AMERICAN EEL IN OAKLAND STREAM

ABSTRACT

Bluenose Coastal Action Foundation, in partnership with Fisheries and Oceans Canada (DFO) and the Commercial Atlantic Elver Fishery, has conducted an annual study, beginning 2009, on the American eel in Oakland Lake, Mahone Bay, Nova Scotia. From 2009 to 2011, the objective of the study was to determine the habitat characteristics that American eel prefer based on a standardized habitat assessment form. However, 2012-2014 focused on a mark-recapture study. From 2009 until 2014 (excluding 2010) a trap was placed in Oakland Stream to observe eels exiting Oakland Lake to the Mahone Bay estuary, presumably on their way to spawning grounds. In 2015, only the instream portion of the project was conducted. The results of the study are specific to the Mahone Bay area; however, they will be viewed in a more general context and related to the entire Scotia-Fundy area of the Atlantic region.

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Introduction

Bluenose Coastal Action Foundation

Bluenose Coastal Action Foundation is a community-based charitable organization with a mandate to address environmental concerns along the South Shore of Nova Scotia. Coastal Action's goal is to promote the restoration, enhancement, and conservation of our ecosystem through research, education, and action. The organization has been an established member of the Lunenburg County community since its inception in December 1993. Over the past 20+ years, Coastal Action has successfully completed a vast number of projects within the South Shore Region of the province. Recently, four of our projects have specifically targeted species at risk within local watersheds – the Roseate tern and the Atlantic whitefish (*SARA* listed endangered), the Southern Uplands Atlantic salmon (COSEWIC listed endangered), as well as the American eel (COSEWIC listed threatened). Coastal Action has been diligently working on American eel fisheries research projects since 2009.

American Eel (*Anguilla rostrata*)

The American eel was listed as a species of special concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2006. In May 2012, the American eel was re-examined and designated to a higher risk category as a threatened species. However, as of yet the species has not received protection under Schedule 1 of the federal S*pecies at Risk Act* (SARA) (COSEWIC, 2012).

The American eel has an elongated body with the most distinct feature being a long dorsal fin which starts well behind the pectoral fin, and extending along the back, around the tail, and under the belly (Figure 1). The skin of the eel is tough and covered with a layer of mucus secreted for protection. The American eel is considered to be a facultative catadromous fish species, meaning typically, it lives the majority of its life in freshwater, while going to salt water to spawn. However, they are able to and sometimes do travel back and forth between salt and fresh water, and are found in a variety of habitats from brackish to freshwater. Their geographic distribution ranges from Greenland, south along the Atlantic coast, to northern South America.

American eel are a panmictic species, spawning as a single breeding population in an area of the Southwestern part of the North Atlantic Ocean known as the Sargasso Sea. They have a complex life cycle consisting of a number of distinct stages (Figure 2). When eggs hatch, they emerge as leptocephali (larvae), floating along ocean currents. Larvae metamorphose into unpigmented glass eel to pigmented elvers, and begin their upstream migration from estuaries to rivers, streams, and lakes in search of freshwater. They spend the majority of their life in the growth phase, known as yellow eel, which can last from seven to twenty-four years or more. Eventually, yellow eel mature into silver eel, which is the sexually mature life stage, and encompasses migration back to the ocean spawning grounds where they spawn and presumably die (Figure 3).

Figure 1. American eel adult by Ellen Edmonson and Hugh Chrisp. Retrieved from Wikipedia (2015).

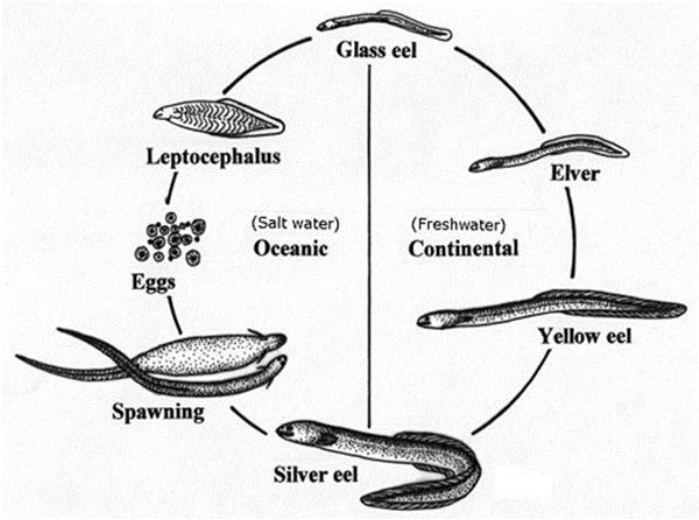

Figure 2. American eel lifecycle (created by Rob Slapkauskas). Retrieved from Ontario Ministry of Natural Resources (2007).

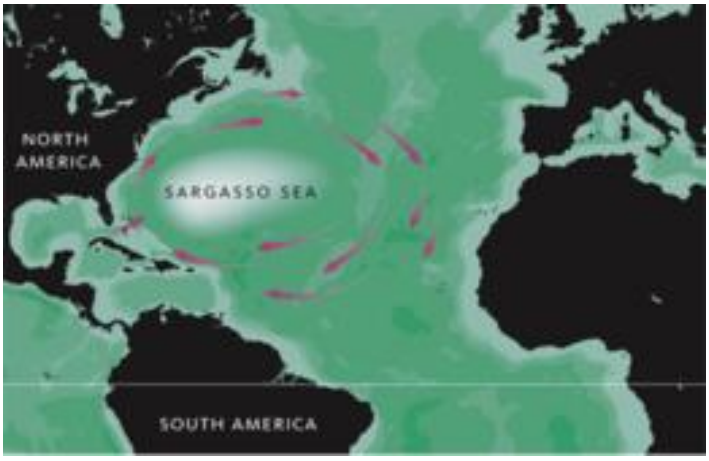

Figure 3. Sargasso Sea. Retrieved from Wikipedia (2015).

American eel face a number of threats, both natural and anthropogenic. Dams and turbines pose migration barriers and may impede or inhibit elver and juvenile migration upstream, as well adult eel migration downstream. Turbines also pose a high mortality risk for mature seaward migrating eels, as they attempt to pass through them. Loss of habitat and fishing are also considered risk factors to the American eel, along with biological and chemical contaminants (pollution), and the parasitic nematode *Anguillicolides crassus*, that mainly affects the swim bladder. Other potential threats may include changes in ocean conditions related to climate change that may affect eel ability to navigate to and from the spawning grounds, as well as the unknown effects of stocking programs which could cause changes to sex ratios (COSEWIC, 2012).

Study Area

Oakland Lake and Stream

Oakland Lake (Figure 4) is located approximately one kilometer northeast of the Town of Mahone Bay, at UTM 20T E391480.3335 N4924067.847. The surface area of the lake is roughly 0.65km^2, with depths up to 15m. The surrounding watershed is approximately 4.05km^2. The lake serves as the drinking water supply for the Town of Mahone Bay, and has been designated as a protected watershed where human activity in the area is regulated and restricted in an effort to protect the water quality of the lake. The protected status of the lake makes it ideal for the American eel study. Potential human disturbances in the area include a walking trail along one side of the lake, as well as the Town of Mahone Bay pump house, storage buildings and water treatment intake pipe which was recently expanded in the last year.

The only outgoing water flow from Oakland Lake is Oakland Stream, which drains into the Mahone Bay estuary. The stream runs through two culverts; the furthest upstream runs under Sleepy Hollow Road and the other downstream under Oakland Road and into Mahone Bay estuary.

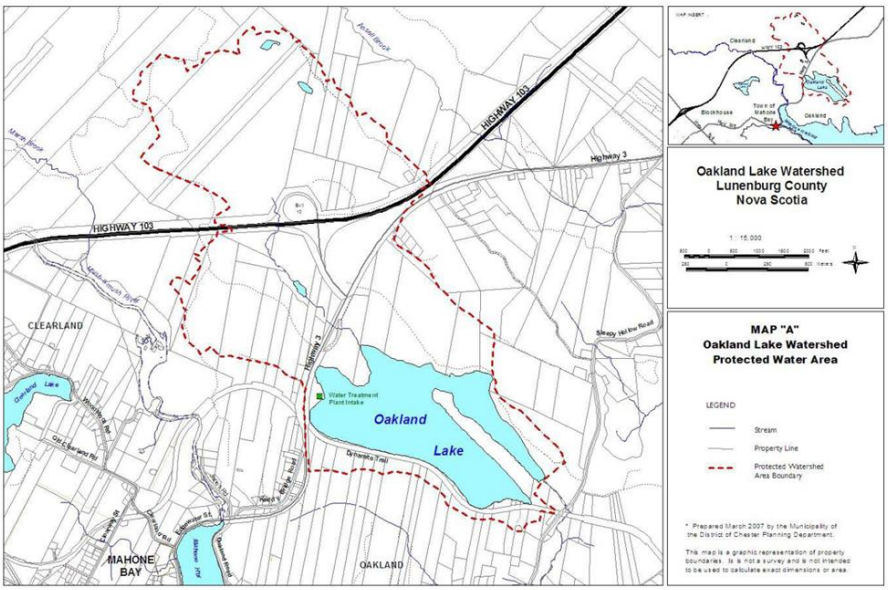

Figure 4. Oakland Lake, Mahone Bay, NS. The red arrow shows the general direction of the outflow stream.

Materials and Methods

Oakland Stream

A trap was placed in Oakland Stream, which runs from Oakland Lake into Mahone Bay estuary off of Sleepy Hollow Road, from August 29 to November 6, 2015. The trap, which was also used in 2012 and 2013, was designed by Wayne Carey and consists of a large plastic funnel, plastic tube, and large square cage (Figure 5). The funnel encompasses the entire width of the stream, while rocks and moss are built up around it. Therefore, everything traveling downstream must enter the funnel, pass through the plastic tube, and into the large square holding cage, which is submerged halfway in the stream. The holding area was modified in 2015 to safely hold a larger number of eel. The trap was checked seven days a week. Anything caught in the trap was scooped out with a large net, and a viewfinder was used to ensure that everything in the holding box was collected daily. Sampling of each individual eel included length and weight measurements, vertical and horizontal eye diameter, pectoral fin length and head length measurements taken with digital calipers (Figure 6). These measurements were taken to aid in the identification of silver eel, as their eyes and pectoral fin enlarge as they prepare for ocean migration. A thermograph was also placed beside the trap to monitor and record stream temperatures throughout the duration of the study. Every eel was scanned for a PIT tag, to determine of any were recaptures from the previous Oakland Lake potting study.

Figure 5. Oakland Instream silver eel trap, 2015.

Figure 6. Measuring horizontal eye diameter of silver eel (millimeters).

Biological Sampling

Three PIT tagged eels were sacrificed and collected from Oakland Stream. American eel were collected and bagged on ice, then frozen in water. The eel were thawed and sampled in February 2016. External measurements such as length, weight, vertical and horizontal eye diameter, head and pectoral fin length were taken first, before the eel were opened for internal examination. Gonads were extracted and weighed to d = ±0.005g and determined as either male, female, or undifferentiated. The head was cut vertically between the eyes with a set of sharp shears (Figure 7) and the otoliths were extracted.

Results

Oakland Stream

The Oakland in-stream trap was operational from August 29 to November 6, 2015. Similar to the previous year, the trap was installed earlier than in the past, in hopes of catching a larger number of migrating eel. The trap was in place for a total of 70 days, similar to 2014 and compared to 81 days in 2013 and only 45 days in 2012 (Table 1). The longer time frame allows adequate time to capture any eel running early. A total of 555 eel were captured in 2015, with nine recaptures tagged previously in the lake, all silver eel. Due to difficulties with the PIT tag reader, numbers were unreadable for the first two recaptured eel. According to past field notes, there were two eel tagged in 2011, two in 2012, two in 2013, and one in 2010. Assuming silver eel larger than 400 millimeters are female, the majority of the eels were male (about 3:1). The largest silver eel length was 869mm, while the smallest silver eel was 290mm. A total of 32 yellow eel were captured, mostly between September 5 and October 2, and one on October 13. Migrating eel came slowly throughout September, with the majority coming during a heavy rainfall event on October 1 and 2 (Figure 8). The first eel was captured on August 31, and the last three eels were caught on November 1.

Table 1. Annual American eel captured in Oakland Stream, 2009 to 2015. Note that 2010 is excluded, no instream trap project occurred that year.

Year	2009	2011	2012	2013	2014	2015	Total
Days trap was in place	29	26	45	81	70	70	
Total eel captured	221	283	405	559	513	555	2,536
Recaptures	2	1	13	17	10	9	52

Figure 7. Vertical cut for otolith, pointing at otolith (2014 picture).

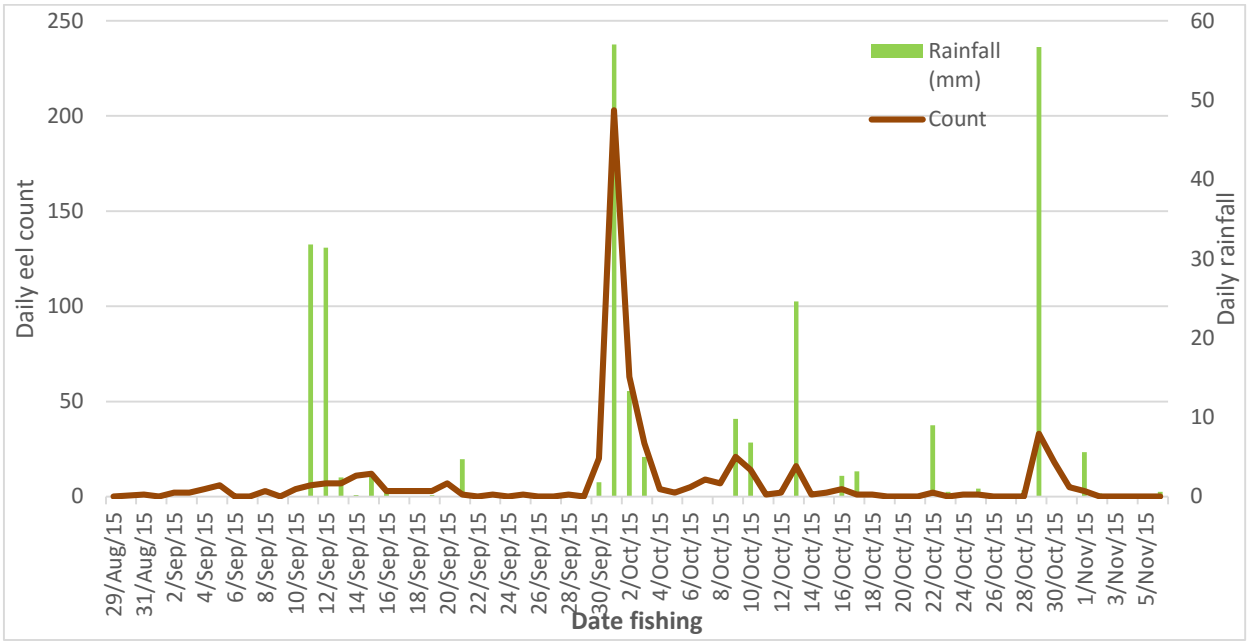

Figure 8. Oakland Stream 2015 eel run and rainfall. Note that the date refers to "date fishing," meaning the eels came on the sundown of that date, but the trap would have actually been checked the next morning.

Biological Sampling

Of the three tagged eel that were sacrificed, all were female. There was no presence or evidence of swim bladder parasites; however, small, pinkish coloured worms were found outside of the stomach on two of the eel. Otoliths will later be analysed to age the eels. PIT tags were retrieved from two of the sacrificed eel as well. Of the three sacrificial eel, one was from 2010, one from 2012, and one from 2013.

Discussion

Oakland Stream

The 2015 Oakland silver eel study accounted for the second highest number of eel captured with a total of 555, next to 559 in 2013. Since the study began in 2009, a total of 2,536 eel have been captured at this site, with only 52 recaptures. Of the nine recaptured PIT tagged eel in 2015, presumably all were female, based on length.

Trap efficiency may be influenced by practice installing the trap, and again the longer time frame (70 days) allowing more eel to be captured.

During the 2013 field season, by-catch mortality was an issue, so preventative measures were taken in 2014 and 2015. As several muskrats and a number of beavers were found drowned in the trap in 2013, a board with rungs was set inside the holding box to provide an escape should any wildlife find themselves in the trap. The board was propped against the trap so critters could crawl out. It has been successful as there have been no mortalities since its installation.

Given the silver eel field season now extends to East River, Chester, it was suggested that for the 2016 season, a larger holding box be made, allowing the eel to be safely held until technicians are able to get there. The largest run recorded since this project began, occurred in 2015, with 203 eel in one night. Creating a larger holding area will prevent overcrowding, as well as extend into quieter, less turbulent waters, to ensure the eel are not injured.

References

COSEWIC. 2012. COSEWIC assessment and status report on the American Eel *Anguilla rostrata* in Canada, Committee on the Status of Endangered Wildlife in Canada. Ottawa, xii + 109 pp. <www.registrelep-sararegistry.gc.ca/default_e.cfm>.