Experience in developing and operating a marine Citizen Science Program in the Strait of Georgia, Canada

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PICES 2019: Connecting Science and Communities in a Changing North Pacific
• 90 to 95% decline in Strait of Georgia Chinook and Coho fisheries in the 90s... with little recovery since that time.

• Resulted in major loss of $$ to local communities

• Numerous other ecological changes observed around the Strait of Georgia

Early marine survival of Pacific salmon in the Strait of Georgia is the likely cause but mechanisms not understood.
What are primary factors affecting juvenile Chinook, coho & steelhead survival in the Salish Sea marine environment?
SSMSP-Hypotheses

A. Bottom-up processes (growth linked to survival)

B. Top-down processes

C. Ecosystem quality
Objectives

- To achieve oceanographic monitoring of the Strait of Georgia at a temporal and spatial scale not done before
- To examine how changes in ocean temperatures, oxygen content, salinity, and nutrients impact the food web of Phytoplankton → Zooplankton → Salmon
- To determine the prevalence of harmful algal blooms throughout the Strait of Georgia
- To determine the timing and propagation of the spring bloom throughout the Strait
Data Collection Methods

Research Vessels
- Wide geographical coverage
- Limited access = Low Resolution
- Expensive to operate

Fixed Infrastructure
- High resolution
- Long time series
- Limited geographical coverage
- Expensive to install
Why use Citizen Oceanographers?

• To allow for oceanographic sampling and monitoring in the Strait of Georgia at a spatial scale not possible before

• How?

• Using small boats “sampling everywhere at once”
Methods

- PEOPLE!
- Equip Boats
- Training modules
- Training video
- Audits
- Feedback
PSF Citizen Science Oceanography Program

Pacific Salmon Foundation, Ocean Networks Canada, DFO, UBC

Sampling Plan
2015 - 2019
February – October (now year-round)
~ 2/3 times a month

~ 80 stations
CTD (temperature, salinity, depth, DO, fluorescence) to 150m or bottom
Secchi
Phytoplankton (surface, 5m, 10m, 20m)

~10 stations
Nutrients (surface & 20m) – nitrate + nitrite, silicate, phosphorus
Chlorophyll a (5m)
Field Operations
Ocean Acidity

eDNA?
Remote Area Data Collection

Mobile Application
- Provides near-real time data transfer
- Automatically associates all data with Time and GPS
- Simplifies transfer process
- Maintains established instrument settings
- Capable of connecting to any manufacturer
- Properly archived and passed to Data Specialists for QA/QC

Shared Data Access

OCEANS 2.0

Data Transfer-ONC’s Community Fishers App
Raw data tables are processed daily and made available as 'corrected' data.

Data are processed by shifting T by 2 scans, then both the shifted T and C are smoothed using a 5-point running mean filter.

Derived values (practical salinity, density, sound speed etc) are calculated using the shifted, smoothed T and smoothed C (the standard used is EOS-80).

The processed data are used to clip the downcasts from the entire dataset. This uses a dP/dt > 0.3 to select time when the cast has hit a minimum downward velocity and generally seems to work. When the minimum cast velocity is not met and/or there are many reversals, the casts are manually clipped by selecting the start/end of the downcast.

All data are separated into casts by the start/stop times selected in the previous step binned and averaged into 1m bins, where the centre of the bin is the half metre. The closest timestamps for lat/lon are also selected to interpolate the GPS data onto the corrected timestamps to be made publicly-available.

Corrected down cast data are written to files that are device based.

Files are uploaded to an ftp server and picked up for ingestion into the ONC database via a scheduled task.

Ingested files are parsed into 'corrected' sensors, and made publicly-available.

Data are downloaded from the database via web service.

Files are uploaded to an ftp server and picked up for ingestion into the ONC database via a scheduled task.

All data are plotted vs time and depth.

Obviously 'bad' data timestamps are noted e.g. conductivity dropouts, etc...
### Data

**2015 - 2019**
- CTD ~6000 CTD casts
- Secchi ~12000 reading
- Phytoplankton >8000 samples
- Nutrients ~8000 samples
- Zooplankton ~400 samples

<table>
<thead>
<tr>
<th>Sampling Years</th>
<th>Sample Dates</th>
<th>Vessel Trips</th>
<th>CTD casts</th>
<th>Nutrients</th>
<th>Phyto/HABS</th>
<th>Chlorophyll</th>
<th>Secchi Recordings</th>
<th>Zooplankton</th>
<th>Total Samples</th>
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</thead>
<tbody>
<tr>
<td>2015</td>
<td>19</td>
<td>150</td>
<td>1,132</td>
<td>2,264</td>
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<td>193</td>
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<tr>
<td>2017</td>
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<td>340</td>
<td>2,814</td>
<td>54</td>
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<tr>
<td>2018</td>
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<td>362</td>
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<td>2019*</td>
<td>15</td>
<td>80</td>
<td>578</td>
<td>794</td>
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<td><strong>5 years</strong></td>
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<td><strong>831</strong></td>
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<td><strong>11,757</strong></td>
<td><strong>374</strong></td>
<td><strong>35,349</strong></td>
</tr>
</tbody>
</table>

* 2019 data is compiled of only 15 dates so far, more data to be collected.*

http://www.oceannetworks.ca
http://sogdatacentre.ca/
How We are Using Data from the Citizen Science Program?

SAMPLE ANALYSES:
Nutrients & Chlorophyll- IOS
Phytoplankton-Svetlana Esenkulova
Zooplankton- IOS
CTD data-ONC

www.sogdatacentre.ca
Chlorophyll from CTD- 2015-2019

**SOG Depth-Integrated Chl from Fl Profiles**

- **SOG Mean (Apr-Oct): 59 mg/m²**
- **SOG Mean (Apr-Oct): 177 mg/m²**
- **SOG Mean (Apr-Oct): 90 mg/m²**
- **SOG Mean (Apr-Oct): 107 mg/m²**
- **SOG Mean (Apr-Oct): 122 mg/m²**
British Columbia salmon farmers on alert after Grieg’s toxic algae disaster

Spring & Summer blooms & HABs
Temperature & DO - Malaspina Strait

[Graphs showing temperature and oxygen concentration over depth and time intervals from 2016 to 2019.]
Timing of Seasonal Cycle

Stevens & Pawlowicz
Citizen Science Data is being used to study the following:

- Strategic Salmon Health Initiative: is there a relationship between level of stress (fish from areas temps > 17°C temp & <6ppm O₂) and expression of disease states?
- Harmful algal blooms: How does water temperature/salinity/DO/nutrients affect prevalence of HABS?
- Migration Pathways of Pacific Salmon: Is there a relationship between water quality/hotspots of plankton & migration pathways?
- Kelp and Eelgrass Restoration: Characterizing turbidity and water properties in a number of estuaries around the Strait
- Juvenile Salmon Studies: Relating the distribution, diet and fish size for key juvenile salmon stocks to temperature, salinity and dissolved oxygen.
- Modeling Studies and Satellite Data: Data collected by the citizen science program is being used to validate 3D biological models of the Salish Sea, and to ground-truth satellite imagery with on-ground data
Transport Canada has provided funding for Citizen Science data collection with ONC using the model developed by PSF to between 4 and 6 communities across Canada through the OPP Program for Enhanced Maritime Situational Awareness (PEMSA).

DFO has provided funding for Iqaluit, Nu.
Other SoG community sampling programs

- Uvic Adult Diet Study- forage fish trends, winter diets
- Avid Anglers- Pacific salmon stock composition, year round, residency
- FN and Uvic- Kelp Mapping- Identifying Resilient Stocks
- Seachange- monitoring eelgrass populations
- WWF & VIU- forage fish embryo surveys
Summary

• Citizen Science is a very cost effective way to gather a large number of samples.

• This collaborative program is now continuing for a fifth year, providing oceanographic information at a temporal and spatial scale not easily achieved with large traditional research vessels.

• The data collected allow us to assess annual variation in physical/chemical oceanography, develop ecosystem models, validate satellite imagery, and understand spatial and temporal changes in productivity of the Strait of Georgia.
Thank you!

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