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Portage Creek Chinook Conservation and Enhancement

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Prepared for:

Fish and Wildlife Compensation Program

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Prepared for the Fish and Wildlife Compensation Program on behalf of its program partners: BC Hydro, Fisheries and Oceans Canada, and St'át'imc Eco-Resources Ltd.

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EXECUTIVE SUMMARY

Portage Creek Chinook are classified under the Government of Canada's Wild Salmon Policy as a vulnerable single site Conservation Unit. This stock has had diminishing returns for approximately 20 years. The current adult Chinook returns are likely insufficient to maintain the population. Fisheries and Oceans Canada (DFO) anticipates that this population will become extinct over the next two generations (ten years) without intervention, resulting in the loss of a genetically unique Conservation Unit. With support from BC Hydro's Fish and Wildlife Compensation Program (FWCP), DFO proposed strategic enhancement of this stock for a minimum of one generation (five years) to support preservation and rebuilding of this population and its unique genetics, while further investigating the limiting factors contributing to the population decline. This project is aligned with FWCP's Bridge-Seton Watershed Action Plan priority action BRG.ALL.SB.04.02: Implement high priority habitat and/or species-based actions for fish and/or wildlife.

DFO staff from Tenderfoot Creek Hatchery and Regional Headquarters, in collaboration with St'at'imc Eco-Resources Ltd., conducted broodstock collection activities from October 15 through October 28, 2019, which resulted in the first ever successful spawning of Portage Creek Chinook. A total of 12 females and 25 males were spawned, for a total egg take of 54,300 eggs and an average fecundity of 4,525 eggs/female.

Offspring (approximately 4,000 fish) from a female which screened low-positive for *Renibacterium salmoninarum* (the causative agent for Bacterial Kidney Disease) were released as fry on Feb 19th, 2020. The remaining 48,000 Portage Creek Chinook fry on hand at Tenderfoot Creek Hatchery are scheduled for release as yearling smolts in spring 2021. Discussion on specific details surrounding rearing and release strategies are ongoing at this time.

INTRODUCTION

Canada's Policy for Conservation of Wild Pacific Salmon (WSP) identifies Seton-Portage Chinook as a unique, isolated, and single-site Conservation Unit. Conservation Units (CUs) have been defined by the WSP as a group of wild salmon sufficiently isolated from other groups that, if extirpated, is very unlikely to recolonize naturally within an acceptable timeframe. Under the WSP, CUs have two roles: first as units of biodiversity, and second as accounting units for documenting the progress of achieving WSP goals (Holtby and Ciruna 2007). Portage Creek Chinook are the only population within the Seton-Portage Chinook CU.

Portage Creek Chinook escapement has been declining for approximately two decades, with only 12 adults estimated in 2016 (Figure 1). Since records started in 1977 the peak escapement estimate was 445 in 2002. The cause of the population decline is currently unknown. Chinook stocks have been declining precipitously throughout the Fraser region, and in general across the Pacific Northwest in recent years. These declines have been attributed to various causes including, but not limited to: poor ocean conditions, loss or degradation of freshwater rearing habitat, over-fishing, increases in predation (pinnipeds specifically), changes in water chemistry, and climate change (e.g., increased frequency of droughts, higher summer temperatures that increase pre-spawn mortality, and "the blob" – the large mass of abnormally warm water located in the Pacific Ocean). Although the specific causes for the population decline of Portage Creek Chinook are currently unknown, enhancement can be used to increase the egg-to-smolt survival rates, resulting in greater adult returns. The objective of this project is to preserve this genetically unique salmon population through enhancement, while the reasons for their decline are examined and addressed.

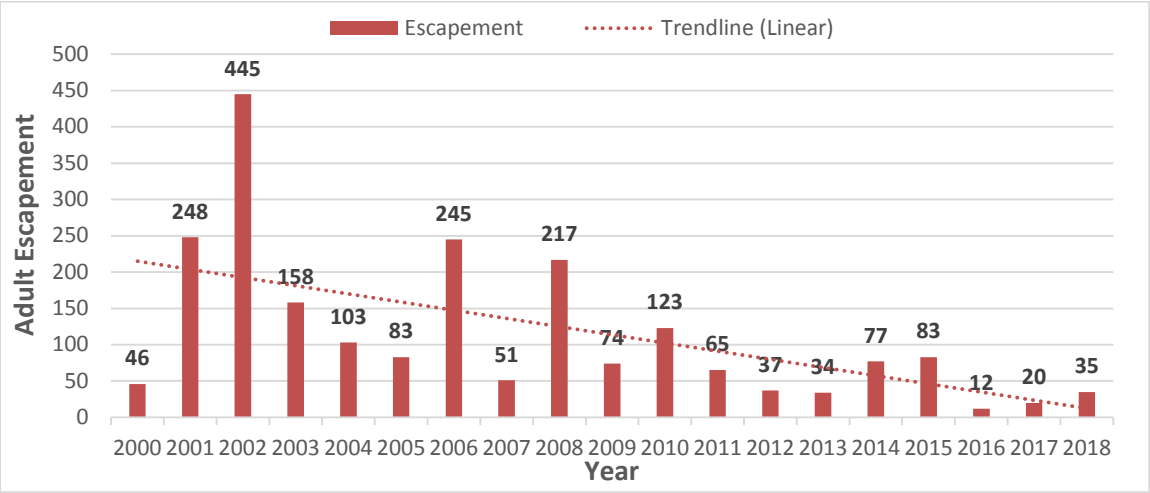


Figure 1. Portage Creek Chinook escapement estimates, 2000-2018 (NuSEDS Database).

PROJECT AREA

Project Coordinates: 50.70638889, -122.28194444

Portage Creek is an approximately 2.9 km long stream that connects Anderson Lake to Seton Lake and is the only known spawning area of Portage Creek Chinook. Seton Lake is impounded by the Seton Dam and ultimately discharges into the Fraser River. The Seton Dam was completed in 1956, which raised the height of Seton Lake by approximately 2 m. Seton Lake receives water from Portage Creek, discharge from the Bridge River generating station and

discharge from the diversion of Cayoosh Creek. The impacts of these developments and the Seton Dam on Chinook salmon cannot be quantified as we do not have accurate accounts of Portage Creek Chinook escapement prior to or recently after dam construction. Anderson Lake, the headwater of Portage Creek, is fed by Gates Creek, as well as by smaller, mountain run-off tributaries. Both Gates and Portage Creek support major sockeye spawning populations, among other salmonid populations such as coho.

Landslide and debris flow events affecting Anderson Lake and Portage Creek and the avulsion of Whitecap Creek in 2015 are believed to have caused damage to the salmon habitat in Portage Creek (Figure 2). Landslides and stream avulsions can dramatically increase egg and alevin mortality. Salmon deposit their eggs in gravels; these eggs require clean, flowing, and well-oxygenated water. The sediment from a landslide can fill in the gravel interstices (space between gravels) cutting off the supply of stream flow and oxygen to eggs, as well as limit the ability of emerging juvenile salmon to escape when hatched. It is believed incubating eggs and alevin in 2015 and, to a lesser extent, 2016 brood years were severely impacted by these events. The habitat has since recovered significantly, though additional restorative efforts would likely be of value.

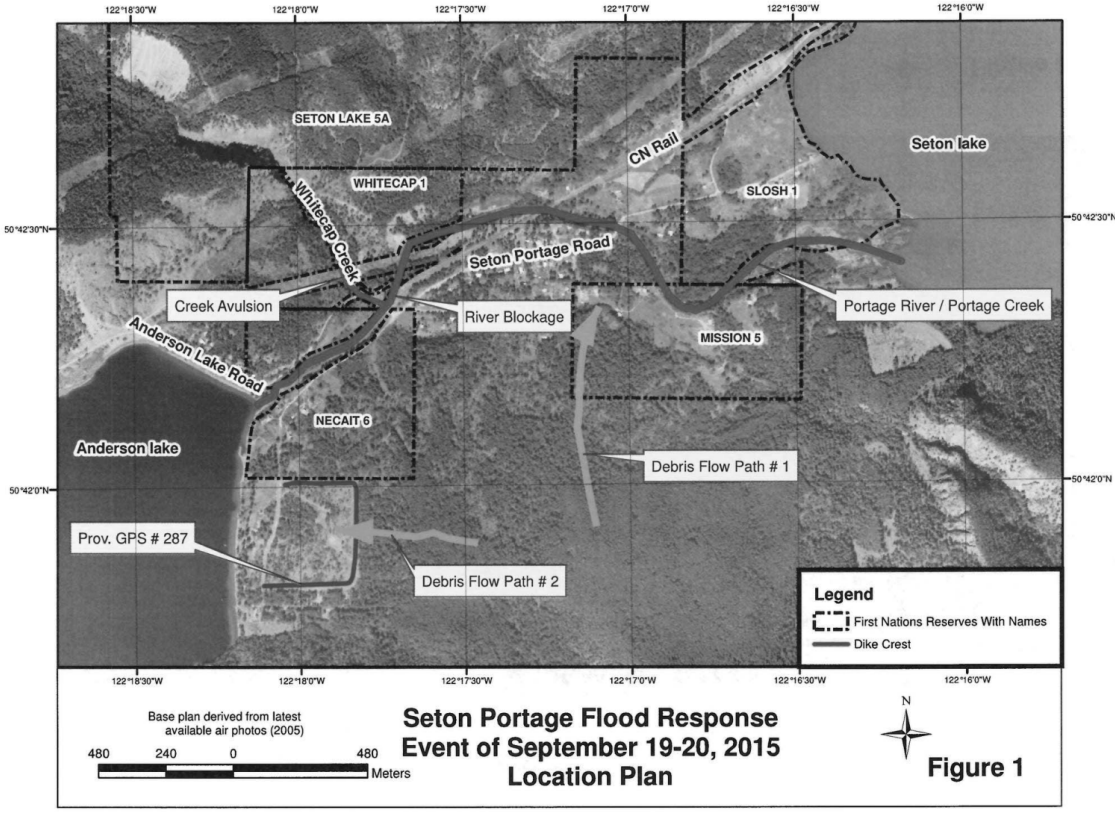


Figure 2. Visual depiction of landslides/debris flows which affect Portage Creek (BC Government Situation Report – Southwest Provincial Operations Centre 2015)

PROJECT PLAN & METHODS

Given recent escapement estimates, Portage Creek Chinook are at risk of extirpation without human intervention. The primary goal of this project is to increase the number of outmigrating juveniles with an end goal of increasing the adult Chinook escapement to Portage Creek so that the population can be self-sustaining in future generations. This will be achieved through strategic enhancement, which is known to increase egg to juvenile survival rate. We have proposed a minimum of one generation (5 years) of enhancement, with an annual release target of 50,000 yearling smolts to support the preservation and rebuilding of this stock, while further work is done to assess and address the other factors limiting this population. The release target was selected to reflect the historical average escapement to Portage Creek. Based on expected survival and exploitation rates, 50,000 yearling smolts should result in approximately 200-500 returning adults. Given the relative size of the creek, it is likely unable to support a large Chinook population.

Factoring in typical egg-to-smolt mortality in a hatchery setting, as well as potential Bacterial Kidney Disease (BKD) screening and other disease mitigation, a 60,000 -75,000 green egg target was set in order to achieve a 50,000 smolt release target. Successful collection and spawning of Portage Creek Chinook in 2019 yielded the first ever fecundity estimate for this stock: 4,525 eggs/female. Futures years of collection and spawning of this stock will help generate a more reliable average fecundity estimate, and ultimately the number of female broodstock required to achieve a given egg target:

Eggs / Female	No. females required (for 70K eggs)
3000	24
4000	18
5000	14
6000	12

Tenderfoot Creek Hatchery (hereafter referred to as Tenderfoot) was identified as a suitable location for incubation and rearing of Portage Creek Chinook based on both logistics (i.e., adequate water supply and rearing space) and proximity. Tenderfoot also has a tagging facility on location to allow for marking and tagging of juveniles.

For this program, gametes are collected from adults on-site (i.e., no adults will be transported to the hatchery). The moving of adults for holding outside their native watershed is not supported, unless systems are in place at the receiving site for effluent decontamination prior to discharge to non-natal fish-bearing waters. Nested or factorial mating designs were deemed most appropriate for this stock. Nested mating designs typically involve crossing a member of

one sex with two or more members of the other sex (Neff et al. 2011). For example, one female may be crossed independently with each of three males. Full factorial mating design, which is also known as the matrix mating design, involves crossing males and females in all possible combinations (Neff et al. 2011). Importantly, both nested and factorial mating schemes do not pool the milt, but instead perform separate fertilization events with each additional mate, thereby eliminating sperm competition and balancing reproductive contributions.

Egg segregation by females is required until adult screening results for vertically transmitted pathogens are available. Progeny from females testing positive for BKD will be reared as per the SEP BKD Control Plan recommendations (DFO 2016), with higher risk progeny released early (spring 2020) or destroyed to avoid disease amplification through enhancement operations.

LOOKING FORWARD:

Smolts from the 2019 brood year will be transported to and released into Portage Creek in spring 2021 to ensure they imprint on their natal stream. While a mixed strategy of fry and yearling smolt releases might be preferable for purposes of reducing domestication effects and facilitating diversity in life histories (among other benefits), maximizing the survival and number of outmigrating smolts is the priority during Preservation and Recolonization phases of the program (HSRG 2015). In addition, yearling smolts have been demonstrated to provide the greatest release-to-adult survival rates. Depending on the availability of resources and capacity, the enhancement strategy may be altered as progressive phases (Local Adaptation and Full Restoration) are achieved or lost. For more information on the aforementioned enhancement phases (e.g., Preservation) and respective enhancement considerations, the reader is referred to the Hatchery Scientific Review Group's 2015 report on the application of up-to-date science in management of salmon.

All smolts will be coded wire tagged, as well as visually marked by way of an adipose fin-clip. This will allow us to establish if and where Portage Chinook are caught in the fisheries, as well as determine the proportion of hatchery-origin Chinook in the river. In addition to fisheries, coded wire tags can also be recovered from broodstock and from deadpitch. Similarly designed and sized programs have been initiated elsewhere (e.g. Cheakamus, Shovelnose, Mamquam, and Ashlu Rivers in the Squamish watershed), and DFO-SEP found that 50,000 tags provides sufficient detail for recovery and conservation program assessment and analysis. Results from the aforementioned assessments will guide future enhancement decision-making and strategies.

RESULTS AND OUTCOMES

Tenderfoot staff, with support from St'at'imc Eco-Resources Ltd. and Salmonid Enhancement Program (SEP) staff from Regional Headquarters, conducted broodstock collection activities from October 15 through October 28, 2019. This year's unprecedented broodstock collection efforts resulted in the first ever successful spawning of Portage Creek Chinook. Gametes were collected from adults on-site and transported back to Tenderfoot Creek Hatchery (no adults were transported to the hatchery). A total of 12 females and 25 males were spawned, for a total egg take of 54,300 eggs and an average fecundity of 4,525 eggs/female. Due to a preponderance of males and the limited number of adults collected and on hand at any one time over the broodstock collection period, a nested mating design was used, whereby each female was crossed independently with two or three males.

The primary location used for adult broodstock collection was the outlet of Anderson Lake (Figure 2). This location was originally suggested by Science Branch Stock Assessment technicians who were experienced surveyors of Portage Creek. Similar to previous years, Portage Creek Chinook exhibited what appeared to be a bi-modal pattern of peak spawning, with one peak occurring in mid-October, and another around October 28, with limited episodes of spawning in between. Daily attendance, multiple sets across all hours of the day, and crews of five (three trained in field operations) were believed to instrumental to this year's success. These Chinook exhibit unique behavior where they hold in Anderson Lake until they are ripe (physiologically ready to spawn), drop down from Anderson Lake into Portage Creek, and spawn in a matter of hours, or even minutes. If staff are not on site for the majority of the spawning period (second half of October) to watch and wait for these fish to drop down, a great deal of broodstock collection opportunities can easily be missed.

Genetic sampling conducted by DFO Science confirmed that all Chinook collected and spawned were of Portage Creek origin (i.e., no strays were collected) and their collective genetic diversity, as determined by a family analysis on the genotypes, was deemed favourable as founders in a conservation program. Disease screening by the DFO Fish Health Diagnostics Lab revealed that only one low-positive (LP) female for *Renibacterium salmoninarum* (the causative agent for BKD) was collected. Ovarian fluids tested for Infectious Hematopoietic Necrosis Virus (IHNV) came back negative for all female broodstock collected.

Offspring from the LP BKD female (approximately 4000 fish) were released as fry on Feb 19th, 2020. All fry were transported and released safely in healthy condition. The release was coordinated with, and attended by St'át'imc (photos 1-4). The release event was posted by St'át'imc Eco-Resources Ltd. on their Facebook page:
https://m.facebook.com/story.php?story_fbid=3012379615473697&id=1684183528293319

While it is anticipated that the remaining 48,000 Portage Creek Chinook on hand will be released as yearling smolts in spring 2021, discussion on specific details surrounding rearing and release strategies (e.g., timing, size, and location of release) are ongoing at this time. DFO staff will reach out and coordinate with St'at'imc as soon as these details and the release plan are finalized.

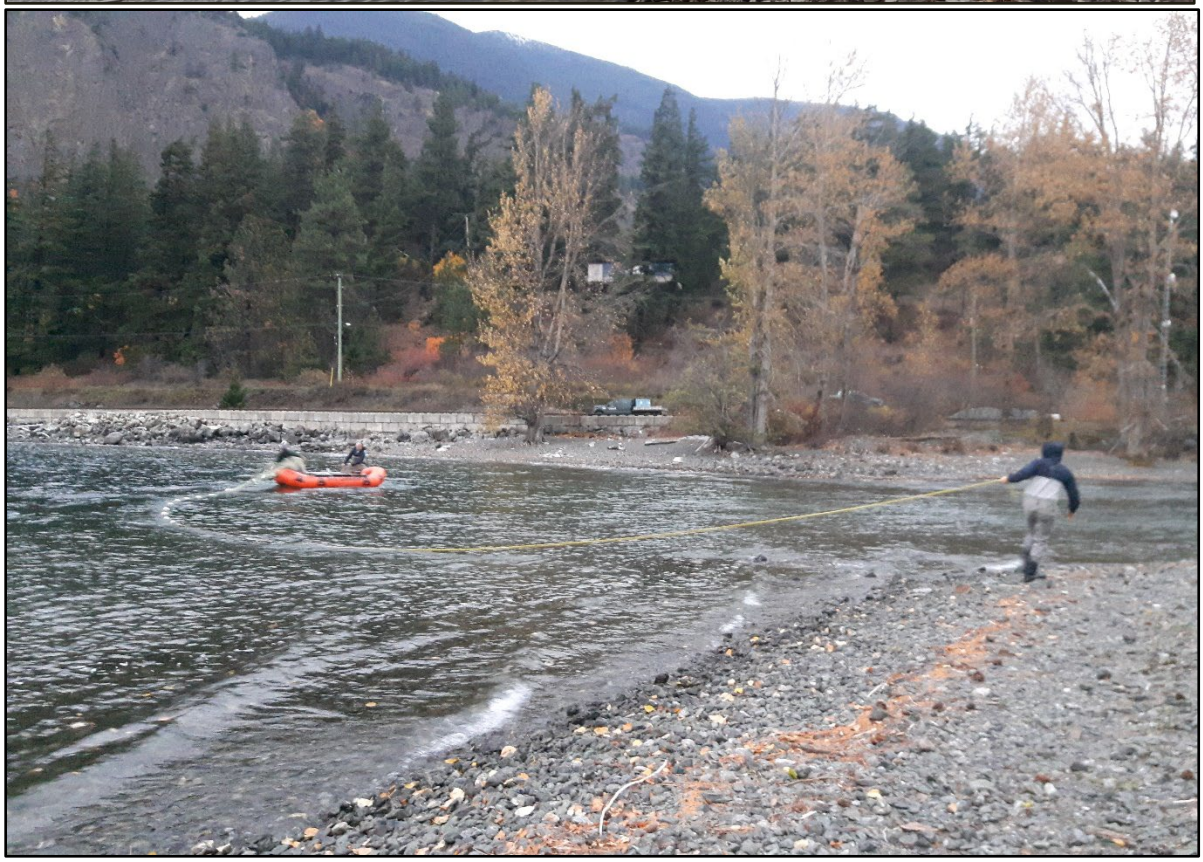
Photos 1-4. Portage Creek Chinook fry release, Feb 19th, 2020.

2019 Recommendations and Further Considerations

High sockeye abundance in Portage Creek can make Chinook broodstock capture efforts difficult. In 2018, Portage Creek saw the second largest sockeye escapement on record, with an estimated total of 35,548 spawners returning to the system. The peak of the run occurred from October 25th to 30th, which directly overlapped with Chinook broodstock collection efforts. Each time a net was set, hundreds of sockeye were caught that needed to be picked out of the net immediately for their safe release. This was labour-intensive and very challenging for the staff. This however was not an issue in 2019 given the extremely poor return of sockeye to the system. For context, there were only 253 live sockeye counted in the system near peak of spawn on October 22nd, 2019 (final sockeye escapement estimates are not yet available).

A key recommendation that came from 2018 broodstock efforts was the need to have increased, and continuous on-site presence during the Portage Creek Chinook peak spawning window (second half of October). These Chinook exhibit unique behavior where they hold in Anderson Lake until they are ripe (physiologically ready to spawn), drop down from Anderson Lake into Portage Creek, and spawn in a matter of hours, or even minutes. If staff are not on site for the majority of the spawning period to watch and wait for these fish to drop down, a great deal of broodstock collection opportunities can easily be missed.

In 2019, SEP put into action this recommendation and spent two full weeks in Seton-Portage. This unprecedented broodstock collection effort resulted in the first ever successful spawning of Portage Creek Chinook. Tenderfoot staff also implemented a new broodstock collection technique, which proved very effective. In previous years, a “set net” approach was used, whereby a net was placed at the outlet of the Anderson Lake to intercept Chinook leaving the lake for lake-outlet and downstream spawning areas. This year, Tenderfoot staff took a more active approach and implemented a modified beach seine tactic (see photos 5 and 6 for comparative imagery of the two methods). This involved a two person operated raft deploying the tangle net around fish holding near the outlet of the lake, followed by walking the net down stream for 20 - 40 m. The net was then brought to shore and fish were rapidly removed from the net. Throughout the entire process, fish in the net remained completely submerged in water, resulting in only 2 - 4 seconds of air exposure as fish were either transferred by hand from the net to individual fish bags for temporary holding prior to spawning (Photo 7), or released (in the case of bycatch or unripe Chinook). In summary, daily attendance, multiple sets across all hours of the day, implementation of the beach seine approach, and crews of five (three trained in field operations) were believed to instrumental to this year’s success.



Photos 5 and 6. Images comparing the different broodstock collection methodologies, with photo 5 (top) depicting the set net method used in 2018, and photo 6 (bottom) capturing the highly successful beach seine method used in 2019.

Photo 7. A freshly captured Portage Creek Chinook male being transferred from the tangle net to a broodstock bag for temporary holding prior to on-site spawning, October 2019.

Also crucial to this year's success and logistical feasibility was BC Hydro's generous provision of accommodations. Not only did the accommodations provide adequate housing for a required field crew of five, but it also contained a full sized fridge-freezer unit, which was imperative for safely storing the numerous tissue samples that were collected until they could be shipped to the Fish Health Diagnostics Lab in Nanaimo for analysis. As such, a similar broodstock collection effort of two week's time in the second half of October, and the provision of BC Hydro accommodations, are likely required to ensure repeated program success in 2020.

REFERENCES:

BC Government Situation Report – Southwest Provincial Operations Centre 2015. (http://docs.openinfo.gov.bc.ca/Response_Package_FNR-2016-63010.pdf)

DFO. 2016. A Compilation of Operational Planning Guidelines for the Salmonid Enhancement. Salmonid Enhancement Program, Fisheries and Oceans Canada.

DFO. 2019. NuSEDS - New Salmon Escapement Database System. (Accessed July 22, 2019) http://vsbciosdevws01/nuseds.query/#/Query

Hatchery Scientific Review Group (HSRG). 2015. Annual report to congress on the science of hatcheries 2015. http://hatcheryreform.us/wp-content/uploads/2016/05/HSRG_Report-to-Congress_2015.pdf

Holtby, L.B. and K.A. Ciruna. 2009. Conservation units for Pacific salmon under the Wild Salmon Policy. http://waves-vagues.dfo-mpo.gc.ca/Library/334860.pdf

Neff, Bryan D.; Garner, Shawn R.; and Pitcher, Trevor E.. (2011). Conservation and enhancement of wild fish populations: preserving genetic quality versus genetic diversity. *Canadian Journal of Fisheries and Aquatic Sciences*, 68 (6), 1139-1154.