



Department of Environmental Conservation

2023 Report: Experimental pen-rearing of Atlantic salmon in Lake Champlain 2021-2025



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Introduction

The Lake Champlain experimental pen rearing project is an effort by NYSDEC and USFWS to increase returns of Atlantic salmon to the Saranac River to promote river fidelity while also improving recreational fishing. Pen rearing has been shown to provide increased post-stocking survival in Chinook salmon fingerlings and yearling steelhead in Lake Ontario (Bishop et al. 2006 and Connerton et al. 2016). The relative performance of pen-reared and direct-stocked Chinook salmon was assessed through a three-year study during 2010, 2011, and 2013. The study found that, on average, pen-reared Chinook salmon provided a 2:1 return to the open lake fishery (Connerton et al. 2016).

The current stocking allocation of Atlantic salmon in the Saranac River is 45,000 smolts below Imperial Dam (the first impassible barrier) and 70,000 fry upstream from Imperial Dam to Kent Falls (Lake Champlain Stocking Book Policy). Smolts are stocked in the river in the hopes that these fish will imprint and return as adults to spawn. Fry are stocked to utilize the available juvenile habitat in the river but may have a much smaller rate of return compared to smolts. Holding pre-smolt fish in the pens will allow for the parr-smolt transformation process to occur in the river water and allow imprinting to occur, which may significantly increase post-stocking survival of the salmon. Pre-smolt salmon undergo smoltification, or morphological changes, where the scales become silver and the parr marks disappear, preparing them for life in the open lake over the course of a few weeks.

The Saranac River provides an excellent location for an experimental pen rearing project due to the depth of the water, existing infrastructure to support the pens and the potential for volunteer help from the Lake Champlain Chapter Trout Unlimited (TU) members.

Another factor influencing our decision to use the Saranac River for this experimental project is the Department's plans to install a fish ladder at Imperial Mills Dam. The salmon's access to spawning habitat in the Saranac River has been impeded since the construction of Imperial Mills Dam in the 1880s. Atlantic salmon currently can only access about nine acres of spawning habitat from the river mouth upstream to Imperial Mills Dam; this is a limiting factor to how much natural reproduction by salmon is possible in the Saranac River. The Department is addressing this bottleneck by installing a fish ladder at Imperial Mills Dam to allow upstream access to historic Atlantic salmon spawning grounds. The fish ladder is specifically designed to allow salmon to move upstream of the dam. Between Imperial Mills Dam and the next impediment, Treadwell Mills Dam, there is another 27 acres of spawning habitat. Providing access to more spawning habitat will increase the potential for natural reproduction in the Saranac River.

Pens were installed at the Plattsburgh Boat Basin docks in the Saranac River estuary. In partnership with Plattsburgh Boat Basin, US Fish and Wildlife Service and the Lake Champlain Chapter of Trout Unlimited, NYSDEC Region 5 Fisheries staff completed the third year of the experimental pen rearing project in Lake Champlain in April of 2023. This report summarizes the third year of the five-year project.

Methods

The Lake Ontario pen rearing project (Legard 2018) was followed for pen design, while the SOP was modified to better fit the Lake Champlain project.

Starting in 2022, all Atlantic salmon stocked in Lake Champlain and its tributaries are identifiable as progeny of a specific pair of parents using Parental Based Tagging, or PBT (Ardren 2020). Fish will no longer be marked using fin clips or Coded Wire Tags. A pre-smolt lot

of Atlantic salmon were stocked into the pens in the Saranac River estuary and held for approximately three weeks prior to release. Additionally, an equivalent lot of smolts was stocked directly into the Saranac River estuary the same week that the pen reared smolts were released. Direct stocking is the typical stocking method and serves as the control in this experiment. All Atlantic salmon captured in future sampling efforts will be scanned for Coded Wire Tags, fin clips will be recorded, and tissue samples will be collected to identify PBT fish. Pre-smolts were stocked into the pens on April 14th and released on May 8th, 2023, a span of 24 days.

Trout Unlimited volunteers recorded a daily logbook of activities at the pens over the period of the project. Water temperature was recorded using thermometers located within the pens, automatic feeders were filled, mortality counts were conducted, and predatory bird activity was documented.

Results

The duration of holding time in the pen in 2023 was similar to past years. Temperatures remained in the acceptable range throughout the holding time, 46-54 °F. Coordination between the volunteer group, Trout Unlimited, and Region 5 Fisheries staff, was excellent throughout the project. Like previous years, the project was successful in terms of stocking, rearing, and releasing the Atlantic salmon smolts.

Growth:

The pen reared pre-smolt average total length at the hatchery on April 7th (pre-stocking) was 176.4 mm ± 13.9 SD. The smolts were measured again on May 2nd, just prior to release, and the average total length was 182.8 mm ± 15.0 SD. Smolts were significantly larger upon release ($t = 0.0$), having grown an average of 6.3 mm or 0.25 inches. Most of the fish (96%) reached the last silvering stage (stage 3) of the smolt assessment index used by Eisenhower National Fish Hatchery; the fish had lost their parr marks and were fully silvered.

Mortalities:

Daily counts of mortalities were manually recorded in the data logbook by volunteers. Total mortality was based on the number of dead fish collected from the pens during captivity and from the bottom of the pens after release. Mortality does not include fish lost to cannibalism or from predators that may have gained access to pens.

A total of about 525 individuals were collected as mortalities in 2023 (Figure 1). This represents 2% of the 26,000 fish that were stocked into the pens. Over the 24-day holding time, 114 smolts were collected during the daily feedings and on release day, 411 smolts were collected from the bottom of the pens.

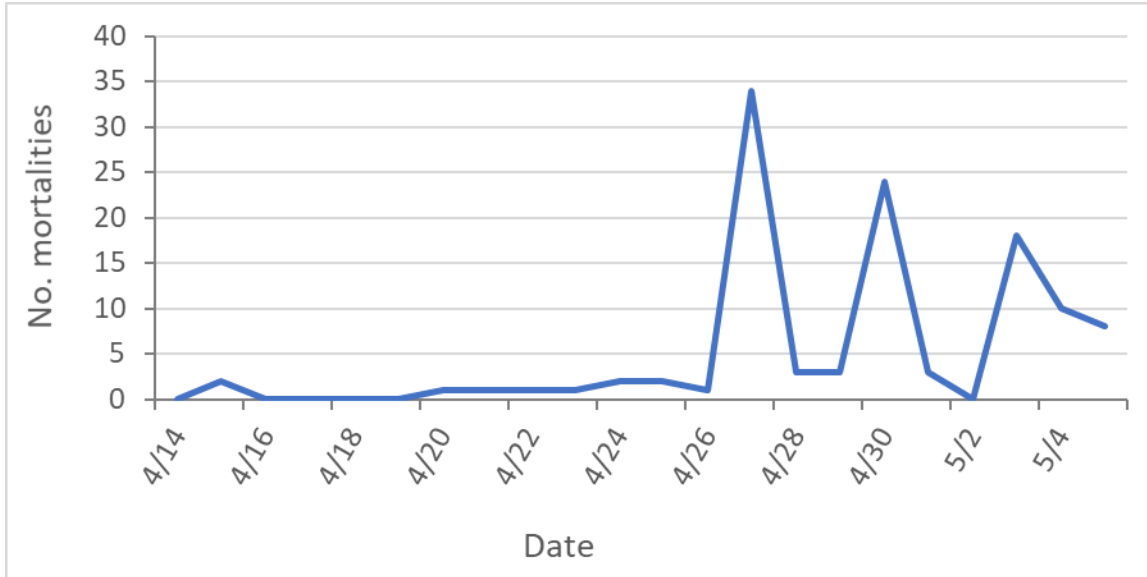


Figure 1. Mortalities collected each day April 14 to May 5, 2023.

Table 1. Annual mortality rates for the experimental pen-rearing of Atlantic salmon in Lake Champlain project.

Year	2021	2022	2023
Percent Mortality	1.4	1.0	2.0

Water temperature:

Water temperature remained within the range preferred by Atlantic salmon over the entire 24 days of the project (Figure 2). Fish displayed little to no signs of stress due to temperature over the period of the project.

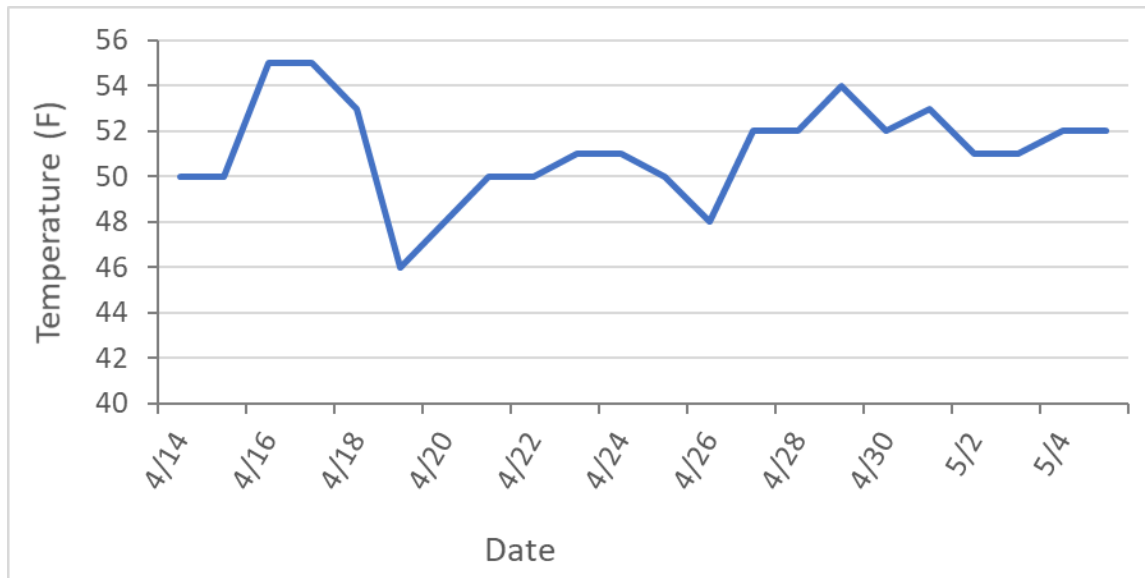


Figure 2. Surface water temperatures at the pen site April 14 to May 5, 2023.

Discussion

The goal of the experimental pen rearing project is to increase returns of Atlantic salmon to the Saranac River, where they were stocked. Stocking smolts in the Saranac River is meant to increase the Atlantic salmon population in both the Saranac River and in Lake Champlain as they go through their life cycle. Atlantic salmon that survive to adulthood can spawn multiple times; therefore, improvements to stocking can have significant impact on the restoration of the species in the Champlain system.

There is currently a small run of Atlantic salmon in the Saranac River. It is not known if the salmon are reproducing naturally or if the fishery is supported by annual stocking. Part of the experimental pen rearing project is to use Parental Based Tagging to determine if fry captured in annual surveys were produced by one of the stocked groups or by wild fish. If the fry were determined to be from stocked fish, we will also know which stocking treatment they were from, the pen stocked or control group. The contribution of pen stocked fish to the river fishery can then be evaluated.

Salmon are known for their ability to return to their river of origin (homing) to spawn. The window for imprinting is a few weeks during the pre-smolt to smolt transition. Pen rearing capitalizes on this life strategy, holding pre-smolt salmon in pens near the Saranac River for three weeks before they move into the lake. After two to three years of growing in the lake, the salmon will return to their home river to spawn in the fall. Any salmon fry produced in the Saranac River will spend up to three years living and growing in the river (imprinting) and are expected to return to the Saranac River, continuing the life cycle.

Using the pen rearing stocking method may increase survival and returns of salmon to the Saranac River compared to direct stocking. Direct stocking is the typical method as it is straightforward; fish raised in the hatchery are released directly into the river. One drawback is that the fish are naïve to predators, having had no experience with them in the hatchery setting, and they are disoriented once they enter the river, making them easy prey. In other locations, direct stocking has resulted in huge observed losses due to predation near the stocking location by fish and avian predators.

On the Saranac River, predation by avian predators has not been observed at past direct stocking events; however, smolts are likely lost to fish predators in the immediate vicinity. Pen rearing reduces this potential loss to fish predation by protecting the pre-smolt salmon immediately after stocking and allowing them time to acclimate to their new environment (Rosenberger et al. 2013). Pen rearing reduces vulnerability to predation by allowing the fish to grow a little larger before release. These larger fish spend less time near the stocking site, moving to the open lake and reducing their exposure to predation in the predator-rich nearshore waters (Connor et al. 2004, Johnson et al. 2007). Pen rearing also reduces disorientation upon release, gradually exposing salmon to fish and avian predators and giving them time to learn predator avoidance behaviors, increasing their chances of survival upon release compared to direct stocking. If natural reproduction is enough for the population to be self-sustaining, stocking could eventually be reduced or eliminated. An increase in salmon returns could also lead to an increase in fishing activity, which will stimulate the local economy.

Parental Based Tagging:

The two groups of stocked fish, pen reared and direct stocked, will be tracked as part of a USFWS project using Parental Based Tagging (PBT) to assess return rates. Since 2022, all Atlantic salmon stocked into Lake Champlain and the tributaries as fry or smolts are identifiable

using PBT. Another aspect of the PBT study is testing the survival of two strains of salmon raised at Eisenhower National Fish Hatchery, the typical strain (Max diversity) and a thiamine-tolerant strain (TT). An equal amount of both strains has been stocked at each fry and smolt location.

Higher survival, measured by a higher return rate, is expected for the pen reared fish than for the direct stocked fish. Salmon from the first experimental groups stocked in 2021 including the net pen project, are expected to return to the Saranac River as adults (lake age-2) beginning in the fall of 2023. This will be the first opportunity to begin assessing the success of the experimental pen rearing project. The salmon returning in 2024 will be the first opportunity to evaluate the PBT project.

Along with identifying which group a fish was stocked as, PBT can also tell us if salmon fry produced in the Saranac River are from wild fish parents or from stocked fish parents. We can also track whether straying occurred, if a salmon that was stocked in the Saranac River is found in a spawning run on another river. Once we have collected several years of data from returning fish, we can assess the Atlantic salmon population in the Saranac River and evaluate our stocking methods.

Growth:

The pen reared salmon did exhibit growth while in the pens indicating that they were eating and healthy. The intent of the project is to hold salmon while they transition from para to smolts and imprint while also increasing the potential for survival and higher return rates. Fish reaching stage 3 of the smolt assessment index used by Eisenhower National Fish Hatchery was the desired state of the smolts. The estimated 96% smoltification is seen as a success and evidence that the holding period was sufficient to achieve the desired response in the fish.

Mortality:

Mortality rates were acceptable again this year. Previous years have had slightly less mortality, but we expect some variation from year to year. For comparison, in 2021, the Lake Ontario pen rearing study average mortality for Atlantic salmon was 4-5% (Scott Prindle, personal communication). The Ontario pen rearing project was not continued after 2021.

Ring-billed gulls appeared to be the most common predator in 2023. Next year, the floats will be mounted at the same height. We may try attaching fiberglass screen material to the pen lids, leaving holes for the feed to fall through. This is to address continued bird predation. The birds have been pouncing repeatedly on the current lid mesh and stretching it so that it touches the surface of the water. The smolts swim up to investigate the splashing, assuming food is falling from the feeder, and are injured and/or eaten by the birds. The snow fencing will have the added benefit of providing shade for the fish in the pens.

Algae:

Algae buildup did not appear to be as significant as in past years and once again, it did not seem to affect the health of the smolts.

Cormorants:

No double crested cormorants were observed and documented in the pen area this year. A few were observed at a distance but were not considered a threat to the smolts in the pens. Control measures were not necessary this year. Other bird species like the gulls and blue herons appeared more often near the pens and were observed actively feeding on smolts. One loon was observed near the pens.

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