American Eel (*Anguilla rostrata*)

Research Project in

Oakland Lake, Nova Scotia

June-September 2012

Sarah Crnec

Bluenose Coastal Action Foundation

Abstract

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 Eel. The study took place on Oakland Lake, Lunenburg County, Nova Scotia and began on June 14th running through to September 6th, 2012. Although the objective of the study from 2009 to 2011 was to determine the habitat characteristics that American Eel prefer based on a standardized habitat assessment form, the 2012 field season focused on a mark – recapture study. In addition to the Oakland Lake study, an in-stream trap was placed in the Oakland Stream to observe eels exiting the lake into the Mahone Bay estuary. The trap was installed on September 10th and removed on October 24th, 2012. The results of the study are specific to the Mahone Bay area; however, they will be viewed in a more general context and relate to the entire Scotia Fundy area of the Atlantic Region. In association with the BCAF study, eight eel were acoustic tagged in Oakland Lake to track their movements (Lydia Stevens, M.Sc. Thesis, Acadia University, 2013), and a by-catch study (Will Ross, Honours Thesis, Acadia University, 2013) was also conducted.

Introduction

Since April 2006, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) had assessed the American Eel as a species of special concern. After re-examination of the species in May 2012, COSEWIC has now designated the American Eel as threatened.

The American Eel has an elongated body with the most distinct feature being its long dorsal fin that runs along three quarters of its slender, snake like body. Its skin is extremely tough and is covered with a layer of mucus which it secretes for protection. The American Eel is considered to be a catadromous fish species, meaning it lives the majority of its life in fresh water and then travels to salt water where it will spawn and presumably, die. The spawning takes place in the Sargasso Sea, located in the Southwestern part of the North Atlantic Ocean. This fish is a carnivorous, opportunistic species and consumes many different types of fish and invertebrates. It occupies a wide variety of aquatic habitats that includes estuarine, brackish, and freshwater areas. The eel is known to be an indicator of a healthy aquatic ecosystem. Distribution of the American Eel ranges from Greenland along the east coast of North America to northern South America.

American Eel are all part of a single breeding population and have complex life cycles consisting of a number of distinct stages. When eggs hatch, they emerge as leptocephalus and absorb nutrients from the currents upon which they float. They then metamorphose from glass eel to elver and begin their migration from estuaries up rivers and streams in search of fresh water. They spend most of their lives in the yellow eel stage, which can last from seven to twenty-four years or longer. When they eventually mature into sliver eel, they will begin their migration back to their spawning grounds in the Sargasso Sea.

Study Area

Oakland Lake

Oakland Lake is located approximately 1km northeast of the Town of Mahone Bay, just off Highway #3 at UTM 20T E391480.3335 N4924067.847. It serves as the Town's drinking water supply and has been designated as a protected watershed. Human activity in the area has been regulated and restricted in an effort to protect the water quality of the lake. Due to this added protection, Oakland Lake is an excellent candidate for this study. Potential human disturbances in the area include a walking trail to one side of the lake as well as the Town of Mahone Bay's water treatment intake, pump-house, and storage buildings. The surface area of the lake itself is roughly 0.65 km^2 and has depths up to 15m. The surrounding watershed area is approximately 4.05 km^2 (Figure 1).

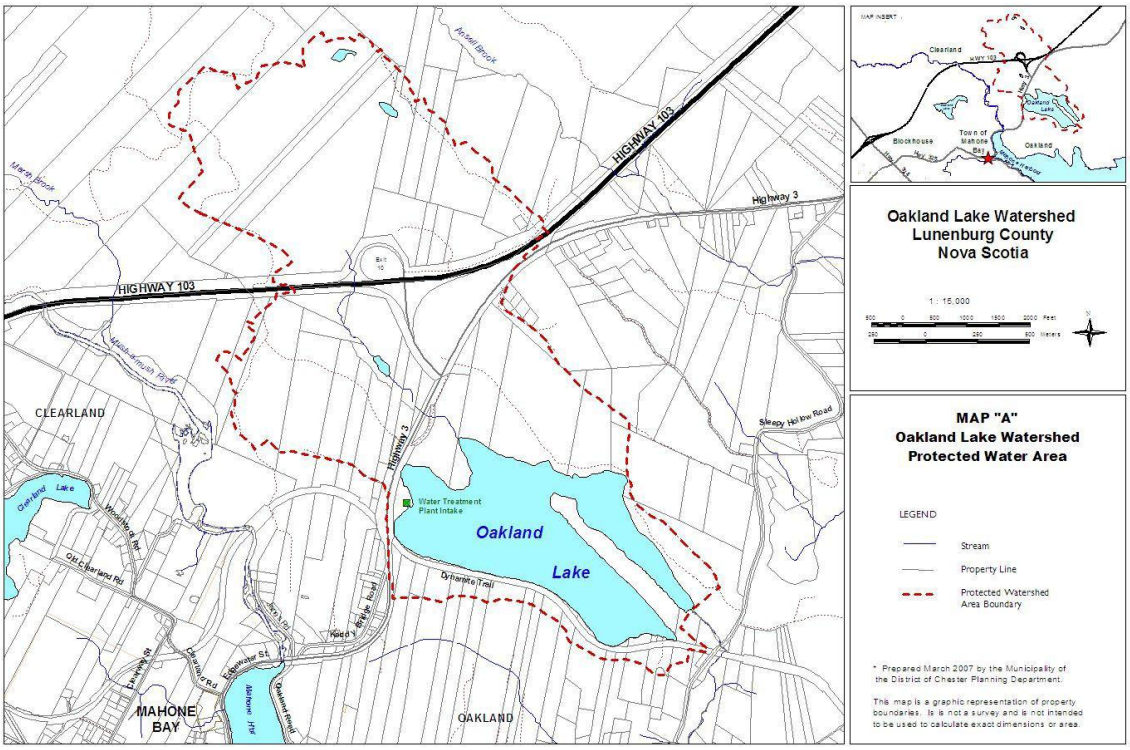

Figure 1. Map of Oakland Lake study area.

Oakland Stream

The only outgoing water flow from Oakland Lake is Oakland Stream which drains into the Mahone Bay estuary. This is the lake's only means of aquatic connectivity. The stream runs through two culverts, the furthest upstream runs under Sleepy Hallow Road and the furthest downstream runs under Oakland Road into the Mahone Bay estuary.

Materials and Methods

Oakland Lake

Traps were set in Oakland Lake from June until September, 2012. A total of 43 traps were used during the study period and placed around Oakland Lake. 35 of these were stationary eel traps with the other 8 being

minnow traps that were rotated around the lake throughout the study period. The minnow traps had a smaller mesh size than the eel traps used in previous study years and were incorporated into the 2012 project in an attempt to catch smaller eel.

Traps were baited with frozen herring that was supplied from the Lunenburg Fish Company, Lunenburg, Nova Scotia. Trap placement was determined based on previous study years' criteria which used a standardized habitat assessment form to take into account slope, distance from shore, amount and type of vegetation, lake-bottom composition, shore composition, and depth (Figures 2 and 3). A 12-foot aluminum boat was used to survey the lake. On account of Oakland Lake being the drinking water source for the Town of Mahone Bay and, therefore, a protected watershed, an electric motor with a marine battery was used in favour of a gas motor to ensure no pollutants entered the waterway.

Figure 2. Eel trap placement on Oakland Lake.

Traps were checked approximately every two days. Eel and by-catch data were recorded in water-proof field books and later transferred to an electronic spreadsheet. Captured eel were separated by trap number and contained in holding bags attached to the side of the boat. Eel were then taken to shore, scanned for PIT tags, anesthetized with clove oil, measured to the nearest 0.5 cm, and weighed to the nearest gram. While handling the eel, latex rubber gloves covered by cotton gloves were worn to protect hands as well as the eel's self induced slime layer, while at the same time allowed for easier handling and reduced stress on the eel.

Figure 3. Minnow trap placement on Oakland Lake.

To carry out the biological sampling procedure, eels were transferred from holding bags into a bucket with small holes in it. A PIT (Passive Integrated Transponder) tag scanner was used to determine if the eel had been previously tagged and if so, the tag number was recorded. The bucket and eel were weighed with a digital scale that had been previously tarred at the bucket weight. The weight was then recorded. A larger bucket without holes was filled half way with water and approximately 10mL of clove oil. The smaller bucket with holes was placed inside the larger bucket and submerged, with the eel, in the clove oil solution. The eels were submerged in clove oil for varying lengths of time at the field technician's discretion, depending on size and activity of the eel. After several seconds of exposure, the eels were removed when they appeared to calm down. Once the eel became docile it was laid on a measuring board where the length was recorded (Figure 4). Whenever possible, eels that were docile and easy to handle were not subjected to the clove oil solution. If the eel had not been previously tagged, a PIT tag was injected approximately 2cm in front of the dorsal fin to either side of the spine (Figure 5). Once successfully tagged, the eel was scanned and the ID number recorded. The eel was then returned to freshwater; if clove oiled, was moved side to side to pass oxygenated water over its gills until it had sufficiently recovered.

Figure 4. American eel on measuring board.

Figure 5. American eel being PIT tagged.

Oakland Stream

From September 10th until October 24th, 2012, a trap was placed in the stream that runs from Oakland Lake into the Mahone Bay estuary off Sleepy Hollow Rd. The trap used for the 2012 study was a modified version of the trap that was used in the 2009 and 2011 field sessions. Essentially, the entire trap and funnel was made larger to accommodate more water flow due to higher water levels as the season progressed (Figure 6). The trap was designed by Wayne Carey and consisted of a large plastic funnel that sat in the stream and was able to capture the entire width of the watercourse. Attached to the funnel was a plastic tube which led into a square cage that was half submerged in the stream (Figure 7). Anything moving down stream was flushed into the tube and trapped in the cage. This trap was checked on a daily basis and any eel caught in the trap were scooped out of the cage using a net. The same sampling procedures were applied to these eel as in the Oakland Lake phase of the study, with the addition of measuring the vertical and horizontal eye diameter of the eel using digital calipers (Figure 8). This was done to aid in the identification of silvers eel that were leaving the lake for the estuary, since at the silver life stage the eyes are known to develop by becoming extremely dilated and clouded over. In addition, a thermograph was place beside the trap to monitor and record water temperatures throughout the duration of the study.

Figure 6. In-stream trap funnel.

Figure 7. In-stream trap with cage attached.

Figure 8. Field technicians measuring an American eel's eye diameter using digital calipers.

Results

Oakland Lake

The 2012 Oakland Lake study season began with the first eel being caught on June 15th and ended on September 6th. The total number of eel caught during the 2012 study season were 156, compared to 374 in 2011, 176 in 2010, and 145 in 2009 (Table 1). For the 2012 season, there were 55 recaptures: 5 from 2010, 21 from 2011, 27 from 2012, and 2 that were unknown (Figure 9). It is thought that the two unknown recaptures were due to an error in copying the digits from the PIT scanner into the field book. The traps that had the greatest success catch rate were Trap #7 with 23 eels and Trap # 30 with 12 eels (Figure 10). The overall average length and weight for the eels caught in Oakland Lake was 178g and 43cm.

	2009 July 29 – August 21	2010 May 21 – August 24	2011 June 6 – September 29	2012 June 15-Sep 6
Days Fishing	15	34	47	46
Total Eel Caught	91	249	374 (301 tagged)	156
Unique Tags (Eel tagged but never recaptured)	67	139	152	78
Recaptures	24	110 (22 from 2009)	149 (5 from 2009) (33 from 2010)	55 (21 from 2012) (27 from 2011) (5 from 2010) (2 unknown)

Table 1. Summary Table of American eel numbers and recaptures for 2009-12.

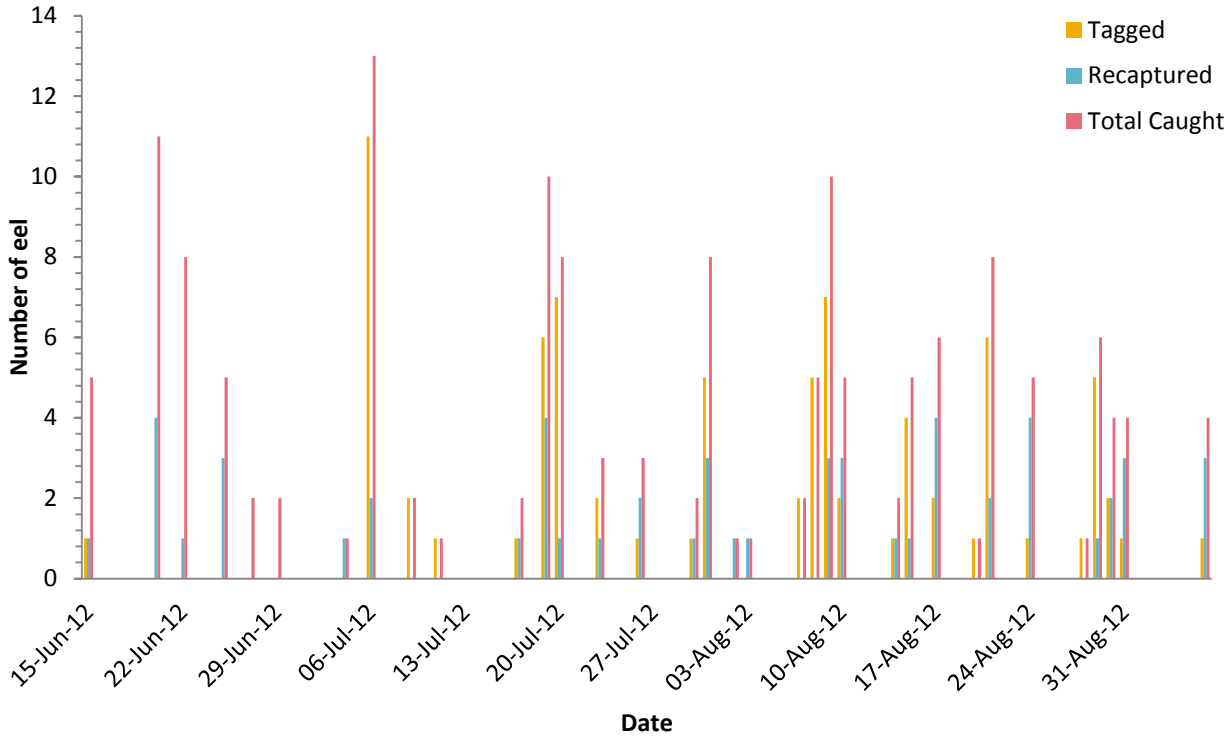

Figure 9. Total American eel catches in relation to tags and recaptures.

In an effort to catch smaller eels, minnow traps with a smaller mesh size were used. These traps were rotated around the lake throughout the study season. The traps that caught the most eels were Trap Min 3 with 3 eels and Trap Min 1D with 3 eels. The average length and weight for the eels caught in the minnow traps was 38.9cm and 108g (Figure 10).

Oakland Stream

The trap was first checked on September 11th, 2012; one day after the trap was installed in the stream. On this day the catch totaled 168 eel, the highest daily catch for the study season. The last eel was caught on October 18th and the trap was removed on October 24th. The total number of eels caught during the 2012 in-stream trap study amounted to 405 eels (Figure 11) with 13 recaptures; 2 from 2009, 6 from 2010, 1 from 2011, and 4 from 2012 (Table 2). This is the highest catch since the study began in 2009. One of the recaptured eels had been acoustic tagged as well as PIT tagged.

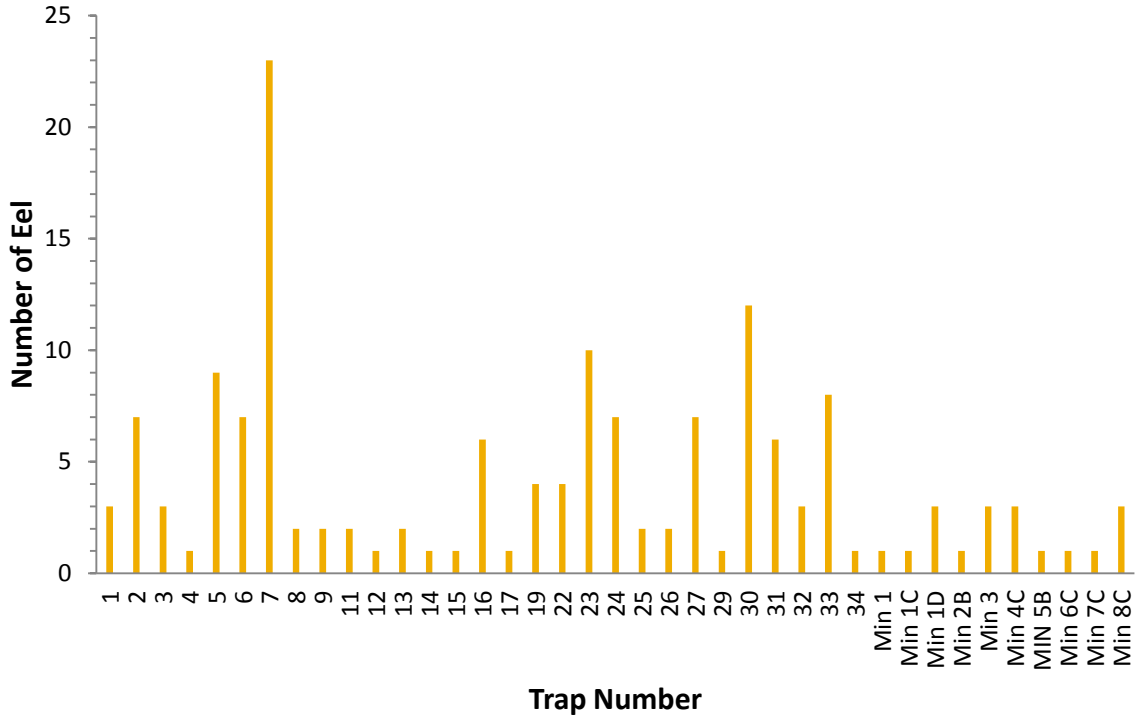

Figure 10. Total number of eel caught per trap over the duration of the study.

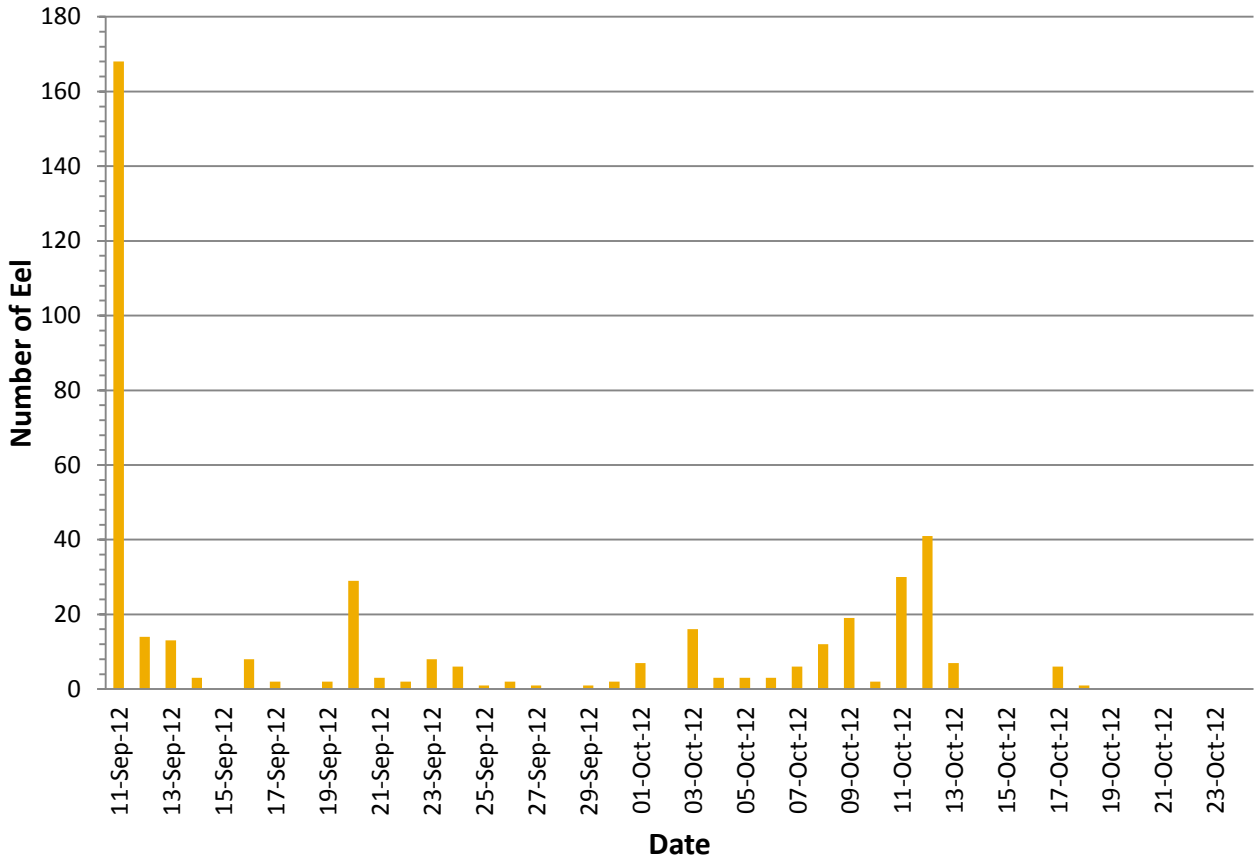

Figure 11. Number of eel caught via in-stream trap throughout study period.

STUDY YEAR	NUMBER OF EELS	RECAPTURES	NUMBER OF DAYS TRAP WAS IN-STREAM
2012	405	13	45
2011	283	1	26
2009	221	2	29

Table 2. Summary of American eel numbers for 2009-2012.

Discussion

Oakland Lake

At the beginning of the study traps were checked two days after baiting. As the season progressed, it was noticed that fewer eels were being caught and there was no bait left in the traps. It was thought that eels were entering the traps, eating the bait, and then exiting the traps. Traps were then checked the next day after baiting, beginning on July 9th, until the end of the study season.

Due to the disappearance of traps on the trail side of the lake in the 2011 study, traps that were placed on this side in 2012 had no buoys, so they would not be as visible to the public. Instead they were equipped with a long floatable rope. This made it more difficult for field technicians to locate the traps and required the use of a GPS unit. Despite the efforts made to conceal the traps, some still went missing. It is thought that most of these traps rolled down the steep embankment into waters that were too deep to allow for retrieval. Trap 32 was lost on June 27th and replaced July 10th. Trap 34 was lost on June 19th, replaced on July 10th, was lost again July 25th, and then not replaced. Field technicians were unable to check Trap 16 as it became stuck on the bottom from July 13th through July 23rd. Trap 33 was lost on June 27th; however, once water levels dropped, it was made visible again and retrieved on July 23rd. Trap 8 was lost on July 3rd due to the rope breaking free from the trap.

Similar to previous study years, there were a few occasions when eel were found in traps with chewed tails. It is presumed that they were predated on by snapping turtles which are known to inhabit the lake. In fact, one of these turtles was observed walking towards an eel trap that contained an eel.

Oakland Stream

On September 11th, 2012, the in-steam trap caught 168 eel, the highest daily catch for the study season. The reason for this high catch on the first day is thought to have been on account of heavy rainfall events occurring over the two days prior to trap installation. The rainfall brought the water level up in the lake so that it was finally high enough for the eel to move from the lake into the stream.

On a few occasions, both live and deceased muskrats were removed from the trap and, on one occasion, a snapping turtle was removed. Another larger snapping turtle was observed crawling along the bank and entering the water in the eel “release” location. As the study progressed, a beaver began frequenting the trap location and filling the trap in with debris and foliage that had to be removed on a daily basis.

On October 12th, the average daily water temperature was 14.1 C° (Figure 12). On this day the larger, more developed silver eel that were removed from the trap appeared to be extremely lethargic. When these eel

were released, many of them remained on the stream bottom without moving. When the trap was checked the next day, some of these eel were still laying on the stream bottom, some belly up and dead, while others appeared to be close to death. Two of the dead eel were taken as samples and given to Fisheries and Oceans Canada (DFO) to further investigate.

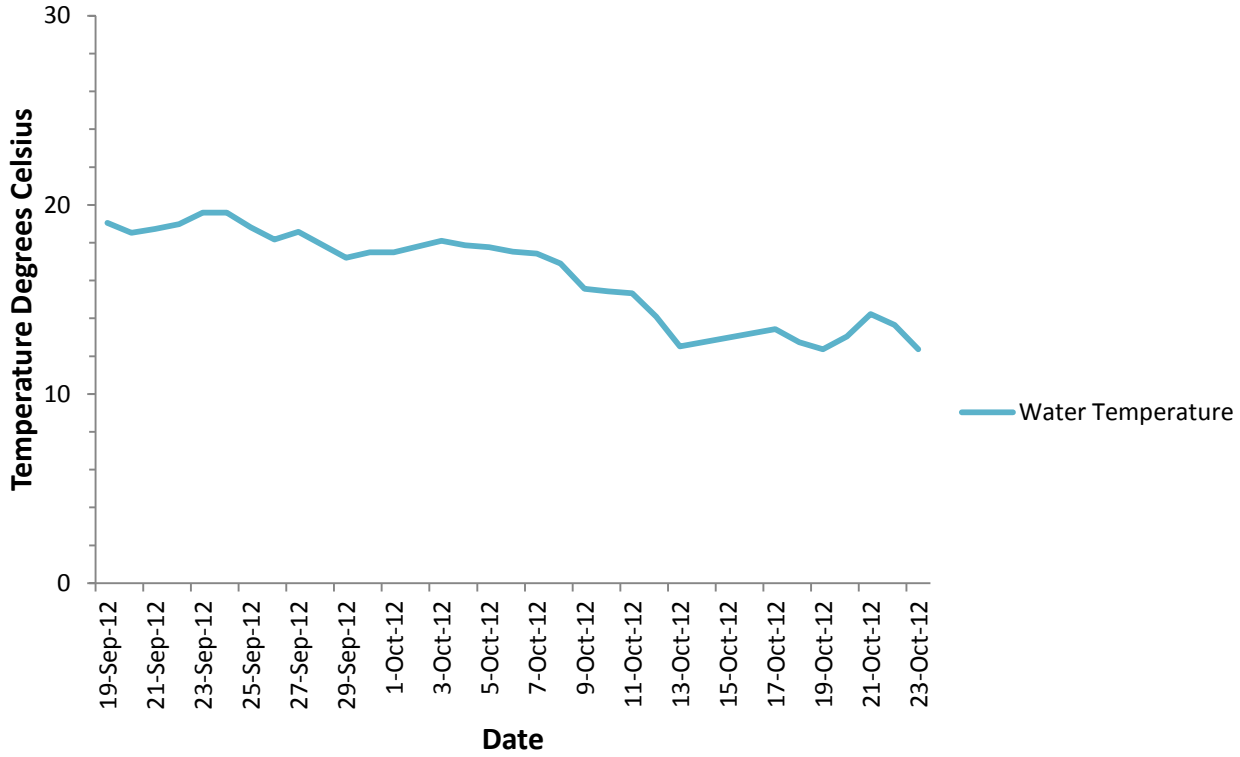

Figure 12. Average daily water temperature at in-stream trap site from Sept 19 until Oct 23.

Acknowledgements

BCAF would like to thank all those who helped with the project: field technician Will Ross; the assistance of Wayne, Yvonne, and Genna Carey of Atlantic Elver Fishery; Rod Bradford (DFO); and Trevor Avery (Acadia University) for guidance throughout the study. BCAF would also like to thank the Town of Mahone Bay who have annually granted BCAF permission to access and use their property at Oakland Lake for project delivery as well as equipment storage. Last but certainly not least, all the volunteers who contributed to the study.

Thank you to all our 2012 American Eel Project funding partners, making it possible to complete all the activities outlined in this report. Funders for this year include: Acadia University and the Atlantic Canadian Elver License Holders.