LIFE SKILLS TRAINING AND THE EFFECT OF PREDATOR CONDITIONING ON THE BEHAVIOUR AND POST-RELEASE SURVIVAL OF HATCHERY-REARED COHO SALMON (Oncorhynchus kisutch)

When compared to their wild counterparts, hatchery-reared salmon often perform poorly after release. The lack of stimuli in the barren hatchery tanks results in naive fish that have difficulty adapting to wild conditions and an overall decrease in fitness. Recent work has examined the effect of modifying hatchery conditions to better emulate natural conditions. Although these modifications have been met with some success, hatchery fish still exhibit post-release behavioural deficits when encountering predators. Predation has a pervasive effect on juvenile salmon, and hatchery fish are not given an opportunity to learn about the risk that predators pose. There is a significant lack of information detailing if hatchery salmon can be conditioned to respond appropriately to the high levels of predation they encounter upon release.

This project seeks to understand if life skills training via simulated predator conditioning will mitigate high rates of post-stocking mortality of hatchery-reared Coho salmon. Using in-hatchery predator exposure followed by behavioural assessments and in-stream survival analyses of Coho salmon, this project will determine:

i) If hatchery Coho respond to the alarm cues of adult and/or juvenile conspecifics.

ii) If conditioning hatchery Coho to alarm cues result in anti-predator/ neophobic behaviour.

iii) If exposure to avian predator models results in anti-predator/neophobic behaviour.

iv) The role that conspecific alarm cues play on enhancing predator conditioning

v) If exposure to perceived predators increases post-stocking survival of juvenile Coho.

Assessment of the effect of predator conditioning on juvenile behaviour and outmigration survival will take place from January to May in 2023, 2024, 2025, and 2026.

Over a series of investigations, the behaviour and post release survival of hatchery-reared Coho from predator-conditioned and predator-naive samples will be monitored.

The first experiment will assess the behavioural response threshold of juvenile Coho to varying concentrations of conspecific alarm cue* (see below for definition). This will be done to determine a level of alarm cue exposure that will minimize stress levels while still eliciting expected anti-predator behaviours.

The second investigation will examine if conditioning hatchery Coho to alarm cues for 7 days will result in neophobic behaviour. Neophobia is a predator avoidance response to any new potentially threatening stimulus. Because there are a multitude of predators in the natural environment it will be better to train hatchery Coho to be wary of all potential threats rather than training them to recognize a specific predator. Alarm cue has been shown to reliably induce neophobic responses in a variety of fish species. Hatchery Coho will be conditioned for 7 days under one of three conditions of ambient perceived predation risk. The Coho will be assigned to one of three treatments. Two times each day, alarm cue (concentration and type is dependent on the results of experiment 1), hazelnut extract (control), or distilled water (control) will be administered to each tank. After the 7-day conditioning period behavioural examinations will be conducted to determine if Coho conditioned under high risk (alarm cues) will respond to the novel odour of an environmentally relevant predator. After behavioural data is obtained, fish will be acclimated and released into streams. Post-stocking survival will be monitored until the end of May.

The third investigation of the project will examine the effect of simulated avian predators on behaviour and post-release survival. Juvenile Coho will be assigned to one of four treatments. The first treatment group will be exposed to alarm cues, immediately be followed by the presentation of a visual threat: a model of a great blue heron (Ardea herodias). The heron model will attack the water and give chase to schooling coho while the controller of the heron remains out of sight. The second treatment will be subject to the same avian predator model without the addition of the chemical cues. The third group will receive only the chemical alarm cues of conspecifics. The final treatment group will serve as the baseline control and receive only distilled water. Conditioning for this part of the experiment will be conducted twice per day for 1 week at the pre-smolt stage. After the treatment period, the neophobic behaviours of the Coho will be assessed. The intent of this is to use conditioning in the hatchery such that the Coho will show weariness towards new stimuli that they will be subject to upon release. If neophobia is inducible, then we expect their survival to increase as they will be better at avoiding predators. After behavioural data is obtained, fish will be acclimated and released into streams. Post-stocking survival will be monitored until the end of May.

*Alarm cues: Alarm cues are chemical compounds that are released from damaged tissues of fish, such as during a predation event. With the release of alarm cues, nearby fish are alerted of potential nearby risk. Alarm cue will be extracted from the skin and muscle tissue of adult coho that have previously been euthanized during the regular hatchery practice of egg and milt collection for brood stock.

Successfully meeting the objectives of short- and long-term survival benefits of this project will determine if predator exposure enhances the functional population such that Coho stocks begin to recover. Conditioning hatchery Atlantic salmon to predators has been shown to elicit anti-predator responses and increased survival. Based on those results, we expect the survival of conditioned hatchery Coho to greatly increase.

Using an in-stream camera in Millstream, escapement in previous years was 204, 114, and 274 in 2021, 2020, and 2019 respectively. Recent habitat restoration that has been done on Millstream, including in-stream modification and the construction of fish passages, has created access to 7km of spawning and rearing habitat. This has increased the estimated capacity of Millstream to 3000 Coho spawners.

Restored streams, such as Millstream, can rapidly benefit from enhancement strategies that increase the survival ability of hatchery fish. Meeting the conservation objectives for Coho salmon through enhancement requires informed evidence-based decision making. Current studies evaluating predator conditioning are insufficient to develop standardized techniques to improve post-release survival of Coho salmon. There is still a need to consider the effectiveness of conditioning to potential predators, the concentration of alarm cues used, as well as how post-release survival translates to long term survival and adult return-to-spawn rates. Examining a variety of conditioning strategies will help us to better understand the ways in which captive rearing affects their fitness-related traits and may help improve post-release survival.