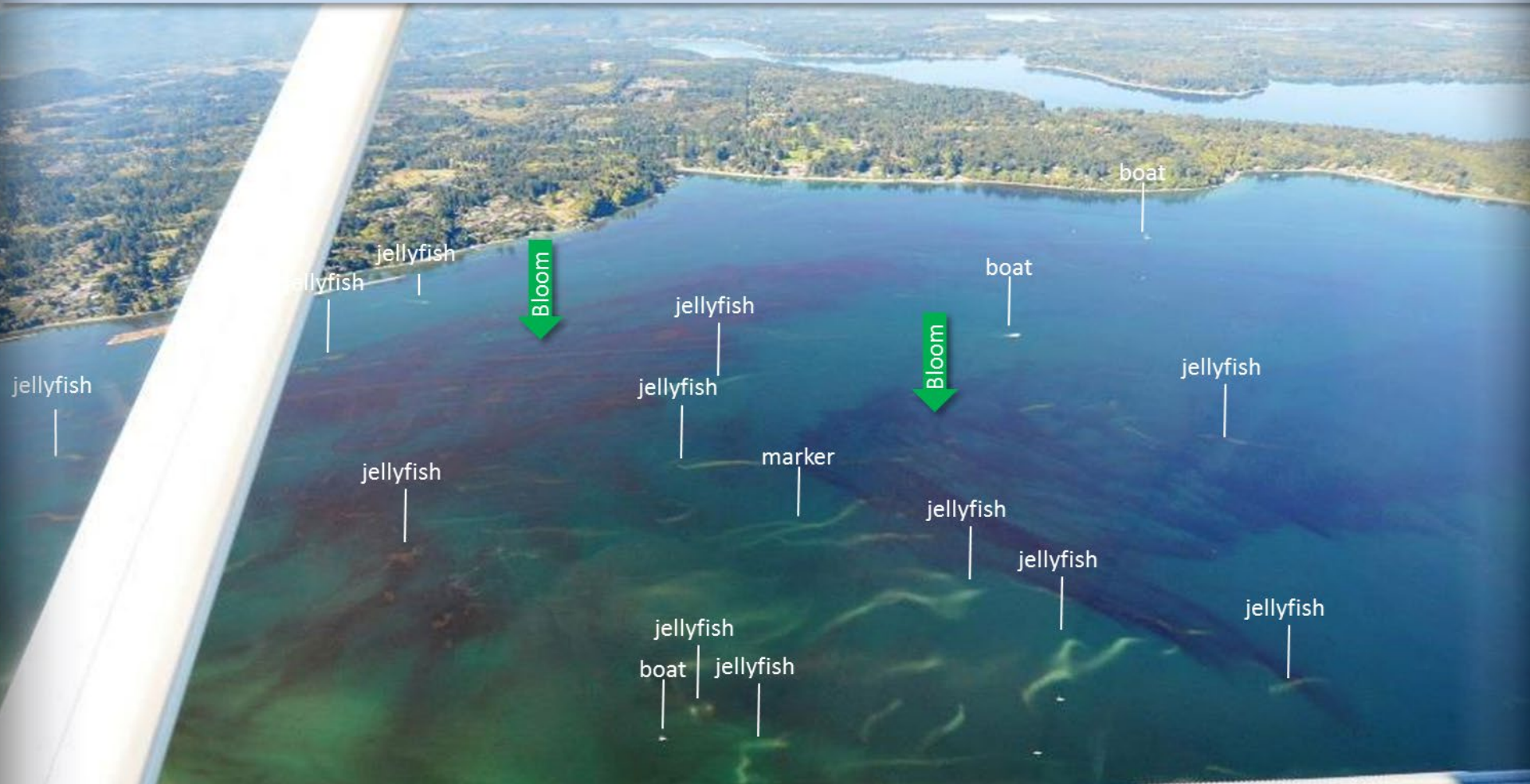
Where do all the macroalgae end up after July? A lot of the material ends up on beaches.



Algae washed up on beaches in thick layers and rotting.
Location: Edmonds Underwater Park, Snohomish County, July 2016.

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Jellyfish and red-brown dinoflagellate blooms thriving in warm, stagnant water in late summer.



*Two differently colored red-brown blooms and abundant jellyfish patches.
Location: Budd Inlet (South Sound), September 2016.*

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Noctiluca thriving in eutrophic, stagnating water in many places, May-August 2016.



Noctiluca bloom, marine in Budd Inlet



Noctiluca and organic material accumulating near Boston Harbor Entrance to Budd Inlet (South Sound),.



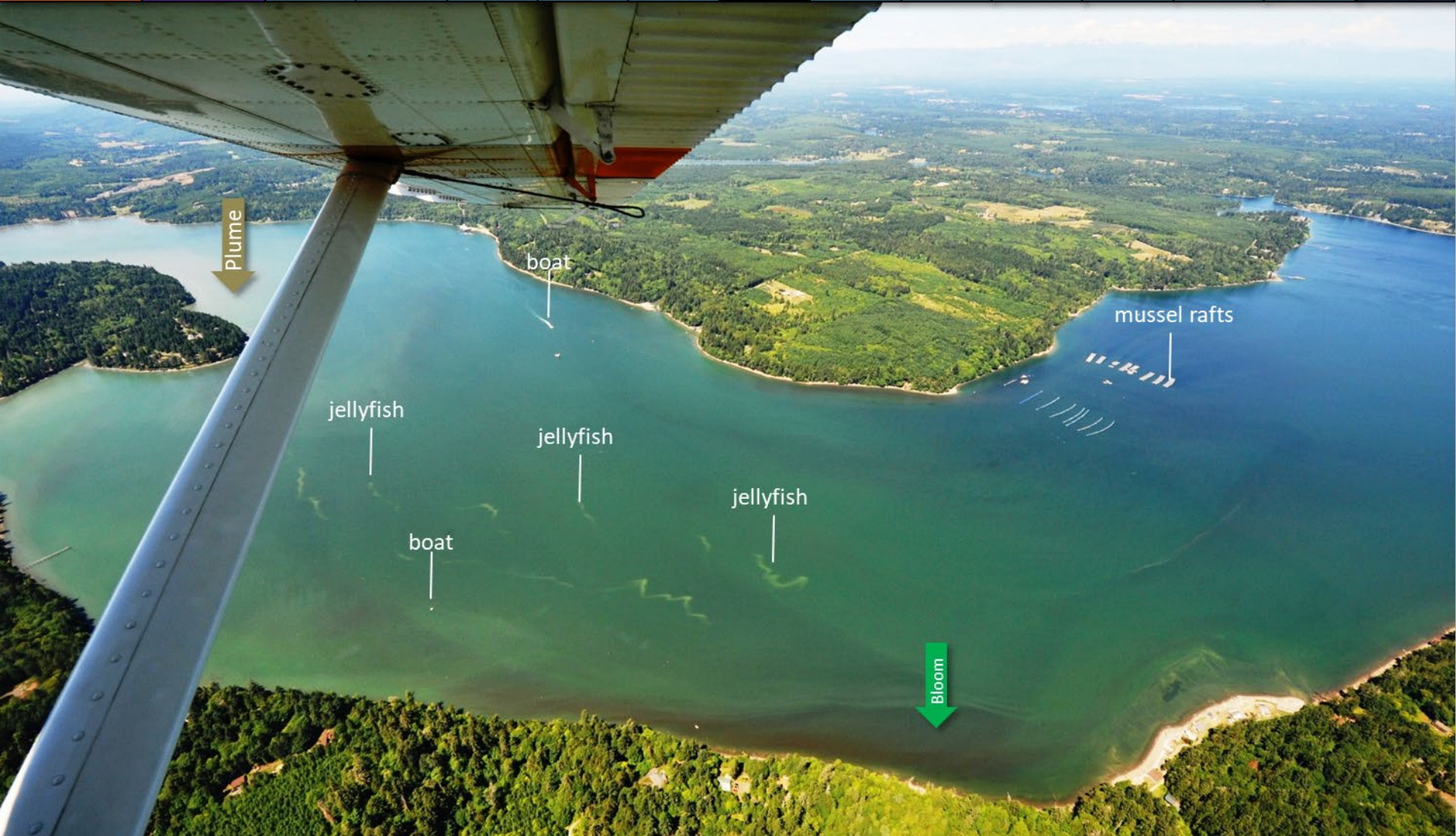
Noctiluca bloom Pickering Passage, Case Inlet

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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*Organic material accumulating in large ribbons along tidal front at the entrance to Budd Inlet.
Location: Across from Boston Harbor, Budd Inlet (South Sound), 12:51 PM.*

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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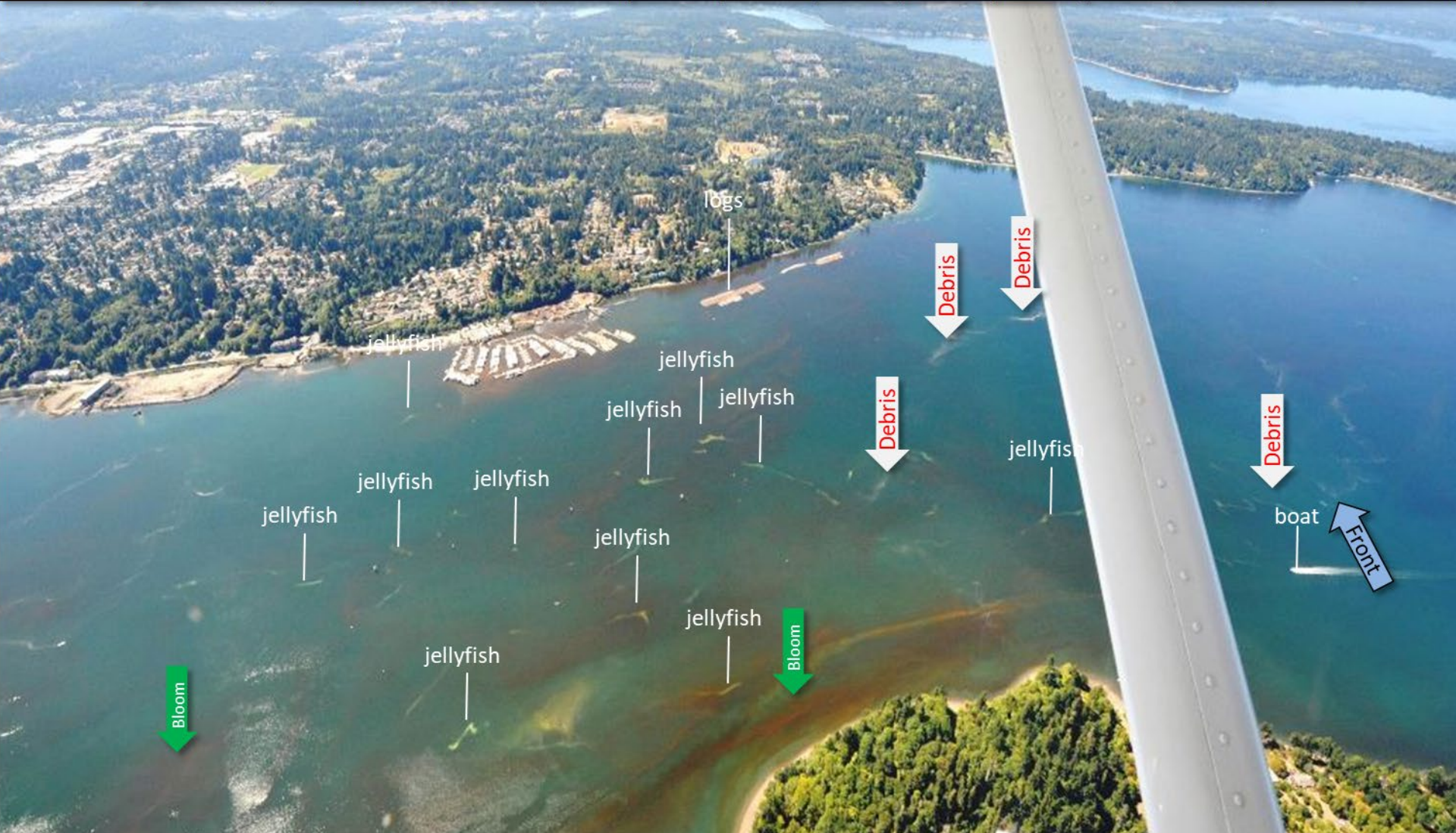
*Large patches of jellyfish, sediment-rich river plume, and red-brown bloom near eastern shore.
Location: Totten Inlet (South Sound), 12:59 PM.*

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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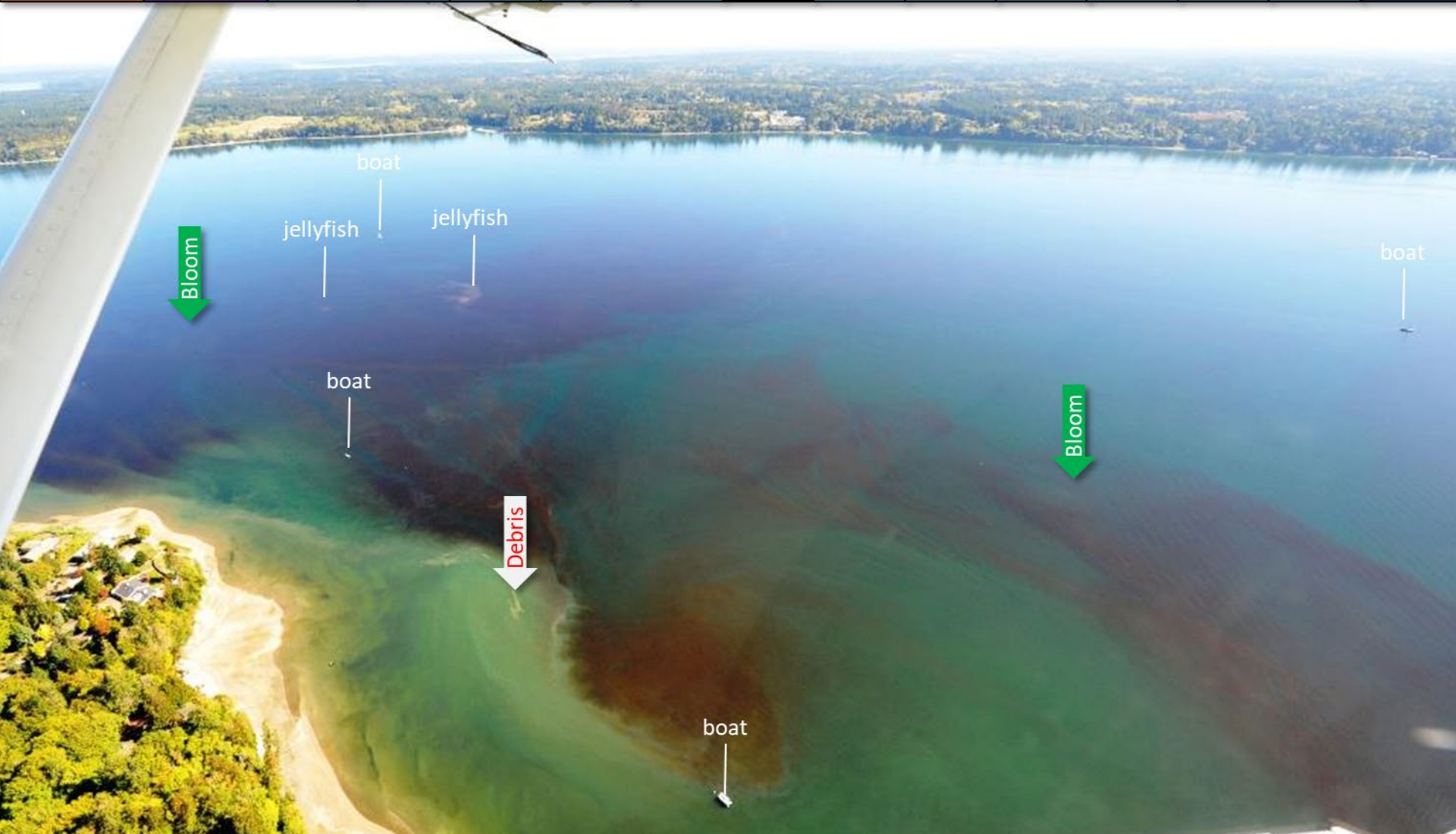
*Red-brown bloom and large patches of jellyfish. Turquoise water is likely freshwater.
Location: Across from Young Cove, Eld Inlet (South Sound), 3:08 PM.*

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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*Strong red-brown bloom, abundant jellyfish patches and organic debris at surface.
Location: Budd Inlet (South Sound), 2:25 PM.*

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Strong red-brown bloom, jellyfish patches, and organic debris at surface.
Location: Near Big Tykel Cove, Budd Inlet (South Sound), 12:28 PM.

2015

The year 2015 in pictures: Jellyfish patches persisted through the entire year in response to the exceptionally warm water caused by the Blob. Sediment loads are high as snow melts fast in the winter of 2015. Unexpected phytoplankton species occur in some bays in spring. *Noctiluca*, jellyfish, and macroalgae appear in high numbers when rivers drop to record-low flows in early summer. Low river flows slow the renewal of in Puget Sound throughout summer and fall and jellyfish patches reach record highs.

Publication No. 15-03-080



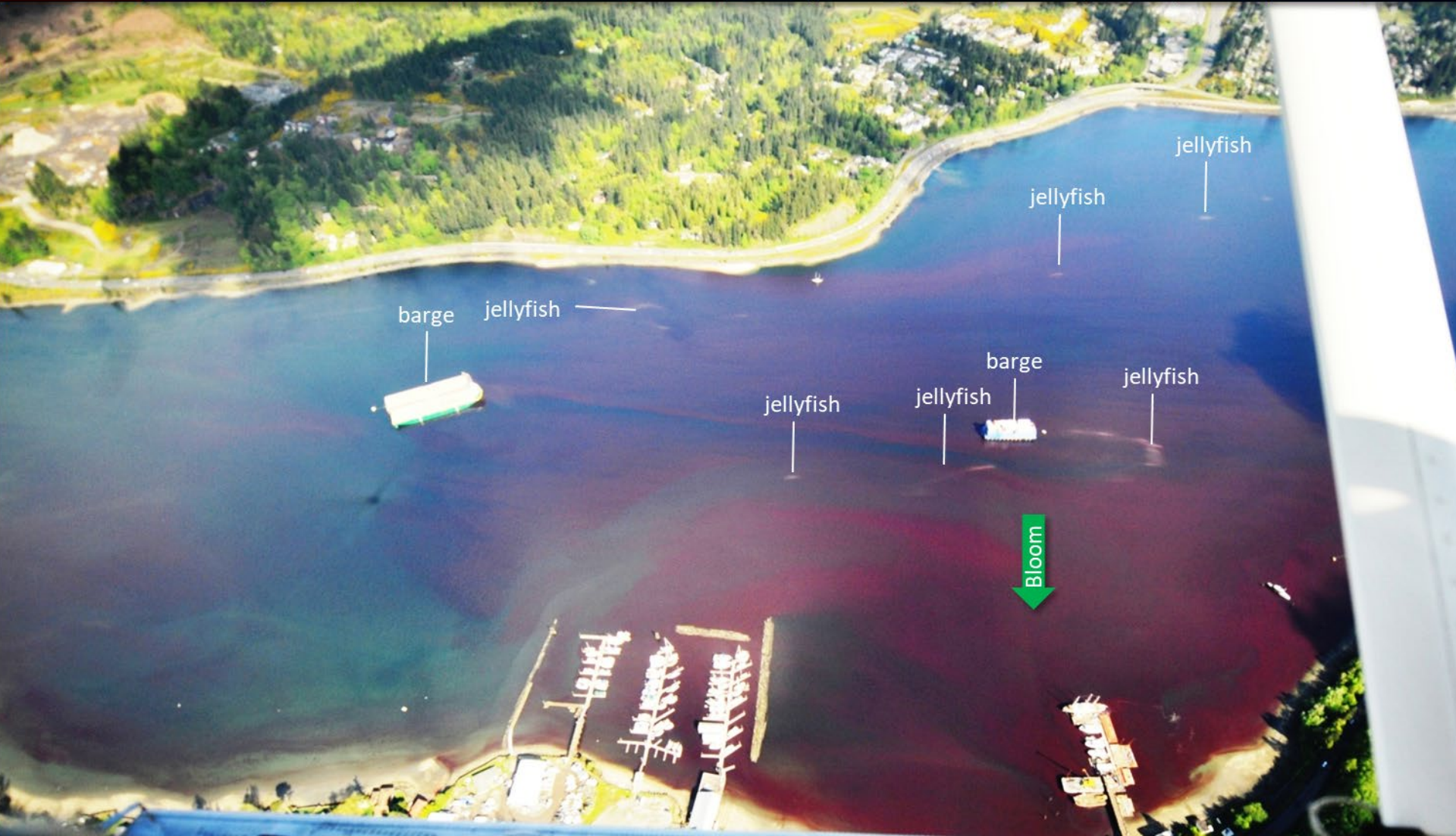
Eyes Over Puget Sound

Hypothesis | EOPS | People | Climate | Beach | Water column | Aerial photos

2015 Review

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

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Red bloom and patches of jellyfish.

Location: Kitsap Marina, Sinclair Inlet (Bremerton), 9:52 AM.



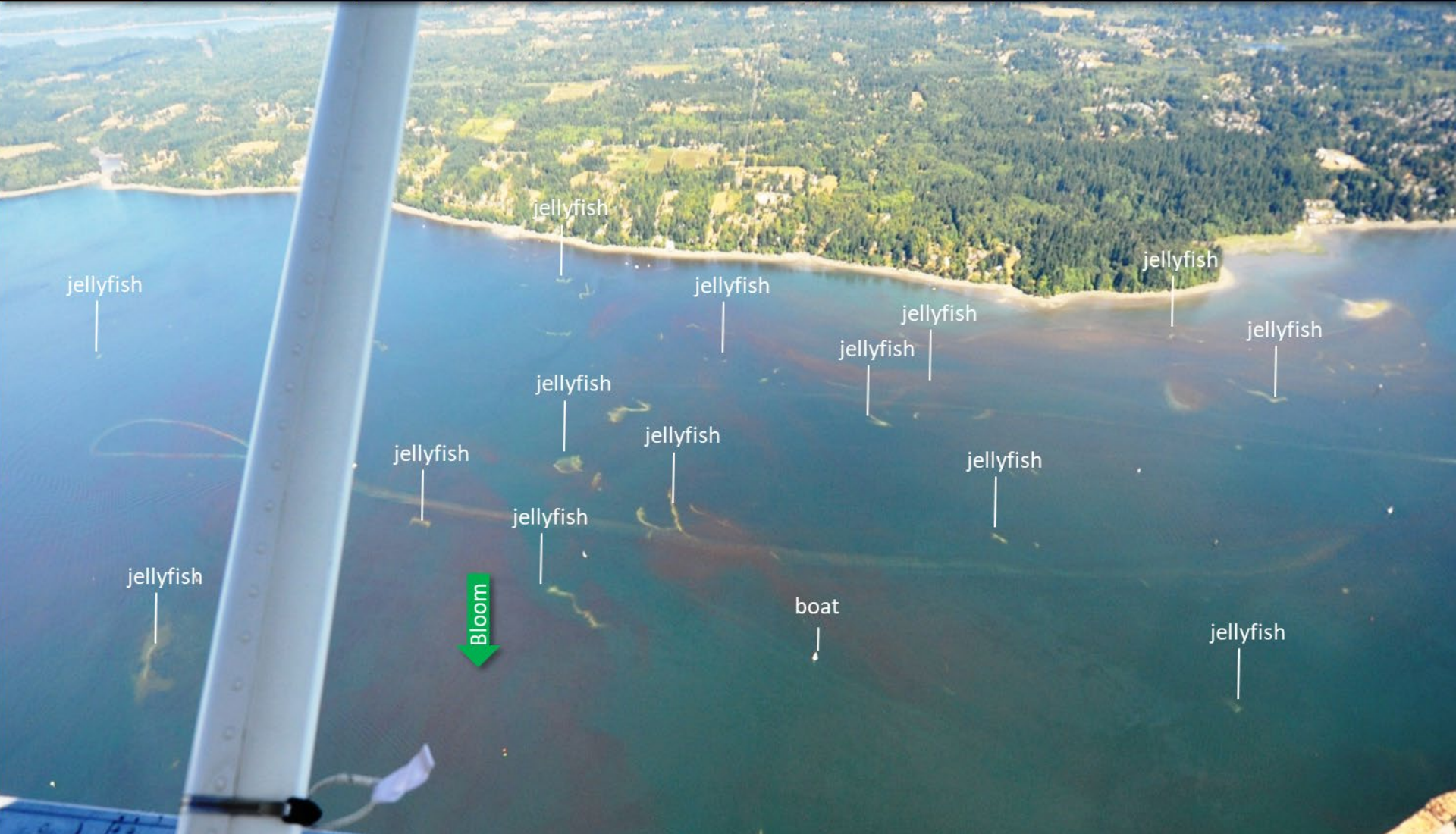
Large Noctiluca bloom surfacing and gathering in large quantities at tidal front.
Location: Commencement Bay (Central Sound), 3:32 PM.

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Sediment plume of Puyallup River with internal waves meandering into bay and mixing with a bloom.
Location: Commencement Bay (Central Sound), 3:28 PM.

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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*Numerous large patches of jellyfish in water containing red-brown algal bloom.
Location: Budd Inlet (South Sound), 3:12 PM.*

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Extensive and multiple oil sheens (reported).

Location: Port Orchard, Sinclair Inlet (Central Sound), 3:05 PM.



*Boat wake shows thin sediment-rich layer at surface. Front and water carrying glacial flour off Lummi Island.
Location: Off Portage Island, Bellingham Bay (North Sound), 12:58 PM.*

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Brown-colored Duwamish River plume with ferry tracks reveal the thin layer of suspended sediment across Elliott Bay. Location: Elliott Bay, Seattle (Central Sound), 2:46 PM.

2014

The year 2014 in pictures: In 2014, Puget Sound and Hood Canal behaved distinctly different in temperature and dissolved oxygen. In Puget Sound, generally warmer conditions, abundant and diverse algal blooms, and large pools of organic material persisted along with lower oxygen, high jellyfish abundances, and a lot of suspended sediment. On the other hand, Hood Canal was colder, more oxygenated, and algae blooms were rare. People and planes: past and present.

Publication No. 14-03-080



Eyes Over Puget Sound

Flight log | People | Water column | Aerial photos | Hypothesis | [Start here](#)

2014 Review

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



*Large tidal eddy transporting suspended sediment from beach into Carr Inlet.
Location: Near Pitt Passage (Carr Inlet), 2:50 PM.*

Summary

People

2011

2012

2013

2014

2015

2016

2017

2018

2019

2020

2021

2022

Data



Orange-red bloom, likely Noctiluca, in East Sound.
Location: Orcas Island (San Juan Islands), 12:05 PM



*Sediment-rich water leaving Port Susan at Camano Island during outgoing tide.
Location: Possession Sound (Whidbey Basin), 10:13 AM.*

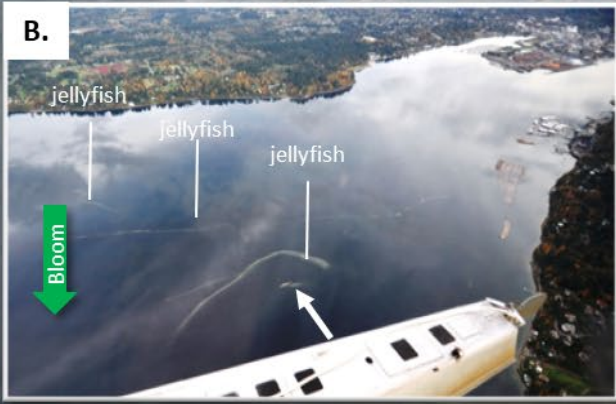


Intense yellow-green phytoplankton bloom inside bay.

Location: Fossil and Mud Bays, Sucia Island (San Juan Islands), 11:22 AM.

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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A.



Extensive smacks of moon jellies, both in size and density with pinkish tint.

Location: A. On the water; B. From air showing location on the water, Budd Inlet (South Sound), 3:50 PM.

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Numerous jellyfish smacks with underlying red-brown bloom.
Location: Off Little Tykle Cove, Budd Inlet (South Sound), 9:25 AM.

2013

The year 2013 in pictures: Low oxygen conditions persisted from January into August and broke a two-year anomaly of more favorable water quality conditions (lower temperature and salinity and higher dissolved oxygen). Dramatic *Noctiluca* blooms appeared one month earlier than normal (May), lasted for two months, and coincided with lower oxygen. Large jellyfish patches persisted over the winter but then were less visible for the rest of the year. Large drifting algal mats appeared in August.

DEPARTMENT OF ECOLOGY State of Washington

Eyes Over Puget Sound

Publication No. 13-03-081

Flight log | Water column | Aerial photos | **Start here**

2013 Review

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

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Large and intense red-orange-brown plankton bloom and river plume.

Location: Hood Canal, 3:33 PM

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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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

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Noctiluca bloom at surface in very long bands.

Location: Between Bainbridge Island and Elliott Bay (Central Basin), 5:27 PM.

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Noctiluca bloom at surface in large patch washing onto public beach.
Location: Alki Beach, West Seattle (Central Basin), 4:51 PM.

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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*Orange and red-brown bloom and patches of jellyfish near the surface.
Location: Eld Inlet (South Sound), 1:47 PM.*

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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*Fraser River sediment traversing and mixing dramatically with water in the San Juan Islands.
Location: Near Obstruction Island (San Juan Islands), 11:49 AM.*

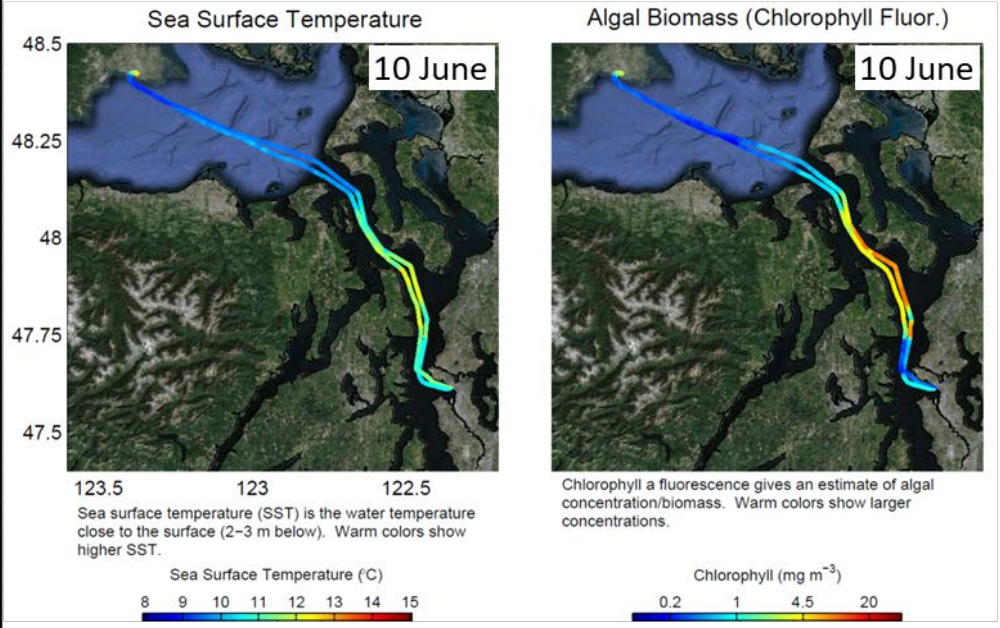


2012

The year 2012 began with a wet, late winter. Extensive freshwater plumes, rich in sediment, extend far into the waterways. Surface debris was abundant and jellyfish persisted through winter in Budd Inlet. Higher river flows continued into May when strong algal blooms appeared across South Sound, Central Basin and most smaller bays. By June, extensive orange *Noctiluca* streaks develop in Central Basin paralleled by a strong red-brown bloom in Case Inlet and one month later in Whidbey Basin. By July, water temperatures approach 15 °C. Macroalgae appear in Central Sound in August along with jellyfish. High jellyfish numbers persist into December in finger inlets of South Sound, which also saw red-brown blooms well into fall.



Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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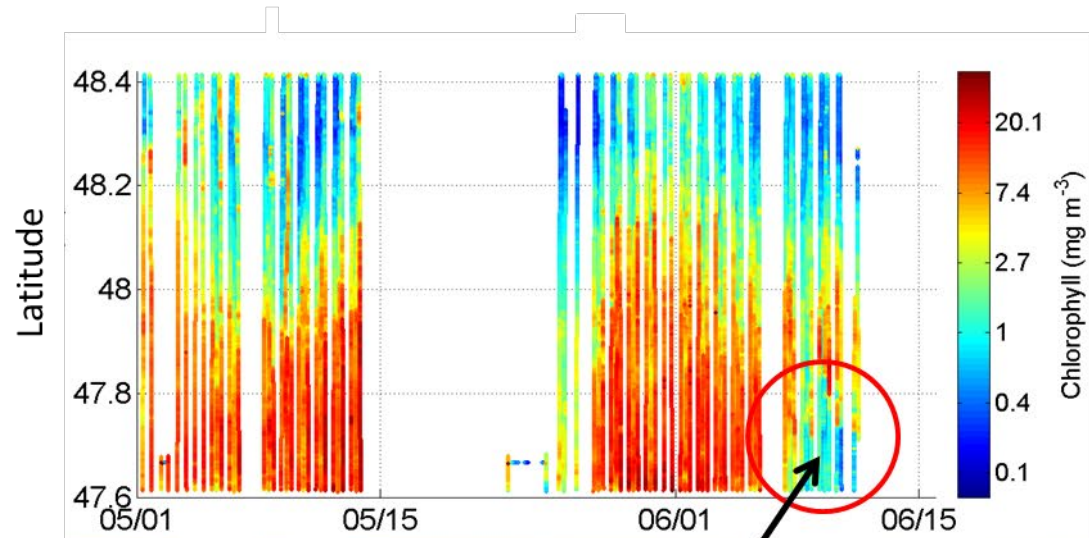


Current Conditions: Reduced fluorescence south of Edmonds; likely related to intense *Noctiluca* bloom. Temperatures near Triple Junction > 12°C; associated with freshwater entering Central Sound from Whidbey Basin.

MERIS True Color image used for spatial context (19 February 2011). Image is not coincident with ferry data shown on right.

The widespread *Noctiluca* bloom in Central Sound (*observed south of Edmonds from 47.6-47.75N*) was associated with 3 conditions:

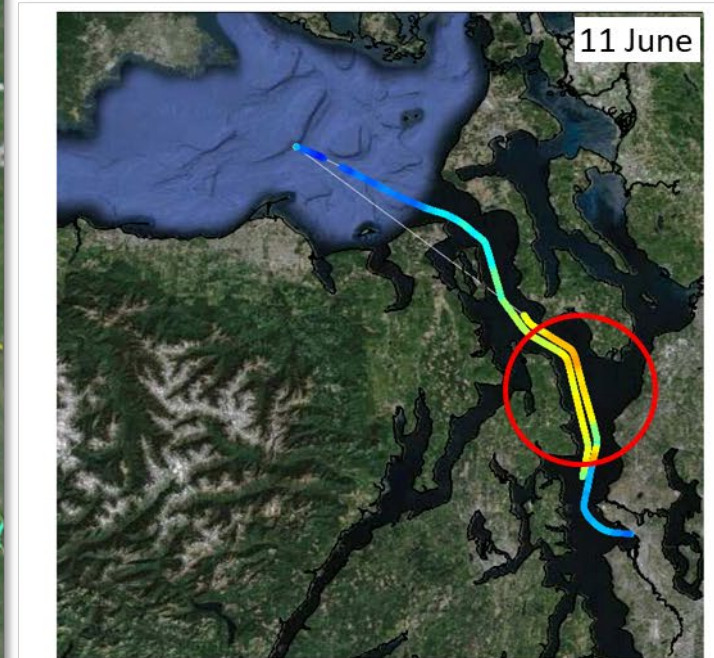
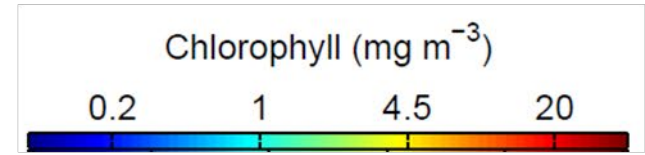
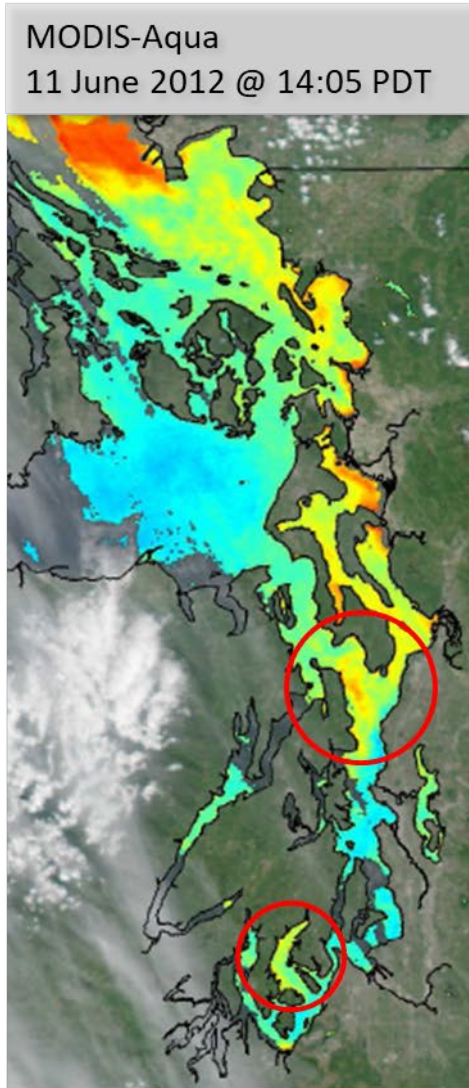
- 1) **Clearer water** (reduced fluorescence and turbidity); possibly the result of increased grazing by *Noctiluca*
- 2) **Cooler sea surface temperatures**
- 3) **Lower CDOM concentrations**



Modest fluorescence and satellite chlorophyll levels remain in Triple Junction, north of the area where *Noctiluca* was observed

Elevated satellite chlorophyll levels also associated with blooms in Carr Inlet and Whidbey Basin.

Chlorophyll α

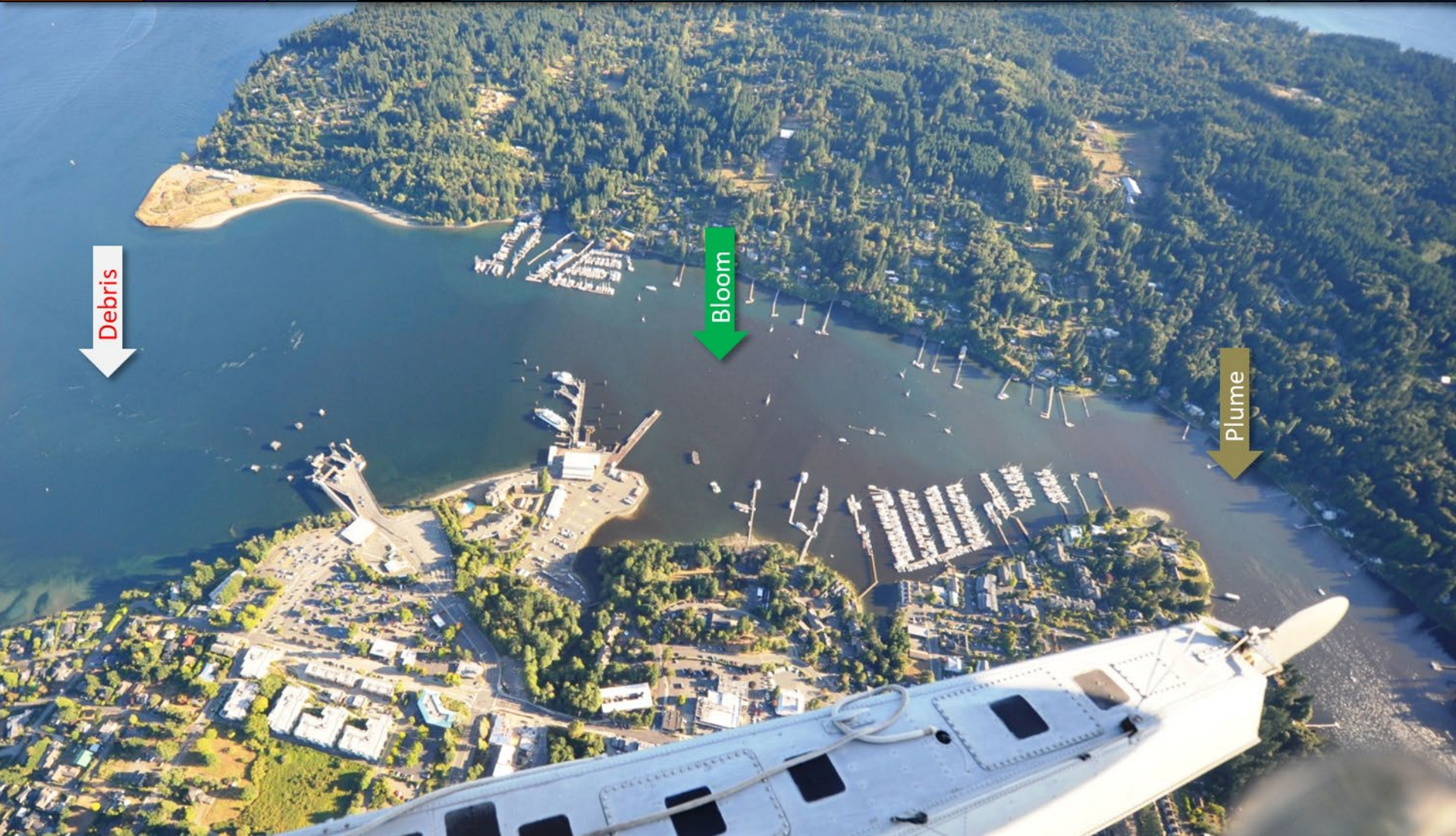


Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Jellyfish patches persist in South Sound Bays. Location: Eld Inlet, 10:52 AM

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Red-brown colored algae blooms. Location: Eagle Harbor (Bainbridge Island) 5:45 PM

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Jellyfish, red-brown and turquoise bloom. Location: Sinclair Inlet (Central Sound), 2:26 PM.

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Extensive red-brown bloom. Location: Case Inlet (South Sound), 4:33 PM



Red-brown and turquoise blooms, jellyfish (+ cloud reflections).

Location: Budd Inlet (South Sound), 4:56 PM

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Puyallup River plume entering Tacoma Narrows. Location: Point Defiance (Tacoma) 5:38 PM

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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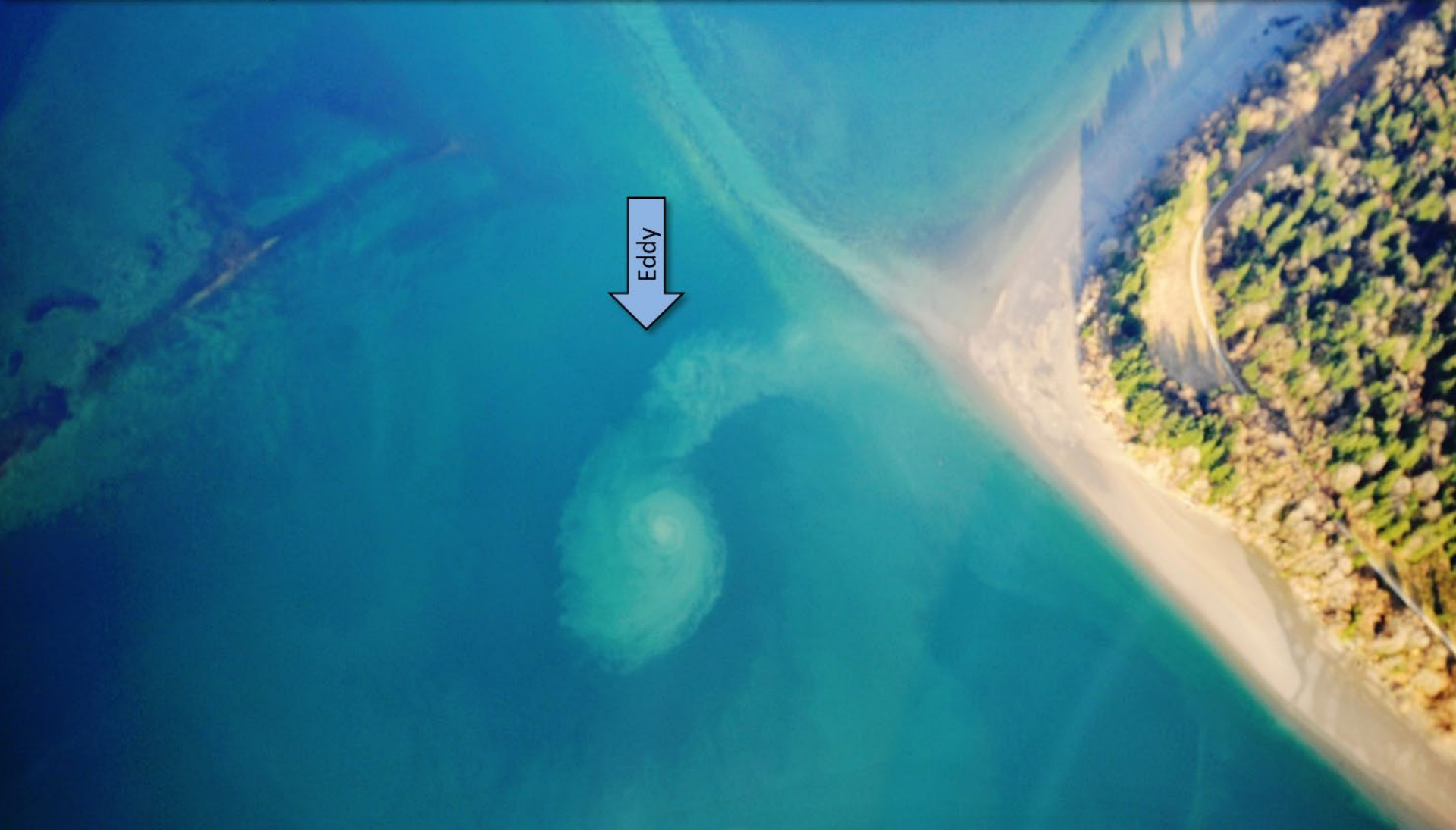


Noctiluca bloom east of Port Blakely. Location: Bainbridge Island (Central Sound), 8:07 AM

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
---------	--------	------	------	------	------	------	------	------	------	------	------	------	------	------



Puyallup river plume and algae bloom? Location: Vashon Island/Tacoma, 3:53 PM



Eddy with suspended sediment. Location: McNeil Island (South Sound), 4:20 PM

2011

The year 2011 warmer and sunnier conditions give rise to enhanced oxygen production and algae growth in Whidbey and Central Basin, extending into South Sound from April through June. Macroalgae are abundant. By June, a massive *Noctiluca* bloom forms in Central Sound paralleled by a red-brown bloom in South Sound. By July, extensive macroalgae and phytoplankton blooms are present in Central and South Sounds, culminating in a kaleidoscope of diverse colors. By September, blooms have weakened but still persist in bays of South Sound, where they extend into October. In November, jellyfish appear in Budd Inlet in increasing numbers through December.

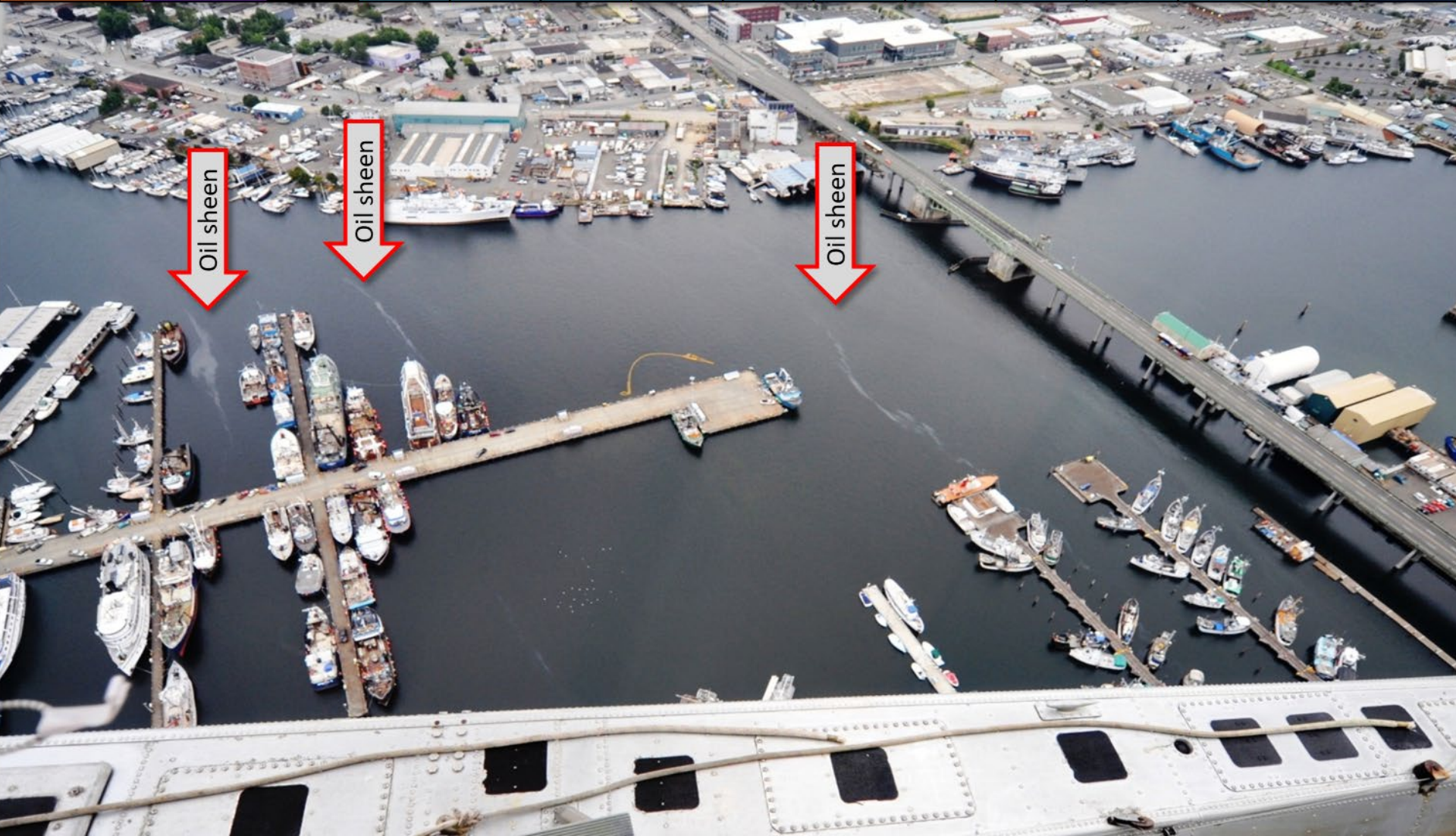


Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Aggregations of jellyfish (unconfirmed). Location: Western Sinclair Inlet, 9:12 AM

Summary	People	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Data
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Oil sheen. Location: Ballard Bridge, Seattle, 8:30 AM

Summary

People

2011

2012

2013

2014

2015

2016

2017

2018

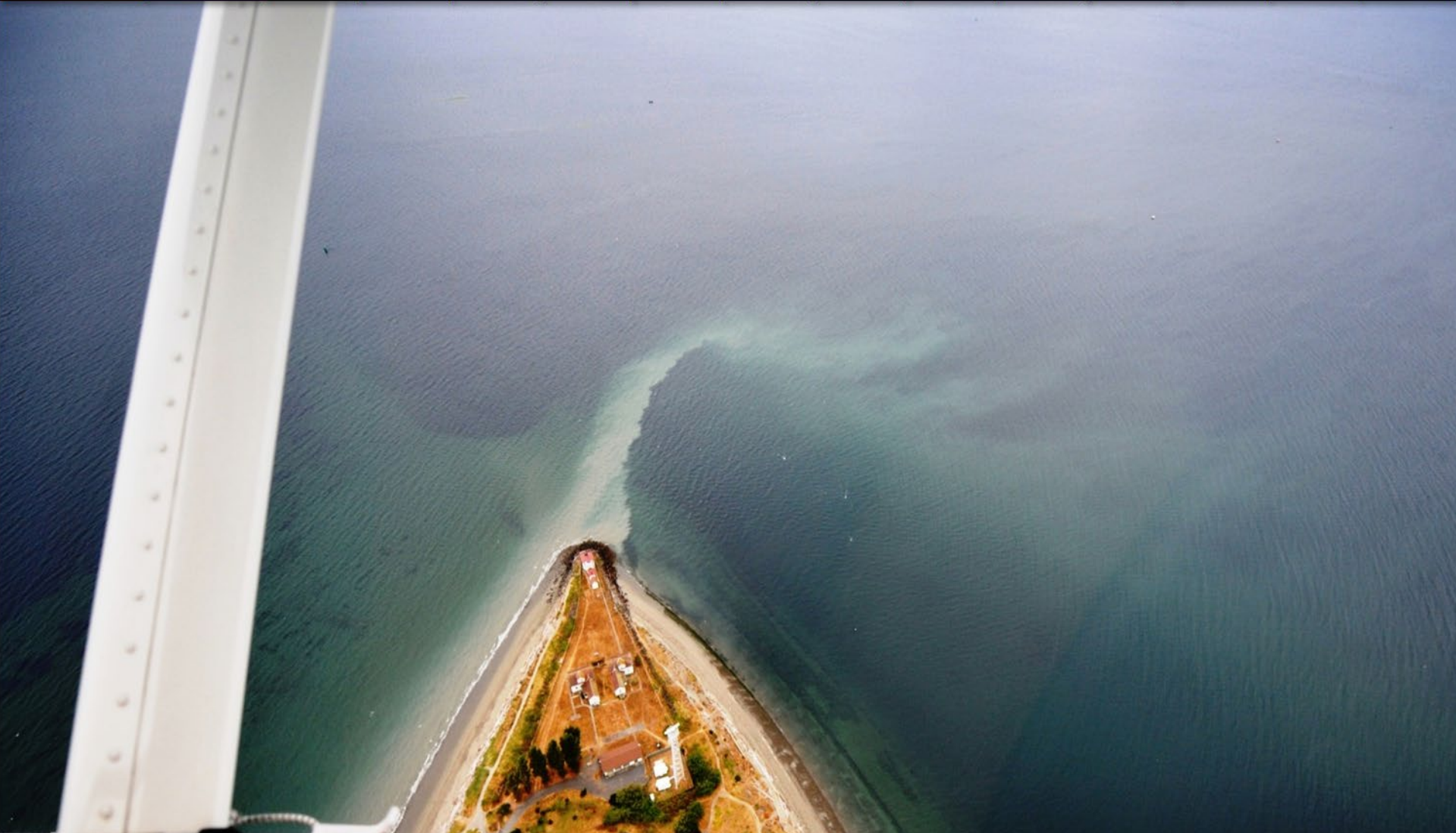
2019

2020

2021

2022

Data



Beach erosion. Location: Off Discovery Park, Seattle, 7:32AM

Summary

People

2011

2012

2013

2014

2015

2016

2017

2018

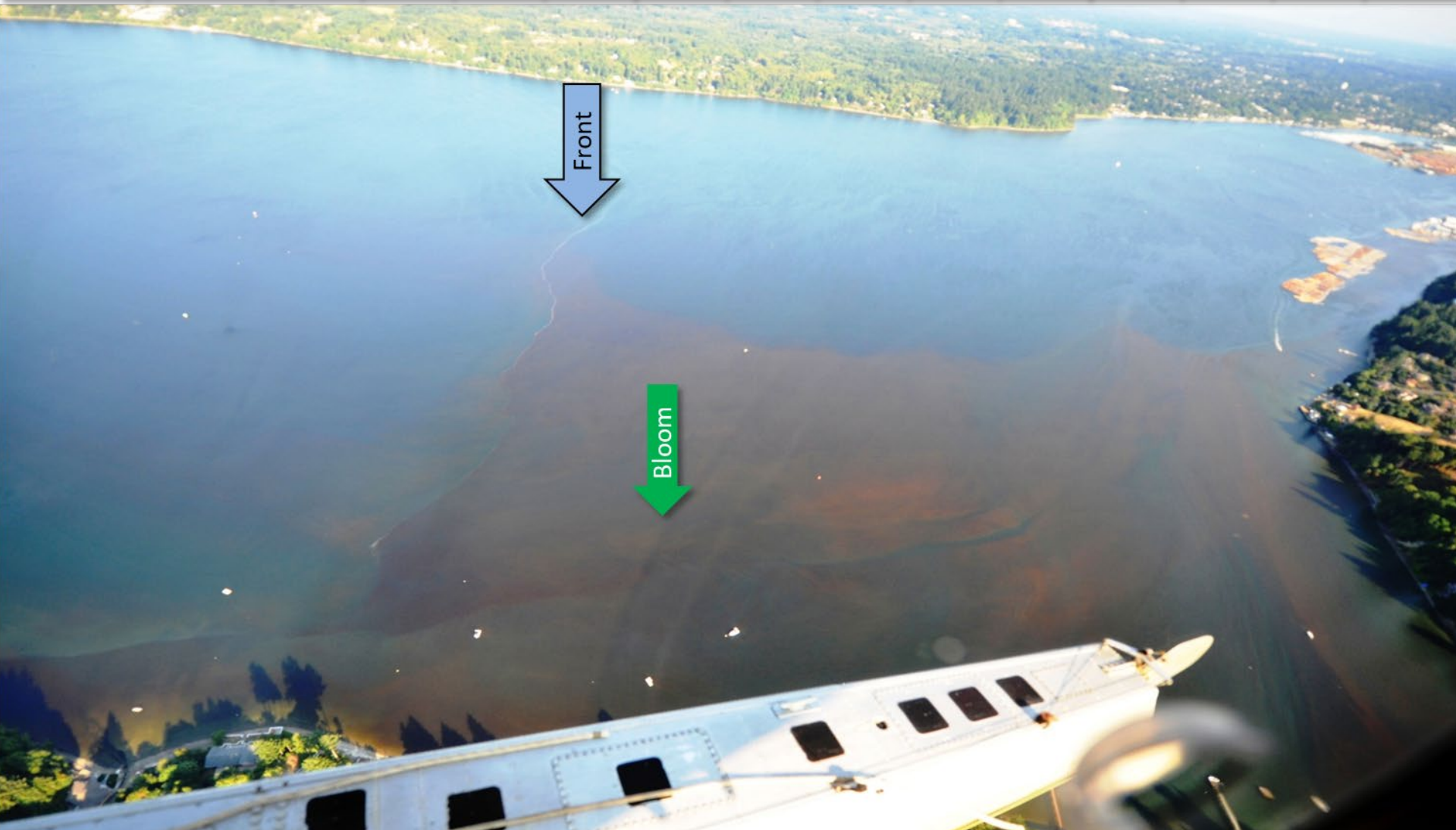
2019

2020

2021

2022

Data



Red-brown bloom. Location: Budd Inlet (South Sound), 4:40PM

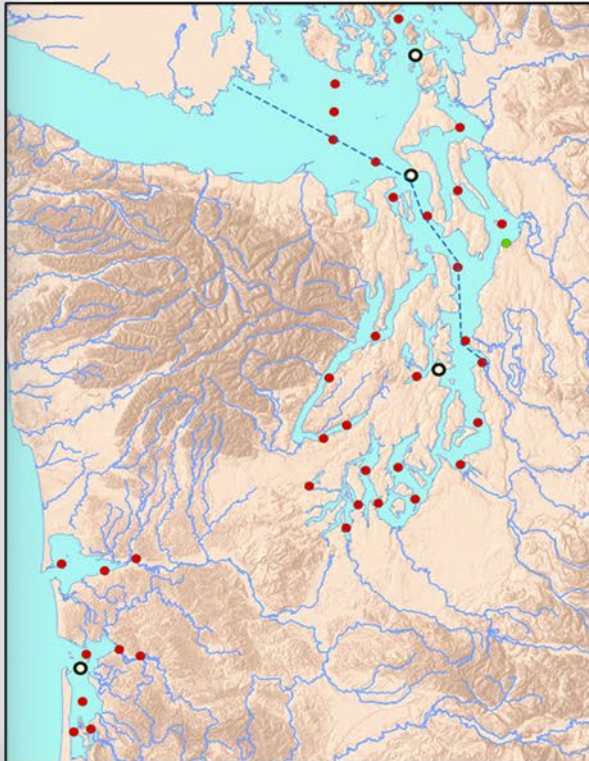
Marine Monitoring Unit, Environmental Assessment Program, Washington State Department of Ecology



Noctiluca filaments drifting at the surfac, looking onto Des Moines.
Location: Vashon Island (Central Sound) 4:44 PM

Long-term monitoring data from Puget Sound and coastal bays

- 39 stations sampled monthly
- 16 physical, chemical, biogeochemical parameters
- data from 1999-present



The Salish SeaCat



Natalie and Holly on our new Research Vessel

Get your data from our online database here