

Operation of a Removable Barrier on Morpion Stream - 2015



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Abstract

During the spring of 2014, the US Fish and Wildlife Service began operation of a removable barrier on 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 intended to block adult sea lamprey from reaching over 17 miles (27 km) of upstream spawning and larval habitat.

In 2015, during the second year of operating the removable barrier, 248 adult sea lamprey were captured. This is an increase from the 134 adult sea lamprey that were captured in the spring of 2014. A number of improvements and modifications were made between the 2014 and 2015 spring trapping seasons. This report summarizes our experiences and observations during the 2015 trapping season, identifies what modifications and improvements we made following the 2014 trapping season, and identifies future modifications and improvements that we plan to make to the barrier.

The Barrier

One of the most important and innovative features of the Morpion barrier is its ability to be easily installed in the spring, prior to adult lamprey retuning to spawn, and removed from the stream after the spawning season. This allows the stream to remain free-flowing for nearly 10 months during 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 stream bed 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 fall down to the stream bed. 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 to increase the surface area of the barrier while also directing fish that encounter the barrier while moving upstream into a 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 “V – Trap”, fish must pass through the V notch. This V notch 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 V – Trap into the second stage trap, fish must make their way through one of four funnels. The narrow end of the funnels have a 2.5 inch (64mm) square opening (Figure 2.). This two-stage trap is designed to facilitate the passage of fish that encounter the trap, while also allowing 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 sea lamprey barrier. The modules are shown here during storage, and are shown with the grates in the down position, as they would be if the barrels were to float during a high water event and allow the grates to fall to the streambed.

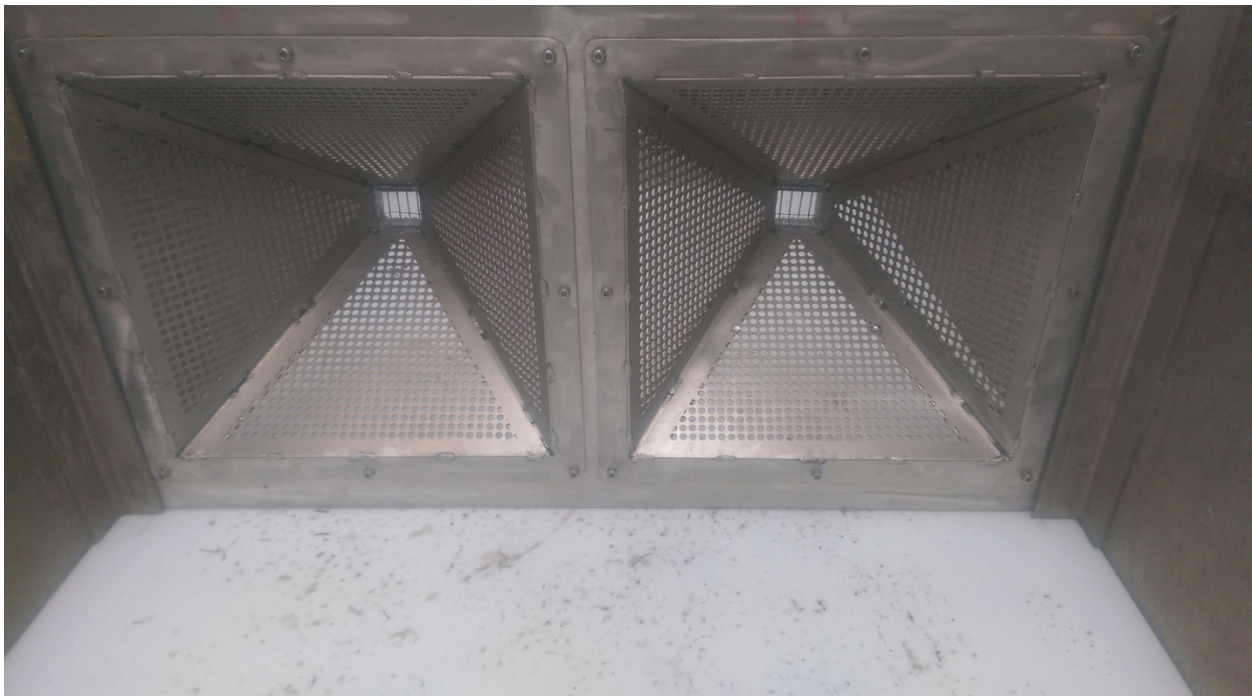


Figure 2. A picture of the funnels that separate the first and second stages of the fish and lamprey trap on Morpion Stream. In addition to the two funnels shown in this picture, two additional funnels are stacked on top.

The Catch

Lamprey

In 2015, the barrier was installed and began operating on May 1st. All grates were lowered on June 29th and the barrier modules were removed from the stream leaving only the concrete apron in the bottom of the stream and the concrete wing walls in place. These dates compare to the 2014 trapping season which spanned from April 25th to June 18th.

The first adult lamprey (54) were captured on May 4th (Figure 3.), the first date that the trap was checked in 2015. This compares to the first adult captured on May 9th in 2014. The last adult sea lamprey was captured on June 8th. That compares to June 13th in 2014. For the season we captured 248 adult sea lamprey, compared to 134 in 2014. Most of the adult sea lamprey captured in 2015 were held in a live cage and transferred to the University of Montreal for research.

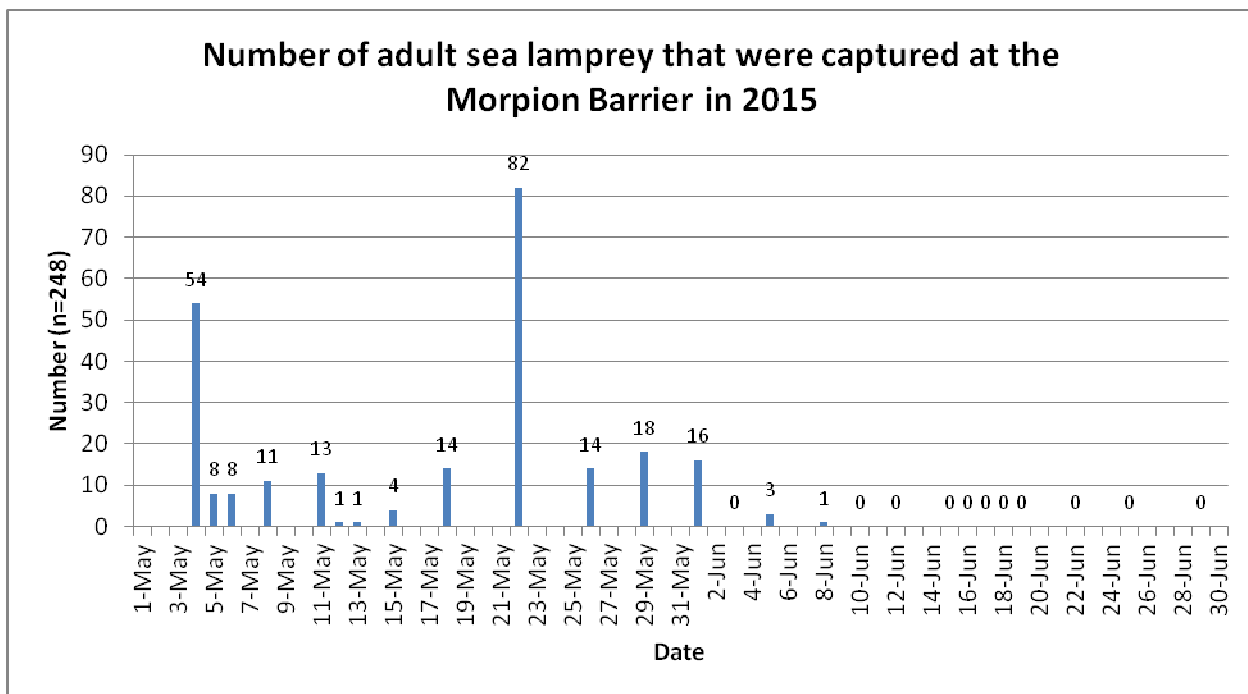


Figure 3. Date and number of adult sea lamprey captured at the Morpion barrier in the spring of 2015.

Fish

During the 2015 trapping season, we captured a total of 2,264 non-target fish, 258 crayfish, 6 frogs, 6 Merganser ducklings, and 1 snapping turtle (Table 1.). Of the total 2,535 non-targets captured, we observed only 26 mortalities. That is a 99.0% success rate for passing non-targets captured in the trap. The total of 2,535 non-targets captured in 2015 is nearly double the 1283 non-targets that were captured in 2014. This was likely a result of the new floor (Figure 4.) that was installed in the trap and the addition of “finger boxes” which are hinged pins over the funnel opening that can be easily pushed open by lamprey and other species, but then lock behind them to prevent their exit through the funnel opening.



Figure 4. A view of the bottom of the two stage trap on Morpion Stream (in these pictures the diving wall and funnels that separate the first and second stages of the trap have been removed). The picture on the left shows the bottom of the trap during the 2014 season. The picture on the right shows the new floor that was installed prior to the 2015 trapping season to prevent lamprey and non-target fish from escaping, and to facilitate easier removal when checking the trap.

The catch was dominated by Fallfish (n=735; 31.7%), Common shiners (n=679; 26.8%), Rock bass (n=370; 14.6%), and White suckers (n=160; 6.3%) which combined, made up over 77% of the non-targets captured.

In 2015, we captured 10 fish species that we did not observe during the 2014 trapping season (spottail shiner, bluntnose minnow, log perch, emerald shiner, fathead minnow, tench, longnose dace, tessellated darter, rudd, and rosyface shiner). There were three fish species that we collected in small numbers in 2014 that we did not observe in 2015, eastern silvery minnow (4 in 2014), American eel (1 in 2014), and Atlantic salmon (1 in 2014).

In 2014, the largest number of a single species was yellow perch with a total of 332 fish. Of those 332, 309 were collected in April. In 2015, we did not have the trap installed in April and it looks like we may have missed the run of yellow perch. The next four most abundant species in 2014: rock bass, fall fish, common shiner, and white sucker, were the top four most abundant species that we observed in 2015.

One species of interest to note was muskellunge, observed both downstream and upstream of the barrier. While we did not capture any in the trap, on at least two occasions we observed a total of at least 6 individuals above and below the barrier. A number of these individuals were well in excess of 1 meter in length.

Table 1. Number of non-target species collected at the sea lamprey barrier on Morpion Stream in 2015.

| Common Name | Scientific Name | # Alive | # Dead | Total |
|---|---|-------------|-----------|-------------|
| Fallfish / Ouitouche | <i>Semotilus corporalis</i> | 738 | 7 | 745 |
| Common Shiner / Méné à Nageoires | <i>Luxilus cornutus</i> | 679 | 1 | 680 |
| Rock Bass / Crapet de Roche | <i>Ambloplites rupestris</i> | 370 | 0 | 370 |
| White Sucker / Meunier Noir | <i>Catostomus commersoni</i> | 160 | 0 | 160 |
| Stonecat / Barbotte des Rapides | <i>Noturus flavus</i> | 84 | 3 | 87 |
| Smallmouth Bass / Achigan à Petite | <i>Micropterus dolomieu</i> | 44 | 0 | 44 |
| Spottail Shiner / méné à tache noire | <i>Notropis hudsonius</i> | 36 | 0 | 36 |
| Yellow Perch / Perchaude | <i>Perca flavescens</i> | 33 | 0 | 33 |
| Creek Chub / Mulet à Cornes | <i>Semotilus atromaculatus</i> | 30 | 1 | 31 |
| Brown Bullhead / Barbotte Brune | <i>Ameiurus nebulosus</i> | 26 | 0 | 26 |
| Bluntnose Minnow / méné à museau arrondi | <i>Pimephales notatus</i> | 16 | 0 | 16 |
| Log Perch / Fouille-roche zébré | <i>Percina caprodes</i> | 8 | 1 | 9 |
| Golden Shiner / Chatte de l'Est | <i>Notemigonus crysoleucas</i> | 4 | 0 | 4 |
| Pumpkinseed / Crapet-Soleil | <i>Lepomis gibbosus</i> | 3 | 0 | 3 |
| Emerald Shiner / Méné émeraude | <i>Notropis atherinoides</i> | 3 | 0 | 3 |
| Fathead Minnow / Tête de boule | <i>Pimephales promelas</i> | 3 | 0 | 3 |
| Tench / Tanche | <i>Tinca tinca</i> | 3 | 0 | 3 |
| Northern Pike / Grand Brochet | <i>Esox lucius</i> | 2 | 0 | 2 |
| Longnosed Dace / Naseux des rapids | <i>Rhinichthys cataractae</i> | 2 | 0 | 2 |
| Tessellated Darter / Raseux-de-terre gris | <i>Etheostoma olmstedii</i> | 1 | 0 | 1 |
| Rudd / Gradon rouge | <i>Scardinius erthrophthalmus</i> | 1 | 0 | 1 |
| Rosyface shiner / méné à tête rose | <i>Notropis rubellus</i> | 1 | 0 | 1 |
| Unknown Minnow | <i>Cyprinidae sp.</i> | 0 | 4 | 4 |
| | | | | |
| | Total Fish | 2247 | 17 | 2264 |
| | | | | |
| Leapord Frog / Grenouille Léopard | <i>Rana sphenoccephala</i> | 4 | 0 | 4 |
| Green Frog / Grenouille verte | <i>Rana clamitans</i> | 2 | 0 | 2 |
| Snapping Turtle / Chélydre serpentine | <i>Chelydra serpentina</i> | 1 | 0 | 1 |
| | | | | |
| Cray Fish / écrevisse | | 252 | 6 | 258 |
| | | | | |
| Merganser Ducklings / Harle bièvre poussins | <i>Mergus merganser</i> | 3 | 3 | 6 |
| | | | | |
| | Total Other | 262 | 9 | 271 |
| | | | | |
| | Total Capture | 2509 | 26 | 2535 |
| | 99.0 % of non-targets passed alive | | | |

In the first stage of the trap (V-Trap section), we collected only seven non-targets all season: one large snapping turtle we successfully netted and passed upstream, and one of each of the following, smallmouth bass, common shiner, creek chub, unknown minnow (dead), tench, and a fall fish.

Observations / Problems / Modifications / and Future Modifications

Barrel Floats

During the spring 2014 trapping season, we found that the bank elevation on the west bank of the barrier was lower than the elevation that the water would need to reach in order to raise the barrels, thereby allowing the grates to trip and lower. This was an error in construction that prevented the barrier from operating as designed. To address this problem, either a berm (raise the bank elevation) could be built or the height of the barrels could be lowered. A decision was made to lower the barrels rather than alter the river bank. To do this, we added new extension brackets that allow the barrels to extend further downward, approximately 1 meter, such that they will trip while the water level is below bankfull. Kleinschmidt Associates, the engineers who designed the barrier, drafted the new engineering plans for the float modifications. This will prevent the barrier from backing up water and flooding the adjacent field in the future. Due to the time required to draft engineering plans, secure funding, obtain materials, and fabricate the modifications we were not able to make the modifications during the 2014 trapping season. Prior to the start of the 2015 trapping season, barrel extensions were added to lower the barrels (Figure 5. and 6.).

During the 2015 trapping season, we had a number of high water events in June, and the barrels functioned as designed by tripping and allowing the grates to drop to the streambed before the water elevation reaches bankfull and spills into the neighboring field. During a flood event on June 9th the Pike River (no gage available on Morpion stream) rose from 15cms to over 120cms. Water from the Pike flooded its banks, and a portion of the park near the mouth of Morpion stream was flooded. During this flood event all 12 barrels tripped and the grates were lowered to the stream bed as designed.



Figure 5. – New barrel extensions were added prior to the 2015 trapping season to lower the elevation of the barrels approximately 3 feet (1 meter) to allow the grates to drop before the water reached bankfull height.



Figure 6. – Height of the float barrels during the 2014 season (on the left). Height of the barrels after installing the barrel extensions to lower the barrels prior to the 2015 trapping season (on the right).

Modules

The barrier is made up of 6 modules, each having 2 grates and corresponding barrel floats. These 6 modules line up flush with each other and form the wall of the barrier. Each module is held in place by a steel rail in the concrete apron at the upstream end, and by a C channel groove that the module sits in on the downstream side. The downstream C channel is approximately 4 inches (100mm) deep. During the installation in the spring of 2015 we noticed that some of the modules were sitting up a little higher on the downstream end, likely because sand or debris was in the C channel. We thought that if the modules were sitting in the channel 2 – 3 inches (50mm – 75mm), that it would be enough to prevent downstream movement of the modules. While the modules stayed in place under low to moderate flows, this was not the case during high flow events (Figure 7.). Four times during the beginning of June we experienced rain and high flows that pushed one or more of the modules downstream on the concrete apron. Each time, when flows receded we would manually move the modules back into place, but could never get the modules to sit completely into the C channel. In the future we now know that the C channel needs to be completely cleaned out to prevent any downstream movement of the modules.



Figure 7. – In this picture module #2 (second from the river right) of the Morpion barrier had been pushed back approximately 6 feet (2 meters) during a high water event in early June of 2015.

Winches and Cables

To raise each grate from the streambed after it has been manually released or dropped by high water, each grate has a hand winch with a steel cable attached. The winches are set in “free spool” mode so that when the barrel floats are tripped, either by rising water levels or manually, the cable is allowed to spool out unrestricted. This allows the grates to trip automatically if stream levels rise. During each trap check we lower the grates to clean them. During the 2014 trapping season, when we manually trip the barrel floats while the winches are in free spool mode, we found that the cables often backlash causing the cables to fray and weaken or even break. During the 2014 season, we replaced multiple cables that broke or became badly frayed. To slow the winch spool and prevent the cable from backlashing we have equipped each winch with a hand brake that can be used when the gates are tripped manually. Late in the 2014 season, we also replaced all twelve steel cables with Amsteel Blue™, a synthetic winch line as strong as steel, but does not fray or backlash. These new synthetic winch lines and the hand brakes worked well during the 2015 season and we did not break any lines this year.

V Trap

The first stage of the trap, or the V-Trap section, is designed to capture and retain larger fish looking to migrate upstream, while smaller fish and lamprey are able to pass through the four cones and into the second stage of the trap. During the 2014 season, we adjusted the bar racks in the entrance to the V-Trap to a width of 254 - 305mm. For the entire season, we captured only two Snapping Turtles and one White Sucker that had become stuck in the corner of the V-Trap. Prior to the 2015 we installed trigger entrances that create a one-way entrance (Figure 8). By installing the trigger entrances, we hoped to better facilitate upstream passage of larger fish and other non-target species that encounter the barrier by ensuring they stayed in the V Trap once they entered. During the 2015 trapping season, we captured only 7 non-targets in the first stage of the two stage trap including one large snapping turtle. We found that if something large entered through the V-trap the trigger fingers would often push open and remain open allowing fish or other non-target species to exit. We hope to find a better way to attach the trigger entrance to the V-trap so that they will spring back and prevent non-targets from exiting through the V-trap entrance.



Figure 8.- The V-trap with trigger entrances (in black) attached to retain larger fish that enter the first stage of the trap were added prior to the 2015 trapping season.

Lamprey Trap

During the 2014 trapping season, we were successful at removing 134 adult sea lamprey before they had an opportunity to spawn, but we had reason to believe that many more were able to make it above the barrier that year. The floor of the two stage trap did not have a solid bottom, but sat on the concrete apron installed in the bottom of the streambed. While we thought that the trap would sit flush on the concrete pad and create a good seal, we later found that this was not the case. Late during the 2014 trapping season, once water levels had dropped enough that we were able to fully inspect the trap, we found that there was a gap wide enough that most lamprey could squeeze through and continue upstream. During the 2014 trapping season we also collected three adult sea lamprey that were pinned to the upstream side of the grates, possibly washed there after they died following spawning. We were also able to confirm that spawning had occurred above the barrier in 2014 by finding young of year lamprey at 3 of 6 access sites surveyed that summer during our electro-fishing larval survey. While some adults may have passed when screens were down during high flow events, it is also likely that many were able to pass through the trap and continue upstream while we thought we had the stream blocked off.

Prior to the 2015 trapping season we installed a floor in the bottom of the two stage trap. We installed a white high-density polyethylene floor in the bottom of both the first and second stage of the trap to prevent fish and lamprey from escaping through the channel in the bottom of the trap. We believe the new floor was very successful at preventing both fish and lamprey from escaping and was evident in the large increase in both the number of lamprey and non-target fish we collected in the trap this year. The white floor was also helpful for seeing into the trap making it easier to net and remove both lamprey and non-targets. The floor was also great at providing a flat surface for netting and removing both sea lamprey and non-targets.

Erosion

During a high water event in early May of 2014, water flowed over the west bank and flooded a portion of an adjacent field. As water exited the field and back into the stream it caused erosion immediately downstream from the trap. We have met with the landowner and are in the process of finding a contractor to repair the bank. We hope to either repair the bank while the ground is frozen this winter, or possibly in the spring while we have heavy equipment onsite to assist with the installation of the barrier. We did not observe any new erosion during the 2015 trapping season.

Gate Puller

While the barrier was designed to trip automatically during high flow events, a mechanism is needed to manually trip the grates if they fail to trip during high flows, or to clean the grates during our regular barrier and trap visits. During the first season this was accomplished by using two pry bars attached to ropes that we would toss out and attach to support beams on either side of the barrel floats. This required two people and became increasingly difficult as the water level would rise on the upstream side of the barrier applying pressure on the grates. Under low water conditions, when there is no difference in head above and below the barrier, a third person was required at times to manually push the grate and start it lowering to the streambed. We made it through the first season, but it was clear that we needed to come up with a better solution in the future. Between the 2014 and 2015 trapping seasons we had a device fabricated that allowed one person to easily raise the float barrels and allow the grates to drop to the stream bed. While our current device does the job, it is a bit cumbersome and we may investigate other possible options to manually raise the float barrels.

Checking the Trap

To check the trap, we place a ladder in the trap and climb down approximately 15ft to pass one net of fish and lamprey up at a time. While we are doing this, we are standing on the concrete pad in the bottom of the stream. When water levels are even moderately high, we can no longer stand on the concrete pad and must try to net the fish and lamprey while standing on the ladder. This is not easily done and can be dangerous during higher flows. Great attention to safety must be observed at all times. We also have found that trying to net around the four cones that allow lamprey and smaller fish to enter the second stage of the two-stage trap to be difficult. We have engineering plans to construct an insert that fits into the trap and can be raised so that fish and lamprey can be lifted up with a winch and removed and sorted more efficiently. This will eliminate the need to climb down into the trap entirely. We are currently working to find a metal fabricator that can build the new insert for the trapping module.

Barrier and Trap SOP and Operation

Our original plan was to operate the barrier for part of the first season, create a standard operating procedures document (SOP), and begin training municipality staff on how to operate the barrier and check the trap. We quickly learned that this would take longer to accomplish than we had originally planned. Throughout the first and second season, we were constantly learning new ways to improve our operations, and continue to make small, but important improvements to the equipment we used, and the procedures we follow. With our planned modifications to the trap we envision efficient operation that will allow the development of an operation SOP allowing us to begin the transition to having the municipality staff regularly operate the barrier and trap.

Conclusion

During the 2015 trapping seasons, we made some very important improvements to the barrier and trap. First, by lowering the barrels approximately 1 meter we were able to see them function as originally designed and trap before the water level reached bankfull height. We also found that the new floor that was installed in the trapping module was successful at retaining both lamprey, and non-targets as well as making fish removal from trap much easier. We currently have engineering plans and hope to fabricate and install an insert into the trap that can be raised to facilitate easier checking of the trap. We did experience trapping modules being pushed downstream this year during high flow events, but we know what caused this and plan to make changes during the installation process that should prevent this from happening in the future. While we nearly doubled the number of adult sea lamprey this year, we believe we may have missed the beginning of the sea lamprey migration and hope to install the barrier a little earlier in the future as conditions allow. We have learned a lot during the first two years of operating the Morpion Barrier, but still have a number of improvements that we plan to make to improve the effectiveness of the barrier as well as improving its ease of operation.