

# **Removal of American Eel from Port Dalhousie - 2018 and 2019 summary report**

Erin N. Budgell, Scott Blair, Warren J.S. Currie, Lisa M. O'Connor, Thomas C. Pratt, and Jonathan D. Midwood

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## ABSTRACT

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Fisheries and Oceans Canada conducted a project in 2018 and 2019 dedicated to the removal of American Eel (*Anguilla rostrata*) from Port Dalhousie to mitigate potential impacts of in-water construction on American eel while an essential harbour revitalization was being completed in Port Dalhousie Harbour. American Eel is an endangered species under the Province of Ontario's *Endangered Species Act* and are known to be present in the area. A combination of passive eel traps and boat electrofishing were used to capture eels. A total of seven eels were captured and relocated over the duration of the study. Of the seven individuals captured, three were released at Jones Beach and four were released in Hamilton Harbour. Multiple acoustic telemetry receivers were used to determine if acoustically tagged American Eel were present in the Harbour. Five of the seven relocated individuals were large enough to be acoustically tagged, and four of the tagged individuals returned to the harbour and remained for varying durations after being moved.

## RÉSUMÉ

Budgell, E.N., Blair, S., Currie, W., O'Connor L., Pratt, T., Midwood, J.D. 2021. Removal of American Eel from Port Dalhousie – 2018 and 2019 summary report. Can. Tech. Rep. Fish. Aquat. Sci. 3412: vi + 21 p.

Pêches et Océans Canada a mené en 2018 et 2019 un projet qui visait le retrait de l'anguille d'Amérique de Port Dalhousie afin d'atténuer les répercussions potentielles des travaux de construction dans l'eau sur l'anguille d'Amérique (*Anguilla rostrata*) pendant la revitalisation essentielle du havre à Port Dalhousie. L'anguille d'Amérique est une espèce en péril en vertu de la *Loi sur les espèces en péril* de l'Ontario et est présente dans le secteur. On a eu recours à une combinaison de pièges à anguilles passifs et à la pêche à l'électricité en bateau pour capturer les anguilles. Au total, sept anguilles ont été capturées et relocalisées sur la durée de l'étude. Des sept individus capturés, trois ont été relâchés à Jones Beach et quatre au havre Hamilton. Plusieurs récepteurs de télémétrie acoustique ont été utilisés pour déterminer si des anguilles d'Amérique marquées d'étiquettes acoustiques étaient présentes dans le havre. Seulement cinq individus étaient suffisamment grands pour être marqués avec des étiquettes acoustiques et quatre d'entre eux sont retournés au port et y sont demeurés à des durées variables malgré leur relocalisation.



## INTRODUCTION

American Eel (*Anguilla rostrata*) are a catadromous fish species with a unique reproductive strategy that involves spawning in the Sargasso Sea. Their flat, leaf-like larvae (known as leptocephali) migrate passively on ocean currents towards the east coast of North and South America and remain in this life stage for up to 12 months (Schmidt, 1923; Miller and Tsukamoto 2016). Once the leptocephali reach inshore waters of the continental shelf, they undergo metamorphosis into their anguilliform shape and their next life stage known as “glass eels.” The eels gain pigment as they proceed into rivers and estuaries to reach rearing grounds and continue their growth and production phase as “yellow eels” (Scott and Crossman, 1998). American Eel reach sexual maturity and undergo another metamorphosis, increasing eye and fin size and having their stomach atrophy, into their final adult stage (silver eels). Sexually mature eels then migrate back into the ocean, returning to the Sargasso Sea to spawn, die, and the resulting leptocephali begin the cycle again.

American Eel are a culturally, ecologically, and economically important species [Committee on the Status of Endangered Wildlife in Canada (COSEWIC), 2012]. Given their wide distribution, they play an important ecological role as both predators and prey. American Eel are carnivorous making them an important predatory species of both fish and invertebrates. Despite population declines, American Eels are still valued among commercial and Indigenous fisheries. In 2016, the average cost of elver was approximately \$3,000 per kilogram (wet weight) and the landing value was just over \$15 million (Fisheries and Oceans Canada, 2018). Commercial harvests at various life stages from New Brunswick and Nova Scotia continue, silver eels are harvested from the St. Lawrence River, and eel fisheries are important for Indigenous communities throughout their range (COSEWIC, 2012).

Due to their obligate migrant status, American Eel have been negatively affected by the development of hydroelectric dams along their migration route (Casselman 2003). Within the St Lawrence watershed, American Eel have experienced a 99% decline in their population. This decline has resulted in American Eel being listed as “Endangered” under the Province of Ontario’s *Endangered Species Act* (MacGregor et al. 2013), and is a serious concern for management agencies and hydroelectric industry representatives. Efforts to improve the population of American Eel by reducing mortality and stocking in the upper St. Lawrence River and Lake Ontario have been ongoing for over 15 years, and represent a strong ongoing collaboration among Indigenous, Federal, Provincial, and industry partners.

Given the concern around low abundance of American Eel in the St. Lawrence watershed, in 2018 Fisheries and Oceans Canada began an American Eel project at Port Dalhousie, situated on the south-western shore of Lake Ontario (Figure 1) with the initial objective of determining their presences at the site. Once their presence was confirmed, a removal project was put in place to help avoid and / or mitigate the potential negative effects of an essential harbour revitalization project. This report documents results from this project where the main objective was to capture and

relocate American Eel from Port Dalhousie prior to and during the harbour revitalization works. As a secondary objective, we explore the feasibility of “fishing-out” and transporting American Eel for this type of construction project and evaluate the potential for eel pots or traps to be used to capture American Eel (as an alternative to boat electrofishing). Finally, we discuss the results of acoustic telemetry tracking of captured and tagged American Eel.

## **METHODS**

### **STUDY SITE**

Port Dalhousie harbour is located on the south-western shore of Lake Ontario in St. Catharines, Ontario (Figure 1). Sampling for American Eel occurred throughout Port Dalhousie harbour, with emphasis on its piers which extend approximately 650 meters into Lake Ontario. Areas sampled ranged in depth from 1.0 to > 8.0 meters. Construction within Port Dalhousie started in early 2019 and involves the complete refurbishment of the piers with new sheet piling, base-aggregates, and surfaces.

### **CAPTURING AMERICAN EEL - BOAT ELECTROFISHING**

Initial boat electrofishing surveys to determine the presence or absence of American Eel in the anticipated work area were conducted between June 4 and June 7, 2018. Four days of fishing surveys were conducted during the day as well as at night, avoiding the crepuscular periods (approximately 30 minutes before and after sunset). Sampling was conducted using a Smith-Root electrofishing vessel with a 5.0 Generator Powered Pulsator (GPP). Power was applied consistently at approximately 4 amps, on the 180 volts range. Adjustment of output settings were required to maintain 4 amps as waters within the piers of Port Dalhousie had higher conductivity than the waters of Lake Ontario. Vessel speed was variable, as current conditions varied greatly, but were generally between 0.5 and 1.5 km/h – a speed at which netters could effectively capture fish. Whenever possible, the boat was directed downstream so that the current would not position stunned fish under the vessel, preventing the netting crew from successfully netting the individuals. Fishing was conducted along the inner piers upriver to the dam along both the east and west walls and within the Port Dalhousie Yacht Club (Figure 2). Electrofishing surveys were also conducted along the outside piers on both the east and west sides and along the east side of the east pier and into the Port Dalhousie Pier Marina. Staff from the Fish and Fish Habitat Protection Program specifically asked that a breakwall for the marina located outside the work area also be assessed, as this was historically a high density American Eel location (area indicated in orange on Figure 2). Fishing was conducted in water depths ranging from 0.3 to > 2.0 m. Waters inside the piers were deep (> 2.0 m) and turbid, with higher velocities, making electrofishing ineffective. Each location inside the proposed work area (indicated in yellow on Figure 2) was electrofished four times to maximize the probability of American Eel detection. An additional electrofishing survey was conducted on November 23<sup>rd</sup>, 2018 after sunset. Only one electrofishing survey was conducted in 2019 (June 6<sup>th</sup>) after sunset. During this survey, electrofishing was completed along the inner piers, east outer pier, along the docks upstream of the St. Catharines Fish and Game Association and Port

Dalhousie Pier Marina (Figure 2). Additional surveys in 2019 were not possible due to high-water levels that covered the piers and made night electrofishing unsafe.

### **CAPTURING AMERICAN EEL - TRAPS**

Given some of the challenges of using electrofishing in the deeper (> 2.0 m) and higher velocity waters found within Port Dalhousie, an alternative sampling approach was piloted in September 2018. Several studies have documented the utility of pots or traps for capturing American Eel (Morrison and Secor 2004; Hightower and Nesnow 2006). From September 17<sup>th</sup> to September 28<sup>th</sup>, 2018, 20 eel pots (Brooks Trap Mill; rectangular in shape, 91 x 30 x 30 cm, with 1 cm mesh and open on one end with a 50 cm long entrance funnel) were deployed throughout Port Dalhousie. From September 17<sup>th</sup> to September 24<sup>th</sup> the eel traps were located both on the inside ( $n = 16$ ) and outside ( $n = 4$ ) of the piers (Figure 3). On September 24<sup>th</sup> all eel traps were moved to the west side of the harbour to focus sampling efforts on the immediate construction area. The traps remained there until they were collected on September 28<sup>th</sup> (Figure 3). Individual traps were attached to a runner line of stainless steel aircraft cable that was secured to the pier (or surface float) and connected to a 13.6 kg steel plate. This setup allowed the traps to be retrieved and checked daily while maintaining a consistent location within the system. During the 10 day sampling period, several different types of bait were added to the traps starting with chicken livers, then fatty ground pork, and finally cat food.

The same traps were deployed from June 6<sup>th</sup> to October 10<sup>th</sup>, 2019, but an adaptive sampling strategy was used to try and increase capture rates of American Eel. The traps were deployed in pairs, set in 10 different sampling locations (20 traps total) and checked twice weekly (Figure 3). Traps were once again deployed using a runner line of galvanized aircraft cable that was secured to the pier or to a surface float and connected to a 13.6 kg steel plate and baited with cat food or sardines. Based on the lack of American Eel catch in the traps and the considerable field effort necessary to service the deployed traps, 15 of the traps were removed on July 3<sup>rd</sup>. Five individual traps remained at five of the sites until July 10<sup>th</sup>, when they were last checked and removed. After July, trapping only occurred for one week per month before concluding in October. Specifically, five individual traps were baited and set out (in the same five locations as July) from August 7<sup>th</sup> to 14<sup>th</sup>, September 11<sup>th</sup> to 18<sup>th</sup> and October 7<sup>th</sup> to 11<sup>th</sup>. Additionally, in 2019, PVC traps were constructed and distributed within the Port Dalhousie Pier Marina ( $n = 7$ ). These traps were constructed out of 1.5 m sections of PVC pipe (diameter = ~15 cm), with an eel funnel on one end and a cap on the other. All were secured to shore and baited with sardines or cat food. These traps were deployed June 21<sup>st</sup>, checked weekly and removed July 10<sup>th</sup> (Figure 3; see Appendix 1 for a complete list of sampling dates for all gear).

### **PROCESSING OF CAPTURED AMERICAN EEL**

Captured American Eel were measured for total length (mm) and wet mass (g), tagged with a 11 to 12 mm passive integrated transponder (PIT) tag, and if sufficiently large, an acoustic transmitter [V13, Vemco (Innovasea), Bedford, NS, 48 mm L, 11 g in air, 6 g in water weights] was surgically inserted into their intracoelomic cavity. For the transmitter surgery, individuals were anesthetized using clove oil and a small incision was made

ventrally. The transmitter was then inserted and the incision was closed using 1 to 2 simple interrupted sutures. Tagged American Eel were then placed in a flow through holding container with lake water and allowed to recover (full swimming ability) prior to release. In 2018, the three acoustically tagged American Eels were released at Jones Beach located on the eastern side of the Welland Canal, approximately 4.5 km east of Port Dalhousie. One additional American Eel that was not acoustically tagged was released in Hamilton Harbour, approximately 45.0 km west of Port Dalhousie. In 2019, three American Eel were relocated to Hamilton Harbour, two of which were acoustically tagged (Table 1). All tagging followed GLLFAS Animal Care Permit numbers 1850 and 1950.

## **ACOUSTIC TELEMETRY**

Acoustic telemetry was used to determine if and when tagged American Eel were present in Port Dalhousie. The receiver array changed considerably over the course of the study to adapt to the location and intensity of construction works and to account for the loss of some receivers. Two acoustic receivers (VR2W, 69 kHz, Vemco (Innovasea), Bedford, NS) were deployed on the inside of the harbour starting on May 1<sup>st</sup>, 2018. One receiver was positioned adjacent to the marina on the western side of the inner harbour (upstream; herein UpS) and the other one was located closer to the mouth of the harbour on the western pier (downstream; herein DnS) as shown in Figure 2). These receivers were downloaded several times, with the final download for 2018 on November 23<sup>rd</sup>. Detections at the UpS receiver can be used to confirm whether an American Eel was inside Port Dalhousie, whereas detections at the DnS receiver may be indicative of American Eel either inside Port Dalhousie or in Lake Ontario.

An additional three receivers were deployed on June 6<sup>th</sup>, 2018. The receivers were set with one on the eastern pier, one on the outer western pier near the point and one in the Port Dalhousie Pier Marina, along the western pier (Figure 2). Receivers were left in place until August 21<sup>st</sup>, 2018 when they were removed, and the data were downloaded.

The two receivers situated at the UpS and DnS locations remained in Port Dalhousie throughout the winter of 2019. However, the upstream receiver was lost in January and the downstream receiver experienced a malfunction, resulting in a data gap for January 2019. Three new receivers were deployed in Port Dalhousie in June 2019. One was located downstream on the inner eastern pier, one just upstream near the St. Catherine's Fish and Game Association boat ramp and one on the west side of the harbour near the port Dalhousie Yacht Club west docks (both of these are reflective of UpS conditions). Two of these receivers (model type = VR2TX) recorded ambient sound (mV) and temperature (°C) throughout the year (Figure 2). The ambient sound recordings do not cover a specific range of frequencies but instead cover a broad spectrum and better thought of as relative changes in overall noise in the system. The upstream VR2TX was removed in January 2020 in preparation for works shifting to the eastern pier.

The acoustic transmitters used for this study are compatible with receivers used by the Great Lakes Acoustic Telemetry Observation System, a collaborative research group

that share information on where and when transmitters are detected within the Great Lakes. Most germane for this study, receivers have been deployed throughout much of western Lake Ontario with high concentrations in Hamilton Harbour, Toronto Harbour, and the Niagara River (<https://glatos.glos.us/>). Similarly, American Eel have been tagged as part of research efforts in eastern Lake Ontario (Bay of Quinte) and the upper St. Lawrence River and these individuals can potentially be detected on the receivers deployed in Port Dalhousie.

## **HABITAT MAPPING**

On September 13<sup>th</sup>, 2018, a Biosonics MX (204.8 kHz and 8.4° beam width) was used to survey the system for depth and the presence and cover of submerged aquatic vegetation (SAV). Surveys followed the shoreline of the system as well as zig-zagging down the main portion of the harbour. Hydroacoustic data were processed in Visual Habitat (Biosonics, Seattle, WA) with the following parameters: rising edge threshold = -40 dB, plant detection threshold = -70 dB, maximum plant depth = 10 m, and plant detection length criterion = 10 cm. Occasionally when the bottom was comprised of unconsolidated or soft substrates, it was necessary to manually delineate this feature and to correct for resulting errors in SAV coverage estimates. The resulting data were then plotted in ArcMap 10.6 (ESRI, Redland, CA) to help characterize the local habitat conditions within the survey area.

## **RESULTS**

### **CAPTURE**

A total of nine American Eels were observed during the June 2018 electrofishing surveys (total effort = 26 324 shock seconds), and three of the captured American Eels were of sufficient size to be implanted with acoustic transmitters (Table 1). One American Eel was located at a single location within the inner harbour (near the old mill; Figure 2). Two additional American Eels were observed along the outside east wall, two were detected outside the west wall outside of the Port Dalhousie Pier Marina, and four American Eels were located within the Port Dalhousie Pier Marina, along the breakwall (Figure 2). Two were captured during day surveys (June 6<sup>th</sup>) (outer western pier area) and one during the night surveys (June 7<sup>th</sup>) in the Port Dalhousie Pier Marina western pier. No American Eel were observed during the November 2018 electrofishing survey.

A single American Eel was captured in the 2018 eel traps (Figure 2). This trap was one that had been relocated to the west side of the harbour (blue dot marked with a 1 in Figure 3) and the American Eel was captured on the final day of the trapping survey. This individual (680 mm) was deemed too small for an acoustic transmitter, but was PIT tagged and relocated to Hamilton Harbour. Other species commonly encountered in the traps included: Rock Bass (*Ambloplites rupestris*), Round Goby (*Neogobius melanostomus*), and Stonecat (*Noturus flavus*), see Table 2 for a complete list of captured species.

Five American Eels were observed during the electrofishing survey conducted June 6<sup>th</sup>, 2019 (total effort = 4 701 shock seconds); however, none were captured. Three American Eels were observed within the Port Dalhousie Pier Marina, one was observed outside of the west pier and one was observed at the end of the inner west wall (see Figure 2). A total of three American Eels were captured in the eel traps. All three eel were caught in the same trap location (yellow dot labelled as 13 and 14 in Figure 3). Two of these eels were captured on the same day and one was captured four days later. Two of the eels were implanted with an acoustic transmitter while one individual was deemed too small (510 mm). All three individuals were also PIT tagged and released in Hamilton Harbour. Rock Bass, Round Goby, and Stonecat were commonly encountered in the traps (see Table 2 for a complete list of captured species). Only Round Goby were captured in the PVC pipe traps.

### **ACOUSTIC TELEMETRY**

Five different American Eel were detected via acoustic telemetry between June 14<sup>th</sup> and November 11<sup>th</sup>, 2018. Two were originally tagged and translocated from Port Dalhousie to Jones Beach and three were originally tagged by the Ontario Ministry of Natural Resources and Forestry in the Bay of Quinte. The two American Eels translocated to Jones Beach (8708 and 8709) returned to Port Dalhousie within 8 and 31 days, respectively. Most detections occurred at the DnS receiver and they were generally intermittent; however, two American Eel were detected at the UpS receiver suggesting that they were inside Port Dalhousie for some duration between August and November 2018 (Table 3; Figure 4). There was a notable absence of American Eel detections at the UpS receiver during the two week trap sampling window (Figure 4).

Four different American Eel were detected between November 2018 and January 2020, three of which were tagged in Port Dalhousie and one that was originally tagged in the Bay of Quinte. There were no American Eels detected within Port Dalhousie over winter i.e. between November 2018 and April 2019 (Table 3; Figure 5). Considerably more daily detections were observed at DnS sites compared to UpS portions of Port Dalhousie. The majority of DnS detections occurred between June and July, while UpS detections occurred between late July and early August (Figure 5). Both American Eels 8712 and 8718, which were tagged in 2019 and re-located to Hamilton Harbour, were detected back in Port Dalhousie within 30 days (8 and 25 days, respectively).

Ambient noise ranged from ~ 150 to 625 mV across both DnS and UpS sites while American Eel were present in the system. Noise did not appear to influence American Eel detections at the DnS site, as they were detected across a large noise gradient (~ 150 – 500 mV) during both day and night. Though there were few observations UpS from June on, American Eels were only detected UpS at comparatively low noise levels (< 250 mV), where the majority of detections occurred at night (Figure 6). Water temperatures ranged between 10 – 25 °C at both the UpS and DnS locations. The majority of American Eel detections UpS occurred near the upper end of the measured temperature range between ~ 22 – 25 °C during the day and night (Figure 6). American Eels were detected DnS regardless of temperature variation.

## HABITAT MAPPING

Several pockets of SAV were apparent from the hydroacoustic surveys, with dense stands (50 – 100% cover) found within the Port Dalhousie Pier Marina and the Port Dalhousie Yacht Club (Figure 7). These areas were also among the shallowest in the survey area (Figure 8). Similar depths along the western pier were found to lack SAV, likely due to exposure to wind and wave action from Lake Ontario.

## DISCUSSION

American Eel were present in the proposed work area at Port Dalhousie. American Eel were successfully captured in low numbers by both sampling methods; boat electrofishing and eel traps. However, it was clear that neither method would be capable of capturing all eels potentially available in the project area due to challenging sampling conditions and high habitat heterogeneity. Acoustic telemetry data provided a way of remotely assessing American Eel presence based on a small number of tagged individuals, and it was apparent that American Eel were present in the project area throughout the year except for the winter months. Additionally, acoustic telemetry demonstrated that in some instances the translocated American Eel returned back to the system within a month.

During the electrofishing surveys, most American Eels were observed along the outer piers and the Port Dalhousie Pier Marina, with only two observations in the inner harbour. The limited catch and detection of American Eels during the electrofishing surveys in the inner harbour does not mean that they are not present. Given the depth in much of the channel (> 6 m), as well as the swift current, the degraded structure of the piers (considerable undercutting and open spaces) and low water clarity, boat electrofishing is unlikely to be as effective at collecting American Eel in this location as it is in others (including the outer breakwall, which is situated in shallower water). Under sampling conditions more conducive to detecting American Eels, only 50% of American Eels may be sampled during single-pass backpack electrofishing surveys (Naismith and Knights 1990; Graynoth et al. 2008). This would suggest that there are more American Eel in the study area than we have observed.

While limited catch of American Eel using the traps may suggest this method is not appropriate for catching this species in Port Dalhousie, the absence of acoustic detections during the two week sampling window in 2018 (when they were detected both before and after sampling) suggests that American Eel may not have been present or were only present in low numbers during this period. During 2019, acoustically tagged American Eels were present in the system during trapping events and during this period, three were captured, all of which were untagged. The trapping methodology may also be a significant factor in catch variability. All trapped eels were captured in wire-mesh eel traps, while the PVC tube style traps caught none. The difference in trap effectiveness may also be highlighted through an examination of the by-catch associated with these two trap styles. The PVC traps captured only one species, Round Goby, while the wire-mesh pots captured 11 species. Although similar trap-based approaches have been used successfully in other systems (Morrison and Secor 2004;

Hightower and Nesnow 2006), it is clear that there is limited capture success in Port Dalhousie for American Eel. There are several potential reasons for this limited capture success including: high flows reducing the efficacy of bait, insufficient trap coverage given the size of the system, sufficient forage in the area such that the bait was not attractive (e.g., Round Goby have been identified as important forage for American Eel and were regularly captured in eel traps; Fitzsimons et al. 2013), and generally low densities of American Eel in the system. The exact causal mechanism cannot be determined at this time and it is unclear what, if any, additional steps could be taken to increase capture rates in Port Dalhousie.

American Eel were detected UpS in Port Dalhousie when noise levels were  $\leq 250$  mV, however, the majority of these detections also occurred at night when noise levels were generally low-moderate ( $\leq 350$  mV). It is well established that American Eel are primarily nocturnal (Baras et al. 1998), so given this and the observed differences between noise levels during the day and night, it is not possible to conclude which factor (time of day or noise level) was the more important driver of American Eel presence. However, even at night American Eel were not detected when ambient noise exceeded 250 mV, suggesting there may be an upper threshold. As noted, the mV measure of noise is quite crude and can be influenced by a range of natural (e.g. rain and wind) or anthropogenic (e.g. construction) factors. Further exploration of the sensitivity of the mV measurement of noise on VR2Tx receivers is likely warranted to determine the magnitude of changes in mV that occur in the presence of natural and anthropogenic noises. Without this calibration, the present interpretation of potential avoidance of high levels of noise by American Eel is somewhat confounded. Regardless, further works should explore the effect of noise on American Eels since it may present a novel means for excluding them from areas where in-water works are underway.

It is noteworthy that American Eel 8709 was originally detected and captured at an outside breakwall location, but after returning back to the Port Dalhousie area following translocation it spent significant time in the inner harbour in the summer and fall of 2018 before leaving the area in December. This American Eel also returned to Port Dalhousie in May 2019 and was last detected in December 2019 suggesting it is locally resident throughout the spring, summer, fall, and early winter. In contrast, other American Eel detected in the system were present for shorter periods of time. More specifically, American Eel 8712 was occasionally detected at the downstream reaches of the harbour several months apart but was only encountered upstream on one occasion, and American Eel 8718 entered Port Dalhousie for approximately two weeks in July but has not been detected since.

In general, acoustically tagged American Eel were found to move in and out of Port Dalhousie, which suggests that they are utilizing much of the surrounding area and are not using a small restricted territory during certain times of the year as is sometimes identified in the literature for this species (Burliuk 2018). Given the long-distance migrations ( $\sim 5000$  km round trip migration) that American Eel are capable of undertaking for spawning (Schmidt, 1923), it is not surprising that some of the tagged individuals returned to Port Dalhousie after being re-located more than 45 km away in



Hamilton Harbour. The rapid (<30 days) rate of return by these individuals was more surprising and raises the question of whether relocation of this species is an effective approach for reducing potential interactions with local construction activities.

Continued acoustic telemetry tracking both within Port Dalhousie and more broadly in Lake Ontario via the Great Lakes Acoustic Telemetry Observation System will inform the timing and duration of residency of tagged American Eel in Port Dalhousie. It may also provide an indication of the distances that may be required to increase the efficacy of relocation as a tool for limiting interactions between American Eel and in-water activities.

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Table 1. Summary information on captured and tagged American Eel in 2018 and 2019.

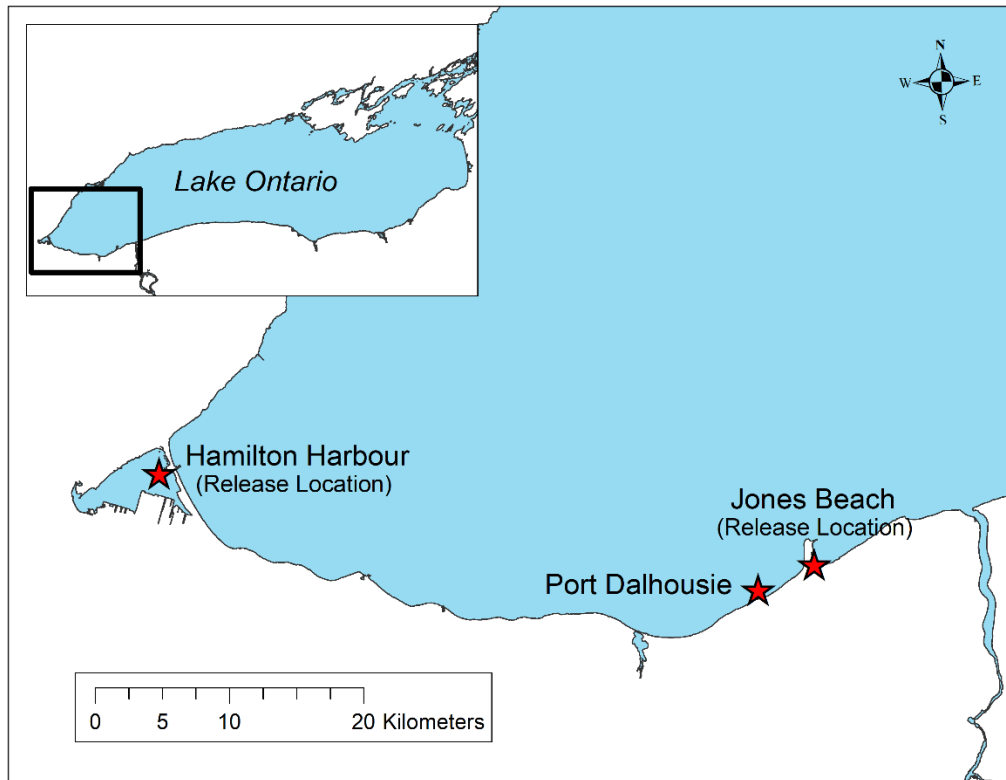
Capture Date	Release Location	Acoustic ID	Total Length (mm)	PIT #
June 6, 2018	Jones Beach	8708	1045	982000362573483
June 6, 2018	Jones Beach	8709	739	982000362573522
June 7, 2018	Jones Beach	8714	890	982000362573565
Sep 28, 2018	Hamilton Harbour	Not tagged	680	9892004250671
Jun 17, 2019	Hamilton Harbour	8718	815	160620
Jun 17, 2019	Hamilton Harbour	8712	767	160510
Jun 21, 2019	Hamilton Harbour	Not tagged	510	N/A

Table 2. Summary of fish species and quantities captured in Port Dalhousie in baited eel traps in 2018 (n=20) and 2019 (n=20, June 6 to July 3; n=5 July 3 to October 10) for a total of 220 trap-days and 610 trap-days, respectively. Catches for 2019 also include individuals captured in baited PVC pipe traps (n=7). Summary of fish species and quantities captured in Port Dalhousie in baited eel traps in 2018 (n=20) and 2019 (n=20, June 6 to July 3; n=5 July 3 to October 10) for a total of 220 trap-days and 610 trap-days, respectively. Catches for 2019 also include individuals captured in baited PVC pipe traps (n=7).

Fish Species	Scientific Name	2018 Captures	2019 Captures
Alewife	<i>Alosa pseudoharengus</i>	0	1
American Eel	<i>Anguilla rostrata</i>	1	3
Bluegill	<i>Lepomis macrochirus</i>	4	3
Largemouth Bass	<i>Micropterus salmoides</i>	2	3
Northern Pike	<i>Esox lucius</i>	1	0
Pumpkinseed	<i>Lepomis gibbosus</i>	22	1
Rock Bass	<i>Ambloplites rupestris</i>	117	226
Round Goby	<i>Neogobius melanostomus</i>	41	126
Smallmouth Bass	<i>Micropterus dolomieu</i>	8	7
Spottail Shiner	<i>Notropis hudsonius</i>	1	1
Stonecat	<i>Noturus flavus</i>	20	22
Yellow Perch	<i>Perca flavescens</i>	8	18

*Table 3. Summary of American Eel detections at the downstream (DnS; proximate to Lake Ontario) and upstream (UpS; proximate to the west marina) acoustic receivers in 2018 (top section) and 2019 (bottom section). Their original tagging location is indicated as either BoQ (Bay of Quinte) or PortDal (Port Dalhousie).*

<b>Location</b>	<b>Tagging Location</b>	<b>ID</b>	<b>First Date</b>	<b>First Time</b>	<b>Last Date</b>	<b>Last Time</b>	<b>Window (days)</b>	<b># Detections</b>
DnS	BoQ	5290	9/12/2018	0:58:33	10/5/2018	23:11:41	23.9	122
	BoQ	5292	9/27/2018	2:24:21	9/27/2018	2:27:15	<1.0	3
	BoQ	5326	11/7/2018	3:00:38	11/7/2018	6:43:56	0.2	4
	PortDal	8708	6/14/2018	5:37:18	7/11/2018	5:35:23	27.0	1500
	PortDal	8709	7/12/2018	4:09:28	11/19/2018	6:48:51	130.2	4065
UpS	BoQ	5290	9/12/2018	1:21:17	9/14/2018	1:12:30	2.0	81
	PortDal	8709	8/16/2018	22:47:04	11/19/2018	6:47:13	94.4	1084
DnS	PortDal	8709	5/3/2019	22:02:00	12/6/2019	21:16:00	217.0	21858
	PortDal	8712	6/26/2019	1:16:00	11/5/2019	15:13:00	132.6	20
	PortDal	8718	7/12/2019	4:03:00	7/29/2019	12:02:00	17.3	5435
UpS	BoQ	5305	5/29/2019	4:03:00	5/29/2019	4:04:00	<1.0	2
	PortDal	8709	5/3/2019	21:57:00	12/10/2019	21:42:00	221.0	439
	PortDal	8712	6/26/2019	1:36:00	6/26/2019	1:36:00	<1.0	1
	PortDal	8718	7/23/2019	15:44:00	7/26/2019	5:42:00	2.6	74



*Figure 1. Location of Port Dalhousie in western Lake Ontario. American Eel captured in Port Dalhousie were released either at Jones Beach (2018,  $n=3$ ) or Hamilton Harbour (2018,  $n=1$ ; 2019,  $n=3$ ).*

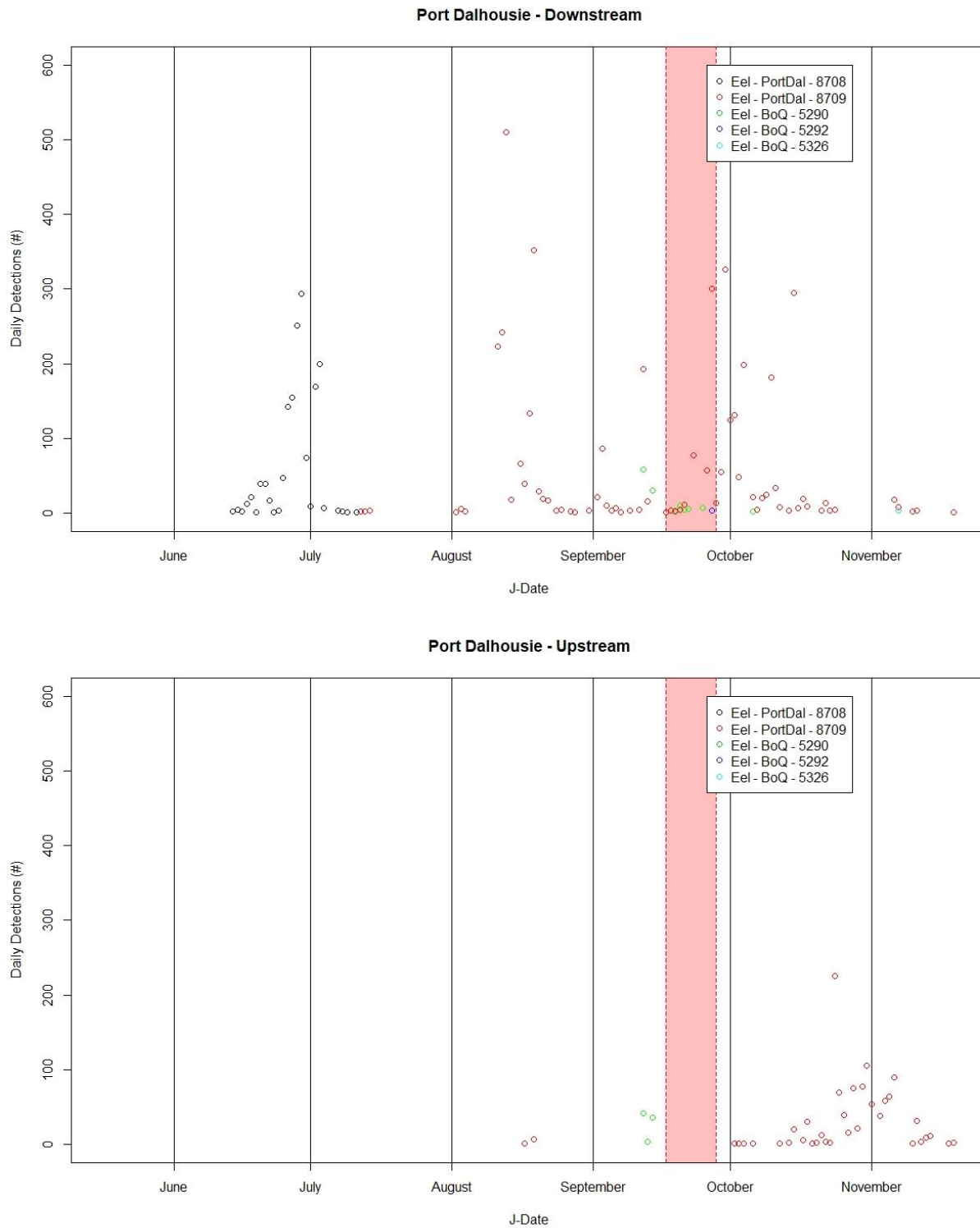


Figure 2. Left figure: Sampling and capture locations for 2018. Yellow lines indicate areas fished within the proposed work zone, while the orange line indicates an area outside of the work zone where American Eels were historically abundant. White circles indicate locations where American Eels were observed and purple circles indicate the locations of the three American Eels captured and tagged (June 2018) during electrofishing surveys. The pink circle indicates the location where a single American Eel was captured using an eel trap (September 2018) and the black squares indicate the locations of the upstream (UpS) and downstream (DnS) acoustic receivers. Right figure: Sampling and capture locations for 2019. Yellow lines indicate areas fished and the white circles indicate locations where American Eels were observed during the electrofishing survey. The pink circles indicate the capture location of the three American Eels using eel trap (June 2019). Black squares indicate the locations of the UpS and DnS acoustic receivers.



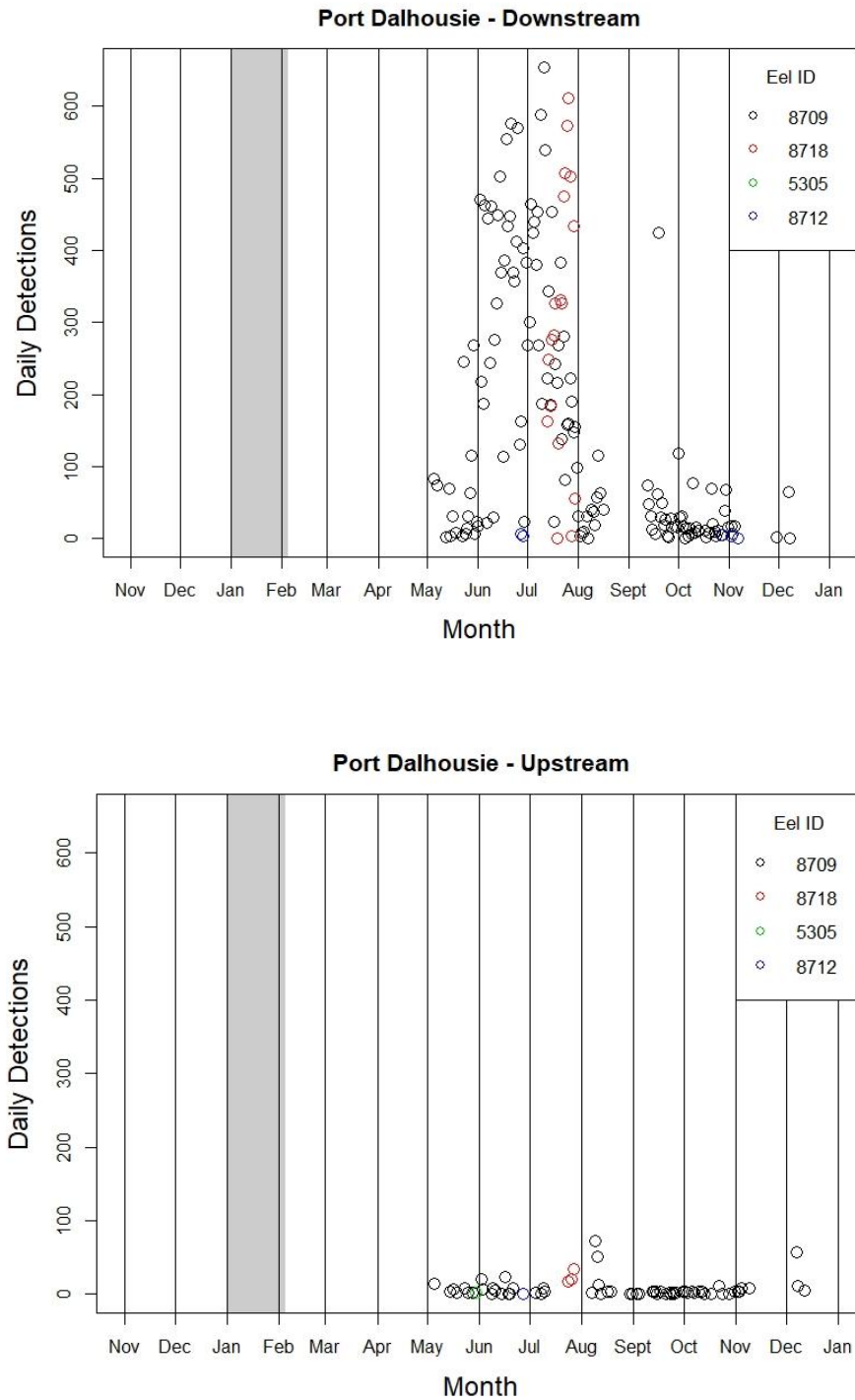


Figure 3. Left figure: Eel traps deployment locations in Port Dalhousie in 2018. Yellow dots indicate positions where traps were maintained for the entire two week sampling period. The green dots indicate the initial position of traps and the blue dots indicate their re-location positions. Right figure: Eel traps (T) and PVC pipe traps (P) deployment locations in Port Dalhousie in 2019. The yellow dots indicate positions where traps were maintained for the entire sampling period. The red dots indicate traps that were removed July 3<sup>rd</sup> and the teal dots indicate the locations of the PVC pipe traps.



*Figure 4. Total detections per day at the downstream (top panel) and upstream (bottom panel) acoustic receivers deployed in Port Dalhousie. Detections are separated by individual American Eel. The eel trap sampling window is shown as the red shaded area (September 17<sup>th</sup> to September 28<sup>th</sup>, 2018).*





*Figure 5. Daily detections (#) of acoustically tagged American Eel within downstream and upstream reaches of Port Dalhousie between November 2018 and December 2019. The grey shaded region represents a period when there were no receivers functioning in the system and therefore no detections could be logged.*

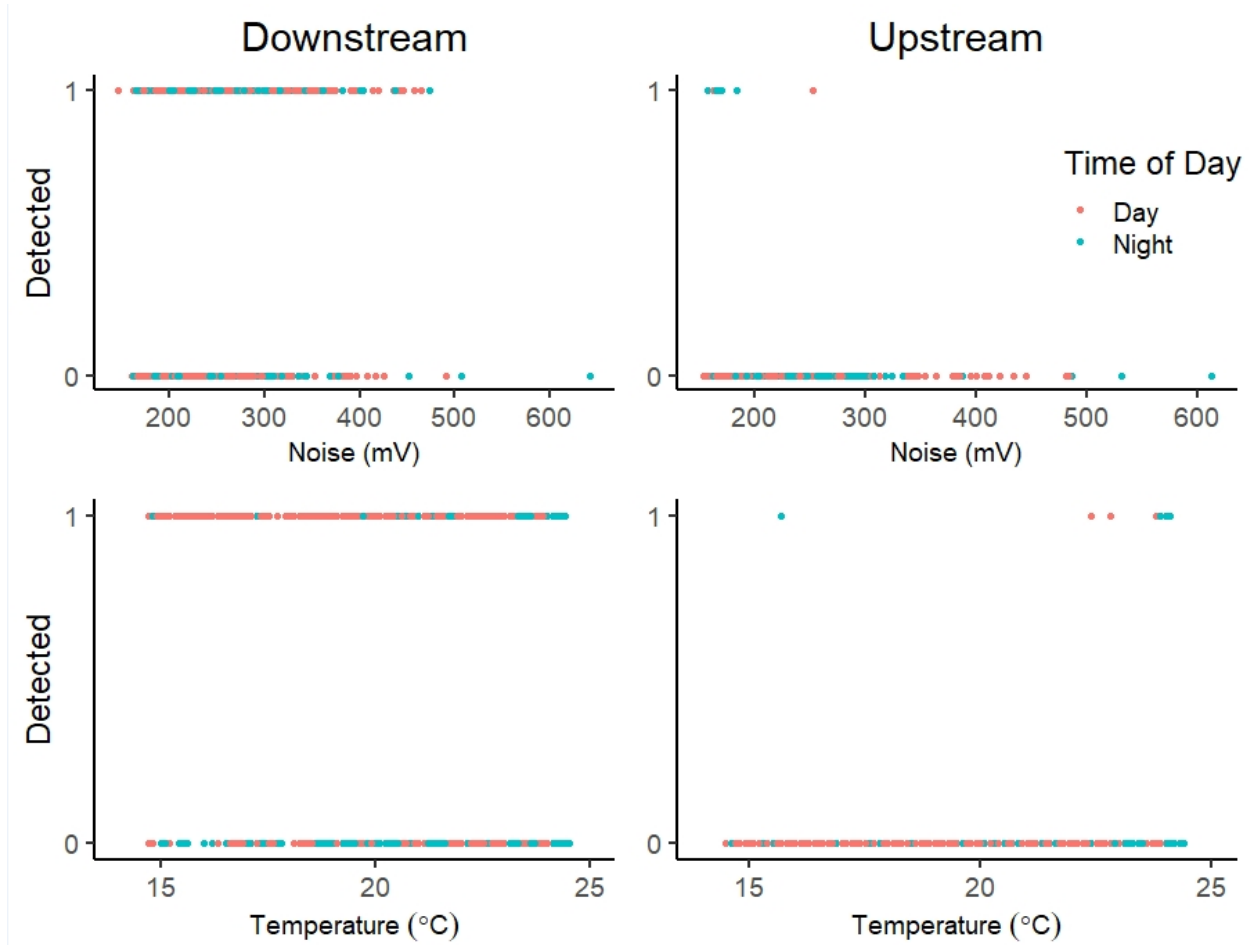


Figure 6. Relationships between ambient noise (mV) and temperature (°C) on the individual detections of American Eel between day and night within downstream and upstream reaches of Port Dalhousie between June and December, 2019. Noise and temperature data were recorded via acoustic telemetry receiver sensors (VR2Tx). Daytime was defined as 6 am – 8 pm, while night was defined as 9 pm – 5 am.

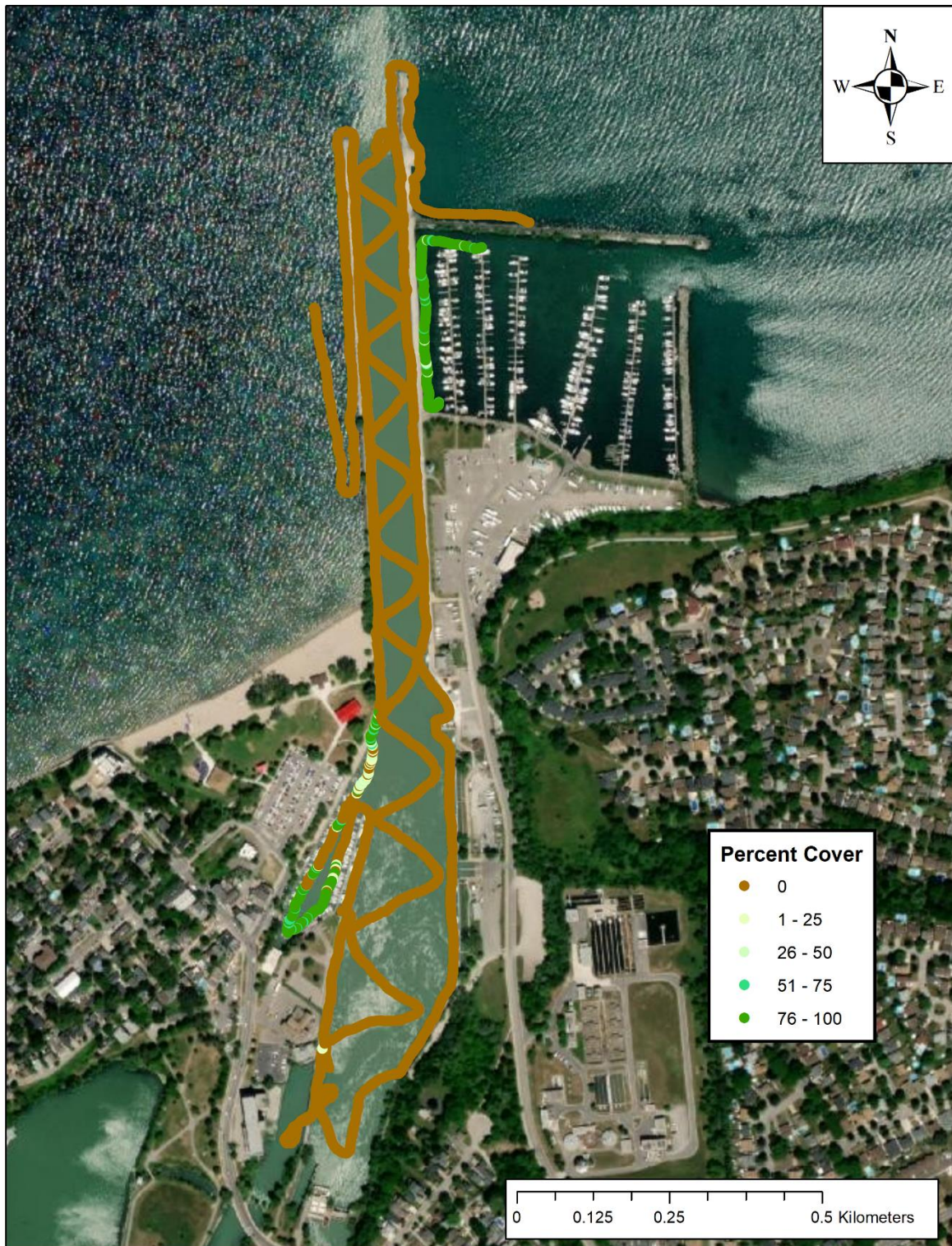


Figure 7. Submerged aquatic vegetation (SAV) coverage as determined using hydroacoustics. Brown areas were not found to contain SAV whereas some level of SAV was detected in the green regions, with darker green indicating higher percent cover.





Figure 8. Water depth (m) as determined using hydroacoustics. Darker blue areas show deeper depths.

## APPENDIX

*Appendix 1. Timeline for when different sampling gear were used in Port Dalhousie Timeline for when different sampling gear were used in Port Dalhousie.*

<b>Sampling Type</b>	<b>Date</b>	<b>Quantity</b>	<b>Location</b>
Boat Electrofishing	June 4 to 7 2018	N/A	Throughout Port Dalhousie Harbour
Boat Electrofishing	November 23 2018	N/A	Throughout Port Dalhousie Harbour
Boat Electrofishing	June 6 2019	N/A	Throughout Port Dalhousie Harbour
Eel Trap	September 18 to 24 2018	20	20 locations inside and outside of piers
Eel Trap	September 24 to 28 2018	20	West piers only
Eel Trap	June 6 to July 3 2019	20	10 locations inside and outside of piers
Eel Trap	July 3 to 10 2019	5	Inside and outside of piers
Eel Trap	August 7 to 14 2019	5	Inside and outside of piers
Eel Trap	September 11 to 18 2019	5	Inside and outside of piers
Eel Trap	October 7 to 11 2019	5	Inside and outside of piers
PVC Pipe Trap	June 21 to July 10 2019	7	Port Dalhousie Pier Marina