

Operation of a Removable Lamprey Barrier **in Morpion Stream - 2023**



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Abstract

During the spring of 2014, the U.S. Fish and Wildlife Service began operation of a removable barrier in Morpion Stream to capture adult sea lamprey as they make their upstream spawning migration. The new, one-of-a-kind, and state-of-the-art-barrier had been in the planning process for over 10 years. The barrier is located in Notre Dame de Stanbridge, Quebec, just upstream from the confluence with the Pike River. The barrier is designed to block adult sea lamprey from reaching over 29km (18 miles) of upstream spawning and larval habitat.

Since 2014, the number of adult sea lamprey captured at the Morpion Barrier has ranged from a low of 30 in 2017 to a high of 248 in 2015. The number of adults captured has fluctuated in part due to mechanical issues with the barrier and stream flows that prevent the barrier from being installed or operated under high flow conditions. Each year a number of modifications and improvements have been made to increase capture efficiency and ease of operation.

Due to Covid 19 and cross-border travel restrictions the Morpion Barrier was not installed in 2020 or 2021. This report summarizes our experiences and observations during the 2023 trapping season, identifies what modifications and improvements were made prior to the 2023 trapping season, and identifies modifications and improvements that are planned for the 2024 trapping season.

On May 11th, 2023, with the help of staff from the Notre Dame de Stanbridge Town Office, we hosted a celebration of 10 years since the barrier was completed (2013). The event was well attended with many dignitaries from State, Federal, and Provincial Government as well as many residents from the town and surrounding areas. At the event we demonstrated how the barrier operates, and highlighted what we have learned over the years, the results that we have seen, and the future of the barrier.

The Barrier

One of the most important and innovative features of the Morpion Barrier is its ability to be installed in the spring, prior to adult lamprey retuning to spawn, and removed from the stream once the spawning season is complete. This allows the stream to remain free flowing for nearly 10 months of the year. The barrier consists of a walkway above a series of screen panels or “grates” that are placed side by side and raised from the streambed forming the face of the barrier. Each individual grate has an attached float barrel mechanism (Figure 1) so that if the water rises high enough for the barrel to float, it will automatically trip, allowing the grate to be released and return to the streambed. This feature allows the water and any debris that has accumulated to pass downstream. The barrier has 12 vertical grates that are placed at a 60-degree angle to stream flow. This increases the surface area of the barrier, while also directing fish that encounter the barrier while moving upstream into the trap.

The trap is a two-stage trap with larger fish being collected in the first stage, and smaller fish and lamprey being collected in the second stage. To enter the first stage of the trap, also known as the “Vee – Trap”, fish must pass through the V-shaped notch (Figure 2). This Vee - Trap consists of two bar racks oriented vertically and can be adjusted to allow larger fish to enter, or closed to allow only smaller sized fish

to enter. The second stage of the trap is where the lamprey and smaller fish are collected. To pass from the Vee – Trap into the second stage trap, fish must make their way through one of four funnels. The narrow end of the funnels have a 64mm (2.5 inch) square opening (Figure 3). This two-stage trap is designed to facilitate the passage of fish that encounter the barrier, while also allowing for easier processing by separating out lamprey and smaller fish into the second stage of the trap.



Figure 1. A picture of the barrel floats on the Morpion Stream sea lamprey barrier. This picture is looking downstream towards the barrier. This is considered high water (approximately 2 meters deep) When the water levels reach approximately 2.3 meters deep the lower barrels (3) will trip allowing those grates to drop downstream allowing the water level to drop. If the water level continues to rise additional barrels (9) will trip.



Figure 2. Entrance to the first stage of the trap (Vee-Trap section) of the Morpion Stream sea lamprey barrier.

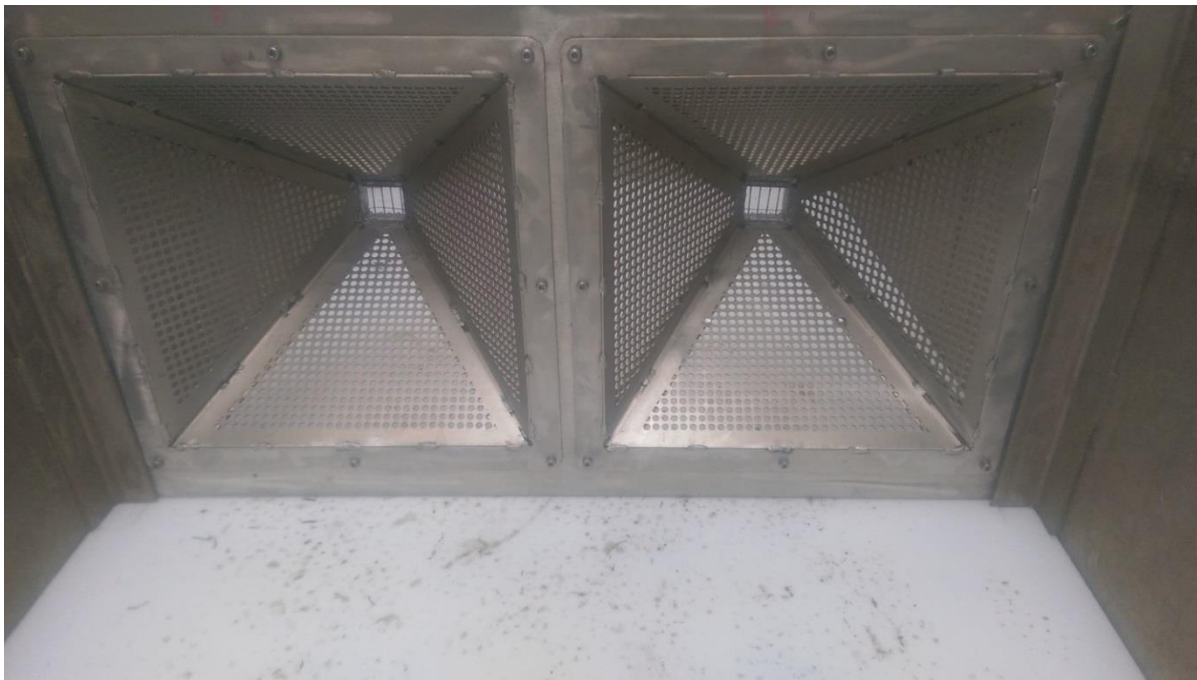


Figure 3. A picture of the funnels that separate the first and second stage of the lamprey trap in Morpion Stream. In addition to the two funnels shown in this picture, two additional funnels are stacked on top.

The Catch

Lamprey

In 2023, the Morpion Barrier was installed and began blocking adult sea lamprey from moving upstream on April 13th. Flows during the installation were approximately 0.75cms (26cfs) and the water temperature was 8.8°C (47.8°F). All grates were lowered on June 14th which returned the stream to a state of unimpeded flow. The barrier modules were removed from the stream on June 27th leaving only the concrete apron on the bottom of the stream and the concrete wing walls in place. Table 1 shows the dates that the barrier was installed and blocking lamprey, the dates of the first and last lamprey captured each year, the dates when grates were lowered, and the total number of adult sea lamprey captured each year since 2014.

Table 1. Dates when the Morpion sea lamprey barrier was installed, date of first and last lamprey capture, dates that grates were lowered, and the total number of adult sea lamprey captured each year (2014 – 2023).

Year	Date of Installation	Date of 1st Lamprey	Date of Last Lamprey	Date Grates Were Lowered	Total Number of Sea Lamprey Captured
2014	April 25 th	May 9 th	June 13 th	June 18 th	134
2015	May 1 st	May 4 th	June 8 th	June 29 th	248
2016	April 20 th	April 22 nd	May 31 st	June 16 th	140
2017	April 25 th	April 27 th	May 26 th	June 26 th	30
2018	May 9 th	May 10 th	June 1 st	June 19 th	40
2019	May 7 th	May 10 th	June 17 th	July 1 st	177
2022	May 3 rd	May 4 th	June 15 th	June 21 st	83
2023	April 13 th	April 14 th	May 30 th	June 14 th	54

The first adult sea lamprey (2) were captured on April 14th (Figure 4), which was the first date that the trap was checked in 2023. Lamprey have been caught during the first trap check every year except 2014, a year when lamprey were able to escape from the trap. The last adult sea lamprey (2) were caught on May 30th. For the season, a total of 54 adult sea lamprey were captured. This number is below the previous 7-year average of 122.

High water levels in the spring often do not allow us to install the barrier as early as we would like. For example, flows on April 6th, 2023 were approximately 33cms (1165cfs). Conditions were favorable the following week (0.75cms; 26cfs) and allowed us to install the barrier a full week earlier than ever before. We had a few highwater events during the 2023 trapping season, but only one event that caused water levels to rise high enough to trip one of the grates at the barrier. On May 2nd a rain event increased flows to 4.5cms (160cfs), raising water levels quickly and tripped one grate. We returned on May 3rd, cleaned off debris from the high water, and raised the grate back into blocking position. For the season the barrier was completely blocking lamprey from passing on 61 of the 62 days that the barrier was in place (98.4%).

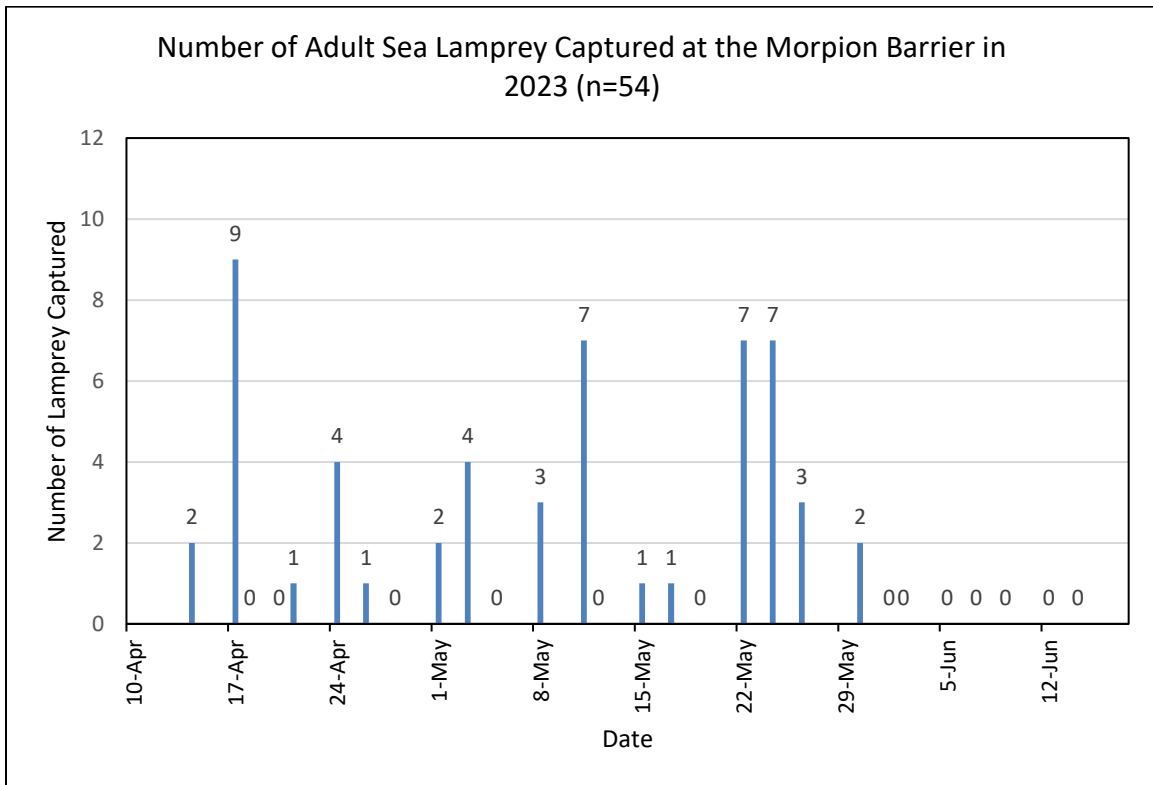


Figure 4. Dates and the numbers of adult sea lamprey captured at the Morpion Stream sea lamprey barrier during the spring of 2023.

Mark-recapture

For many years the Lake Champlain Sea Lamprey Control Program has used wounding rates on salmon and lake trout as a measure of how well the program is doing. While this provides us with some metric for measuring the number of adult sea lamprey in the lake, we know that there are many other predator / prey factors that are involved. For example, the number of adult sea lamprey could be down, but if the number of prey (host species) is also down then our wounding rates may remain unchanged or even go up. For many years the Great Lakes Sea Lamprey Control Program has moved away from wounding rates and have been using lake-wide abundance estimates of spawning-phase sea lamprey to evaluate control efforts.

In 2022, we began a mark-recapture program on a number of rivers and streams throughout the Lake Champlain Basin. This includes Morpion Stream. Lamprey that are collected at the trap are given a single fin clip (Figure 5) and released downstream, just above the covered bridge at St. Charles Road. This is approximately 2.4km (1.5 miles) downstream. If lamprey are recaptured at the barrier they are then removed from the population. In 2023, no sea lamprey were released after May 26th as it is believed that lamprey were transitioning from their migratory-phase to their spawning-phase with a decreased urge to migrate.

Of the 54 total adult sea lamprey captured at the barrier in 2023, 52 were captured on or before May 26th, clipped and released downstream. Of the 52 adults clipped and released, 12 were recaptured (23.1%) back at the barrier. Using the Chapman adjusted Pooled Petersen method for estimating populations using mark-recapture it produced a spawning population estimate of 217 adults at our release site. This compares to an estimate of 401 adults in 2022.



Figure 5. Picture of an adult sea lamprey collected at the Morpion Barrier and given a fin clip to the second (posterior) dorsal fin as part of a mark-recapture program to estimate the size of the spawning population.

Fish

During the 2023 trapping season, we captured a total of 3,318 non-target fish, 437 crayfish, and 4 frogs and toads (Table 2). Of the total 3,759 non-targets captured, we observed only 58 mortalities. That is a 98.5% success rate for passing non-targets captured in the trap. Previous years non-target totals have ranged from 1,211 to 6,415 (Table 3). The catch was dominated by common shiners (n=1,448; 38.5%), yellow perch (n=1,006; 26.8%), white suckers (n=520; 13.8%), and crayfish (n=437; 11.6%) which combined made up over 90% of all the non-targets captured.

Prior to the 2017 trapping season, we installed a new raisable floor (Figure 6) in the bottom of both the first stage (Vee-Trap) and second stage of the trap. Prior to this we would empty the trap by lowering a ladder down into each section and passing fish and lamprey up one net full at a time. Between 2014 and 2016, we captured a total of just 13 non-targets in the Vee-Trap section. In 2023, we captured 190 non-targets in the Vee-Trap section. Since 2014 we have captured 36 different fish species at the Morpion Barrier. We observed no new species at the barrier in 2023.

Table 2. Number of non-target species collected at the sea lamprey barrier in Morpion Stream in 2023.

Common Name	Scientific Name	# Alive	# Dead	Total
Common Shiner	<i>Luxilus cornutus</i>	1426	22	1448
Yellow Perch	<i>Perca flavescens</i>	993	13	1006
White Sucker	<i>Catostomus commersoni</i>	519	1	520
Fallfish	<i>Semotilus corporalis</i>	111	2	113
Creek Chub	<i>Semotilus atromaculatus</i>	88	2	90
Rock Bass	<i>Ambloplites rupestris</i>	58	1	59
Stonecat	<i>Noturus flavus</i>	18	0	18
Longnose Dace	<i>Rhinichthys cataractae</i>	17	0	17
Tessellated Darter	<i>Etheostoma olmstedi</i>	9	1	10
Log Perch	<i>Percina caprodes</i>	9	0	9
Brown Bullhead	<i>Ameiurus nebulosus</i>	4	0	4
Fathead Minnow	<i>Pimephales promelas</i>	4	0	4
Spottail Shiner	<i>Notropis hudsonius</i>	3	1	4
Unknown Minnow		1	2	3
Golden Shiner	<i>Notemigonus crysoleucas</i>	2	0	2
Bluntnose Minnow	<i>Pimephales notatus</i>	2	0	2
Juvenile Esox	<i>Esox sp.</i>	2	0	2
Tench	<i>Tinca tinca</i>	2	0	2
Smallmouth Bass	<i>Micropertus dolomieu</i>	1	0	1
Spotfin Shiner	<i>Cyprinella spiloptera</i>	1	0	1
Eastern Silvery Minnow	<i>Hybognathus regius</i>	1	0	1
American Eel	<i>Anguilla rostrata</i>	1	0	1
Northern Pike	<i>Esox lucius</i>	1	0	1
Total Fish		3273	45	3318

Other

Crayfish	<i>Unknown</i>	424	13	437
Green Frog	<i>Lithobates clamitans</i>	1	0	1
American Bullfrog	<i>Lithobates catesbeianus</i>	1	0	1
Northern Leopard Frog	<i>Lithobates pipiens</i>	1	0	1
American Toad	<i>Anaxyrus americanus</i>	1	0	1
Total Other		428	13	441

Total Capture **3701** **58** **3759**

98.5% **of all non-targets passed alive**

Table 3. Number of non-target species collected in the 1st stage (Vee-Trap) and 2nd stage of the sea lamprey barrier in Morpion Stream in 2014 - 2023.

Year	Vee-Trap Capture	2 nd Stage Capture	Total # of Non-Targets Captured	# of Mortalities	% Mortality
2014	3	1,283	1,286	8	0.6%
2015	7	2,528	2,535	26	1.0%
2016	3	6,412	6,415	52	0.8%
2017	283	3,662	3,945	61	1.5%
2018	58	1,153	1,211	44	3.6%
2019	49	1,430	1,479	37	2.5%
2022	77	2,325	2,402	69	2.9%
2023	190	3,569	3,759	58	1.5%



Figure 6. A picture of the second stage trap of the Morpion Barrier being raised to be sorted.

Pike River

In 2023, we also placed 3 lamprey pots at the base of the dam on the Pike River. A lamprey pot is a PVC pipe approximately 0.7m (28 inches) long and 0.2m (8 inches) in diameter. A funnel is placed at one end to allow fish and lamprey to enter but reduce the likelihood of them escaping. For the season we captured 2 adult sea lamprey, 99 crayfish, 29 yellow perch, 6 white suckers, 5 brown bullhead, 5 yellow bullhead, 2 stonecats, 1 rock bass, and 1 green frog. One of the adult sea lamprey was given two fin clips and released at the same location as adults that were captured at the Morpion Barrier. The second adult was captured after May 26th and was not released. The adult that was released was not recaptured.

Observations / Problems / Modifications / and Future Modifications

Each season we continue to make modifications and improvements. Since the barrier was first installed in 2014 many modifications have been made. While the overall structure is the same, many improvements have been made to better block upstream migration of sea lamprey, improve fish passage, improve efficiency of checking the trap, and improve operator safety. With this barrier being one of a kind, it was expected that some modifications would need to be made. Some of the larger modifications to the barrier include lowering the barrels to prevent flooding of the adjoining field (2015), installing a floor in the 1st and 2nd stages of the trap to prevent lamprey escapement (2015), Installing a raisable floor in both the 1st and 2nd stages of the trap so that the trap could be emptied by raising the floor up rather than having to enter the trap and emptying it one net full at a time (2017), installing brackets to the grates in areas that may allow some lamprey to pass through and continue upstream to spawn (2019), and blocking off areas around the funnel entrances to the second stage of the trap (2017 & 2022). These repairs and modifications and many others are outline in previous versions of this annual report (Operation of a Removal Lamprey Barrier in Morpion Stream 2014.... 2022).

The barrier and trap operated very well in 2023 and we are hopeful that only minor repairs and annual maintenance will be needed in the near future. The barrier is now 10 years old, and we have started to see wear items start to fail. In 2023 we replaced the plastic pullies that allow the grates to be lowered to the streambed with metal pullies because some of the plastic ones had begun to warp and become brittle over time. The barrier is currently in good shape and should need only minor repairs and inspection before the 2024 spring trapping season.

Morpion Streams drainage area includes a lot of agricultural land with lots of drainage ditches. This often causes stream flows to rise and fall rapidly during rain events. We closely monitor real time stream flow observations (3.1km / 1.9 miles upstream) posted on the internet during the trapping season. In 2022 and 2023 we also installed a video camera so that we can monitor conditions at the barrier remotely. After having some issue with the camera in 2022, we made some modification and the camera worked well during the 2023 trapping season. We plan to continue to use this as a tool for monitoring conditions at the barrier.

In the spring of 2018, we began monitoring the water temperature at the barrier with a HOBO™ temperature logger. Prior to 2018, we would record the water temperature each time we visited the trap, but water temperatures in the spring often range over 5°C during a single day. Collecting a single water temperature that varies this much each day is not very useful. The temperature logger can be programed to collect water temperature every half hour (or more if needed), allowing us to calculate a daily average water temperature. We can combine water temperature data with adult catch numbers and determine if there is a strong correlation between the water temperature and the timing of the sea lamprey spawning migration. This could potentially lead us to shift or shorten the time period that we have the barrier in place. If water levels remain too high to install the barrier in the spring, we can at least install a temp logger to monitor water temperature and know if lamprey are likely migrating or not.

Conclusion

We will always be at the mercy of the weather such that, during high flow events, the grates will trip and if lamprey are migrating upstream during that time, they may get past the barrier before we have a chance to raise the grates back up. We can only hope that these events are few and far between. Recent high-water events have shown that the barrier does operate as designed, with floats tripping and grates being lowered automatically during these events. During the 2023 trapping season water levels rose after heavy rains on several occasions, but only once did they rise high enough to trip one of the lower most barrels. This allowed enough debris and water to pass that no additional barrels were tripped. This is how the barrier was designed to operate.

Our biggest challenge is installing the barrier as early after ice out as possible, before the lamprey spawning migration begins. Water levels and favorable conditions allowed us to install the barrier a full week earlier than ever before and over 3 weeks earlier than we were able to in 2018 and 2019. Even with the early date of installation, we still caught 2 adult lamprey at the barrier on the day following the installation. We have caught adult lamprey at the barrier during the first trap check every year that we have operated the barrier except 2014. In 2014, there was no floor to the trap, and we found that lamprey were able to enter the trap and then escape and continue upstream to spawn. It's possible that in 2014 adult sea lamprey had entered the trap and continued upstream prior to us finding one in the trap during our trap checks. We will continue to try to install the barrier as early as possible and can only hope that few lamprey make it above the barrier prior to the barrier being installed.

We plan to continue to include Morpion Stream and the Pike River as part of our mark recapture program for estimating adult sea lamprey abundance in Lake Champlain. Mark-recapture estimates of spawning run size have been shown to be better predictors of lake wide populations than trap catch totals due to season variations in catchability.

The spring of 2024 will be the 9th year of operating the Morpion Barrier and we hope to soon capture the 1,000th lamprey at the barrier. During that time the barrier has prevented 10's of millions of eggs being released and potentially thousands of parasitic phase sea lamprey from out migrating to feed on salmonids and other fish species throughout Lake Champlain.