PACIFIC SALMON FOUNDATION

SURVIVAL BOTTLENECKS STUDY

The Pacific Salmon Foundation, together with the British Columbia Conservation Foundation, are investigating survival bottlenecks for salmon and steelhead throughout the Salish Sea and Southern BC regions

MARINE SCIENCE PROGRAM

PSF.ca

Photo by Danny Swainson
Cover photos by Ryan Miller and Eiko Jones

THE PROJECT

Recent declines in the abundance of Chinook and Coho salmon, and Steelhead trout in the Salish Sea have resulted in numerous ecological, economic, and cultural impacts in British Columbia. Indeed, unprecedented restrictions on commercial, recreational, and First Nations fisheries and even the poorer health of Southern Resident Killer Whales have all been linked to recent declines in these species. Now there is growing consensus that the first year of marine life plays a key role in regulating productivity for juvenile salmon, and that predation, competition, and climate change all contribute to poor salmon and steelhead returns in southern BC, particularly on Vancouver Island. Understanding the mechanisms and relative contributions of the factors that may be limiting Chinook, Coho, and steelhead productivity is a key cultural, economic, and ecological priority in the Province. Moreover, as wild salmon and steelhead abundance continues to decline or remain at historic lows, there is growing recognition that traditional hatchery mitigation is not meeting conservation and recovery objectives for wild stocks. For enhancement programs to effectively contribute to both harvest and conservation, the performance of hatchery fish must be similar to that of wild fish.

Recently, the Pacific Salmon Foundation's (PSF) Salish Sea Marine Survival Program utilized Passive Integrated Transponder (PIT) tags to examine the survival of juvenile Chinook salmon in the Cowichan River. Small, injectable PIT tags (12mm x 2mm) produce a unique identification code when a fish encounters an antenna — similar to the way the 'tap' feature works on a bank card — and can be used to track individual survival through various stages of their life-history. This research on juvenile Cowichan River Chinook highlighted the importance of critical mortality periods during both the early marine period and the first winter of marine life, and the much lower survival of hatchery-produced salmon relative to wild counterparts. In light of these observations and the need for a much broader assessment, PSF, together with the British Columbia Conservation Foundation (BCCF), applied for and received funding from the BC Salmon Restoration and Innovation Fund to investigate survival bottlenecks throughout freshwater and marine regions of the Salish Sea and parts of Southern BC. Our goals for this study are to: **(a)** develop the monitoring and evaluation framework and infrastructure to determine survival bottlenecks for wild and hatchery Chinook, Coho and steelhead, **(b)** implement infrastructure to allow for adaptive management of hatchery programs for harvest, conservation, and sustainability objectives, and **(c)** conduct research, monitoring, and evaluation that will help guide management to improve the performance of hatchery and wild stocks .

Photo by Kevin Pellett

PIT antenna in the Cowichan River

Photo by Danny Swainson

PIT tag implantation in a juvenile Coho salmon

COLLABORATIONS

This project is broad and highly collaborative in nature, with key project partners including DFO's Salmonid Enhancement (SEP) and Stock Assessment Division (StAD), the Provincial Ministry of Forests, Lands, and Natural Resource Operations (FLNRO), and the University of Victoria (UVic) — all of whom are partners in scientific study development and on the ground operations. We have also partnered with a number of community groups, non-profit stewardship organizations, and First Nations — whose traditional lands and rivers we are working in — to carry out field programs. Other academic institutions (SFU, UBC) are partners in mutual data collection and field sampling and are providing additional on the ground support. Lastly, the majority of our marine sampling is being carried out by a group of volunteers throughout the Salish Sea region, to whom we are very grateful for their continued efforts and dedication.

APPROACH

The aim of this project is to provide new information on survival bottlenecks for Chinook, Coho, and steelhead in both freshwater and marine environments. The primary components are:

1. establishing PIT antenna arrays in a number of priority freshwater systems and hatchery facilities, and implementing an extensive juvenile salmon/steelhead PIT tagging program;
2. investigating the ecology of juvenile salmon during their first ocean winter;
3. utilizing PIT and video technology to electronically monitor recreational fishery catches and better understand predation mortality;
4. examining survival, dispersal, mortality mechanisms, and evaluating alternative hatchery strategies as conservation tools for juvenile and adult steelhead.

1. PIT Antennas and Tagging

Using a staged approach over the next three years, PSF, together with BCCF, will implement new PIT antenna arrays in key Vancouver Island, Sunshine Coast, and possibly Fraser River systems, as well as DFO-SEP hatchery facilities (Figure 1). Implementation of PIT infrastructure at hatcheries will also provide an innovative means of monitoring and evaluating experimental rearing and release strategies, hatchery-wild interactions, and future research opportunities at these enhancement facilities. To maximize this infrastructure investment, an ongoing PIT tagging program that aims to tag over 50,000 wild and hatchery juvenile Chinook, Coho, and steelhead throughout the Salish Sea region each year for the next four years has been implemented. Tagging will take place at hatchery facilities; in rivers and estuaries targeting wild fish; and in the marine environment for both hatchery and wild fish via capture by micro-trolling — a modified method of recreational fishing that utilizes miniature trolling gear (hooks, spoons, flashers) to target

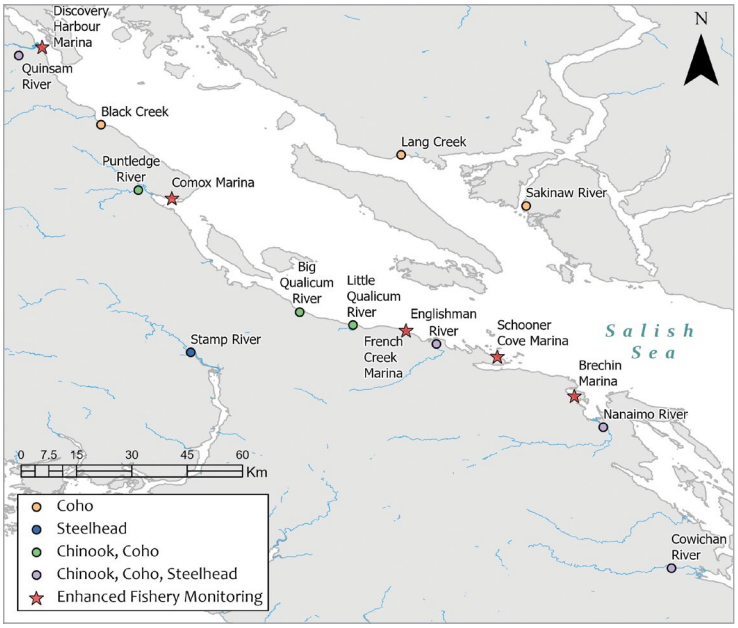

Figure 1. Map of the Bottlenecks study region showing the locations of river systems to be outfitted with PIT infrastructure and target species for tagging (color-coded circles), and recreational landing sites for enhanced fishery monitoring program (red stars).

juvenile salmon. Data from this extensive PIT program will help elucidate key survival bottlenecks in both freshwater and early marine environments for Chinook, Coho, and steelhead, and will be used to develop strategies that may help improve survival.

2. Juvenile Winter Ecology

Despite a widely held belief that the first winter in the ocean plays a critical role in regulating salmon survival, there is a conspicuous lack of data on the winter habitat, diet, and health of these fish. A primary focus of the Bottlenecks project is to understand if, and how, the first winter at sea regulates survival of both hatchery and wild fish. To address this objective, a detailed study is being conducted in partnership with UVic to specifically examine the winter habitat use, diet, pathogen load, immune status, and bioenergetics of juvenile Chinook salmon. By sampling juvenile Chinook Salmon from October to March, researchers will develop the first complete picture of how these fish use their environment during the winter. The condition and energy content of individual fish will be related to their previous growth history (determined from scales) and their disease status (as indicated by cutting edge molecular genetic techniques). Integrating results will provide insight into how winter conditions may interact with pathogens and growing conditions during the previous summer to control survival. Results will be incorporated into models that will simulate the response of Chinook salmon to changes in winter ocean temperatures due to climate change.

Microtrolling tackle — flasher and spoon

3. Enhanced Fishery and Predation Monitoring

Another mainstay of the Bottlenecks project is an innovative and novel fishery and predation monitoring program being conducted in collaboration with DFO-StAD with support from the BC Sport Fishing Advisory Board and local marinas. This program will utilize PIT and video technology integrated into cleaning tables at a number of high-traffic recreational landing sites on Vancouver Island (Figure 1), and routinely scan known pinniped haulouts and heron rookeries for expelled PIT tags. Detection of tagged fish and video data collected at landing sites will provide valuable supplemental information to DFO's creel survey program and help quantify stock-specific exploitation rates, while scanning for expelled tags will help to better understand the proportional levels of mortality occurring from avian and pinniped predation. These two activities will provide valuable additional capture information that would be unavailable by any other means and further contribute new information on survival bottlenecks for salmon in the Salish Sea.

4. Understanding Steelhead Bottlenecks

Working with our partners at FLNRO, we will examine survival bottlenecks for Steelhead trout during both the juvenile and adult life history stages of this species. Juvenile PIT tagging programs on the Cowichan, Englishman, and Quinsam Rivers will provide information on timing, abundance, and both freshwater and marine survival, while an experimental program at Robertson Creek Hatchery will evaluate how alternative juvenile release and/or rearing strategies may be used to increase overall survival and adult returns. We will also evaluate the effectiveness of reconditioning wild kelts[1] as a tool to promote increased survival and repeat spawning, while satellite tags will be used to explore distribution and potential mortality mechanisms of reconditioned adult steelhead while at large in the Salish Sea and elsewhere. Data generated from this study will provide information on where survival bottlenecks could be occurring in freshwater and marine environments and evaluate strategies that may help facilitate population persistence and recovery for this species in the Province.

1 Steelhead are iteroparous, a natural life history strategy whereby some individuals (2-15% of a population typically) will return to the ocean after spawning — a process known as kelting — and return to freshwater again to spawn in future years. Reconditioning is the process of culturing post-spawned steelhead (kelts) in a captive environment where they are fed and grown to a suitable healthy size before being released to continue their seaward migration.

Juvenile Chinook salmon caught by microtrolling

Microtrolling in Maple Bay, southern Vancouver Island

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