



PACIFIC SALMON FOUNDATION



CITIZEN SCIENCE OCEANOGRAPHY PROGRAM: A HIGH-RESOLUTION DATASET OF OCEANOGRAPHIC CONDITIONS IN THE STRAIT OF GEORGIA

Funded by:



Fisheries and Oceans
Canada

Pêches et Océans
Canada



Photo by Kevin Swobodas
 Cover photos by Mitch Miller (top)
 Nicole Frederickson (left and centre)
 and Rob Newell (right)



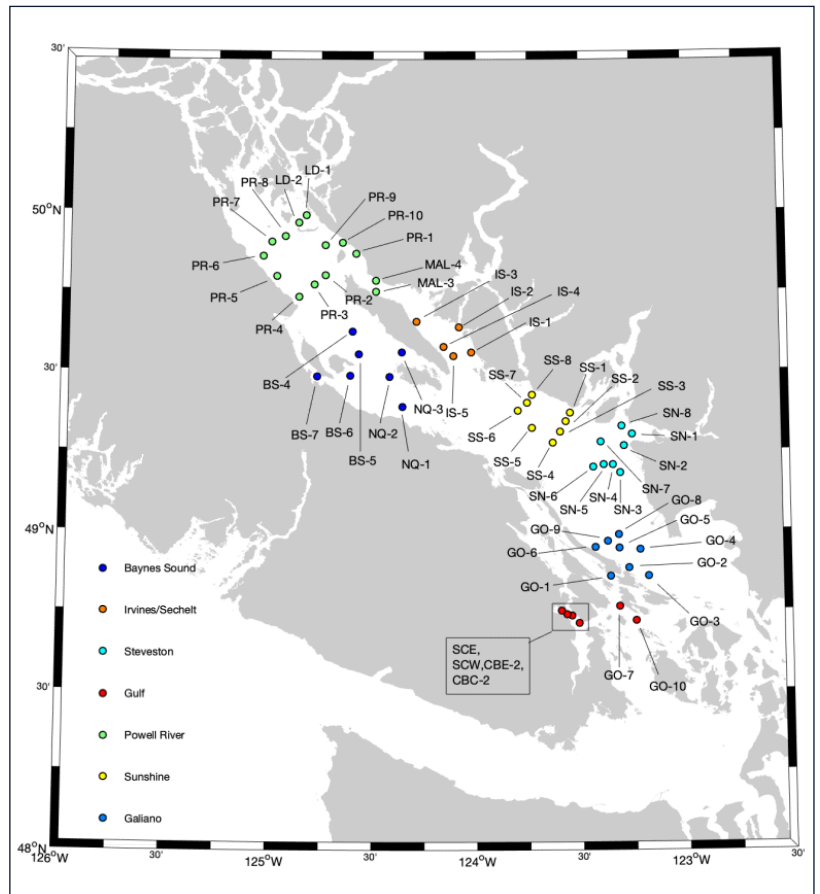
What were oceanographic conditions like in the Strait of Georgia in August of 2018? What about that month, or any month, in some other year? Answers to these questions are available thanks to the Salish Sea Citizen Science Oceanography Program. The Program started in 2015 as part of the [Salish Sea Marine Survival Project](#) and has been operating every year since then. The program is currently composed of seven “patrols” geographically spread over the entire Strait of Georgia. These patrols measure oceanographic conditions from the surface down to 150 m at approximately **55 locations**, about **20 times per year**. Sampling by all patrols occurs within two days of scheduled sample dates so that nearly “instantaneous” views of the Strait can be generated.

WHAT MAKES IT UNIQUE?

The Program is unique in that Citizen Scientists use their personal recreational fishing vessels as a means to go out and collect oceanographic samples throughout the Strait of Georgia, year-round. The use of these small recreational fishing vessels and groups of Citizen Scientists allows for oceanographic samples from a huge portion of the Strait to be collected on essentially the exact same date. The program design allows for spatial and temporal data coverage of the entire Strait of Georgia at a level that is impossible to achieve by larger research vessels/programs.

One of the most important features of the program is that the data collected [are freely and openly available to all!](#)

Figure 1. The network of sampling stations (dots) and patrols (colours) by the PSF Citizen Science Oceanography Program. Sampling locations provide coverage of the whole Strait but are also designed to be complementary to other observational programs.



HOW ARE DATA COLLECTED?

Data are collected by the Citizen Scientists using AML-6 CTDs equipped with conductivity, temperature, chlorophyll, turbidity, and dissolved oxygen sensors to collect hydrographic profiles at each site. CTD data are automatically uploaded to the [Community Fishers App](#), which was specifically developed by Ocean Networks Canada for this program. Individual profiles can be examined within hours of sampling, but the entire dataset of thousands of profiles is also available for [download](#). Don't know what's there? Summary figures and other information can be found in an [Atlas of Oceanographic Conditions](#), available at the Strait of Georgia Data Centre.

In addition to profile data, physical water samples are also collected at the surface and at various depths (using a Niskin bottle) for nutrient and plankton analysis. Crews also use a Secchi disc to measure water clarity.

All data collection methods are outlined in a [Sampling Manual](#) which was developed by oceanographers and researchers according to standardized methodology and best practices. The manual is updated annually.

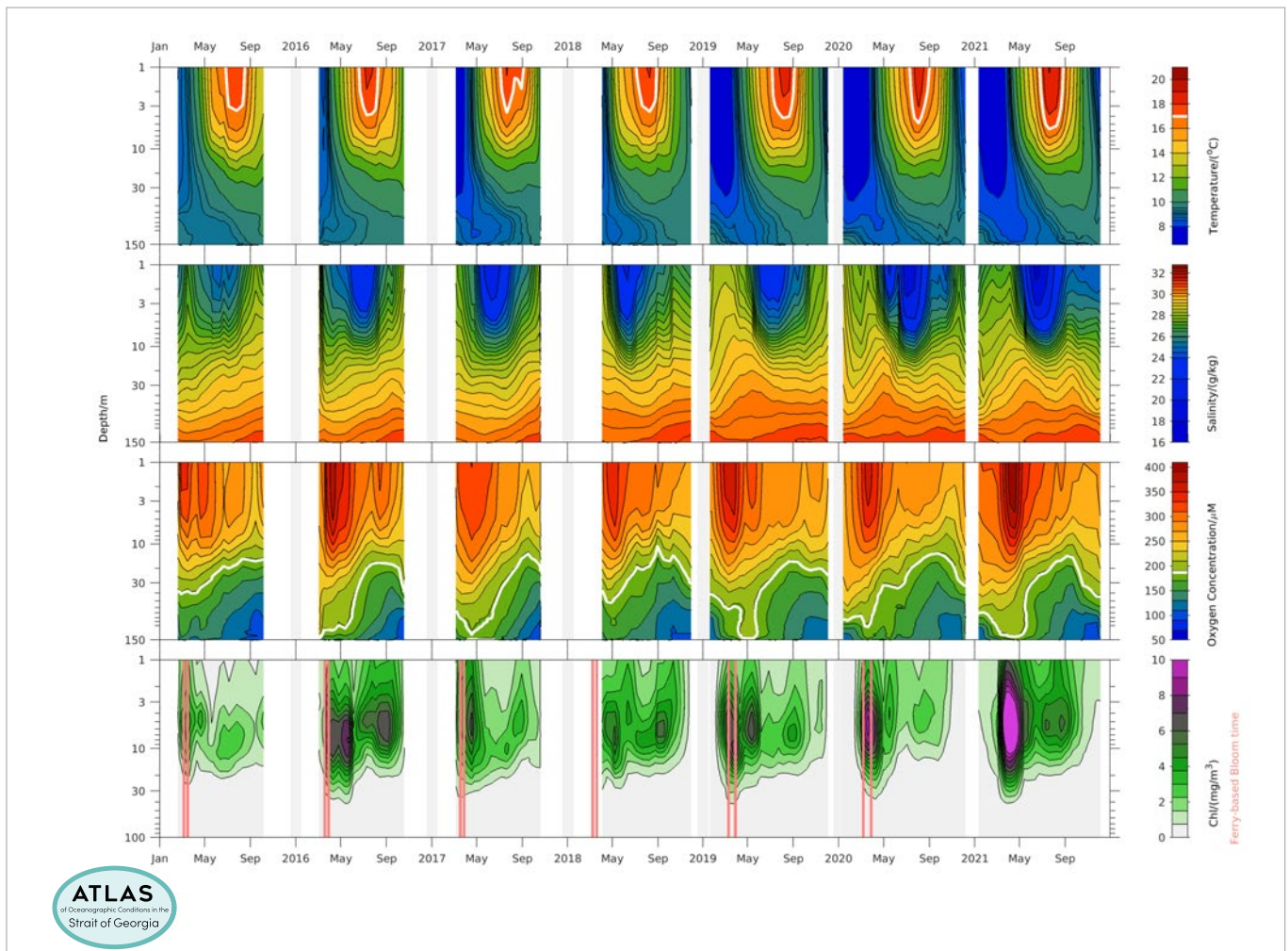


Figure 2. Monthly averaged conditions in the Strait of Georgia to a depth of 150 m from 2015–2021. From top to bottom, rows show temperature, salinity, dissolved oxygen, and chlorophyll (note logarithmic depth scale for chlorophyll). White lines show stress limits in temperature and dissolved oxygen for juvenile salmon. Credit: Dr. Pawlowicz via the SoG Data Centre's [Atlas of Oceanographic Conditions](#).



Photo by Mitch Miller

WHAT TYPES OF DATA ARE COLLECTED AND ANALYZED?

- Hydrographic data (using the CTDs)
- Water clarity
- Phytoplankton species cell counts (emphasizing Harmful Algae)
- Nutrients
- Biotoxins
- Chlorophyll
- Any other unique observations about weather, wildlife, ocean conditions, etc.



Photo by Rob Newell

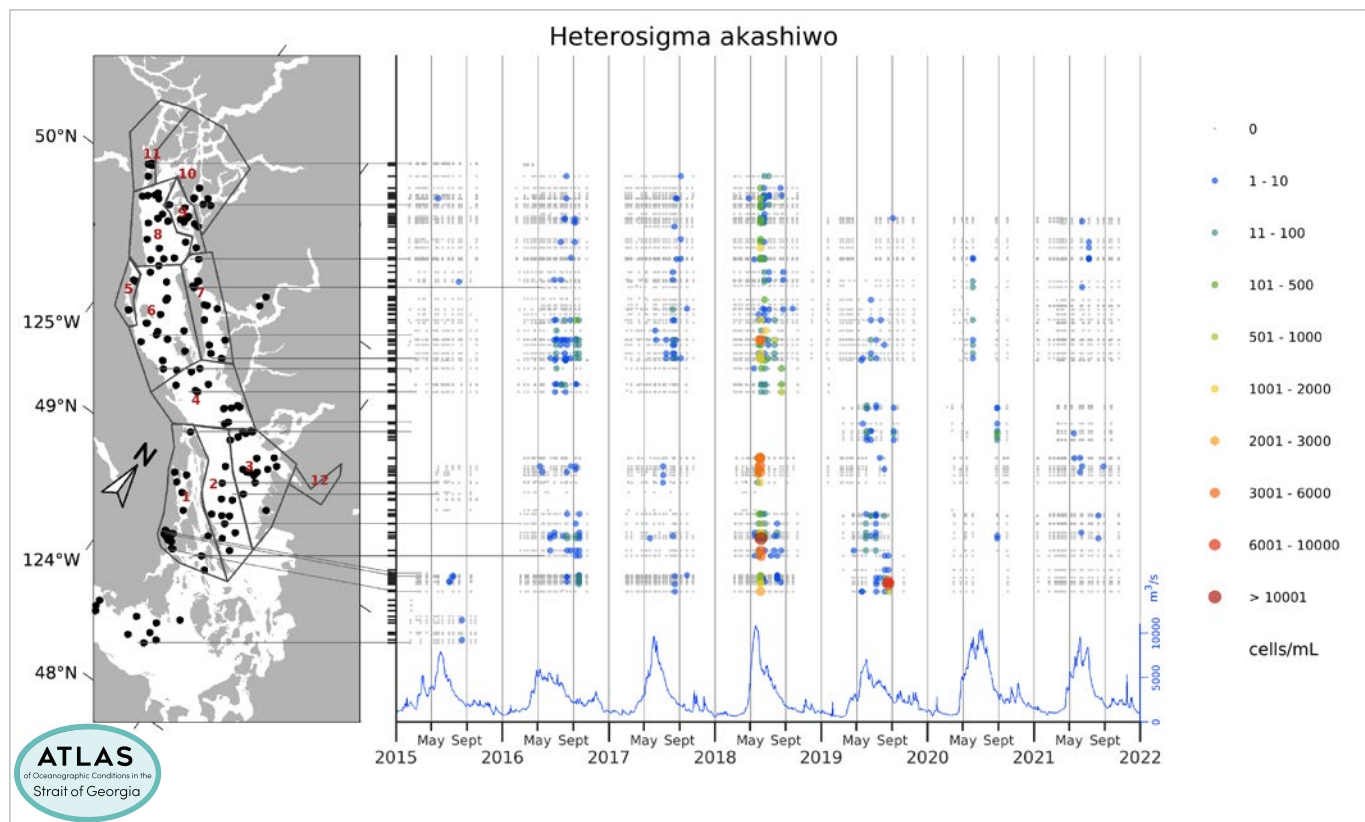


Figure 3. Occurrence of *Heterosigma akashiwo* in the Strait from 2015 to 2021. The June 2018 outbreak coincided with widespread fish kills. Credit: Dr. Pawlowicz via the SoG Data Centre's [Atlas of Oceanographic Conditions](#).



ATLAS OF OCEANOGRAPHIC CONDITIONS IN THE STRAIT OF GEORGIA

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WATER SAMPLES READY FOR ANALYSIS

Water samples from the Spring Bloom in 2021: nutrient vials in front, preserved phytoplankton at right, biotoxin assays (new!) at left. Log sheet in foreground.

Welcome to the **Atlas of Oceanographic Conditions in the Strait of Georgia**, based on the Pacific Salmon Foundation's Citizen Science Dataset. The 'PSF CitSci' Program visits about 60 locations in the Strait roughly 20 times a year to measure a variety of ocean properties, resulting in around 1000 stations sampled every year. Additional information in the atlas comes from stations sampled by the [Hakai Institute](#) in the far northern Strait of Georgia, the

HOW ARE THE DATA USED?

Every year the data from this program, and other complementary observational programs run by different government departments and private foundations* are analyzed and key trends and findings are summarized in the "Atlas of Oceanographic Conditions in the Strait of Georgia". All plots are available [online](#).

Annual findings from Phytoplankton, Biotoxin and Oceanographic samples collected through the Program are presented and contribute to DFO's [Annual State of the Pacific Ocean Report](#).

A number of peer-reviewed scientific journal articles have already been published using this data.

DATA QUALITY

Often a big concern within the scientific community regarding citizen science is the quality of the data being collected. The PSF Citizen Science Oceanography program has implemented a number of key quality control/quality assurance measures to ensure high-quality data are collected, including:

- A sampling manual developed by oceanographers and researchers – updated annually
- Collection and analysis of duplicate samples
- The majority of the Citizen Scientists have been with the Program since it started in 2015
- On-board training of crew members by PSF Biologist
- Regular audits of field sampling protocols/data collection by a PSF Biologist
- Lab QA/QC protocols implemented during sample analysis
- QA/QC during data entry
- Raw and processed (QA/QC'd) data are publicly available



Photo by Luci Marshall

*Hakai Institute (northern Strait of Georgia), Tsleil Waututh Nation (Burrard Inlet) are currently included in the Atlas. Plans are underway to also include data from DFO and 'Nanoose Time Series', Department of National Defence.

QUICK FACTS

7 patrols throughout the Strait of Georgia

55 stations

11 long-standing Citizen Scientists

Over 8,500 kms travelled each year

Consistent (~20x/year) annual data collection from 2015-2022

50,000+ SAMPLES COLLECTED AND GROWING!

7 vessels in operation

Including:

- > 9,000+ CTD casts
- > 10,500+ nutrients
- > 11,500+ Phytoplankton
- > 1,900+ Chlorophyll
- > 16,400+ Secchi readings
- > 500+ zooplankton
- > 140+ Biotoxin samples



QA/QC protocols in place to ensure high quality of data



6 AML Oceanographic multi-Parameter CTD's each equipped with: conductivity, temperature, chlorophyll, and dissolved oxygen sensors



CTD data **automatically uploaded** to **Community Fishers App** developed by ONC



All data are publicly available on: [ONC Oceans 3.0 Data Portal](#), [Strait of Georgia Datacentre](#), [Atlas of Oceanographic Conditions in the Strait of Georgia](#)

WE'D LOVE TO HEAR YOUR FEEDBACK

We would love to hear your feedback on how these data may support your current or future research, or if you have any suggestions on how to improve the program to support your research and address any knowledge gaps. Please visit the link below to complete a short (less than 2 minutes) [survey](#) to help us improve the Program!

Keep in touch! Please reach out with any questions and let us know if you will use these data for your research. Contact us at pearsalli@psf.ca, nfrederickson@psf.ca. Learn more about the [program](#) and the other [PSF Marine Science programs](#).



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