Anguilla rostrata (American Eel) habitat preference study in Oakland Lake and Mahone Bay estuarine system, Nova Scotia

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Abstract

The Bluenose Coastal Action Foundation conducted an American eel habitat assessment study in Oakland Lake and the Mahone Bay estuary. Data on abundance and physical characteristics was also collected from a stream that runs from Oakland Lake into the estuary itself. The elver abundance study for Oakland Stream was operational from April 23rd to June 30th, 2010. The eel study for Oakland Lake began May 26th, 2010 and was completed on August 24t, 2010. The study began in Oakland Lake with 29 eel pots. Eels caught which required sampling were anesthetised using clove oil then measured for length and weight. Untagged eels were marked using a PIT tag which was injected just under the skin. If recapture occurred, the tag number was traced back to data on the individual eel. Over the 2010 season, a total of 176 eels were caught in the lake with 67 of them being recaptures from either 2009 or 2010. This procedure was duplicated in the Mahone Bay estuary and yielded a capture of only two eels total.

Introduction

Anguilla rostrata, more commonly known as the American Eel, has not been a highly studied species. However, there is some general information commonly known on the species. For example, the American Eel is considered a catadromous fish. Meaning, unlike most fish, American Eels spawn in salt water and spend the majority of their life in freshwater. Breeding grounds for *Anguilla rostrata* only occur in the Sargasso Sea, located in the North Atlantic and surrounded by ocean currents. It is bounded on the west by the Gulf Stream, on the north by the North Atlantic Current, on the east by the Canary Current, and on the South by the North Atlantic Equatorial Current.

After spawning occurs amongst *Anguilla rostrata,* development of their eggs begin, where the American Eel will undergo a multitude of life stages including; leptocephali, glass eel, yellow eel, and silver eel. Leptocephali metamorphose into glass eels as they migrate up the eastern seaboard of North America into freshwater. Although most eels migrate into freshwater, many will remain in salt water estuaries for the majority of their life. Glass eels develop into several pigmented stages as they move into brackish or freshwater. Usually by age two, small pigmented eels transition into the yellow eel stage. Yellow eels inhabit fresh, brackish, and saltwater environments where they feed primarily on invertebrates and smaller fishes. Sexual maturity occurs any time between seven and twenty-four years of age. When yellow eels start to sexually mature, they begin a downstream migration toward their spawning grounds. During this migration, yellow eels metamorphose into the adult silver eel phase.

The Bluenose Coastal Action Foundation has conducted a study in partnership with Fisheries and Oceans Canada and the Commercial Atlantic Elver Fishers regarding American Eels. The Study took place on Oakland Lake, Mahone Bay, as well as the Mahone Bay estuary. The objective of this study is to determine the habitat conditions American Eels prefer based on a standardized habitat assessment. Although the results of the study are specific to the Mahone Bay area, they will be looked at in a more general context and related to the entire Scotia Fundy area of the Atlantic Region.

Study Area

Oakland Lake is located in Mahone Bay and is the town's water supply, thus making it a protected watershed and an excellent candidate for this study. Few residential properties exist near its shoreline and recreational activity on the lake is limited. Coordinates of the lake itself are 391480.3335, 4924067.847, where there is an estimated surface area of 0.65 km^2 (CBCL Ltd, Consulting Engineers, 2005). Although the lake itself is small, it contains deep sections that reach a nearing of 45 feet in depth. Possible disturbances surrounding Oakland Lake may occur from a trail running parallel to the lake and the area where the town has access to the water intake, pump house, and storage buildings (Figure 1).

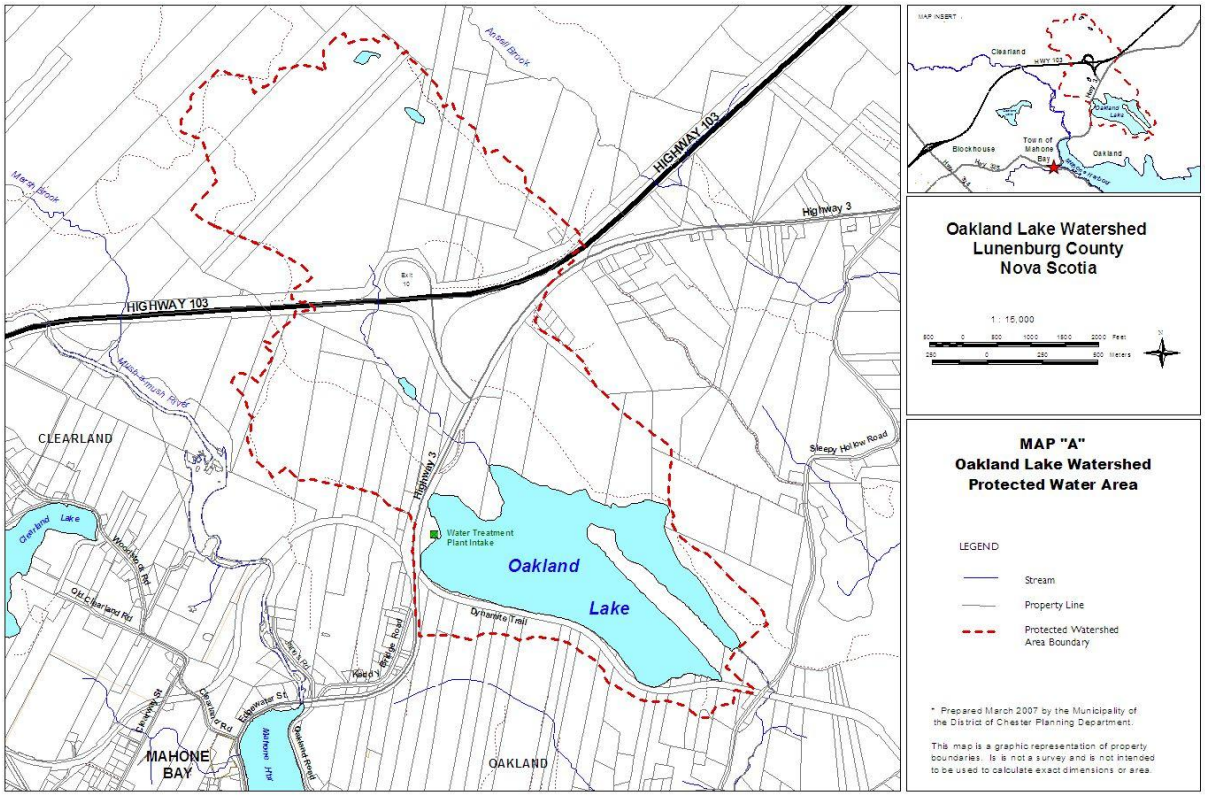

Figure 1. Map of Oakland Lake study area.

Materials and Methods

Oakland Lake

Traps were set in Oakland Lake from May 26th to August 24th, 2010. A total of 29 traps were used for this experiment and placed around Oakland Lake based on differing habitat environments. Frozen herring was used as bait for the traps, which was supplied from a business in Blandford, NS (Figure 2).

Figure 2. Bait used for American eel traps.

Trap placements were chosen based on slope, amount of vegetation, lake-bottom composition, shore composition, and depth. The goal was to ensure the traps were in as many different habitats as possible. Lake and trap depth in Oakland Lake was calculated using depth maps and a fish finder. On the habitat assessment form (Appendix 1), the slope of shoreline and slope of underlying bottom substrate were determined using a 1-5 scale where 1 had no slope and 5 had a very steep slope, almost vertical. A 12ft aluminum boat was used along with two marine batteries and an electric motor to travel around the lake (Figure 3).

Figure 3. 12ft aluminum boat used for Oakland Lake study area.

A gas motor could not be used due to the fact that Oakland Lake is a protected watershed area and no pollutants are allowed entry.

The traps were checked approximately every other day, one at a time and separated by trap number in holding bags tied to the side of the boat (Figure 4).

Figure 4. Holding bags used to keep the eels alive until sampling occurs.

The eels were scanned, either in the boat or on shore, and only sampled if they had not been anesthetised for one month to reduce excessive exposure to clove oil. If the eels had not been sampled for over a month, they were taken to shore near the habitat in which they were caught. Once on shore the eels were exposed to clove oil where biological sampling would occur (Figure 5).

Figure 5. The clove oil used to anesthetise the eels.

Figure 6. Cotton gloves used for better handling of eels.

Eels produce a layer of slime as a defence mechanism and therefore it is important to handle the eels with care, using cotton gloves for better handling (Figure 6). It is also important to use rubber gloves that go further up the arm as clove oil may cause a numbing and/or burning sensation if contact with skin occurs. When handling old and new bait it is important to wear latex gloves, preferably powdered, so your hands are protected. Keeping a knife or utility tool handy makes it easier to cut up bait if required. Each marine battery should be fully charged before heading out on the lake, and having a set of paddles on the boat for backup is essential. Data is recorded using a waterproof clipboard and notepad, preferably weatherproof paper (Figure 7).

Figure 7. Waterproof notepad used for recording data.

Biological sampling conducted on each eel consisted of measuring, weighing, and tagging the individual. To carry out the procedure, eels were transferred from the holding bags into a bucket with small holes in it (Figure 8). Another larger bucket without holes was half-filled with water. Approximately 10mL of clove oil was added to the larger bucket. The smaller bucket with holes was then placed inside the larger bucket so the eel would be submerged in clove oil. At the field technician's own judgement, the eels were submerged in the clove oil for varying lengths of time depending on size. After several seconds of exposure, the eels were removed when they appeared to slow down and "fall asleep". If this did not happen, the eel was placed back in the clove oil for a second time for an even shorter duration. Once the eel was limp it was laid out on a measuring board where the length was recorded (Figure 9).

Figure 8. Smaller bucket with holes to allow clove oil and water to drain out.

Figure 9. Measuring board used to determine length of eels.

Each eel's weight was then measured using a portable digital scale. A PIT (Passive Integrated Transponder) tag was then injected only after scanning occurred to determine if the eel had previously been tagged. To insert the tag, one technician inserted the needle containing the tag while another technician held the eel using cotton gloves. The tag was injected approximately 2cm in front of the dorsal fin to either side of the spine (Figure 10). The cotton gloves make it hard for the eel to escape if it is not entirely docile. Once successfully tagged, the eel was scanned and the 15 digit ID number was recorded. The eel was then placed in freshwater and moved side to side to pass oxygenated water over its gills. Eventually the eel will recover from the clove oil, right itself, and swim off.

Figure 10. Tagging an eel approximately 2cm in front of its dorsal fin to either side of the spine.

Mahone Bay Estuary

Ten traps were set in the estuary on July 28th, 2010 and removed on August 24th, 2010. Similar to the lake, frozen herring was used as bait for the traps. A 14ft aluminum boat was used for this study area and was stored at the government wharf in Mahone Bay. The boat was used once a week to check the traps. A four stroke motor was used for this study site as the estuary was not part of a protected watershed and the area was much larger. This location had high boat traffic and recreational activity. To minimize trap disturbances, eel pots were set away from boats, the public marina, and in front of residential properties. The biological sampling procedure followed that of Oakland Lake.

Oakland Stream Elver Traps

Traps used for the 2010 elver study at Oakland Stream were Irish style elver traps and were placed in the stream on April 12th, 2010. Traps were operational from April 23rd through to June 30th, 2010. Two traps were used in total, one on each side of the stream just below the culvert (Figure 11).

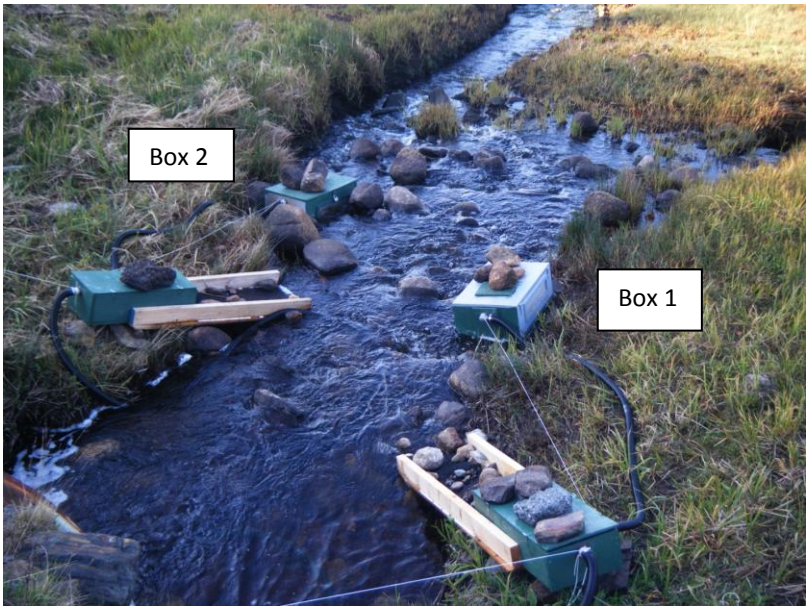

Figure 11: Traps one and two placed on either side of Oakland stream, downstream from the culvert.

Wooden ramps equipped with moss and small rocks were placed above the traps. Trap numbers were assigned as follows: Trap one was on the Mahone Bay side (right side facing estuary) and trap two was on the Indian Point side (left side facing estuary). Narrowness of the stream into Oakland Lake ensured a high-catch potential of migrating elvers. The elvers used the edge of the stream near the estuary to find calm water in which to travel upstream. Wooden ramps were used instead of cement for easy manoeuvrability during tide changes. Similar to East River, ramps were placed in the path of least resistance for the elvers to follow. Water flow to the ramps was provided by hoses that were gravity fed from within the culvert. Water was flushed through the hoses to the ramps creating a running current. Once elvers climbed the ramps, water flushed them into a holding box where they were collected. Due to constantly changing tidal waters, Inca mats were secured to the bottom of the ramps to ensure there were no gap between the water level and the ramps, impeding elver movement. Low water levels throughout most of June, resulted in few elvers being caught. Traps were no longer checked after June 30th, 2010 and were removed from the site on July 22nd, 2010.

Oakland Stream Trap

Unlike 2009, due to budget constraints, there was no in-stream trap used to catch eels leaving Oakland Lake in the fall of 2010.

Results

Oakland Lake

A total of 176 eels were caught in Oakland Lake during the 2010 season in comparison to a total of 145 in 2009. Of those 176 eels, 67 were recaptures from either 2009 or 2010 and 109 were tagged this year (Figure 12).

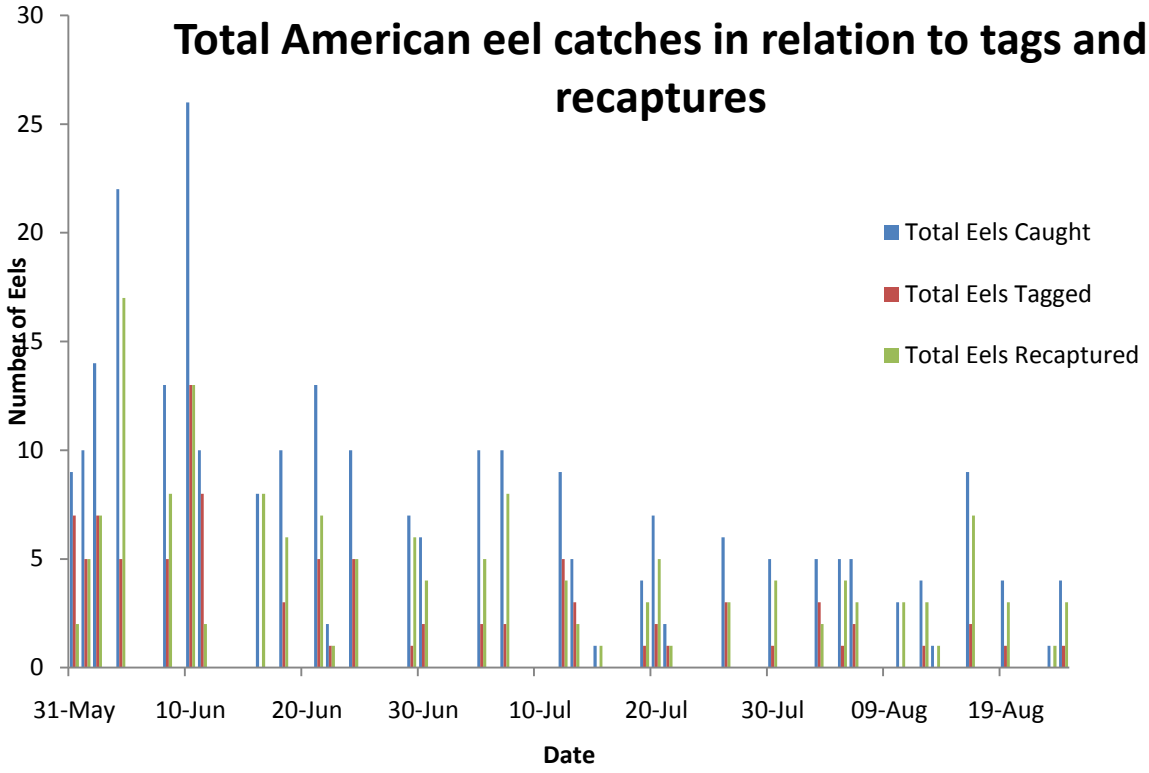

Figure 12. Total number of eels caught each date in relation to how many were tagged or recaptured.

Traps remained in the same location for the duration of the lake study with a few minor adjustments (Figure 13). When looking at what traps were most successful, Trap 9 caught the most eels with a total of 17, followed by Trap 20 with 16 eels (Figure 14). These traps were set on different sides of the lake. Trap 9 was set 12.2m from a grassy shore at a depth of 1.83m. Lake bottom was comprised of 30% boulder and 70% cobble, where the vegetation consisted primarily of water lilies, bulrushes, and water smartweed. Trap 20 was set 3m from a rocky shoreline at a depth of 3m. Lake bottom consisted of 60% boulder and 40% cobble, where vegetation was sparse and comprised only bulrushes (Table 1).

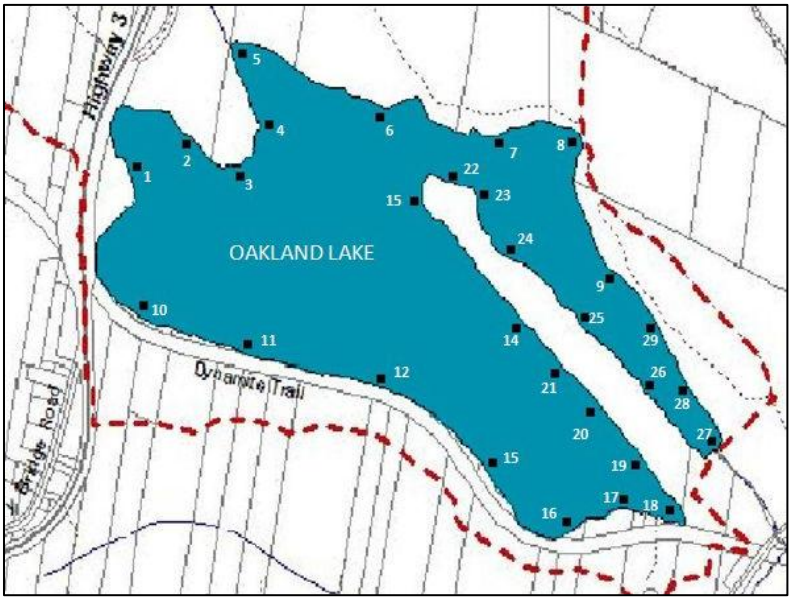

Figure 13. Map of Oakland Lake showing trap placement.

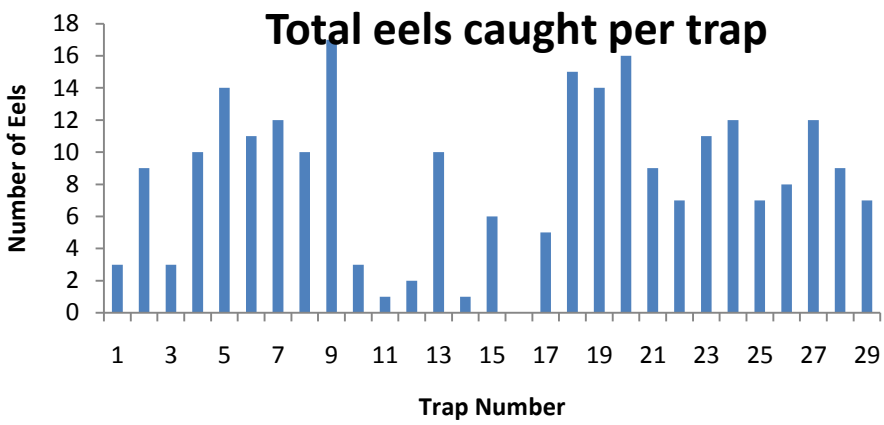

Figure 14. Total number of eels caught per trap over the duration of the study.

	Most Successful Traps			Least Successful Traps		
Trap #	**9**	**21**	**15**	**23**	**25**	**28**
UTM	4427674 06421395	4427557 06421426	4427764 06421721	4422770 06421598	4427615 06421394	4427539 06421227
Depth (m)	1.8	3	0.6	1.2	0.9	1.1
Distance from shore (m)	12.2	3	4.6	6.1	4.6	6.1
Lake Bottom % Boulder	30	60	10		20	90
% Cobble	70	40	70	70	80	10
% Sand			20	30		
Slope underwater	2	4	2	2	2	2
Slope of shoreline	2	4	3	1	2	2
Shoreline % Boulder	5	100	70	70	50	30
% Cobble			30	30	50	70
% Sand	95					
Vegetation	Lily pads, Smartweed, Bulrushes	A few bulrushes	Bulrushes	Canada waterweed, Smartweed, Bulrushes	Lily pads	Bulrushes
Notes	Grassy shoreline	Rocky shoreline	Little vegetation	Trap was set at edge of vegetation		

Table 1: Habitat summary of most successful and least successful traps in Oakland Lake.

Mahone Bay Estuary

Since July 28th, a total of 2 eels were caught during the entire study. These eels were caught during the last week of the study on August 24th, 2010. Similar to 2009, there was a high abundance of Green crab in the Mahone Bay estuary. Green crab small enough to enter the traps will feed on the Herring. The average number of crabs in the pots after 6-7 days was between 15 and 30.

Oakland Stream Elver Traps

Over the 68 day study period, the highest daily count of elvers occurred on May 5th, 2010 where 92 elvers were caught. Although the project continued until June 30th, the last elvers were caught June 18th, 2010. The elver traps used for this study did not have a 100 percent efficiency rate as some elvers were capable of bypassing the traps. The level of escapement was considered low compared with the total number of elvers migrating upstream due to the narrow width of the stream. The total estimated run size in Oakland stream for the 2010 season was 976.

Discussion

On a few occasions during the study, eel pots were pulled containing dead or maimed eels with missing tails. It appeared another animal was preying on the eels from either the outside or inside of the trap. In 2009, it was determined that the cause of these injuries and deaths was due to snapping turtles. While hauling a trap last season, the predator was visible under water biting the trapped eel's tail that stuck out between the mesh. The snapping turtles were using the traps to their advantage with contained prey.

Trap 29 went missing during the week of July 5th, 2010. It is unknown whether the trap sunk to the bottom of the lake due to the steep slope of the bank or if the trap was removed by humans. The trap was set along the shore which has a public trail running parallel to its bank, making the buoys highly visible.

In the Mahone Bay estuary, Green crabs dominated the traps and most likely acted as a deterrent to any eel looking to enter the traps. Unless eels were in the vicinity of the trap when first re-baited and released back into the water, crabs would have entered the traps within a short period of time. Although only 2 eels were caught in total, they were trapped with many Green and Rock crab that did not seem to cause any harm or stress to the eel.

Electrofishing was performed twice throughout the study on the outgoing stream from the lake. This was done to determine an estimate of what occupied the stream during that time. It was found that there were very few eels within the stream but copious amounts of small brook trout and other small fishes.

Acknowledgements

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Appendix 1

American Eel Habitat Survey Form

Summer 2009 Date: _____

Trap #		
Location Notes: **UTM**		
Depth (m)	**Distance from Shore**	**Socked??**
Underwater Composition % Boulder % Cobble % Sand		
Slope Underwater	**Slope of Shoreline**	
Shoreline Composition % Boulder % Cobble % Sand		
Filamentous algae: **Free Floating :** **Submersed :** **Floating Leaved:** **Emergent:**		
Notes		

* Standardized habitat assessment form used at each trap site.