PACIFIC SALMON FOUNDATION

SALMON MIGRATION STUDIES

BOTTLENECKS TO SURVIVAL

Marine Science Program Newsletter

VOL.6 | June 2025

psf.ca

Photo by Sam James
Cover photos by Jamieson Atkinson, Cypress Hunder-Rookes, Nick Bohlender and Sam James

LOOKING BACK, MOVING FORWARD: THE BOTTLENECKS TO SURVIVAL PROJECT

Last year marked the beginning of the next chapter for the Bottlenecks to Survival Project. Between 2020 and 2023, we took on the ambitious task of using Passive Integrated Transponder (PIT) tags to track the survival of Chinook and coho salmon, and steelhead trout throughout their life cycles. Our goal? To break down survival into smaller, more manageable pieces and figure out where fish are facing the biggest challenges.

It was no small feat. We installed extensive **PIT infrastructure in 11 river systems** along the east coast of Vancouver Island, **tagged hundreds of thousands of fish**, and forged **strong connections with community partners**. We've spent countless hours in the field, learning the ins and outs of each river and the salmon populations they support. We've invested enormous effort into **developing a robust data management system** — finding ways to wrangle complex datasets and build clear, practical data structures and visualizations. This has helped us make sense of the massive amount of information collected and has been essential for turning data into insights.

Along the way, we've tackled questions about **hatchery practices, marine distributions of steelhead, overwinter survival, predation, fisheries impacts, and habitat use**. Our efforts have already resulted in 13 technical reports brimming with insights (see our previous newsletter, volume 5 for more info), but really, this is just the beginning.

In 2023, we secured a second round of funding from the BC Salmon Restoration and Innovation Fund (BCSRIF) to keep building on what we've learned. With support through to March 2026, we're not just continuing our successful methods — we're also challenging our assumptions and looking for any biases in our approaches.

Photos by Sam James

WHAT'S NEXT

Here's what we'll be focusing on in phase two of the project, which runs from the spring of 2023 to the spring of 2026.

CONTINUING WHAT WORKS:

- **PIT tagging:** Chinook and coho salmon at multiple life stages to pinpoint survival bottlenecks.
- **Overwinter ecology:** Collecting samples (diets, scales, fin and gill clips) to better understand how Chinook salmon fare in the Strait of Georgia over the critical first winter period.
- **Acoustic tagging:** Tracking juvenile Chinook salmon to learn more about their marine migration strategies (see volume 4 for more details).
- **Hatchery collaborations:** Exploring rearing and release practices to improve survival rates.
- **Wild vs. hatchery comparisons:** Understanding how these groups differ to fine-tune our methods.
- **Maintaining the network:** Keeping our extensive PIT array system up and running.

NEW EXPLORATIONS:

- **Otolith microchemistry:** Analyzing fish ear bones to look back in time and determine size at ocean entry of adult returns and what proportion of returns come from small fish outside our taggable range.
- **Pinniped monitoring:** Partnering with First Nations to track seal and sea lion numbers in lower rivers and estuaries, a new piece of the puzzle in understanding salmon survival.

Photo by Nick Bohlender

SIGNALS FROM BELOW: ACOUSTIC TAGGING

We're excited to share new insights from our acoustic tagging work, which is shedding light on the **overwinter behavior of juvenile Chinook salmon in the northern Strait of Georgia (NSOG)**. This region is home to an **active groundfish trawl fishery** that has caught approximately **28,000 Chinook salmon** in each of the past two years—highlighting the urgent need to understand where these fish are during the winter months.

To address this, we partnered with the Ocean Tracking Network (a Canadian Foundation for Innovation Major Science Initiative at Dalhousie University) and the trawl fleet to deploy a new deep-water acoustic receiver array in the NSOG. These receivers, placed at depths greater than 300 metres, tracked the movements of 18 second ocean winter Chinook salmon within the core fishing area.

The acoustic tags, equipped with pressure sensors, revealed that **Chinook salmon often overwinter at depths exceeding 225 meters**, though they also move vertically throughout the water column. These data will help us explore whether bycatch vulnerability varies by time of day or across the winter season.

Beyond this, our broader study—tracking 329 Chinook salmon—has **uncovered an unexpected and concentrated migration pulse of juvenile Chinook leaving the Strait of Georgia during their second spring at sea**. This finding opens new questions about migration timing and survival strategies that we're eager to explore further.

Photo by Nick Bohlender

Photo by B. Maher

Photo by Micah Quindazzi

DIVING DEEPER: OTOLITH MICROCHEMISTRY

One of the exciting new elements of this phase is our use of otolith microchemistry to better understand the survival of wild Chinook salmon. Otoliths — tiny ear bones in fish — serve as natural data loggers, recording chemical signatures from the water where the fish lived. By analyzing these signatures and measuring the size of the otoliths, we can determine how big the fish were at the time they entered the ocean. We can then compare the otoliths of returning adults with those of outmigrating juveniles to determine **what proportion of returning adults originated from smaller juveniles that were below our tagging threshold**. Additionally, the chemical patterns may help us distinguish between resident (Strait of Georgia) and non-resident migration strategies, providing insights into how these different life history strategies contribute to adult returns.

The challenge we're addressing is rooted in the limitations of our current tagging methods. Our PIT tagging program targets fish that are at least 70 millimetres in fork length to avoid negative tagging impacts on smaller fish. This means we're likely missing data on smaller fry that might still make significant contributions to the adult spawning population. To fill this gap, we're turning to otolith analysis.

Our approach involves collecting otoliths from returning adult wild Chinook in key river systems (Cowichan, Nanaimo, and Puntledge). These samples are then extracted, mounted, polished, and analyzed using a laser ablation inductively coupled mass spectrometer (LA-ICP-MS). This method identifies the point when the fish entered the marine environment by detecting a spike in Strontium (Sr) concentration paired with a decline in Barium (Ba) concentration. **Measuring the distance from the otolith's center to this inflection point allows us to estimate the fish's size at marine emergence**.

Photo by Cypress Hunder-Rookes

By comparing the fork length at marine emergence with the size thresholds for tagging, we can assess **whether smaller fish that we didn't tag still make it back as adults**. Additionally, this analysis will help us distinguish between **resident and non-resident Chinook life histories**, verifying the results from our acoustic tagging studies and shedding light on patterns of local versus migratory survival.

This new approach will provide a more comprehensive understanding of which fish contribute to adult populations, helping us fine-tune our tagging strategies and better interpret our survival data.

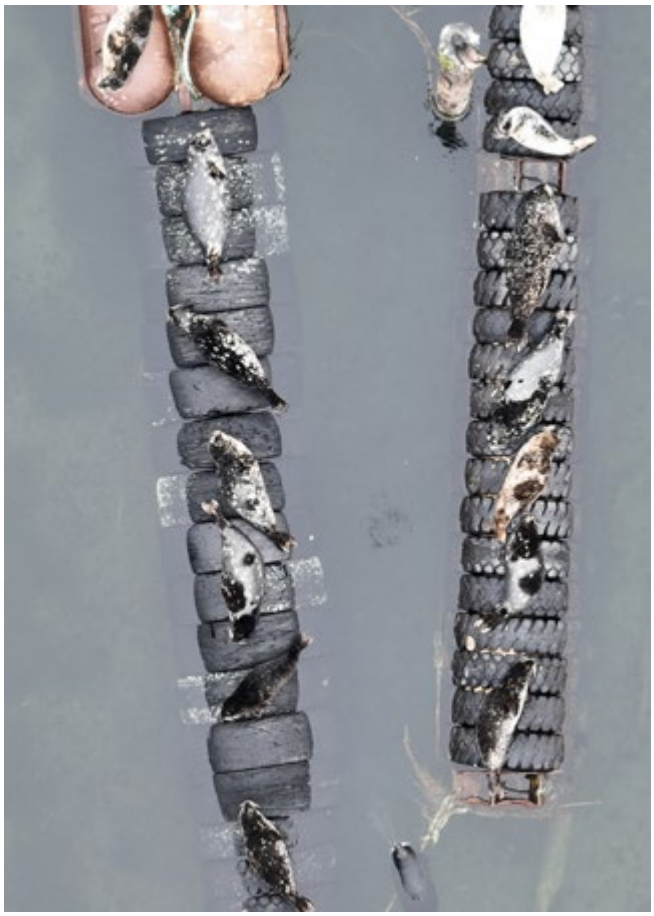
Photos by Dustin Wales (Aeria Solutions)

PARTNERING FOR PINNIPED MONITORING

Another important addition to our work is a pinniped monitoring program. While we know that seals and sea lions can significantly impact salmon populations, their effects within river environments remains largely unknown. To address this gap, we are **collaborating with local First Nation partners to develop a rigorous monitoring framework**. This program will be First Nation-led and is designed to be adaptable for use by multiple partners across different systems.

The goal is to gather fine-scale spatial and temporal data on pinniped abundance and activity in lower river environments. To build upon traditional shore-based counts, we are exploring **innovative technologies like side scan sonar, wildlife camera traps, and drone imagery**. This approach will help us **establish a year-round baseline of seal and sea lion movements into rivers**, giving us a clearer picture of how their movements align with outmigrating and returning Chinook and coho stocks.

Understanding these predator-prey interactions is crucial for interpreting the challenges salmon face as they move between freshwater and marine environments. By linking pinniped abundance data with our PIT-tagged outmigration and adult return data, we hope to gain new insights into how salmon migrations interact with predation pressure. This information will ultimately help us better understand the role of pinnipeds as a potential bottleneck to salmon survival.



Photos by Cypress Hunder-Rookes

LOOKING AHEAD

With these new methods and partnerships, we're gaining a richer, more nuanced understanding of the obstacles salmon face throughout their life cycles. Whether it's shedding light on the fish we've missed with tagging or examining predator interactions in the lower rivers, each piece brings us closer to our ultimate goal: **helping salmon populations thrive**.

Our team is energized by the progress so far and excited about the road ahead. We're committed to working with our partners, sharing what we learn, and continually improving our approaches to give these fish their best chance at survival. Stay tuned for updates as we continue working toward healthier salmon populations on Vancouver Island!

Photo by Cypress Hunder-Rookes

FOR FURTHER INFORMATION, PLEASE CONTACT:

Sam James, PSF Project Manager
sjames@psf.ca

Jamieson Atkinson, BCCF Project Manager
jatkinson@bccf.com

Sign up for our Marine Science quarterly eNews and never miss a newsletter!

PACIFIC SALMON FOUNDATION

1385 West 8th Ave,
Vancouver, BC, V6H 3V9
Tel: 604-664-7664
Email: salmon@psf.ca

BRITISH COLUMBIA CONSERVATION FOUNDATION

Fisheries and Oceans Canada
Pêches et Océans Canada

BRITISH COLUMBIA

Funding for this project is provided by the BC Salmon Restoration and Innovation Fund, a contribution program funded jointly between Fisheries and Oceans Canada and the Province of BC