Results of Fisheries and Oceans Canada's 2016 Asian Carp Early Detection Field Surveillance Program

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RESULTS OF FISHERIES AND OCEANS CANADA'S 2016 ASIAN CARP EARLY DETECTION FIELD SURVEILLANCE PROGRAM

by

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In 2016, Fisheries and Oceans Canada's Asian Carp Program continued early detection field surveillance for Asian carps in the Canadian waters of the Great Lakes. Six crews sampled 1,209 sites from spring to fall at 34 locations in the Canadian waters of the Great Lakes and connecting channels. A crew from the Toronto and Region Conservation Authority sampled an additional 125 sites from six locations in Toronto watersheds using Asian Carp Program gear. Seven gear types were used to target large-bodied and small-bodied fishes in habitats well-suited to different life stages of Asian carps. Additionally, two new gear types were pilot tested in 2016 to search for eggs and juvenile Asian carps. A total of 79,875 fishes were captured, representing 99 species. Surrogate species that share similar habitats and feeding preferences to Asian carps were used to assess the effectiveness of the gear types and sampling techniques. A total of 2,495 Common Carp (*Cyprinus carpio*) and 1,157 buffalo species (*Ictiobus* spp.) were captured in all gear types except hoop nets and the trawl. No Asian carps were captured during the early detection surveillance work in 2016. In 2017, additional sites in eastern Lake Ontario, the Huron-Erie Corridor and Erie-Ontario connecting channels will be scouted.

RÉSUMÉ

Colm, J., Marson, D. and Cudmore, B. 2018. Results of Fisheries and Oceans Canada's 2016 Asian Carp Early Detection Field Surveillance Program. Can. Manuscr. Rep. Fish. Aquat. Sci. 3147 vii+ 67p.

En 2016, le Programme de lutte contre la carpe asiatique du MPO a continué ses activités de surveillance pour la détection rapide sur le terrain des carpes asiatiques dans les eaux canadiennes des Grands Lacs. Du printemps à l'automne, six équipes ont échantillonné 1 209 sites à 34 emplacements se trouvant dans les eaux canadiennes des Grands Lacs et les voies interlacustres. Une équipe de l'Office de protection de la nature de Toronto et de la région a échantillonné 125 autres sites à six emplacements dans les bassins hydrographiques de Toronto à l'aide d'engins du Programme de lutte contre la carpe asiatique. Sept types d'engins ont été utilisés, ce qui nous a permis de cibler des poissons de grandes et de petites tailles dans les habitats adaptés aux différents stades biologiques des carpes asiatiques. De plus, deux nouveaux engins ont été mis à l'essai en 2016 pour chercher les œufs et les juvéniles des carpes asiatiques. Un total de 79 875 poissons ont été capturés, soit 99 espèces. Des espèces de substitution partageant des préférences en matière d'alimentation et d'habitat semblables aux carpes asiatiques ont été utilisées pour évaluer l'efficacité des types d'engins et des techniques d'échantillonnage. Un total de 2 495 carpes communes (*Cyprinus carpio*) et de 1 157 buffalos (*Ictiobus* spp.) ont été capturés avec tous les engins, à l'exception des verveux et du chalut. Aucune carpe asiatique n'a été capturée pendant les travaux de surveillance pour la détection rapide en 2016. En 2017, des sites supplémentaires seront repérés dans l'est du lac Ontario et dans les corridors reliant les lacs Érié-Ontario et Huron-Érié.

INTRODUCTION

The focus of Fisheries and Ocean's Canada's (DFO) Asian Carp Program is to prevent the entry and establishment of Asian carps in the Great Lakes through outreach, early detection, response and management. The Asian Carp Program's early detection surveillance field sampling program was developed in the winter of 2012 and sampling was initiated in the spring of 2013 (Marson et al. 2014). This component of the program involves extensive sampling of targeted sites using traditional fisheries sampling gear types. Field sampling has continued since 2013 and expanded annually, with 2016 marking the fourth year of early detection surveillance.

The early detection of aquatic invasive species is essential for preventing their establishment in aquatic environments, as the sooner a species is detected, the more management response options are available to address the issue (Lodge et al. 2006; Vander Zanden et al. 2010). Using a variety of fish sampling equipment and techniques, the early detection field program surveys sites that have been identified as the most suitable for Grass Carp (*Ctenopharyngodon idella*), Silver Carp (*Hypophthalmichthys molitrix*), Bighead Carp (*H. nobilis*) and Black Carp (*Mylopharyngodon piceus*), as well as those sites that are at highest risk for arrival and establishment of these species in the tributaries of the Canadian side of the Great Lakes (Cudmore et al. 2012). Members of the genus *Ictiobus*[1] and Common Carp (*Cyprinus carpio*) are used as surrogate species to assess the effectiveness of sampling efforts as they are widely distributed through the Great Lakes, occupy similar habitats and have similar feeding strategies to Asian carp species (Dettmers and Creque 2004, ACRCC 2014).

From May 13th to October 27th, 2016, 34 wetlands, tributary rivers and interconnected waters were sampled by the Asian Carp Program's early detection surveillance field crews in the Canadian waters of the Great Lakes (Figure 1). An additional six waterbodies around Toronto were sampled by the Toronto and Region Conservation Authority (TRCA) targeting Asian carps to supplement DFO's sampling. These data are summarized and reported on separately in Appendix 1. The fish community present in each sampling area was assessed, with a focus on the detection of Asian carps and surrogate species.

METHODS

Using climatic and other environmental conditions, and the ecological needs of Asian carps, computer modelling identified areas of the Canadian waters of the Great Lakes most suited to these species (Cudmore et al. 2012; N.E. Mandrak, 1265 Military Trail, Scarborough, ON, unpublished data). High and medium matches were selected as potential early detection surveillance sampling sites and new sites from this list are ground-truthed each year for habitat suitability and sampling feasibility. In 2016, the focus extended from the sites selected in earlier years, concentrated in lakes Huron and Erie, to include more surveillance in Erie-Ontario connecting channels (e.g. Welland Canal system and Welland River) and Lake Ontario tributaries. Six field crews operated

[1] Note: *Ictiobus* spp. hybridize in the Great Lakes and are often indistinguishable as separate species. For ease of reporting, they are all considered buffalo species in this report.

in 2016 (five based out of Burlington, ON and one out of Sault Ste. Marie, ON) to sample the 34 early detection surveillance sites across seasons.

Following captures of Grass Carp in Lake Ontario in 2015, including five around the Toronto Islands (DFO 2017), it was determined that greater surveillance efforts were needed in central Lake Ontario. DFO partnered with the TRCA who had the capacity to sample six Toronto-area waterbodies, including Duffins Creek, Frenchman's Bay and the Rouge River as part of existing monitoring projects. Thus, in 2016, a crew from TRCA pilot tested the Asian Carp Program's sampling protocols using gear provided by DFO to target Asian carps. This preliminary early detection surveillance work conducted by TRCA is summarized and reported on in Appendix 1.

Seven gear types were used to sample the early detection surveillance sites, including boat electrofishing units, fyke nets, hoop nets, seine nets, trammel nets, trap nets and trawls. Following the discovery of Grass Carp eggs in the Sandusky River, Ohio, USA (Embke et al. 2016), the Asian Carp Program pilot tested new gears (bongo nets and larval light traps) in 2016 for detecting larval fishes and suspended eggs. This variety of gear types targeted both large and small-bodied fishes in a variety of habitat types. Sampling the full breadth of the fish community increased the likelihood of detecting all four species of Asian carps, at both juvenile and adult life-stages. Descriptions of each gear type and the standard effort are found below.

BOAT ELECTROFISHER

In 2016, boat electrofishing was conducted using two sizes of Smith-Root Electrofishing vessels and a Henley Jon boat that was outfitted with Smith-Root electrofishing equipment. Burlington crews operated with a 21' extra-heavy duty model Smith-Root Electrofishing boat and a 24' Henley jon boat. Both were equipped with a 7.5 kilowatt Generator Powered Pulsator and dual-anode booms. The Sault Ste. Marie crew operated with a 14' Smith-Root vessel, with a 5.0 kilowatt Generator Powered Pulsator, and dual-anode booms. All crews operated with two netters who would retrieve stunned fishes and transfer them into a live-well in the boat. Sampling effort was recorded as seconds shocked for each site. Electrofishing effort was standardized to approximately 600 seconds per site.

FYKE NET SAMPLING

Box fyke nets with a 0.32 mm ace mesh size, 0.61 m hoop diameter, 0.61 m by 4.6 m lead length and 0.61 m by 1.3 m wing length were deployed. In 2014, the fyke nets were modified to include a 10.16 cm square nylon mesh to the net entrance to reduce the catch of large snapping turtles. Fyke nets were set in wadeable habitat (<1.5 m water depth), with low or no flow, and on a variety of vegetation and substrate types. Fyke nets were set with the lead attached to shore and the net pulled taut perpendicular to the shoreline. When the water depth was greater than the net depth, a float was placed within the bag end of the net (cod-end), to ensure that captured turtles had access to air. Fyke nets were set for approximately 24 hours.

HOOP NET SAMPLING

Three foot diameter hoop nets with a length of 4.57 m with two funnels and 2.54 cm bar mesh were incorporated into the early detection surveillance work as they are less cumbersome to deploy and can be set in shallower flowing waters than larger-sized (six foot) hoop nets. Hoop nets were deployed in habitats that could not be sampled by other gear types due to depth restrictions or flowing water. This gear type is frequently used in efforts in the Mississippi watershed for the removal of Asian carps. Hoop nets were set with the open end of the net facing downstream. The cod-end of the net was tied to an anchor that was set upstream, using the flow of the water to keep the net deployed. When possible, the nets were set for 48 hours. If bad weather or other circumstances precluded a 48 hour set, the nets were fished earlier.

SEINE NET SAMPLING

A bag seine 9.14 m long, 1.52 m tall, with 3.18 mm ace mesh in the bag and 4.76 mm ace mesh on the wings was used for sampling wadeable, low-flow habitats, with moderate vegetation. In flowing waters, seining was performed in the direction of the flow. Captured fishes were transferred into bins filled with water. Generally, three hauls were conducted to target small-bodied fishes.

TRAMMEL NET SAMPLING

Trammel nets were deployed in lengths of either 182.9 m (200 yards) or 91.4 m (100 yards), with inner gill-net mesh sizes ranging from 7.62 cm to 10.16 bar mesh (15.24 cm to 20.32 cm stretch mesh sizes) and net depths of 3 m and 4.2 m. The trammel nets have two additional panels of netting that sandwich the inner gill net panels. The outer netting is 45.72 cm bar mesh nylon netting that works to bag large-bodied fishes in the net (fishes too large to be captured by the inner monofilament gill netting). The nets were used to target large-bodied fishes.

The net is set to the shore and run perpendicular out from shore approximately 20-30 m. The boat is then turned and 120-214 m of net is deployed parallel to shore, and then the final 20-30 m is deployed perpendicular back into shore. This deployment technique blocks fishes into the enclosed area. Heavily vegetated areas can be sampled if the net is deployed on the outer margins of the vegetation so that it would cover the full depth of the water column. Setting the net in very heavy vegetation would limit its effectiveness as the lead-line would not always push through the vegetation and would be held up off bottom, allowing fishes to escape below the lead-line.

Once the net is set, the boat enters the blocked-off and uses a trimmed-up motor to create disturbance in the water. Additionally, crew members use modified plungers to “pound” the area. By revving the engine, banging the hull of the vessel, or pounding the water’s surface with plungers, this actively frightens fishes in an attempt to get them to flee in the direction of the net. This method, referred to as “pounding”, was developed by researchers working in the Mississippi watershed on the removal of Asian carps, which are known to be net avoidant species (ACRCC 2014). Boat electrofishing was also used to disturb the blocked area and cause fishes to flee into the set net. The electrofishing crew would dip net any fishes that were stunned by the electrofishing boat.

This sampling method provides several advantages over traditional gill netting methods, including reduced set times, which reduces stress on captured fishes; increased catch of sedentary fishes; and allows for an increased number of sites to be sampled per day. Trammel nets were set for a short amount of time (effort standardized to approximately 30 minutes) in order to minimize the entanglement time of fishes. Sampling effort was recorded as both the length of the net used and the amount of time (in minutes) from when the net was fully deployed, to the point when crews starting pulling the net back into the boat.

TRAP NET SAMPLING

Trap nets, with a mesh size of 2.54 cm, 1.2 m depth, a 27.43 m long lead and two wings 3 m long by 1.2 m deep were used to sample areas with low to no flow, on a variety of substrate types. Trap nets were set in similar habitats as fyke nets, but the coarser mesh and larger net size targeted larger-bodied fishes. Trap nets required deeper water than fyke nets (i.e. a minimum of 1.2 m set depth) in order to deploy properly. Trap nets were set with the lead attached to shore then the net was pulled taut and deployed perpendicular to the shoreline. A float was added to the net to provide access to the surface for any captured turtles. Trap nets were set for a standardized time of approximately 24 hours.

TRAWL SAMPLING

A 2.5 m Missouri trawl was used to sample fishes in areas where water clarity and depth minimized the effectiveness of other sampling gear types such as fyke nets and trammel nets. Bottom trawling was used by the Sault Ste. Marie crew and occurred primarily in Lake Huron and Lake Superior sites. The Missouri trawl was towed from the bow of the vessel in a downstream direction for approximately 100 m (three minutes per haul). The trawling speed was adjusted to ensure that the trawl did not dig into soft substrate, but stayed on the bottom for proper collection of fishes. A small mesh size of 3.18 mm ace mesh was used to capture small-bodied fishes.

BONGO NET AND LARVAL LIGHT TRAP SAMPLING

Bongo nets targeting fish eggs consisted of a stainless steel frame with two 50 cm diameter openings. Attached to the frame is a pair of 2 m long cylindrical plankton nets, with 50 cm openings, 11 cm codends, and 500 micron mesh size. The net design was consistent with designs used by partner agencies collecting Asian carp larval fish and eggs in rivers in the United States. The Bongo net was deployed off of the bow of the boat, on either the port or starboard side of the vessel. Horizontal tows were completed to sample stretches of river, rather than traditional vertical tows through the water column for plankton. The tow speeds were adjusted to ensure that the nets remained fully deployed, and filtration efficiency remained high. During sampling, a flow meter was deployed adjacent to the nets to calculate the flow rate and corresponding volume of water sampled.

A quadrafoil type larval fish light trap with a cloverleaf shaped design was used to capture larval fishes. The trap is made of clear polycarbonate, is 30 cm in diameter and

25 cm tall, with four entry points that are 5 mm wide. A mesh strainer of 250 microns is installed in the collection basin of the trap. The light trap was lit either by a white waterproof flashlight, or a chemical light stick, placed in the central light tube of the trap. The light tube size is 28 mm in diameter, and 25 cm in depth. The traps were placed in sets of three, tethered together, spaced 1m apart. Three sets of three traps were deployed simultaneously: one set in heavy submerged vegetation, one in open water and one set in, or adjacent to, woody debris. The traps were deployed for one hour, starting 30 minutes after sunset. The standardized set times were one hour in order to minimize the risk of predation of captured larval fishes.

Bongo nets and larval light traps were deployed in a subset of early detection sites in the Huron-Erie Corridor, Lake Erie and Lake Ontario. Deployments in 2016 were completed to test the equipment and develop the deployment methods for future sampling.

FISH AND HABITAT DATA COLLECTION

Captured fishes were identified, measured and returned to the water near the site of capture. Voucher specimens were preserved in 10% formalin for species requiring laboratory verification, and digital vouchers were taken of each species based on DFO vouchering protocols (Mandrak and Bouvier 2014). GPS coordinates and habitat data, including water and air temperature (°C), dissolved oxygen (mg/L), conductivity (µS/cm), pH, turbidity (NTU), wind speed (km/h), water depth (m), sampling distance from shore, substrate percent composition (Wentworth Scale) and aquatic vegetation type and percent cover, were recorded for each site.

RESULTS

DFO's Asian Carp early detection field program sampled 1,209 field sites in tributaries and wetlands in Canadian waters of the Great Lakes using seven different gear types (Figures 1-34, Tables 1-3). The number of sites sampled per waterbody ranged from two (Serpent River) to 129 (Grand River) (Figure 35, Table 4).

In 2016, a total of 79,875 fishes were collected representing 99 species (Tables 1-2). The mean number of fishes sampled per waterbody was 2,349 and the mean number of fishes captured per site was 66 (Table 1). The most fishes were captured in the Grand River (12,806), and the least were captured in the Serpent River (57). The mean number of species captured per waterbody and per site was 32 and 7, respectively. The greatest species richness observed was in the Grand River with 58 species, and the lowest was in Bowmanville Creek with two species (Table 4). The most abundant species captured were Gizzard Shad with 13,091 individuals (16% of all fishes captured), Brown Bullhead with 12,387 individuals (15%), Bluegill with 11,136 individuals (14%), Pumpkinseed with 5,349 individuals (7%), and Largemouth Bass with 3,099 individuals (4%).

Boat electrofishing was the most used gear type, with 437 field sites sampled (Figure 36, Table 4). Hoop nets were the least deployed gear type, deployed at eight sites. The most fishes and species were captured boat electrofishing (31,322 fishes and 88 species), while hoop nets caught the fewest fishes and species (8 fishes, 4 species) (Figures 37-38).

Habitat data were collected at all 1,209 sites (D. Marson, 867 Lakeshore Road, Burlington, ON, unpublished data); however, the results are outside the scope of this report.

BOAT ELECTROFISHER

Boat electrofishing was conducted at 437 sites in 33 waterbodies (Figure 36). A total of 294,648 seconds (81.85 hours) of shocking effort was conducted (Table 3), with an average of 674.42 seconds per site. The greatest amount of shocking effort was conducted in the Grand River, where 31,742 seconds of shocking effort was completed at 45 sites, while the least shocking was done in Serpent River, where 1,323 seconds were completed at two sites (Table 5).

A total of 31,322 fishes were captured representing 88 species using this gear. A total of 1,348 Common Carp and 276 buffalo spp. (surrogates for Asian carps) were captured while boat electrofishing (Figures 37-40, Table 3).

FYKE NET

Fyke nets were fished at 282 sites in 32 waterbodies (Figure 36). A total of 5909.74 hours of fishing were completed with fyke nets (Table 3), with an average of 20.96 hours per site. The greatest amount of fyke net effort was deployed in the Grand River with 673.19 hours across 33 net sets, while the least amount of effort was deployed in Kettle Creek, with 41.25 hours over two fyke net sets (Table 5).

A total of 31,497 fishes representing 76 species were captured in fyke nets, including 75 Common Carp and 10 buffalo spp. (Figures 37-40, Table 3).

HOOP NETS

Hoop nets were fished at eight sites in three waterbodies (Figure 36). Hoop nets were set for a total of 330.44 hours (Table 3) with a mean set time of 41.31 hours per site. The greatest amount of hoop net effort was deployed in the Welland River, with 125.26 hours across three sites, and the least amount of effort was deployed in Big Otter Creek with 83.18 hours at two sites (Table 5).

A total of eight fishes representing four species were captured in hoop nets. No surrogate species (Common Carp and buffalo spp.) were detected using this gear (Figures 37-40, Table 3).

SEINE NET

Seine netting was conducted at 37 sampling sites in 12 waterbodies (Figure 36). A total of 94 seine hauls were conducted (Table 3), with a mean of 2.5 hauls per site. The greatest amount of seining effort took place in Cedar Creek with 21 seine hauls over seven sites. The least amount of seining effort occurred in the Bayfield River and Jordan Harbour, with one seine haul conducted at one site each (Table 5).

A total of 4,882 fishes were captured representing 52 species, including five Common Carp and 14 buffalo spp. (Figures 37-40, Table 3).

TRAMMEL NETS

Trammel nets were used to sample 197 sites in 27 waterbodies (Figures 36). A total of 35,387 m of net were set for a total of 6404.26 minutes (106.74 hours) (Table 3), with a mean set time of 32.51 minutes per site. The greatest amount of trammel net effort was deployed in Lake Gibson, with 1206.71 minutes of sampling and 2195.5 m of net across 12 sites. The least amount of effort was 10 minutes with 100 m of net in the Nottawasaga River at one site (Table 5).

A total of 1,639 fishes representing 15 species were captured in trammel nets, including 490 Common Carp and 776 buffalo spp. (Figures 37-40; Table 3).

TRAP NETS

Trap nets were fished at 216 sites in 32 waterbodies (Figure 36). Trap nets fished for a total of 4538.72 hours (Table 3), averaging 21.01 hours per site. The greatest amount of trap net fishing occurred in the Grand River, with a total of 607.2 hours of fishing across 29 sites, while the least amount occurred in the Pine River, with a total of 18.66 hours at one set site (Table 5).

A total of 9,568 fishes representing 44 species were captured, including 577 Common Carp and 81 buffalo spp. (Figures 37-40, Table 3).

TRAWL

A trawl net was used to sample 32 sites in eight waterbodies (Figure 36). A total of 32 hauls of trawling took place (Table 3), one haul per site. The greatest amount of trawling effort was employed in the Mississagi River with six hauls across six sites while the least effort was employed in the Goulais and Sturgeon rivers with two hauls at two sites each (Table 5).

A total of 959 fishes were captured representing 16 species. No surrogate species (Common Carp and buffalo spp.) were captured with this gear type (Figures 37-40, Table 3).

SURROGATE SPECIES

All species of the genus *Ictiobus* (buffaloes) in the sucker family were considered surrogates for Bighead and Silver carps during the 2016 early detection surveillance program due to shared habitat and food preferences. A total of 1,157 buffalo spp. were captured in 2016, ranging in size from 36 to 943 mm (Tables 1-2). The greatest number was captured in the Welland River, where 274 were captured. Buffalo spp. were captured in 15 of the 34 waterbodies sampled (Table 4).

Trammel nets and boat electrofishing were the two most effective gear types at catching buffalo spp., with 776 (67%) and 276 (24%) buffalo spp., respectively. Buffalo spp. were not collected in hoop nets or trawls (Figures 39; Table 3).

Common Carp was also used as a surrogate species, primarily for Grass Carp. The detection of Common Carp illustrated that the sampling efforts were successful in detecting large-bodied, highly mobile fishes. A total of 2,495 Common Carp were captured during the 2016 sampling season, ranging in size from 38 to 1,059 mm. The greatest number of Common Carp was captured in Cedar Creek, where 306 were captured. Common Carp was detected in 30 waterbodies sampled (Table 4). Common Carp was not detected in tributaries of northern Lake Superior or parts of Georgian Bay.

Boat electrofishing yielded the most Common Carp, as 1,348 (54%) individuals were captured with this gear; trap net was the next most effective gear, catching 577 (23%) of the Common Carp. Common Carp was detected in all gear types except the hoop net and trawl (Figures 40; Table 3).

Overall, the most surrogate species were captured in the Welland River (426), Cedar Creek (385), Thames River (341), Jordan Harbour (337), and Lake Gibson (303).

ASIAN CARPS

No Asian carps were captured during the 2016 early detection surveillance work.

SUMMARY

In 2016, DFO's Asian Carp Program early detection surveillance crews sampled 34 waterbodies identified as highly suitable or high risk for entry of Asian carps. An additional six waterbodies were sampled by TRCA to pilot test Asian Carp Program protocols for targeting Asian carps in Toronto area waters; this includes waterbodies previously sampled (Humber River) or scouted (Duffins Creek, Frenchman's Bay and Rouge River) by the Asian Carp Program. New sites were scouted by the Asian Carp Program in 2016 in Bowmanville Creek, and the Welland River and Canal system following captures of Grass Carp near those areas in 2015 and 2016.

A total of 1,209 sites were sampled by the Asian Carp Program in 2016 using seven gear types to target large and small-bodied fishes in a variety of wetland and riverine habitats. A total of 79,875 fishes representing 99 species were collected across the 34 waterbodies sampled. Surrogate species for Asian carps (i.e. buffalo spp. and Common

Carp) were captured in all gear types except the hoop net and trawl. A total of 1,157 buffalo spp. were captured in 15 waterbodies in the Huron-Erie Corridor, Lake Erie, and the Erie-Ontario connecting channels. A total of 2,495 Common Carp were captured in 30 waterbodies across all four Canadian Great Lakes. The capture of 3,652 surrogates in 30 of 34 waterbodies sampled suggests that gear types are working effectively to target large and small-bodied fishes that occupy similar habitats and have similar ecologies to Asian carps. As such, it is likely that Asian carps would be detected if present.

Similar gear types were used in 2016 as in previous years, with some minor modifications. As a fifth crew operated out of Burlington in 2016, an additional electrofishing boat was deployed. Trammel net sampling replaced tied-down gill net sampling used in previous years as trammels are more effective at detecting large-bodied fishes in the turbid waters that are common in southern Ontario. Additionally, taller 4.2 m trammel nets were deployed at deeper sites. These taller nets ensured that the lead-line always reached the bottom, preventing fishes from escaping underneath the net. These nets were deployed with little additional effort compared to the 3.0 m tall nets used at shallower sites. Only 3’ hoop nets were deployed in 2016, as the 6’ nets used in previous years were cumbersome and difficult to deploy. Both sizes of hoop nets will be used again in 2017 as they are the most effective gear type for sampling deeper, medium to fast flowing river reaches that may be attractive to spawning Asian carps. Seine nets were used more in 2016 than in previous years. As crews became more familiar with the waterbodies sampled, more suitable wadeable habitats were identified. Trawls continued to be conducted in northern rivers where water clarity limits the use of visible passive gears. Both seining and trawling provide valuable baseline data on fish community structure and are important gear types for detecting eggs and larval Asian carps. Additional gear types aimed at detecting Asian carp eggs and larval life stages were pilot tested in 2016. Bongo nets and larval light traps were deployed in the Credit, Sydenham and Thames rivers. Both gear types were successful in capturing larval cyprinids and genetic analyses found no evidence of Asian carps (N.E. Mandrak, 1265 Military Trail, Scarborough, ON, unpublished data). These gears will be incorporated into the early detection surveillance work in 2017, and will be deployed strategically following high flow events in high priority areas.

Traditionally, the Asian Carp Program has had the greatest success capturing Asian carps and surrogate species using boat electrofishing and trammel netting (Marson et al. 2014; Marson et al. 2016; Marson et al. 2018). This held true in 2016, with boat electrofishing and trammel netting capturing 44% and 35% of all surrogates, respectively. It should be noted that boat electrofishing was used at 36% of sites sampled, compared to 16% of sites sampled for trammel nets. Trap nets were also highly successful at capturing surrogates in 2016, detecting 18% of surrogates overall.

No Asian carps were detected during the early detection field surveillance in 2016. However, an angler captured a Grass Carp in Lake Gibson in June 2016, and the resulting response efforts yielded 10 Grass Carp from this waterbody. These fish, along with a dead Grass Carp found in the Niagara River in 2015 prompted extensive

sampling in the Welland River and Canal systems (including Lake Gibson) in 2016. Welland River yielded 426 surrogate species, the most of any waterbody sampled, and an additional 303 were captured in Lake Gibson, suggesting these areas are suitable for Asian carps. The Welland River will continue to be sampled in 2017; however, Lake Gibson is privately owned, and access issues may preclude it from being sampled regularly as part of the early detection surveillance program.

Following the detections of eight Grass Carp in Lake Ontario in 2015 (DFO 2017), additional surveillance was needed there. Sites in Bowmanville Creek were scouted in 2016 and may be sampled in 2017 as part of the early detection surveillance program. The TRCA pilot tested DFO's Asian Carp Program protocols and gears in six waterbodies in the Toronto area (Appendix 1). They will continue to sample five of those waterbodies following Asian Carp Program protocols in 2017 as part of the early detection surveillance program. In 2017, the Asian Carp Program will sample the Rouge River and will begin scouting in the Don River to allow TRCA to focus sampling in other areas.

New environmental data and information on the biology of Asian carps in North America have become available since 2013 when early detection sites were first chosen. Habitat suitability models have been revised to reflect this new information (N.E. Mandrak, 1265 Military Trail, Scarborough, ON, unpublished data). The results of these models will help refine the 2017 early detection surveillance site selection, whether by adding new early detection sites, adjusting effort within an early detection site or increasing sampling effort in certain locations according to important timing windows identified through this work and others (Kolar et al. 2007, Kocovsky et al. 2012).

In 2017, the Asian Carp Program will continue to operate five crews from Burlington, and a satellite crew in Toronto through the TRCA. The program will continue to sample tributaries and wetlands of the Great Lakes following standardized protocols, and will adjust field sites and gear types to reflect local habitat conditions in order to best target Asian carps and prevent their arrival, establishment and spread in Canadian waters.

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REFERENCES

Asian Carp Regional Coordinating Committee (ACRCC) Monitoring and Response Workgroup. 2014. Monitoring and Response Plan for Asian Carp in the Upper Illinois River and Chicago Area Waterway System. xiv+138 p. http://www.asiancarp.us/documents/MRP2014.pdf (accessed November 6, 2017)

Embke, H.S., Kocovsky P.M., Richter, C.A., Pritt, J.J., Mayer, C.M., and Qian, S.S. 2016. First direct confirmation of Grass Carp spawning in a Great Lakes tributary. J. Great Lakes Res. 42 (4): 899-903.

Cudmore, B. Mandrak, N.E., Dettmers, J., Chapman, D.C., and Kolar, C.S. 2012. Binational Ecological Risk Assessment of Bigheaded Carps (*Hypophthalmichthys spp.*) for the Great Lakes Basin. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/114. vi+57 p.

DFO. 2017. Update to the ecological risk assessment of Grass Carp (*Ctenopharyngodon idella*) for the Great Lakes Basin: Lake Ontario. DFO Can. Sci. Advis. Sci. Resp. 2016/049. 16 p.

Dettmers, J.M., and Creque, S.M. 2004. Field assessment of an electric dispersal barrier to protect sport fishes from invasive exotic fishes. Division of Fisheries Illinois Department of Natural Resources. Aquat. Ecol. Tech. Rep. 2004/09. i+20 p.

Lodge, D.M., Williams, S.L., MacIsaac, H., Hayes, K., Leung, B., Reichard, S., Mack, R.N., Moyle, P.B., Smith, M., Andow, D.A., Carlton, J.T., and McMichael, A. 2006. Biological Invasions: recommendations for U.S. policy and management. Ecol. Appl. 16: 2035-2054.

Kocovsky, P.M, Chapman, D.C. and McKenna, J.E. 2012. Thermal and hydrologic suitability of Lake Erie and its major tributaries for spawning of Asian carps. J. Great Lakes Res. 38: 159-166.

Kolar, C.S., Chapman, D.C., Courtenay Jr., W.R., Housel, C.M., Williams, J.D. and Jennings, D.P. 2007. Bigheaded carps: a biological synopsis and environmental risk assessment. Am. Fish Soc. Spec. Publ. 33, Bethesda, Maryland.

Mandrak, N.E., and Bouvier, L.D. 2014. Standardized data collection methods in support of a classification protocol for designation of watercourses as municipal drains. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/077. v + 27 p.

Marson, D., Gertzen, E., and Cudmore, B. 2014. Results of the Burlington 2013 Asian carp early detection field surveillance program. Can. Manuscr. Rep. Fish. Aquat. Sci. 3054: vii + 27 p.

Marson, D., Gertzen, E., and Cudmore, B. 2016. Results of Fisheries and Oceans Canada's 2014 Asian carp early detection field surveillance program. Can. Manuscr. Rep. Fish. Aquat. Sci. 3103: vii + 59 p.

Marson, D., Colm, J., and Cudmore, B. 2018. Results of Fisheries and Oceans Canada's 2015 Asian carp early detection field surveillance program. Can. Manuscr. Rep. Fish. Aquat. Sci. 3146: vii + 63 p.

Page, L.M., Espinosa-Pérez, H., Findley, L.T., Gilbert, C.R., Lea, R.N., Mandrak, N.E., Mayden, R.L., and Nelson, J.S. 2013. Common and scientific names of fishes from the United States, Canada, and Mexico, 7th edition. Am. Fish Soc. Spec. Publ. 34, Bethesda, Maryland.

Vander Zanden, M.J., Hansen, G.J.A., Higgins, S.N., and Kornis, M.S. 2010. A pound of prevention, plus a pound of cure: early detection and eradication of invasive species in the Laurentian Great Lakes. J. Great Lakes Res. 36: 199-205.

FIGURES

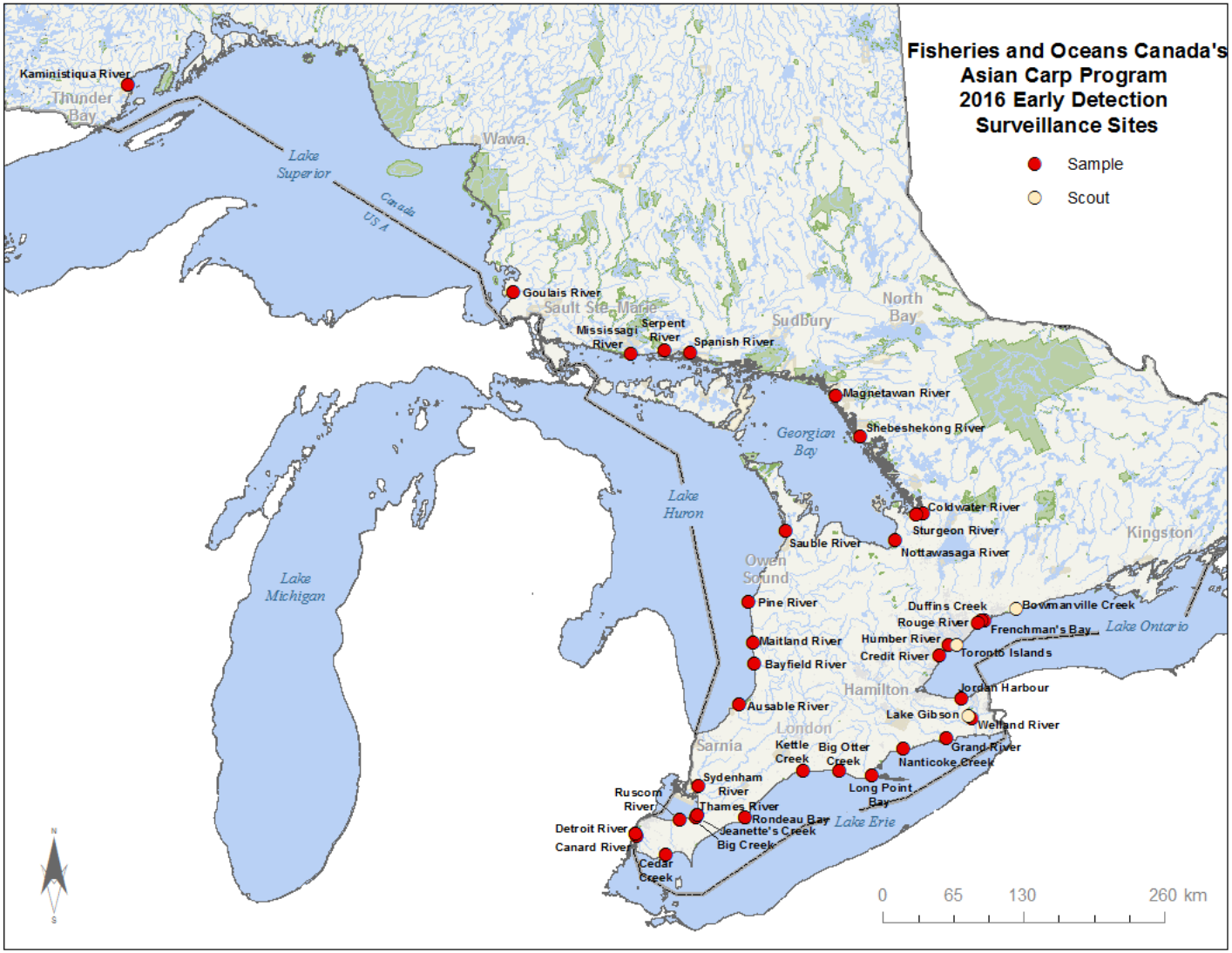

Figure 1. 2016 Asian Carp Program early detection surveillance sites on the Canadian side of the Great Lakes.

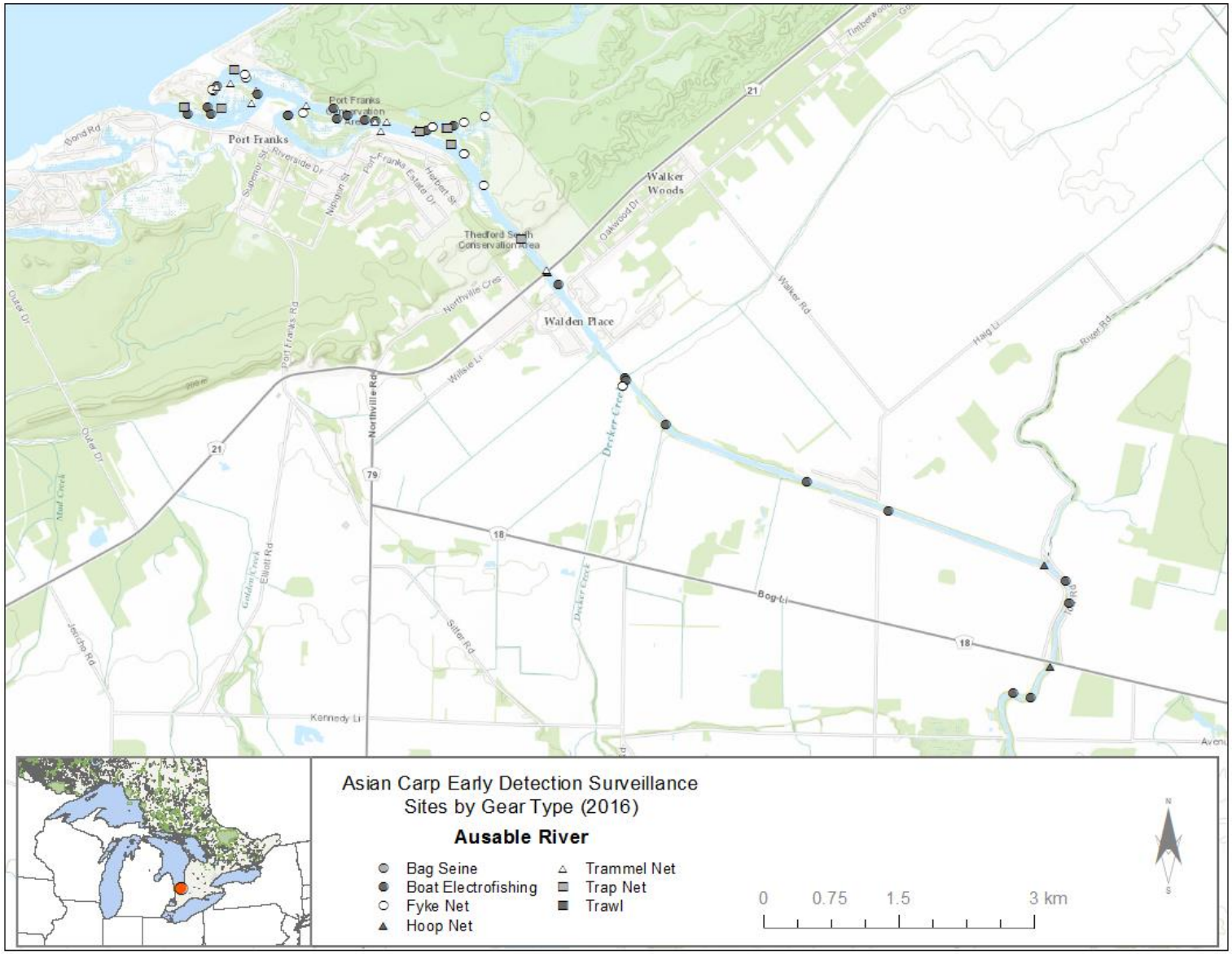

Figure 2. Asian Carp Program early detection surveillance sites and gear types used in the Ausable River in 2016.

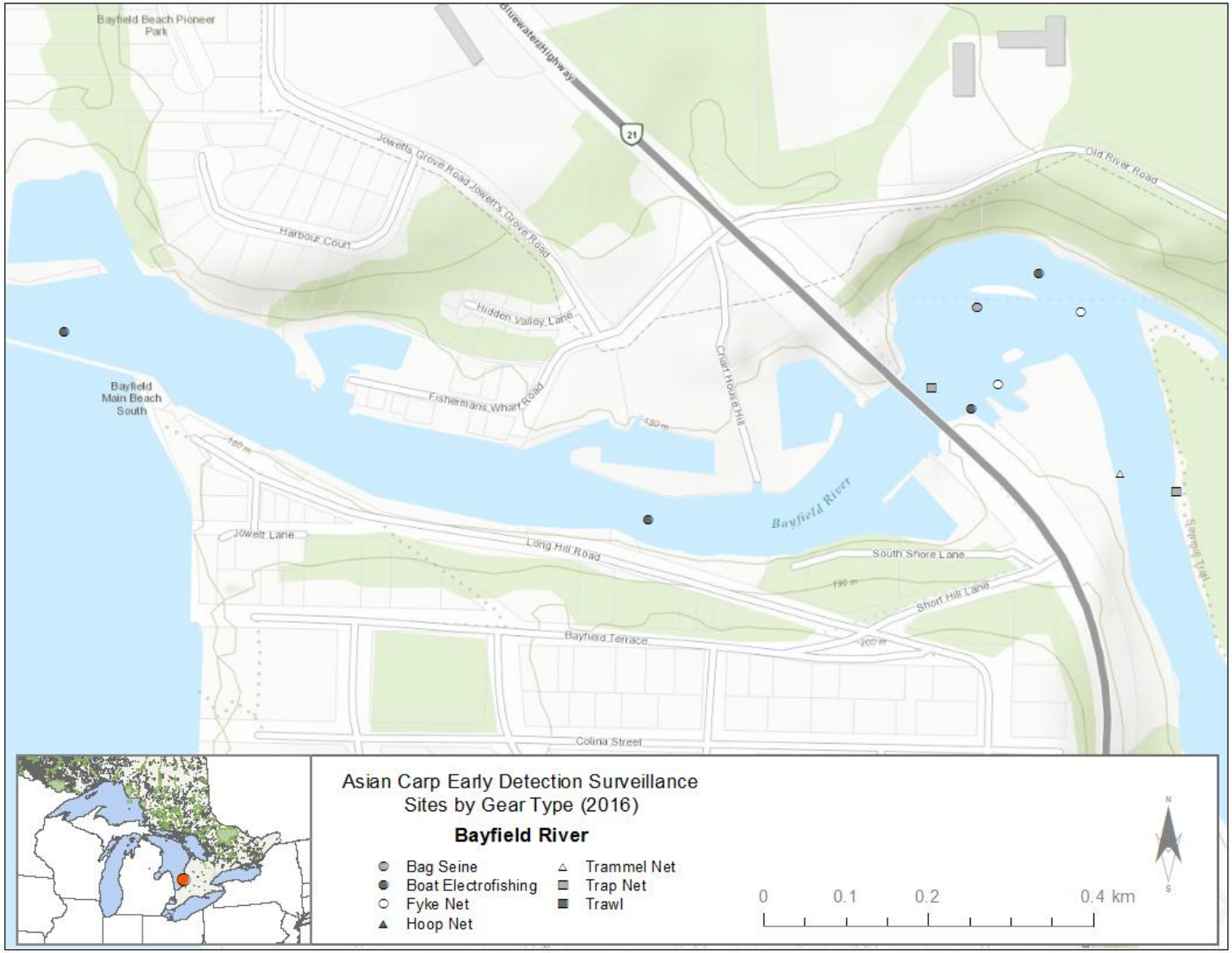

Figure 3. Asian Carp Program early detection surveillance sites and gear types used in the Bayfield River in 2016.

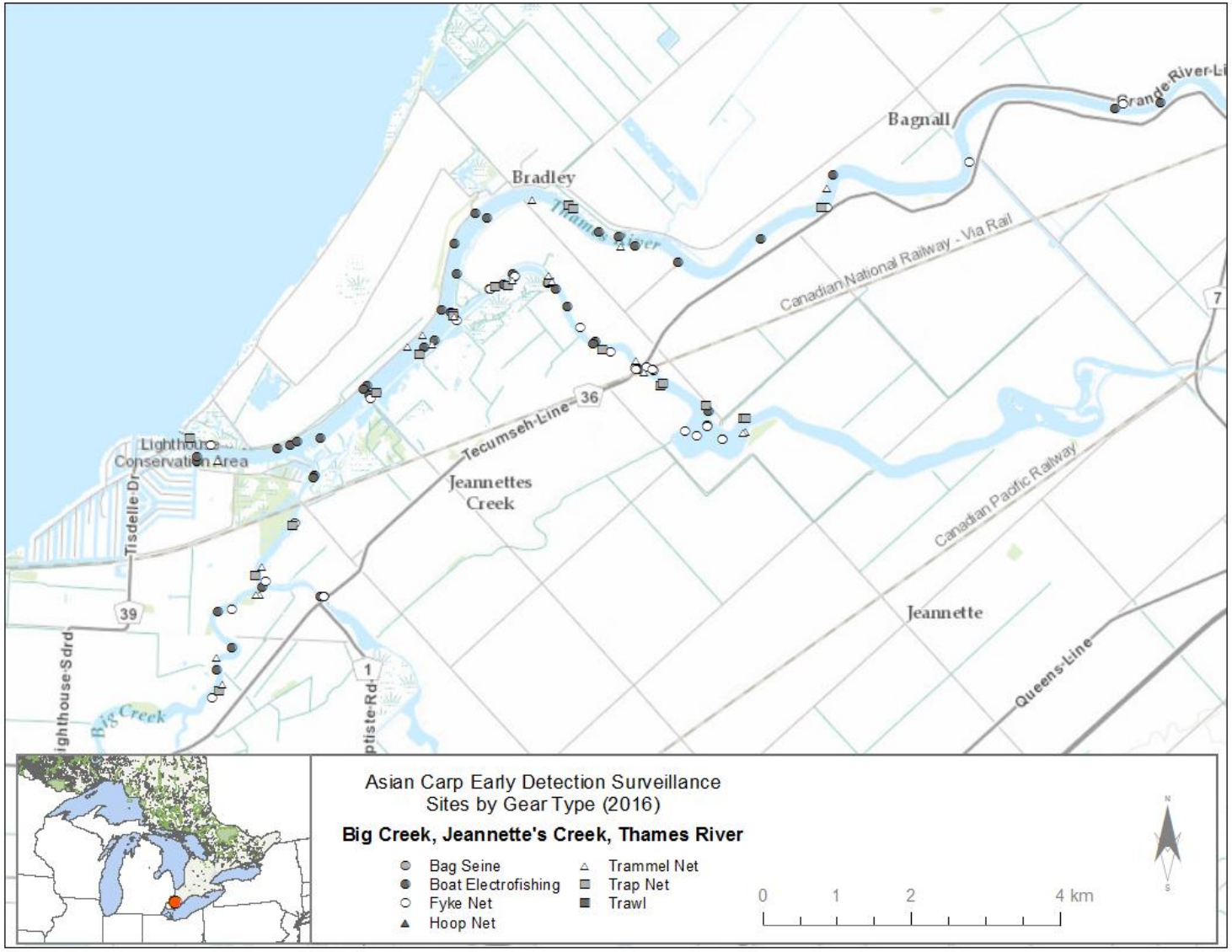

Figure 4. Asian Carp Program early detection surveillance sites and gear types used in Big Creek, Jeannette's Creek and the Thames River in 2016.

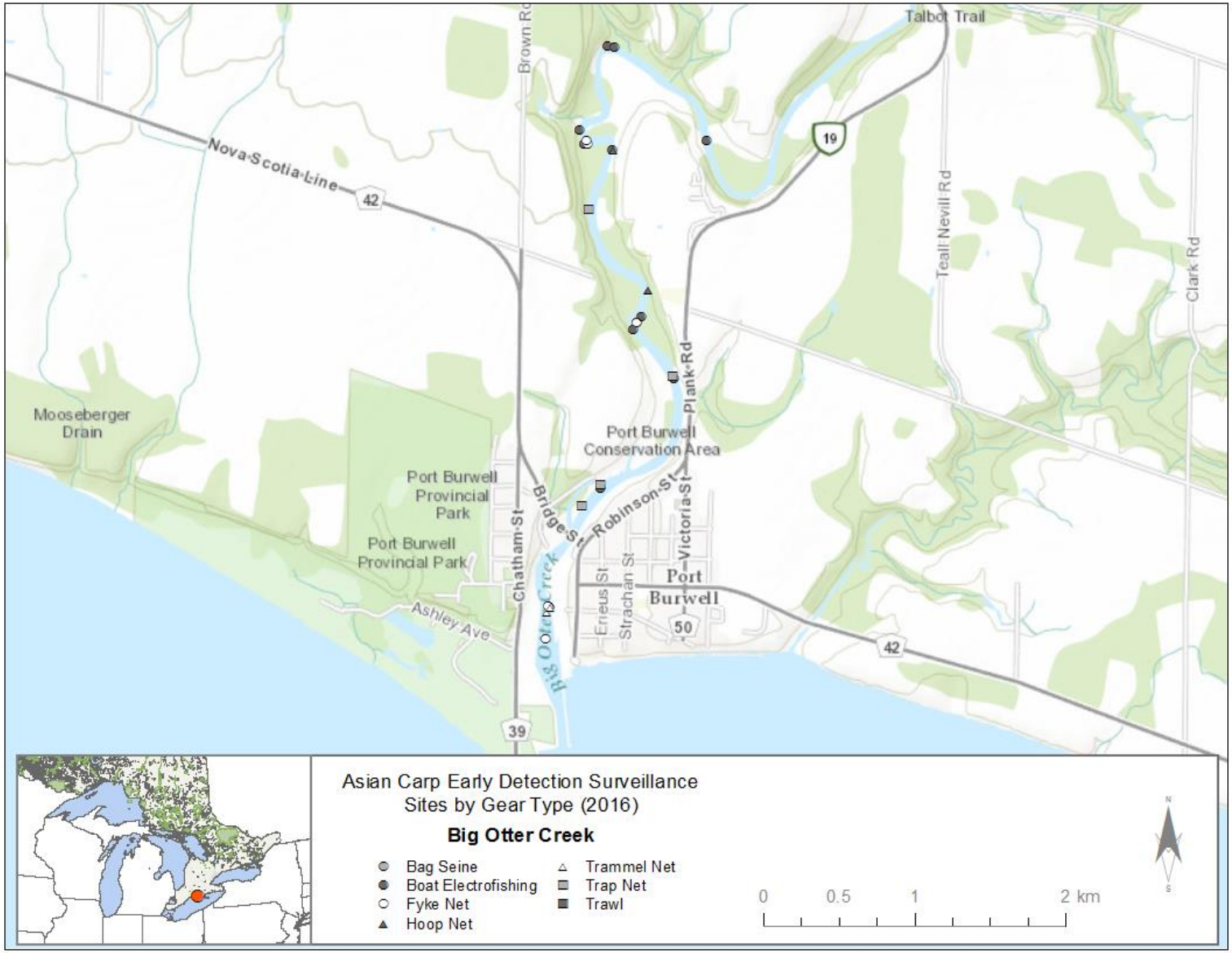

Figure 5. Asian Carp Program early detection surveillance sites and gear types used in Big Otter Creek in 2016.

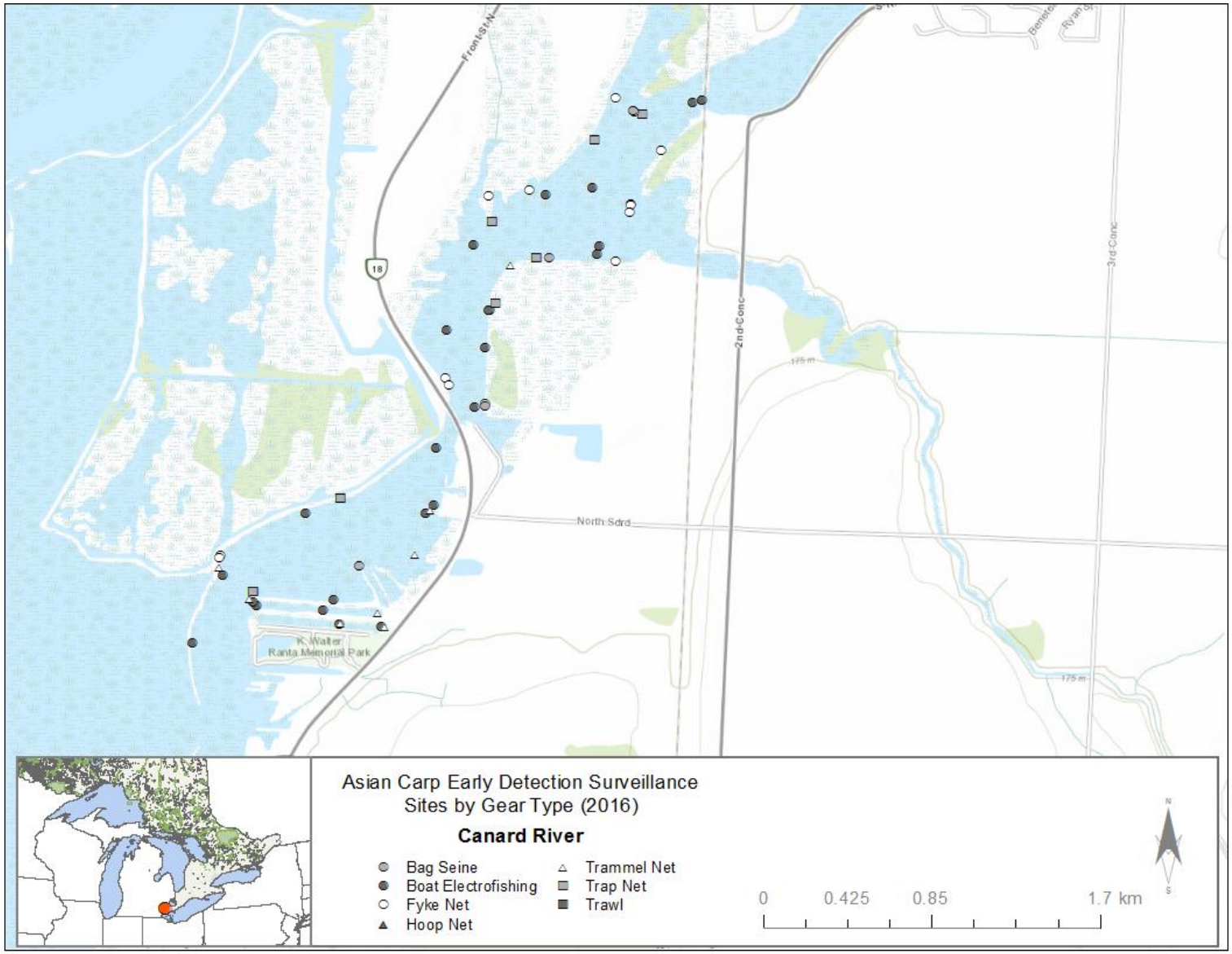

Figure 6. Asian Carp Program early detection surveillance sites and gear types used in the Canard River in 2016.

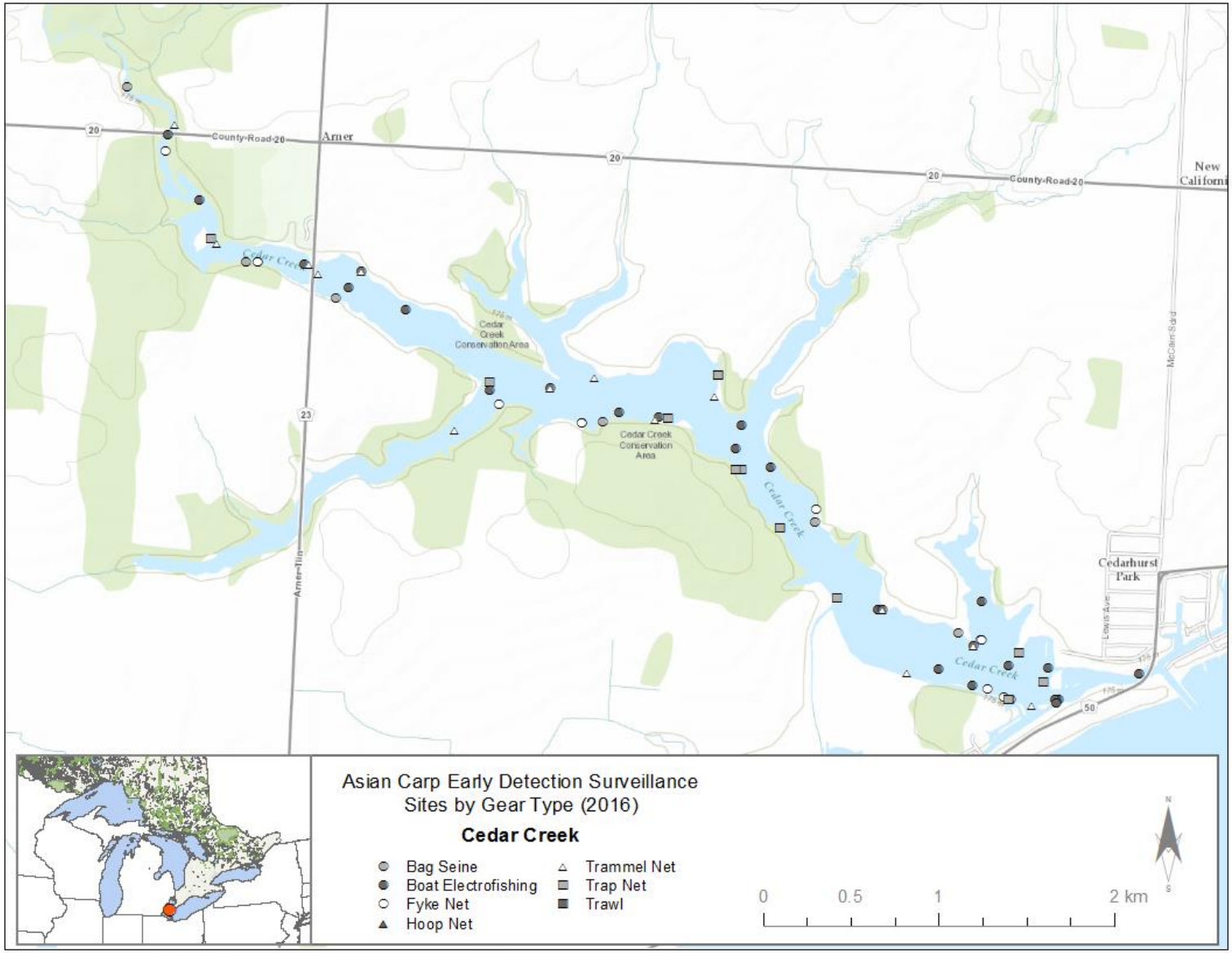

Figure 7. Asian Carp Program early detection surveillance sites and gear types used in Cedar Creek in 2016.

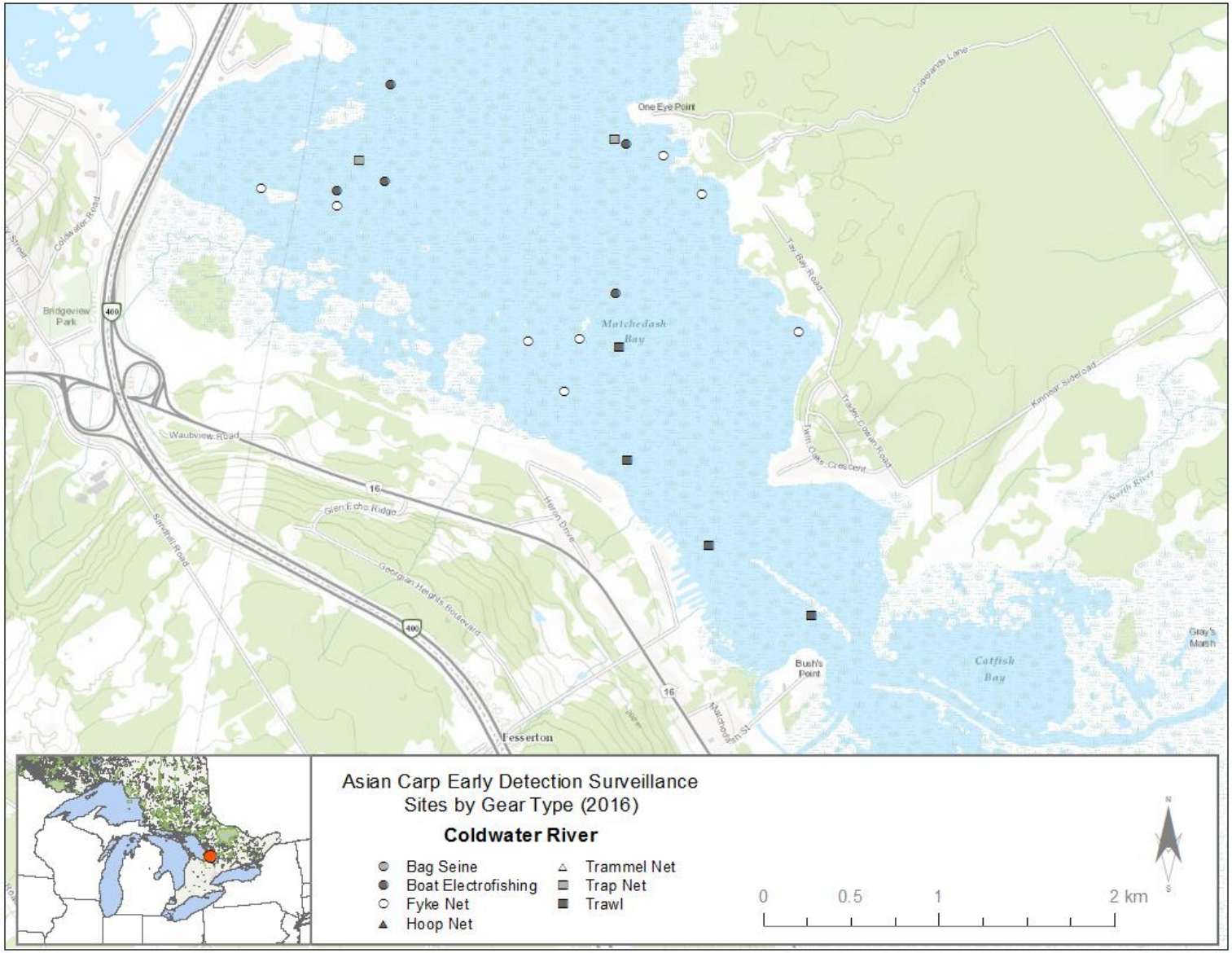

Figure 8. Asian Carp Program early detection surveillance sites and gear types used in the Coldwater River in 2016.

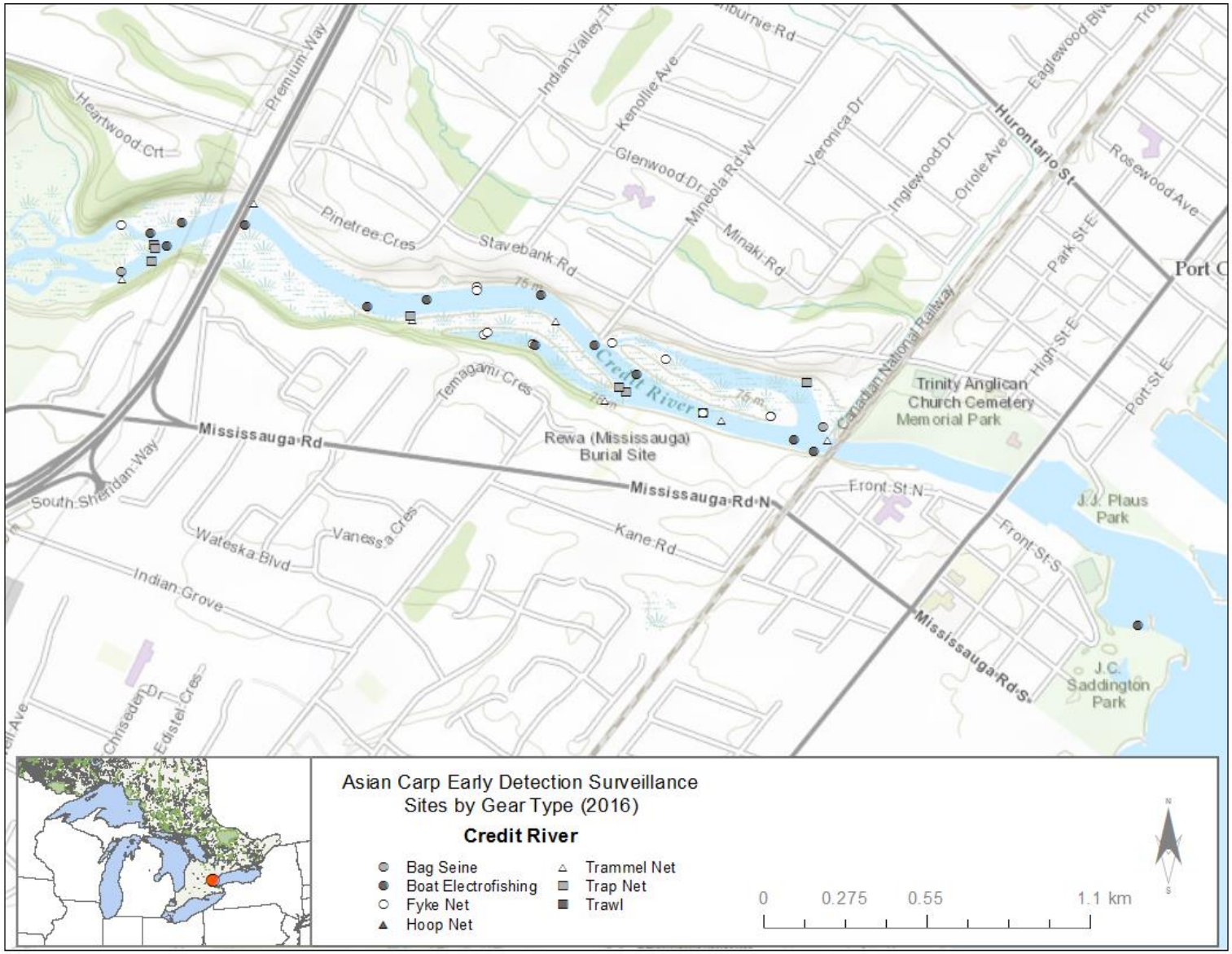

Figure 9. Asian Carp Program early detection surveillance sites and gear types used in the Credit River in 2016.

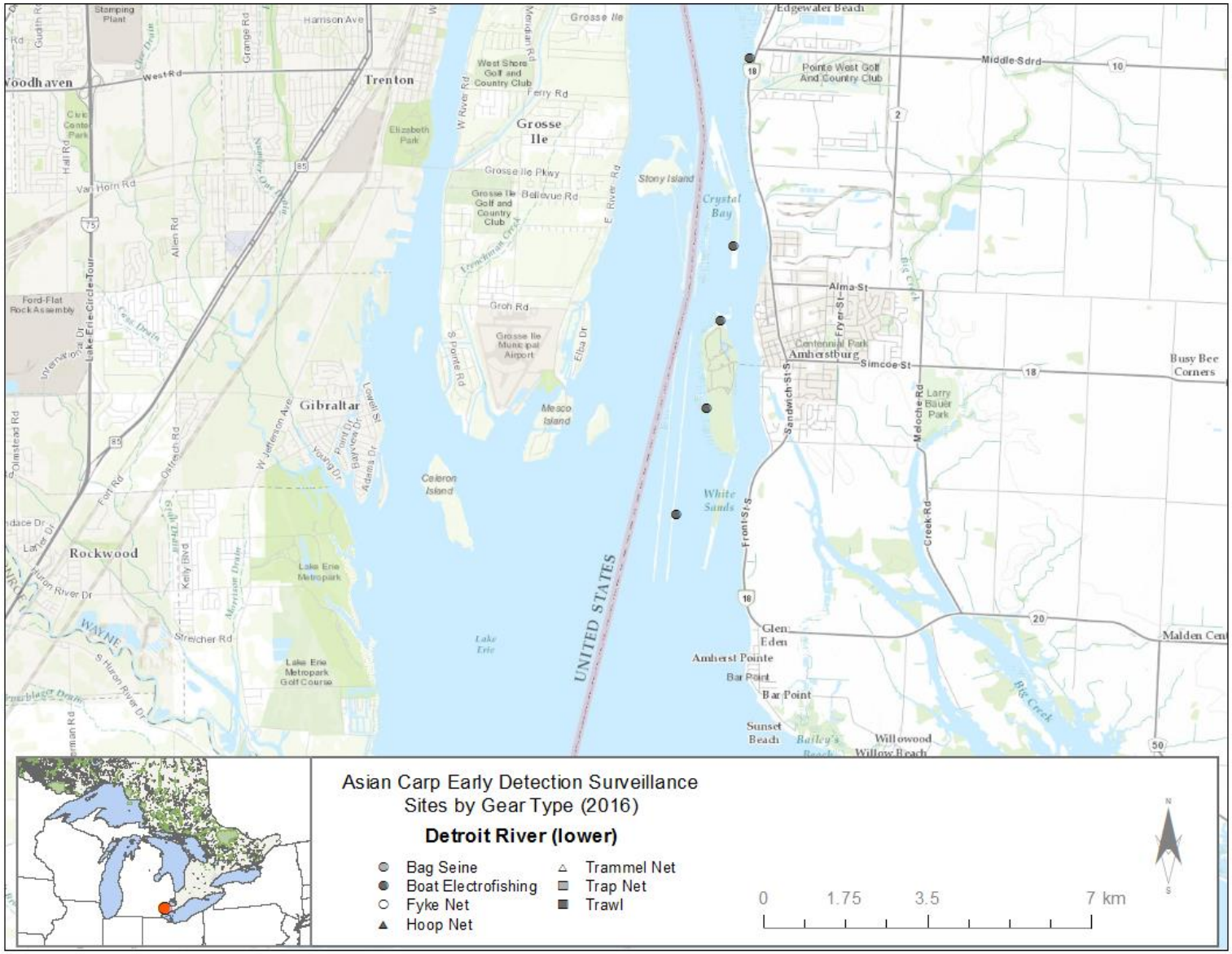

Figure 10. Asian Carp Program early detection surveillance sites and gear types used in the lower Detroit River in 2016.

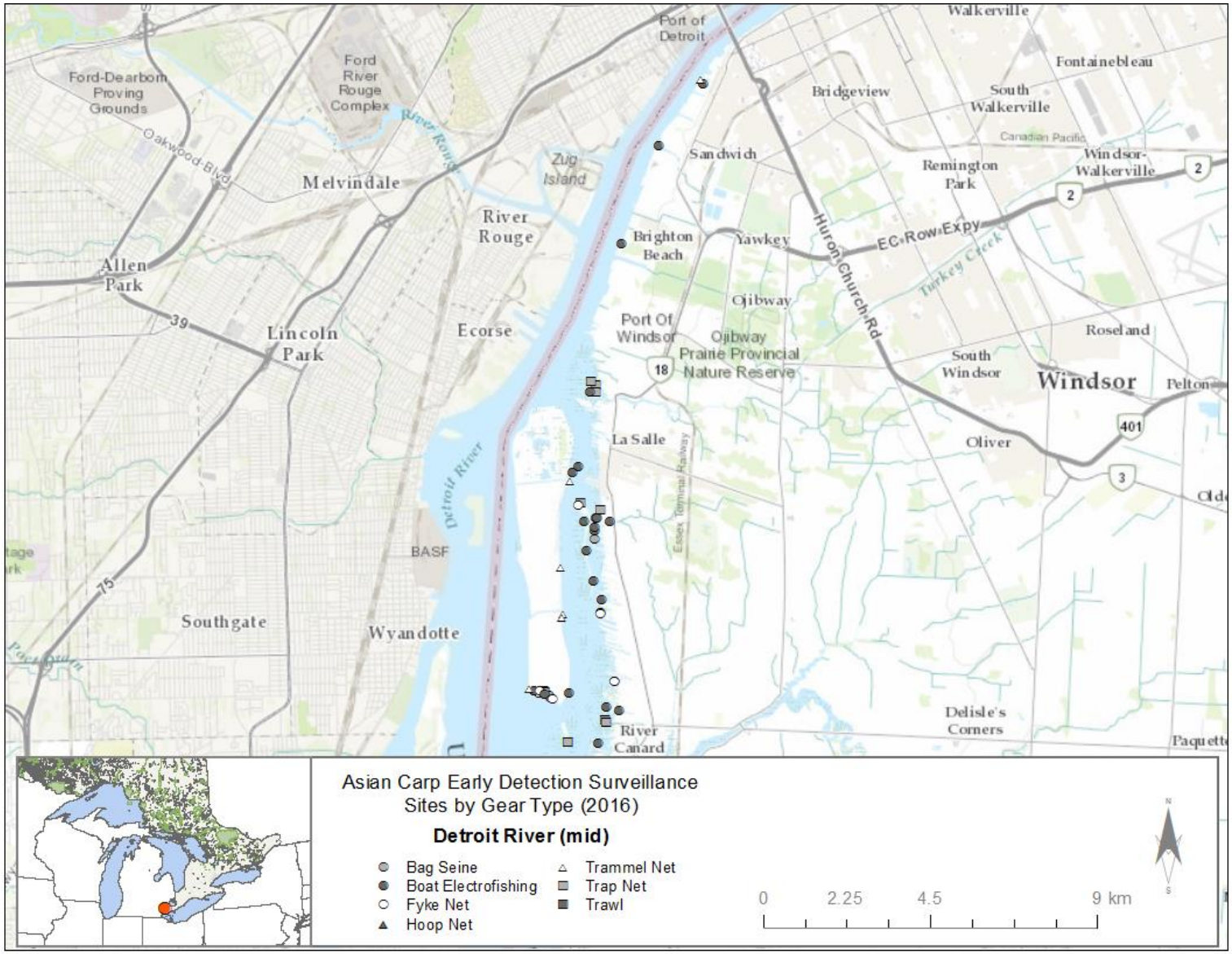

Figure 11. Asian Carp Program early detection surveillance sites and gear types used in the mid Detroit River in 2016.

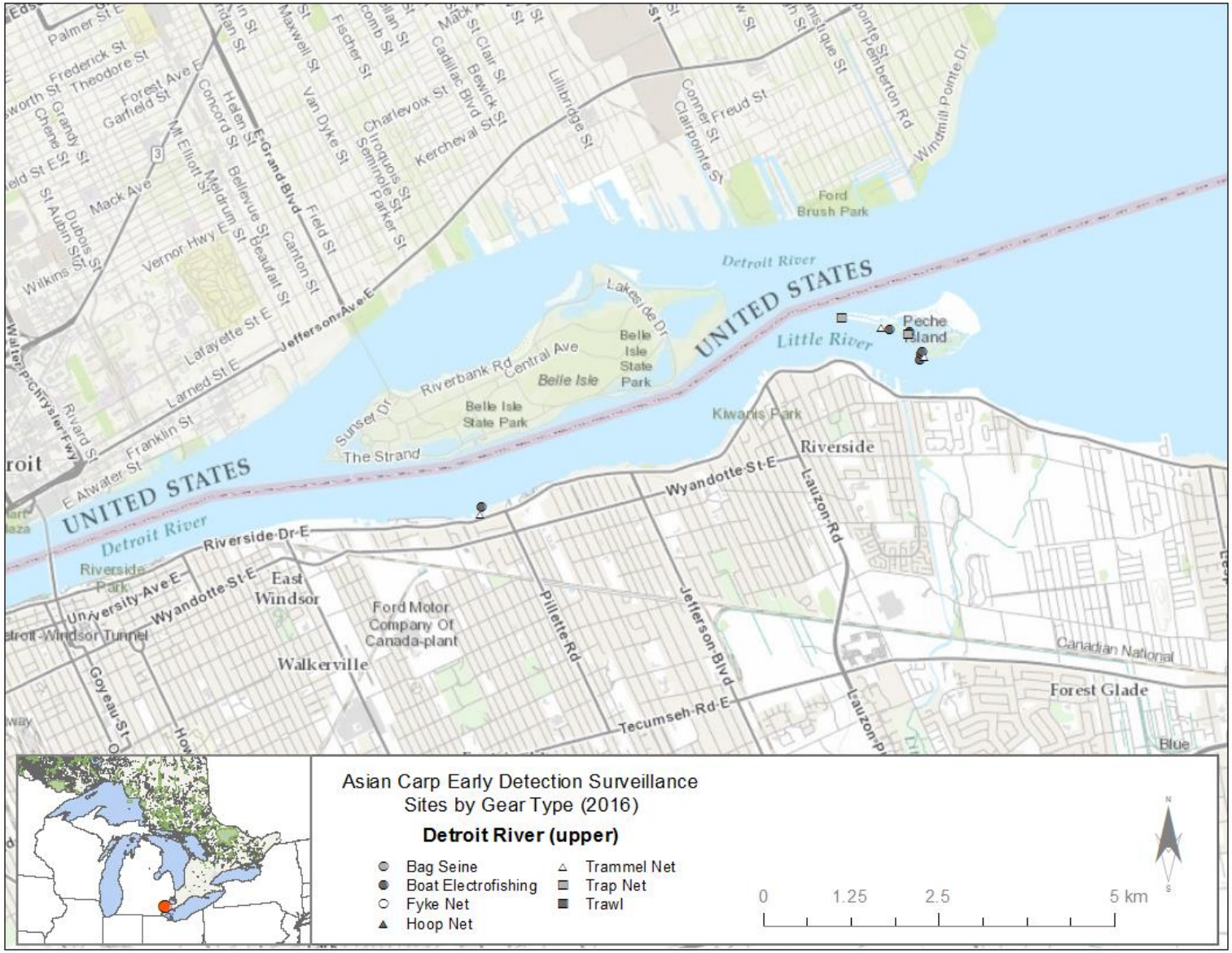

Figure 12. Asian Carp Program early detection surveillance sites and gear types used in the upper Detroit River in 2016.

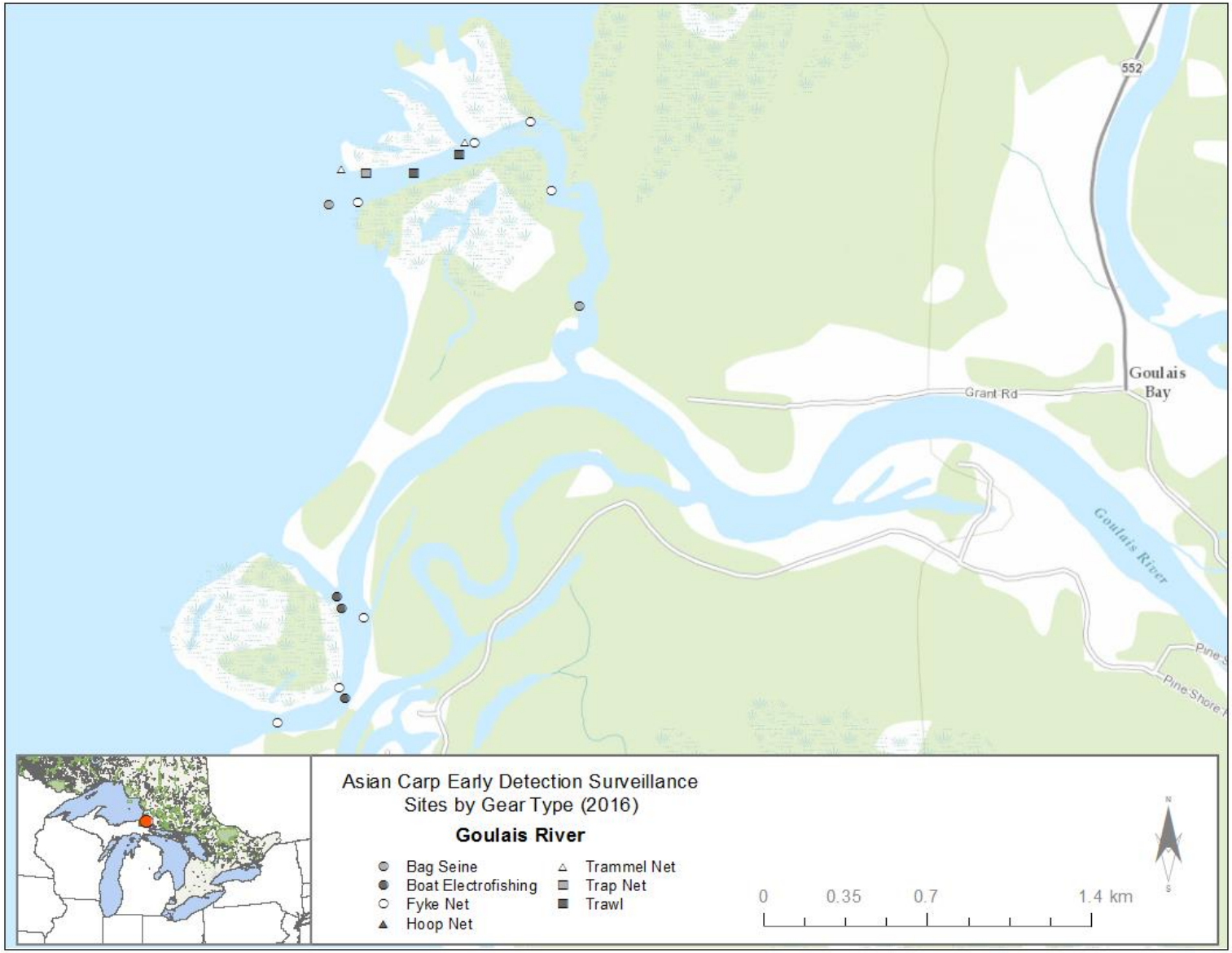

Figure 13. Asian Carp Program early detection surveillance sites and gear types used in the Goulais River in 2016.

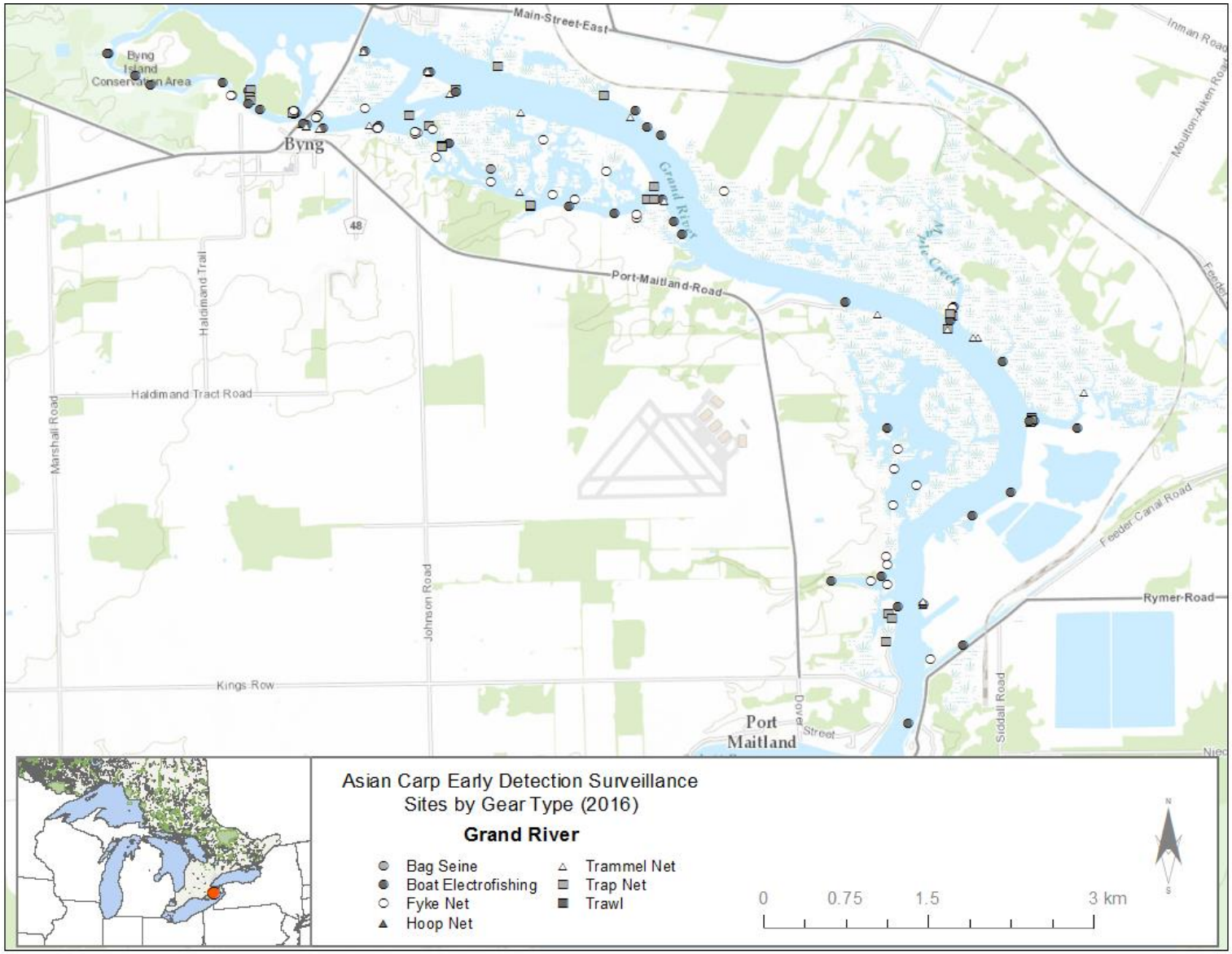

Figure 14. Asian Carp Program early detection surveillance sites and gear types used in the Grand River in 2016.

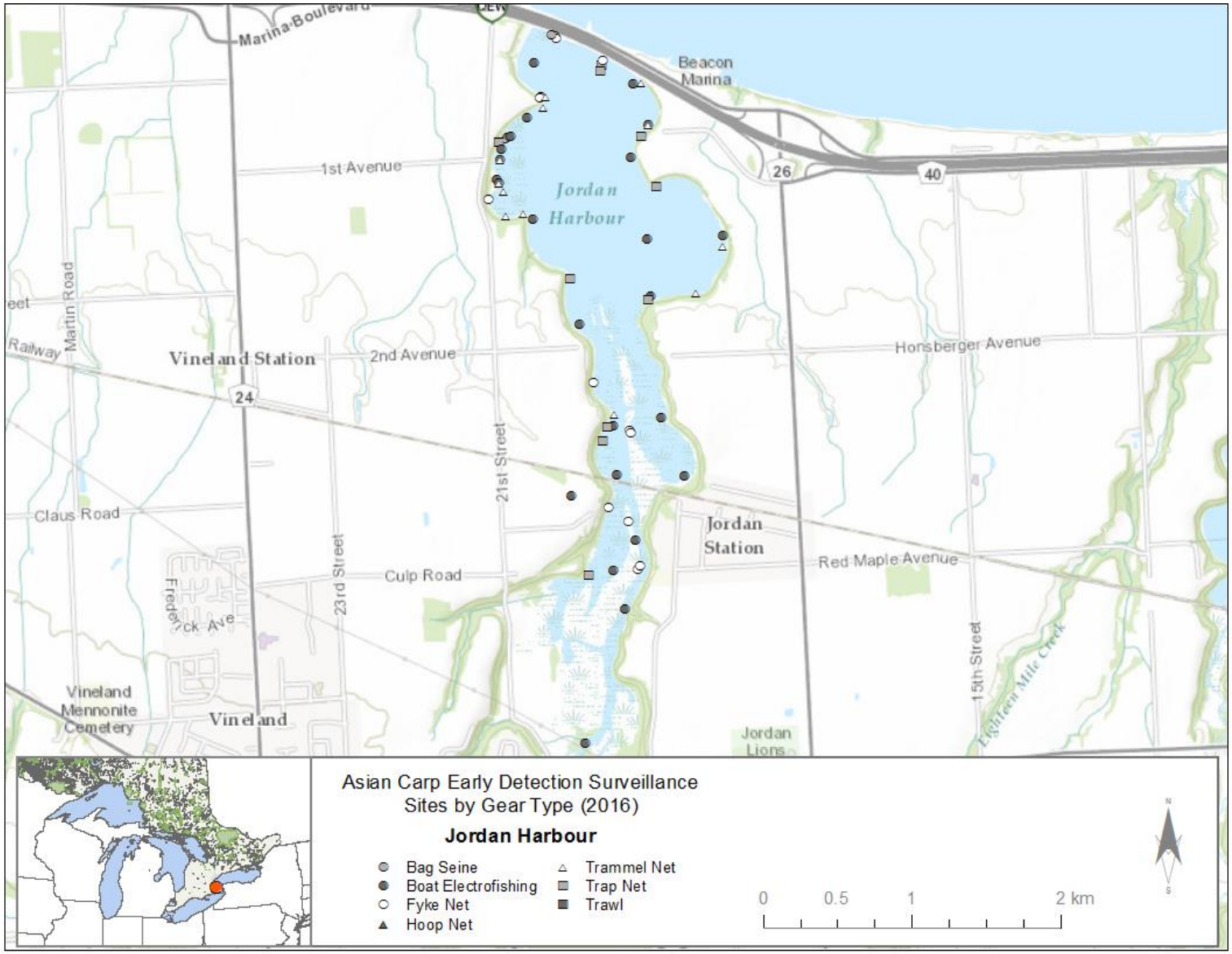

Figure 15. Asian Carp Program early detection surveillance sites and gear types used in Jordan Harbour in 2016.

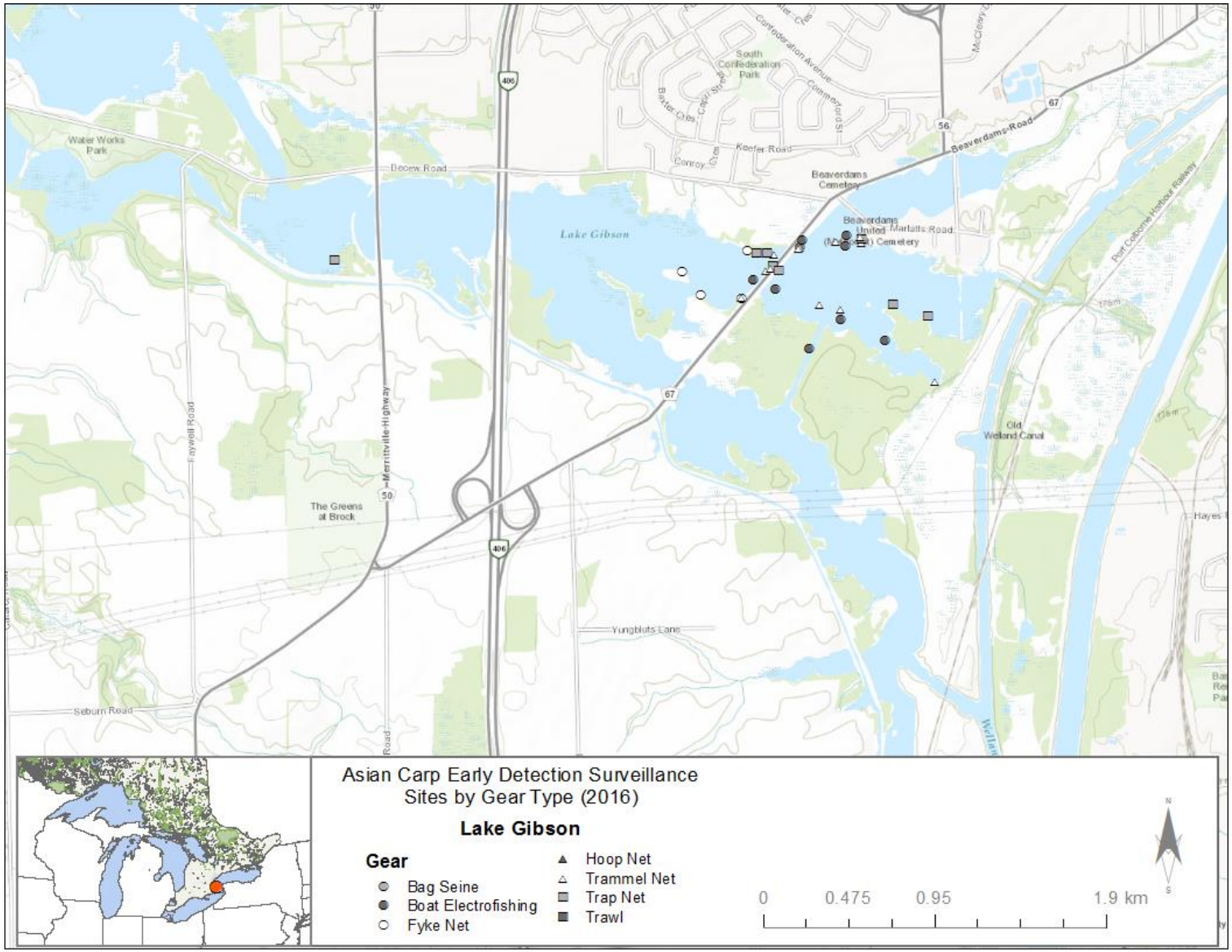

Figure 16. Asian Carp Program early detection surveillance sites and gear types used in Lake Gibson in 2016.

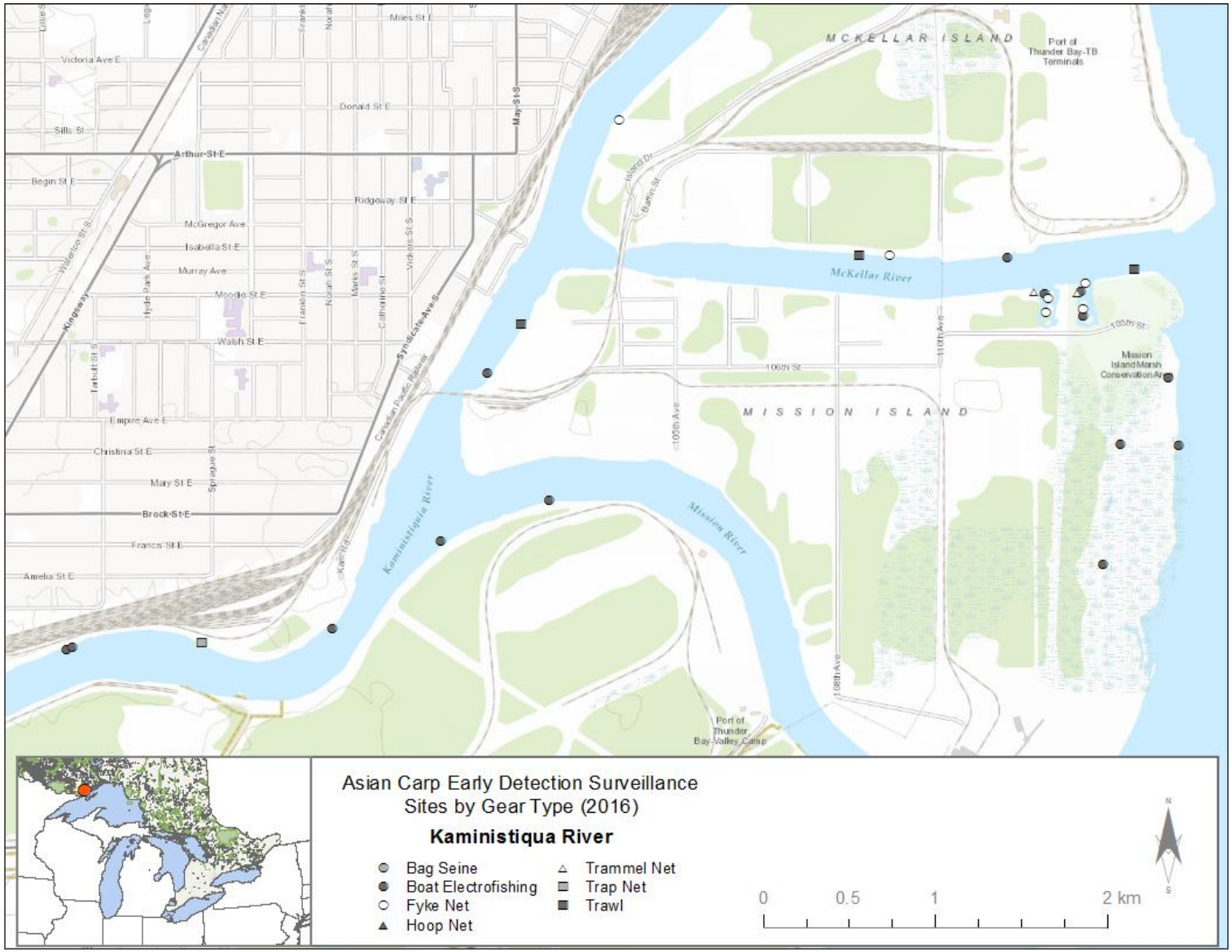

Figure 17. Asian Carp Program early detection surveillance sites and gear types used in the Kaministiqua River in 2016.

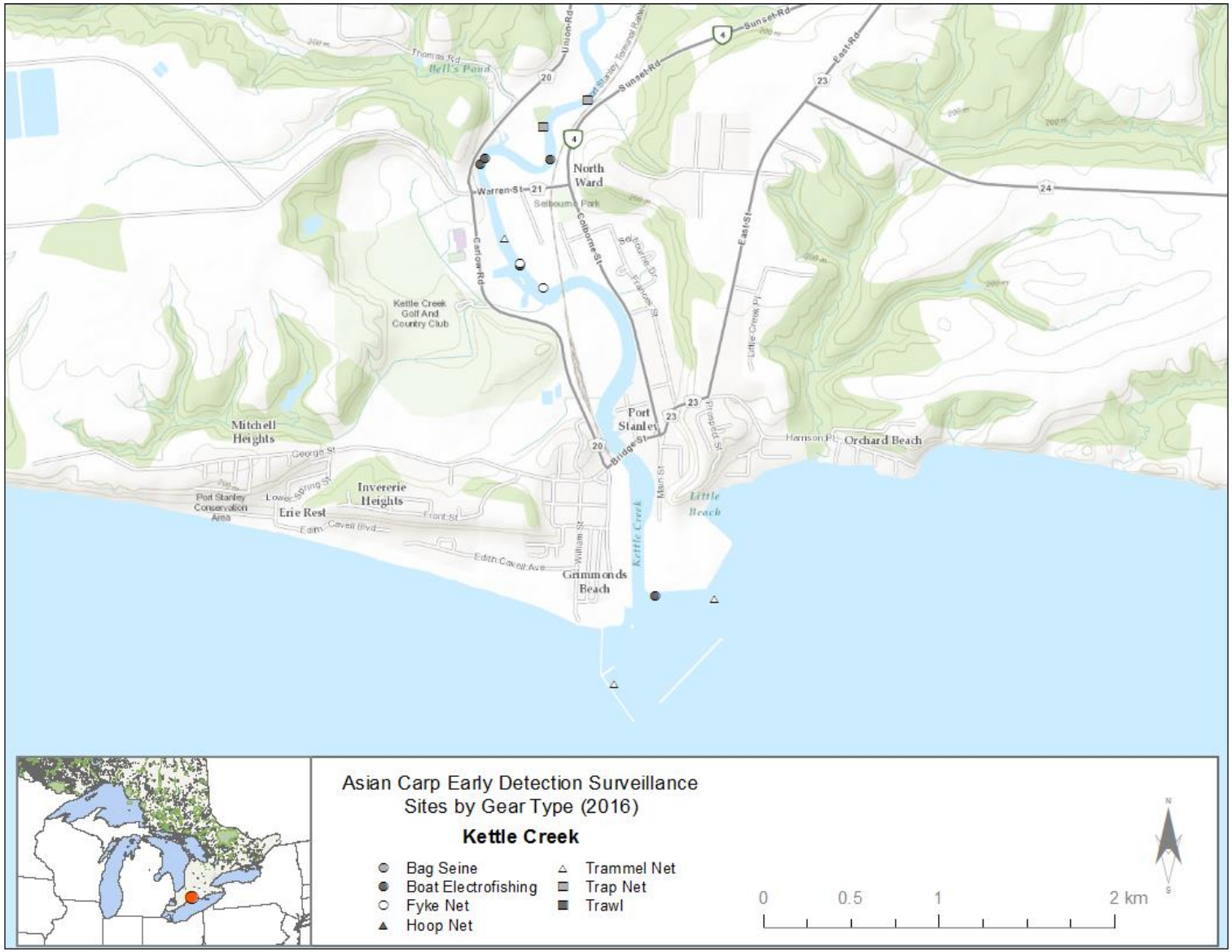

Figure 18. Asian Carp Program early detection surveillance sites and gear types used in Kettle Creek in 2016.

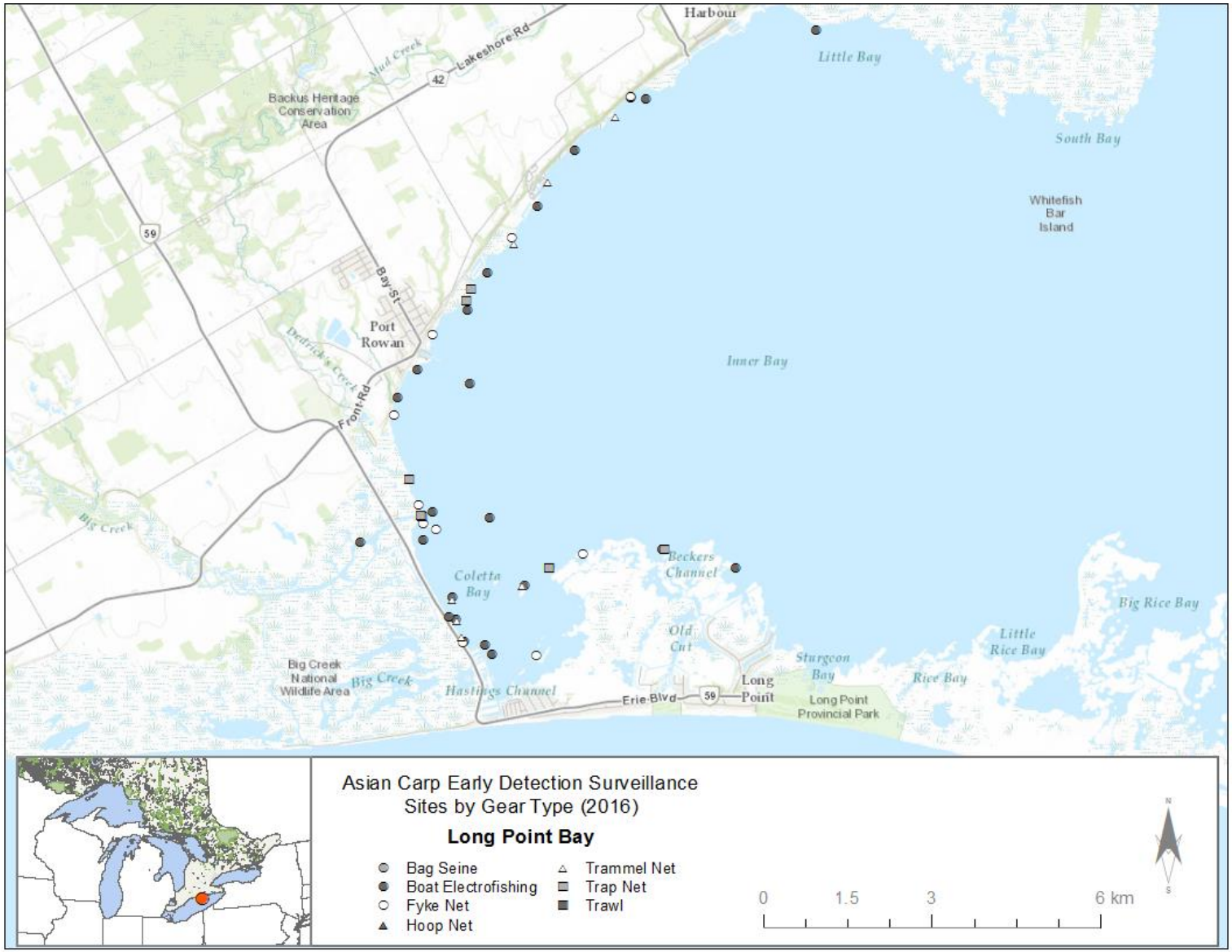

Figure 19. Asian Carp Program early detection surveillance sites and gear types used in Long Point Bay in 2016.

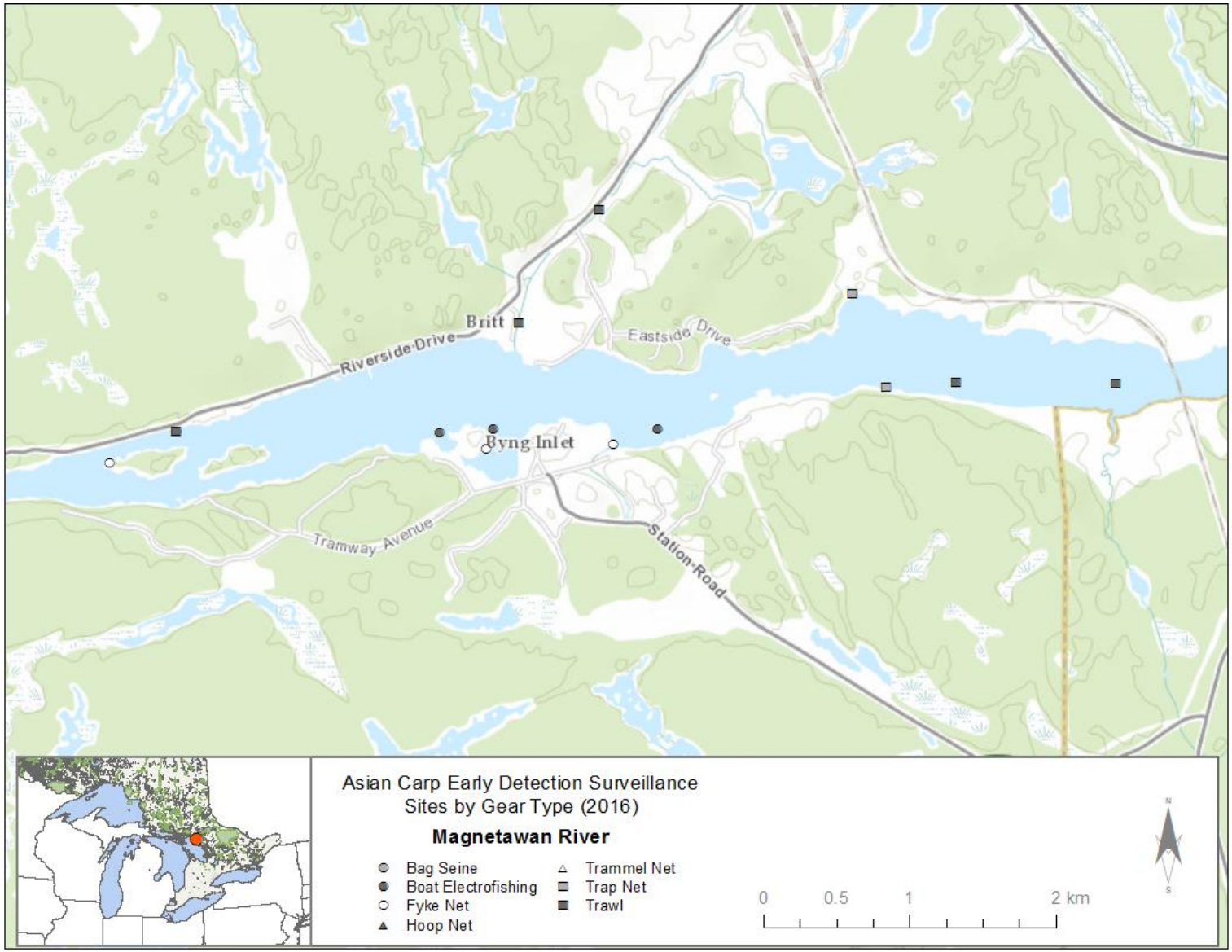

Figure 20. Asian Carp Program early detection surveillance sites and gear types used in the Magnetawan River in 2016.

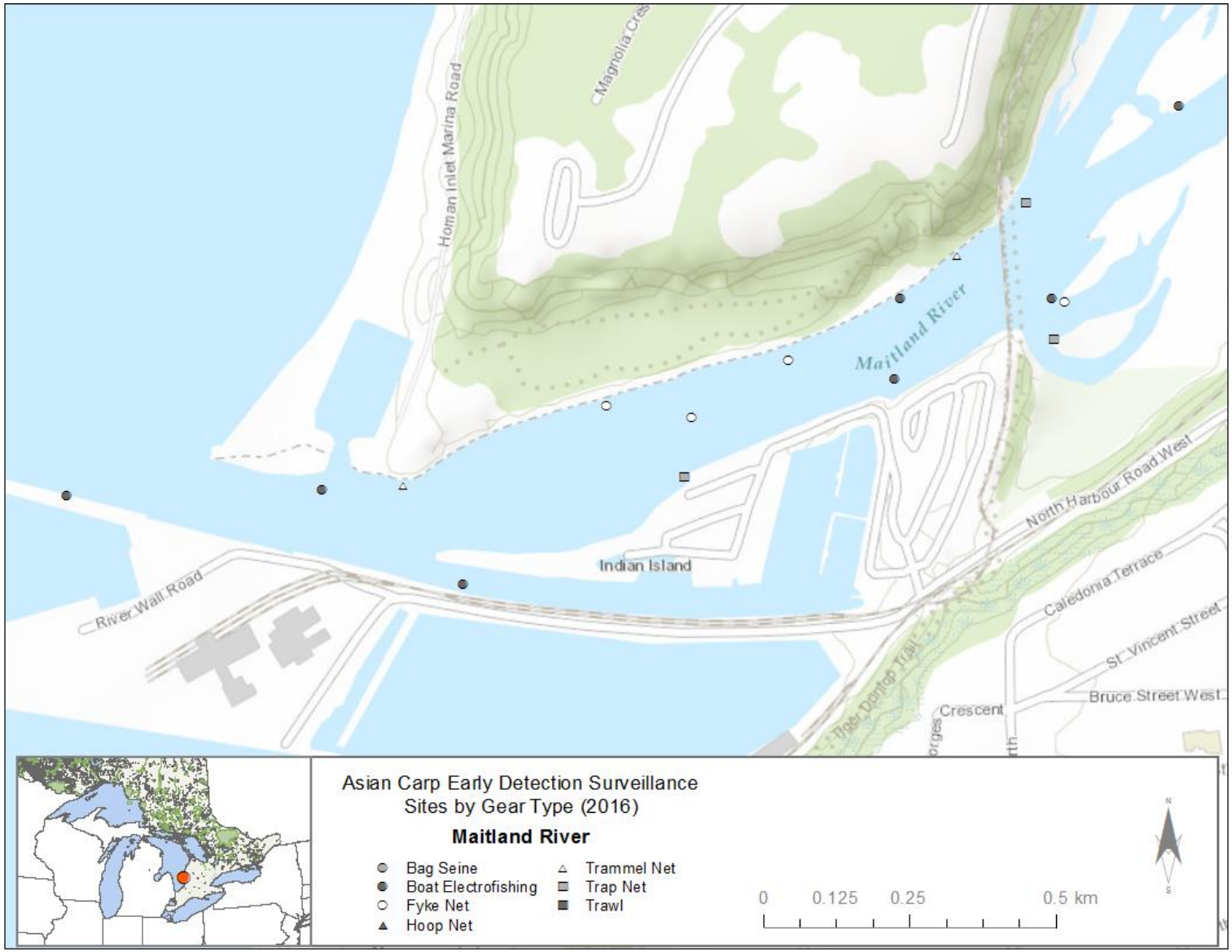

Figure 21. Asian Carp Program early detection surveillance sites and gear types used in the Maitland River in 2016.

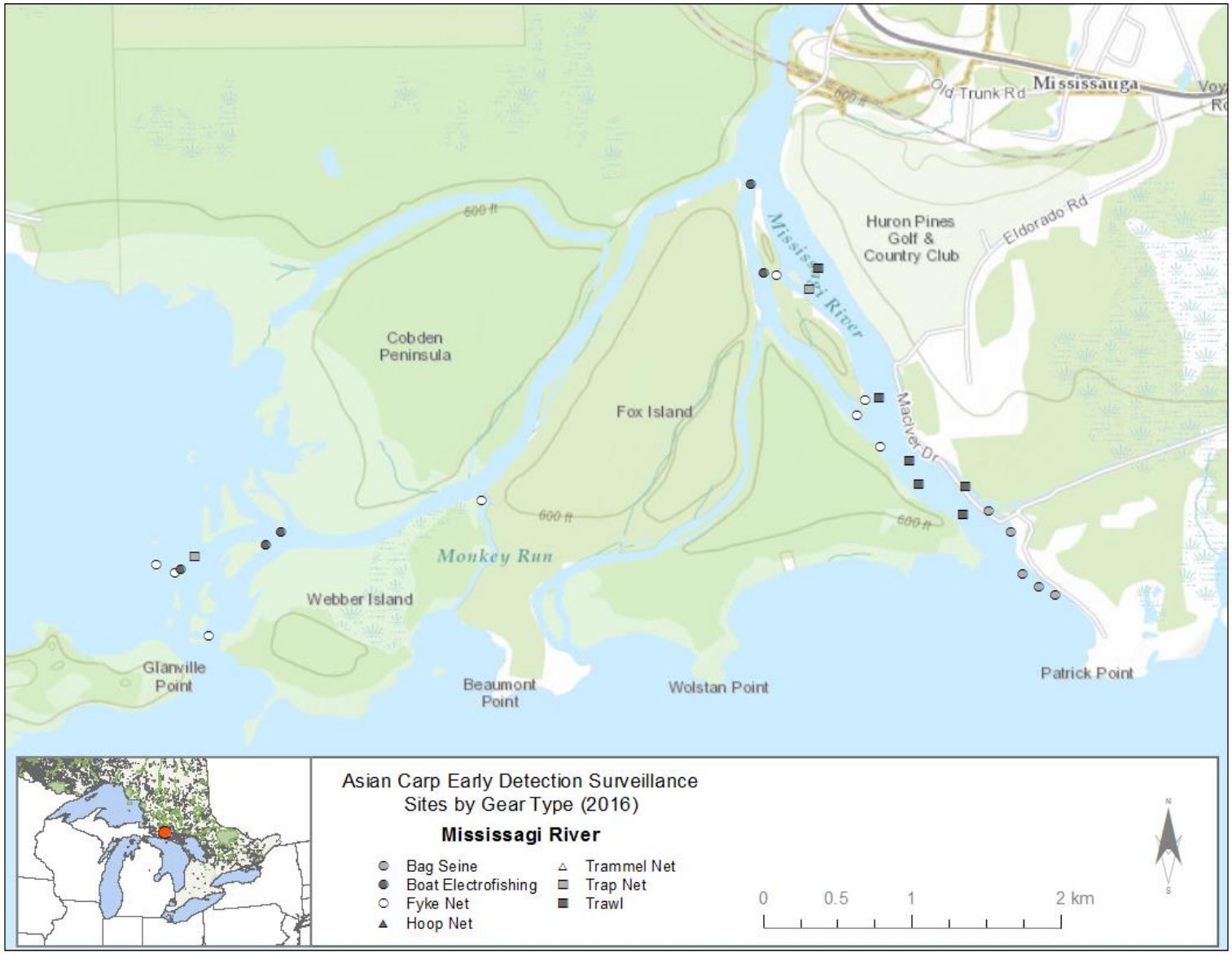

Figure 22. Asian Carp Program early detection surveillance sites and gear types used in the Mississagi River in 2016.

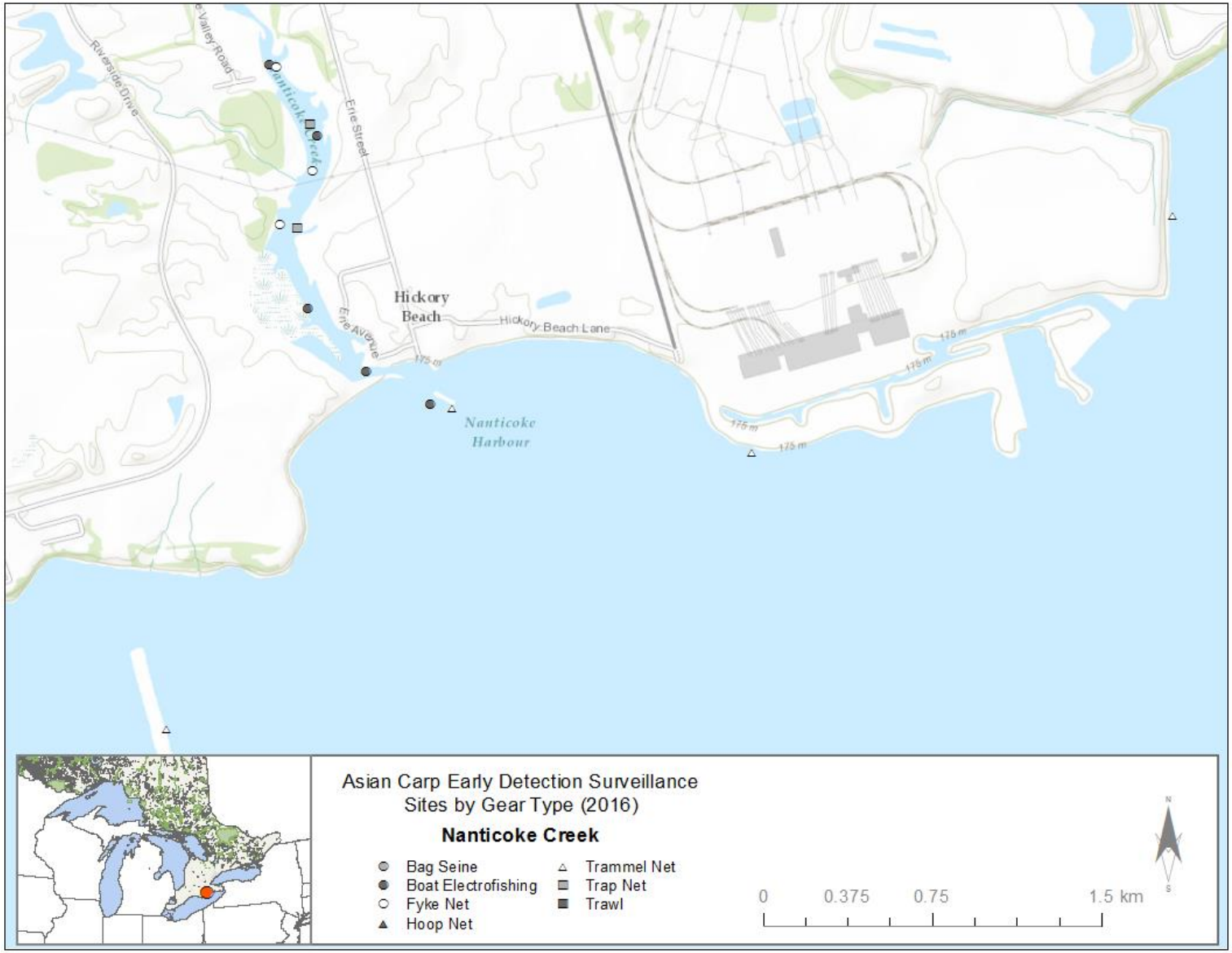

Figure 23. Asian Carp Program early detection surveillance sites and gear types used in Nanticoke Creek in 2016.

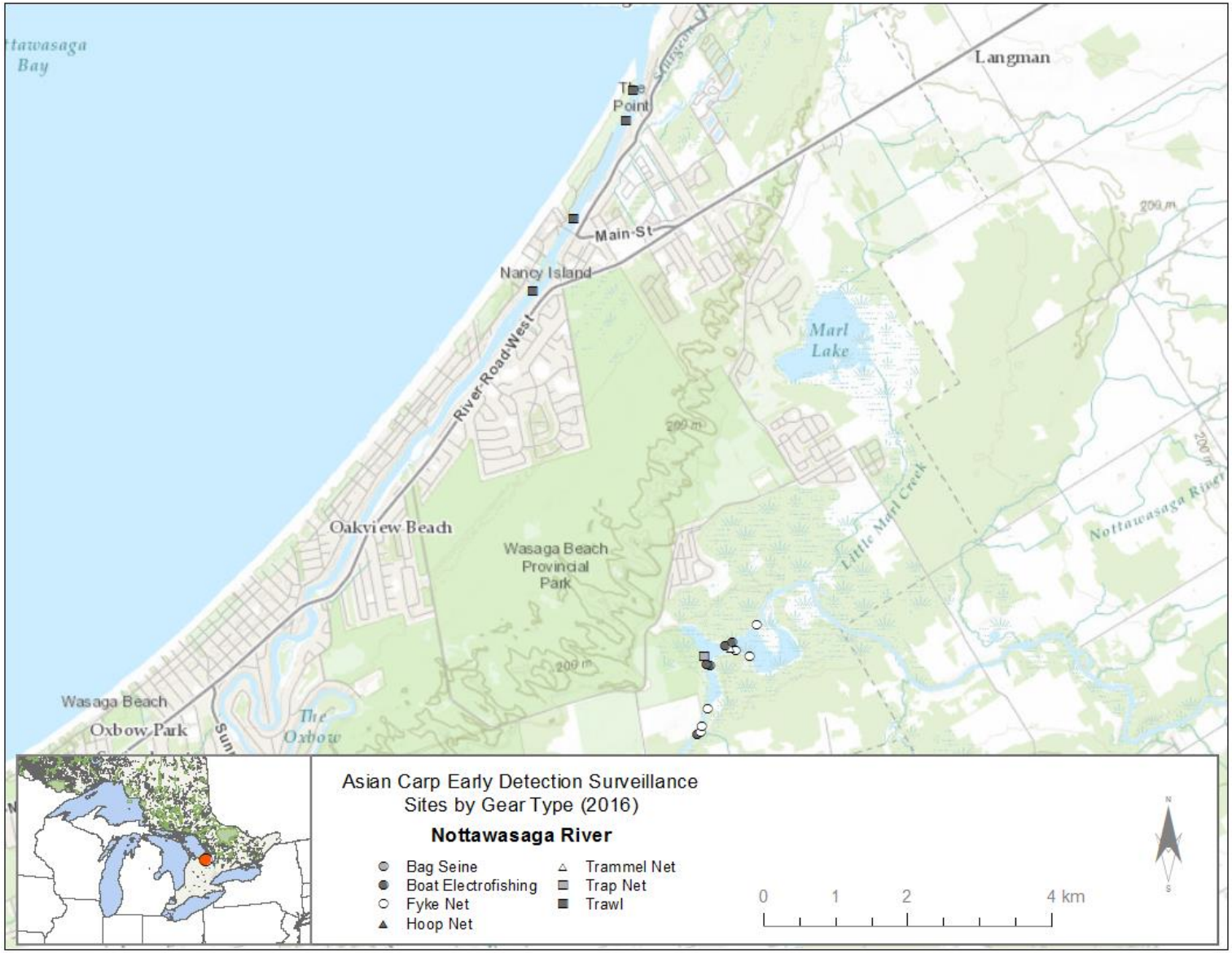

Figure 24. Asian Carp Program early detection surveillance sites and gear types used in the Nottawasaga River in 2016.

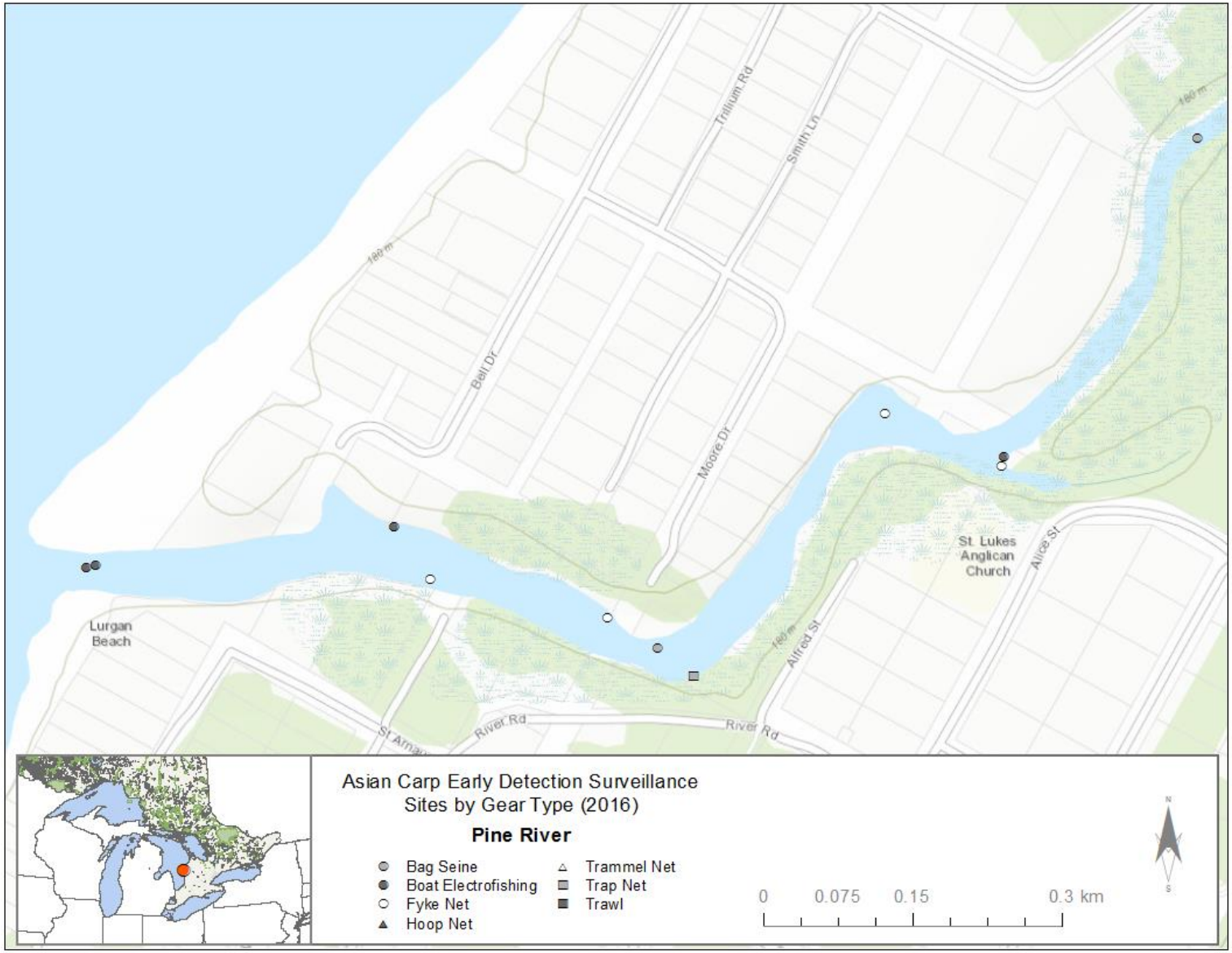

Figure 25. Asian Carp Program early detection surveillance sites and gear types used in the Pine River in 2016.

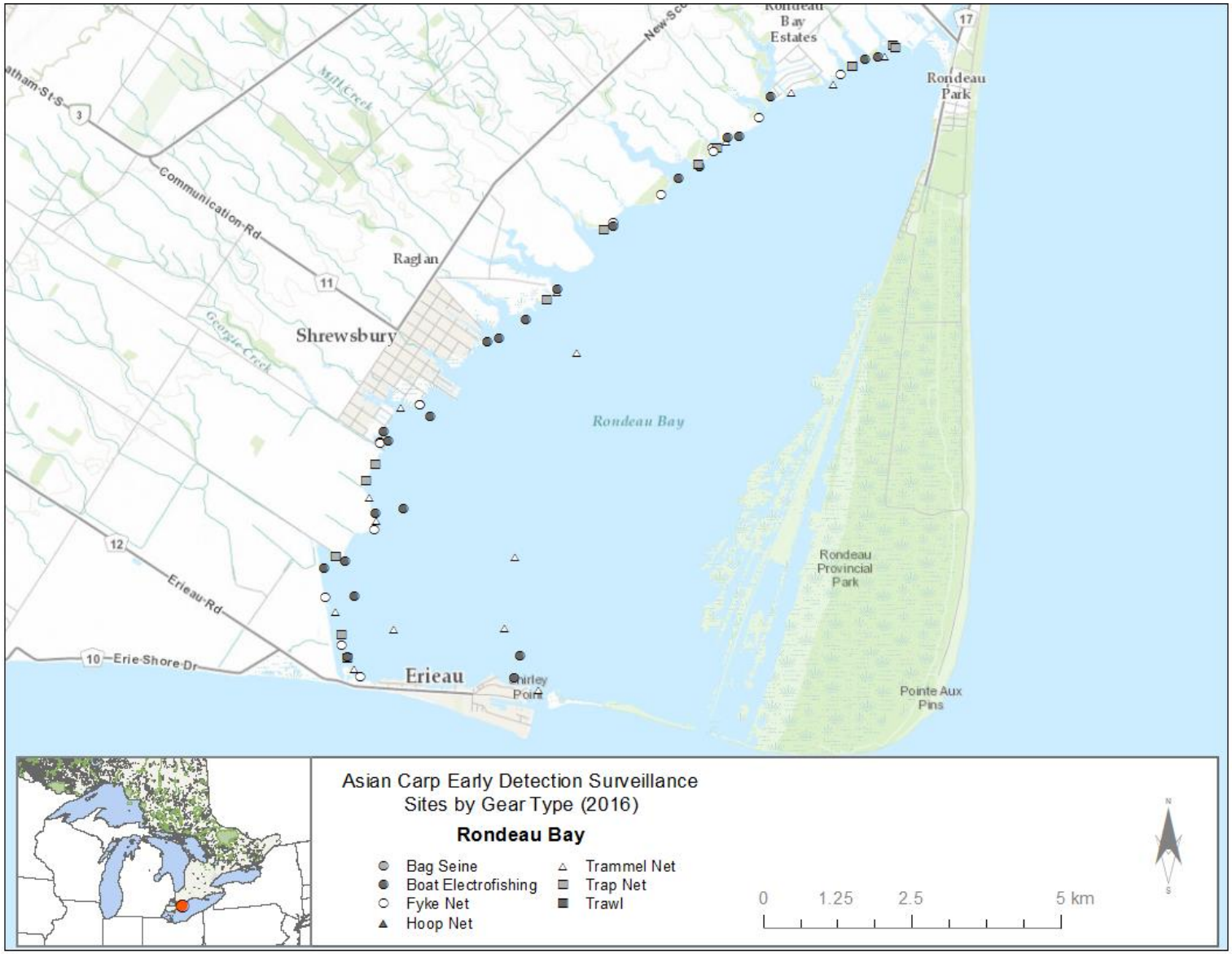

Figure 26. Asian Carp Program early detection surveillance sites and gear types used in Rondeau Bay in 2016.

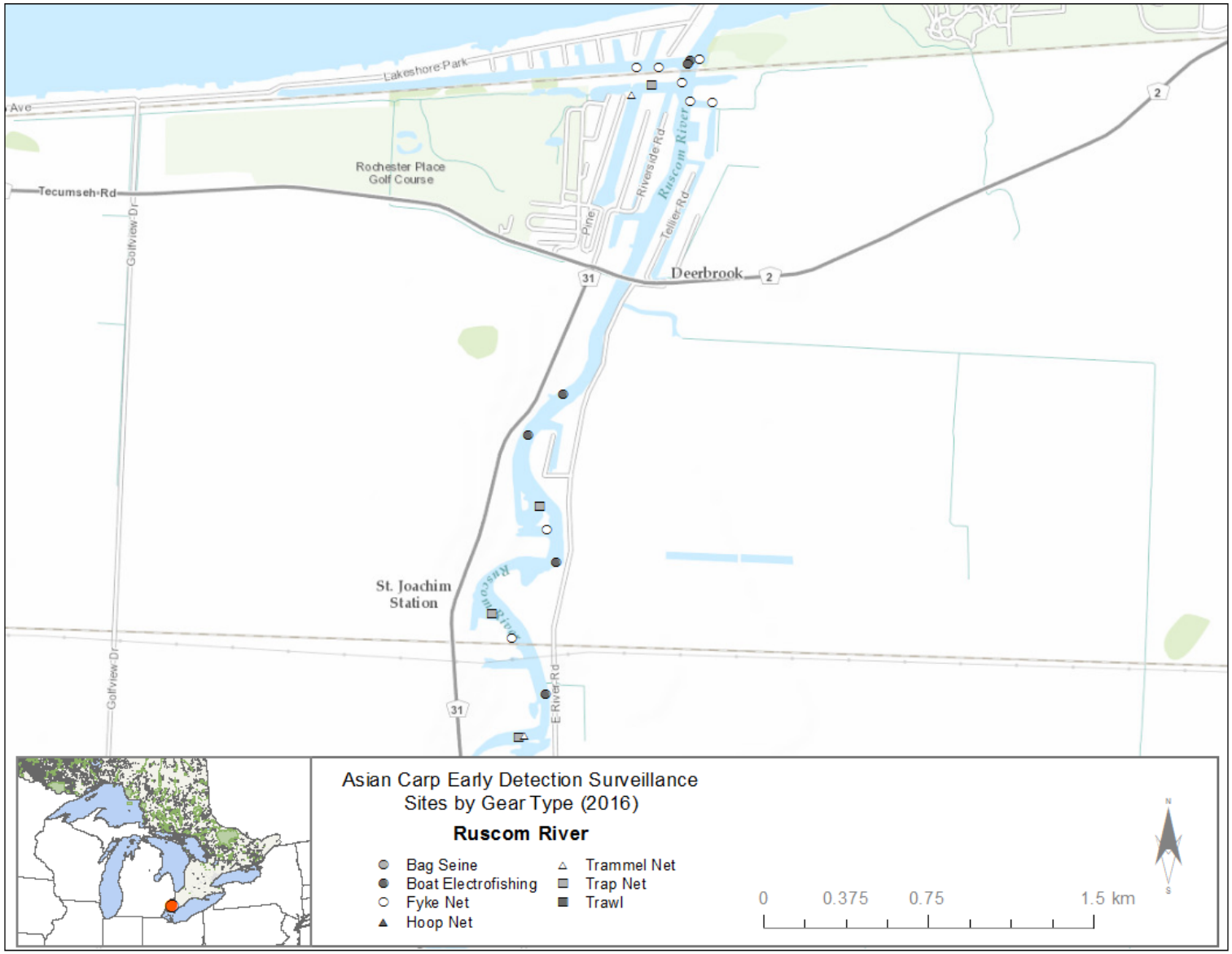

Figure 27. Asian Carp Program early detection surveillance sites and gear types used in the Ruscom River in 2016.

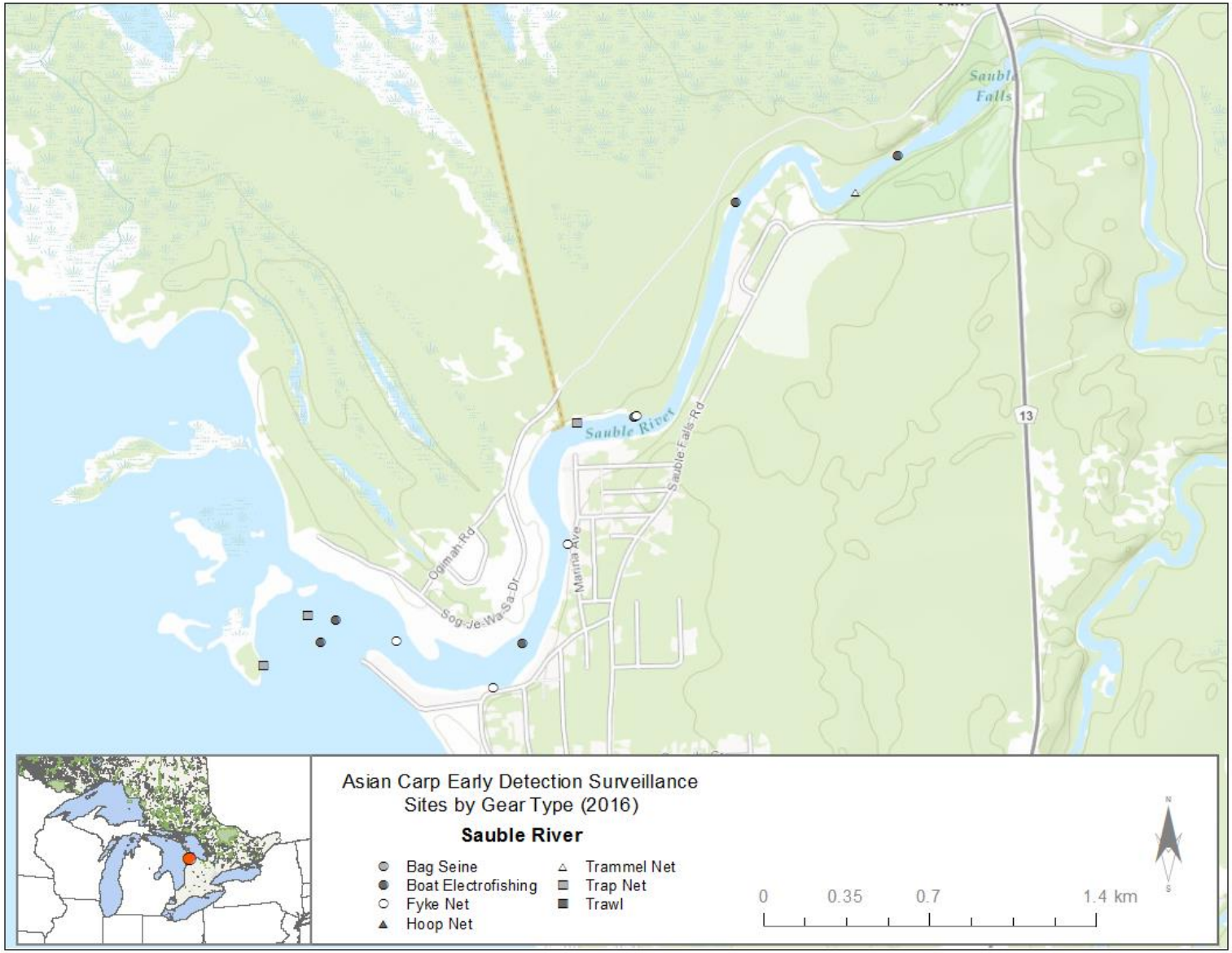

Figure 28. Asian Carp Program early detection surveillance sites and gear types used in the Sauble River in 2016.

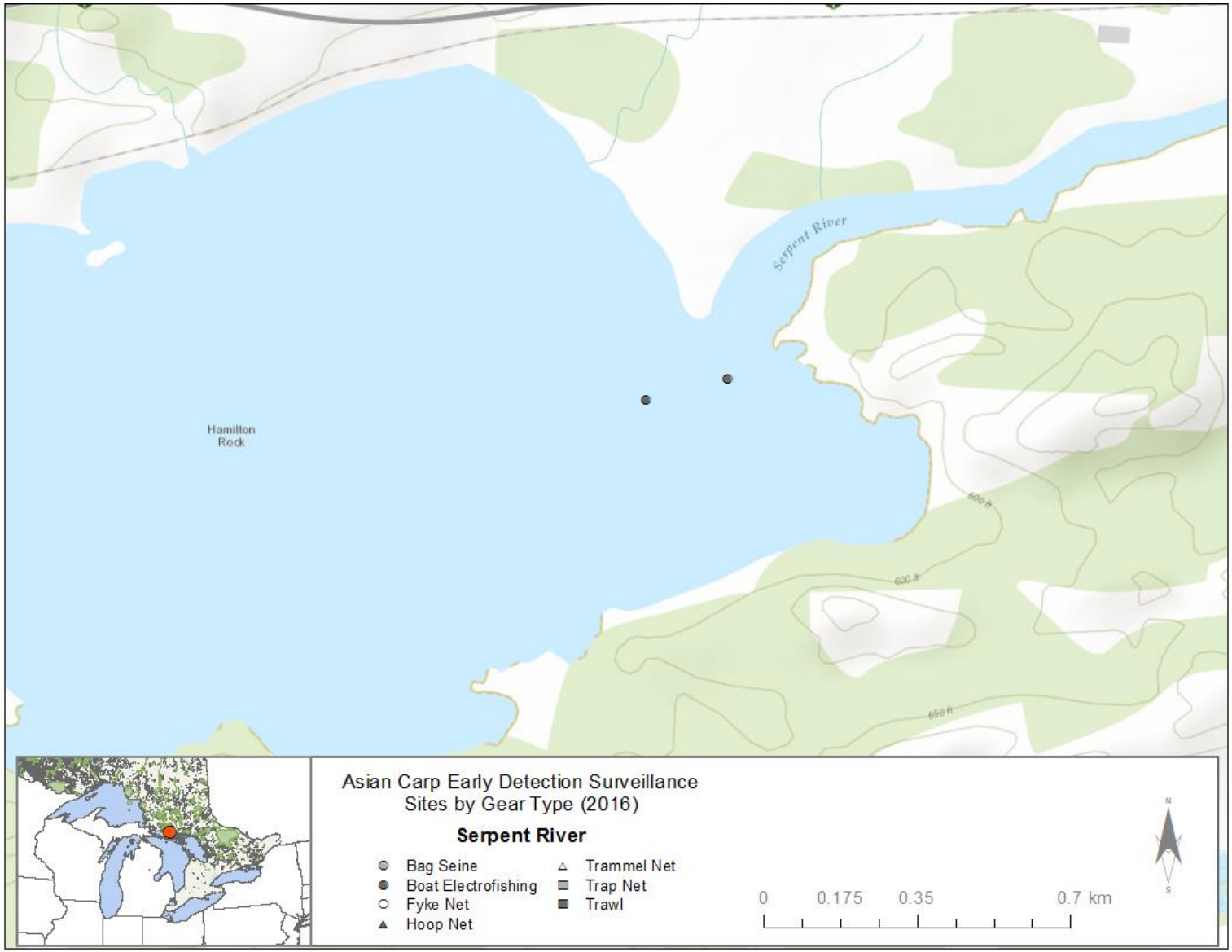

Figure 29. Asian Carp Program early detection surveillance sites and gear types used in the Serpent River in 2016.

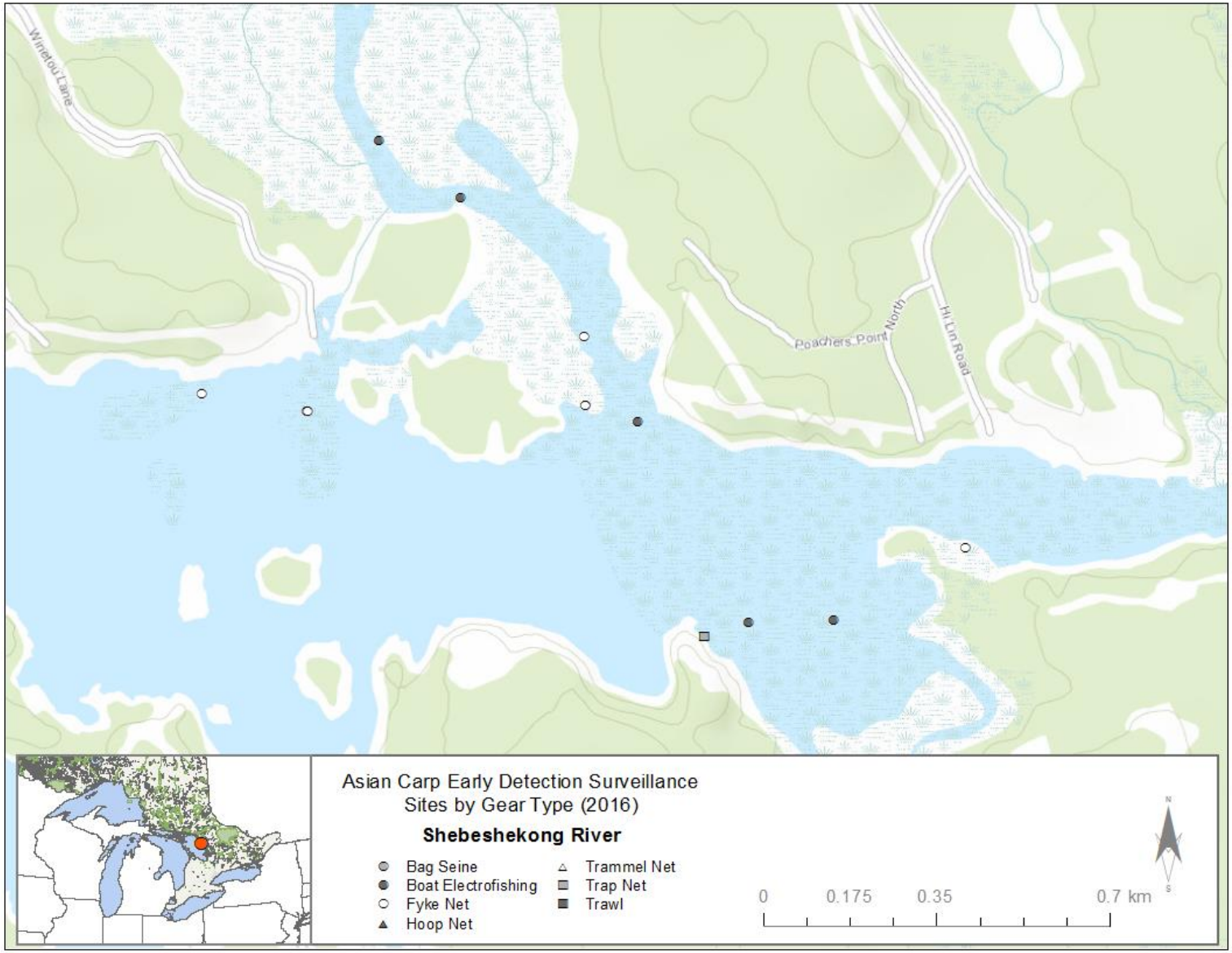

Figure 30. Asian Carp Program early detection surveillance sites and gear types used in the Shebeshekong River in 2016.

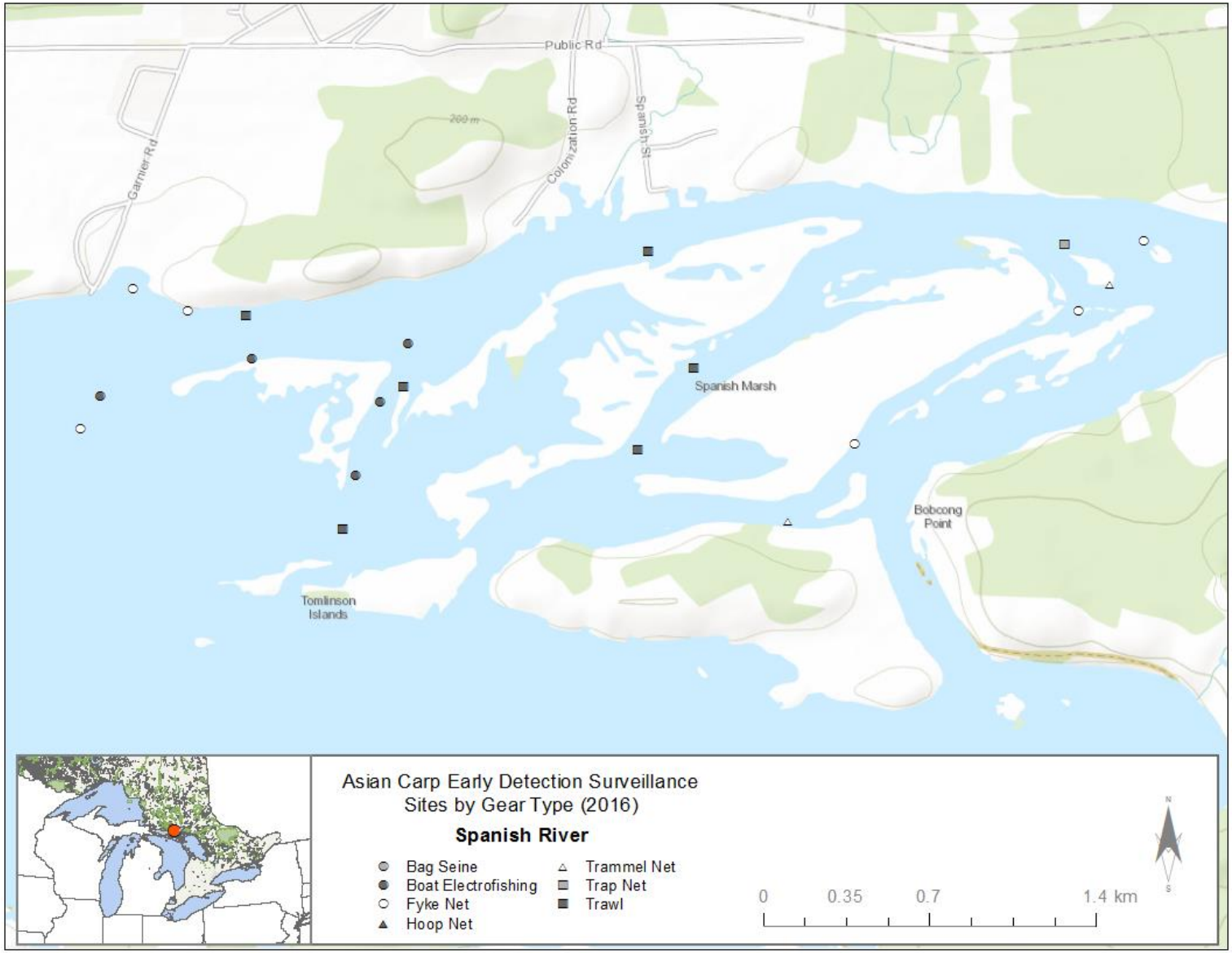

Figure 31. Asian Carp Program early detection surveillance sites and gear types used in the Spanish River in 2016.

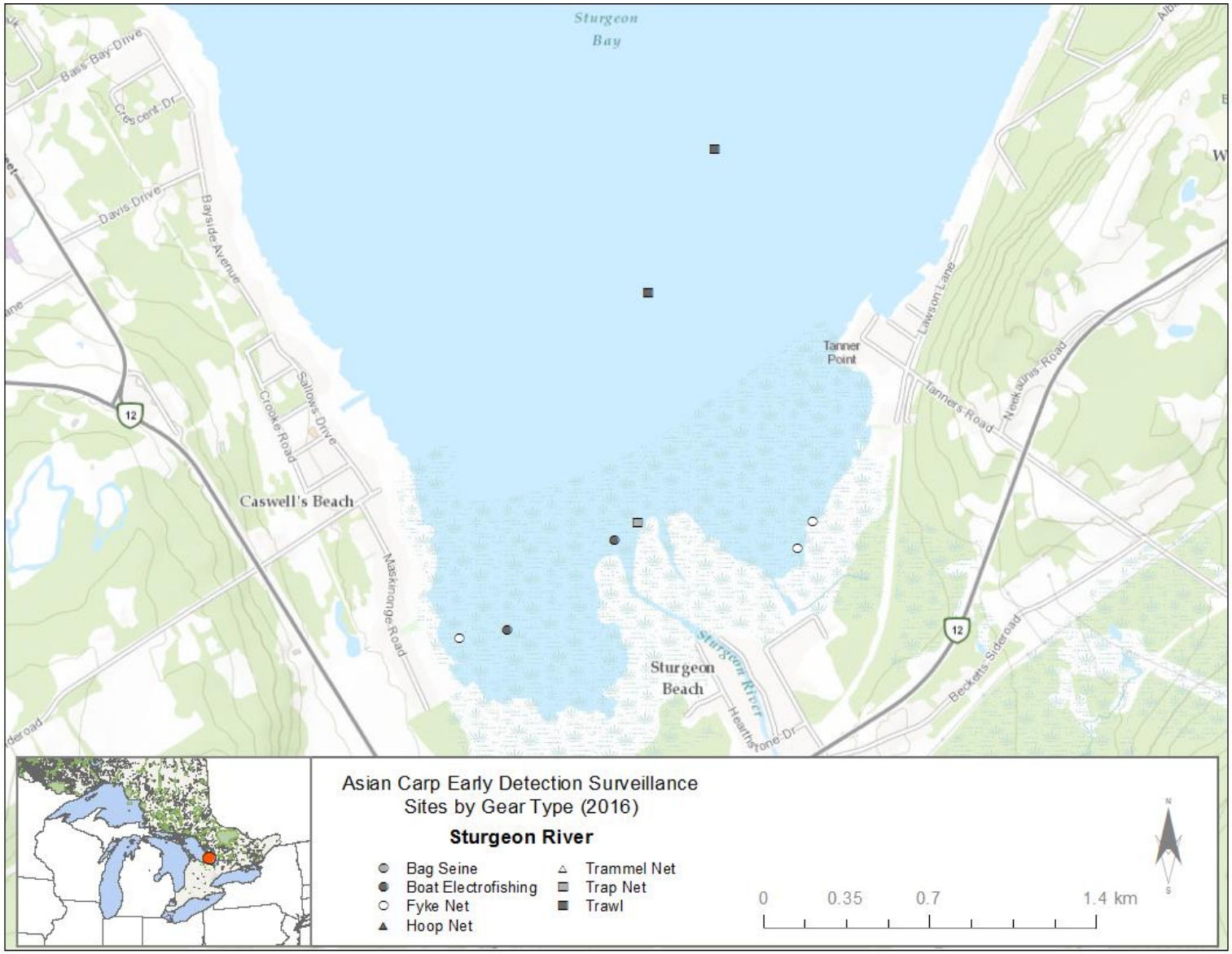

Figure 32. Asian Carp Program early detection surveillance sites and gear types used in the Sturgeon River in 2016.

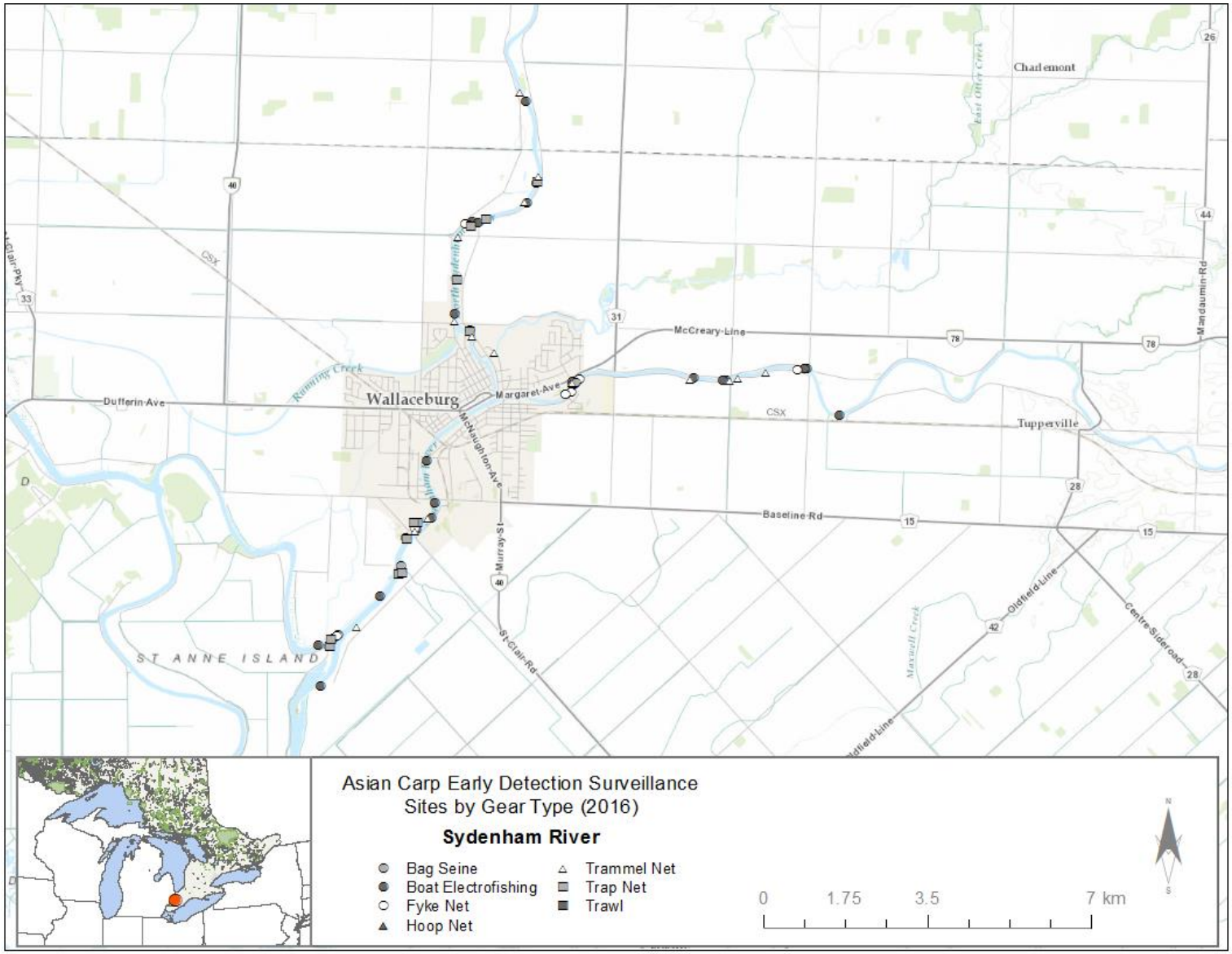

Figure 33. Asian Carp Program early detection surveillance sites and gear types used in the Sydenham River in 2016.

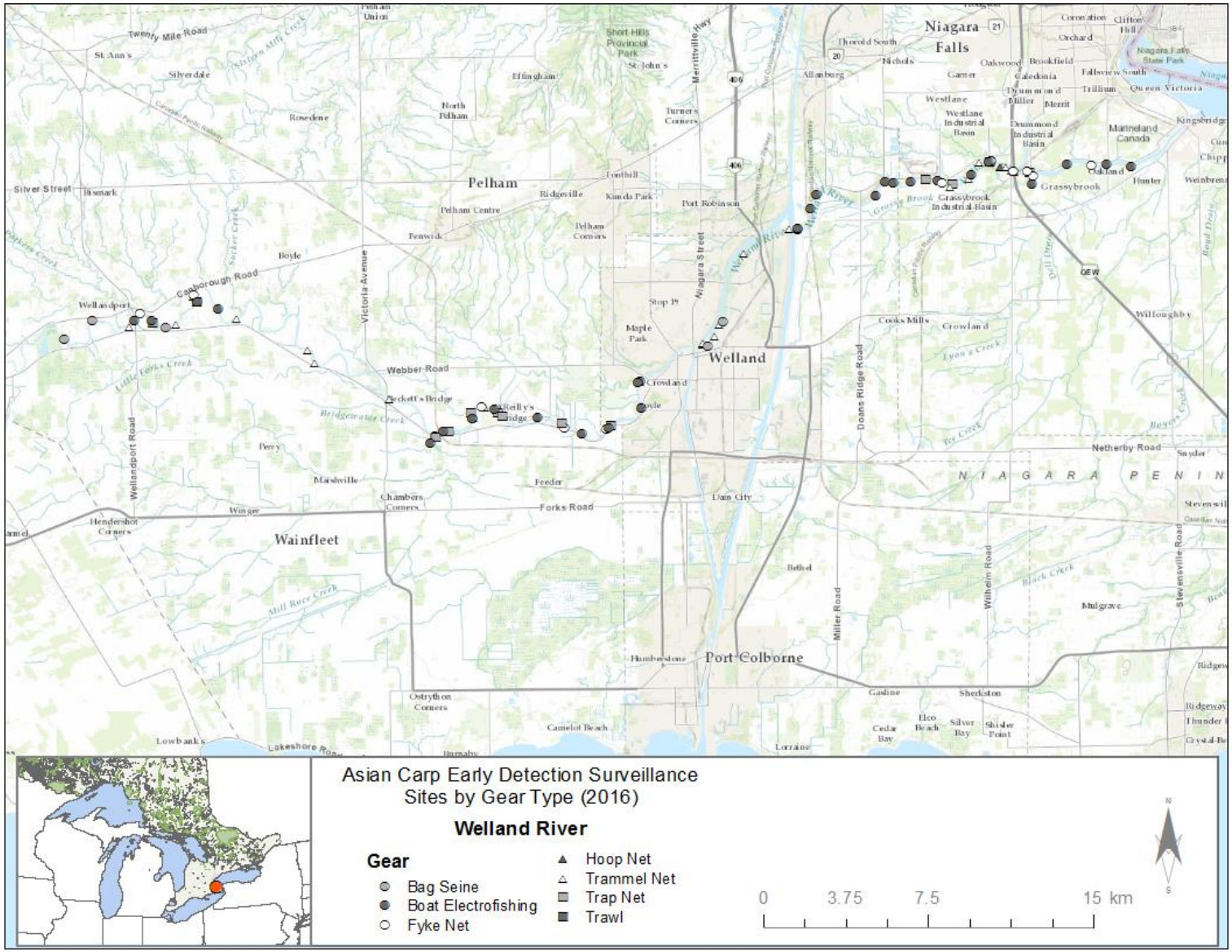

Figure 34. Asian Carp Program early detection surveillance sites and gear types used in the Welland River in 2016.

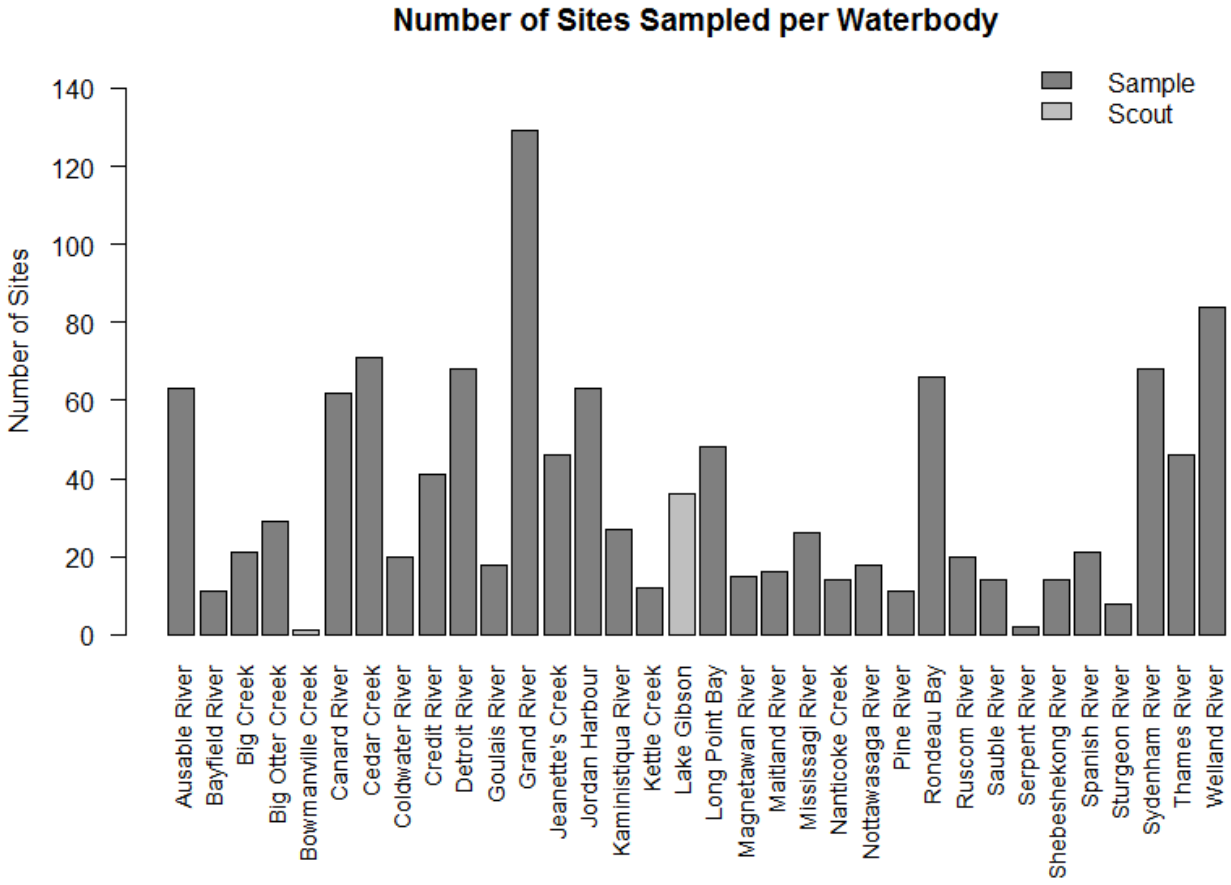

Figure 35. Number of sites sampled per waterbody in the 2016 Asian Carp Program's early detection surveillance.

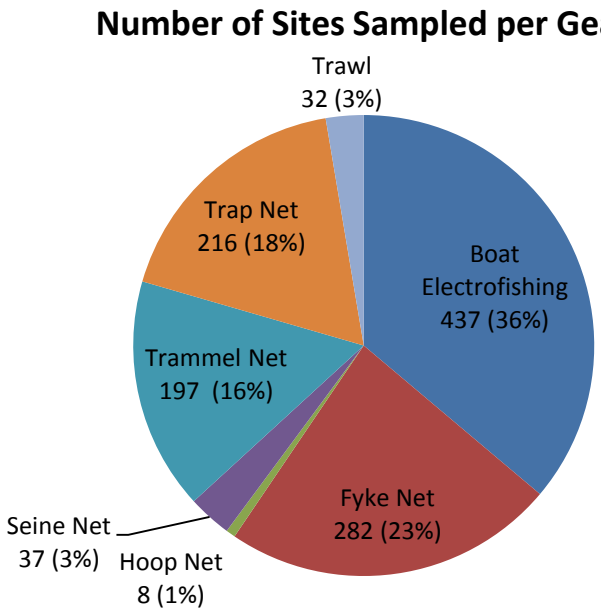

Figure 36. Number and percentage of sites sampled by gear type in the 2016 Asian Carp Program's early detection surveillance. Total number of sites sampled was 1,209.

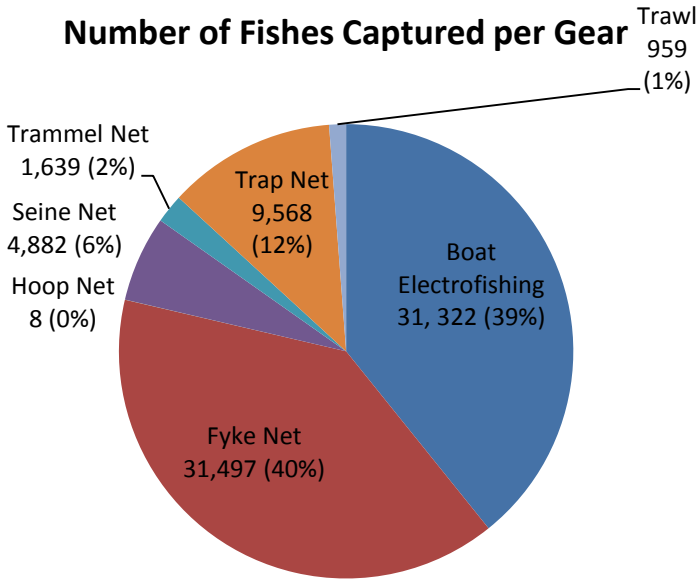

Figure 37. Number and percentage of fishes captured by gear type in the 2016 Asian Carp Program's early detection surveillance. Total number of fishes captured was 79,875.

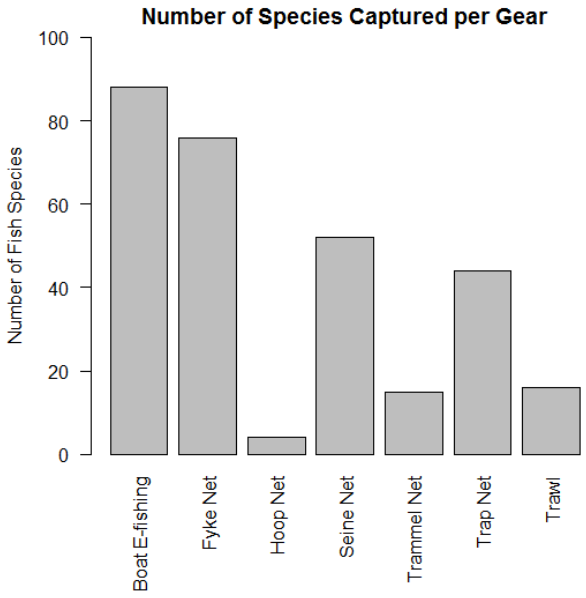

Figure 38. Number of species captured by gear type in the 2016 Asian Carp Program's early detection surveillance. A total of 99 species were detected overall.

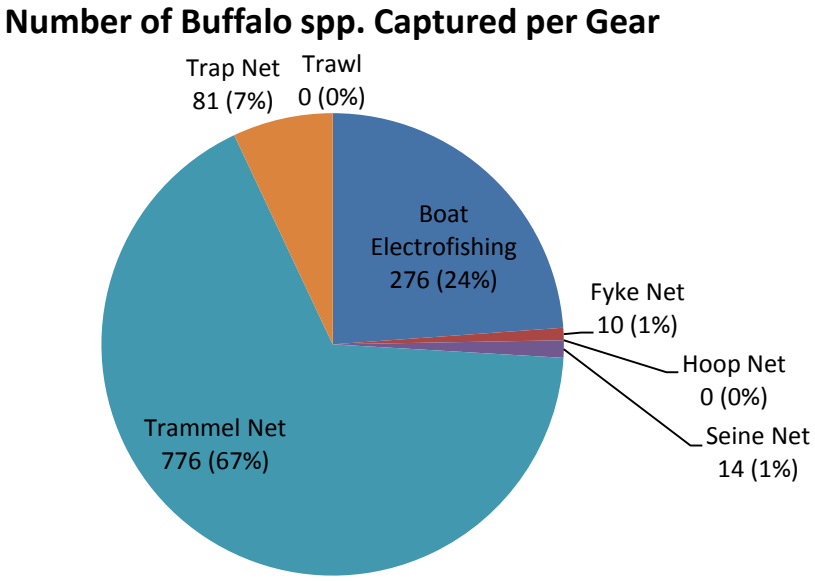

Figure 39. Number and percentage of buffalo species (*Ictiobus spp*.) captured by gear type in the 2016 Asian Carp Program's early detection surveillance. Total number of buffalo spp. captured was 1,157.

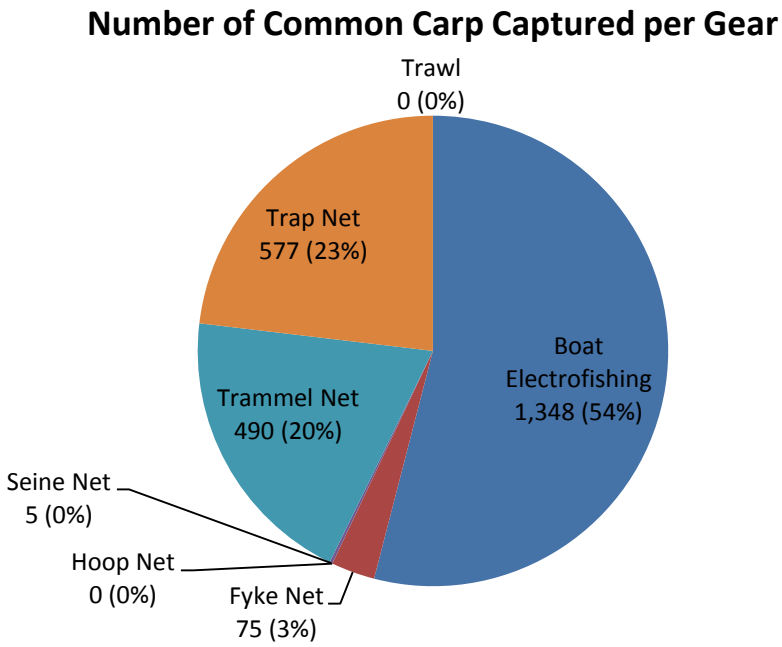

Figure 40. Number and percentage of Common Carp (*Cyprinus carpio*) captured by gear type in the 2016 Asian Carp Program's early detection surveillance. Total number of Common Carp captured was 2,495.

TABLES

Table 1. Summary of the 2016 catch data for the Asian Carp Program's early detection surveillance.

Catch Data	
Total number of sites	1,209
Total number of waterbodies	34
Total number of species detected	99
Total number of fishes caught	79,875
Total number of surrogates caught	3,652
Total number of Asian carps caught	0
Mean number of fishes caught per waterbody	2,349
Least fishes caught per waterbody	57
Most fishes caught per waterbody	12,806
Mean number of fishes caught per site	66
Maximum fishes caught per site	7,491

Table 2. Summary of the species captured during the 2016 Asian Carp Program's early detection surveillance field season. Common and scientific names according to Page et al. (2013).

Common Name	Scientific Name	Number of Specimens	Rank Abundance
Alewife	*Alosa pseudoharengus*	46	53
American Brook Lamprey	*Lampetra appendix*	3	78
American Eel	*Anguilla rostrata*	2	82
Atlantic Salmon	*Salmo salar*	1	93
Banded Killifish	*Fundulus diaphanus*	62	46
Black Bullhead	*Ameiurus melas*	380	29
Black Crappie	*Pomoxis nigromaculatus*	922	16
Black Redhorse	*Moxostoma duquesnei*	57	47
Blackchin Shiner	*Notropis heterodon*	169	41
Blacknose Dace	*Rhinichthys atratulus*	1	93
Blacknose Shiner	*Notropis heterolepis*	20	63
Blackside Darter	*Percina maculata*	2	82
Blackstripe Topminnow	*Fundulus notatus*	24	61
Bluegill	*Lepomis macrochirus*	11,136	3
Bluntnose Minnow	*Pimephales notatus*	2,494	10
Bowfin	*Amia calva*	336	32
Brook Silverside	*Labidesthes sicculus*	1,103	15
Brook Stickleback	*Culaea inconstans*	4	75
Brown Bullhead	*Ameiurus nebulosus*	12,387	2
Brown Trout	*Salmo trutta*	2	82
Buffalo spp.	*Ictiobus sp.*	1,157	14
Burbot	*Lota lota*	1	93
Central Mudminnow	*Umbra limi*	31	57
Central Stoneroller	*Campostoma anomalum*	2	82
Channel Catfish	*Ictalurus punctatus*	1,542	11
Chinook Salmon	*Oncorhynchus tshawytscha*	36	56
Coho Salmon	*Oncorhynchus kisutch*	2	82
Common Carp	*Cyprinus carpio*	2,495	9
Common Shiner	*Luxilus cornutus*	613	23
Creek Chub	*Semotilus atromaculatus*	8	70
Emerald Shiner	*Notropis atherinoides*	2,598	8
Fathead Minnow	*Pimephales promelas*	63	45
Flathead Catfish	*Pylodictis olivaris*	3	78
Freshwater Drum	*Aplodinotus grunniens*	833	18
Ghost Shiner	*Notropis buchanani*	91	44

Gizzard Shad	*Dorosoma cepedianum*	13,091	1
Golden Redhorse	*Moxostoma erythrurum*	266	34
Golden Shiner	*Notemigonus crysoleucas*	825	19
Goldfish	*Carassius auratus*	641	21
Greater Redhorse	*Moxostoma valenciennesi*	49	50
Green Sunfish	*Lepomis cyanellus*	19	65
Greenside Darter	*Etheostoma blennioides*	2	82
Hornyhead Chub	*Nocomis biguttatus*	55	48
Iowa Darter	*Etheostoma exile*	13	67
Johnny Darter	*Etheostoma nigrum*	454	27
Lake Chub	*Couesius plumbeus*	2	82
Lake Chubsucker	*Erimyzon sucetta*	4	75
Lake Trout	*Salvelinus namaycush*	1	93
Largemouth Bass	*Micropterus salmoides*	3,099	5
Least Darter	*Etheostoma microperca*	3	78
Logperch	*Percina caprodes*	225	38
Longnose Gar	*Lepisosteus osseus*	798	20
Mimic Shiner	*Notropis volucellus*	1,390	12
Mooneye	*Hiodon tergisus*	2	82
Mottled Sculpin	*Cottus bairdii*	3	78
Muskellunge	*Esox masquinongy*	20	63
Ninespine Stickleback	*Pungitius pungitius*	1	93
Northern Hogsucker	*Hypentelium nigricans*	24	60
Northern Pike	*Esox lucius*	261	35
Northern Sunfish	*Lepomis peltastes*	232	37
Orange-spotted Sunfish	*Lepomis humilis*	14	66
Pink Salmon	*Oncorhynchus gorbuscha*	2	82
Pugnose Minnow	*Opsopoeodus emiliae*	55	48
Pugnose Shiner	*Notropis anogenus*	21	62
Pumpkinseed	*Lepomis gibbosus*	5,349	4
Quillback	*Carpiodes cyprinus*	409	28
Rainbow Darter	*Etheostoma caeruleum*	8	70
Rainbow Smelt	*Osmerus mordax*	47	52
Rainbow Trout	*Oncorhynchus mykiss*	26	59
River Chub	*Nocomis micropogon*	1	93
River Redhorse	*Moxostoma carinatum*	1	93
Rock Bass	*Ambloplites rupestris*	1,248	13
Rosyface Shiner	*Notropis rubellus*	37	55
Round Goby	*Neogobius melanostomus*	2,752	7
Rudd	*Scardinius erythrophthalmus*	247	36

Ruffe †	*Gymnocephalus cernua*	5	74
Sea Lamprey	*Petromyzon marinus*	2	82
Shorthead Redhorse	*Moxostoma macrolepidotum*	355	31
Silver Lamprey	*Ichthyomyzon unicuspis*	11	68
Silver Redhorse	*Moxostoma anisurum*	167	42
Smallmouth Bass	*Micropterus dolomieu*	457	26
Spotfin Shiner	*Cyprinella spiloptera*	494	24
Spottail Shiner	*Notropis hudsonius*	840	17
Spotted Gar	*Lepisosteus oculatus*	29	58
Spotted Sucker	*Minytrema melanops*	108	43
Stonecat	*Noturus flavus*	2	82
Striped Shiner	*Luxilus chrysocephalus*	49	50
Tadpole Madtom	*Noturus gyrinus*	41	54
Threespine Stickleback	*Gasterosteus aculeatus*	4	75
Trout-perch	*Percopsis omiscomaycus*	8	70
Tubenose Goby	*Proterorhinus semilunaris*	10	69
Walleye	*Sander vitreus*	188	40
Warmouth	*Lepomis gulosus*	6	73
White Bass	*Morone chrysops*	291	33
White Crappie	*Pomoxis annularis*	361	30
White Perch	*Morone americana*	489	25
White Sucker	*Catostomus commersonii*	632	22
Yellow Bullhead	*Ameiurus natalis*	190	39
Yellow Perch	*Perca flavescens*	2,844	6
Bullhead sp.	*Ameiurus sp.*	510	
Goldfish X Common Carp hybrid	*Carrasius auratus x Cyprinus carpio*	56	
Minnow	*Cyprinidae*	64	
Redhorse sp.	*Moxostoma sp.*	87	
Sculpin sp.	*Cottus sp.*	1	
Sucker sp.	*Catostomidae*	2	
Sunfish sp. or hybrid	*Lepomis sp.*	1,249	

† All Ruffe were detected in the Kaministiqua River.

Table 3. Summary of the catch data by gear types used in the 2016 Asian Carp Program's early detection surveillance.

Gear Type	Acronym	Total Effort	Unit of Effort	Number of Sites	Number of Water-bodies	Number of Fishes	Number of Species	Number of Buffalo spp.	Number of Common Carp	Number of Asian carps
Boat Electrofishing	BEF	294,648	seconds	437	33	31,322	88	276	1,348	0
Fyke Net	FN	5,909.74	hours	282	32	31,497	76	10	75	0
Hoop Net	HN	330.44	hours	8	3	8	4	0	0	0
Seine Net	SN	94	hauls	37	12	4,882	52	14	5	0
Trammel Net	TRM	6,404.26	minutes	197	27	1,639	15	776	490	0
Trap Net	TN	4,538.72	hours	216	32	9,568	44	81	577	0
Trawl	TRL	32	hauls	32	8	959	16	0	0	0

Table 4. Catch data by waterbody for the 2016 Asian Carp Program's early detection surveillance.

Waterbody Name	Number of Sites	Number of Species	Number of Fishes	Number of Buffalo spp.	Number of Common Carp
Ausable River	63	54	3,348	26	142
Bayfield River	11	38	1,146	0	14
Big Creek	21	29	580	18	85
Big Otter Creek	29	37	931	0	93
Bowmanville Creek	1	2	100	0	98
Canard River	62	42	3,603	135	149
Cedar Creek	71	41	6,075	79	306
Coldwater River	20	20	750	0	2
Credit River	41	43	2,354	0	109
Detroit River	68	47	3,397	9	75
Goulais River	18	23	1,205	0	1
Grand River	129	58	12,806	36	188
Jeanette's Creek	46	39	1,839	43	86
Jordan Harbour	63	39	6,056	55	282
Kaministiqua River	27	18	366	0	0
Kettle Creek	12	28	406	6	116
Lake Gibson	36	35	1,382	177	126
Long Point Bay	48	42	2,758	5	46
Magnetawan River	15	22	7,903	0	0
Maitland River	16	27	557	0	12
Mississagi River	26	20	242	0	0
Nanticoke Creek	14	34	517	0	33
Nottawasaga River	18	20	939	0	17
Pine River	11	24	445	0	8
Rondeau Bay	66	39	5,110	3	70
Ruscom River	20	30	748	0	37
Sauble River	14	30	424	0	8
Serpent River	2	11	57	0	1
Shebeshekong River	14	22	694	0	1
Spanish River	21	23	2,323	0	1
Sturgeon River	8	20	612	0	0
Sydenham River	68	46	4,439	96	88
Thames River	46	39	1,833	195	146
Welland River	84	43	3,930	274	155

Table 5. Sampling effort by waterbody for boat electrofishing (BEF), fyke nets (FN), hoop nets (HN), seining (SN), trammel nets (TRM), trap nets (TN), and trawl (TRL) during the 2016 Asian Carp Program's early detection surveillance.

Waterbody.Name	BEF Effort (sec)	# of BEF Sites	FN Effort (hrs)	# of FN Sites	HN Effort (hrs)	# of HN Sites	SN Effort (hauls)	# of SN Sites	TRM Effort (mins)	# of TRM Sites	TN Effort (hrs)	# of TN Sites	TRL Effort (hauls)	# of TRL Sites
Ausable River	14,484	24	275.76	14	122.00	3	0	0	268.33	10	251.02	12	0	0
Bayfield River	2,613	4	48.98	3	0	0	1	1	18.00	1	36.17	2	0	0
Big Creek	4,800	8	102.00	5	0	0	0	0	145.00	5	63.34	3	0	0
Big Otter Creek	7,142	12	138.99	7	83.18	2	0	0	104.00	4	79.30	4	0	0
Bowmanville Creek	0	0	0	0	0	0	0	0	25.00	1	0	0	0	0
Canard River	14,144	23	276.99	14	0	0	15	5	142.00	8	237.39	12	0	0
Cedar Creek	14,951	25	234.92	11	0	0	21	7	350.00	14	282.56	14	0	0
Coldwater River	3,075	5	171.17	8	0	0	0	0	0	0	66.60	3	4	4
Credit River	9,489	13	236.89	11	0	0	6	2	135.00	7	173.52	8	0	0
Detroit River	22,644	32	192.07	9	0	0	9	3	239.00	10	281.76	14	0	0
Goulais River	1,941	3	162.00	7	0	0	2	2	18.00	2	49.00	2	2	2
Grand River	31,742	45	693.77	34	0	0	3	1	489.00	20	607.19	29	0	0
Jeanette's Creek	5,600	9	394.21	19	0	0	0	0	272.00	7	223.47	11	0	0
Jordan Harbour	21,276	25	265.47	13	0	0	1	1	972.00	14	205.93	10	0	0
Kaministiqua River	8,686	14	142.00	6	0	0	0	0	22.00	2	44.00	2	3	3
Kettle Creek	3,006	5	41.25	2	0	0	0	0	77.00	3	42.48	2	0	0
Lake Gibson	16,565	10	90.09	4	0	0	0	0	1206.71	12	241.07	10	0	0
Long Point Bay	13,775	23	197.63	10	0	0	0	0	128.00	7	163.76	8	0	0
Magnetawan River	1,697	3	96.00	5	0	0	0	0	0	0	40.00	2	5	5
Maitland River	4,200	7	100.17	4	0	0	0	0	33.00	2	72.24	3	0	0
Mississagi River	3,024	5	170.00	8	0	0	5	5	0	0	45.50	2	6	6
Nanticoke Creek	2,800	5	66.58	3	0	0	0	0	90.22	4	42.65	2	0	0
Nottawasaga River	3,122	5	125.30	6	0	0	0	0	10.00	1	40.40	2	4	4
Pine River	2,518	4	74.97	4	0	0	7	2	0	0	18.66	1	0	0
Rondeau Bay	14,234	23	281.85	14	0	0	0	0	341.00	15	274.88	14	0	0
Ruscom River	3,645	6	165.24	8	0	0	0	0	80.00	2	77.92	4	0	0
Sauble River	3,601	6	69.92	4	0	0	0	0	16.00	1	73.50	3	0	0

Serpent River	1,323	2	0	0	0	0	0	0	0	0	0	0	0	0
Shebeshekong River	3,338	5	162.90	7	0	0	0	0	0	0	43.50	2	0	0
Spanish River	4,077	5	214.50	6	0	0	0	0	37.00	2	72.00	2	6	6
Sturgeon River	1,633	2	63.70	3	0	0	0	0	0	0	23.80	1	2	2
Sydenham River	14,644	24	271.86	14	0	0	9	3	388.00	15	251.60	12	0	0
Thames River	16,615	25	130.42	6	0	0	0	0	327.00	8	153.57	7	0	0
Welland River	18,244	30	252.14	13	125.26	3	15	5	471.00	20	259.94	13	0	0

APPENDIX 1: TORONTO AND REGION CONSERVATION AUTHORITY ASIAN CARP EARLY DETECTION SURVEILLANCE

In 2016, the Toronto and Region Conservation Authority (TRCA) conducted targeted sampling for Asian carps on behalf of DFO's Asian Carp Program. This sampling was conducted in Toronto area waterbodies in conjunction with their on-going monitoring projects in order to reduce overlap of efforts. TRCA pilot-tested Asian Carp Program protocols using four of the same gear types, including: boat electrofishing (operating with an 18' Smith-Root electrofishing boat), fyke nets, trammel nets, and trap nets.

The TRCA sampled 125 field sites in six waterbodies in the Toronto region (Figures A1-A6). Of these six sites, Duffins Creek, Frenchman's Bay, and the Humber and Rouge rivers were previously scouted by DFO's Asian Carp Program for habitat suitability. The TRCA captured 5,758 fishes representing 37 species, including 166 Common Carp, a surrogate for Asian carp species (Table A1-A2). The most sites were sampled in Lake Ontario around the Toronto Islands (60 sites), and the fewest sites were sampled in Humber River and Carruthers Creek (7 and 6 sites, respectively). The most fishes and species were captured around the Toronto Islands (2,999 fishes, 27 species), while the fewest fishes and species were captured in Carruthers Creek (147 fishes, 10 species) (Tables A4-A5).

Boat electrofishing was the most frequently used gear type, sampling at 57 sites for a total of 22,027 seconds. Trammel nets were the least used gear type, deployed at 6 sites for a total of 190 minutes (Tables A3, A5). Fyke nets, set at 21 sites, captured the most fishes (3,009 fishes), while the trammel net caught the fewest (two fishes). Boat electrofishing and fyke nets detected the greatest number of species (27 and 26 species, respectively), while the trammel net detected one species. Trap nets, deployed at 41 sites, captured the greatest number of surrogate species (69 Common Carp), while no surrogates were captured in the trammel net.

In 2017, TRCA will continue to target Asian carps in Duffins Creek, Frenchman's Bay, the Humber River and Toronto Islands following Asian Carp Program protocols as part of the Asian Carp Program's early detection surveillance. The Asian Carp Program will sample in the Rouge River to allow TRCA to focus sampling in other high priorities areas in their watersheds.

FIGURES

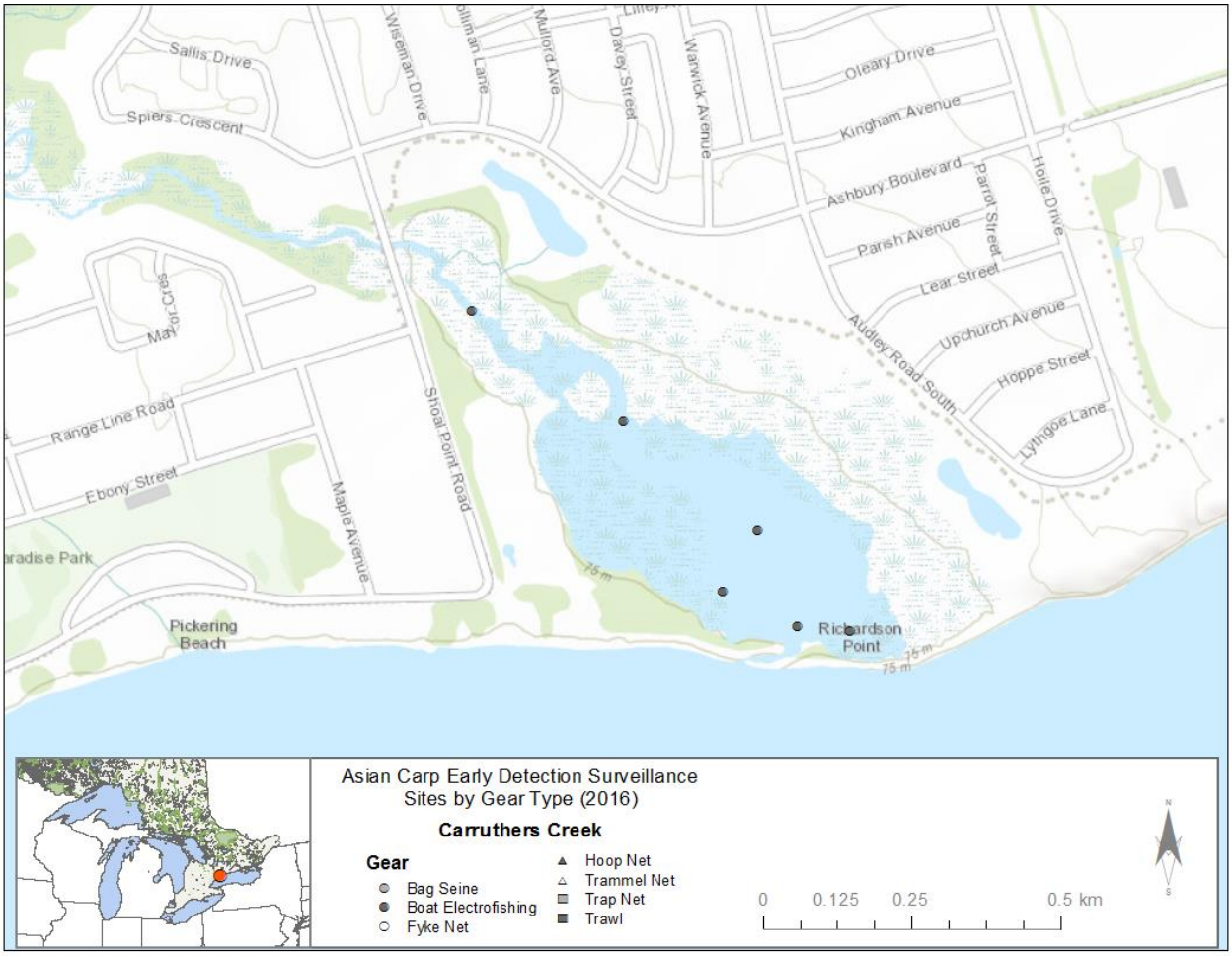

Figure 41. TRCA early detection surveillance sites and gear types used in Carruthers Creek in 2016.

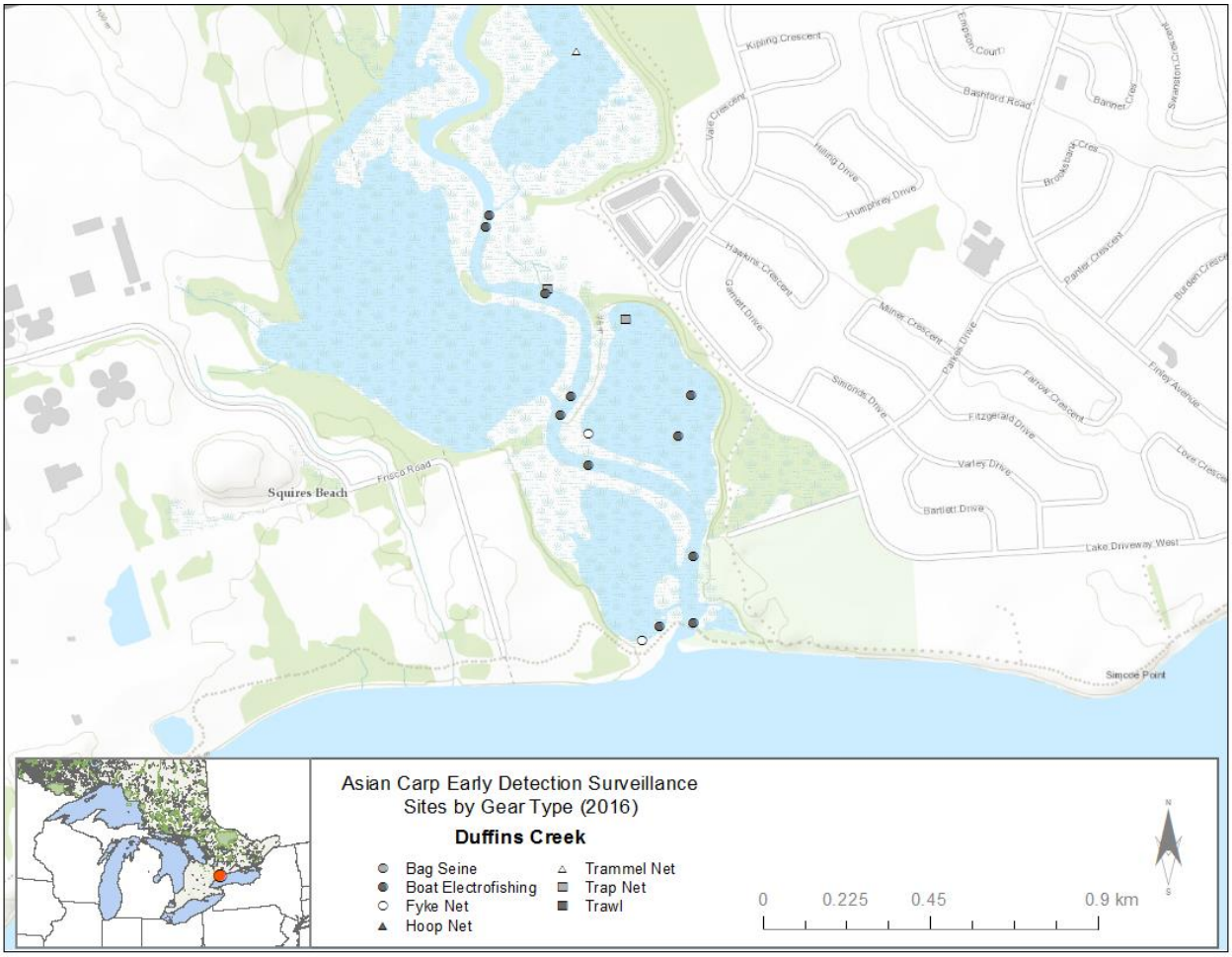

Figure 42. TRCA early detection surveillance sites and gear types used in Duffins Creek in 2016.

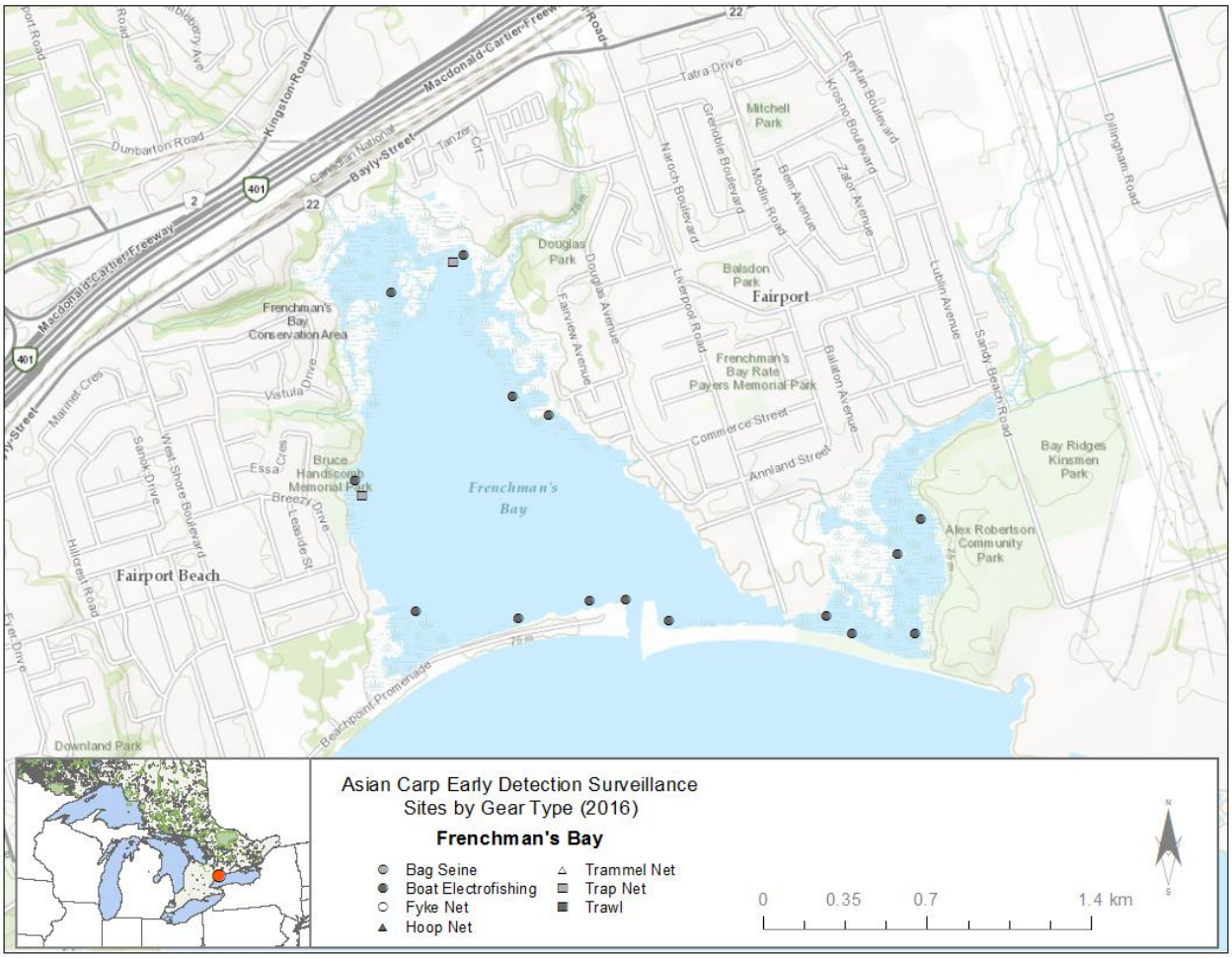

Figure 43. TRCA early detection surveillance sites and gear types used in Frenchman's Bay in 2016.

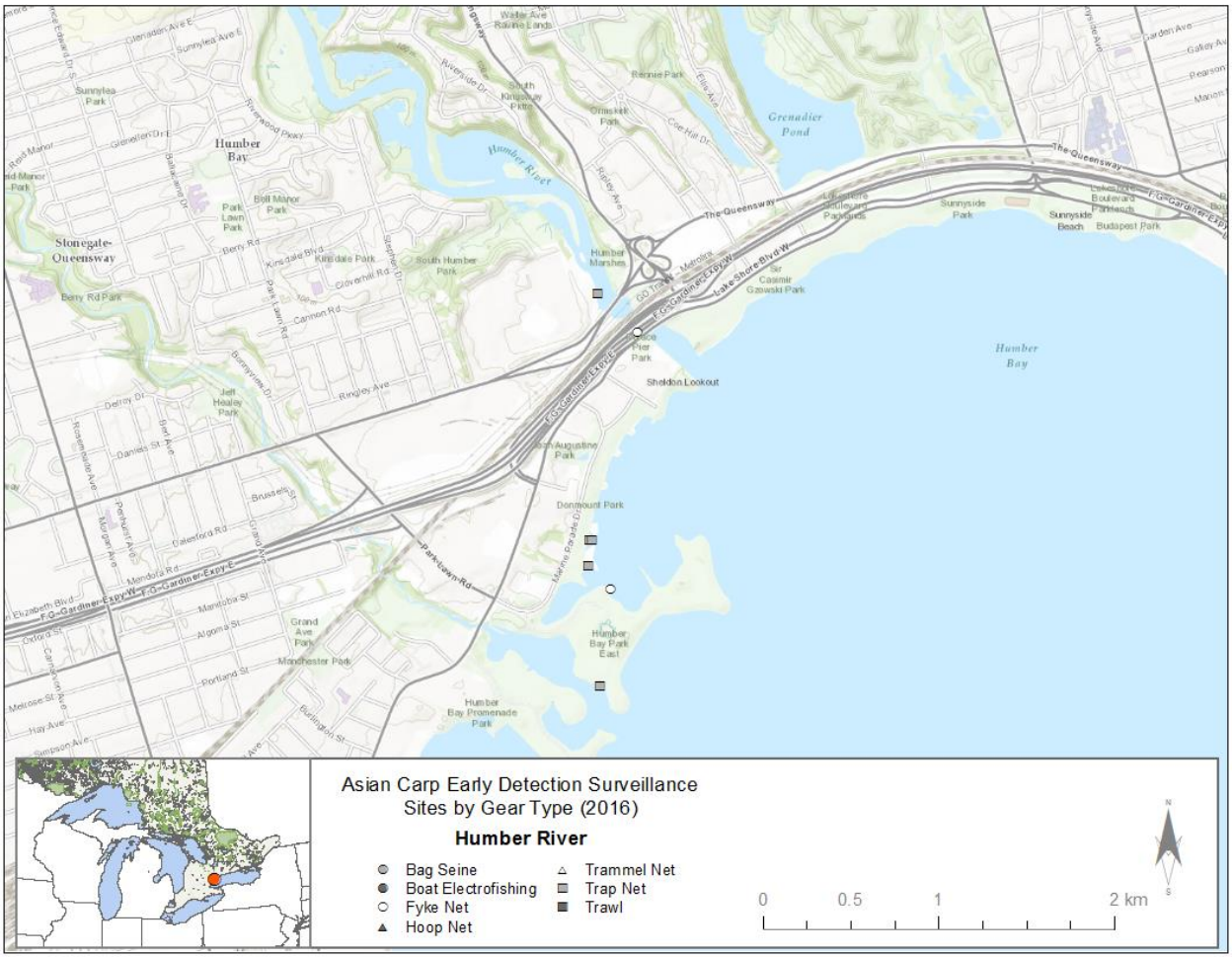

Figure 44. TRCA early detection surveillance sites and gear types used in the Humber River in 2016.

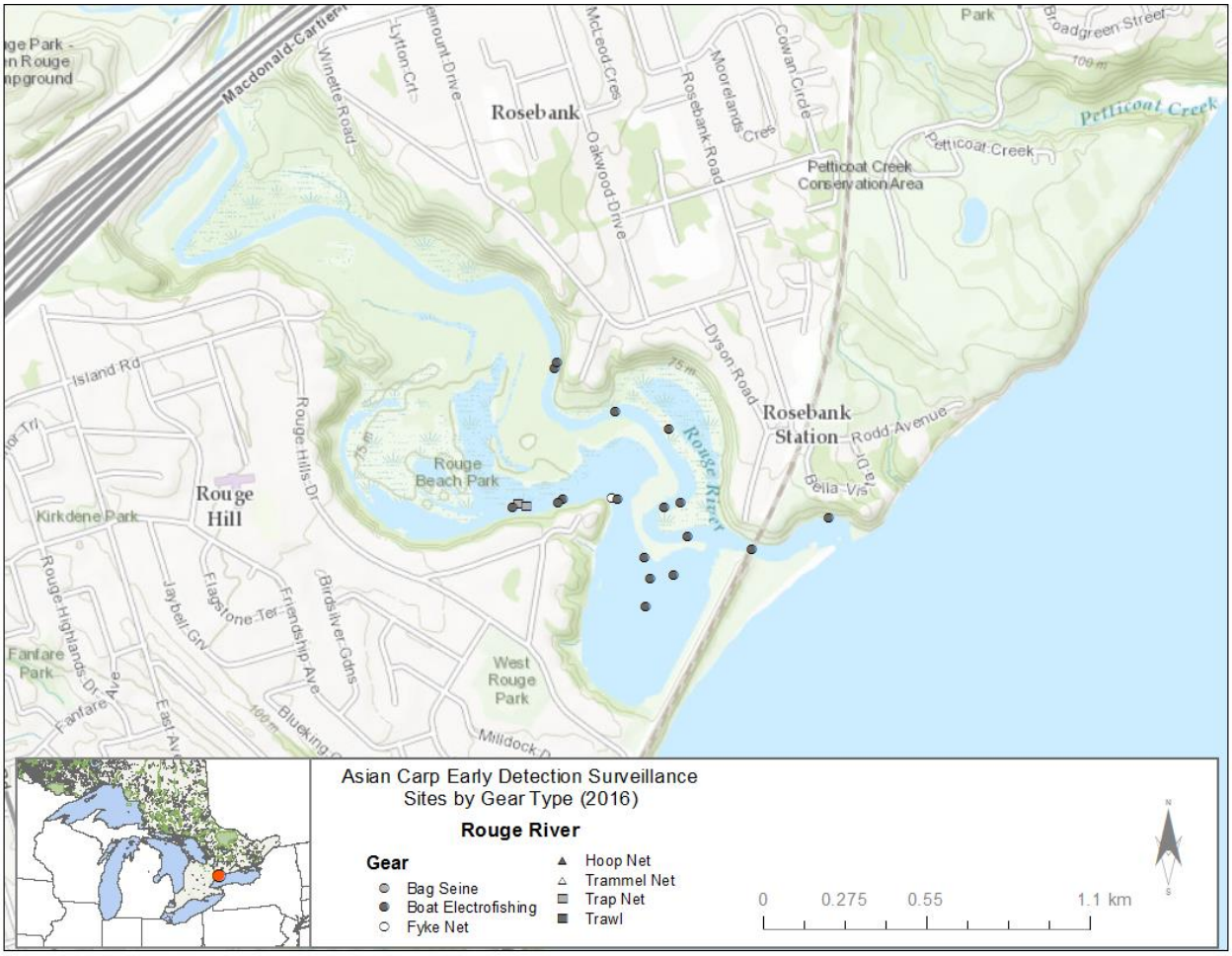

Figure 45. TRCA early detection surveillance sites and gear types used in the Rouge River in 2016.

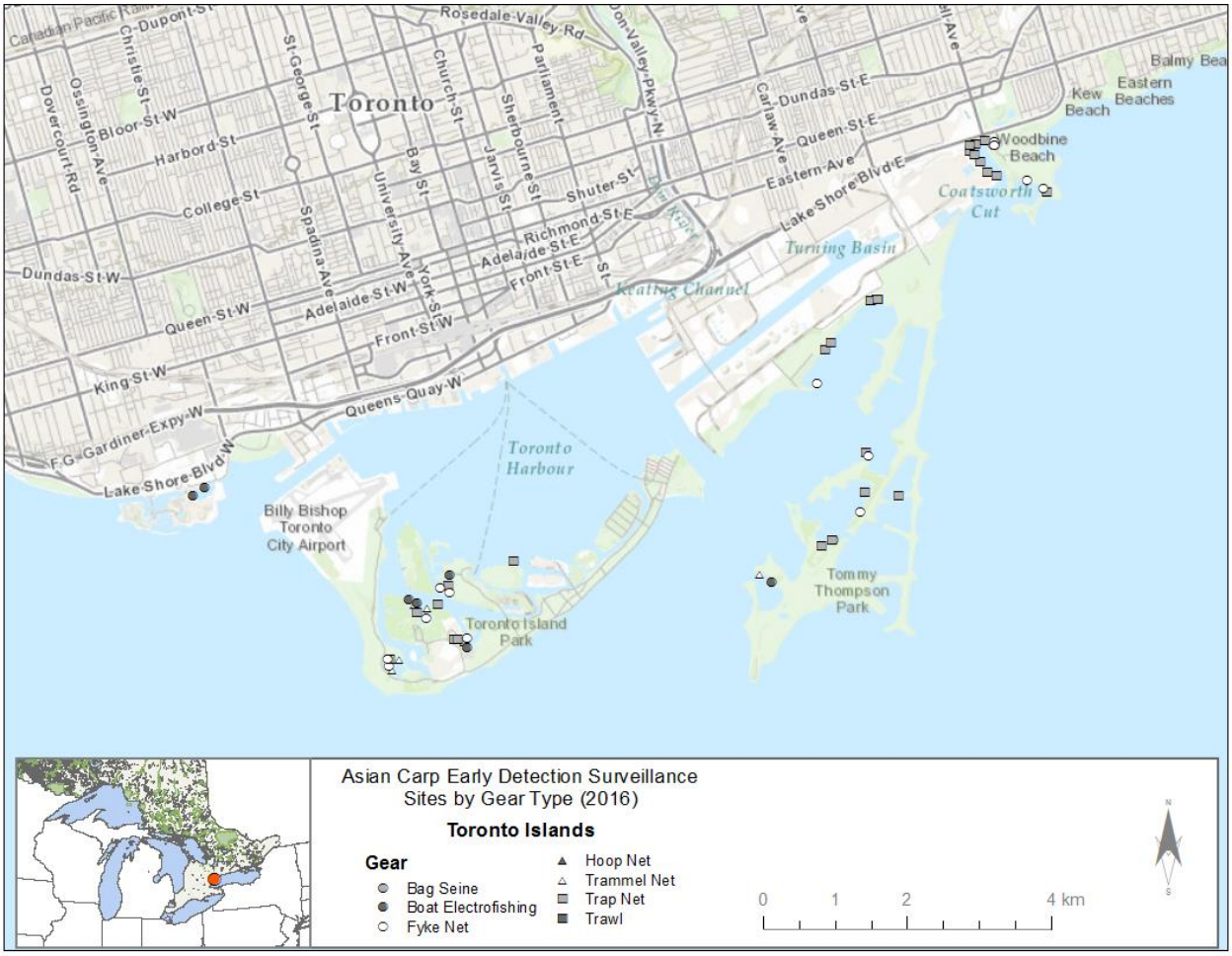

Figure 46. TRCA early detection surveillance sites and gear types used around the Toronto Islands (Lake Ontario) in 2016.

TABLES

Table A1. Summary of the 2016 catch data for TRCA's early detection surveillance.

Catch Data	
Total number of sites	125
Total number of waterbodies	6
Total number of species detected	37
Total number of fishes caught	5,758
Total number of surrogates caught	166
Total number of Asian carps caught	0
Mean number of fishes caught per waterbody	960
Least fishes caught per waterbody	147
Most fishes caught per waterbody	2,999
Mean number of fishes caught per site	46
Maximum fishes caught per site	907

Table A2. Summary of the species captured during the 2016 TRCA early detection surveillance field season. Common and scientific names according to Page et al. (2013).

Common Name	Scientific Name	Number of Specimens	Rank Abundance
Alewife	*Alosa pseudoharengus*	77	13
American Eel	*Anguilla rostrata*	1	32
Banded Killifish	*Fundulus diaphanus*	89	11
Black Crappie	*Pomoxis nigromaculatus*	35	20
Bluegill	*Lepomis macrochirus*	158	10
Bluntnose Minnow	*Pimephales notatus*	63	15
Bowfin	*Amia calva*	56	17
Brook Stickleback	*Culaea inconstans*	212	5
Brown Bullhead	*Ameiurus nebulosus*	1,244	2
Common Carp	*Cyprinus carpio*	166	8
Common Shiner	*Luxilus cornutus*	41	18
Creek Chub	*Semotilus atromaculatus*	1	32
Emerald Shiner	*Notropis atherinoides*	33	21
Fathead Minnow	*Pimephales promelas*	16	22
Freshwater Drum	*Aplodinotus grunniens*	2	29
Gizzard Shad	*Dorosoma cepedianum*	189	6
Golden Shiner	*Notemigonus crysoleucas*	80	12
Goldfish	*Carassius auratus*	5	25
Hornyhead Chub	*Nocomis biguttatus*	1	32
Largemouth Bass	*Micropterus salmoides*	162	9
Logperch	*Percina caprodes*	2	29
Longnose Gar	*Lepisosteus osseus*	1	32
Northern Pike	*Esox lucius*	73	14
Pumpkinseed	*Lepomis gibbosus*	1,153	3
Quillback	*Carpiodes cyprinus*	1	32
Rainbow Trout	*Oncorhynchus mykiss*	3	27
Rock Bass	*Ambloplites rupestris*	188	7
Rosyface Shiner	*Notropis rubellus*	1	32
Round Goby	*Neogobius melanostomus*	1,260	1
Rudd	*Scardinius erythrophthalmus*	3	27
Sea Lamprey	*Petromyzon marinus*	1	32
Smallmouth Bass	*Micropterus dolomieu*	9	24
Spotfin Shiner	*Cyprinella spiloptera*	5	25
Spottail Shiner	*Notropis hudsonius*	11	23
Threespine Stickleback	*Gasterosteus aculeatus*	40	19
White Sucker	*Catostomus commersonii*	61	16
Yellow Perch	*Perca flavescens*	311	4

Table A3. Summary of the catch data by gear types used in the 2016 TRCA early detection surveillance.

Gear Type	Acronym	Total Effort	Unit of Effort	Number of Sites	Number of Waterbodies	Number of Fishes	Number of Species	Number of Buffalo spp.	Number of Common Carp	Number of Asian carps
Boat Electrofishing	BEF	22,027	seconds	57	5	1,182	27	0	46	0
Fyke Net	FN	450.36	hours	21	4	3,009	26	0	51	0
Trammel Net	TRM	190	minutes	6	2	2	1	0	0	0
Trap Net	TN	902.14	hours	41	5	1,565	21	0	69	0

Table A4. Catch data by waterbody for the 2016 TRCA early detection surveillance work.

Waterbody Name	Number of Sites	Number of Species	Number of Fishes	Number of Buffalo spp.	Number of Common Carp
Carruthers Creek	6	10	147	0	19
Duffins Creek	16	22	1,433	0	28
Frenchman's Bay	13	16	175	0	1
Humber River	7	20	472	0	11
Toronto Islands (Lake Ontario)	63	27	2,999	0	69
Rouge River	20	21	532	0	38

Table A5. Sampling effort by waterbody for boat electrofishing (BEF), fyke nets (FN), trammel nets (TRM) and trap nets (TN) during the 2016 TRCA early detection surveillance.

Waterbody Name	BEF Effort (sec)	# of BEF Sites	FN Effort (hrs)	# of FN Sites	TRM Effort (mins)	# of TRM Sites	TN Effort (hrs)	# of TN Sites
Carruthers Creek	750	6	0	0	0	0	0	0
Duffins Creek	3,960	11	47.5	2	45	1	44.68	2
Frenchman's Bay	1,320	11	0	0	0	0	44.97	2
Humber River	0	0	48.8	2	0	0	109.76	5
Toronto Islands (Lake Ontario)	7,243	12	329.04	16	145	5	655.93	30
Rouge River	8,754	17	25.02	1	0	0	46.8	2