PACIFIC SALMON FOUNDATION

HATCHERY EFFECTIVENESS REVIEW

The Pacific Salmon Foundation received funding through the BC Salmon Restoration and Innovation Fund to conduct a science-based review of hatchery effectiveness in BC.

MARINE SCIENCE PROGRAM

PSF.ca

Cover photos by Eiko Jones and Sam James

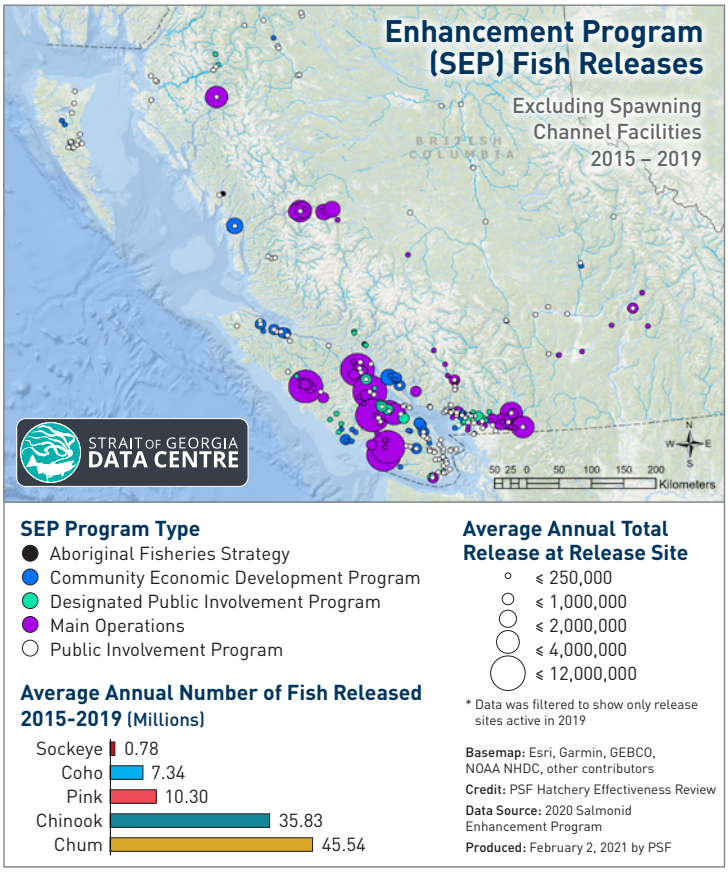
THE PROJECT

Wild stocks of Pacific salmon have experienced significant declines in abundance over the past century. One of the management tools to compensate for these losses has been the use of hatcheries. Over time, hatcheries have also been used to mitigate for habitat losses, to support fisheries, for conservation, and for education. Despite the substantial use of hatcheries and other efforts, Pacific salmon have not recovered, raising concerns about the utility of hatcheries and their potential impacts on naturally produced salmon. There is now widespread and growing recognition of the need to evaluate the role and effectiveness of hatcheries in British Columbia. This need was highlighted in the 2019 BC Wild Salmon Advisory Council Report and is particularly relevant to addressing ongoing fisheries restrictions necessitated by the very poor status of some Chinook and Coho salmon stocks. In addition, there has been a push for greater production of Chinook salmon to meet prey needs of the endangered Southern Resident Killer Whales.

Recent research from the Pacific Salmon Foundation's (PSF) Salish Sea Marine Survival Project (SSMSP) found that hatchery-produced Chinook salmon in the Cowichan River had substantially lower survival compared to their wild counterparts. In light of these findings and the value of a broader assessment, PSF applied for and received funding from the BC Salmon Restoration and Innovation Fund to evaluate the effectiveness of salmon enhancement in BC. Our goal is to support science-based decision-making and lay the foundation for future enhancement programs to support healthy salmon populations.

COLLABORATIONS

The review is being performed with analytical expertise from Landmark Fisheries Research and in collaboration with DFO's Salmonid Enhancement Program, the Provincial government, and community organizations. In addition, we have engaged a number of experts from other sectors to serve as members of the Analytical Advisory Group and Independent Science Review Panel to guide our analytical approaches and ensure that implementation of robust and rigorous methodologies result in sound conclusions and advice.



APPROACH

The aim of this project is to examine the effectiveness of current production, identify scientific advancements in recent years that may be applied to increase effectiveness, and ultimately inform the joint production of hatchery-based and wild Pacific salmon for BC communities and ecosystems. To achieve these objectives, the review consists of three components:

1. a review of cutting-edge research and molecular tools that may be applied to understand and improve the productivity of hatchery-reared salmon in the future;
2. an evaluation of hatchery release strategies applied in past years to assess the resulting marine survival of hatchery-released salmon; and
3. a comprehensive review of hatchery effectiveness and interactions with wild Pacific salmon populations across BC.

1. Review of Molecular Tools

Four 'omics' technologies now provide the opportunity to greatly advance the study of genetics and performance of enhanced salmonids: genomics, transcriptomics, proteomics, and metabolomics. While these tools have been assessed for applications in aquaculture, to date there has been limited review of their use in hatchery production. Tools such as parentage-based tagging, gene and gene expression biomarkers, and e-DNA can provide novel insight into fisheries contributions, changes in salmon traits (e.g. smaller body size at age), and genetic interactions with natural populations. Our technical review was completed in the summer of 2020, with a discussion paper on hatchery applications expected by June 2021.

2. Review of Release Strategies

There are a number of release strategies available to hatcheries for meeting production objectives. These include modifying the size at release, time of release, life stages released, release location, release type (i.e. volitional, forced, or acclimated) or rearing environment. The ability to optimize hatchery practices requires an evaluation of past programs and a major review of findings to date around experimental release studies that DFO has historically carried out. Using all available coded wire tag data for Chinook and Coho salmon, our analyses will allow us to better understand the influence of these release strategies, as well as the role of environmental variables (e.g. freshwater and marine conditions) that may have influenced the survival, catch, and return age. This review will be completed by March 2021.

3. Comprehensive Review (Hatchery x Wild interactions)

Salmon are produced in hatcheries for objectives related to harvest and assessment, conservation and rebuilding, and stewardship activities. Our work will assess how effective hatcheries are at meeting their objectives, and will compile information on hatchery contributions to both fisheries and naturally spawning populations. There is increasing evidence that salmon are experiencing changes in biological traits, such as smaller body size and younger age at return. We will explore available information from both enhanced (for all Pacific salmon species) and wild populations to examine if these trends are occurring throughout BC. And finally, we will be estimating the net value of hatchery production when interactions with natural populations are considered. This latter component involves development of appropriate analytical methods to determine if the current available data are sufficient to make this assessment, and to identify external factors (e.g. fisheries, local and regional environmental conditions, habitat change etc.) that contribute to this outcome. All analyses are expected to be completed by spring 2022 with a final report to follow.

Fish weirs like those on the Puntledge River (top left) help to regulate upstream migrations and the collection of brood stock for hatchery programs. Chinook fry can be seen swimming in a Capilano trough (right), with juveniles then reared in concrete raceways like those at Robertson Creek (bottom left). Photos by Sam James.

THE DATA

Several types of data were collated for this project:

1) Hatchery release and recovery data

2) Biological records of individual fish

3) Release site coordinates and freshwater migration distances

4) Early marine environment data (sea surface temperature [SST], Pacific Decadal Oscillation [PDO], predator abundance)

Relevant hatchery data included weight at release, date of release, numbers released, as well as numbers recovered in fisheries or escapement by age class. These data were extracted from the Enhancement Planning and Assessment Database and provided by the staff of DFO's Salmonid Enhancement Program (SEP) for all species at all facilities in all years of enhancement. Additional data for the numbers of spawning salmon in natural streams were collated from the DFO's Salmonid Escapement Database, NuSEDS. To complement the raw data, hatchery-specific strategies as well as release locations were obtained through in-person and telephone interviews with hatchery managers in 2020. Trends in biological data such as size and age at return were analyzed through DFO's Southern BC Chinook Biodatabase; a compilation of records of individual fish and their biological measurements on assessment rivers across BC. To capture early marine conditions experienced by hatchery fish post-release, SST data were downloaded from NASA's Ocean Colourweb portal and PDO (Pacific Decadal Oscillation https://psl.noaa.gov/pdo/) data were acquired from Dr. Nate Mantua's online dataset hosted by the University of Washington. And finally, harbour seal and killer whale abundance data were taken from the public dataset published by Chasco et al. (2017).

Photos by Eiko Jones

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