The *Anguilla rostrata* (American Eel) Habitat Preference Study in Oakland Lake and Mahone Bay, Nova Scotia

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ABSTRACT

The Bluenose Coastal Action Foundation conducted an American eel habitat assessment study on Oakland Lake and 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 resulting study began on July 13th, 2009, and was completed on October 28th, 2009. The study began in Oakland Lake with 29 eel pots set. Eels caught were processed by being anesthetised in clove oil, then measured in length and weight. The eels were marked using a PIT tag which was injected under the skin. If caught again, the tag number can then be related back to the data on the individual. A total of 145 eel were caught in the lake, with 38 of them being recaptures. This procedure was duplicated in the Mahone Bay estuary but only yielded a capture of 5 eels in total. The trap developed for the stream caught a total of 219 eels, with only 2 being recaptures from the lake study.

INTRODUCTION

Anguilla rostrata, more commonly known as the American Eel, has not been a highly studied species. However, there is some general information that is well known. For example, the American Eel is considered a catadromous fish. This means that unlike most fish, the American Eel spawn in the salt water and spend the majority of its life in the freshwater. The only breeding grounds in the world for *Anguilla rostrata* is the Sargasso Sea, which is 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 the eels spawn in the Sargasso Sea the eggs begin to develop, 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 to find freshwater. Though many eels migrate to freshwater, there are eels that will remain in the salt water estuaries for the majority of their life. Glass eels develop into a pigmented stage as they move into brackish or freshwater. Usually by age two, small pigmented eels make the transition into the yellow eel stage. Yellow eels inhabit fresh, brackish, and saltwater habitats where they feed primarily on invertebrates and smaller fishes. Sexual maturity can occur any time between seven and twenty-four years of age. When yellow eel start to sexually mature, they begin a downstream migration toward the Sargasso Sea spawning grounds. During this migration yellow eel metamorphose into the adult silver eel phase.

The Bluenose Coastal Action Foundation (BCAF) has developed a study in partnership with Fisheries and Oceans Canada (DFO) 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. Though 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 drinking water supply. The lake is protected on account of it being the water source for the town, making it an excellent candidate for this study. The lake only has a couple of residential properties on / near its shoreline and recreational activity on the lake is little to none. The coordinates of the lake itself are 391480.3335, 4924067.847 and has an estimated surface area of 0.65 km² (CBCL Ltd, Consulting Engineers, 2005). Although the lake is not large in size, it has deep sections that reach almost 45 feet in depth. The only potential disturbances surrounding the lake would be from the trail that runs along one section of the lake and the area where the town has access to the water intake, pump house, and storage buildings.

MATERIALS & METHODOLOGY

Oakland Lake: Traps were set in Oakland Lake from July 13th to August 21st, 2009. A total of 29 traps were used for this experiment and placed around Oakland Lake based on differing habitat environments. The bait used for this project was frozen Herring supplied by a business in Blandford, NS. The trap placements were chosen roughly on the slope, amount of vegetation, lake-bottom composition, shore composition, and depth. The goal

was to ensure the traps were in a wide variety of habitats around the lake. The depth of the traps, as well as other areas in Oakland Lake, was calculated using a fish finder as well as depth maps. On the habitat assessment form (Appendix 1), the slope of the shoreline and underwater 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. A gas motor could not be used due to the fact that Oakland Lake is a protected watershed area.

The traps were checked one at a time and separated by trap number in holding bags tied to the side of the boat. The eels would be sampled once there was a significant number or when there was a close sampling site not too far from the habitat in which they were caught. When it was time to sample the eels, they were taken to shore to perform the biological sampling.

Eels produce a layer of slime for protection; therefore, it is very important to carry several pairs of clean cotton gloves. It is also important to use rubber gloves that go further up the arm. The rubber gloves prevent clove oil from getting on your skin, causing a burning sensation that numbs the skin, when reaching into the bucket to sample an eel. 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 the bait if required. It is also very important to have both marine batteries charged before heading out on the lake, as well as a complete set of paddles in case battery power fails. Data is recorded with a waterproof clipboard, notebook, and/or weatherproof paper on hand.

The biological sampling conducted on each eel caught consisted of measuring, weighing, and tagging the eel. In order to carry out these procedures the eels were transferred from the holding bags into a bucket with small holes in it (Figure 1).

Figure 1. Sampling setup with smaller bucket with holes in it to allow the clove oil and water to drain out.

Another larger bucket without holes was half-filled with water. Approximately 1-2 small capfuls of clove oil were added to the larger bucket. The smaller bucket containing the holes was then placed inside of the larger bucket so the eel would be submerged in clove oil. Using personal judgement, the eel was left in the clove oil solution for a few seconds, depending on its size, and then removed until the eels slowed down and "fell asleep." If this did not happen, the eel was placed back in the clove oil solution a second time for an even

shorter amount of time. Once the eel was limp it was laid out on a measuring board and the length was recorded. Each eel's weight was then measured using a portable digital scale.

Figure 2. American eel being measured for length in centimetres.

A PIT (Passive Integrated Transponder) tag was then injected. To determine if the eel had already been tagged, they were scanned to ensure they were "tagless". To insert the tag, one technician inserted the needle containing the tag while another technician held the eel using cotton gloves. The cotton gloves make it hard for the eel to escape if it is not entirely docile. Once the eel is successfully tagged, it is scanned so the data is recorded on the scanner and the 15 digit number can be recorded. The eel is then placed in the water and moved back and forth to pass oxygenated water over its gills. Eventually the eel will recover from the clove oil, right itself, and swim off.

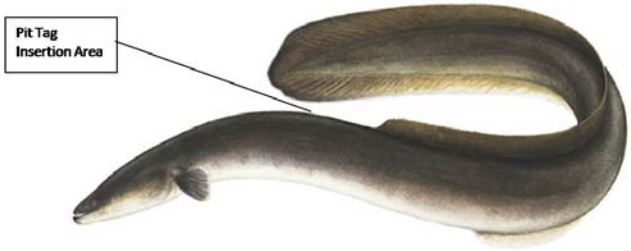


Figure 3. The proper place to insert the PIT Tag.

Figure 4. Eel being injected with a PIT tag.

Mahone Bay Estuary: After the completion of the lake study, the traps were then set in the Mahone Bay estuary and were in place from August 26th to October 8th, 2009. Frozen Herring was used again as the bait for the estuarine traps. For this phase of the study, BCAF stored the boat at Rick Welsford's property and used a four-horse, four stroke motor to manoeuver around the estuary. The area the traps covered ranged from the Welford's property, located on the Hyson Point Road in Oakland, all the way into Mahone Bay to the three churches, and down the other side until they were across from Rick's again. This area has high boat traffic and recreational activity, therefore making it extremely important to try and avoid the traps being disturbed. In order to avoid human tampering, the traps were set away from boats, the marina, and directly in front of residential properties. Like in the lake, the traps were checked every other day and followed the same sampling procedures as previously described.

Oakland Stream Trap: On September 1st until October 28th, 2009, a newly designed trap was placed in the stream that runs from Oakland Lake into the Mahone Bay estuary. The area that was chosen to place the trap was easily accessible, with only a couple minute walk through the woods. It was far enough off the road to not attract attention from passerby's, and property owners near the trap were approached individually o discuss the project and the purpose of the trap. The trap was designed by Wayne Carey and consisted of a large plastic funnel that sat in the stream and was able to take up the width of the stream. Attached to the funnel was a plastic tube, approximately 1 foot in diameter, which led into a square cage that was half submerged in the stream.

Figure 5. Oakland Stream trap.

Anything moving down stream would be flushed into the tube and trapped in the cage. This trap was checked on a daily basis and any eels caught in the trap were scooped out of the cage using a trout net. The same sampling procedures were applied to these eels as from the Oakland Lake and the Mahone Bay estuary phases of the study. This cage had a smaller mesh size than the eel pots used earlier in the study. Therefore, significantly smaller eels were caught during this phase of the study as opposed to the size of eels caught using the pots; these eels would have easily been able to swim in and out of the eel pots. On account of the smaller size of the eels, it was determined to only tag the eels that were larger than 35 cm in length. Small eels that were not tagged were still sampled for their length and weight.

RESULTS

Oakland Lake: A total of 145 eels were caught in Oakland Lake. Of that total, 38 were recaptures meaning 107 eels were tagged in that area (Appendix 2). Traps remained in the same locations for the duration of the lake study (Figure 6). When looking at which traps were most successful, Trap 6 caught the most eels with a total of 13, followed by Trap 17 with 12 eels. Although these traps were set on opposite sides of the lake, they had similar attributes. Trap 6 had a lake bottom composition of 20 percent cobble and 80 percent sand at a depth of 4 feet. This trap was in a small cove with the vegetation being mainly bulrushes. Trap 17 was set in front of a beach area, 2 feet in depth, and a bottom composition of 100 percent sand. Vegetation was bulrushes and

water smartweed. See Appendices 5 and 6 for habitat comparisons of the traps that caught the most and the least.

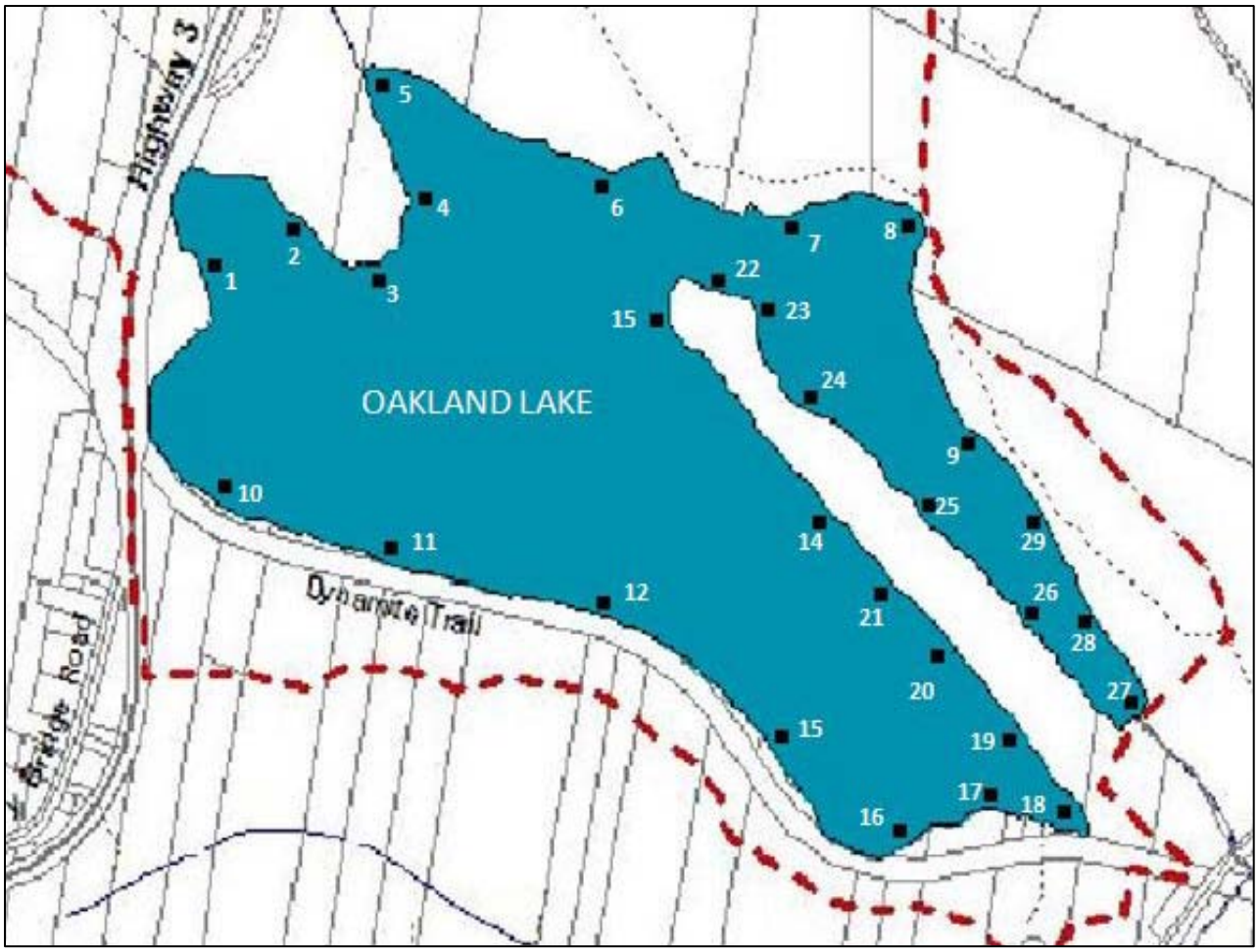


Figure 6: Oakland Lake and location of eel pots with corresponding trap numbers.

Mahone Bay Estuary: A total of 5 eels were caught during the entire estuary study (Appendix 4). These eels were caught within the first few weeks of the study. The abundance of Green crab in Mahone Bay harbour became apparent after checking the traps for the first time. Green crab, small enough to get into the traps, will feed off the Herring. The average number of crabs in the pots after 2-3 days was between 15 and 30. Eels that were successfully caught were located in the traps that were deep into Mahone Bay harbour and close to a freshwater outflow. The substrate of the area was dark sand and mud with little to no seaweed.

Oakland Stream Trap: The total number of eels that were caught in this trap was 221 (Appendix 3). Out of this total, there were 49 tagged. Two large eels caught in the trap had been previously tagged in the lake study (Appendix 2). The first recaptured eel was caught on September 26th. This eel was first caught in the lake on August 4th in Trap 8. It was caught again in the lake on August 17th in Trap 7, before it came down the stream into the trap on September 26th. The second eel was caught and tagged in Oakland Lake between July 15th and July 24th (malfunctions with the tag scanner prevented the retrieval of the exact trap and date of capture). The stream trap also caught several Brook trout and White perch.

DISCUSSION

On two occasions during the Oakland Lake study, BCAF staff pulled eel pots that had a dead eel inside the trap with its tail missing. It appeared from looking at the body that something had gotten into the trap and eaten away at the eel's tail before exiting the trap. Towards the end of the study, as BCAF staff approached a trap that was clearly visible under the water, a snapping turtle was observed sitting on top of the trap biting at the eel whenever its tail would go by. The eel had the same markings and missing flesh as the other eels. The snapping turtles were using the eel traps to their advantage as contained prey.

Two weeks into the project, Trap 11 was not found when checking the traps. The area was searched thoroughly and it was determined that the trap was removed by the public. The stretch of lake shore where the trap had been set also had the public trail running parallel to its bank, making the buoys visible to curious passersby.

In the Mahone Bay estuary study, the Green crab dominated the traps and most likely acted as a deterrent for any eels attempting to enter the traps. Unless the eels were in the vicinity of the trap when it was first re-baited and released back into the water, the crabs would be entering the traps within a short period of time thereafter. Although BCAF staff only caught 5 eels in total, those eels were in the traps with dozens of Green and Rock crab but did not show any visible markings or signs of stress.

The Oakland Stream trap catches were influenced by the weather. Larger numbers of eels were caught after a rainfall, especially when occurring through the night. The most eels caught in one sampling day were 43, and this was after a heavy rainfall during the night. Over the 2009 Thanksgiving weekend, the area received a significant amount of rainfall in a short period of time. The effect of this rain on the small stream was enormous, with the trap becoming non-functional due to the water flowing over the funnel and the cage detaching from the tube. It took 4 days for the water to return the stream to lower levels and the trap was reset and running. Although the trap was operational for another 2.5 weeks, there were no more eels caught in the trap.

Although there was success in the lake and stream phases of the study during the first year of the project, the study was late starting and there was the potential to have missed valuable catch data during the months of May and June. With another year of data to compare to the 2009 catches, a better conclusion can be made regarding habitat preferences and abundance of American Eel in Oakland Lake, the Mahone Bay estuary, and Oakland Stream.

PROJECT PARTNERS

BCAF would like to acknowledge and thank our many project partners and supporters. Without the generous contributions of these groups and individuals, BCAF would not be able to deliver all the various components of the American Eel Habitat Preference Study.

A special thanks to Rod Bradford (DFO-Science), Greg Stevens (DFO-Fisheries Management), and Wayne, Yvonne, and Genna Carey (Commercial Atlantic Elver License Holders) who helped guide the project through their combined knowledge, expertise, and advice; as well as brainstorm new ideas for future project components and funding opportunities. Also, BCAF would like to thank the Town of Mahone Bay and their Public Works staff for allowing us access to their property and facilities on Oakland Lake to carry out the project.

Thank you to all our 2009-10 funding partners, making it possible to complete all the activities outlined in this report. Funders include:

- Habitat Stewardship Program for Species at Risk
- Province of Nova Scotia
- Atlantic Elver Fishery

BCAF would also like to thank all the many volunteers and in-kind partners for their generous support throughout the duration of the project. Your hard work and generosity does not go unnoticed or underappreciated. The list is too long to include in this report; however, you know who you are and BCAF thanks you.

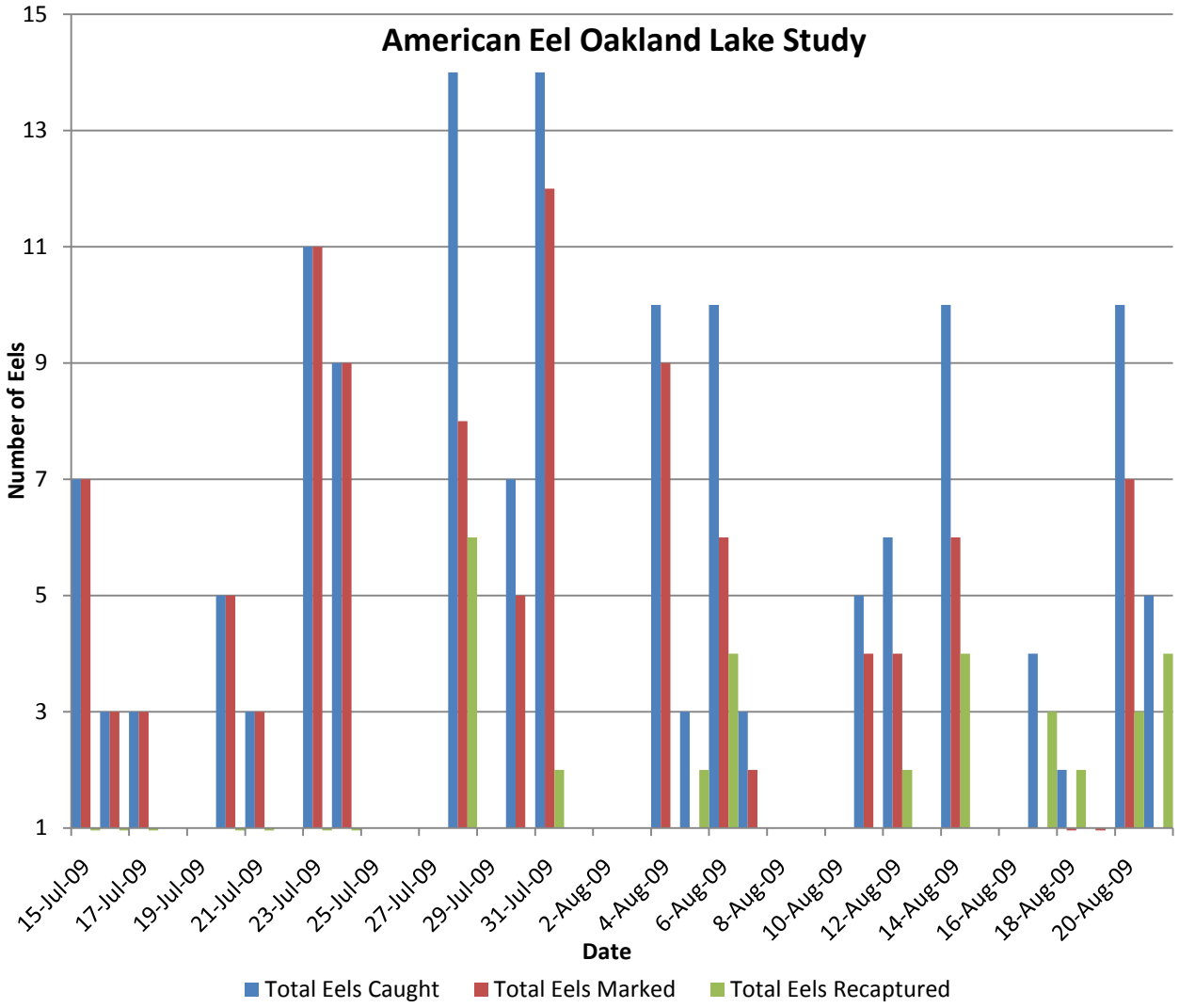
Appendix 1. The standardized habitat assessment form used at each trap site.

American Eel Habitat Survey Form

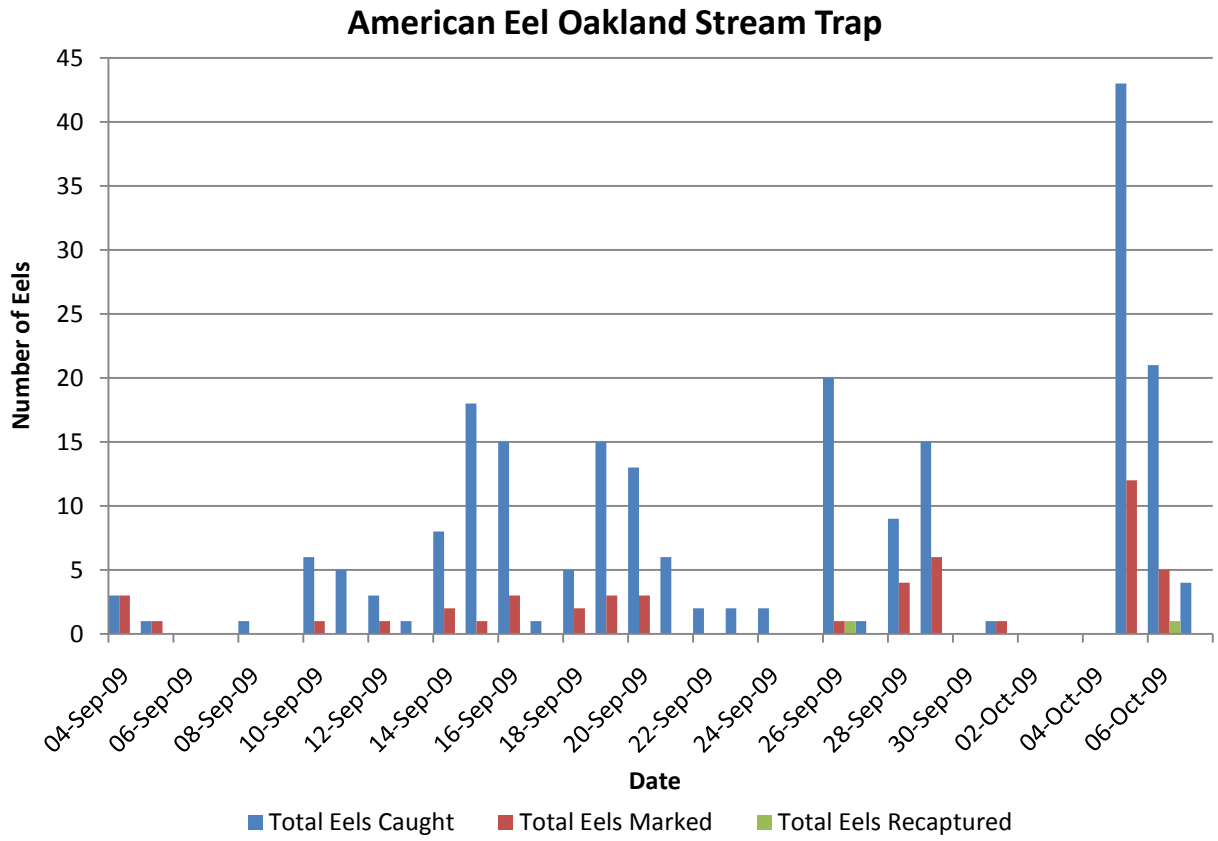
Summer 2009 Date: _____

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		

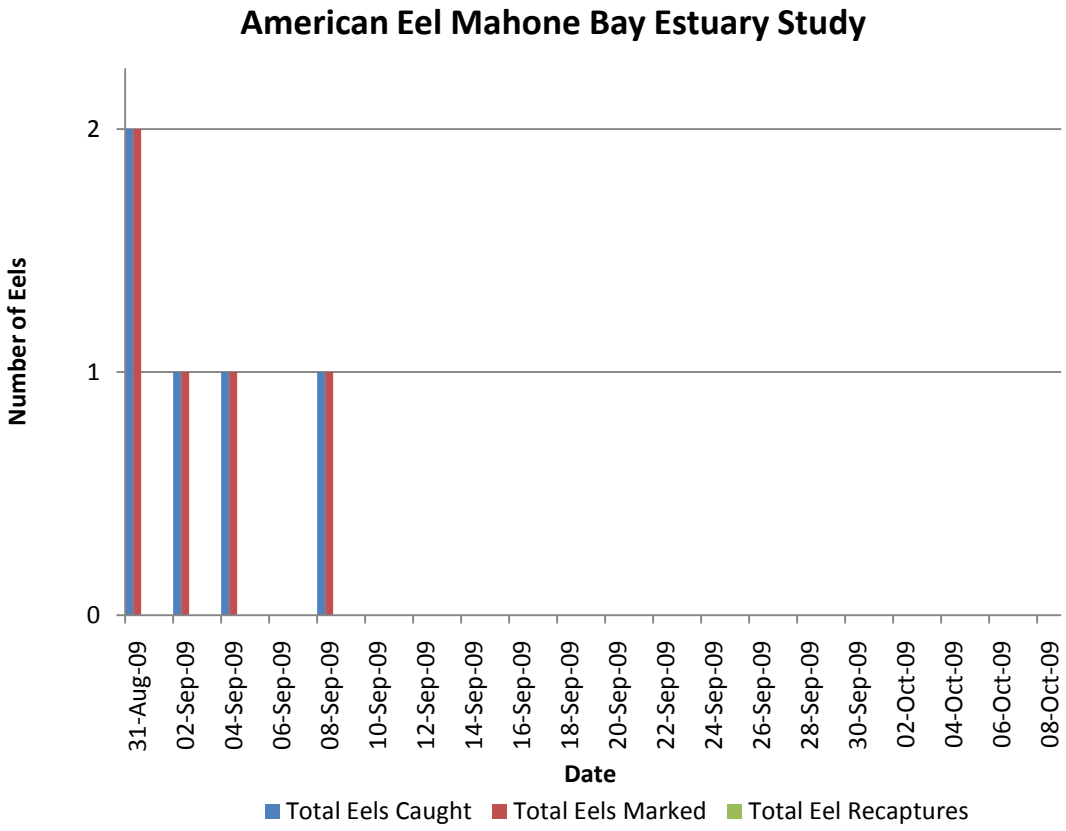
Appendix 2. Number of eels caught by date in Oakland Lake. Reflects total daily catch, number of eels tagged, and number of recaptures.



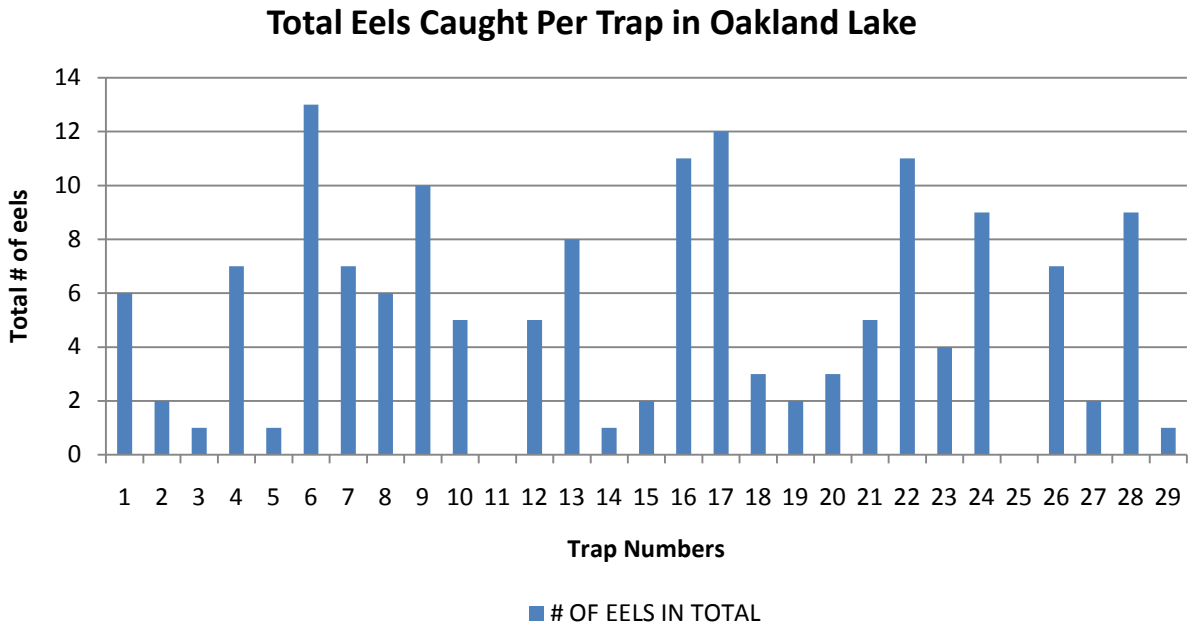
Appendix 3: Comparison of eels captured daily in the stream that runs from Oakland Lake to the Mahone Bay estuary. The data only reflects the time period when there were still eels being caught and shows total daily catch, total number tagged, and number of recaptures.



Appendix 4: The number of eels caught in the Mahone Bay estuary from the first time the traps were checked until the last day of the study.



Appendix 5: The number of eels caught in each trap set in Oakland Lake for the duration of the study.



Appendix 6: Habitat summary of most successful and least successful traps in Oakland Lake.

	Most Successful Traps			Least Successful Traps		
Trap #	**6**	**17**	**16**	**25**	**3**	**5**
UTM	4427852 06421749	4427416 06421421	4427450 06421563	4427615 06421394	4427792 06421982	4427915 06472009
Depth (feet)	4	2	7	3	3.5	4
Distance from shore	15	20	10	15	40	30
Lake Bottom % Boulder			20	20		
% Cobble	20		70	80		50
% Sand	80	100	10		100	50
Slope underwater	2	1	4	2	3	2
Slope of shoreline	3	1	2	2	1	2
Shoreline % Boulder	10	10	30	50	90	100
% Cobble	90		50	50	10	
% Sand		90	20			
Vegetation	Bulrushes	Bulrushes, Smartweed	Bulrushes	Lily pads	Lily pads, Bulrushes	Lily pads, Smartweed
Notes	In cove	Sandy beach area	Steep slope from shore			