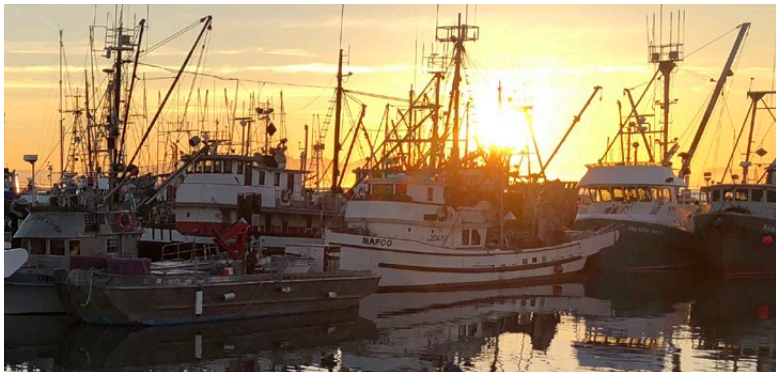
PACIFIC SALMON FOUNDATION



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

VOL.3 | September 2022

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Photo by Eiko Jones
Cover photos by Eiko Jones (top) Danny Swainson (left), Mitch Miller (centre) and Collin Middleton (right)

THE PROJECT

Many populations of wild Chinook, Coho and steelhead have experienced steep declines in the Salish Sea. Considering the importance of these iconic species to BC — ecologically, culturally and economically, it is urgent that we increase our understanding of the factors and mechanisms that may be contributing to their declines.

The Bottlenecks to Survival Program, a collaboration between PSF and British Columbia Conservation Foundation (BCCF), is aiming to do just that. The main objective of the program is to investigate when and where Chinook, Coho and steelhead are facing critical mortality periods or "bottlenecks" during the freshwater and early marine periods of life. We have focused on key Coho and Chinook stocks from river systems along the East Coast Vancouver Island (ECVI) along with steelhead investigations in the Cowichan, Quinsam, and Stamp River systems. There are four primary activities that make up this research project:

1. establishing an extensive marine and freshwater PIT-tagging program and network of PIT tag monitoring antennas on several priority river systems and hatcheries on ECVI;
2. conducting a detailed investigation of the ecology of first-ocean-winter Chinook;
3. evaluating survival bottlenecks and hatchery optimization strategies for juvenile and adult steelhead; and
4. piloting the use of PIT and video technology to enhance recreational catch monitoring.

The four-year research program is nearing its halfway point and has achieved a tremendous amount by working together with a network of partners including First Nations, provincial, and federal governments, academic institutions, and citizen scientists. In this edition, we highlight the progress and results to date of work focusing on activities 3 and 4 — steelhead bottlenecks and hatchery optimization strategies, and enhanced fishery landing sites. A newsletter edition from earlier this year highlighted the first year's efforts and results of the first two activities (remember to sign up to make sure you receive all our updates).

UNDERSTANDING STEELHEAD SURVIVAL

Working with our partners at the Provincial Ministry of Forests, we are examining survival bottlenecks and hatchery optimization strategies for juvenile and adult steelhead from key systems on Vancouver Island.

Juvenile Wild Steelhead

Over the last two springs, with the help of local First Nations and streamkeeper groups, we PIT-tagged 1,349 outmigrating wild steelhead smolts in the Cowichan (411 and 93 per year) and Quinsam (508 and 337 per year) rivers. Fish are captured in-river during their outmigration via a mainstem RST (Rotary Screw Trap) in the Cowichan and a Wolf Trap located on the Quinsam fence (see Figure 1). Fish as small as 70 mm in length can be tagged, but the typical size for the steelhead we tag ranges from 140 to 280 mm. PIT tags, which contain a unique identifier code that is linked to the location and time of tagging, are inserted and remain inside the fish's body for its entire life. The successful survivors of the 919 tagged fish from 2021 are expected to return in late 2023, while those that were tagged in 2022 should start returning in late 2024. As these tagged steelhead swim over the detection arrays installed in each of the rivers, their passage is logged. The resulting data provide information on migration timing, abundance at a given migration stage, and marine survival rates for each steelhead cohort. We anticipate to continue tagging in the spring of 2023 to gain further insights over time.

Juvenile Steelhead Hatchery Release Strategy

At the Robertson Creek hatchery, the normal operation is to release steelhead into the Stamp River for the fish to imprint and move downstream through the Alberni Inlet and out through Barkley Sound to the Pacific Ocean. During this initial migration phase, the steelhead are highly vulnerable to predation. It is hypothesized that if the fish were released at the oceanic entrance to the Sound, much of the predation pressure would be bypassed, ultimately resulting in better survival to adult return. To test this hypothesis, we released two groups of PIT-tagged hatchery origin steelhead at the traditional location in the Stamp River (n = 2500) and in Barkley Sound (n = 2500) in late Spring 2021 and 2022 (Figures 2 & 3). With this split release, we can experimentally examine early freshwater and marine survival bottlenecks and test the effectiveness of alternate release locations as a strategy to increase survival rates. We will see the first age class from 2021 return during the fall and winter of 2022, with the majority of these fish returning in 2023/2024.

Figure 2: *Steelhead smolts were released at different locations to test whether they could get a boost in survival from bypassing migration challenges in the freshwater and nearshore environment. On the top, steelhead smolts are being loaded into a boat for release near outer Barkley Sound and the photo on the bottom shows those being released directly into the Stamp River in May 2021.*

Figure 1: *(Top) A'tlegay Fisheries Society Technicians sampling, from the mainstem Wolf Trap, outmigrating juvenile steelhead from the Quinsam River. (Bottom) The mainstem 8ft Rotary Screw Trap utilized for capturing salmon and steelhead in the Cowichan River.*

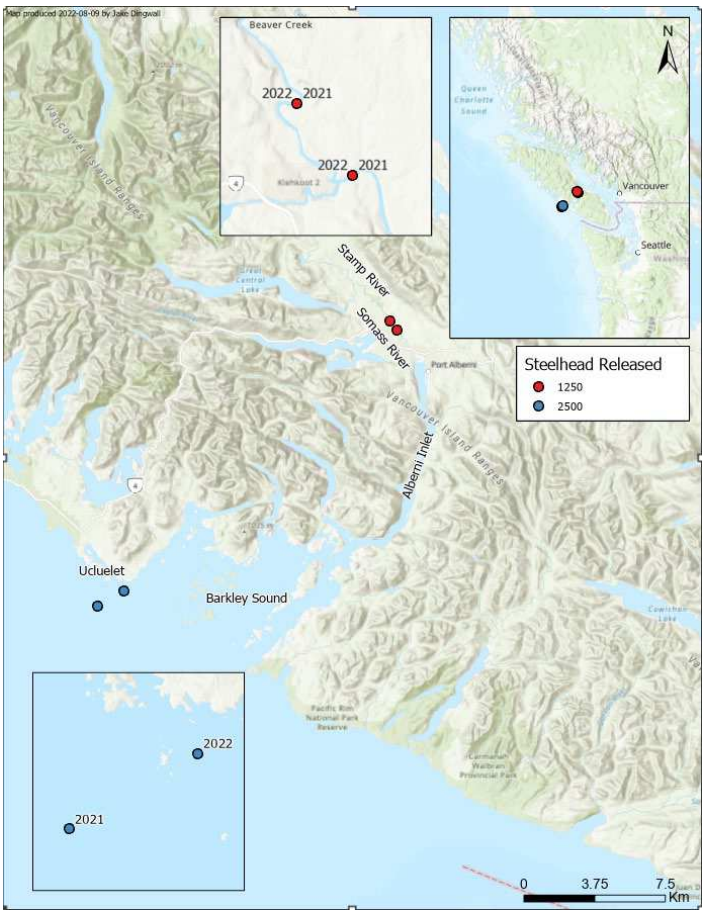


Figure 3: *Steelhead release locations, red indicating river release locations and blue indicating ocean release locations.*

Photo by Danny Swainson

Figure 4: *A satellite tagged steelhead kelt being released into the marine environment.*


Photo by Collin Middleton

Figure 5: *Recovered satellite tags. After a set period or after the fish dies, the satellite tags are designed to pop up to the surface and send out a signal that allows us to recover them. Once recovered we can download additional data and the tags can be recycled by the manufacturer for another deployment.*

Figure 6: *Captured kelts outfitted with satellite tags prior to release back into the marine environment.*

Adult Kelt Satellite Tagging

Unlike the familiar Pacific salmon life cycle where all adults die shortly after spawning ('semelparous'), steelhead trout are 'iteroparous' meaning some individuals (2-15% of a population typically) will return to freshwater to spawn again in future years. These post-spawn steelhead are known as kelts. To study adult steelhead migrations, ocean distribution, and potential mechanisms of mortality, we captured a number of kelts and fitted them with archival satellite tags. The satellite tags differ greatly from the PIT tags in that they transmit location information via satellite (hence the name) and store information on depth, acceleration, and temperature. When fish die or are eaten by predators the tags float to the surface and either upload their data automatically to satellites or can be retrieved for data download (Figure 5). This information allows us to see where fish migrate and to make inferences on the causes of mortality. For example, if we see changes in swimming behaviour and an increase in temperature recorded by the tag we can reasonably assume that the fish was eaten by a marine mammal.

In 2021, 17 kelts were captured from the Cowichan, Englishman, Nahwitti, and Keogh populations. With this cohort, we trialed reconditioning the kelts by keeping and feeding them in captivity for a prolonged period (~ 1 month) with the aim to help them regain health after their spawning migration and overcome the satellite tagging process (Figure 6). Results of weight and condition of the fish on capture and release did not indicate that their condition measurably improved overall, and in some cases, their condition deteriorated. Therefore, in 2022 we adopted the strategy to minimize holding and handling of kelts before re-releasing them to continue their seaward migration. During 2022 we tagged eight Cowichan kelts and released them directly into the ocean off Swartz Bay (Figure 4).

Early investigations of the satellite data indicate that steelhead from northern and southern Vancouver Island populations migrate along the continental shelf north into the Gulf of Alaska and south into waters off the U.S., respectively. The data suggest that some individuals die of natural causes, while others are predated upon by unknown predators which may include salmon sharks and pinnipeds (seals and sea lions).

Figure 7: *The French Creek Enhanced Fishery Monitoring Site, which was retrofitted in 2021. It now has integrated with video recording capabilities, PIT tag detection antennas and a Salmon Head Recovery Depot for anglers to deposit the heads of marked salmon.*

ENHANCED FISHERY MONITORING

Assessment of recreational catch comes from the Fisheries and Oceans Canada (DFO) Creel Survey Program, which was initiated in the 1980s. The program is comprised of an aerial survey of fishing effort (e.g. boats in the water) paired with creel interviews by DFO staff at access points (e.g. boat launches). We have been developing and implementing innovative ways to modernize and supplement this ongoing monitoring. This work is being done in collaboration with DFO's Stock Assessment Division and local marinas, and with support from the BC Sport Fishing Advisory Board.

At key high-traffic recreational landing sites on the east coast of Vancouver Island, we have begun retrofitting and building new cleaning tables with integrated PIT and video technology. Three of these 'enhanced' cleaning tables were installed, one in Nanaimo and two at French Creek Marina, and have been operational since early summer 2021 (Figures 7 & 8). When fish are brought to the tables to be cleaned, overhead video cameras are triggered to collect imagery (Figure 9). Video imagery allows us to record the species caught and identify those that were adipose fin clipped. We can also determine how many heads of clipped fish are deposited for voluntary participation in the coded wire tag recovery program. The person cleaning their fish remains anonymous due to the positioning of the camera, so only information about the fish is collected. If the fish being cleaned happens to be one that has a PIT tag, integrated receivers will log that information as well.

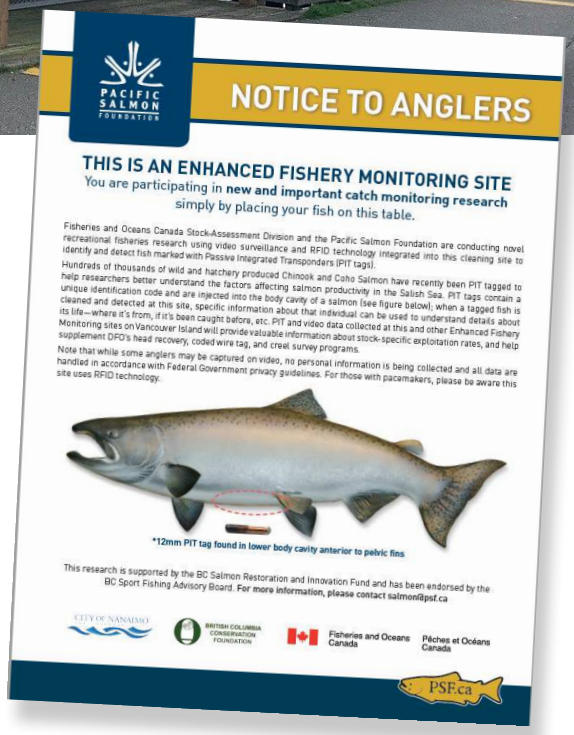
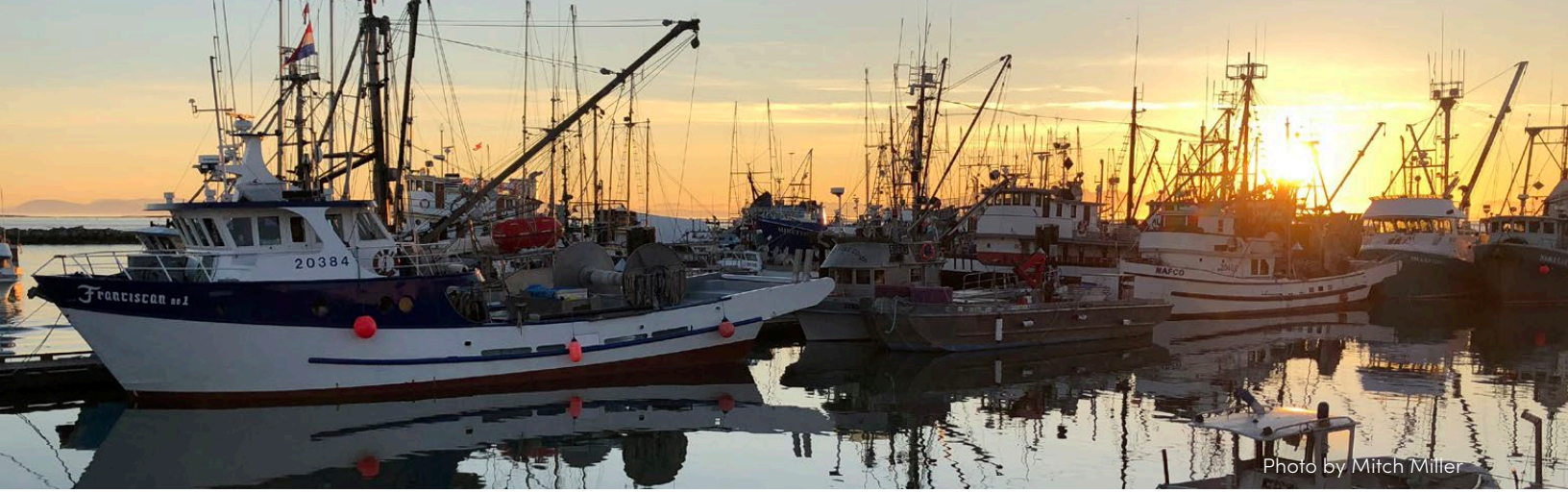


Figure 8: *An example of posters that have been placed at the new enhanced fishery monitoring sites to notify anglers of the program.*

Figure 9: *An example of the imagery captured while anglers are using the station to clean their catch. The recorded image provides enough resolution to identify the species and whether they were adipose fin clipped.*



Data collected at these sites are already providing valuable supplemental information to DFO's Creel Survey Program by helping quantify landings by species and origin (hatchery or wild) during periods when no catch monitors are present (see Figure 10 for an example of the data collected). Data such as this provide capture information that would be unavailable by any other means and contributes to new information on survival bottlenecks for salmon in the Salish Sea. For example, tabletop PIT tag detections may allow us to measure stock-specific exploitation rates. Initial analysis suggests that hatchery-origin fish are showing up at the cleaning tables at a higher rate than wild fish but more samples are required.

Plans are to expand the program to the northern Strait of Georgia and instrument sites near Campbell River. This will allow the necessary information to evaluate catch data from Pacific Fishery Management Areas 13 and 14 which historically represents one of the highest catch regions in the SOG.

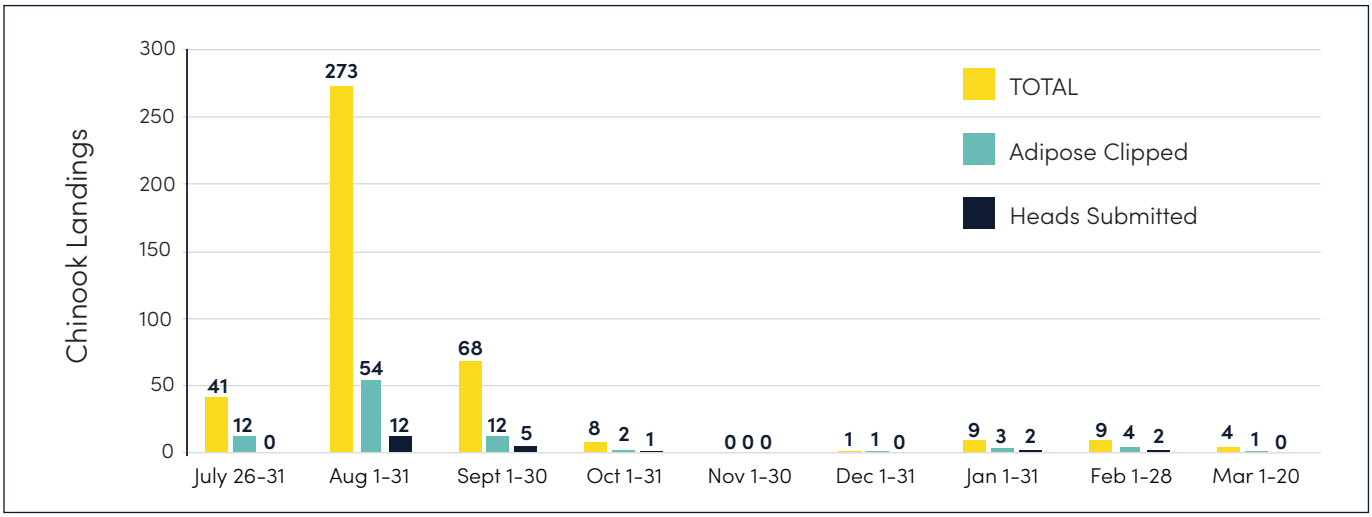


Figure 10: *Data from the Nanaimo Enhanced Fishery Monitoring Site on Chinook landings between July 26, 2021 and March 20, 2022. Depicted are the number of Chinook landed by month, whether the fish were adipose fin clipped and if so how many heads were submitted to Salmon Head Recovery Depot drop off. From the data of Chinook landings during this period, there was about 25% head submission rate and late summer was the busiest time for Chinook landings.*

FOR FURTHER INFORMATION, PLEASE CONTACT:

Will Duguid (PSF Project Manager) at wduguid@psf.ca

or Jamieson Atkinson (BCCF Project Manager) at jatkinson@bccf.com

PACIFIC SALMON FOUNDATION

1682 West 7th Ave,
Vancouver, BC, V6J 4S6
Tel: 604-664-7664
Email: salmon@psf.ca

BRITISH COLUMBIA CONSERVATION FOUNDATION

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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