2011

Anguilla rostrata (American Eel) habitat preference study in a protected watershed in Nova Scotia

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1/1/2011

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May – August 2011

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Abstract

The Bluenose Coastal Action Foundation conducted an American eel habitat assessment study on Oakland Lake, Lunenburg County, Nova Scotia. By-catch data were recorded to provide an insight as to what types of fish other than the American eel populate the lake. The elver abundance study for Oakland Stream was operational from April 20, 2011 to June 6, 2011. The habitat preference study for Oakland Lake began June 6, 2011 and was completed September 29, 2011. The study began in Oakland Lake with 29 eel pots. 16 additional pots were deployed June 29, 2011. Eels were scanned for previously injected tags, anesthetised using clove oil, and then measured for length and weight. Untagged eels were marked using a PIT tag that was injected into the eel. During the 2011 field season, a total of 374 eels were caught in the lake, with 149 of them being recaptures from either 2009 or 2010.

Introduction

Anguilla rostrata, commonly known as the American Eel, has not been the target of many studies. However, there is some information commonly known. For example, the American Eel is considered a catadromous fish. Unlike most migratory fish, American Eels spawn in salt water and sexually mature in freshwater. The American eel spawns in a single breeding population only in the Sargasso Sea; a floating 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.

Post-spawning the young eels hatch from eggs and undergo a number of developmental stages: 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 remain in salt water estuaries for the majority of their life. Glass eels undergo several pigment stages as they move into brackish or freshwater. Normally at two years, 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 to the Sargasso Sea. Prior to, or during migration, yellow eels metamorphose into the adult silver eel phase.

The Bluenose Coastal Action Foundation (BCAF) has conducted a study in partnership with Fisheries and Oceans Canada (DFO), Acadia University, and the Commercial Atlantic Elver Fishers regarding American Eels. The study took place on Oakland Lake, Lunenburg County, Nova Scotia. The objective of the study was to determine the habitat characteristics that American Eels prefer based on a standardized habitat assessment form. Although the results of the study are specific to the Mahone Bay area, they will be viewed in a more general context and relate to the entire Scotia Fundy area of the Atlantic Region.

Study Area

Oakland Lake is located in the Municipality of the District of Lunenburg, just outside the Town of Mahone Bay, and is the town's drinking water supply. To minimize the human effect on water quality, the lake is a protected watershed and therefore 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). In terms of total area Oakland Lake is small; however, it contains deep sections that reach nearly 17m deep (Figure 1). Potential disturbances around Oakland Lake include: a trail running parallel to the shoreline and the Town of Mahone Bay's infrastructure which comprises of their water intake, a pump house, and storage buildings.

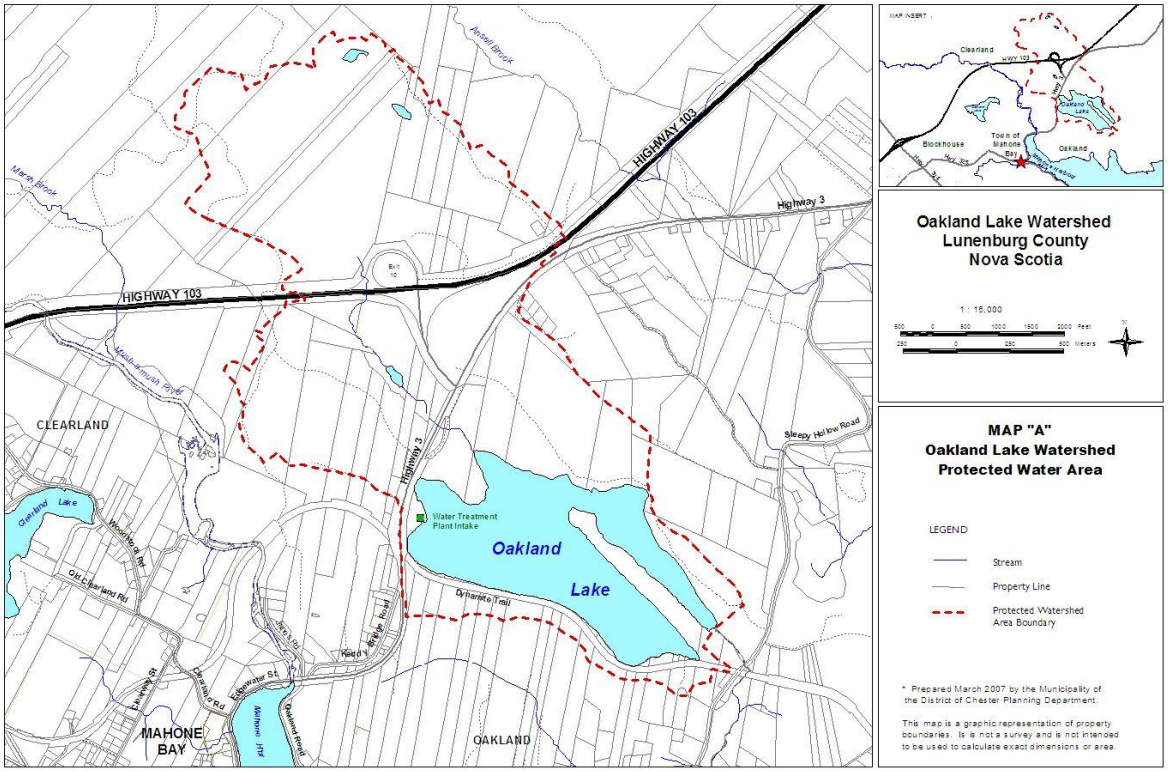

Figure 1. Map of Oakland Lake study area.

Materials and Methods

Oakland Lake

Traps were set in Oakland Lake from June to September 2011. A total of 44 traps were used for this experiment and placed around Oakland Lake based on different habitat criteria. Traps were baited with frozen herring that was supplied from the Lunenburg Fish Company, Lunenburg, Nova Scotia and a local fisherman (Figure 2). Trap placement was chosen based on slope, distance from shore, amount and type of vegetation, lake-bottom composition, shore composition, and depth using a standardized habitat assessment form. 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 a depth map and fish finder. On the habitat assessment form (Appendix 1), the distance from the shore and underwater slope were determined using a nominal scale with values between one and five, where one had no slope and five was a very steep slope, almost vertical.

Figure 2. Bait used for American eel traps.

A 12-foot aluminum boat, marine batteries, and electric motor were used to survey the lake (Figure 3). 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.

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

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

Traps were checked one at a time approximately every second day. Eel and by-catch data were recorded in water-proof notebooks. Captured eels were separated by trap number and contained in holding bags attached to the side of the boat (Figure 4). Eels were taken to shore, scanned for PIT tags, anesthetised with clove oil, measured to the nearest 0.5 cm and weighed to the nearest gram (Figure 5). Starting on July 13, a small sample was taken from the pectoral fin of all captured eels. The samples were preserved in ethanol and are to be used for future DNA analysis.

Eels produce a layer of slime as a defence mechanism; therefore, it is important to handle the fish with care to invoke as little stress to the eel's slime layer as possible. Using gloves makes handling easier resulting in a less stressful experience for the captured eels (Figure 6). Rubber gloves extending further up the arm are also worn to prevent the burning/numbing sensation caused when skin comes in contact with clove oil.

When handling old and new bait it is important to wear latex gloves, preferably powdered, so the hands are protected. Keeping a knife or utility tool handy makes it easier to cut up bait if required. Each marine battery was fully charged before departure and a set of paddles were kept onboard in case the motor failed. Data was recorded in a waterproof notebook and transferred to an electronic spreadsheet (Figure 7).

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

Figure 6. Cotton gloves used for better handling of the eel.

Figure 7. Waterproof notepad used for recording data.

To carry out the biological sampling procedure, eels were transferred from holding bags into a bucket with small holes in it (Figure 8). A 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 submerging the eel in clove oil solution. At the field technician's discretion, the eels were submerged in 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 the eel did not slow down it was placed in the clove oil for a second time. Once the eel became docile it was laid 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 measured using a portable digital scale. A PIT (Passive Integrated Transponder) tag was injected after scanning to determine if the eel was previously 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). Cotton gloves make it difficult for the eel to escape if not entirely docile. Once successfully tagged, the eel was scanned and the 15 digit ID number was recorded. The eel was then returned to 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.

Oakland Stream Elver Traps

Traps used for the 2011 study were Irish style elver traps (Figure 11). The traps were placed in the stream on April 13, 2011. Traps were operational from April 20 through to June 22. Two traps were used in total, one on each side of the stream downstream from the culvert. Wooden ramps covered with moss and small rocks were placed above the traps. Trap one was placed 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. 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 ramps to allow for easy manoeuvrability during tidal fluctuations. Similar to the East River, Chester set-up, ramps were placed in the path of least resistance for 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 was no gap between the water level and the ramps that could impede elver movement. Trap malfunctions and high water levels resulted in fewer elvers being captured. Traps were no longer checked after June 30, and were removed from the site on July 22.

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

Results

Oakland Lake

A total of 374 eels were caught in Oakland Lake during the 2011 field season. Of those, 149 were recaptures (5 from 2009, 33 from 2010) (Figure 12, Appendix 3). Traps remained in the same location for the duration of the lake study with a few minor adjustments (Figure 13). When determining which traps were the 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 number 9 was set 12.2 metres from a grassy shore at a depth of 1.83 metres. Lake bottom was comprised of 30% boulder and 70% cobble, while the vegetation consisted primarily of water lilies, bulrushes, and water smartweed. Trap number 20 was set 3m from a rocky shoreline at a depth of 3m. Lake bottom contained 60% boulder and 40% cobble, while vegetation was sparse and contained only bulrushes (Appendix 2).

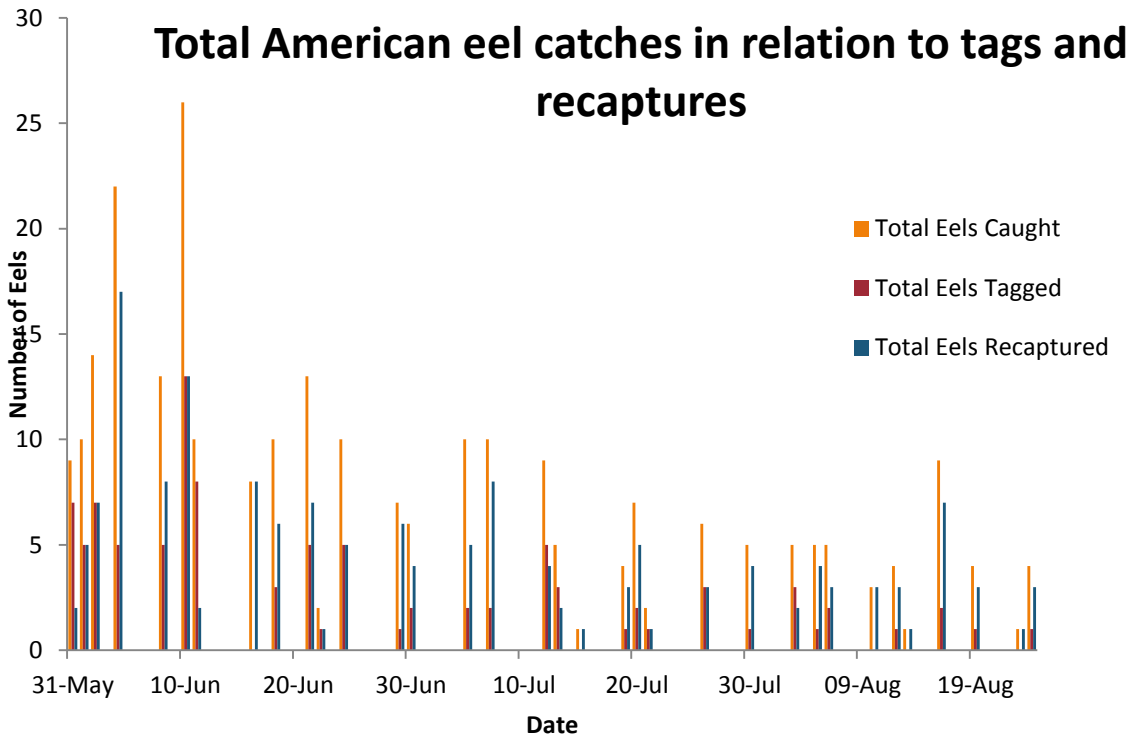

Figure 12. Total number of eels caught each date in relation to how many were tagged or recaptured.

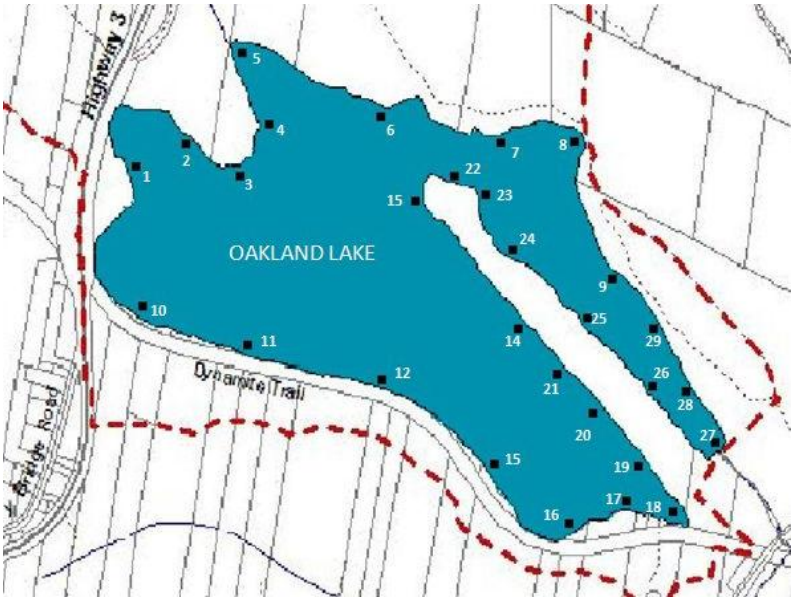

Figure 13. Map of Oakland Lake with trap placement.

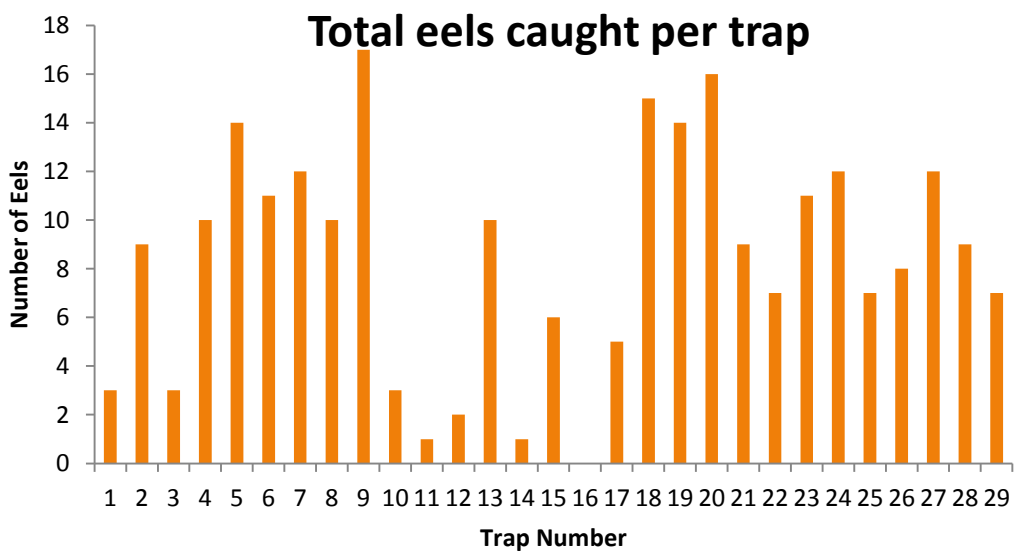

Figure 14. Total number of eels caught per trap over the duration of the study.

Oakland Stream Elver Traps

Over the 68 day study period, the highest daily count of elvers occurred on June 6, where 1740 elvers were caught. Although traps remained set until June 30, the last elvers were caught on June 18. Elver traps used for this study do not have a 100 percent efficiency rate as some elvers were able to bypass the traps. Due to the narrow width of the stream the level of escapement was considered to be low in comparison to the total number of elvers migrating upstream. Total estimated run size in Oakland Stream for 2011 was 7310.

Discussion

On a few occasions during the study, eel pots were retrieved containing dead or maimed eels with missing tails. It appeared as if another animal was preying on the eel from either the outside or inside of the trap. In 2009, it was determined that the cause of these injuries and deaths were from snapping turtles. While hauling a trap during the 2009 field season, the predator was visible under water biting the trapped eel's tail sticking through the wire mesh.

During the days of July11 and 12, eight eel pots were stolen from the Southwestern border of the lake. Traps 23, 24, 25, 26, 27, 28, 29, 39, and 45 were not checked after July 12, 2011.

Acknowledgements

BCAF would like to thank all those who helped with the project: field technician Ian Manning; the assistance of Wayne, Yvonne, and Genna Carey of Atlantic Elver Fishery; Rod Bradford (DFO); and Trevor Avery (Acadia) for guidance in the study. A big thank you also goes out to the Town of Mahone Bay who have annually granted BCAF permission to access and use their property for project delivery as well as gear/equipment storage. Last but certainly not least, all the volunteers who contributed to the study.

Thank you to all our 2011-12 American Eel Project funding partners, making it possible to complete all the activities outlined in this report. Funders include:

- Canadian Wildlife Federation's Endangered Species Fund
- Canada Summer Jobs Program
- Scotia Fundy Elver License Holders
- Wayne & Yvonne Carey
- Acadia University

Appendix 1. Standardized habitat assessment form used at each trap site.

American Eel Habitat Survey Form

Summer 2011 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		

Appendix 2. Habitat summary of most successful and least successful traps in Oakland Lake.

	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		

Appendix 3. Summary Table of American Eel Numbers for 2009-11.

	2009 July 29 – August 21	2010 May 21 – August 24	2011 June 6 – September 29
Days Fishing	15	34	47
Total Eels Caught	91	249	374 (301 tagged)
Unique Tags (Eels tagged but never recaptured)	67	139	152
Recaptures	24	110 (22 from 2009)	149 (5 from 2009) (33 from 2010)