



# STRAIT OF GEORGIA HERRING:

## RESTORING THE SALMON FOOD WEB

Year 1 Progress Report

April 2024



**PACIFIC SALMON  
FOUNDATION**

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# YEAR 1 PROGRESS SUMMARY ACTIVITY 1:

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## INTERACTIONS BETWEEN AGE-0 HERRING AND JUVENILE CHINOOK AND COHO SALMON

**Components:** Field work, lab work, data analysis.

**Author(s) and affiliation:** Will Duguid (PSF Biologist).

### BACKGROUND:

Early marine survival is hypothesized to be a key bottleneck restricting productivity and abundance of Pacific salmon populations. Herring in their first year of life (age-0) are critically important prey for Chinook and Coho salmon in their first year at sea. Consumption of juvenile herring supports accelerated growth of juvenile salmon which in turn increases survival. Comparison of recent and historical diet information suggests that age-0 herring may be less available to juvenile salmon than they were during periods of higher salmon survival and abundance (prior to the 1990s). This reduced availability could be a consequence of lower age-0 herring abundance, later appearance of age-0 herring in the spring, increased herring size relative to juvenile salmon (making them too large to eat) or some combination of these three factors operating at different regional scales in the Strait of Georgia. It is possible that reduced availability of age-0 herring to juvenile salmon is linked to a concurrent loss of satellite spawning sites. Reduced spawn distribution since the 1980s may have influenced the abundance, timing, and size of age-0 herring that appear in different regions of the Strait of Georgia. Alternatively, it is possible that core spawning areas around Denman and Hornby Island are adequate to seed all regions with age-0 herring, and that regional oceanography and density dependent processes control local abundance and size. Understanding the factors controlling juvenile salmon access to age-0 herring is likely key to understanding changes in salmon population productivity and developing strategies for recovery of both herring and salmon.

This activity involves both the reanalysis of historical data collected by DFO and implementation of a field program with First Nations partners to collect contemporary data

on juvenile salmon and age-0 herring trophic interactions. This work will aim to address the questions:

1. Does availability of age-0 herring to juvenile salmon differ by region of the Strait of Georgia and is it related to occurrence of abundant local spawning.
2. Does herring size and growth differ by region of the Strait of Georgia.
3. Do the age-0 herring consumed by juvenile and adult salmon represent only the smallest, slowest growing individuals in the population, does this vary by region?
4. Does consumption of juvenile herring provide a growth advantage to juvenile salmon?

## ACTIVITY PROGRESS:

The initial year of this activity has focused on recruitment of project personnel; developing relationships and contribution agreements with partners, obtaining equipment and applying for necessary approvals.

### **SoG age-0 herring retrospective data project**

A student in the Master of Science in Environment and Management in the School of Environment and Sustainability at Royal Roads University (Niallan O'Brien) has been recruited to undertake this desktop analysis. The work will reanalyze historical age-0 herring survey data (age-0 herring CPUE, size and condition) collected at 10 transects in the Strait of Georgia since 1992, in the context of data from DFO herring spawn surveys conducted in the spring, and publicly available environmental data. Niallan will receive data from DFO during the summer of 2024 and will finalize a thesis proposal by September 2024. Data analysis and writing will occur during 2024 and 2025.

### **Contemporary data on juvenile Salmon age-0 herring trophic interactions**

The field components of this work are complex and extensive effort has been required to plan and prepare to implement this work. A field research coordinator (Avril Hann) and a research technician (Madeleine Thomson) have been hired within Francis Juanes' Lab at the University of Victoria. We anticipate that Madeleine Thomson will evolve into a research associate role in the project in the fall of 2025, taking on a major role in development and implementation of lab analyses.

In addition to the contribution agreement with UVic an equipment loan agreement has been negotiated and signed to facilitate PSF use of two research vessels and a truck to support field research. Staff hired at UVic have also coordinated the purchase of equipment for field work including, downriggers, nets, livewells, tablets for data recording, and laboratory equipment. A data collection application for fieldwork is in development using the Epicollect5 platform. A comprehensive Animal Use Protocol Application covering all planned fieldwork was submitted to the UVic Animal Care Committee and an application for a Permit to Fish for Scientific Purposes was submitted to DFO. Drafts of Standard Operating Procedures for Beach Seining, Purse Seining and Microtrawling are in progress. Planning of field methods has included discussions with and input from Dr. Jonathan Moore (SFU), Dr. Sean Godwin (UC Davis), Samantha James (PSF), Shannon Anderson (DFO retired) and Jamieson Atkinson and other staff from BC Conservation Foundation, all with extensive experience in one or more of the planned methods.

Multiple meetings occurred over the past months with potential and confirmed First Nations partners for field components of this activity. From these meetings Tla'amin Nation, A-Tlegay Fisheries Society, and Cowichan Nation have emerged as confirmed partners in the implementation of Activity 1. Field work in the Powell River, Campbell River, and Cowichan Bay area will be implemented in conjunction with these partners, working closely with their crews and using a combination of First Nation and UVic vessels as available and appropriate. A full suite of field activities will also occur in the vicinity of Comox utilizing UVic crews. Some additional reconnaissance field work will be conducted in the Southern Gulf Islands by UVic and PSF crews. If emergent interest in the project from other potential First Nation partners occurs, we will endeavour to build these relationships in season where possible. Specific sites for sampling by each activity within each region have not yet been defined. Candidate sites for beach seine deployments have been identified in the Campbell River area based on discussions with Shannon Anderson (DFO retired); Comox estuary based on discussions with BC Conservation Foundation Staff, and in the Cowichan Bay area based on data from work carried out by DFO and BC Conservation Foundation during the Salish Sea Marine Survival Project. On the ground reconnaissance during initial field days will be used to refine site selection.

Through discussions with DFO personnel (Dr. Jackie King and Chrys Neville) an emergent opportunity to obtain samples and data highly relevant to the project has been identified. Specifically, Chrys Neville has agreed to provide whole frozen juvenile Chinook salmon (10 per trawl set) from the DFO Strait of Georgia Trawl Survey program and accompanying data for

surveys conducted back to 2014. Further, Dr. King has agreed to provide similar samples from contemporary Strait of Georgia trawl surveys occurring in June/July and September/October of 2024 and 2025. To support collection of these samples PSF will provide staffing support to these projects (Svetlana Esenkulova in summer 2024 and Madeleine Thomson in Fall 2024). These samples and data will provide an extremely valuable compliment and comparison to samples collected through beach seining, purse seining, microtrawling, and the fall age-0 herring survey. The number of samples to be received remains highly uncertain. It may be necessary to reallocate some budget from staffing field activities to supporting lab processing of these samples. Coordination occurred in fall of 2023 with Jennifer Boldt who coordinates the fall age-0 herring surveys for DFO. Salmon captured during these surveys were set aside for the project and are currently in freezers at Pacific Biological Station. We will transfer these fish to UVic in the summer of 2024.

## YEAR 1 PROGRESS SUMMARY ACTIVITY 2:

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### BIOMASS ASSESSMENT AND OTOLITH-BASED DETECTION OF ADULT NON-MIGRATORY HERRING IN THE STRAIT OF GEORGIA

**Components:** Biomass assessment field work, otolith lab work, otolith data analysis.

**Author(s) and affiliation:** Jess Qualley (PSF Project Manager), Rhonda Reidy (ECCC pos-doc), Francis Juanes (UVic), Will Duguid (PSF Biologist), Chris Rooper (DFO), Stephane Gauthier (DFO).

### ACTIVITY PROGRESS

The progress made under this activity in the first year has been hiring the herring team personnel, recruiting a post-doc to start in the final year of the project, purchasing and testing equipment, submitting applications for scientific permits and animal use protocols, and engaging and consulting with First Nations partners and other collaborators. This year has focussed on setting up contribution agreements for First Nations partners to participate in the fieldwork. We have had many discussions and consultations with future post-doc student Rhonda Reidy, Stephane Gauthier (DFO acoustician), Chris Rooper (DFO herring researcher), Jaclyn Cleary (DFO), and Jennifer Bolt (DFO). We recruited Rhonda Reidy who is only available in the final year of the project as Rhonda is currently undertaking a post-doc position with Environment and Climate Change Canada set to end March 31 2025. Rhonda is an expert acoustician and very familiar with the equipment and has an interest in the study region. Given the small pool of acousticians in the this region that are qualified to analyze EK80 data and Rhonda's experience with the equipment and doing her PhD work in this region, we felt this was the best choice for the success of the activity. Similar to activity 1, the Juanes Lab staff and resources will be shared between activity 1 and 2 to carryout field activities. The Juanes Lab staff supported the procurement of field equipment needed for activity 2 and is also supporting the development of the data collection app in the Epicollect5 platform. A joint activity 1 and 2 scientific permit application (attached) has been submitted and is expected to be approved come May 1<sup>st</sup> or shortly thereafter as we have been in contact with the DFO staff member overseeing the file. Activity 2 animal use protocol

(attached) has also been submitted to the April meeting by the UVIC animal care committee and we are waiting to hear back. Drafts of standard operating procedures (SOPs) under this activity are attached and authors are specified in each document.

Multiple meetings occurred (in concert with activity 1) over the past months with potential and confirmed First Nations partners for field components of this activity. From these meetings Tla'amin Nation, A-Tlegay Fisheries Society, and Cowichan Nation have emerged as confirmed partners in the implementation of Activity 2. Field work in the Powell River, Campbell River, and Cowichan Bay area will be implemented in conjunction with these partners, working closely with their crews and using a combination of First Nation and UVic vessels as available and appropriate. Survey sites in the northern Strait of Georgia have been identified from previous fieldwork by Jess Qualley and Will Duguid (S Quadra Island, Savary Island, Grant Reefs, and Kitty Coleman Reef); however, other key sites both in the northern Strait of Georgia and in southern Gulf Islands and Cowichan Bay area are still to be determined through ongoing discussions with First Nations partners. Some reconnaissance work may be conducted by the UVIC field team to identify adult herring sites for acoustic surveys in the southern Strait of Georgia. If emergent interest in the project from other potential First Nation partners occurs, we will endeavour to build these relationships in season where possible (similar to activity 1). We have submitted a request to Jaclyn Cleary (DFO) for adult herring samples captured through the 2024 DFO Roe Herring Test Fishery and for the 2023/24 winter food and bait fishery. These samples are processed by a third party TideView Consulting and will be paid for and obtained for their otoliths and application of the otolith stable isotope tag. Otoliths from the UVIC Adult Salmon Diet Program (ASDP) are intended to be analyzed for stable isotopes to provide insights into migration types selected by salmon in different regions and seasons and years; however, this sub-project has yet to be fully scoped out and requires further development on the stable isotope tag itself. A handful of ASDP otoliths were analyzed to fill in sampling gaps for the preliminary age-4 otolith data analysis described below under Jess Qualley's master's thesis work.

## **Objective 1: Pilot active acoustic methods to assess site-specific adult herring density in summer in the Strait of Georgia.**

### **Background**

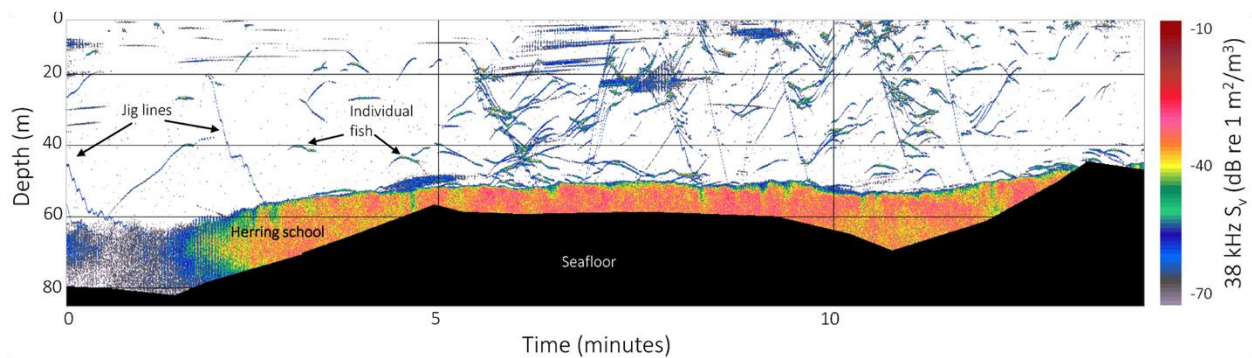
This survey is intended to pilot adult herring biomass survey methods that will integrate data from 3 components: a scientific echosounder, stereocamera, biological samples collected via



jigging. Herring presence and size estimates from time stamped stereo camera and jig samples will inform acoustic data density estimates at 4 sites in the nSoG that we know to host large aggregations of herring schools. Surveys will be conducted at monthly intervals from May to Oct over the next two summers. The goal is not survey everywhere but return to the same sites to estimate interannual changes in herring density at those sites to get at a minimum biomass estimate of adult resident herring. A survey conducted in a given site on a given day will be carried out by 2 vessels: the UVic boat with a mounted EK80 followed by a secondary boat operated by one of our First Nations partner vessels. The UVic boat continuously follows a standardized survey in a "zig-zag" pattern. See Acoustic Survey standard operation procedure for details.

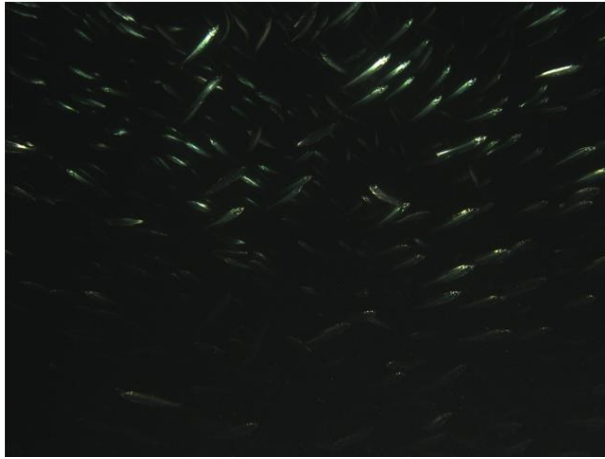
## Field Progress

We have tested acoustic survey components independently but have yet to fully integrate all three components together. We did detect large herring schools last summer 2023 in Dogfish Bay, south of Quadra Island this past summer using the UVIC boat (Liber Ero). This is a beautiful echogram (below) generated by Rhonda Reidy from the EK80 showing herring schools in red at the 38kHz frequency. The vertical jigging lines are descending into the school and the horizontal chevrons are very likely adult salmon.



We also deployed Chris Rooper's stereocamera into a school of herring, at the same site a day before testing the EK80 (see camera images below). Those are herring on the left and an adult salmon on the right. Chris has kindly loaned the camera to us for the duration of this project. It is user-friendly and I think we will get some really nice images once I tweak the strobe light settings. The next step is to get a clear image and then learn how to work with the measurement software. We do intend to pursue and test other camera systems that are smaller and more compact as this camera is large and heavy and requires a pulley/davit

system to safely deploy. However, for the start of the project this system has been tested and Chris will provide technical support as a collaborator on this aspect of activity 2.



March 2024 Rhonda Reidy (post-doc) trained Avril Hann (Juanes Lab field coordinator) and Jess Qualley (activity lead and project manager) to set up and operate the EK80 Portable. We tested the efficacy of the pole mount and EK80 setup from the UVIC boat. We detected some noise in the data associated with the pole mount and have addressed what we think is the problem with a new weld. This will be tested prior to calibration steps conducted with Rhonda

Reidy and Stephane Gauthier prior to field work start in May. Prior to the March pilot trip we requested Paulina Salinas Ruiz with the PSF Data Center help up draw up standardized survey tracks in GIS, which we were able to input into our chart plotter. This approach is so easy and great to follow in the field, while maintaining standardized distances to optimize both survey time in each area and to optimize statistical methods for comparing acoustic data.

## **Objective 2: Develop otolith stable isotope ( $\delta^{13}\text{C}$ and $\delta\text{O}^{18}$ ) tag to differentiate SoG residents from SoG migrants.**

### **Background**

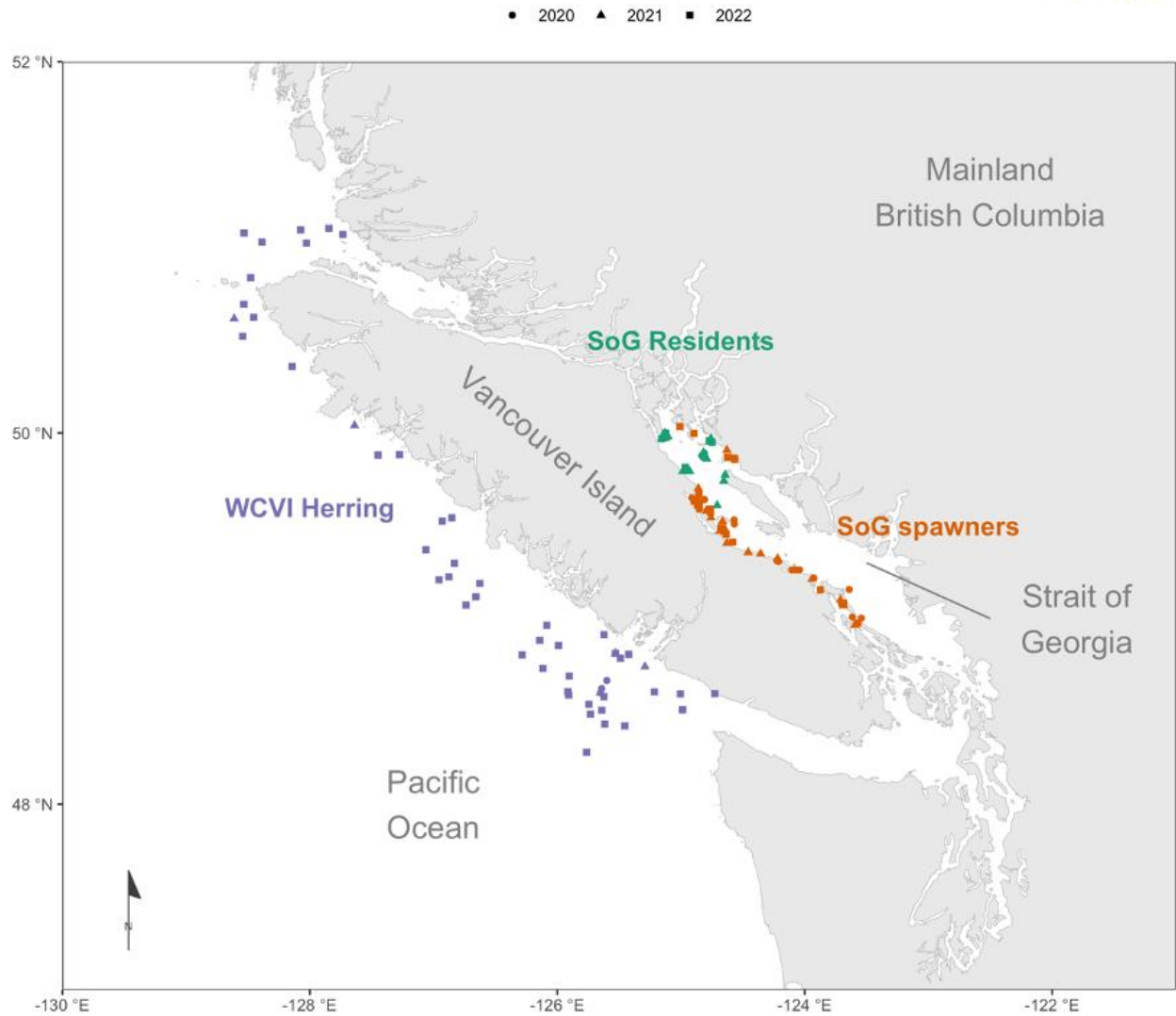
This work is an extension of ongoing MSc work conducted by Jess Qualley with Dr. Francis Juanes (University of Victoria), and in collaboration with Dr. Will Duguid (PSF Biologist). This work has also been supported by Jaclyn Cleary and Jennifer Bolt who have kindly provided samples.

Migratory life histories of Pacific Herring (*Clupea pallasii*) in the Strait of Georgia (SoG) are not well understood. Most adults (age-2+) migrate between spring spawning grounds in the SoG and summer foraging grounds on West Coast Vancouver Island. However, some adult herring are observed in the SoG year-round, suggesting an alternative resident life history. While resident herring likely constitute a small component of the aggregate stock, they may be disproportionately important to the SoG ecosystem and important predators, like Pacific Salmon. This research aims to develop an otolith elemental “tag” to differentiate resident from migratory individuals. Teleost fish grow paired, calcium carbonate structures called otoliths that aid in sound detection and gauging position in the water column. As the fish grows, otoliths accrete material like rings in a tree where elements from the surrounding seawater are incorporated as a lifetime record of the various aquatic habitats occupied by that individual. Otolith stable isotopes of  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  are known to reflect different aspects of the life history of a fish and distinct otolith stable isotope signatures have been found between migratory and resident SoG herring. Further development of an otolith stable isotope tag will have both ecological and fisheries management applications. Such a tag can be used to study the causes of different migration types in the SoG herring population, their role in the marine food web, and the vulnerability of these components to fisheries.

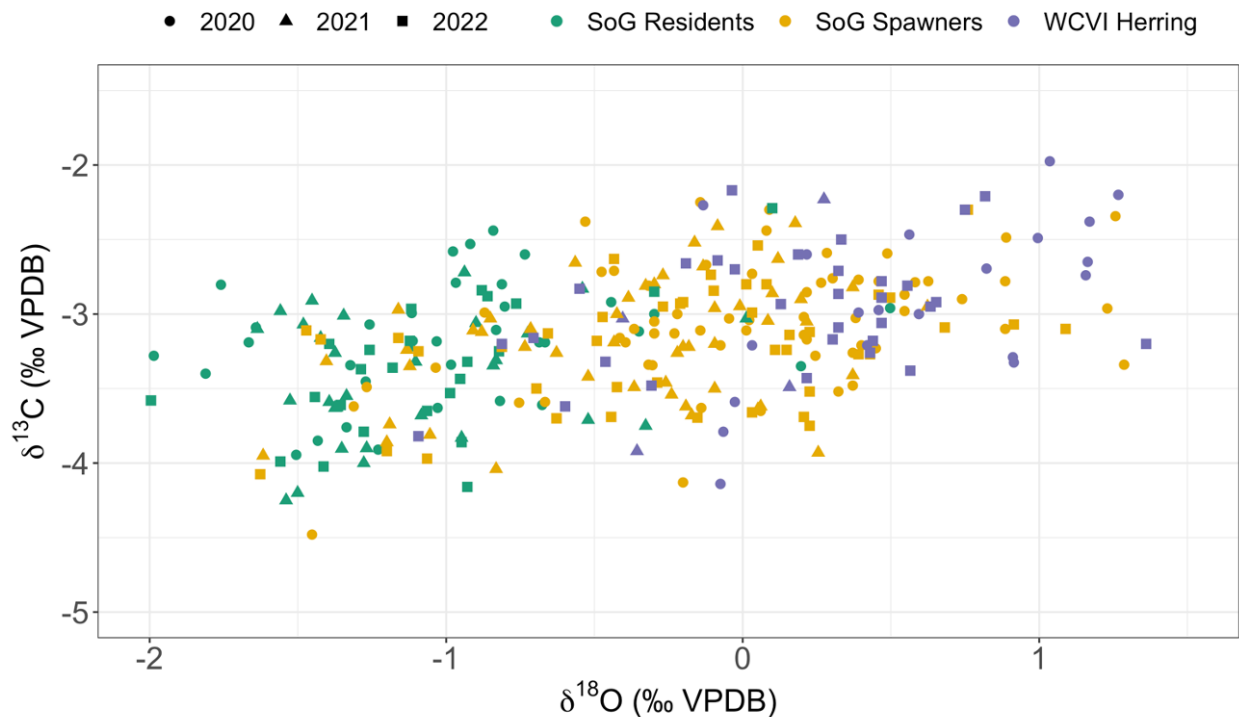
## Otolith Microchemistry Progress

This past year progress has been made in selecting and preparing otolith samples that were sent to the University of Calgary Isotope Lab for IRMS analysis. The following exercise outlines a first attempt at how the data can be modelled and applied to answer the research objectives of this activity. This data analysis will be completed as part of Jess Qualley's master's thesis work expected to be submitted by end of 2024.

This is a map (below) is of capture locations of adult herring collected from 2020-2022 representing 3 groups of interest: WCVI herring in purple and SOG residents in green, both captured in summer. And then SOG spawners in orange captured in spring. Herring were captured by targeted jig sampling, or by seine and trawl sampling through existing DFO surveys. For this initial data exercise, I filtered for age 4 fish only and randomly sampled every fishing event as well as aiming to filter an equal distribution from either side of the SOG.



Lengths/weight have been recorded, and scales taken to estimate age. Otoliths were extracted, cleaned, and photographed to measure an approximation of first year growth from the core to first year mark. One otolith/pair was carefully ground with a mortar and pestle. Those samples were sent to the University of Calgary for stable isotope analysis i.e., Continuous Flow Isotope Ratio Mass Spectrometry (CF-IRMS) using a Thermo Finnigan GasBench® coupled to a DeltaVPlus®.



This is the otolith C and O stable isotope data for 299 age-4 herring. The data points correspond to the same groups in the map. The units are measuring the ratio of the heavy to light isotope in a sample, relative to a standard reference material (e.g., delta C-13 is the ratio of C13 to C12). The general trend is that West Coast herring are more enriched in the heavier C and O isotope, relative to residents that have more of the lighter isotopes, and most of the spawners overlap with both.

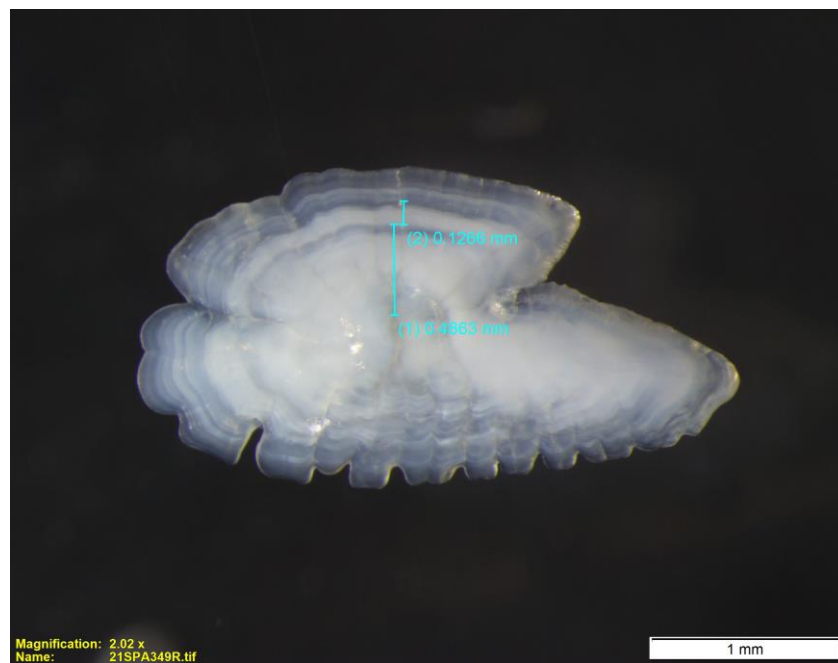
The current understanding is that processes that influence whether heavier or lighter isotopes make it into the otolith are primarily driven by the environment, but to some extent physiology. Oxygen ratios in otoliths are primarily driven by oxygen ratios in seawater, which is driven by temperature and salinity. Carbon ratios in otoliths are primarily driven by carbon ratios in seawater, and that of their diet. The isotope trend in otoliths, tracks what we might expect them to do geographically. Upwelling waters (like on the West Coast) tend to be more enriched in C and O because they are cooler, high salinity waters with lots of marine plankton. Whereas coastal areas (like the SOG) that have a greater terrestrial influence tend to be more depleted due to freshwater inputs lower salinity, create stratification so it's warmer, and deliver terrestrial C to system which is relatively C depleted compared to marine C sources.

The goal with these data is to use those isotopic differences in a binary classification model (or generalized linear model) to predict residents from migrants in the spawner group. This analysis is in progress.

**Objective 3: Apply otolith tag to compare size-at-age and estimate resident proportions in: SoG spawners (DFO roe herring test fishery) and SoG winter herring (DFO winter food and bait test fishery).**

### Activity Progress

Migration type predictions will be used to compare juvenile size at age and adult size at age between Strait of Georgia residents and migrants. Juvenile size at age will be estimated from the otolith increment distance of their first year (pictured below). This analysis is in progress.



Samples from the winter food and bait fishery have been obtained through Jaclyn Cleary (DFO).

## NEXT STEPS

1. Integrate all three components in the field.
2. Calibrate the EK80 to the UVic boat (Liber Ero) which Stephane Gauthier and Rhonda Reidy will support.
3. Optimize the camera settings to collect clear fish image to test out measurement software with support from Chris Rooper.
4. Further investigation of the otolith microchemistry modelling approach.
5. Subsample spawners and send the remaining pair for fine-scale analysis, stage specific isotope patterns, may tease apart intermediate migration types (e.g., residents that become migratory or vice versa).
6. Incorporate otolith stable isotope data from other age classes.
7. Apply otolith tag to other samples with potentially mixed migration types (e.g., DFO winter FB test samples).



# YEAR 1 PROGRESS SUMMARY ACTIVITY 3A:

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## HERRING SPAWN HABITAT: GAP ANALYSIS, CHARACTERIZATION & ASSESSMENT OF ANTHROPOGENIC STRESSORS

**Components:** Satellite spawn detection.

**Author(s) and affiliation:** Loic Dallaire (UVic MSc Student, Costa Lab).

### BACKGROUND

The project seeks to understand drivers of variation in spawn distribution in the Strait of Georgia through the development of alternative methods for detecting spawning events using satellite imagery detection. A satellite approach can complement the existing DFO spawn survey program to provide a more comprehensive understanding of the spatial extent of spawns through time, as a spawn index can be applied to historical satellite images dating back to 1983.

Loïc Dallaire, MSc student at the University of Victoria (UVic), was granted with a MITACS Accelerate scholarship for the length of this project. By March 2024, he helped Jake Dingwall (second MSc UVic student working on Activity 3) in his field instruments deployment, presented at the Pacific Ecology and Evolution Conference (PEEC) and conducted a first field trip for this first part of the project.

At the end of April 2024, the robustness of the satellite remote sensing index is being tested and multiple paths of detection are being explored, each associated with a different level of confidence. The next steps will include the implementation of these methods to an interactive tool such as Google Earth Engine.



*Drone imagery from a herring spawn in Qualicum Beach, March 13<sup>th</sup> 2024. Credit: Loïc Dallaire*

## ACTIVITY PROGRESS

Loïc has been conducting the last phase of the first objective: producing a satellite based remote sensing index to detect the spawn event or milting events to be more precise. He also spent time to understand the spectral, physical, and temporal aspects of the milting phenomenon. This understanding allowed Loïc and his team to develop a promising version of the **Spectral Herring Spawn Index (SHSI)**. This index is presently being tested to better understand the possibility of cases of commission and omission regarding the other potentially complex coastal water pixels such as coccolithophores blooms, shallow and sandy areas and sectors with high concentrations of suspended matter (e.g. mouth of the Fraser River).

March 2024 has also been occupied by a field trip that aimed to explore the potential of using hyperspectral data for the detection of milt and the correlation between the surface reflectance of milt-loaded waters and the concentration of milt in mg/L. This work was not aimed at the production of robust results and was instead focused on testing methodology. Some observations can be pulled from this work, but it has also been possible to generate some excellent images of a near-entire spawning event at very high spatial resolution. Moreover, some images have been very popular when shared on social media. The large amount of attention received from a diversity of medias has allowed the project to be introduced to a broader audience in this kind of article by the [National Observer](#) for example.

# YEAR 1 PROGRESS SUMMARY ACTIVITY 3B:

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## HERRING SPAWN HABITAT: GAP ANALYSIS, CHARACTERIZATION & ASSESSMENT OF ANTHROPOGENIC STRESSORS

**Components:** Spawn Habitat Survey.

**Author(s) and affiliation:** Jake Dingwall (UVic MSc Student, Bates Lab).

### BACKGROUND

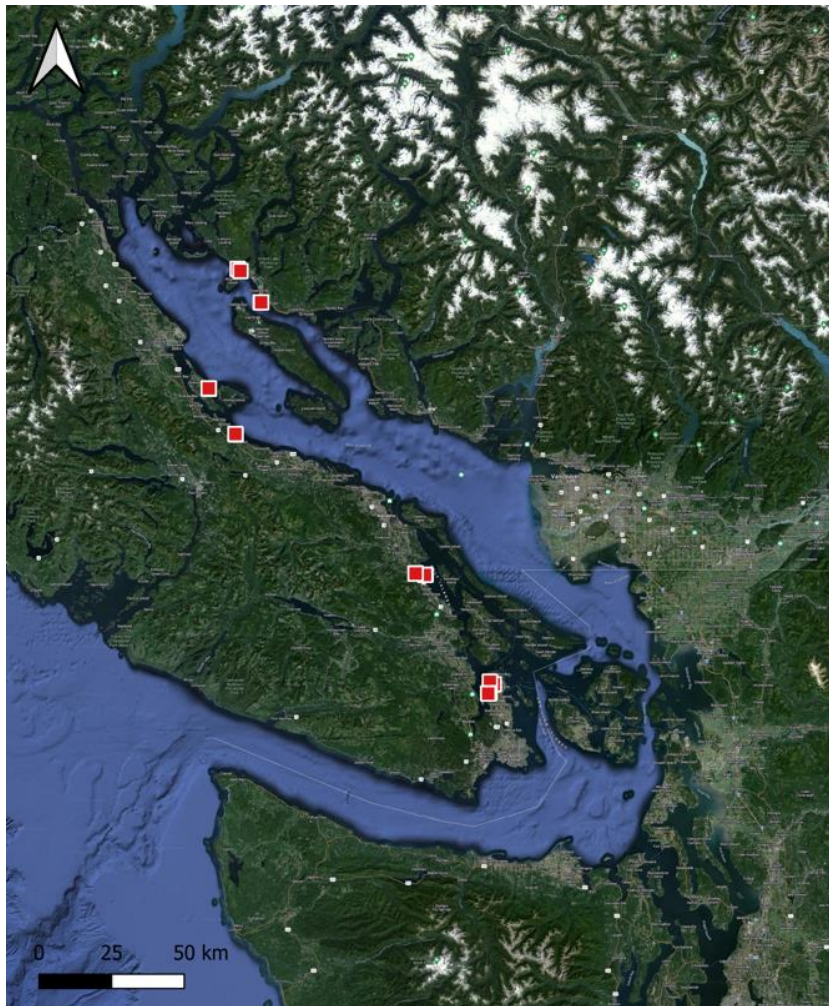
This summary covers the work completed by Jake Dingwall, University of Victoria Masters Student, for Activity 3, *Herring Spawn Habitat: Gap Analysis, Characterization & Assessment of Anthropogenic Stressors*. Jake began his M.Sc. under Dr. Amanda Bates at the University of Victoria in September 2023. In the last 8 months, they completed two field campaigns, developed local relationships, achieved MITACS Accelerate funding, and in collaboration with the herring team at large, created a variety of social media products.

The project seeks to understand the health of herring spawning habitat in the Strait of Georgia. As such, the team are measuring a variety of ecological factors. In February 2024, they deployed 32 temperature loggers in the intertidal zone at eight sites using novel methods (Figure 1). These loggers will provide an understanding on high resolution intertidal temperature dynamics.

### ACTIVITY PROGRESS

In April 2024 they conducted three weeks of fieldwork at our eight sites conducting underwater video transects via remotely operated vehicles (ROV) and collecting water and sediment contaminant samples (Figure 1). In addition, the ROV hosted temperature, conductivity (salinity), and dissolved oxygen probes. The ROV was piloted perpendicular to shore and obtained novel datasets on nearshore marine vegetation and health (Figure 2).

Altogether over 150 transects were flown – over five times as many that could be completed by traditional dive surveys. Three sediment grabs and three surface water samples were taken at each site. These samples were submitted to various labs to be analyzed for a whole host of contaminants including contaminants demonstrated to be toxic to salmon and killer whales.



**Figure 1.** Location of habitat survey sites in the Strait of Georgia. They include sites near Powell River, Denman Island, Qualicum Beach, Ladysmith Harbour, and Coles Bay, Saanich Inlet.

The fieldwork in April was conducted in partnership with various partners including Tla'amin Nation, Stz'uminus Nation, Pauquachin Nation, Malahat Nation, MC Wright and Associates, and Raincoast Conservation Foundation.



**Figure 2.** Screen Capture of a dense eelgrass meadow from a transect piloted off Denman Island.

In addition to fieldwork, the team was granted a \$75,000 MITACS funding agreement from May 2024 to December 2025. Jake also presented his work through various initiatives including lecturing to Biology 319 Marine Ecology at the University of Victoria, speaking to middle schoolers via Skype a Scientist, and presenting his work at the Pacific Ecology and Evolution Conference and the BCCF 6PPDQ Workshop (Figure 3).

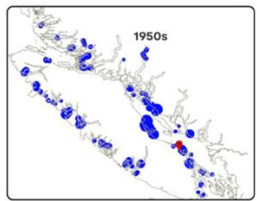
# CHARACTERIZING THE CONTAMINANT RISK WITHIN PACIFIC HERRING SPAWNING HABITAT

Jake Dingwall<sup>1,2</sup>, Peter Ross<sup>3</sup>, Samantha Scott<sup>3</sup>, Isobel Pearsall<sup>1</sup>, Jess Qualley<sup>1,2</sup>, Amanda Bates<sup>2</sup>  
<sup>1</sup> University of Victoria; <sup>2</sup> Pacific Salmon Foundation; <sup>3</sup> Raincoast Conservation Foundation

\*jdingwall@uvic.ca

**Context** Pacific herring are a fundamental component of the food web in the Strait of Georgia. Comprising, at times, the entire diet for many species including Chinook salmon and humpback whales. Every March they return to lay eggs on nearshore vegetation like eelgrass and sargassum.

Since the 1980s we've seen a shift in where and when herring spawn in the Strait. This has major consequences for local food webs and First Nations traditional harvests.



The driving factor for this shift is unknown. However, local knowledge has highlighted **significant decline in the health of historical spawning habitat**. Although, it is likely a myriad of factors including fisheries or climate, the declining condition of spawning habitat is likely a key driver of this range shift.

To assess the potential of risk chemical contaminants to herring embryos and larvae we will complete the following objectives.

**Objective 1: Compare the magnitude and profile of chemical contamination between sites**

**Objective 2: Assess the contribution of land based inputs into marine waters**

**Objective 3: Assess the risk of chemical contaminant profiles at sites via published thresholds**

For more on PSF's herring project

**Methods** This work is being conducted across 8 sites, in 4 regions of the Strait of Georgia. Six of these sites (red) represent locations that have historically displayed strong herring spawn but are now intermittent or abandoned. Two sites (green) receive significant annual spawn.



Marine sediments and surface water were sampled in April 2024. Three sediment and water samples were taken at each site and homogenized.



In July and December 2024, in collaboration with Raincoast Conservation's Healthy Waters Program, we will also be sampling freshwater throughout two watersheds.

Samples will be analyzed for pharmaceuticals (PPCPs), PCBs, PBDEs, PCDD/DFs, heavy metals, PFAs, BPAs, 6PPD-Q, PAHs, pesticides, sucralose, and more.



## Preliminary Results

6PPD-Q was not detected in marine water below the detection limit of 0.5 ng/L. Further work is required for solid phase extraction to lower the detection limit.

All other samples from April are currently being analyzed by SGS AXYS and ALS.

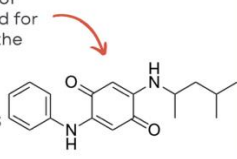


Figure 3. Poster for the Pacific Ecology and Evolution Conference and the BCCF 6PPDQ Workshop.

# YEAR 1 PROGRESS SUMMARY ACTIVITY 4:

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## REBUILDING HERRING INDIGENOUS KNOWLEDGE WITHIN FIRST NATIONS COMMUNITIES IN THE STRAIT OF GEORGIA

**Components:** Partnership building, meetings, products progress.

**Author(s) and affiliation:** Isobel Pearsall (PSF Director of Marine Science Program).

### BACKGROUND

Herring has a significant place in coastal First Nations' culture and their relationship with the marine environment. With declines in herring abundance and spawning ground extent, that connection to the traditions associated with herring is at risk of being lost. This activity is intended to be a community outreach and educational initiative to convene groups and create resources to share the value and traditions associated with herring. This is being accomplished through:

- videos documenting oral histories where First Nations elders and representatives discuss the value of herring to First Nations communities,
- a series of gatherings, celebrations and events that enable knowledge transfer about herring from First Nation elders to youth
- educational materials and curriculum to teach First Nation youth about herring,
- educational videos of cultural practices around herring and herring food preparation.

The benefits of this final activity will be a shared understanding of the historical status and utilization of herring in the Strait of Georgia, and will also engage and educate youth to develop the next generation of marine stewards.



## ACTIVITY PROGRESS

Activity 4 was developed over 2022–2023 with Tim Kulchyski (Biologist, Cowichan Tribes) and Nick Chowdhury (IMAWG and 'wi'la'mola consulting).

### Meetings

Our work during 2023–2024 focussed on meeting with several First Nations leaders and representatives around the Strait of Georgia to discuss the project and potential ways to support learning and knowledge transfer about herring in their communities. We wished to identify their need for and interest in workshops, training, or celebrations.

Through these meetings, it became clear that many First Nations keenly feel the loss of herring in their communities, and most importantly, are concerned about the loss of understanding and knowledge about the value of herring in First Nation youth. Different communities expressed interest in various products and potential events to be held in their communities.

### Events/Videos Funded in 2023–2024

The meetings (listed above) led to discussions about possible events/products of interest to be held during 2024–2025 fiscal year, and we were also able to support several activities during 2023–2024 fiscal year. This included:

1. A large community gathering convened through the Q'ul-Ihanumutsun Aquatic Resources Society (QARS) which was held on February 23, 2024. This gathering brought together over 90 people from Stz'uminus First Nation and was an opportunity to screen a documentary on the importance of herring to ecology, economy, and First Nation's culture in southern Vancouver Island. The community celebration brought together knowledge holders who appeared in the documentary with the filmmakers, Elders, youth, and supporters, for the first official community screening of the film. The film—which featured Elders and knowledge holders from Stz'uminus as well as Cowichan Tribes and Penelakut— was a co-production of the communities and the Q'ul-Ihanumutsun Aquatic Resources Society (QARS), Kingtide Films, and Trailmark Systems. The documentary gives voice to the Hul'qumi'num communities that have felt impacts from the disappearance of

herring in recent decades. This gathering brought together youth and elders, shared knowledge, and held a feast for the community with traditional foods.

Sign-ups were done at the meeting to enlist Stz'uminus First Nations interested in being involved in a herring rake production video (for fiscal year 2) and a video about herring food preparation.



# SLHEWUT

Hul'q'umi'num knowledge of herring



The original contract with QARS, and a summary report from QARS and Trailmark about the event are both provided.

2. The second event was held on March 14, 2024. The *Skwxwú7mesh Úxwumixw* / Squamish Nation and St'a7mes School hosted a Welcome Ceremony at the beginning of *Tem Lhawt'* / the time of herring and herring spawns in Skwxwú7mesh territory. The event was organized by Matthew Van Oostdam, who is a school teacher at the St'a7mes School and the Marine Stewardship Initiative's Search for Slhawt' / Herring Program Coordinator. The funding received allowed the Howe Sound Marine Stewardship Initiative (MSI) to support logistics of the Welcome Ceremony, as well as document activities surrounding Tem Lhawt' in photo and video. The Welcome Ceremony took place on March 14th at Totem Hall, where over 200 attendees gathered to celebrate *Tem Lhawt'* / the time of herring. There were songs, dancing, and stories were shared by elders. Hemlock and cedar boughs were tied together so that they could be set in the water for herring to spawn on. School children had prepared anchors made of river rocks and cedar bark. These boughs were transported and anchored in the water in front of St'a7mes Village, with help from Addison Farr of Sea Dog Expeditions, Jonny Williams, and Matthew Van Oostdam. After setting the boughs, everyone returned to Totem Hall for a feast of salmon and bannock to celebrate.

With the funding through the Herring BCSRIF, the MSI contracted Kieran Brownie, a local photographer / videographer to create a series of four videos. These videos document and share the story of how *slhawt'* / herring are connected to the *Skwxwú7mesh Úxwumixw* / Squamish Nation, *Átl'ka7tsem* / Howe Sound, and all the species that call this region home.

Three of the videos are interviews, featuring Squamish Nation member Charlene Williams, Squamish Nation ACE Technician Matty Moore, and Search for Slhawt' Program Coordinator Matthew Van Oostdam.

The final video created is a short narrative film, that encompasses the broader story of herring in *Átl'ka7tsem* / Howe Sound, and how fluctuations in herring populations have impacted both the wildlife and *Skwxwú7mesh Úxwumixw* / Squamish Nation. This film was shared during their end-of-season event at the Brackendale Art Gallery.

## FUTURE PLANNING

The meetings listed above resulted in planning for several 2024-2025 fiscal year events and/or products that will likely include:

1. A community event to be held through Cowichan Tribes. This will involve screening of the QARS herring video and gathering of elders/youth.
2. A community event to be held through the Marine Stewardship Initiative to bring Squamish First Nation elders and youth together.
3. A celebration to bring Tsleil-Waututh First Nation youth and elders together at local spawns in Burrard Inlet.
4. A community event and videography with Tla'amin First Nation.
5. A community event and videography with Qualicum First Nation.
6. 2 educational videos through St'uminuz First Nation and QARS a) How to create a herring rake and b) Herring food preparation.
7. An educational video about traditional practices using cedar boughs to collect herring roe for Qualicum First Nations youth.
8. Development of a full curriculum for Grades K-6 First Nations schools about herring-to be developed by St'a7mes school teacher Matthew Van Oostdom.



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