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Report on American eel (Anguilla rostrata) mark recapture study: Year 1

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2017 Report on American Eel (*Anguilla Rostrata*)
Mark Recapture Study: Year 1

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Sipayik Environmental Department

January 2018

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Abstract

In 2017, Sipayik Environmental Department staff conducted a abundance and distribution study, using a mark-recapture method study focusing on the American eel (*Anguillla rostrata*), a species of cultural importance to the Passamaquoddy. The study's focus area, the Pennamaquan Watershed, spans from its northernmost extent in Pembroke, Maine, south to Charlotte, Maine.This was the first time since 2005 that the Passamaquoddy Tribe studied the American eel. The 2005 study observed preferred eel habitat and migration routes on the dam at little river located in Perry Maine, 7 miles east of the Pennamaquan Lake. It also served as a pilot project to test different mediums for eel passage. The Tribe has interest in continuing research efforts on eels as they once provided a vital food source in the traditional diet of the Passamaquoddy before colonization. Eels now contribute to a glass eel fishery that is highly sought after by state and tribal fisherman.

Acknowledgements

The Sipayik Environmental Department would like to thank all those who helped us with this research, including the Maine Department of Marine Resources, US Fish and Wildlife, University of Maine, Wabanaki Youth in Science, and the Summer Youth Program. Special thanks to the Maine Department of Marine Resources for providing trainings, and the summer interns for their dedicated assistance throughout field season. We look forward to a continuing partnership in the future.

Introduction

The Sipayik Environmental Department is a non-profit organization focusing on environmental restoration efforts for the Passamaquoddy Tribe at Pleasant Point. The department works on several federally funded projects under the Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS), and Bureau of Indian Affairs (BIA), as well as projects funded by other state and non-profit organizations.

The Atlantic States Marine Fisheries Committee (ASMFC), Maine Department of Marine Resources (DMR), and many other organizations continue to monitor the status of the American eel, especially in more recent years, as fishing effort continues to increase despite declining eel populations. Canadian organizations such as the Bluenose Coastal Action Foundation in Nova Scotia are very aware of the eel decline and are taking a closer look at the American eel life cycle. We hope to collaborate with researchers and other organizations in the future to restore this important species.

American Eel

The American eel (*Anguilla rostrata)* is of great significance not only to the Passamaquoddy people, but to the entire ecosystem. The eel, once a vital food source for the Passamaquoddy, is now primarily harvested as glass eels for commercial use. The eel, a catadromous species, spends most of their lifestyle in freshwater and estuarine environments before migrating to the ocean to spawn. They are highly adaptive, and an indicator species for the health of the overall environment. Despite system-specific indications of healthy eel populations, most datasets raise concern about the decreasing numbers, and are thought to reflect a range-wide decline in the eel population.

The allowable recreational harvest for eels declined since 1998 due to legislative protection. On October 7, 2015 a USFWS assessment found that American eels are not considered to be endangered or threatened, and do not require protection under the Endangered Species Act at this time; however,USFWS does recommend that eels continue to be monitored. The In the mid-1990’s, the ASMFC developed the first Interstate Fisheries Management Plan for American eels in response to increased demand, heavy harvest pressure, declines in population size, and limited stock assessments. Also, The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has listed the american eel as threatened.These trends, coupled with

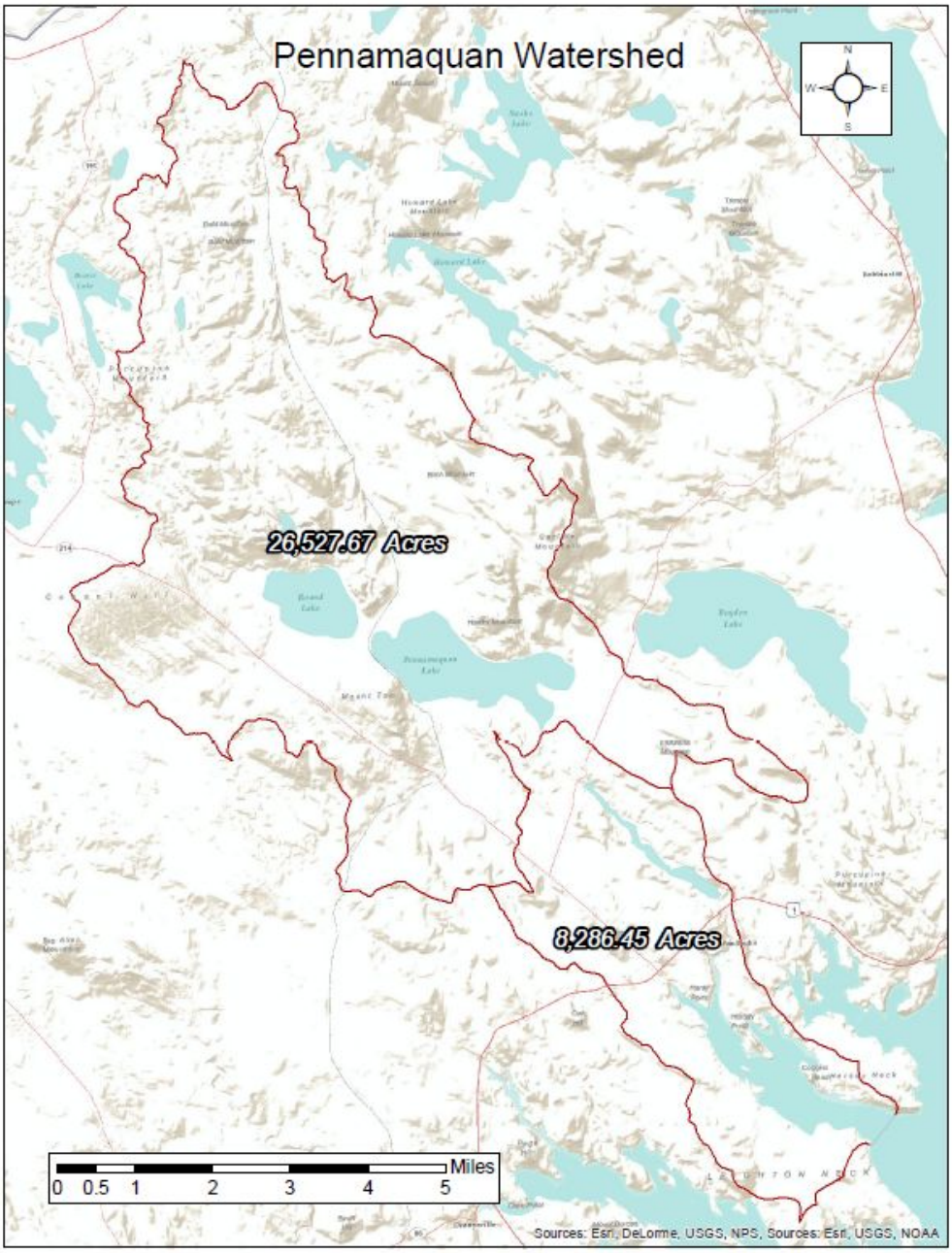
long-term monitoring datasets, may be indicative of large-scale declines in eel populations.

Fish passage is a growing concern on the Pennamaquan River. The dams, which have been there since the late 1800's, are used to control water levels for the houses and camps on the Pennamaquan Lake and River. The existing fish ladders have no designated eel passage, and the concrete structures are crumbling and in need of repair. The entrance to the lowermost ladder is at an angle not conducive to fish passage. There is a small population of beavers on the river that block fish passage on the two dams, blocking the upper entrance of the fish ladder and creating restricted passage for both anadromous and catadromous fish species. Passage is also restricted due to decreased precipitation and low flows. It will be important to continue monitoring river connectivity in future studies.

In this study, we mainly looked at yellow and silver eel abundance and movement. Originally, the study was designed to assess spawning habits, and we hope to incorporate this into future studies. We also hope to expand the study to include the full life cycle of the eel.

Study Area

Pennamaquan Watershed (figure 1), totaling 34,814.12 acres, is located approximately 4 miles north of Cobscook Bay (Figure 1). The area is significant to the Passamaquoddy as traditional hunting and fishing grounds. Pennamaquan translates to "the place to gather maple syrup", and it is evident that our ancestors were closely tied to the natural resources there. We aim to preserve the natural resources provided by the land and waters of the Pennamaquan Watershed. It's tributaries include Taylor Brook, Moosehorn Brook, Round Lake, Ohio Brook, and Crow Brook, that all flow into Cobscook Bay.



(Figure 1: Pennamaquan Watershed)

The lake and river also have many seasonal camps and houses and some year-round residences, which may affect lake water quality through nutrient loading. Given unpredictable weather conditions, water quality was only monitored once at the beginning of the study. Temperature and dissolved oxygen levels were determined to be within a suitable range. In the future, water quality will be monitored on a more regular basis.

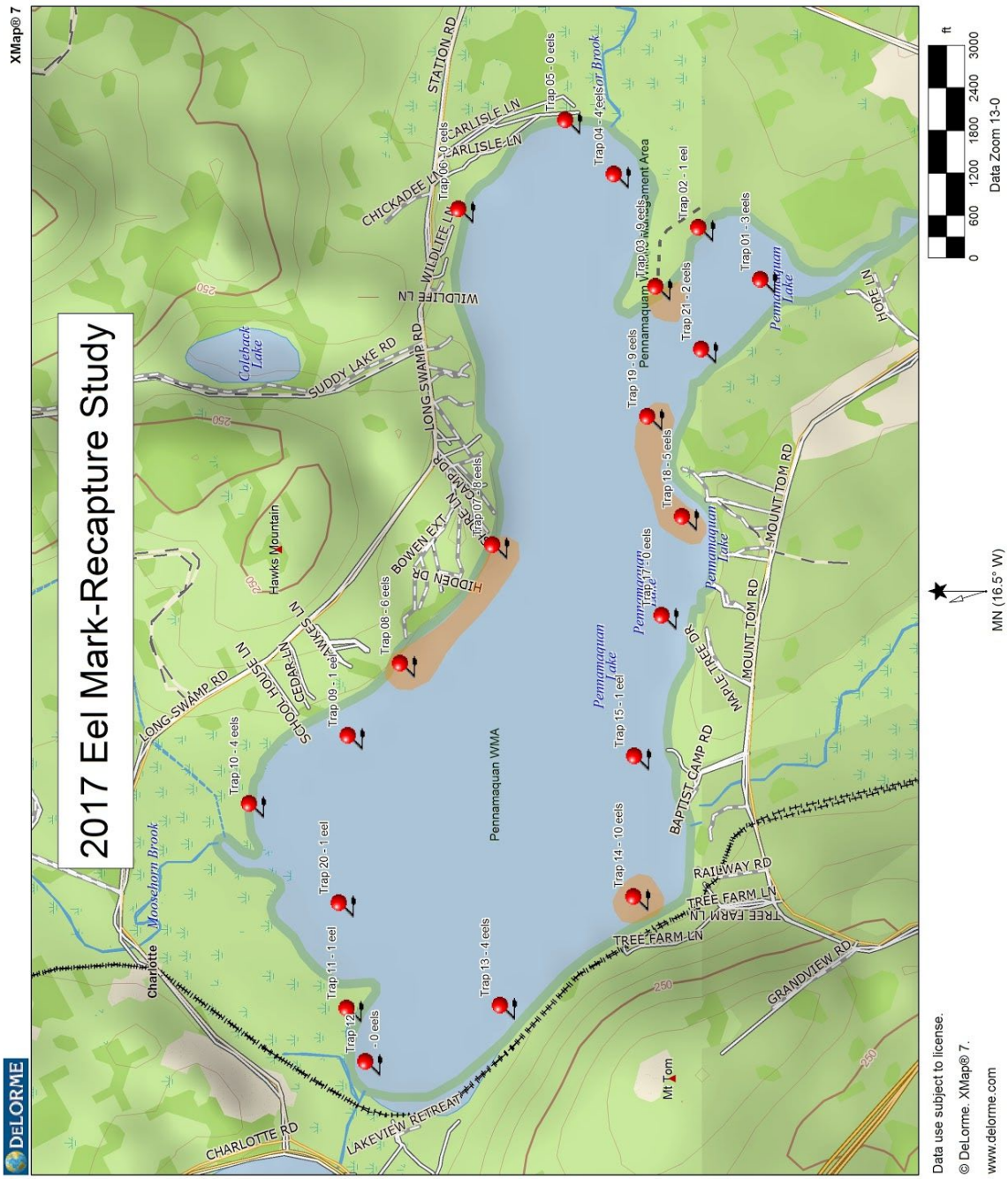
Materials and Methodology

Our first priority was to ensure safe boat access to Pennamaquan Lake. Using the Department's 14 ft. Boston Whaler, we launched from the closest boat launch in Pembroke, approximately 1 mile from the study area. Conditions later in the season made it more difficult to navigate due to low water levels, and we adapted by turning off our motor and paddling up river to the lake. To avoid spreading aquatic invasive species, the boat was fully washed after each use. All traps were thoroughly washed in July, at the end of the study period.

Twenty eel traps were set around the perimeter of Pennamaquan Lake (Figure 2). Traps were set in a range of habitats, depths, and distances from shore. Trap 16 was lost at the beginning of the study, but we eventually found it on the other side of the lake. Traps were set and baited for a 48 hour period and then retrieved to tag, count, and measure eels and bycatch. Traps placed at greater depths showed the least amount of eels caught.

Traps were baited with either frozen herring caught in the spring on the Pennamaquan River or a commercial mackerel. Each trap was baited with one alewife or mackerel cut in half to release natural fish oils. Traps were set once every other week during the months of June and July and then retrieved for tagging after a 48 hour period. All trapping days coincided with the same quarter moon phase from biweekly tending traps. In the future, we would like to conduct a longer study to see if moon phase affects eel spawning and migration. Future studies will also look at downstream migration and the timing of silver eel spawning events in the estuary.

Commercial fishing gloves and nitrile gloves were used during the retrieving and tagging of eels and bycatch. Bycatch species were counted, recorded, and separated quickly to reduce mortality. Eels were then sedated with ice, measured for total length, and tagged using visible implant elastomer tags. These tags inject a small amount of non-toxic pigment under the skin approximately one inch below the pectoral fin, and were used for identification of recapture. A different color (blue, orange or purple) was used at each tagging session.



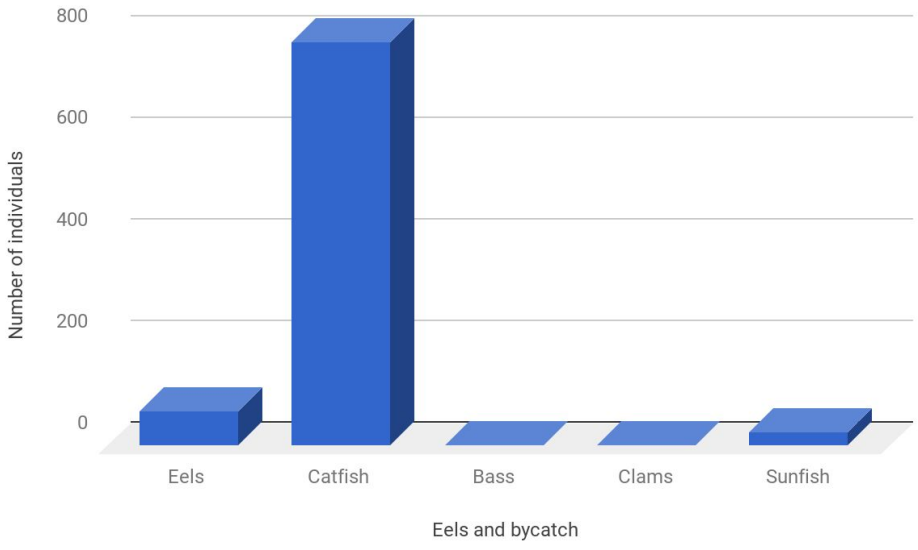
We found the highest eel densities in three areas of the lake, near traps highlighted in orange (Figure 2)

The mark-recapture study was a first for the department and, despite a few challenges, was a successful pilot study for eel monitoring in the Pennamaquan Watershed. One challenge was finding a suitable method of sedation. Since MS-222 and clove oil are not approved methods, DMR suggested that we use ice to slow them down. This worked well, and we will continue to use this method in future studies.

It is important to note that eels are very aggressive in nature and will try to escape at all costs.. Our first attempts at tagging proved to be difficult and therefore we were only able to tag a small number of eels. We also encountered a thunderstorm that prevented us from tagging, as the eels were released quickly to avoid stressings all species in the traps. In total, we were able to tag 16 of the 69 eels that were caught, keeping in mind that during the storm we had to release 37 of those eels to prevent stress and potential mortality.

Throughout the season, we found only one potential recapture, which we found to be inconclusive.. The orange mark was of the same color and size as the orange tag; however,it also looked like scarring from predators or other natural causes.

Eels comprised 7.7%, or 69 individuals, of all species caught. Bycatch was 96% catfish, or 793 individuals (Figure 3).We also found two bass, two clams, and 28 sunfish. The high numbers of catfish was largely attributed to the placement of the traps on the bottom of the lake as they are most noted as bottom feeders. It was evident in this study.



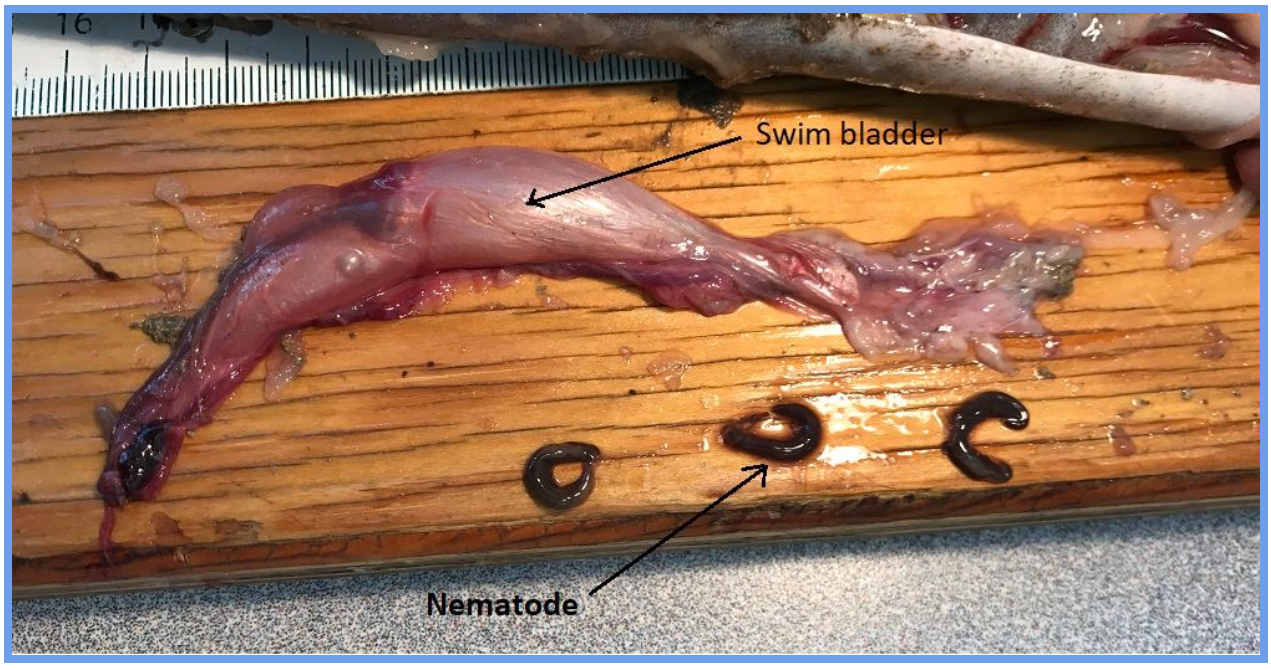
(Figure 3: Eels and bycatch)

Aging and Invasive Species

In collaboration with DMR, we received training from experts in the field on eel dissection and otolith extraction, preparation and aging techniques. Each eel was measured, their swim bladders dissected and examined for the presence of parasites, and otoliths extracted according to established protocol.

A total of 3 eels were lethally subsampled for dissection, otolith extraction, and aging. Once otoliths were extracted, they were placed in a flat embedding mold using epoxy and hardener and dried for 24 hours. Once dry, the otoliths were cut with an IsoMet low speed saw. It was important to start cutting at slower speeds and then gradually build up speed starting cutting. Once cut, otoliths were polished with lapping film to get a clear image of the anulli rings that are counted to determine age. We determined all eels collected were 7-8 years of age.

The swim bladders were also dissected from each eel. All eels contained the invasive nematode (*Anguillicola crassus*), which develops inside the swim bladder (Figure 4). We found a total of 36 nematodes, with 30 in one swim bladder. The relationship between eels and nematode is unknown, and future research may focus on the effects of nematodes on eel survival.



(Figure 4: *Invasive nematode*)

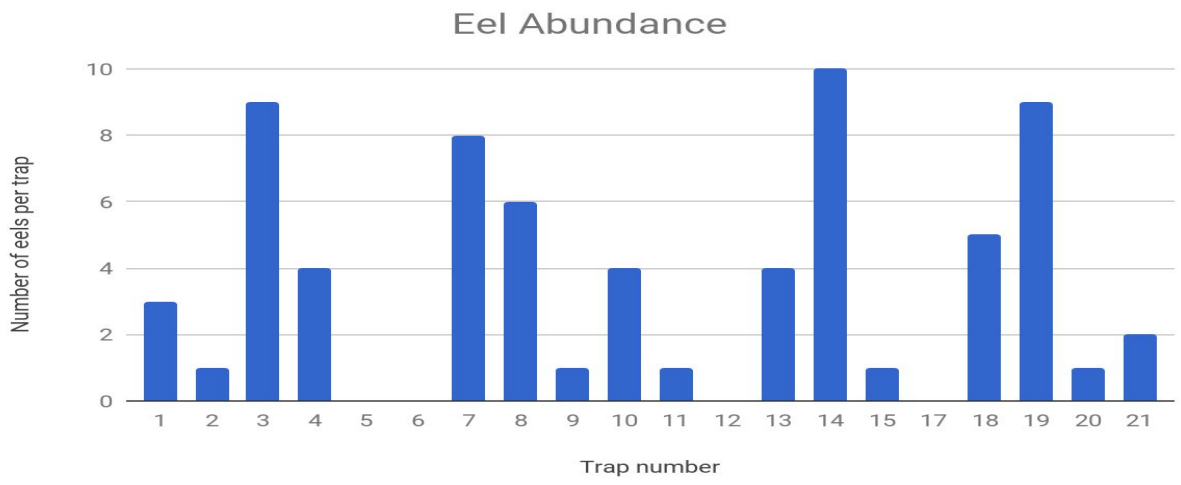
Water Quality

Temperature, pH, dissolved oxygen, conductivity and turbidity were measured at five locations with a Pro DSS on the bottom and surface of the lake once during this study. Results indicated mean surface temperatures of 20.18 °C and mean dissolved oxygen levels were 8.76 mg/L.

In 2018, we will deploy remote temperature sensors to continually monitor water temperature in the lake and river and enhance our understanding of water quality effects on eel behaviour. We would also like to test for toxins and contaminants in the water and eel tissue.

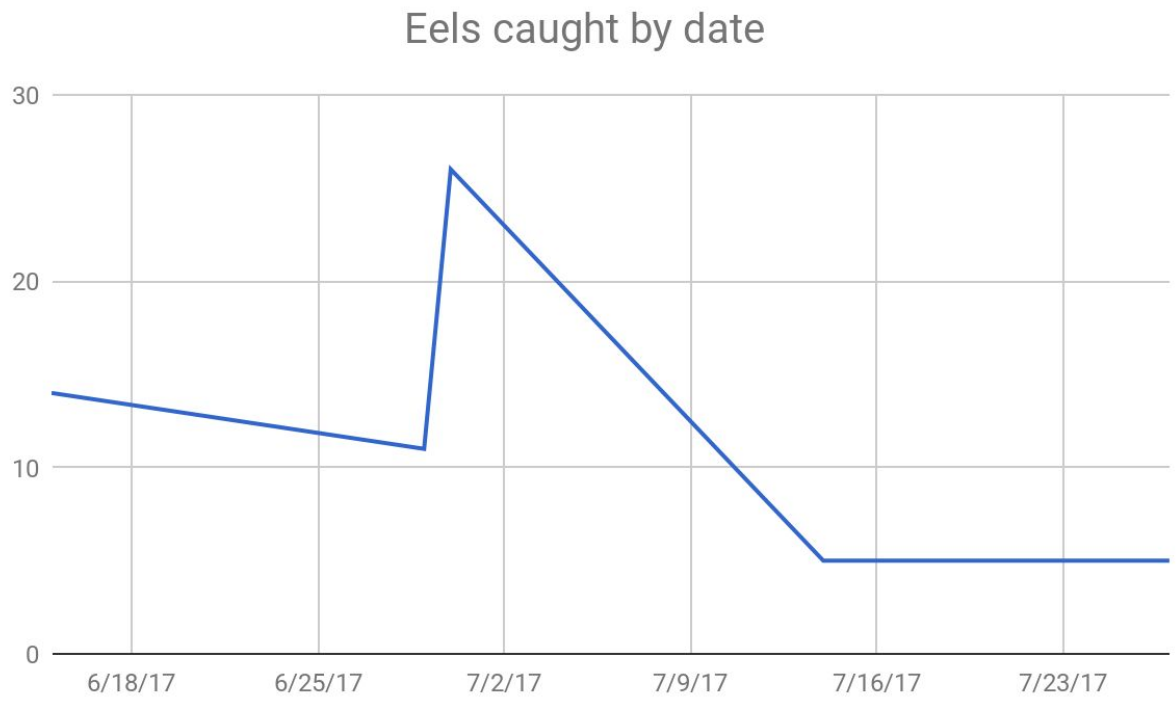
Results

The study season began on June 15, 2017 and ended on July 27, 2017. A total of 69 eels were captured, 37 were released to reduce stress on the eels and bycatch in a thunderstorm, 16 were tagged, and 3 were lethally subsampled for aging. Traps 14 (n=10), 3 (n=9), and 19 (n=9) had the most eels over the entire season (Figure 5).



(figure 5: Eel abundance)

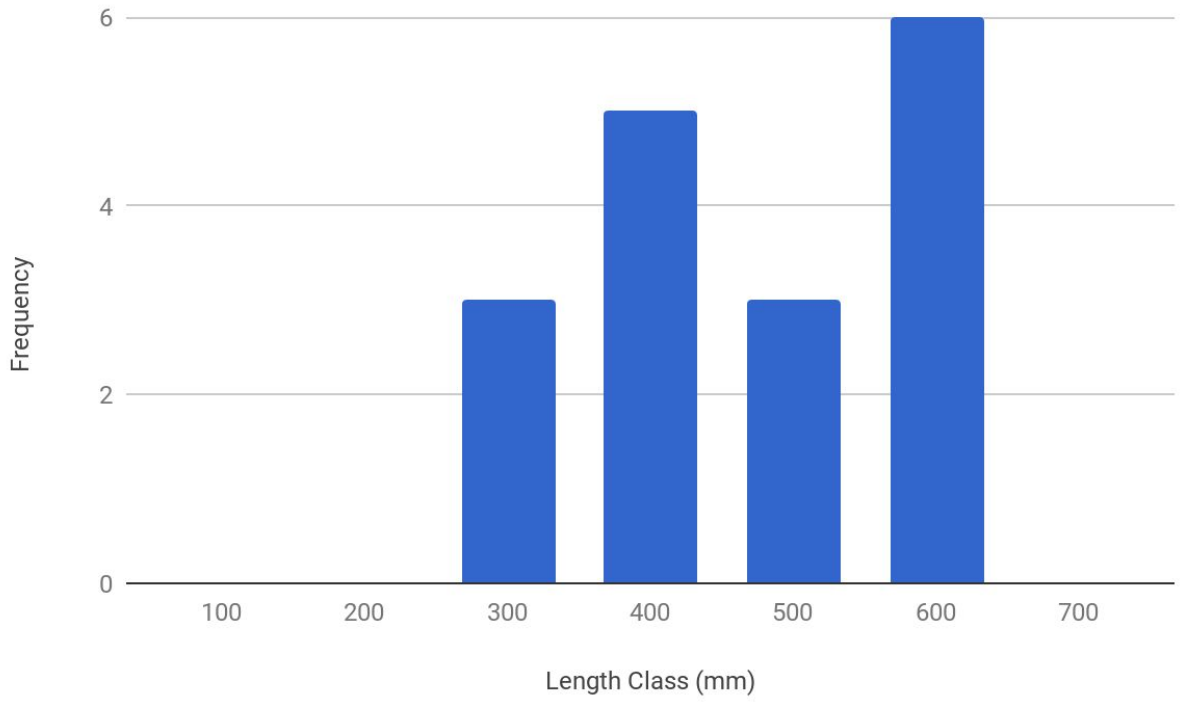
Also, eels were most abundant in traps at the beginning of July and decreased by the end of July. (figure 6)



(Figure 6: Eels caught throughout June and July)

Although there were no recaptures, eels that were tagged can be identified in future studies. We found the VIE tags had a short shelf life and did not effectively penetrate the thick skin of the eels. The needle was very fine and easily broken, which happened twice over the field season. Given that the VIE tags did not work as well as hoped, future research may incorporate other tracking techniques, including Passive Integrated Transponder (PIT) arrays to monitor downstream migration and detect spawning activity.

Most eels were within the 600mm length class (figure 7). We would like to length more eels to get a better understanding of how large eels are growing and at what rate. Eels that are recaptured in future studies can give us an understanding of how fast or slow eels are growing in the Pennamaquan watershed.



(Figure 7: Length Classes)

Preliminary water quality tests suggest normal temperature and dissolved oxygen ranges for eels, but needs to be monitored throughout the entire study season. In 2018, we will partner with the Maine Stream Temperature Working Group to deploy remote temperature loggers that will monitor the seasonality of temperature regimes in the system. These will also help establish a long-term dataset of temperature variations in the Pennamaquan Watershed.

The presence of the nematode suggests that the parasite does has established itself in the Pennamaquan system and should be monitored. Host eels may have increased bacterial infection rates and mortality, which could be contributing to the decline in eel populations.

Almost every area of the lake had brown bullheads (*Ameiurus nebulosus)*, and most caught on these catfish were smaller in size due to the restricted entrance restricted smaller entrance of the eel traps. We also found other were able to catch a few other species of fish and molluscs, including bass, sunfish, and freshwater clams.

Discussion

The 2017 data show that there is a presence of yellow eels within the lake portion of the Pennamaquan watershed with a total of 69 eels captured. A greater portion that were lenthed were within the larger length class of eels at 600mm. We now know that conditions can sustain eels that are 7-8 years of age, but we still need to collect more data. In future studies, we would to take a larger sample of eels to identify more length classes. If we can recapture eels that were tagged, then we can identify growth rates.

Our data also shows there's a presence of the swimbladder nematode within the Pennamaquan watershed, which may have a long term impact on survival of the species which could be affecting eel populations and their swimming ability. Further management will be to monitor emerging eel farms and create more awareness of their presence to avoid further spread of *Anguillicola crassus.*

Overall presence of eels declined in July which was interesting to find. This was when lake water levels had dropped considerably. We're still unsure about specific spawning behaviors, something which we would like to further research.

We observed blockages at two dams on the river later in the season due to low water levels and beavers, which could be affecting eel migration. We're currently working with local agencies to discuss and fix some of the problems with fish passage at the two dams. We would like to install eel ladders at each dam for better access to rearing habitat.

We hope to continue this study in 2018, with minor changes in methodology to account for lessons learned in the 2017 season. Proposed changes include finding alternate access routes, assessing the impacts of moon and tide cycles, water quality, impacts of invasive species and other factors on the life cycle of the American eel. We will be pursuing opportunities to continue the study beyond 2018, with the hopes of securing funding to switch to PIT tag methodology. PIT tags will help us gain a better understanding of species interaction with dams and other barriers, spawning behaviour and migration timing, and the effects of variations in flow on eel migration.

We will continue efforts in eel restoration and research to better understand the American eel and their behaviors. Sustainability is key in order for this species to thrive and more research will be of benefit to the long term sustainability of this species. This study was a good start in order to fulfill long term monitoring, which we hope to continue in 2018 and build capacity to do a full life cycle study.

Web Sites

Atlantic States Marine Fisheries Commission: American Eels
http://www.asmfc.org/species/american-eel

Gulf of Maine Council on the Marine Environment: Restoring a Vanishing Resources in the Gulf of Maine *www.gulfofmaine.org*

Bibliography

Atlantic States Marine Fisheries Commission (ASMFC). Chapter 7: American Eel (*Anguilla rostrata*) p. 171-172