

Results of Fisheries and Oceans Canada's 2019 Asian Carp Early Detection Field Surveillance Program

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DETECTION FIELD SURVEILLANCE PROGRAM

by

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ABSTRACT

Colm, J.,E and Marson, D.M. 2020. Results of Fisheries and Oceans Canada's 2019 Asian Carp Early Detection Field Surveillance Program. Can. Manuscr. Rep. Fish. Aquat. Sci. 3168-2: viii + 65 p.

In 2019, Fisheries and Oceans Canada's Asian Carp Program continued early detection surveillance for Asian carps in Canadian waters of the Laurentian Great Lakes. A total of 1 197 field sites were sampled at 36 locations using seven gear types. These locations included 35 early detection locations and a scout site. A total of 57 027 fishes were caught representing 86 species. Buffalo (*Ictiobus* spp.) and Common Carp (*Cyprinus carpio*) were used as surrogate species to assess the effectiveness of gear types. A total of 864 buffalo and 1 876 Common Carp were caught. Trammel nets, boat electrofishing and trap nets were the most effective at capturing these surrogate species. An additional 105 field sites were sampled at three locations for larval fishes and eggs using two gear types. A total of 18 551 larval fishes were caught. No Asian carps were caught during the 2019 early detection surveillance efforts. Surveillance for Asian carps will continue in 2020, with an emphasis on the lower Great Lakes where the threat of arrival remains highest.

RÉSUMÉ

Colm, J.E., and Marson, D.M. 2020. Results of Fisheries and Oceans Canada's 2019 Asian Carp Early Detection Field Surveillance Program. Can. Manuscr. Rep. Fish. Aquat. Sci. 3168-2: viii + 65 p.

En 2019, le Programme de la carpe asiatique de Pêches et Océans Canada a poursuivi ses activités de détection précoce de la carpe asiatique dans les eaux canadiennes des Grands Lacs laurentiens. Au total, 1 197 sites sur le terrain ont été échantillonnés à 36 emplacements à l'aide de 7 types d'engins. Ces emplacements comprenaient 35 sites de détection précoce et un site de reconnaissance. Au total, 57 027 poissons ont été capturés, représentant 86 espèces. Le buffalo (*Ictiobus* spp.) et la carpe commune (*Cyprinus carpio*) ont été utilisés comme espèces de remplacement pour évaluer l'efficacité des types d'engins. Au total, 864 buffalos et 1 876 carpes communes ont été capturés. Les trémails, la pêche à l'électricité en bateau et les trappes en filet ont été les plus efficaces pour capturer ces espèces de remplacement. En outre, 105 autres sites sur le terrain ont été échantillonnés à 3 emplacements pour les larves et les œufs de poissons à l'aide de 2 types d'engins. Au total, 18 551 larves de poissons ont été capturées. Aucune carpe asiatique n'a été capturée pendant les travaux de surveillance et de détection précoce de 2019. La surveillance des carpes asiatiques se poursuivra en 2020, l'accent étant mis sur les Grands Lacs inférieurs où la menace d'arrivée demeure la plus élevée.

PREFACE

Fisheries and Oceans Canada's Asian Carp Program has conducted early detection surveillance for Asian carps throughout the Great Lakes basin since 2013. The program has improved sampling protocols and identified early detection locations considered suitable for Asian carps (for reproduction or feeding) that can be sampled effectively with a suite of gear types. The Asian Carp Program surveillance data has been summarized in reports, like this one, produced each year since 2013. As 2017 marked the fifth year of sampling, standard protocols have been realized, and the sampling methods and locations are not expected to change greatly from year to year. The Asian Carp Program will continue early detection surveillance in and around the Great Lakes basin for the foreseeable future. As such, shorter data summaries will be produced each year as a sub-series to the 2017 report (Colm et al. 2019). Any changes to methodology or sampling locations will be noted in the data summary reports, but readers will be referred back to the 2017 report for detailed descriptions of methods. An in-depth report is planned for every five years that will highlight major changes and updates to the program as well as present cumulative summaries from the previous five years of sampling as an appendix.

For full description of methods, please refer to:

Colm, J., Marson, D. and Cudmore, B. 2019. Results of Fisheries and Oceans Canada's 2017 Asian Carp Early Detection Field Surveillance Program. Can. Manuscr. Rep. Fish. Aquat. Sci. 3168: vi + 69 p.

INTRODUCTION

The focus of Fisheries and Oceans Canada's (DFO) Asian Carp Program is to prevent the entry and establishment of Asian carps in Canadian waters of the Great Lakes through outreach, early detection, response and management. The Asian Carp Program has conducted early detection surveillance in Canadian waters since 2013, expanding in scope each year. Early detection is essential to prevent the establishment of aquatic invasive species, as more response options are available and it is less costly than managing or controlling an established invasive species (Lodge et al. 2006; Vander Zanden et al. 2010).

For early detection surveillance, the Asian Carp Program uses a variety of gear types targeting all sizes and life stages of four species of Asian carps: Bighead Carp (*Hypophthalmichthys nobilis*), Black Carp (*Mylopharyngodon piceus*), Grass Carp (*Ctenopharyngodon idella*) and Silver Carp (*Hypophthalmichthys molitrix*). As Grass Carp eggs and larvae have been detected in two Lake Erie tributaries in Ohio waters (Embke et al. 2016; USGS 2019), more emphasis has been placed on targeting Grass Carp in recent years. Asian carps are not established in Canadian waters, so in place of capture data on target species, buffalo species (*Ictiobus* spp., referred to hereafter as buffalo) and Common Carp (*Cyprinus carpio*) are used to assess the effectiveness of gear types and sampling techniques. Both surrogate species are large-bodied and mobile, and relatively widespread in the basin. Although early detection of Asian carps is the primary objective of surveillance, collecting baseline fish community data in areas that could be impacted by Asian carps is also important in order to properly assess impacts should they arrive.

Surveillance sampling in 2019 took place from May 8th to November 6th in 36 locations (wetlands, tributary rivers and interconnected channels) of the Great Lakes. A summary of the results from the 2019 early detection surveillance sampling effort is presented here.

METHODS

Thirty-seven early detection locations were identified for surveillance in Canadian waters of the Great Lakes (Figure 1). These are large tributary rivers suitable to Asian carp spawning and large, productive wetlands with abundant submerged aquatic vegetation that would be attractive to Grass Carp for feeding (Cudmore et al. 2012, 2017). In these locations, sites were selected semi-randomly based on where gears could be deployed and fished effectively. Maps of 2019 sampling sites at each location are found in Appendix 2.

Sites were sampled using seven gear types: boat electrofishing, hoop nets, mini fyke nets, seine nets, tied-down gill nets, trammel nets and trap nets (details and dimensions provided in Appendix 1). These gear types capture both large- and small-bodied fishes in a variety of habitats. Sampling the full extent of the fish community increases the likelihood of detecting all four species of Asian carp at both juvenile and adult life-stages. All fish captured are identified, counted (up to a maximum of 250 individuals per species) and total lengths of ten representative individuals are measured. A habitat assessment is also completed at each site; the results of which are not presented here. Surveillance in some Lake Ontario locations (Duffins Creek, Frenchman's Bay, Humber and Rouge rivers) was completed by the Toronto and Region Conservation Authority (TRCA) following DFO Asian Carp Program protocols. Sampling for larval fishes and eggs was also conducted using two gear types (bongo nets and light traps) in select high-risk tributaries in lakes Erie and Huron (maps in Appendix 3).

RESULTS

In 2019, the Asian Carp early detection field surveillance program sampled 1 197 sites in 36 waterbodies (i.e. wetlands, tributary rivers and interconnected channels) within Canadian waters of the Great Lakes basin. This covered 35 of the program's 37 early detection locations. In total, 270 field sites were sampled in 12 Lake Huron waterbodies, 437 sites in nine waterbodies in the Huron-Erie Corridor (HEC), 323 sites in eight Lake Erie waterbodies and 167 field sites in seven Lake Ontario waterbodies.

A total of 57 027 fishes were caught in 2019, representing 86 species (Table 1). The mean number of fishes and species caught per site were 48 and five, respectively. Of the species caught, the most abundant were Gizzard Shad (*Dorosoma cepedianum*) totalling 11 703 fish (~20.5% of all fishes caught), Bluegill (*Lepomis macrochirus*) totalling 4 741 fish (~8.3%), Yellow Perch (*Perca flavescens*) totalling 3 671 fish (~6.4%), Pumpkinseed (*Lepomis gibbosus*) totalling 3 610 fish (~6.3%) and Brown Bullhead (*Ameiurus nebulosus*) totalling 2 644 fish (~4.6%; Table 3). The species that were caught most frequently were Common Carp (caught at 36.5% of all sites sampled), Bluegill (33.3%), Pumpkinseed (33.0%), Largemouth Bass (*Micropterus salmoides*; 27.5%) and Yellow Perch (24.5%).

An additional 105 field sites were sampled for larval fish and eggs. Approximately 18 551 larval fishes weighing a total of 903.7 g were collected in the two gear types.

BOAT ELECTROFISHER

Boat electrofishing was conducted at 406 sites in 35 of the 36 waterbodies sampled. A total of 4 325.35 minutes of shocking were completed, with a mean of 10.65 minutes per site (Table 4). A total of 24 385 fishes were caught with this gear, representing 73 species. The mean catch per unit effort (CPUE) was 5.71 fishes per minute of shocking. There were eight boat electrofishing sites where no fish were caught.

Boat electrofishing is often conducted in combination with either tied-down gill or trammel nets to prevent large fishes from fleeing the site; this method has been effective for DFO at capturing Grass Carp. Fish captures and effort were recorded separately for each gear. Of the 406 sites sampled with boat electrofishing, 251 were sampled with this gear alone, and had a mean CPUE of 4.43 fishes per minute of shocking. Sixty-three sites were sampled in combination with tied-down gill nets, with a mean CPUE of 4.89 fishes per minute, and 92 sites were sampled in combination with trammel nets with a mean CPUE of 9.76 fishes per minute.

The most abundant species caught with this gear type were Gizzard Shad (36.9% of fishes caught), Yellow Perch (11.5%) and Bluegill (6.6%). The most frequently caught species were Common Carp (caught at 55.8% of sites sampled), Largemouth Bass (50.9%) and Yellow Perch (48.9%). There were 192 buffalo and 788 Common Carp caught with boat electrofishing.

In Lake Huron, 107 sites were sampled with boat electrofishing. A total of 3 466 fishes were caught, representing 54 species. The mean CPUE across these sites was 3.05 fishes per minute of shocking (Tables 2, 5).

In the HEC, 150 sites were sampled with boat electrofishing. A total of 14 629 fishes, representing 53 species, were caught. The mean CPUE across these sites was 9.36.

In Lake Erie, 100 sites were sampled with boat electrofishing. A total of 5 108 fishes were caught, representing 52 species. The mean CPUE across these sites was 4.78.

In Lake Ontario, 49 sites were sampled with boat electrofishing. A total of 1 182 fishes, representing 30 species, were caught. The mean CPUE across these sites was 2.26.

HOOP NET

Hoop nets were set at 42 sites in six waterbodies. Nets were set for a total of 1 878.06 hours, with a mean of 44.72 hours per site (Table 4). A total of 120 fishes were caught with this gear, representing 17 species. The mean CPUE was 0.07 fishes per hour of set time. There were 22 hoop net sites where no fish were caught.

The most abundant species caught in hoop nets were Bluegill (65.8% of fishes caught), Channel Catfish (*Ictalurus punctatus*; 5.8%) and White Perch (*Morone americana*; 4.2%). The most frequently caught species in hoop nets were Bluegill (caught at 14.3% of sites sampled) and Freshwater Drum (*Aplodinotus grunniens*; 9.5%). There were no buffalo or Common Carp caught in the hoop nets.

In the HEC, 34 sites were sampled with hoop nets. A total of 108 fishes were caught, representing 13 species. The mean CPUE across these sites in the HEC was 0.07 fishes per hour of set time (Tables 2, 5).

In Lake Erie, four sites were sampled with hoop nets. A total of nine fishes were caught, representing five species. The mean CPUE across Lake Erie sites was 0.05.

In Lake Ontario, four sites were sampled with hoop nets. A total of three fishes, representing three species, were caught. The mean CPUE across sites in this lake was 0.02.

There were no hoop nets set in Lake Huron.

MINI FYKE NET

Mini fyke nets were set at 329 sites in 35 waterbodies sampled. Nets were set for a total of 7 231.36 hours, with a mean of 21.98 hours per site (Table 4). A total of 17 508 fishes were caught with this gear, representing 67 species. The mean CPUE was 2.39 fishes per hour of set time. There were seven sites where no fish were caught in this gear.

The most abundant species caught with this gear type were bullhead species (*Ameiurus* sp.; 13.2% of fishes caught), sunfish species (*Lepomis* sp.; 12.7%) and Pumpkinseed (10.7%). The most frequently caught species were Pumpkinseed (caught at 46.2% of sites sampled), Bluegill (41.6%) and Rock Bass (*Ambloplites rupestris*; 38.9%). There was one buffalo and 91 Common Carp caught in mini fyke nets.

In Lake Huron, 79 sites were sampled with mini fyke nets. A total of 6 313 fishes were caught, representing 54 species. The mean CPUE across sites in Lake Huron was 3.50 fishes per hour (Tables 2, 5).

In the HEC, 103 sites were sampled with mini fyke nets. A total of 3 696 fishes were caught, representing 40 species. The mean CPUE across sites in the HEC was 1.71.

In Lake Erie, 100 sites were sampled with mini fyke nets. A total of 3 540 fishes were caught, representing 47 species. The mean CPUE across Lake Erie fyke net sites was 1.62.

In Lake Ontario, 47 sites were sampled with mini fyke nets. A total of 3 959 fishes were caught, representing 28 species. The mean CPUE across sites in this lake was 3.68 fishes per hour.

SEINE NET

Seine nets were used at 35 sites in 18 of the waterbodies sampled. A total of 102 hauls were pulled, with a mean of 2.91 hauls per site (Table 4). A total of 4 345 fishes were caught with this gear, representing 51 species. The mean CPUE was 41.55 fishes per haul. There were two seine net sites where no fish were caught.

The most abundant species caught with this gear type were Rock Bass (18.7% of fishes caught), Brook Silverside (*Labidesthes sicculus*; 10.5%) and Bluntnose Minnow (*Pimephales notatus*; 9.0%). The most frequently caught species in the seine nets were Round Goby (*Neogobius melanostomus*; caught at 48.6% of sites sampled), Rock Bass (42.9%) and Largemouth Bass (40.0%). There were two buffalo and three Common Carp caught in seine nets.

In Lake Huron, 18 sites were sampled with seine nets. A total of 3 262 fishes, representing 38 species, were caught. The mean CPUE across seine net sites in Lake Huron was 60.49 fishes per haul (Tables 2, 5).

In the HEC, seven sites were sampled with seine nets. A total of 144 fishes were caught, representing 17 species. The mean CPUE across sites in the HEC was 7.50 fishes per haul.

In Lake Erie, nine sites were sampled with seine nets. A total of 927 fishes were caught, representing 31 species. The mean CPUE across these sites was 34.33 fishes per haul.

In Lake Ontario, one site was sampled with a seine net. A total of 12 fishes, representing four species, were caught. The mean CPUE was 4.00 fishes per haul.

TIED-DOWN GILL AND TRAMMEL NETS

Tied-down gill nets were set at 65 sites in 17 waterbodies sampled. Nets were set for a total of 2 917 minutes, with a mean of 44.88 minutes per site (Table 4). A total of 238 fishes were caught with this gear, representing seven species. The mean CPUE was 0.08 fishes per minute of set time. There were 39 tied-down gill net sites where no fish were caught.

The most abundant species caught with this gear type were Common Carp (60.1% of fishes caught), Freshwater Drum (20.2%) and buffalo (12.2%). The most frequently caught species were Common Carp (caught at 36.9% of sites sampled), Channel Catfish (10.8%) and Freshwater Drum (10.8%). There were 29 buffalo and 143 Common Carp caught in tied-down gill nets.

Trammel nets were set at 124 sites in 18 waterbodies sampled. Nets were set for a total of 4 959.53 minutes, with a mean of 40.00 minutes per site (Table 4). A total of 1 205 fishes were caught with this gear, representing 15 species. The mean CPUE was 0.26 fishes per minute of set time. There were 40 sites where no fish were caught in this gear.

The most abundant species caught with this gear type were buffalo (44.6% of fishes caught), Common Carp (43.1%) and Channel Catfish (7.7%). The most frequently caught species in trammel nets were Common Carp (caught at 57.3% of sites sampled), buffalo (41.1%) and Channel Catfish (22.6%). There were 537 buffalo and 519 Common Carp caught in trammel nets.

Tied-down gill nets and trammel nets are often set in combination with boat electrofishing. This combination drives fish towards the net and prevents escape from the site. Of the 65 sites sampled with a tied-down gill net, two were sampled with this gear alone (with noise disturbance), and the mean CPUE was 0.04 fishes per minute of set time. Sixty-three sites were sampled by tied-down gill nets in combination with boat electrofishing with a mean CPUE of 0.08 fishes per minute. Of the 124 sites sampled with trammel nets, 32 were sampled with this gear alone (with noise disturbance), and the mean CPUE was 0.37 fishes per minute. The other 92 sites sampled by trammel nets were in combination with boat electrofishing, with a mean CPUE of 0.22 fishes per minute.

In Lake Huron, 20 sites were sampled with tied-down gill nets. A total of 42 fishes were caught, representing three species. The mean CPUE across sites in Lake Huron was 0.04 fishes per minute (Tables 2, 5). In trammel nets, nine Huron sites were sampled, with 95 fishes caught representing four species. The mean CPUE in trammel nets was 0.18 fishes per minute.

In the HEC, 11 sites were sampled with tied-down gill nets. A total of 158 fishes were caught, representing five species. The mean CPUE across sites in the HEC was 0.27. In trammel nets, 61 sites were sampled, with 784 fishes caught representing 11 species. The mean CPUE in trammel nets was 0.38 fishes per minute in the HEC.

In Lake Erie, 24 sites were sampled with tied-down gill nets. A total of 20 fish were caught, representing one species. The mean CPUE across Lake Erie sites was 0.02. In trammel nets, 29 sites were sampled, with 275 fishes caught representing 12 species. The mean CPUE in trammel nets in Lake Erie was 0.22 fishes per minute.

In Lake Ontario, 10 sites were sampled with tied-down gill nets. A total of 18 fishes, representing three species, were caught. The mean CPUE across sites in this lake was 0.08. In

trammel nets, 25 sites were sampled, with 51 fishes caught representing three species. The mean CPUE in trammel nets was 0.04 fishes per minute in Lake Ontario.

TRAP NET

Trap nets were set at 196 sites in 34 of the waterbodies sampled. Trap nets were set for a total of 4 251.41 hours, with a mean of 21.69 hours per site (Table 4). A total of 9 226 fishes were caught with this gear, representing 41 species. The mean CPUE was 2.21 fishes per hour of set time. There were 11 sites where no fish were caught in this gear.

The most abundant species caught in trap nets were Bluegill (19.0% of fishes caught), Channel Catfish (15.1%) and Brown Bullhead (14.5%). The most frequently caught species were Bluegill (caught at 48.5% of sites sampled), Common Carp (43.9%) and Channel Catfish (40.3%). There were 103 buffalo and 332 Common Carp caught in trap nets.

In Lake Huron, 37 sites were sampled with trap nets. A total of 700 fishes were caught, representing 28 species. The mean CPUE across sites in Lake Huron was 0.99 fishes per hour of set time (Tables 2, 5).

In the HEC, 71 sites were sampled with trap nets. A total of 4 379 fishes were caught, representing 32 species. The mean CPUE across sites in the HEC was 2.95.

In Lake Erie, 57 sites were sampled with trap nets. A total of 3 234 fishes were caught, representing 34 species. The mean CPUE across Lake Erie sites was 2.57.

In Lake Ontario, 31 sites were sampled with trap nets. A total of 913 fishes were caught, representing 20 species. The mean CPUE across sites in this lake was 1.33.

SURROGATE SPECIES

A total of 2 740 surrogate fishes were caught in 2019 consisting of 864 buffalo and 1 876 Common Carp. Buffalo ranged in size from 59 to 928 mm total length, with a mean and median total length of 593.3 mm and 629 mm, respectively. Buffalo was the 15th most abundant and the 11th most frequently caught species in 2019. It was caught in 14 of 36 waterbodies in all Great Lakes sampled; however, in Lake Huron, it was only caught in the Ausable River, and in Lake Ontario, only in Jordan Harbour. The most buffalo were caught in the Canard River (245 individuals, approximately 3.1 per site).

Common Carp ranged in size from 30 to 967 mm total length, with a mean and median total length of 624.6 mm and 649 mm, respectively. Common Carp was the seventh most abundant and the most frequently caught species in 2019. It was caught in all but two waterbodies sampled (Magnetawan and Sturgeon rivers). The most Common Carp were caught in the Canard River totalling 290 individuals (3.7 per site), but the greatest number per site was in the Ruscom River (119 individuals, 5.2 per site sampled).

The most buffalo were caught in trammel nets, a total of 537 (62.2% of all buffalo caught; approximately 4.3 buffalo per trammel net site; Table 4). Boat electrofishing and trap nets were also effective at capturing buffalo, with 192 (22%; 0.5 per site) and 103 (11.9%; 0.5 per site) caught in these gear types, respectively.

The most Common Carp were caught by boat electrofishing, with a total of 788 individuals (42.0% of all Common Carp caught; 1.9 per site); however, trammel nets caught the greatest number per site, a total of 519 individuals (27.7%; 4.2 individuals per site).

ASIAN CARPS

No Asian carps were caught during the 2019 early detection surveillance work and none were otherwise detected in Canadian waters of the Great Lakes.

OTHER NON-INDIGENOUS AQUATIC SPECIES

Other non-indigenous fish species (as listed in Sturtevant et al. 2019, updated from Mills et al. 1993) were caught during DFO's early detection surveillance work targeting Asian carps. This includes 38 Alewife (*Alosa pseudoharengus*); one Brown Trout (*Salmo trutta*); 15 Chinook Salmon (*Oncorhynchus tshawytscha*); one Coho Salmon (*Oncorhynchus kisutch*); five Flathead Catfish (*Pylodictis olivaris*); 146 Goldfish (*Carassius auratus*); 29 Goldfish x Common Carp hybrids (*Carassius auratus* X *Cyprinus carpio*); one Rainbow Smelt (*Osmerus mordax*); 18 Rainbow Trout (*Oncorhynchus mykiss*); 715 Round Goby; 118 Rudd (*Scardinius erythrophthalmus*); seven Tubenose Goby (*Proterorhinus semilunaris*); and 127 White Perch (Table 3).

LARVAL BONGO NETS

Bongo nets were deployed in three waterbodies at 45 sites in early summer 2019 (Table 6). Bongo nets were deployed for 8 120 seconds. A total of 4 613 larval fishes were caught, weighing 49.8 g. The greatest CPUE was in the Sydenham River with 76.0 fishes per 60 seconds of bongo tow. Fish eggs were noticeable in five of the bongo nets in the Grand River. Species identifications through genetic analysis are underway.

LARVAL LIGHT TRAPS

Light traps were deployed in three waterbodies at 60 sites in early summer (Table 6). Light traps were deployed for 4 209 minutes. A total of 13 938 larval fishes were caught, with a weight of 853.8 g. The greatest CPUE was 5.5 fishes per minute of set time in the Sydenham River. Species identifications through genetic analysis are underway. Non-larval fish caught and released included Blackchin Shiner (*Notropis heterodon*) and young-of-year Largemouth Bass.

SUMMARY

In 2019, DFO's Asian Carp Program early detection surveillance crews sampled 36 waterbodies in the Great Lakes basin that are at high risk for arrival of Asian carps. This included 35 early detection surveillance locations and an additional scout location. Seven gear types were used to target large- and small-bodied fishes in a variety of wetland and riverine habitats where Asian

carps are likely to arrive. A total of 1 197 field sites were sampled and 57 027 fishes representing 86 species were caught. Additionally, two gear types were used to target Asian carp ichthyoplankton (larval fish and eggs); another 105 field sites were sampled resulting in 18 551 larval fishes. No Asian carps were detected during the 2019 surveillance.

Trammel nets, boat electrofishing and trap nets continue to be the most effective gear types for capturing surrogate species, trammel nets especially so for buffalo, and boat electrofishing for Common Carp. This is generally consistent with effectiveness of gear types at capturing Asian carps in the Missouri River, USA (Wanner and Klumb 2009). Buffalo and Common Carp were the 15th and seventh most abundant species caught, and the 11th and most frequently caught species, respectively, suggesting our methods are targeting large-bodied fishes effectively.

There were minimal changes in the gear types used for early detection surveillance in 2019. The program deployed two custom Henley boats fitted with Halltech/Midwest Lake electrofishing equipment to improve consistency in sampling efforts. No changes in gear are anticipated for the 2020 sampling season.

The Asian Carp Program conducted early detection surveillance in 35 of 37 early detection locations identified as highly suitable for Asian carps. The two early detection locations in Lake Superior (Kaministiquia and Goulais rivers) were not visited in 2019 as Lake Superior remains lower priority than sites in the lower Great Lakes where Grass Carp have been detected and/or are reproducing (i.e. two Lake Erie tributaries in US waters). These early detection sites will be visited when opportunity allows or if the threat to Lake Superior increases. The St. Clair River was scouted in 2018 due to Grass Carp captures nearby in 2017 and 2018 by commercial fishers, and it will continue to be sampled as an early detection location going forward. Due to fast flows in the St. Clair River, sites suitable for setting nets are limited, but we will continue to identify more areas that can be sampled effectively. Additionally, nearshore areas in southeastern Lake St. Clair (near the mouth of the Thames River) were scouted in 2019. Only boat electrofishing and trammel netting were conducted. This area will likely be sampled again in 2020; however, the use of additional gears (i.e. overnight nets) may not be feasible as wind conditions can change rapidly and could cause nets to collapse or change position.

No Asian carps were caught during early detection surveillance efforts or during other non-target fishing activities (i.e. science/monitoring programs, or commercial or recreational fishing) in Canadian waters. Grass Carp continued to be captured in several Lake Erie tributaries in Ohio waters with reproduction occurring in the Sandusky and Maumee rivers (USGS 2019).

In 2020, the Asian Carp Program will continue to conduct early detection surveillance for Asian carps, but will concentrate efforts in the western basin of Lake Erie, and the southern HEC where the threat of Grass Carp is most imminent. Other sites in the basin may be visited fewer times or may be sampled with non-traditional techniques (e.g. environmental DNA surveillance); this work will be triaged based on risk and as time allows. This change in strategy is intended to prevent the spread of Grass Carp beyond western Lake Erie and into Canadian waters.

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TABLES

Table 1 Summary of the 2019 catch data for the Asian Carp Program's early detection surveillance.

Number of Sites	1197
Number of Waterbodies	36
Total Number of Fishes Caught	57027
Mean Number of Fish per Site	47.64
Maximum Number of Fish per Site	801
Total Number of Species	86
Mean Number of Species per Site	5.38
Maximum Number of Species per Site	20
Total Number of Asian carps	0
Total Number of Buffalo	864
Total Number of Common Carp	1 876

Table 2 Catch data by waterbody for the 2019 Asian Carp Program's early detection surveillance.

Great Lake	Waterbody Name	Number of Sites	Total Number of Fish Captured	Mean Number of Fish Captured per Site	Number of Species	Mean Number of Species per Site	Number of Sites with No Fish	Number of Buffalo	Number of Common Carp
Huron	Ausable River	82	4841	59.04	47	6.89	5	20	223
	Bayfield River	13	1681	129.31	39	9.38	0	0	40
	Coldwater River	33	650	19.70	20	4.70	5	0	20
	Magnetawan River	17	537	31.59	22	5.94	2	0	0
	Maitland River	19	901	47.42	36	7.16	0	0	42
	Mississagi River	12	200	16.67	19	4.08	0	0	1
	Nottawasaga River	13	203	15.62	19	4.31	1	0	6
	Pine River	11	826	75.09	22	7.45	0	0	10
	Sauble River	21	1280	60.95	28	5.29	2	0	3
	Shebeshekong River	15	830	55.33	22	5.93	1	0	13
	Spanish River	19	1425	75.00	26	5.32	2	0	3
	Sturgeon River	15	504	33.60	19	4.13	2	0	0
HEC	Big Creek	19	1555	81.84	24	5.16	0	21	84
	Canard River	78	8061	103.35	40	6.87	3	245	290
	Detroit River	78	4952	63.49	42	5.38	8	55	111
	Jeanette's Creek	51	2448	48.00	30	4.92	2	78	56
	Lake St. Clair	6	145	24.17	21	6.83	0	4	50
	Ruscom River	23	753	32.74	28	5.91	1	7	119
	St. Clair River	33	365	11.06	33	2.94	10	0	12
	Sydenham River	34	507	14.91	30	5.88	1	4	45
	Thames River	115	5112	44.45	38	4.43	17	227	199
Erie	Big Otter Creek	24	868	36.17	35	5.75	3	0	35
	Cedar Creek	20	1109	55.45	25	6.75	0	7	19
	Grand River	69	2068	29.97	42	6.38	5	39	77
	Kettle Creek	12	139	11.58	23	5.08	0	0	20

	Long Point Bay	68	2789	41.01	34	6.10	11	0	62
	Nanticoke Creek	22	636	28.91	27	4.36	1	0	89
	Rondeau Bay	50	3785	75.70	34	7.10	9	6	43
	Welland River	58	1719	29.64	32	5.81	3	99	90
Ontario	Credit River	33	540	16.36	25	3.55	3	0	17
	Duffins Creek	18	1029	57.17	19	3.61	4	0	7
	Frenchman's Bay	12	352	29.33	10	4.00	2	0	2
	Humber River	27	2105	77.96	22	3.44	12	0	21
	Jordan Harbour	25	1561	62.44	29	6.76	1	52	46
	Toronto Islands (Lake Ontario)	31	320	10.32	16	2.55	8	0	20
	Rouge River	21	231	11.00	16	2.95	5	0	1

Table 3 Summary of the species caught during the 2019 Asian Carp Program's early detection surveillance. Common and scientific names according to Page et al. (2013). Status in capital letters refers to Species at Risk Act listing; lower case status refers to Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessment.

Common Name	Species Name	Number Captured	Status*
Alewife	<i>Alosa pseudoharengus</i>	38	
Atlantic salmon	<i>Salmo salar</i>	1	
Banded Killifish	<i>Fundulus diaphanus</i>	81	
Black Bullhead	<i>Ameiurus melas</i>	14	
Black Crappie	<i>Pomoxis nigromaculatus</i>	553	
Black Redhorse	<i>Moxostoma duquesnei</i>	3	THR
Blackchin Shiner	<i>Notropis heterodon</i>	233	
Blacknose Dace	<i>Rhinichthys atratulus</i>	1	
Blacknose Shiner	<i>Notropis heterolepis</i>	7	
Blackside Darter	<i>Percina maculata</i>	17	
Bluegill	<i>Lepomis macrochirus</i>	4741	
Bluntnose Minnow	<i>Pimephales notatus</i>	1796	
Bowfin	<i>Amia calva</i>	445	
Brook Silverside	<i>Labidesthes sicculus</i>	1889	
Brook Stickleback	<i>Culaea inconstans</i>	9	
Brown Bullhead	<i>Ameiurus nebulosus</i>	2644	
Brown Trout	<i>Salmo trutta</i>	1	
buffalo species	<i>Ictiobus sp</i>	864	
Burbot	<i>Lota lota</i>	1	
Central Mudminnow	<i>Umbra limi</i>	275	
Channel Catfish	<i>Ictalurus punctatus</i>	1587	
Chinook Salmon	<i>Oncorhynchus tshawytscha</i>	15	
Coho Salmon	<i>Oncorhynchus kisutch</i>	1	
Common Carp	<i>Cyprinus carpio</i>	1876	
Common Shiner	<i>Luxilus cornutus</i>	455	
Creek Chub	<i>Semotilus atromaculatus</i>	35	
Emerald Shiner	<i>Notropis atherinoides</i>	1828	
Fathead Minnow	<i>Pimephales promelas</i>	15	
Flathead Catfish	<i>Pylodictis olivaris</i>	5	
Freshwater Drum	<i>Aplodinotus grunniens</i>	333	
Ghost Shiner	<i>Notropis buechanani</i>	159	
Gizzard Shad	<i>Dorosoma cepedianum</i>	11703	
Golden Redhorse	<i>Moxostoma erythrurum</i>	71	
Golden Shiner	<i>Notemigonus crysoleucas</i>	724	
Goldfish	<i>Carassius auratus</i>	146	
Grass Pickerel	<i>Esox americanus vermiculatus</i>	24	SC
Greater Redhorse	<i>Moxostoma valenciennesi</i>	37	
Green Sunfish	<i>Lepomis cyanellus</i>	27	
Greenside Darter	<i>Etheostoma blennioides</i>	5	

Hornyhead Chub	<i>Nocomis biguttatus</i>	40	
Johnny Darter	<i>Etheostoma nigrum</i>	34	
Lake Chub	<i>Couesius plumbeus</i>	2	
Lake Chubsucker	<i>Erimyzon sucetta</i>	5	END
Largemouth Bass	<i>Micropterus salmoides</i>	1170	
Logperch	<i>Percina caprodes</i>	91	
Longnose Dace	<i>Rhinichthys cataractae</i>	1	
Longnose Gar	<i>Lepisosteus osseus</i>	674	
Longnose Sucker	<i>Catostomus catostomus</i>	4	
Mimic Shiner	<i>Notropis volucellus</i>	528	
Mooneye	<i>Hiodon tergisus</i>	1	
Muskellunge	<i>Esox masquinongy</i>	10	
Northern Hog Sucker	<i>Hypentelium nigricans</i>	7	
Northern Pike	<i>Esox lucius</i>	218	
Northern Sunfish	<i>Lepomis peltastes</i>	42	
Pugnose Minnow	<i>Opsopoeodus emiliae</i>	2	THR
Pugnose Shiner	<i>Notropis anogenus</i>	7	THR
Pumpkinseed	<i>Lepomis gibbosus</i>	3610	
Quillback	<i>Carpionodes cyprinus</i>	82	
Rainbow Smelt	<i>Osmerus mordax</i>	1	
Rainbow Trout	<i>Oncorhynchus mykiss</i>	18	
River Redhorse	<i>Moxostoma carinatum</i>	1	SC
Rock Bass	<i>Ambloplites rupestris</i>	1557	
Rosyface Shiner	<i>Notropis rubellus</i>	146	
Round Goby	<i>Neogobius melanostomus</i>	715	
Rudd	<i>Scardinius erythrophthalmus</i>	118	
Shorthead Redhorse	<i>Moxostoma macrolepidotum</i>	239	
Silver Lamprey	<i>Ichthyomyzon unicuspis</i>	5	
Silver Redhorse	<i>Moxostoma anisurum</i>	96	
Smallmouth Bass	<i>Micropterus dolomieu</i>	954	
Spotfin Shiner	<i>Cyprinella spiloptera</i>	248	
Spottail Shiner	<i>Notropis hudsonius</i>	959	
Spotted Gar	<i>Lepisosteus oculatus</i>	16	END
Spotted Sucker	<i>Minytrema melanops</i>	129	SC
Stonecat	<i>Noturus flavus</i>	4	
Striped Shiner	<i>Luxilus chrysocephalus</i>	72	
Tadpole Madtom	<i>Noturus gyrinus</i>	4	
Trout-perch	<i>Percopsis omiscomaycus</i>	6	
Tubenose Goby	<i>Proterorhinus semilunaris</i>	7	
Walleye	<i>Sander vitreus</i>	126	
Warmouth	<i>Lepomis gulosus</i>	21	end/SC
White Bass	<i>Morone chrysops</i>	206	
White Crappie	<i>Pomoxis annularis</i>	228	
White Perch	<i>Morone americana</i>	127	

White Sucker	<i>Catostomus commersonii</i>	297
Yellow Bullhead	<i>Ameiurus natalis</i>	368
Yellow Perch	<i>Perca flavescens</i>	3671
bullhead	<i>Ameiurus</i> sp	2330
Goldfish X Common Carp	<i>Carassius auratus</i> X <i>Cyprinus</i>	
hybrid	<i>carpio</i>	29
Sucker family	Catostomidae	218
Sunfishes and basses family	Centrarchidae	2
Minnow family	Cyprinidae	570
pike or pickerel	<i>Esox</i> sp	2
darter	<i>Etheostoma</i> sp	1
lamprey	<i>Ichthyomyzon</i> sp	2
North American catfishes		
family	Ictaluridae	17
gar	<i>Lepisosteus</i> sp	1
sunfish hybrid	<i>Lepomis</i> hybrid	1
sunfish	<i>Lepomis</i> sp	2430
shiner	<i>Luxilus</i> sp	48
Temperate basses	<i>Morone</i> sp	40
redhorse	<i>Moxostoma</i> sp	123
shiner	<i>Notropis</i> sp	1643
madtom	<i>Noturus</i> sp	2
darter	<i>Percina</i> sp	1
crappie	<i>Pomoxis</i> sp	27
Walleye or Sauger	<i>Sander</i> sp	5
Unknown	Unknown	9

*END=Endangered; SC=Special Concern; THR=Threatened

Table 4 Summary of the catch data by gear type used in the 2019 Asian Carp Program's early detection surveillance.

Gear Type	Acronym	Number of Sites	Number of Waterbodies	Total Effort	Mean Effort per Site	Effort Units	Number of Fishes	Mean Number of Fishes Caught per Site	Mean Catch per Unit Effort	Number of Species	Mean Number of Species per Site	Number of Sites with No Fish Caught	Number of Buffalo sp.	Number of Common Carp
Boat Electrofishing	BEF	406	35	4325.35	10.65	minutes	24385	60.06	5.71	73	7.84	8	192	788
Hoop Net	HN	42	6	1878.06	44.72	hours	120	2.86	0.07	17	1.48	22	0	0
Mini Fyke Net	MFN	329	35	7231.36	21.98	hours	17508	53.22	2.39	67	4.92	7	1	91
Seine Net	SN	35	18	102.00	2.91	hauls	4345	124.14	41.55	51	7.51	2	2	3
Tied-down Gill Net	TDG	65	17	2917.00	44.88	minutes	238	3.66	0.08	7	1.31	39	29	143
Trap Net	TN	196	34	4251.41	21.69	hours	9226	47.07	2.21	41	5.55	11	103	332
Trammel Net	TRM	124	18	4959.53	40.00	minutes	1205	9.72	0.26	15	1.82	40	537	519

Table 5 Summary of sampling effort by waterbody for boat electrofishing (BEF), hoop nets (HN), mini fyke nets (MFN), seine nets (SN), tied-down gill nets (TDG), trammel nets (TRM) and trap nets (TN) during the 2019 Asian Carp Program's early detection surveillance.

Great Lake	Waterbody Name	Boat Electrofishing			Hoop Net			Mini Fyke Net			Seine Net		
		Number of Sites	Total Effort (minutes)	Mean CPUE (catch per minute)	Number of Sites	Total Effort (hours)	Mean CPUE (catch per hour)	Number of Sites	Total Effort (hours)	Mean CPUE (catch per hour)	Number of Sites	Total Effort (hauls)	Mean CPUE (catch per haul)
Huron	Ausable River	37	365.05	3.25	0			21	467.00	5.83	2	6.00	87.33
	Bayfield River	4	50.00	3.26	0			4	94.68	3.69	3	9.00	128.67
	Coldwater River	12	125.00	2.91	0			10	218.03	0.89	4	12.00	3.58
	Magnetawan River	7	83.00	4.94	0			5	109.31	1.32	0		
	Maitland River	9	100.00	1.57	0			5	120.81	3.83	2	6.00	39.83
	Mississagi River	5	76.00	2.15	0			5	115.31	0.19	0		
	Nottawasaga River	5	55.00	2.41	0			4	89.79	0.68	1	2.00	4.50
	Pine River	4	45.00	1.82	0			4	86.05	6.31	2	6.00	32.83
	Sauble River	8	80.00	3.70	0			6	123.72	1.94	2	6.00	120.00
	Shebeshekong River	5	65.00	5.28	0			5	118.65	2.87	0		
	Spanish River	7	82.50	2.69	0			6	136.53	8.12	0		
	Sturgeon River	4	40.00	1.20	0			4	87.84	0.25	2	6.00	62.00
HEC	Big Creek	7	75.00	20.51	0			4	83.89	0.48	0		
	Canard River	24	264.17	11.19	0			22	483.02	4.59	4	10.00	10.63
	Detroit River	35	385.10	10.92	2	94.75	0.01	11	236.45	2.05	1	3.00	1.33
	Jeanette's Creek	15	158.50	10.17	4	192.09	0.01	15	338.68	1.35	0		
	Lake St. Clair	4	45.00	2.56	0			0			0		
	Ruscom River	5	53.33	4.05	0			8	176.44	0.71	1	3.00	8.33
	St. Clair River	18	183.00	1.57	0			5	111.21	0.20	1	3.00	0.33
	Sydenham River	12	120.33	1.77	0			12	262.85	0.67	0		
	Thames River	30	316.42	12.56	28	1245.09	0.09	26	578.94	0.59	0		
Erie	Big Otter Creek	11	110.00	1.26	2	87.84	0.00	9	184.16	3.79	0		
	Cedar Creek	0			0			12	274.10	2.62	2	6.00	27.17
	Grand River	17	170.80	3.72	2	83.42	0.11	22	454.11	0.69	4	12.00	39.17
	Kettle Creek	6	60.00	0.95	0			4	80.51	0.65	0		
	Long Point Bay	24	276.02	7.30	0			16	347.79	0.76	1	3.00	15.67
	Nanticoke Creek	8	86.83	1.86	0			7	155.02	0.50	1	3.00	2.00
	Rondeau Bay	10	105.83	10.58	0			17	370.46	2.75	1	3.00	80.33
	Welland River	24	236.50	4.13	0			13	283.31	1.23	0		

Ontario	Credit River	9	99.00	0.65	4	174.87	0.02	13	292.59	1.28	0	3.00	4.00
	Duffins Creek	4	40.00	1.13	0			6	135.41	6.67	0		
	Frenchman's Bay	4	40.00	2.05	0			3	69.16	2.01	0		
	Humber River	8	80.00	0.95	0			6	139.65	14.51	0		
	Jordan Harbour	8	85.00	9.33	0			6	137.44	2.13	1		
	Toronto Islands (Lake Ontario)	9	97.80	0.70	0			8	152.11	0.65	0		
	Rouge River	7	70.17	0.54	0			5	116.34	1.02	0		

Great Lake	Waterbody Name	Tied-down Gill Net			Trammel Net			Trap Net		
		Number of Sites	Total Effort (minutes)	Mean CPUE (catch per minute)	Number of Sites	Total Effort (minutes)	Mean CPUE (catch per minute)	Number of Sites	Total Effort (hours)	Mean CPUE (catch per hour)
Huron	Ausable River	0			9	445.00	0.18	13	284.81	0.78
	Bayfield River	1	66.00	0.18	0			1	23.77	0.63
	Coldwater River	3	106.00	0.00	0			4	86.84	0.74
	Magnetawan River	2	99.00	0.00	0			3	61.92	0.28
	Maitland River	2	98.00	0.23	0			1	23.05	0.95
	Mississagi River	0			0			2	47.72	0.35
	Nottawasaga River	2	82.00	0.01	0			1	23.00	0.22
	Pine River	1	54.00	0.02	0			0		
	Sauble River	3	202.00	0.00	0			2	41.83	0.38
	Shebeshekong River	2	122.00	0.02	0			3	69.87	2.64
	Spanish River	2	99.00	0.00	0			4	91.56	0.86
	Sturgeon River	2	71.00	0.00	0			3	43.48	2.74
HEC	Big Creek	0			4	231.00	0.19	4	74.59	0.33
	Canard River	3	165.00	0.78	9	388.00	0.51	16	341.78	8.37
	Detroit River	0			20	768.00	0.13	9	192.96	1.99
	Jeanette's Creek	1	55.00	0.47	5	273.00	0.23	11	247.57	1.05
	Lake St. Clair	0			2	52.00	0.98	0		
	Ruscom River	0			4	168.00	0.41	5	111.65	2.64
	St. Clair River	7	280.00	0.02	0			2	45.52	0.77
	Sydenham River	0			2	113.00	0.05	8	175.02	0.71
	Thames River	0			15	568.00	0.70	16	346.79	1.52
Erie	Big Otter Creek	0			0			2	40.78	0.52

	Cedar Creek	0			0			6	136.09	1.76
	Grand River	0			12	506.00	0.22	12	258.95	2.08
	Kettle Creek	0			0			2	40.33	0.75
	Long Point Bay	16	713.00	0.03	0			11	229.07	1.63
	Nanticoke Creek	0			4	173.00	0.35	2	50.04	7.07
	Rondeau Bay	8	407.00	0.00	0			14	300.98	4.62
	Welland River	0			13	639.00	0.19	8	180.45	1.46
Ontario	Credit River	2	46.00	0.23	1	28.00	0.00	4	90.13	0.84
	Duffins Creek	0			4	84.33	0.00	4	92.50	0.97
	Frenchman's Bay	0			2	45.00	0.00	3	68.21	1.91
	Humber River	0			9	190.20	0.00	4	88.64	0.08
	Jordan Harbour	0			4	188.00	0.23	6	135.90	2.98
	Toronto Islands (Lake Ontario)	8	252.00	0.04	0			6	114.68	1.15
	Rouge River	0			5	100.00	0.00	4	90.93	0.80

Table 6 Summary of larval fish and egg sampling during the 2019 Asian Carp Program's early detection surveillance.

Waterbody Name	Gear Type	Number of Sites	Effort	Units	Number of Fish	Fish per Minute	Total Weight (g)
Grand River	Bongo Net	17	3080	seconds	97	1.88	0.603
Grand River	Light Trap	24	1722	minutes	1114	0.61	11.421
Sydenham River	Bongo Net	16	2880	seconds	3647	75.98	48.16
Sydenham River	Light Trap	24	1602	minutes	9841	5.58	806.36
Thames River	Bongo Net	12	2160	seconds	869	24.14	1.05
Thames River	Light Trap	12	885	minutes	2983	3.64	36.09

FIGURES



Figure 1 DFO's Asian Carp Program's early detection surveillance sites in Canadian waters of the Great Lakes.

APPENDIX 1: GEAR DESCRIPTIONS

Gear Type	Dimensions	Habitat	Standardized Effort	Notes
Boat Electrofishing	6.4-7.3 m (21-24') boat; dual boom; Midwest Lake Infinity control box	Nearshore to offshore areas in 3.5 m of water or less. Low to moderate flow. Little to heavy vegetation coverage. All substrate types.	600 seconds	
Hoop Net	1.5 m (5') diameter; 6.1 m (20') length; 2.5 cm (1") square mesh; treated; 2 funnels 0.91 m (3') diameter; 4.57 m (15') length; 2.5 cm (1") square mesh; 2 funnels	Deep (>3.5 m), fast flowing areas in mid-channel/ thalweg. Clay, silt and sand substrates. Depth range: 1.5-3.5 m	48 hours	
Mini Fyke Net	3 mm (1/8") ace mesh; 0.61 m x 4.6 m (2'x15') lead; 0.61 m (2') seines; 0.61 m x 1.22 m (2'x4') box	Nearshore, shallow areas (<2 m of water). Low or no flow; back-bays and still shorelines. Little to heavy vegetation coverage. Clay, silt, sand and cobble substrates.	24 hours	Turtle exclusion netting added
Seine Net (bag)	6.3 mm (1/4") bag mesh; 6.3 mm (1/4") wing mesh; 9.1 m (30') length	Nearshore, wadeable areas up to 1.5 m in depth. Low to moderate flow. Little to moderate vegetation. Clay, silt, sand, cobble and bedrock substrates.	3 hauls	

Tied-down Gill and Trammel Net	Tied-down Gill Net 8.9 cm (3.5") mesh; 3.7 m (12') height tied down to 3.0 m (10'); 183 m (200 yd) long Trammel Net 10.1 cm (4") mesh; 4.3 m (14') height; 183 m (200 yd) long; 10.1 cm (4") square inner wall panels; 45.7 cm (18") outer wall panels	Nearshore areas up to 5 m in depth. Low or no flow. Little to moderate vegetation. All substrate types. Set near coarse woody debris recommended.	20 minutes	Site is disturbed by pounding the water, revving the engine, or with electrofishing to drive fish to net
Trap Net	2.9 cm (1-1/8") square mesh, 5.7 cm (2-1/4") stretch mesh; 1.2 m wide x 2.4 m long x 1.2 m deep (4' x 8' x 4') crib; 3 m wings; 25 m lead.	Nearshore areas up to 2.5 m in depth. Low or no flow. Little to heavy vegetation coverage. All substrate types.	24 hours	
Bongo Net	50 cm diameter ring openings; 2 m long conical nets; 500 micron mesh; 11 cm cod-ends	Slightly offshore to mid-channel, >1 m in depth. Low to moderate flow. Little vegetation coverage. All substrate types.	180 seconds	Flow is recorded to calculate discharge; 0.4-0.6 m/s target velocity during tow
Light Trap	Polycarbonate cloverleaf; 30 cm diameter; 25 cm height; 5 mm entry slits; 250 micron mesh strainer; central tube for flashlight	Nearshore to offshore areas >0.5 m in depth. Low or no flow. Clusters set in heavy submerged vegetation, around coarse woody debris objects or in open water. All substrate types.	60 minutes	Set in clusters of three, 30 minutes before sunset

APPENDIX 2: MAPS OF ASIAN CARP SURVEILLANCE LOCATIONS

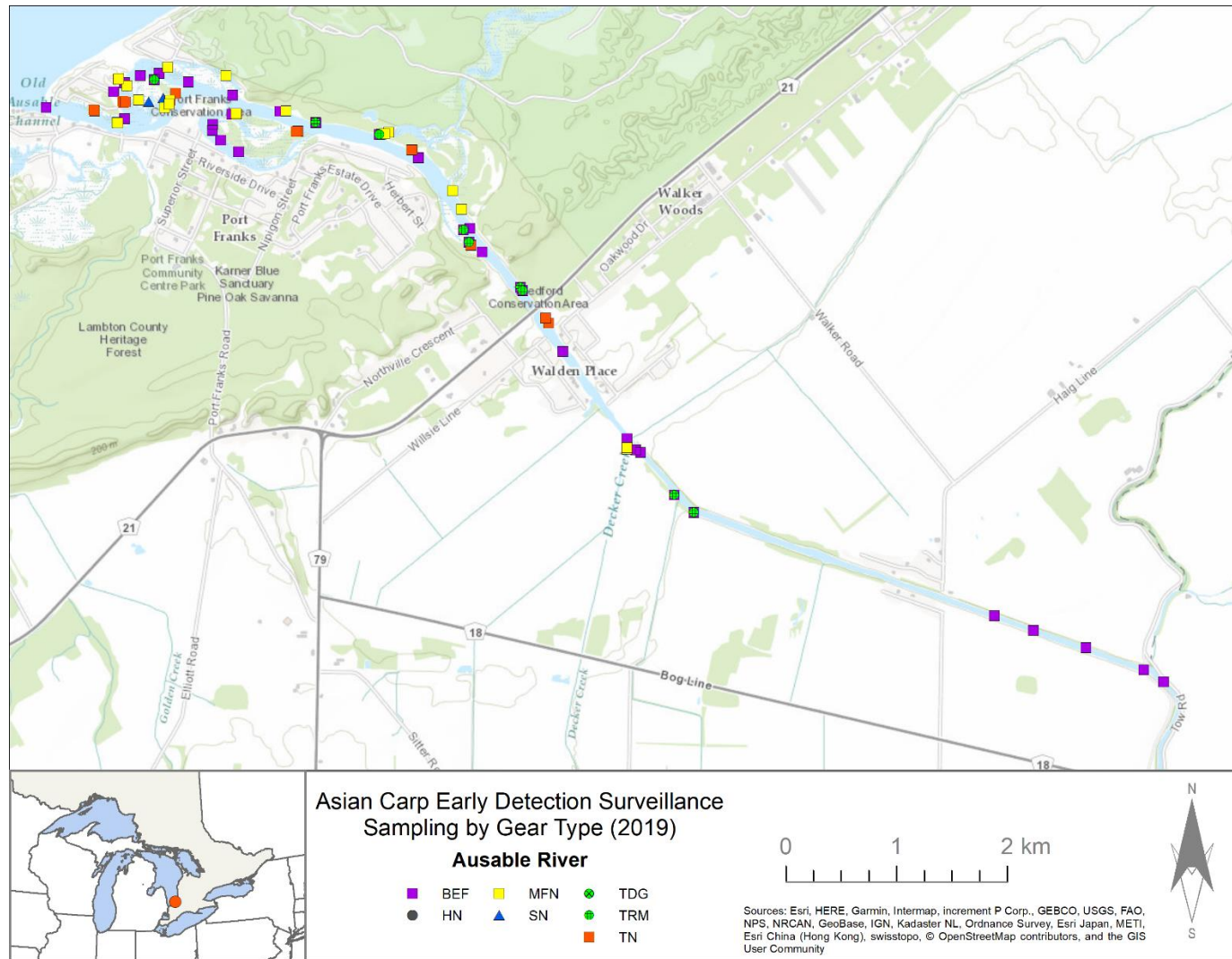


Figure A2.1 2019 Asian Carp Program Early detection surveillance field sites in the Ausable River.

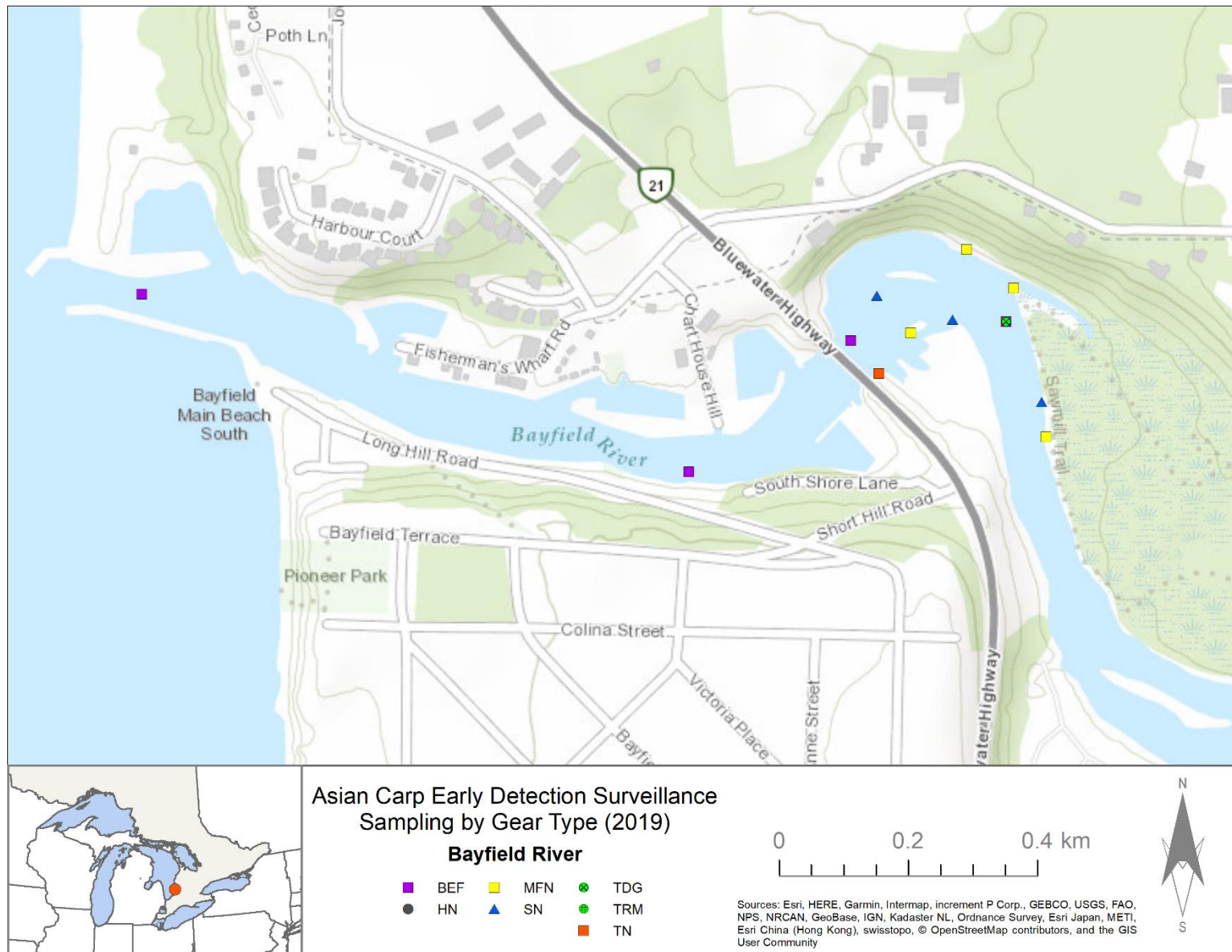


Figure A2.2 2019 Asian Carp Program early detection surveillance field sites in the Bayfield River.

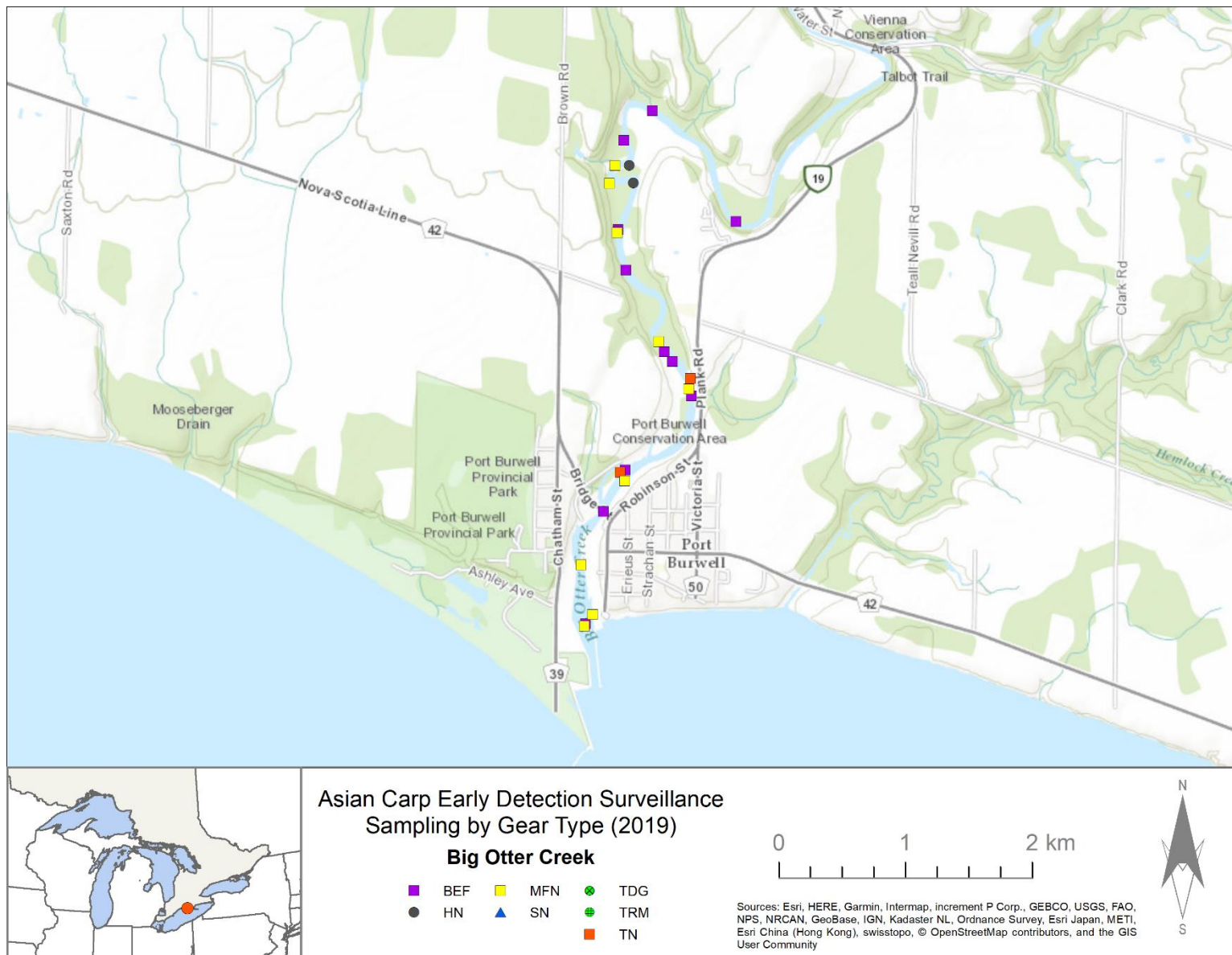


Figure A2.3 2019 Asian Carp Program early detection surveillance field sites in Big Otter Creek.

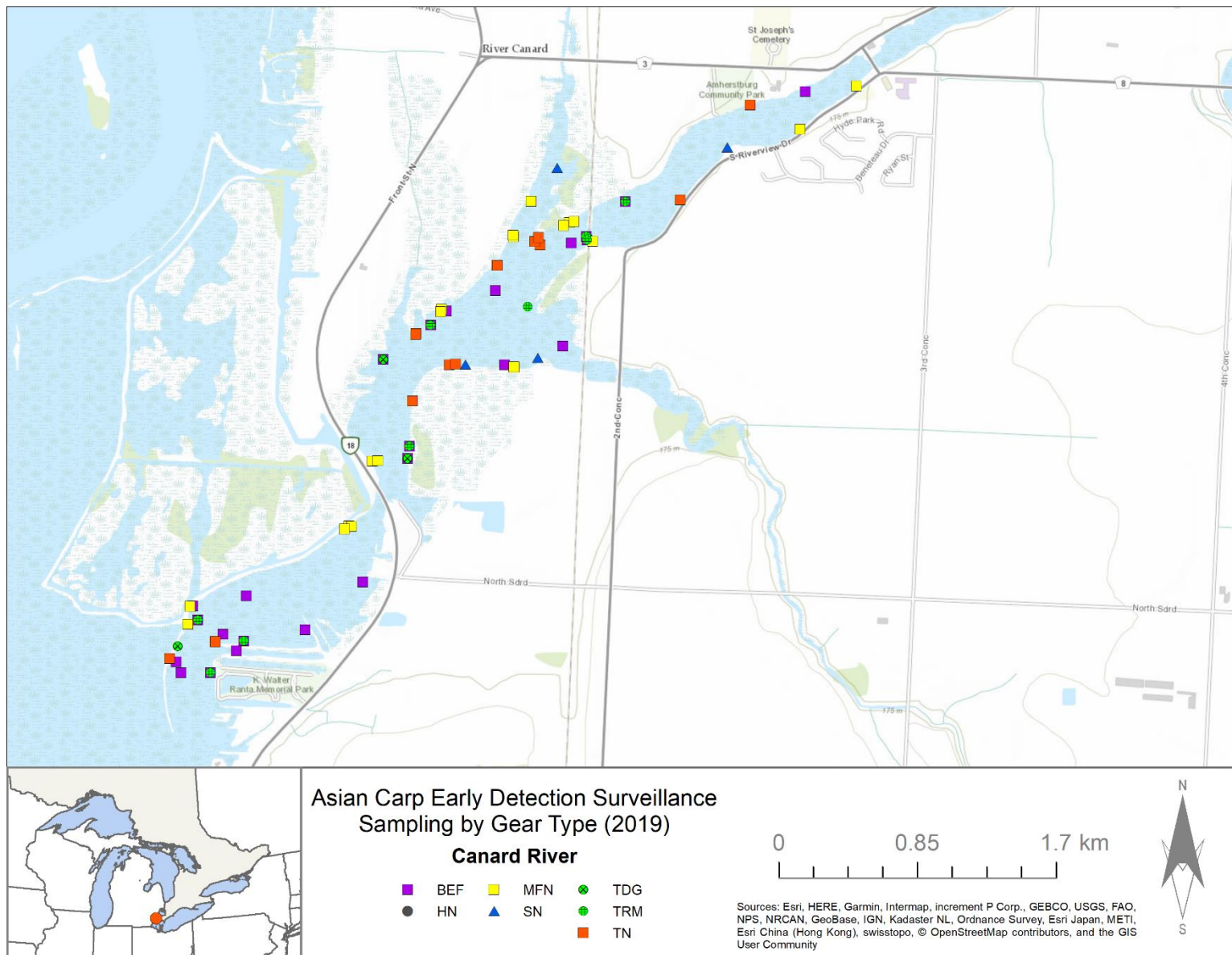


Figure A2.4 2019 Asian Carp Program early detection surveillance field sites in the Canard River.

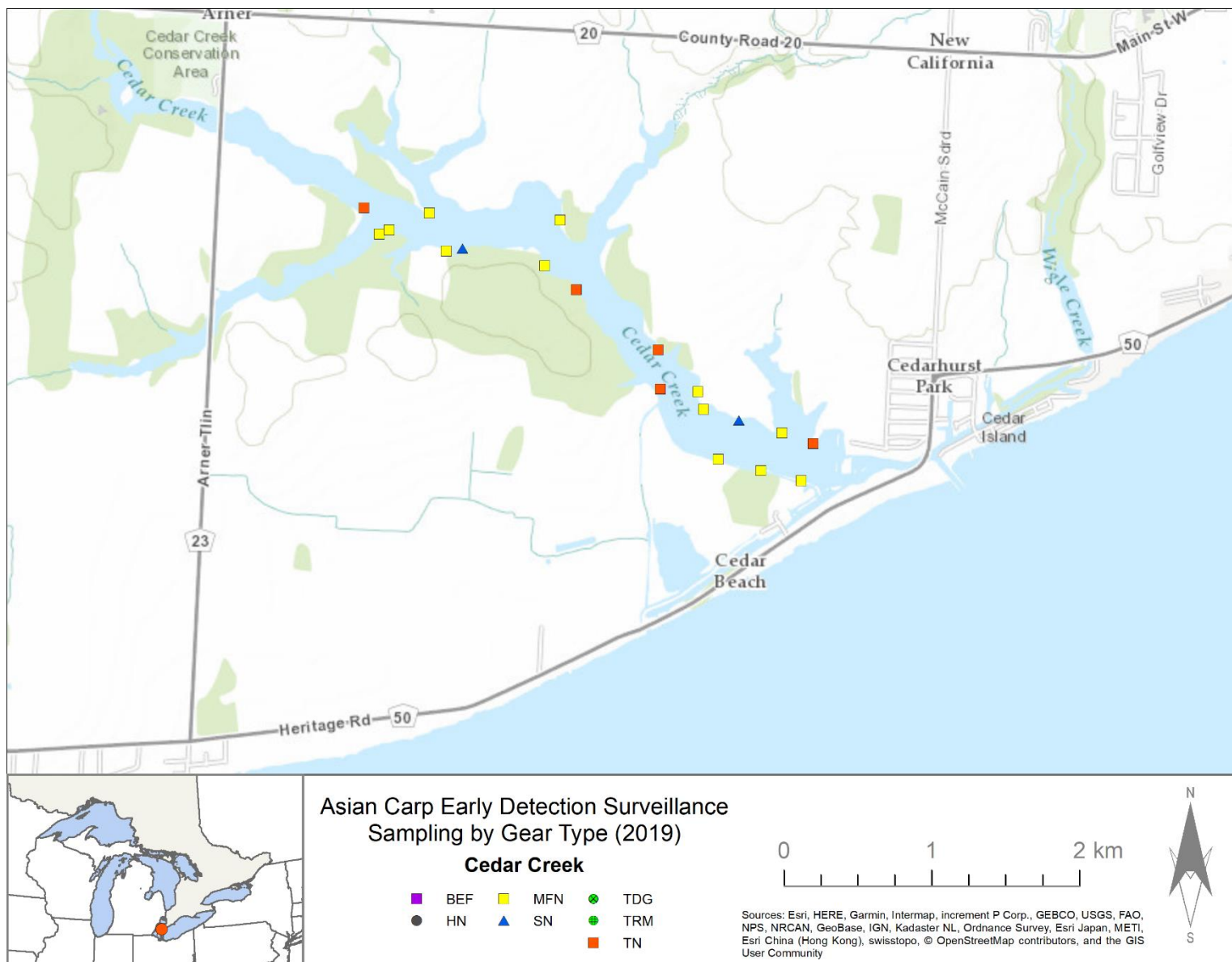


Figure A2.5 2019 Asian Carp Program early detection surveillance field sites in Cedar Creek.

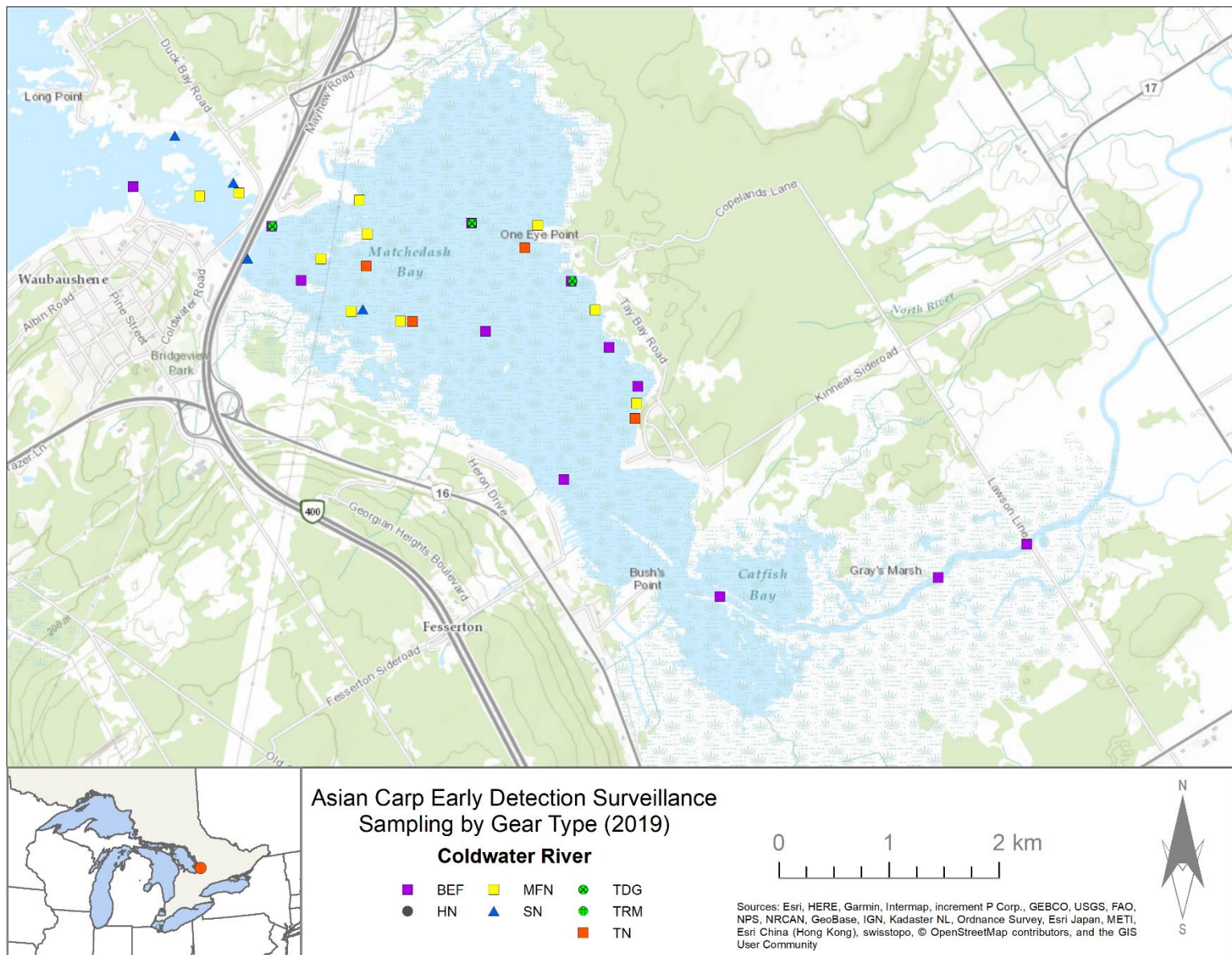


Figure A2.6 2019 Asian Carp Program early detection surveillance field sites in the Coldwater River.

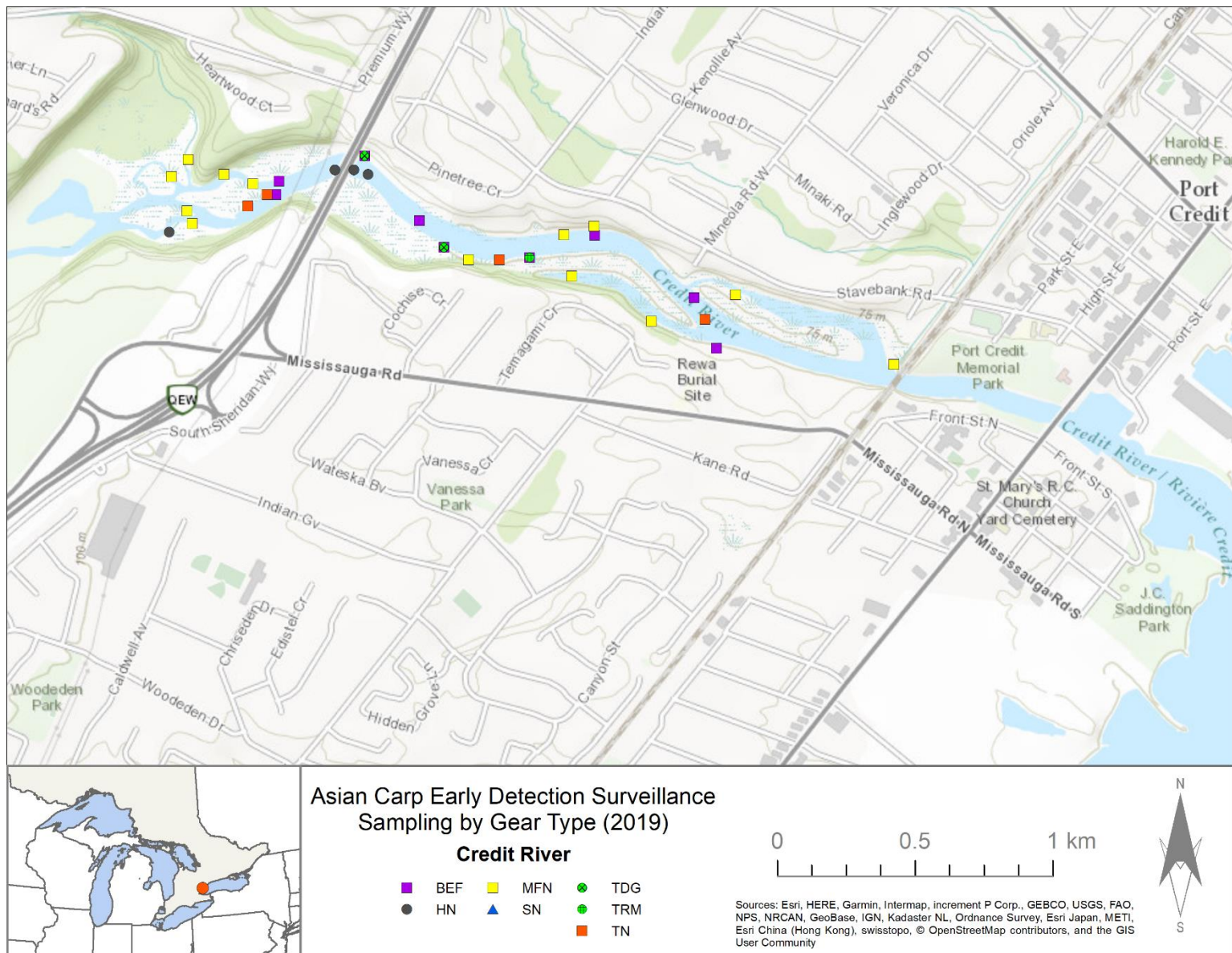


Figure A2.7 2019 Asian Carp Program early detection surveillance field sites in the Credit River.

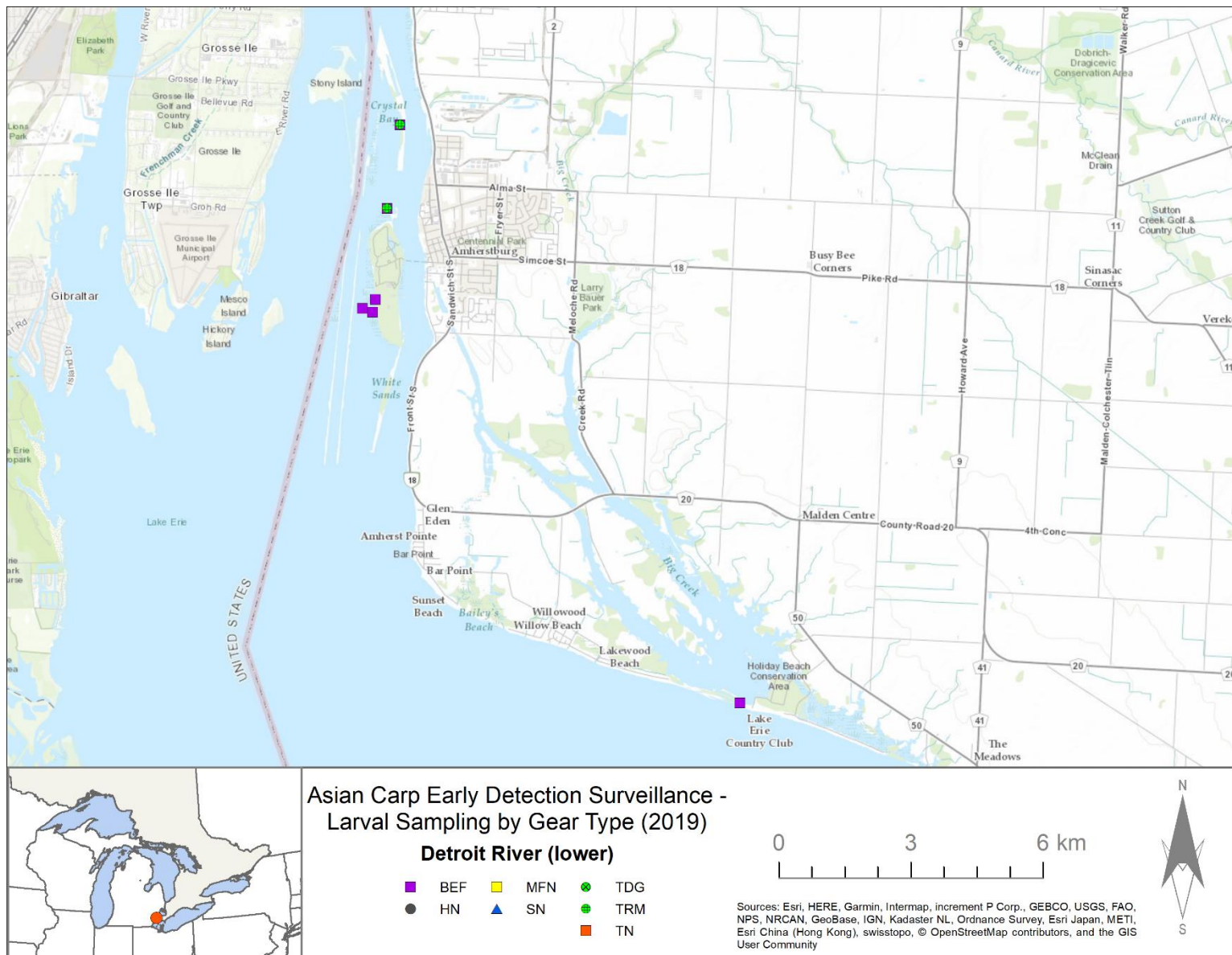


Figure A2.8 2019 Asian Carp Program early detection surveillance field sites in the lower Detroit River.

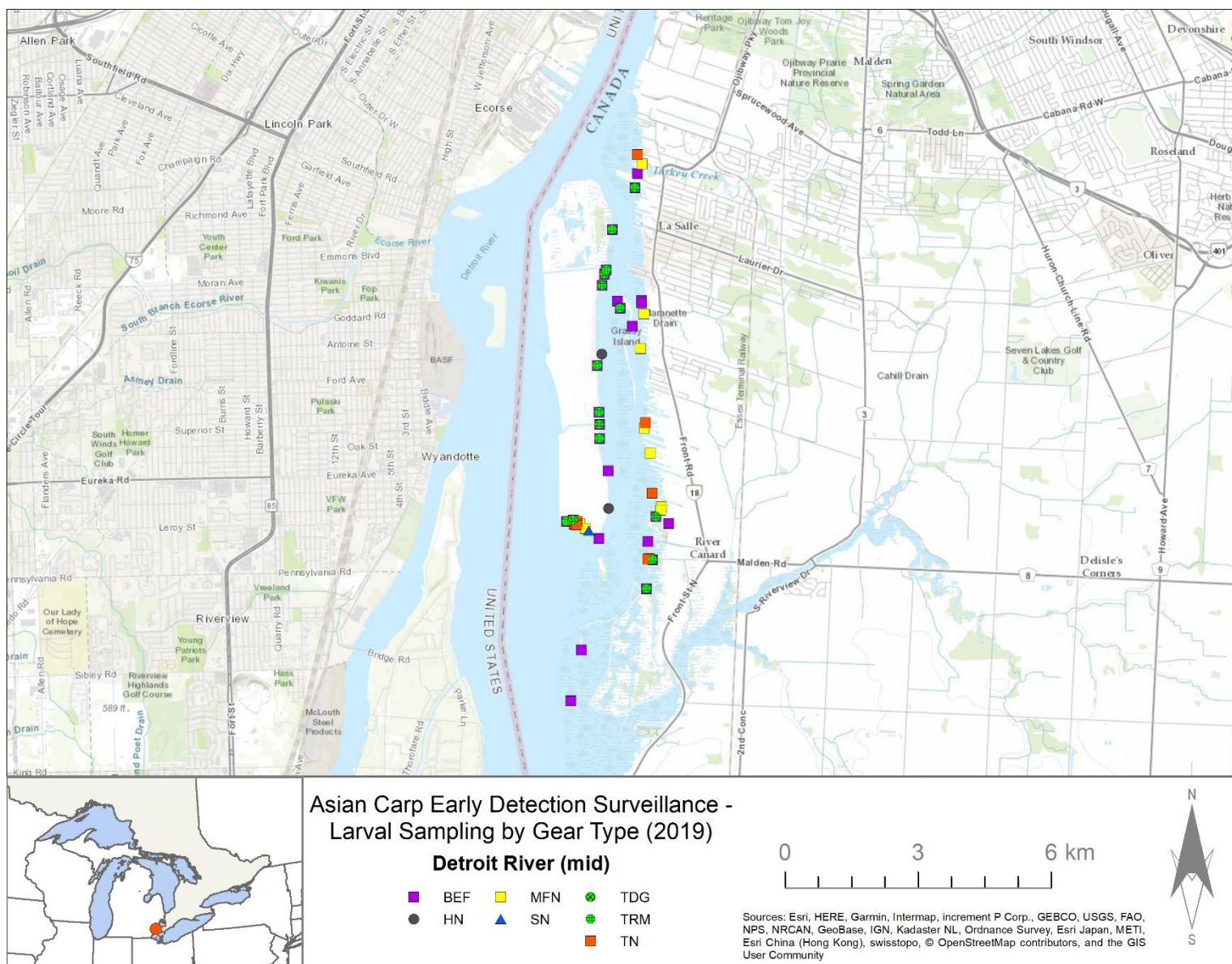


Figure A2.9 2019 Asian Carp Program early detection surveillance field sites in the mid Detroit River.

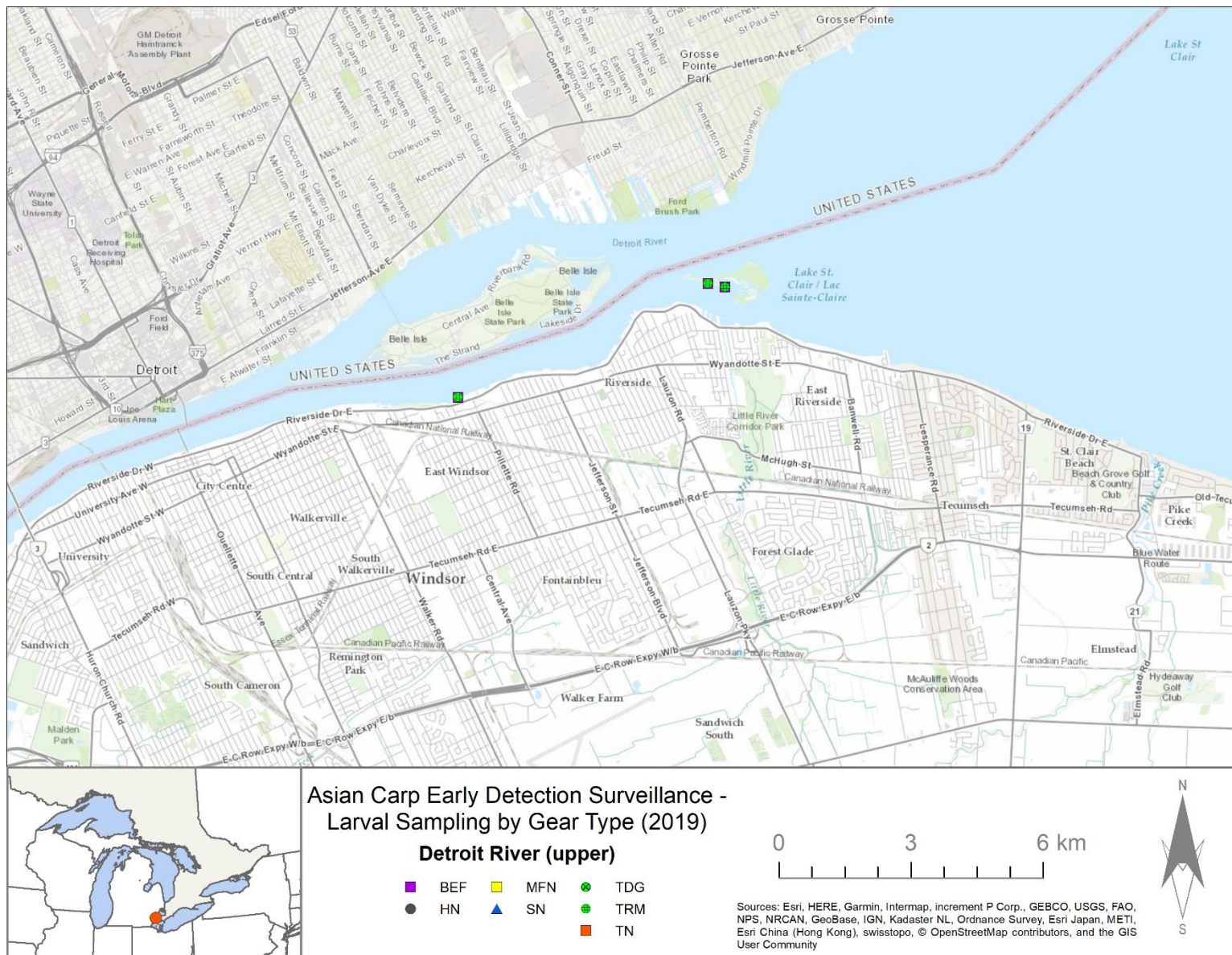


Figure A2.10 2019 Asian Carp Program early detection surveillance field sites in the upper Detroit River.

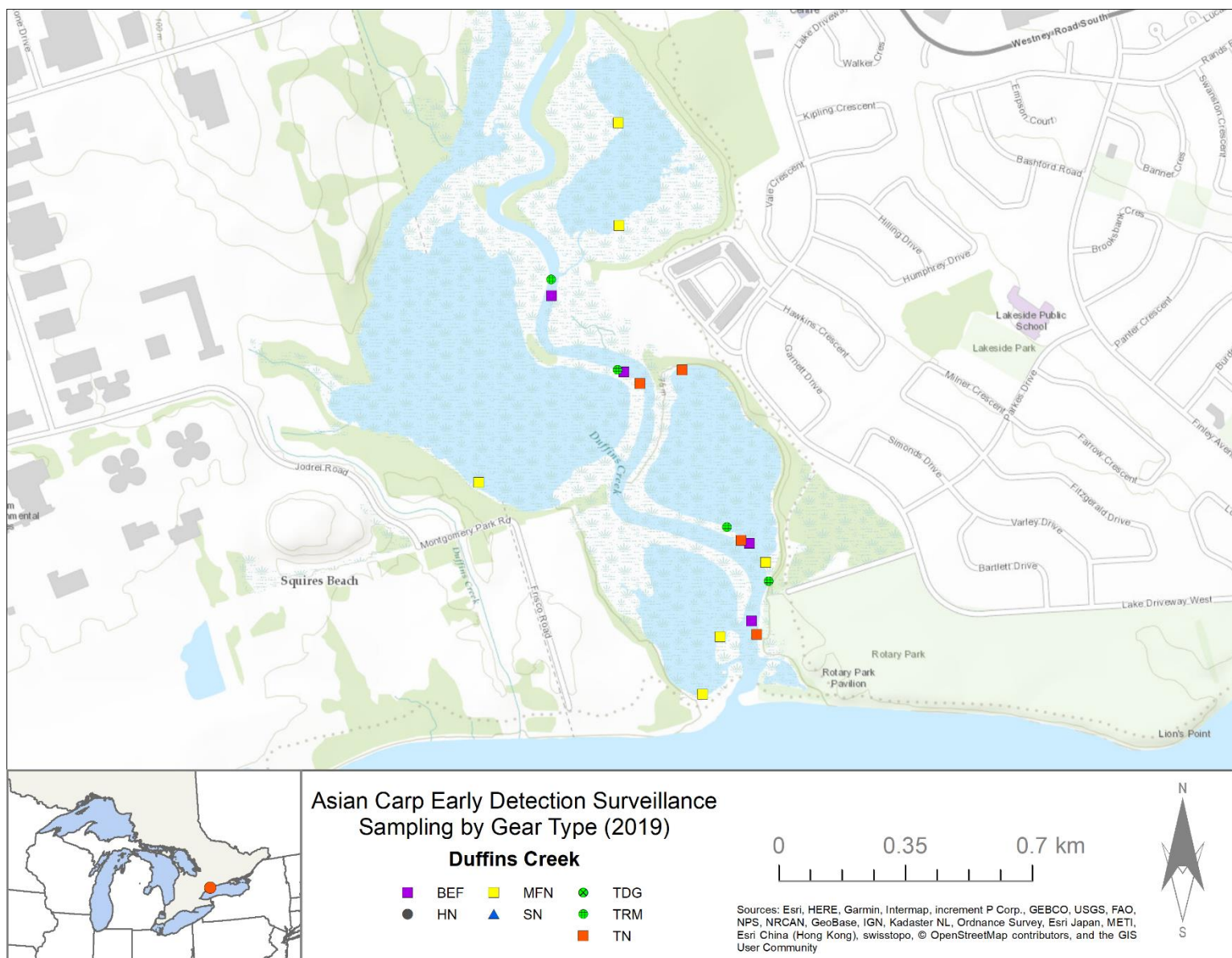


Figure A2.11 2019 Asian Carp Program early detection surveillance field sites in Duffins Creek.

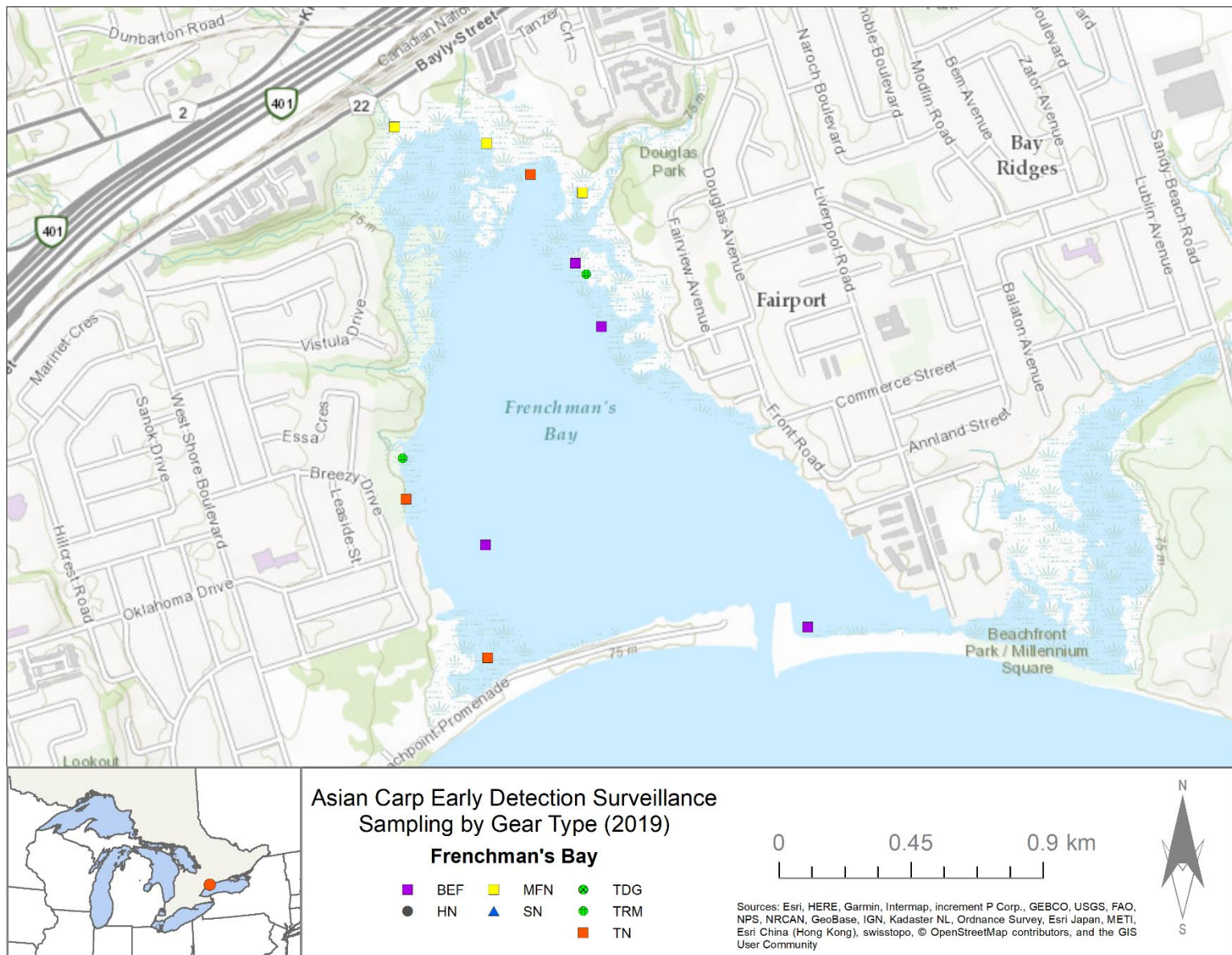


Figure A2.12 2019 Asian Carp Program early detection surveillance field sites in Frenchman's Bay.

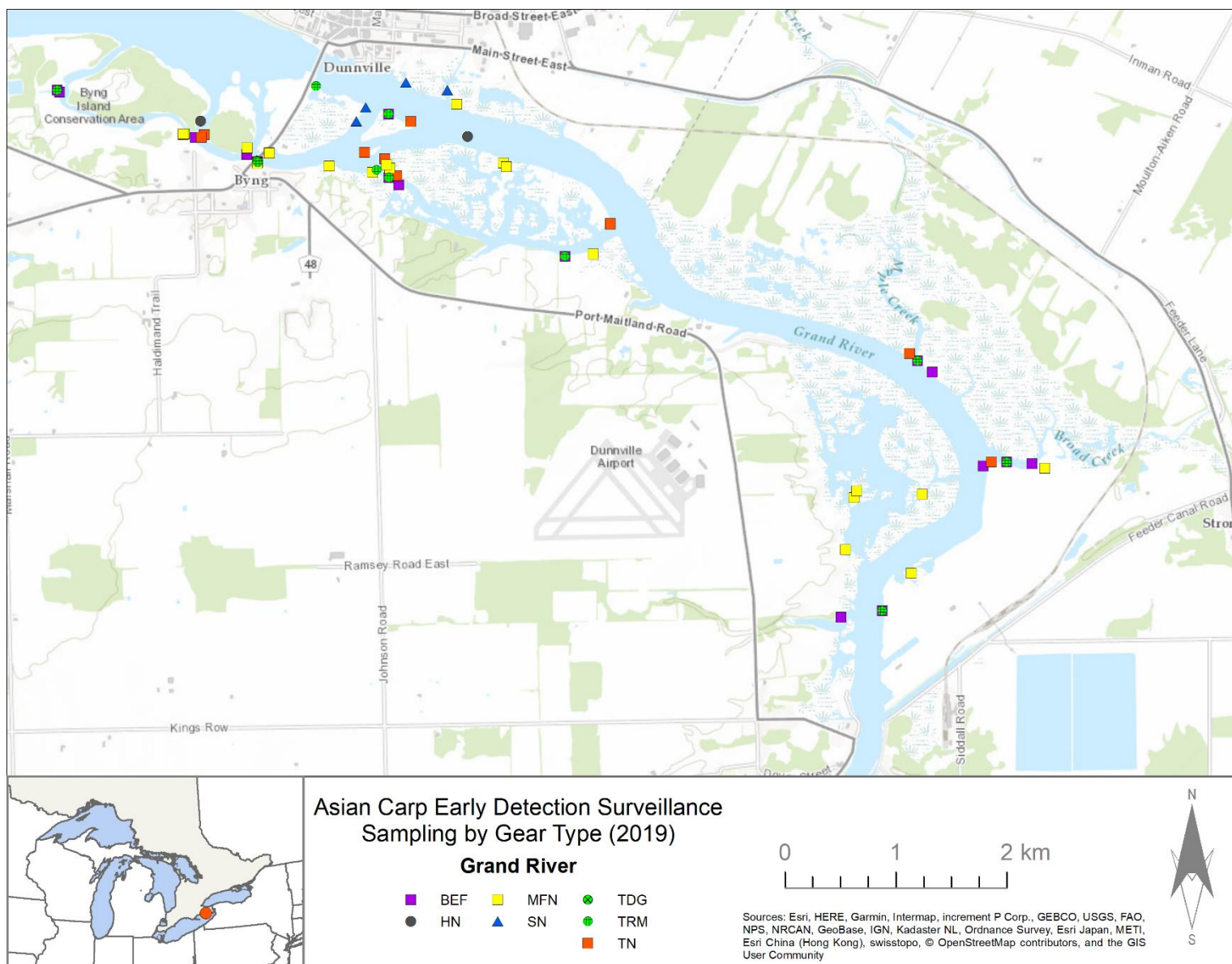


Figure A2.13 2019 Asian Carp Program early detection surveillance field sites in the Grand River.

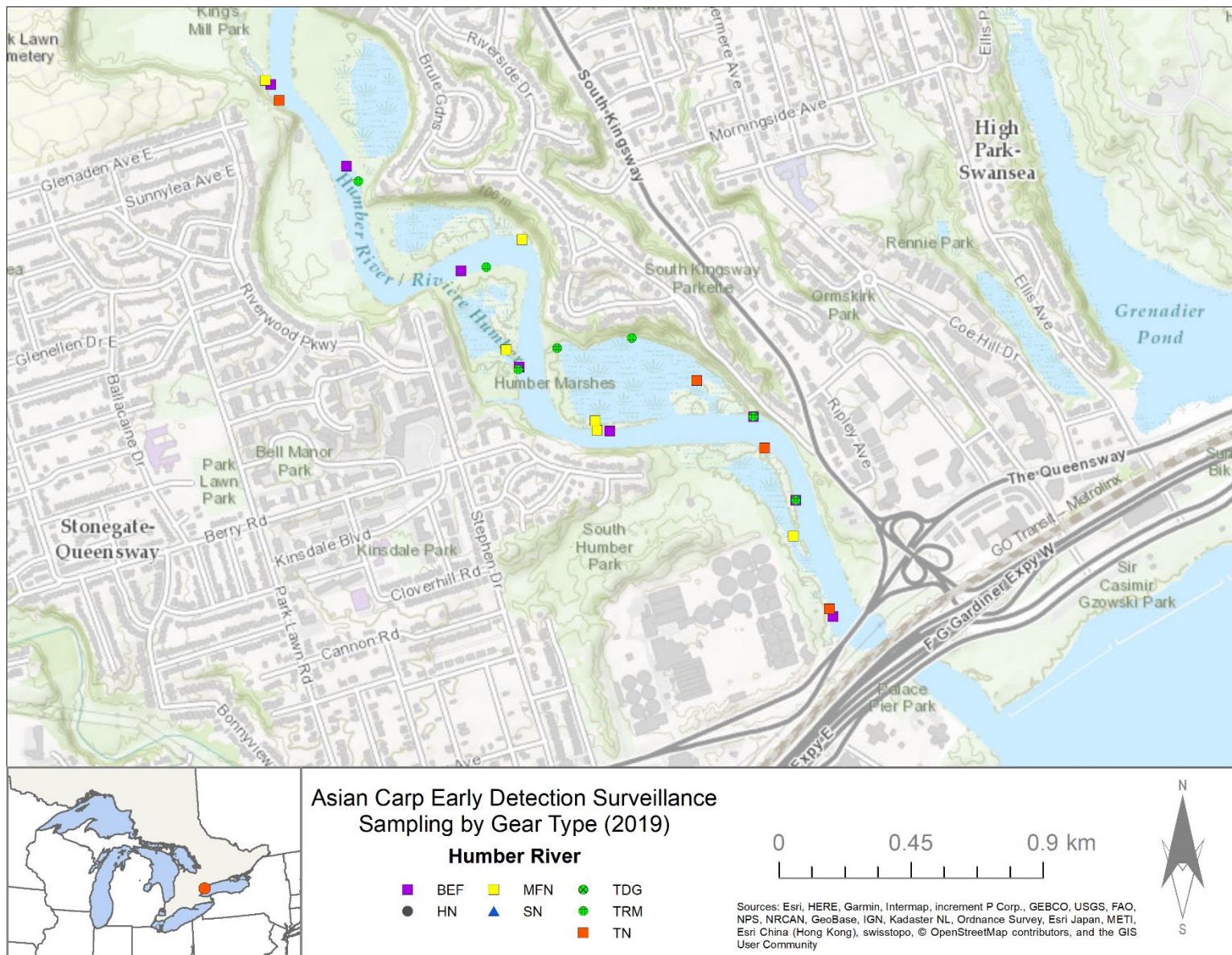


Figure A2.14 2019 Asian Carp Program early detection surveillance field sites in the Humber River.

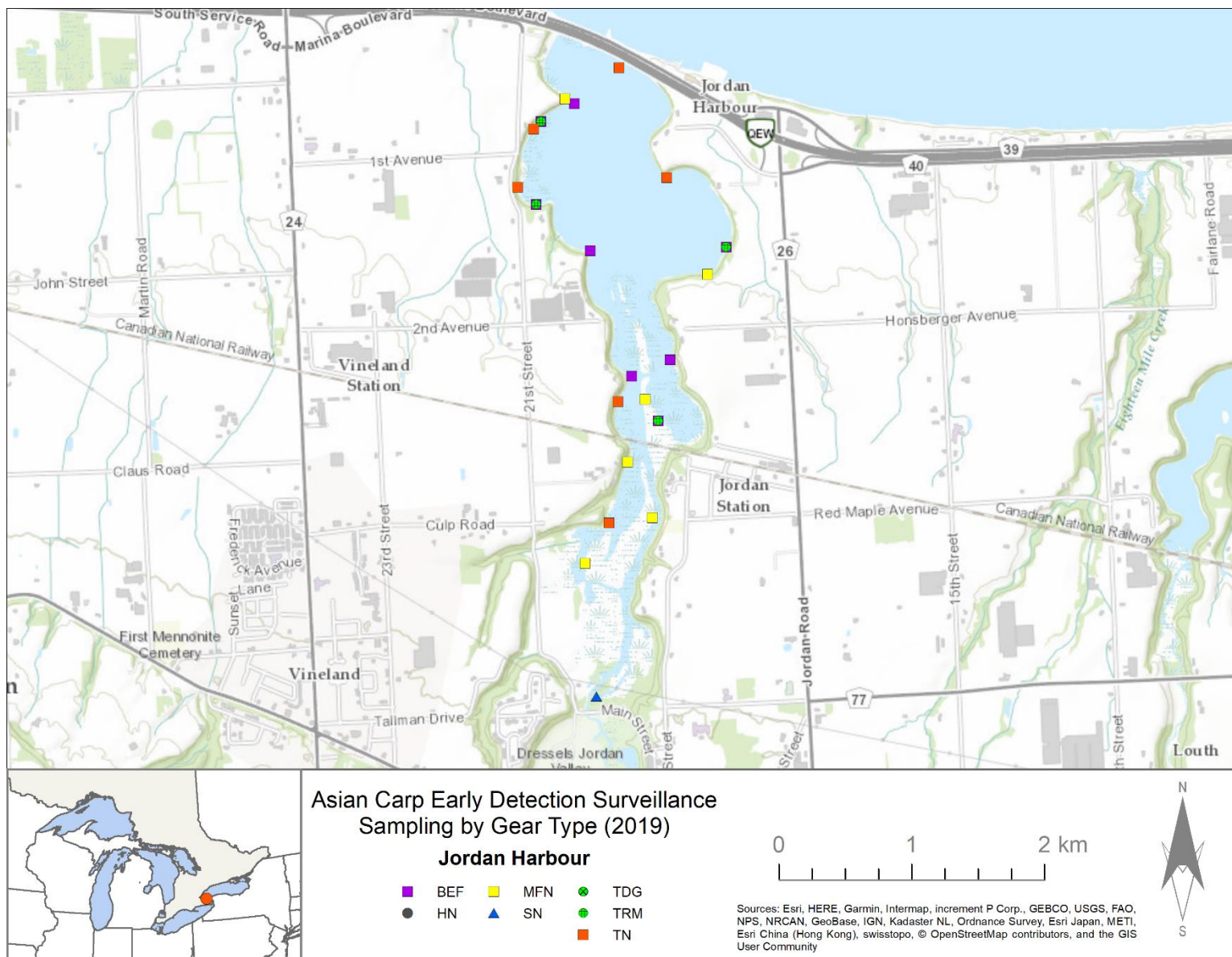


Figure A2.15 2019 Asian Carp Program early detection surveillance field sites in Jordan Harbour.

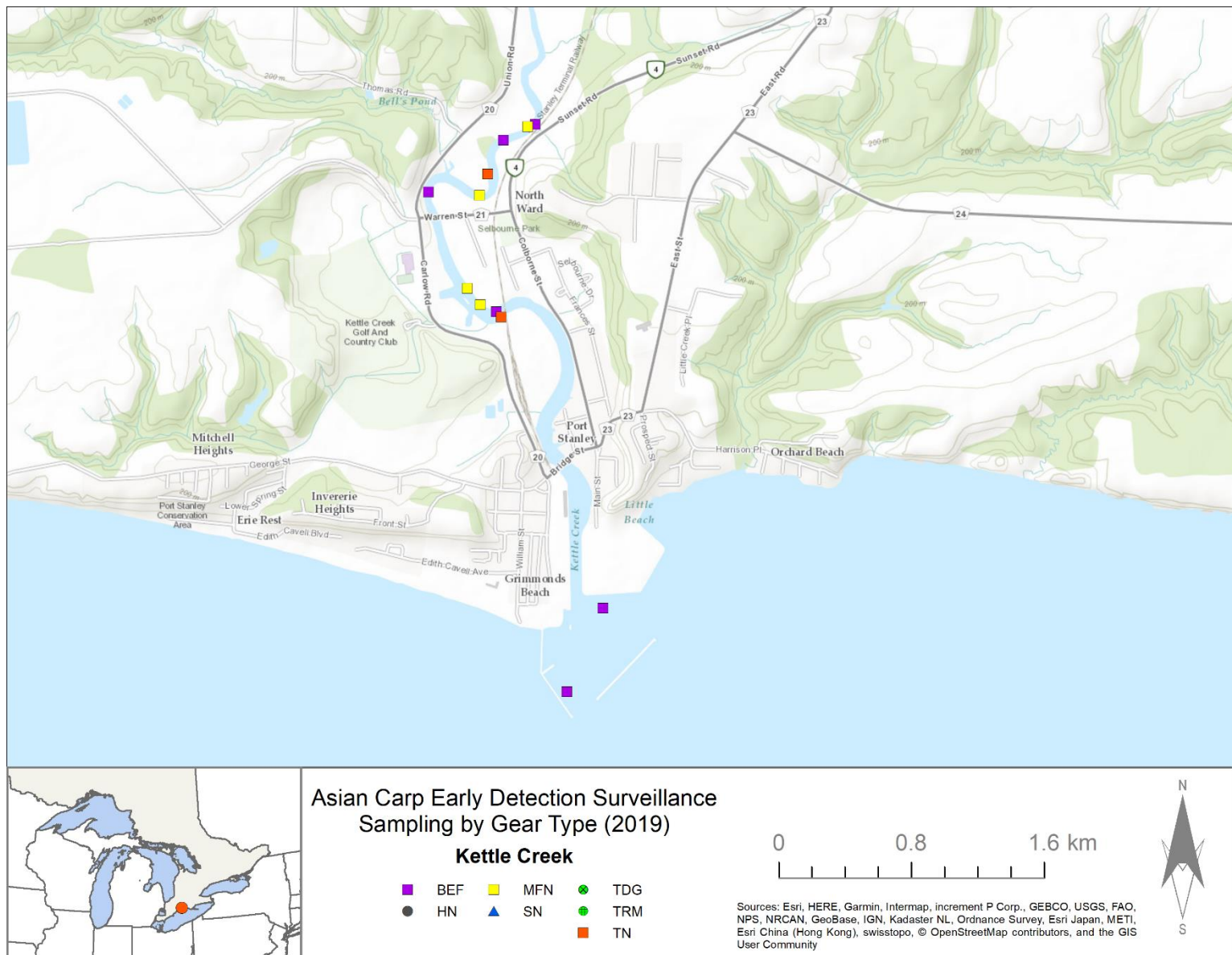


Figure A2.16 2019 Asian Carp Program early detection surveillance field sites in Kettle Creek.

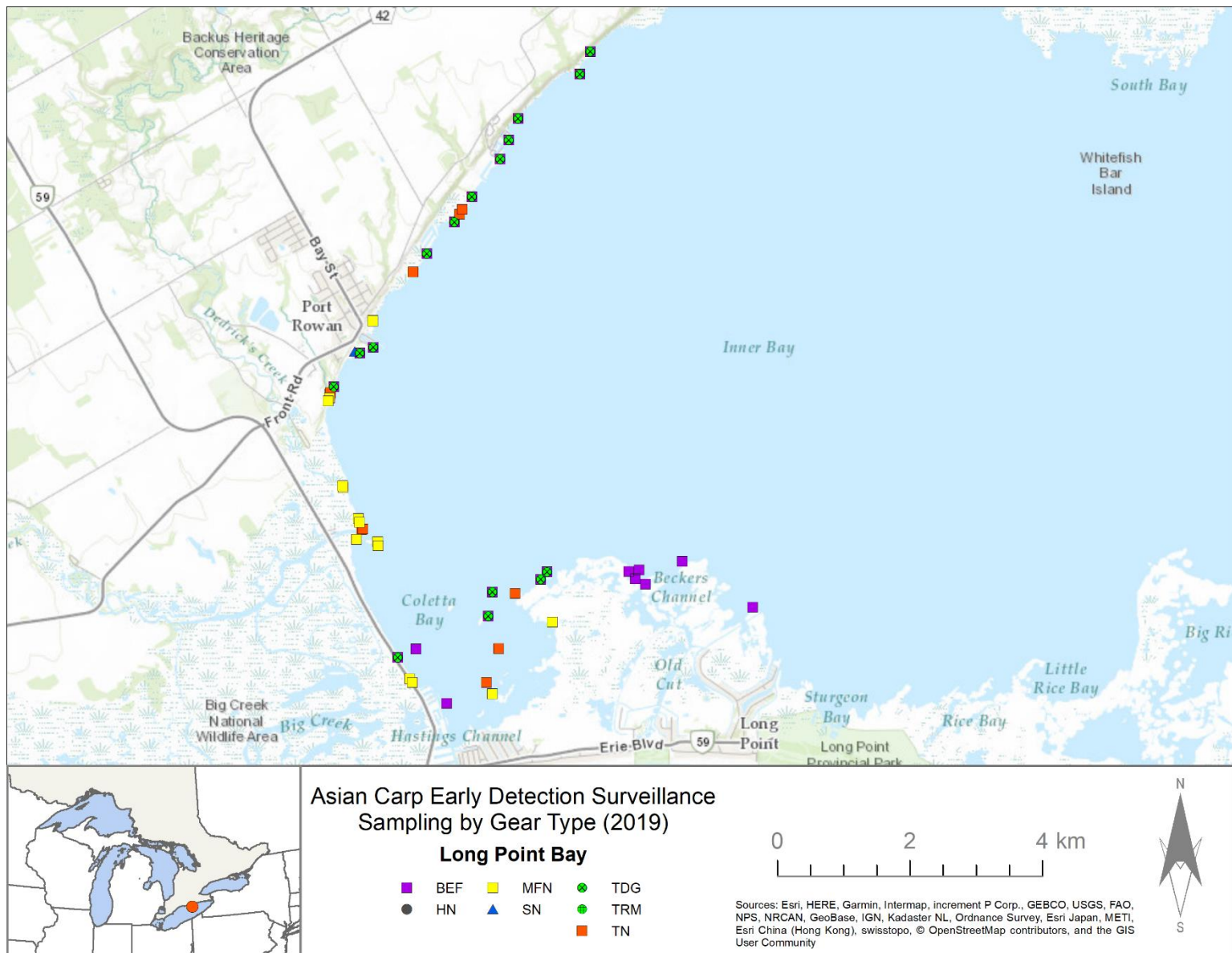


Figure A2.17 2019 Asian Carp Program early detection surveillance field sites in Long Point Bay.

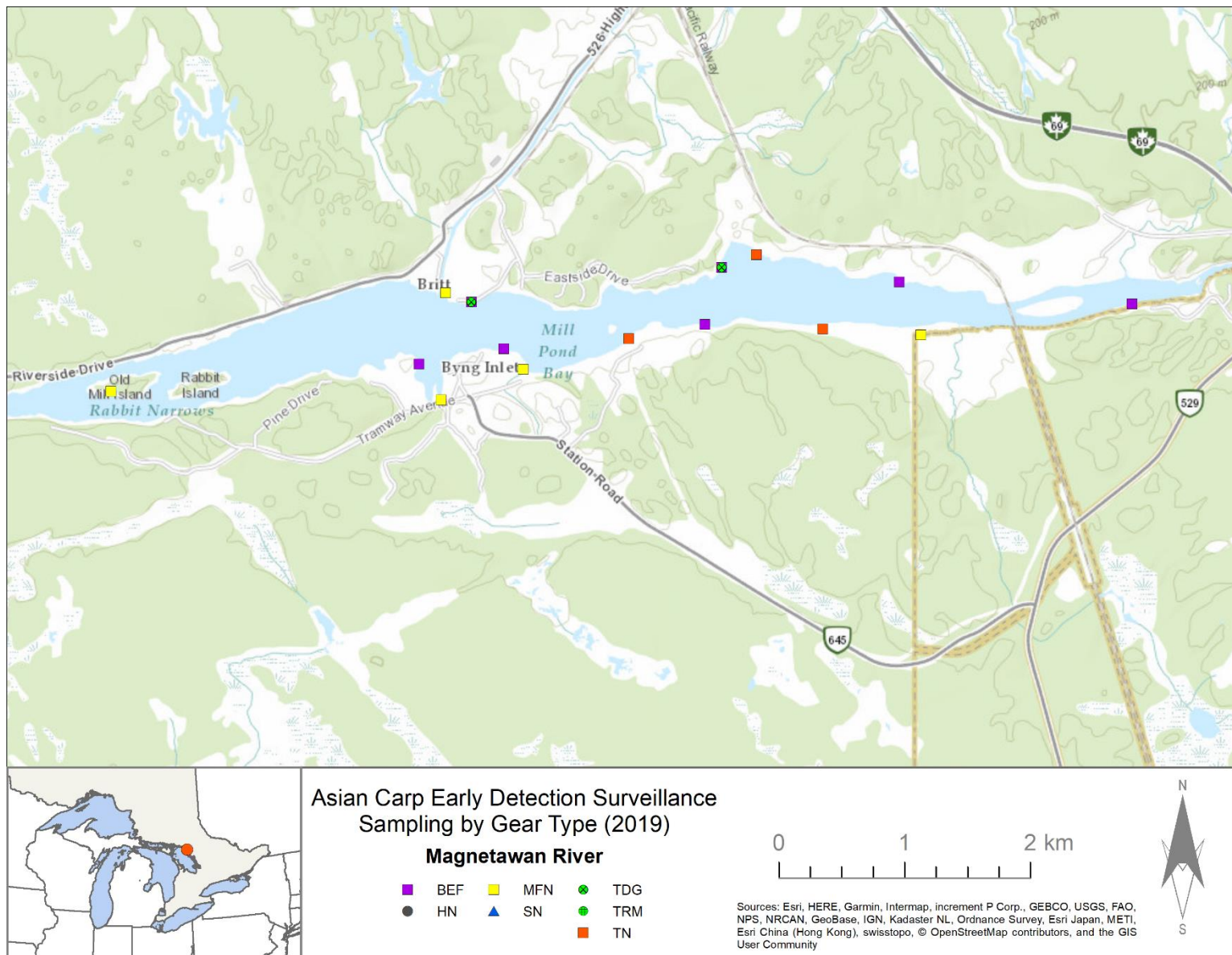


Figure A2.18 2019 Asian Carp Program early detection surveillance field sites in the Magnetawan River.

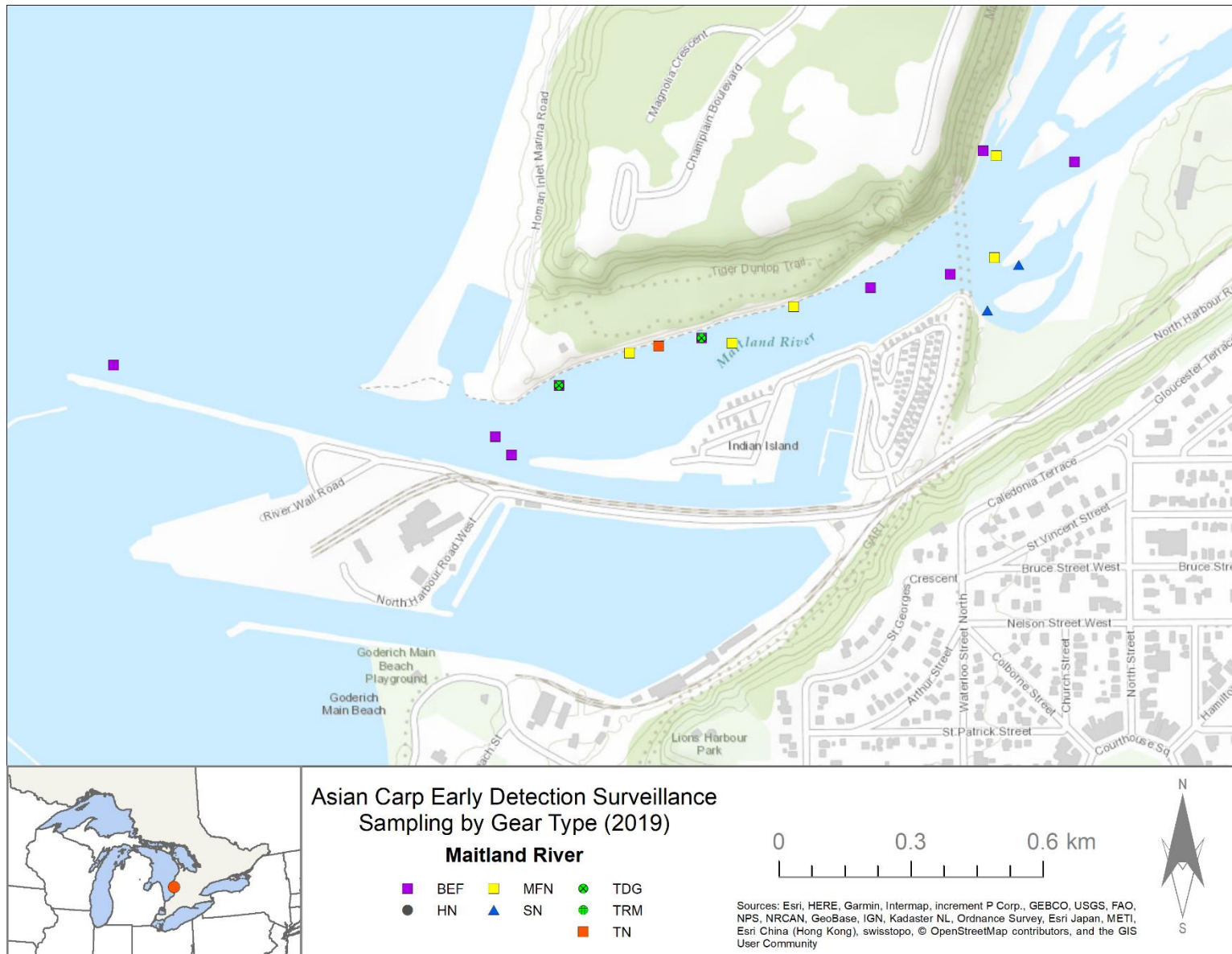


Figure A2.19 2019 Asian Carp Program early detection surveillance field sites in the Maitland River.

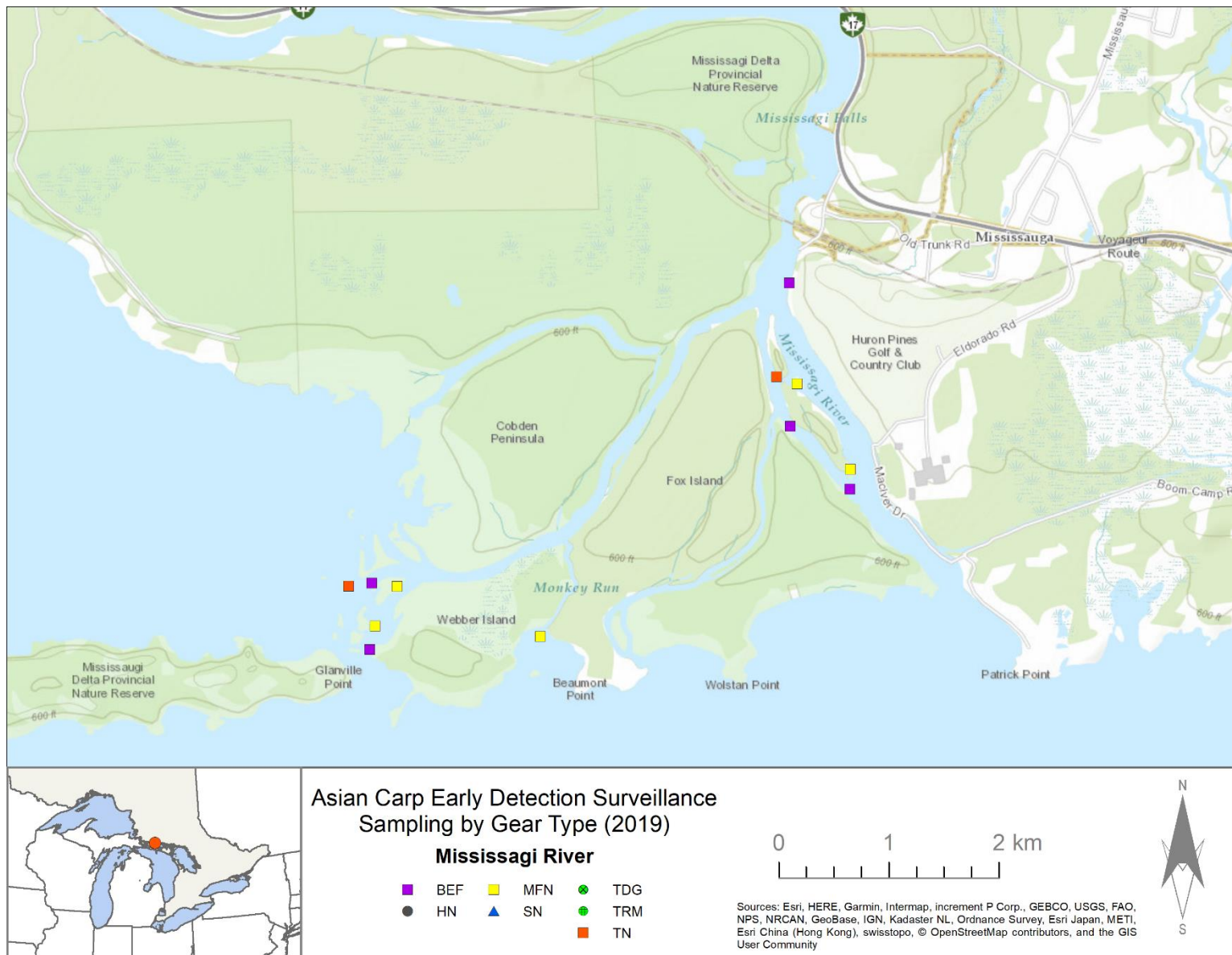


Figure A2.20 2019 Asian Carp Program early detection surveillance field sites in the Mississagi River.

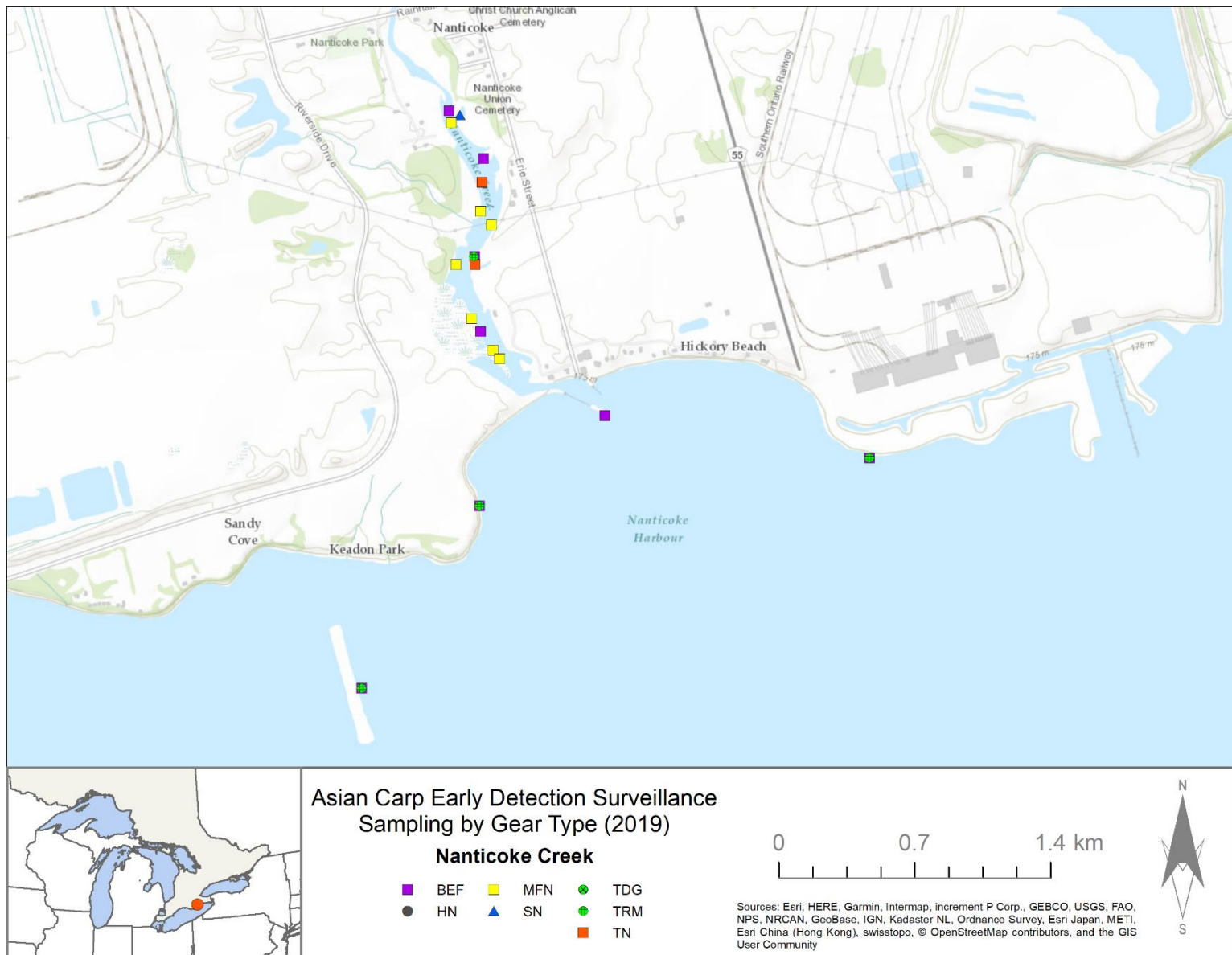


Figure A2.21 2019 Asian Carp Program early detection surveillance field sites in Nanticoke Creek.

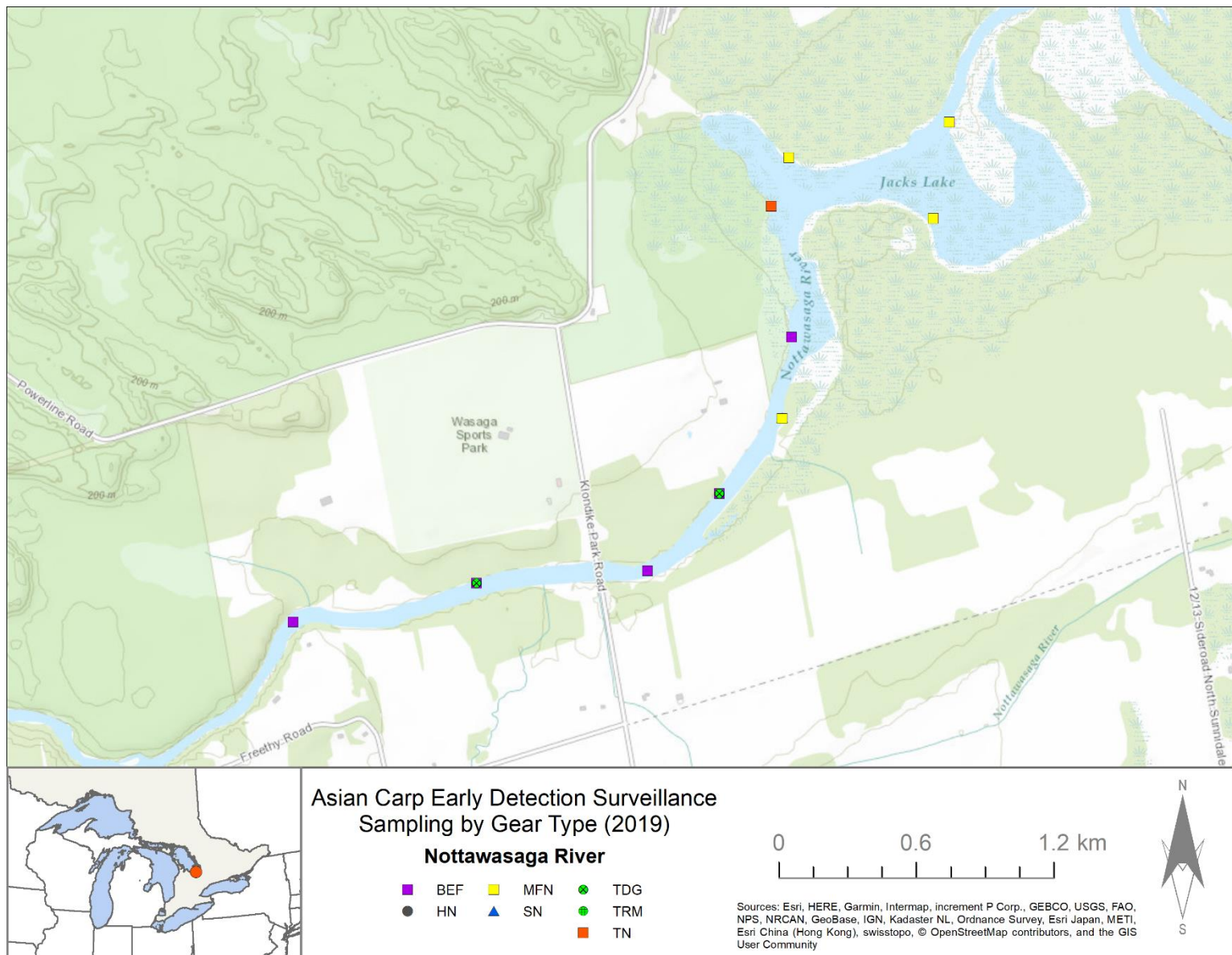


Figure A2.22 2019 Asian Carp Program early detection surveillance field sites in the Nottawasaga River.

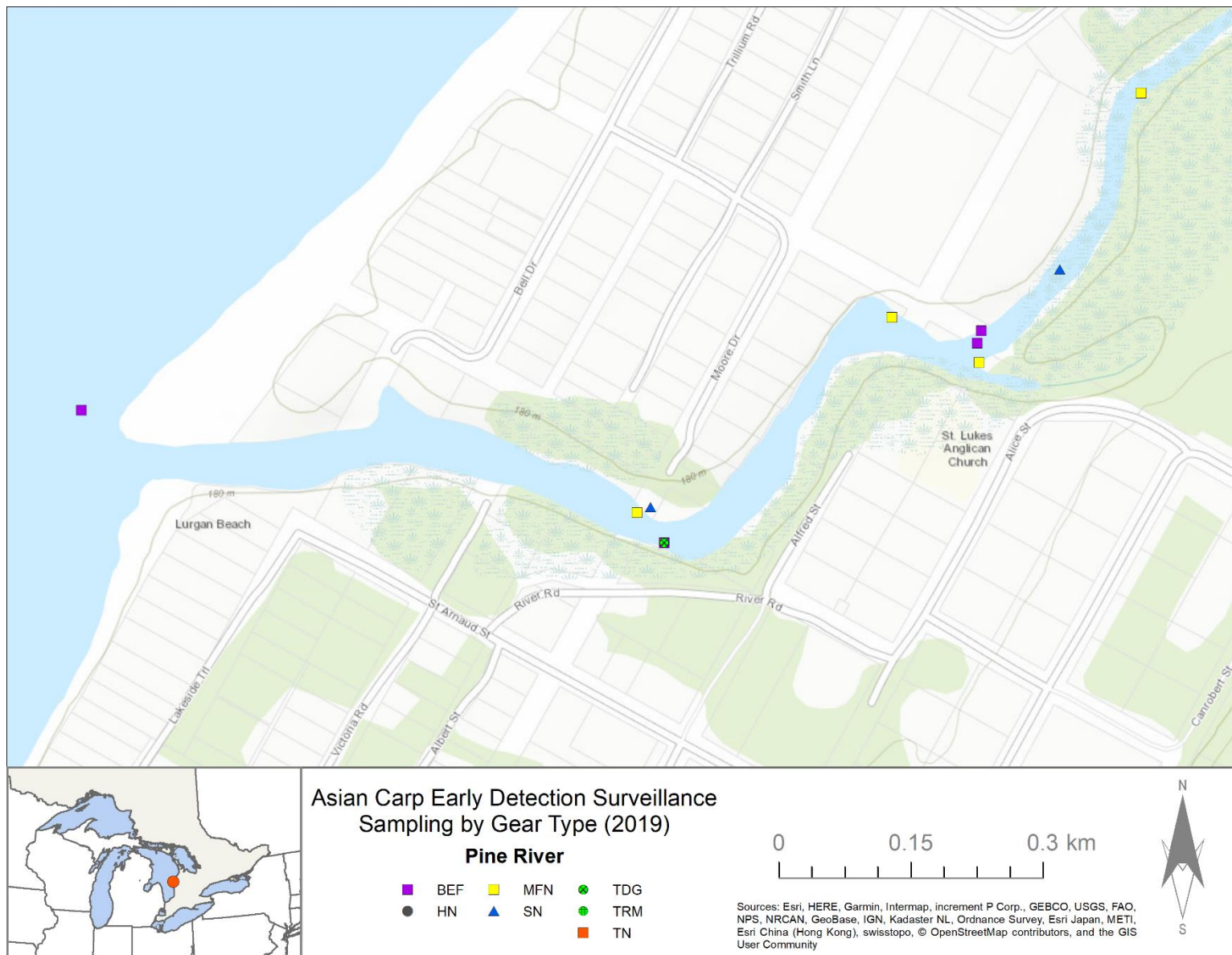


Figure A2.23 2019 Asian Carp Program early detection surveillance field sites in the Pine River.

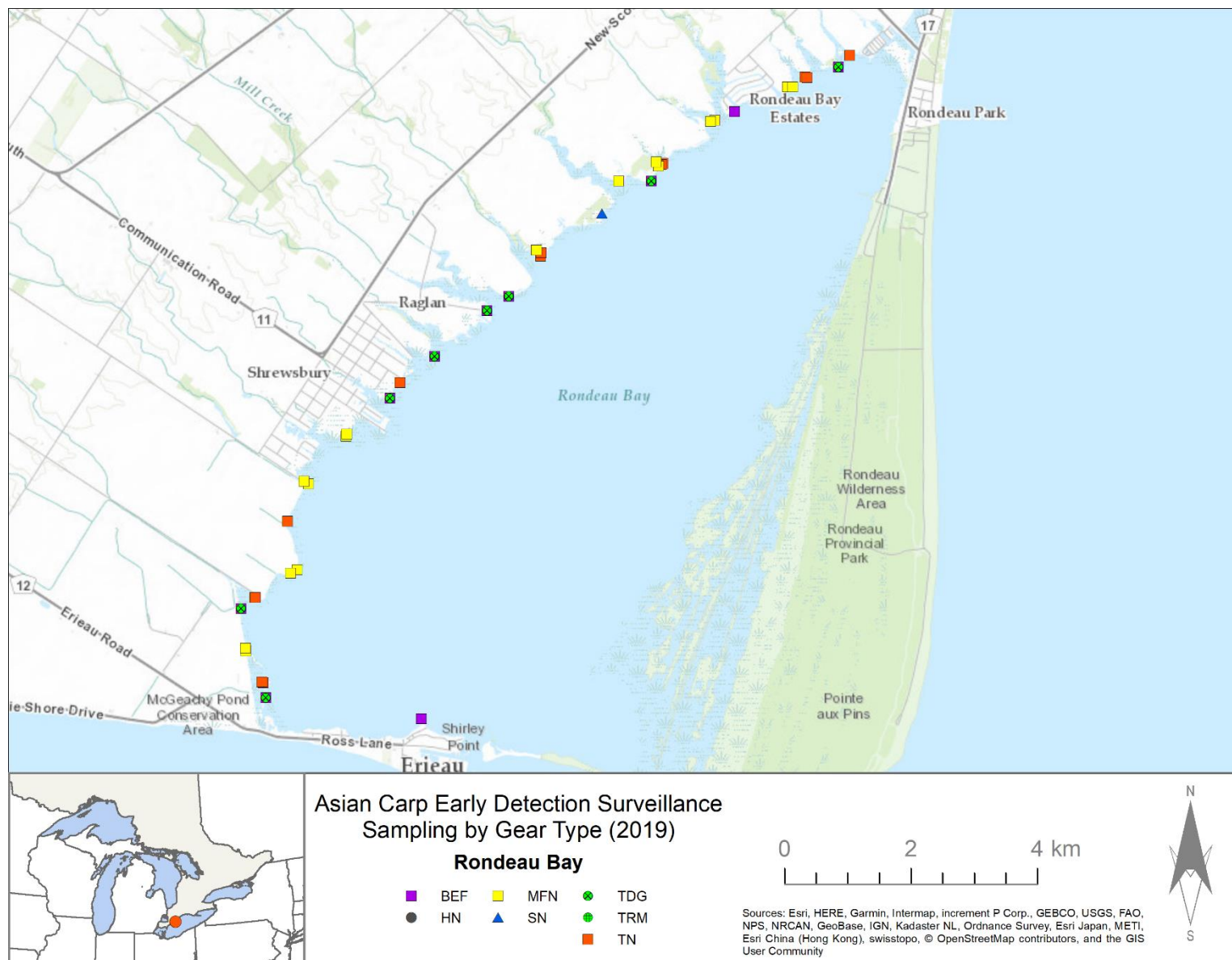


Figure A2.24 2019 Asian Carp Program early detection surveillance field sites in Rondeau Bay.

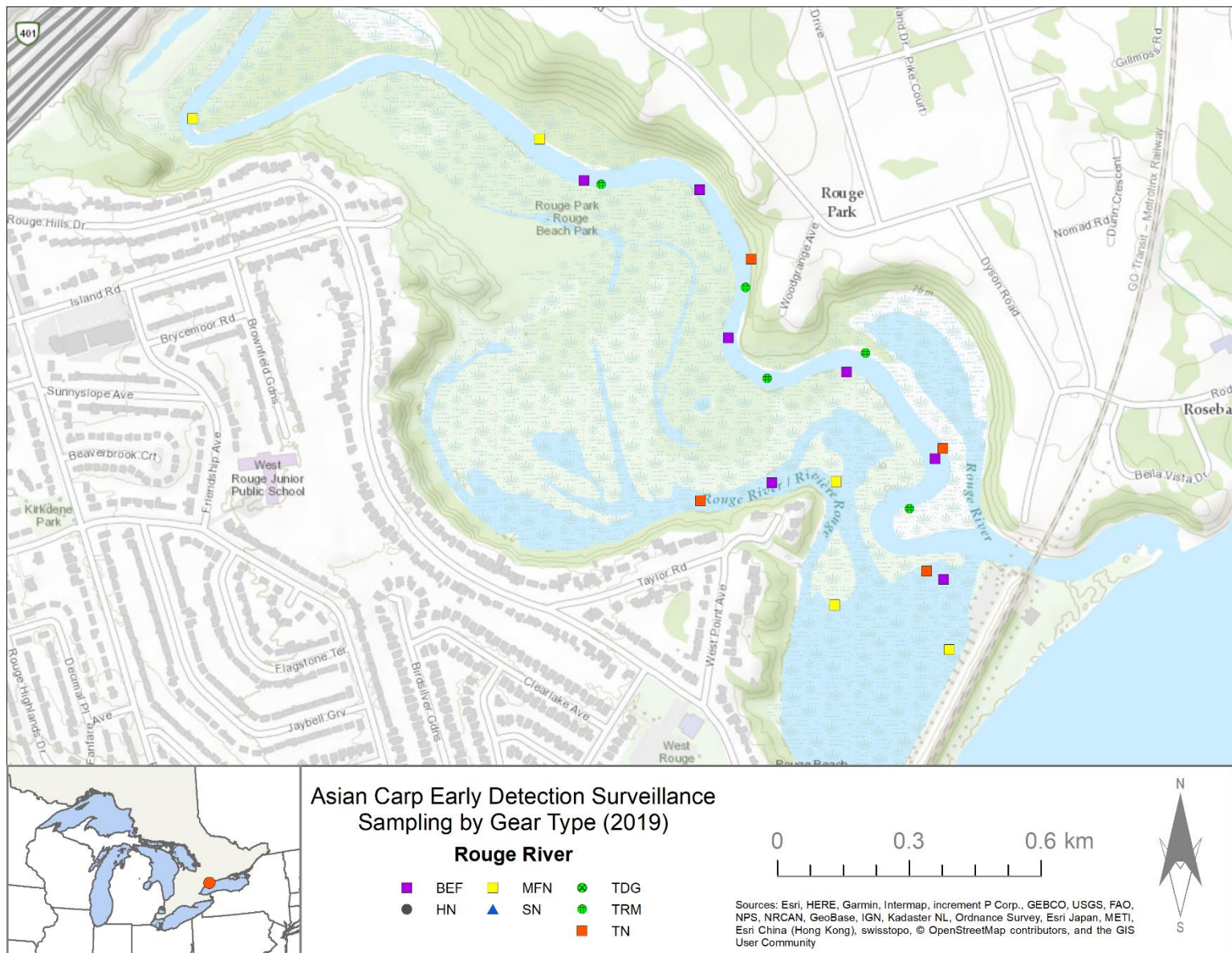


Figure A2.25 2019 Asian Carp Program early detection surveillance field sites in the Rouge River.

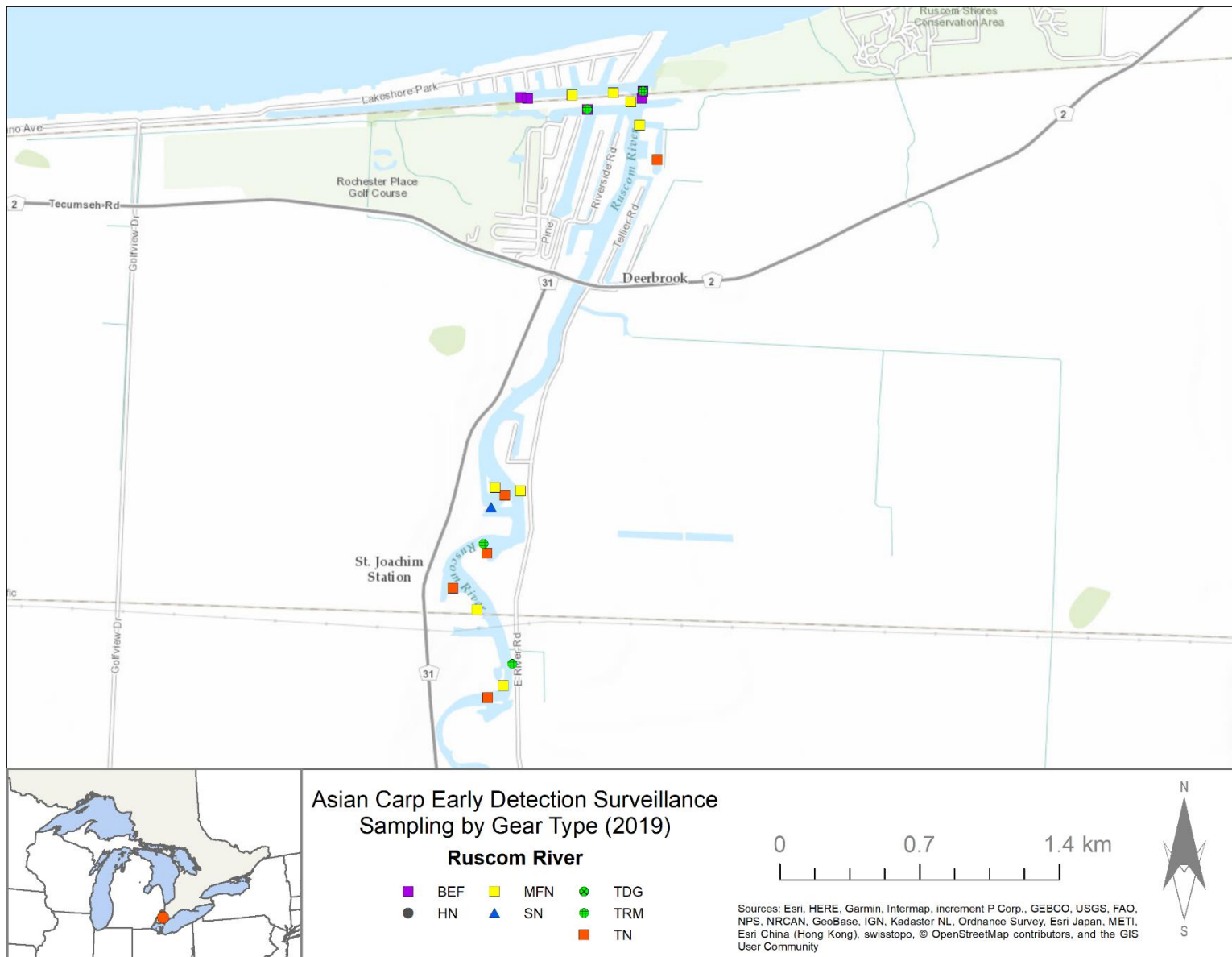


Figure A2.26 2019 Asian Carp Program early detection surveillance field sites in the Ruscom River.

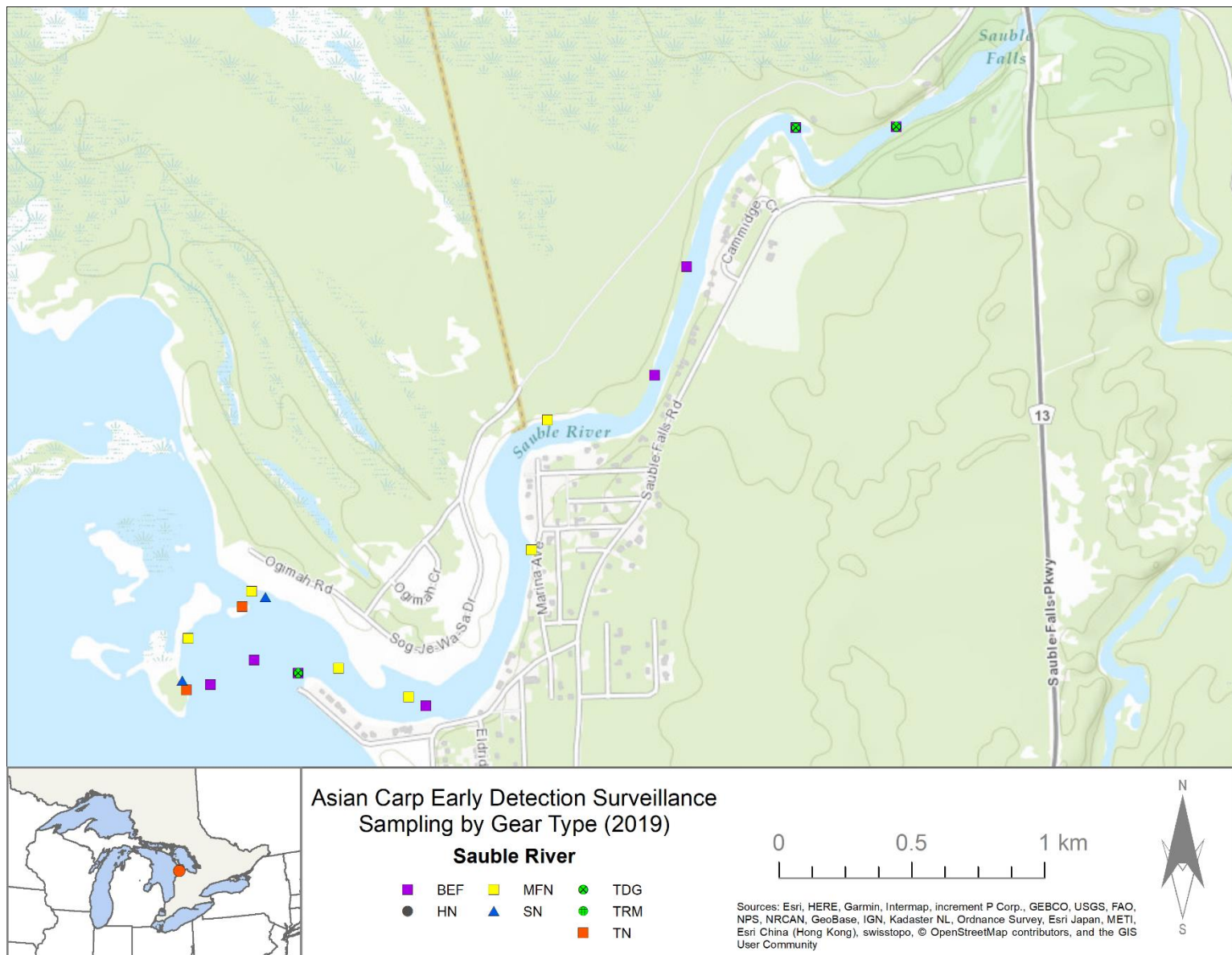


Figure A2.27 2019 Asian Carp Program early detection surveillance field sites in the Sauble River.

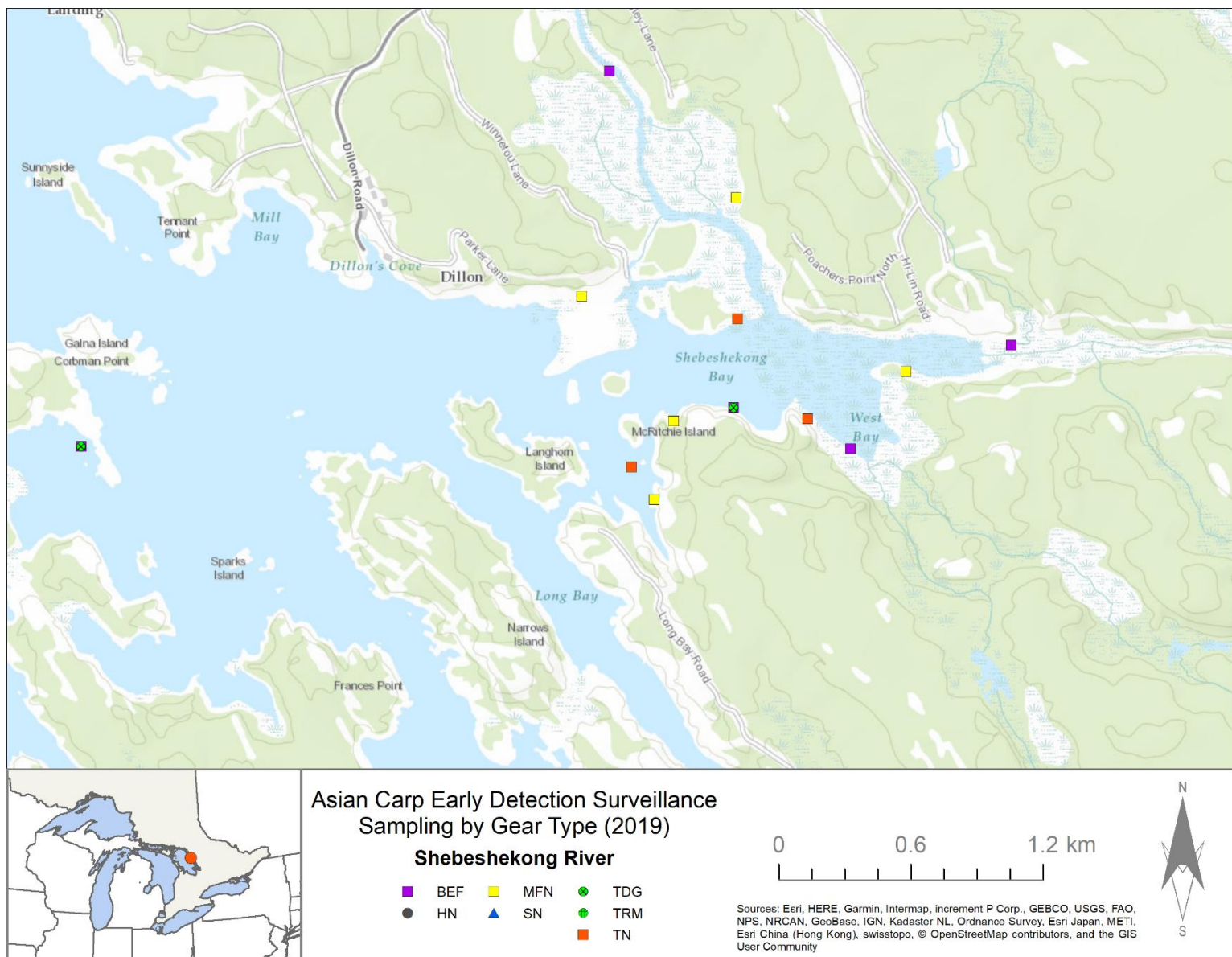


Figure A2.28 2019 Asian Carp Program early detection surveillance field sites in the Shebeshekong River.

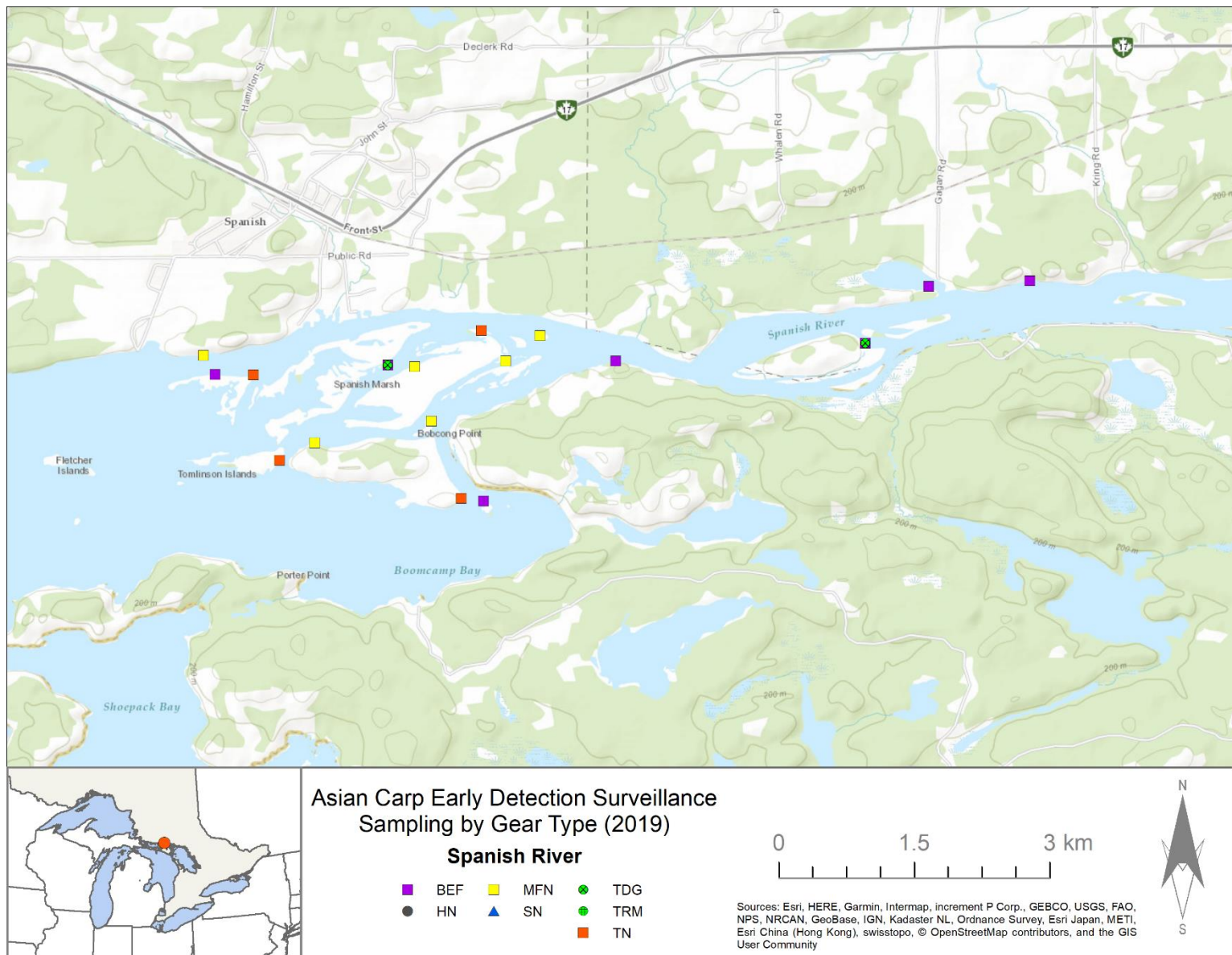


Figure A2.29 2019 Asian Carp Program early detection surveillance field sites in the Spanish River.

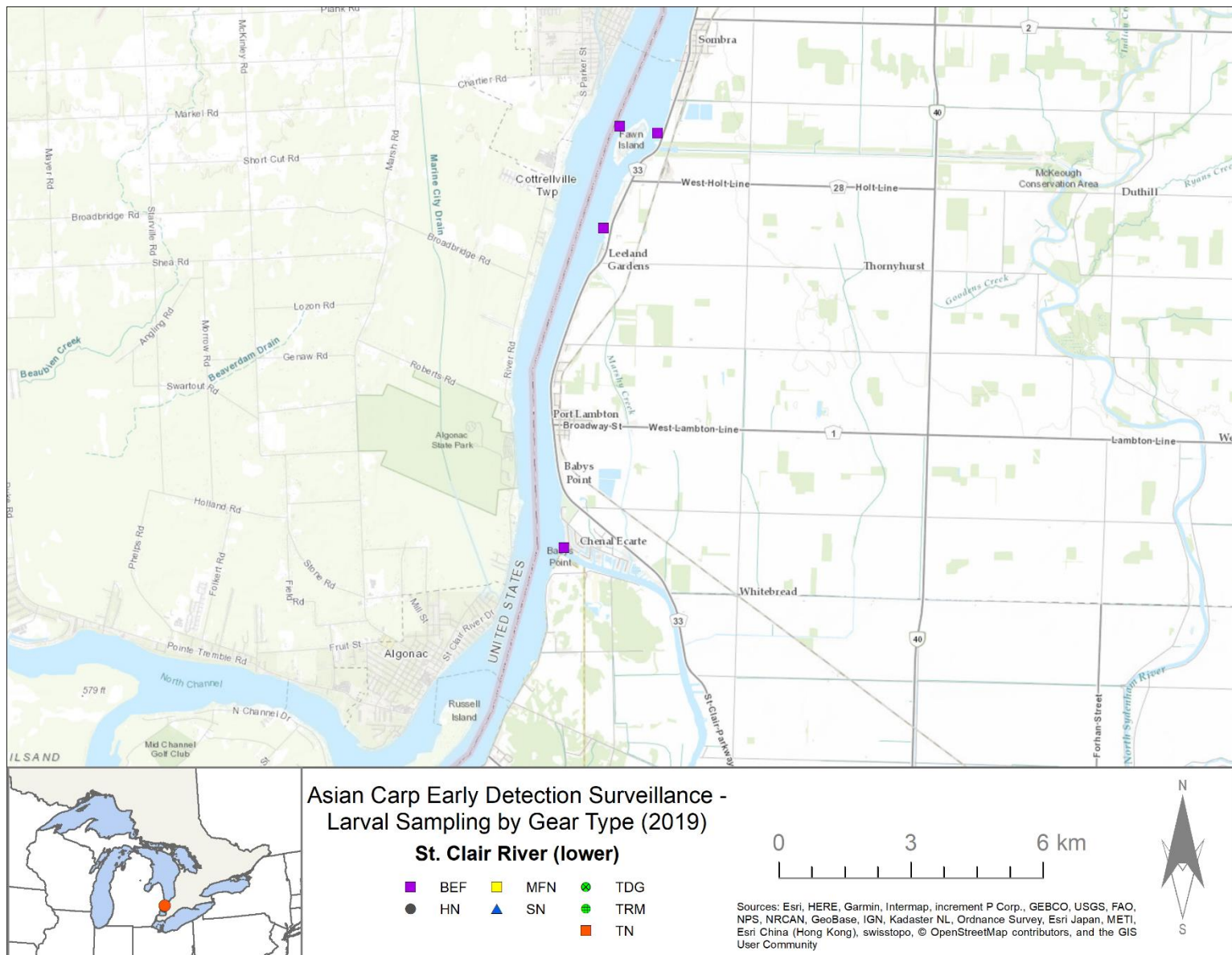


Figure A2.30 2019 Asian Carp Program early detection surveillance field sites in the lower St. Clair River.

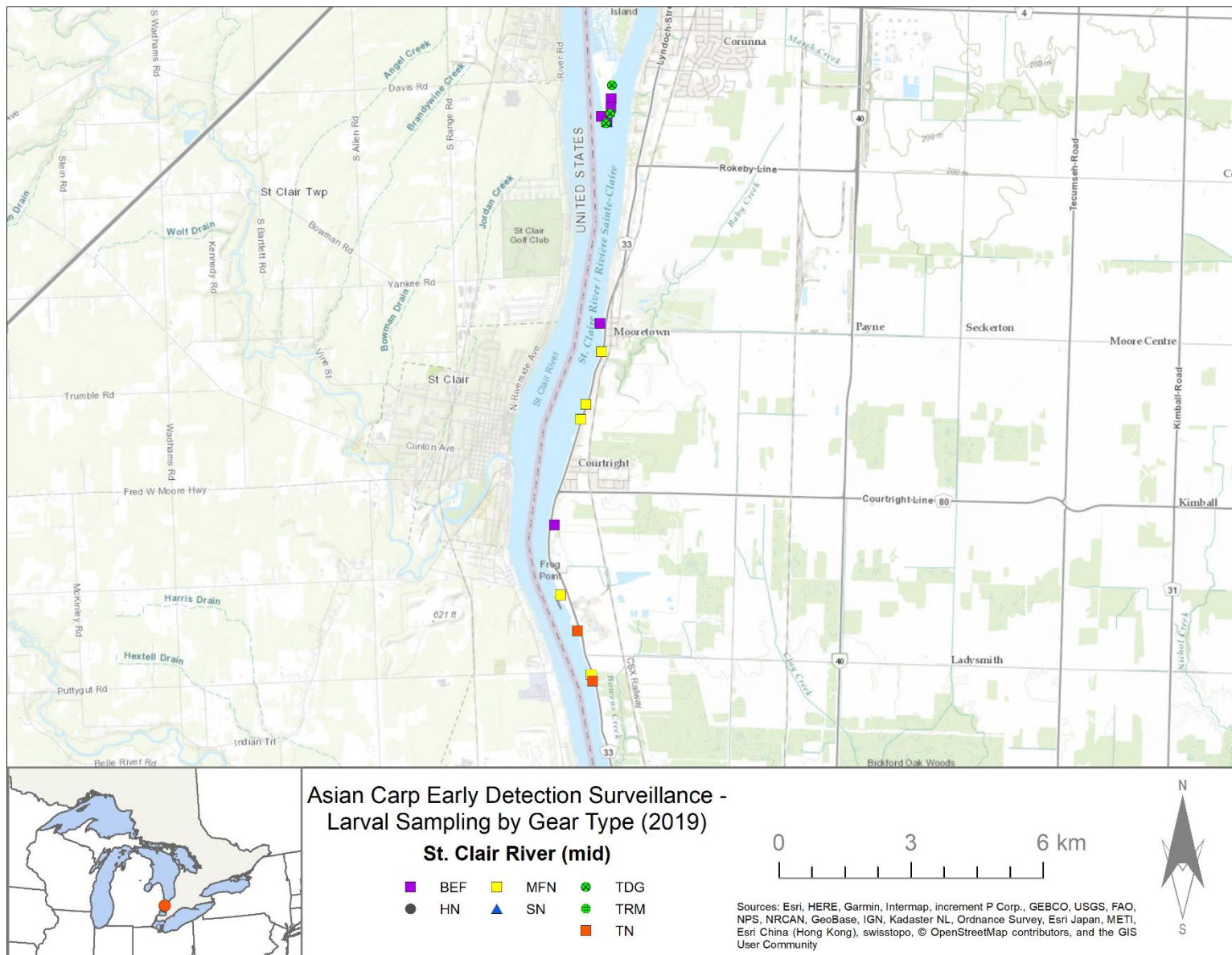


Figure A2.31 2019 Asian Carp Program early detection surveillance field sites in the mid St. Clair River.

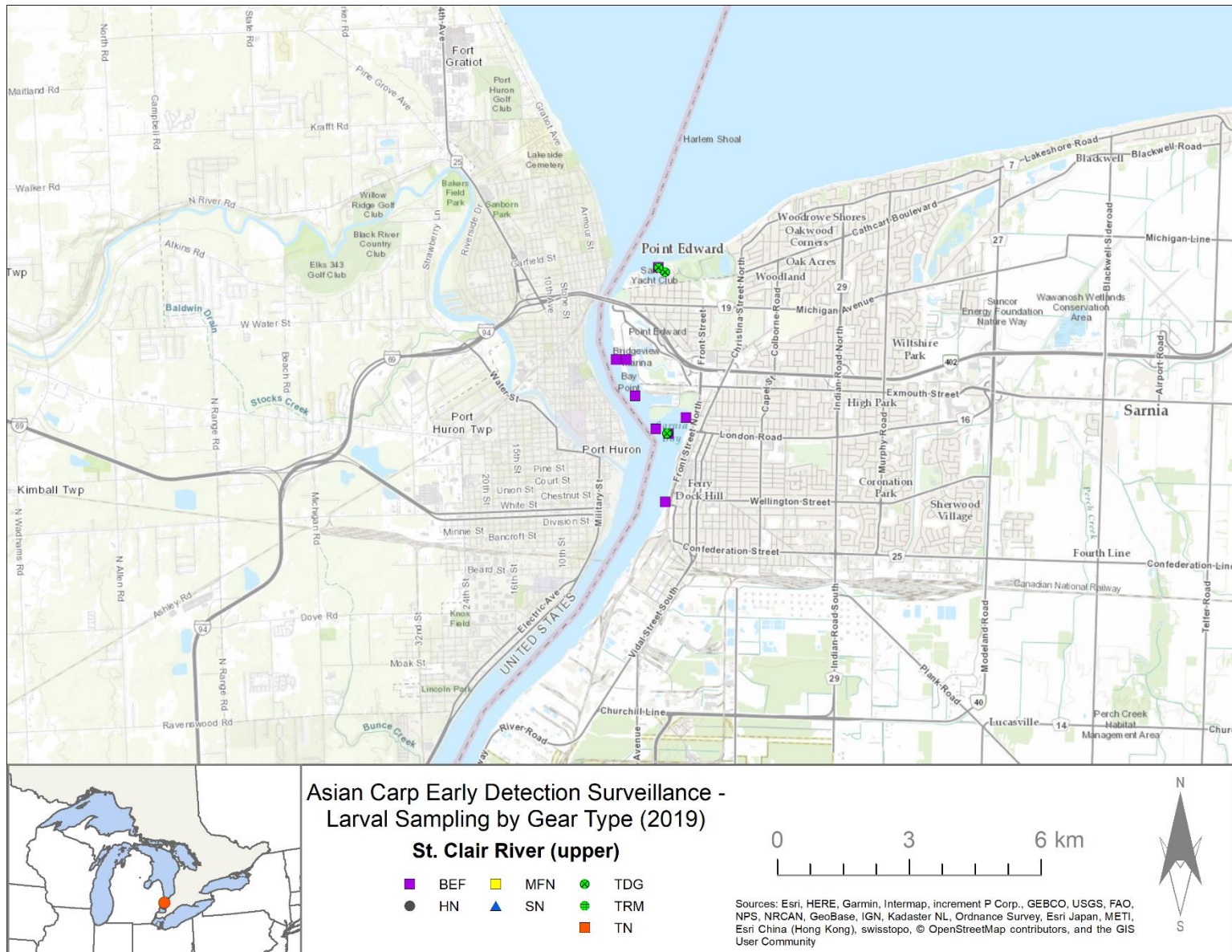


Figure A2.32 2019 Asian Carp Program early detection surveillance field sites in the upper St. Clair River.

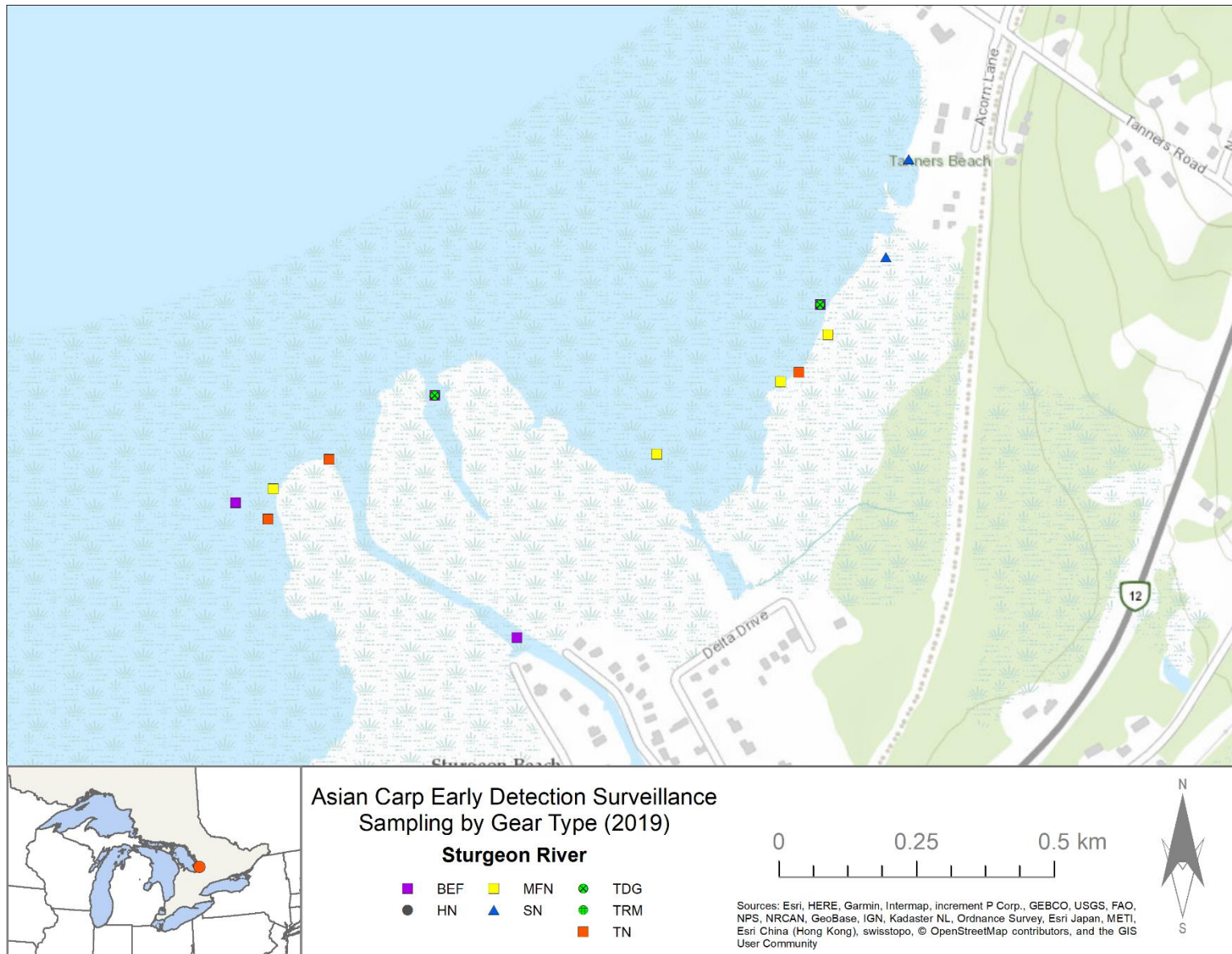


Figure A2.33 2019 Asian Carp Program early detection surveillance field sites in Sturgeon Creek.

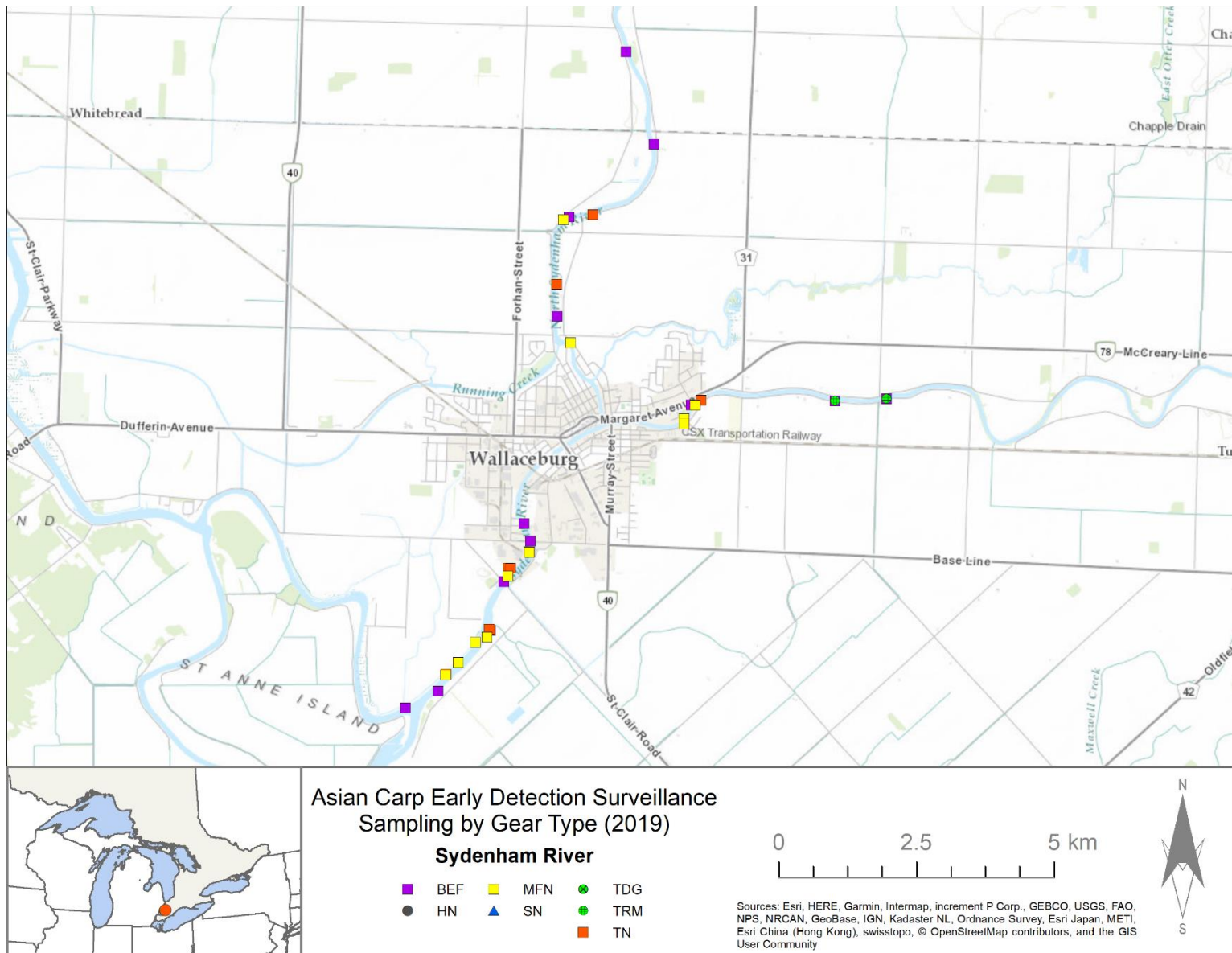


Figure A2.34 2019 Asian Carp Program early detection surveillance field sites in the Sydenham River.

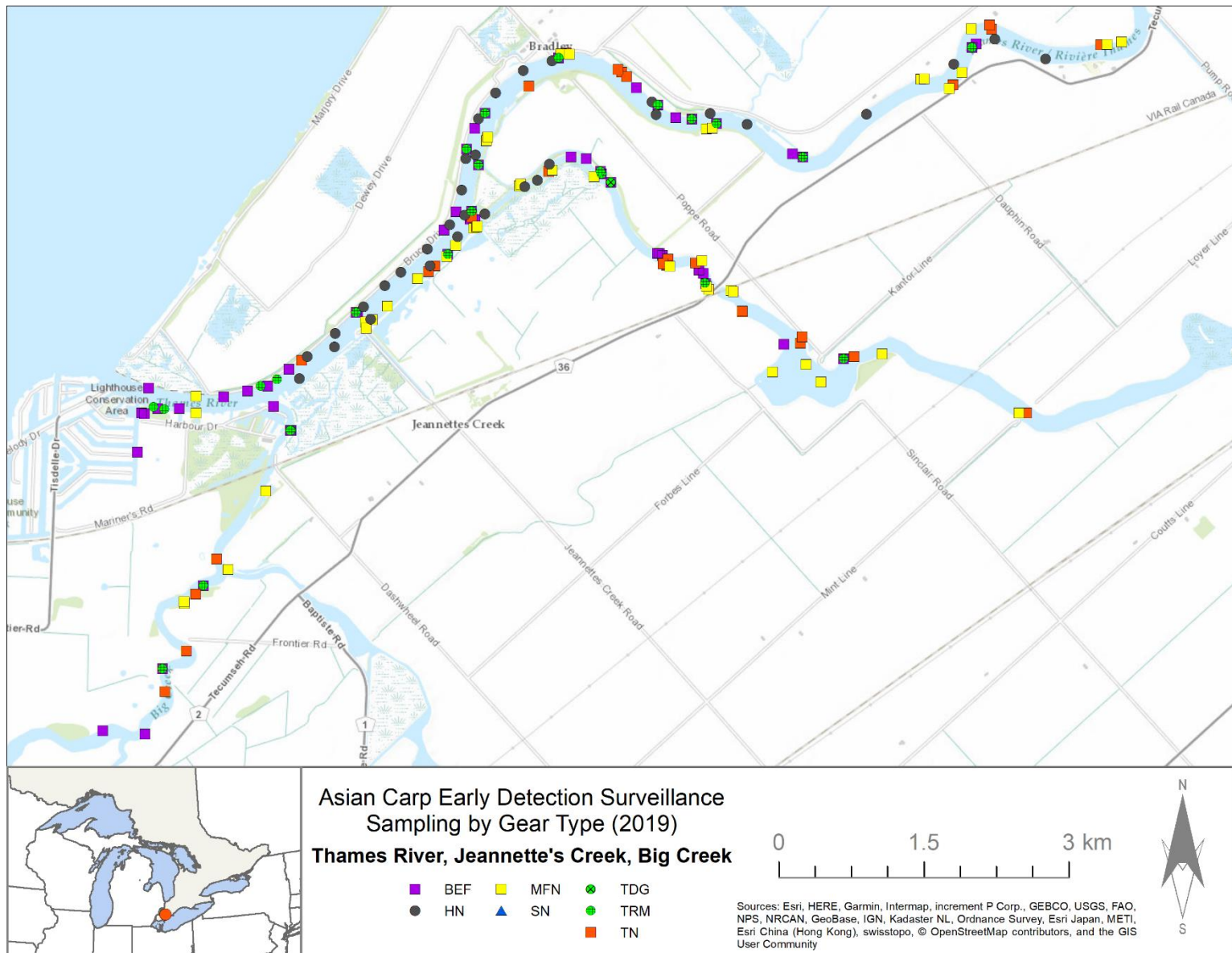


Figure A2.35 2019 Asian Carp Program early detection surveillance field sites in the Thames River, Jeannette's Creek and Big Creek.

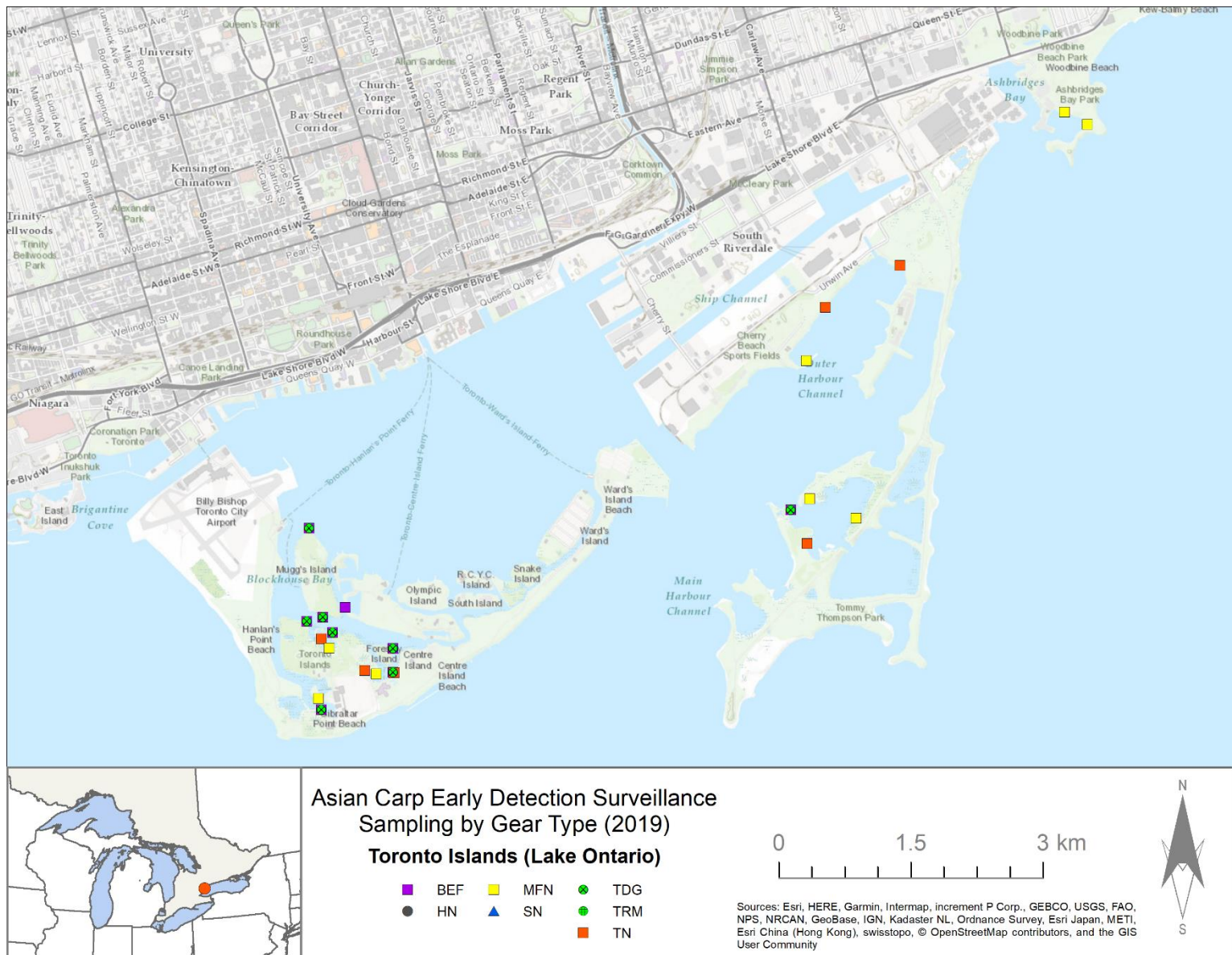


Figure A2.36 2019 Asian Carp Program early detection surveillance field sites around the Toronto Islands.

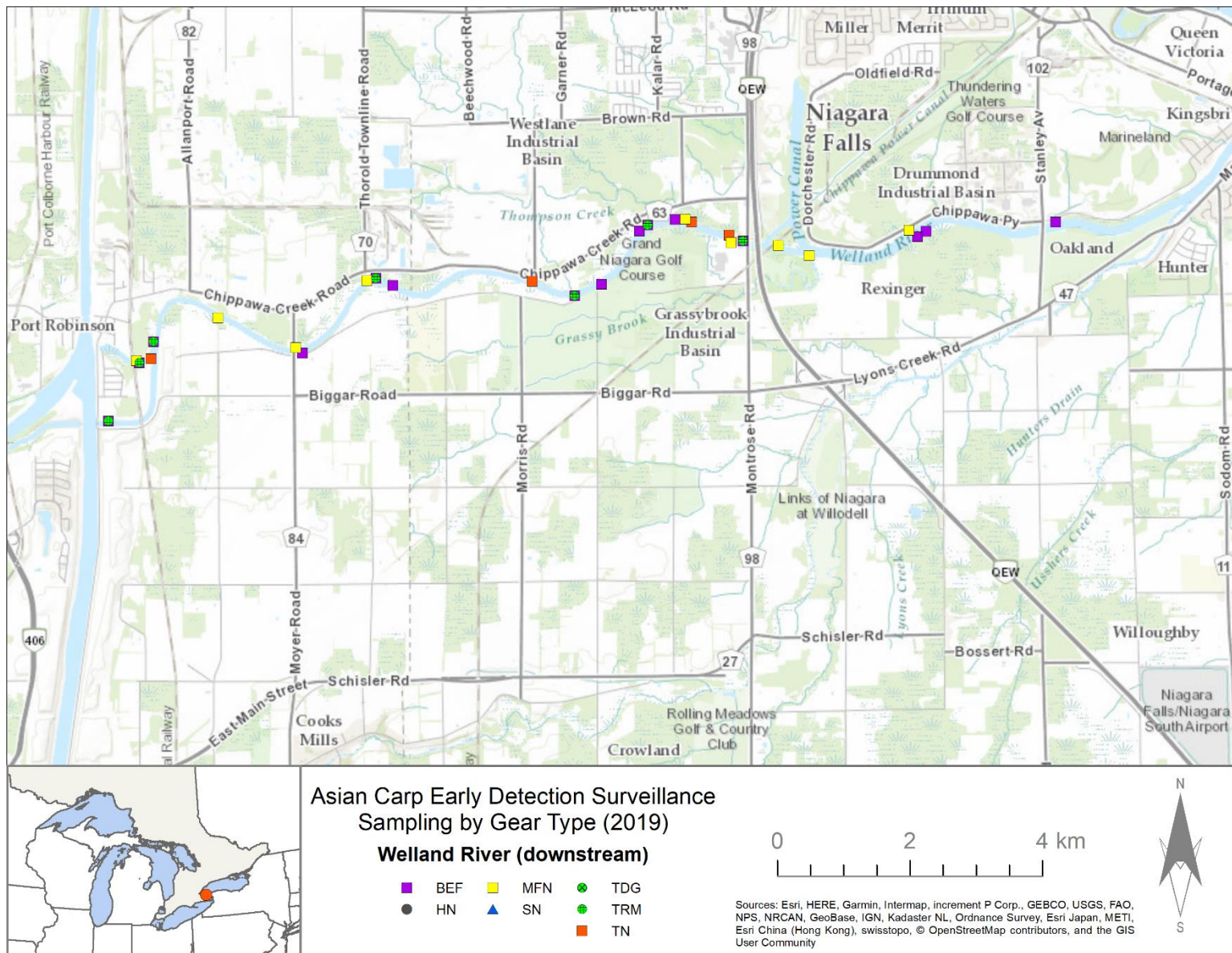


Figure A2.37 2019 Asian Carp Program early detection surveillance field sites in the lower Welland River.

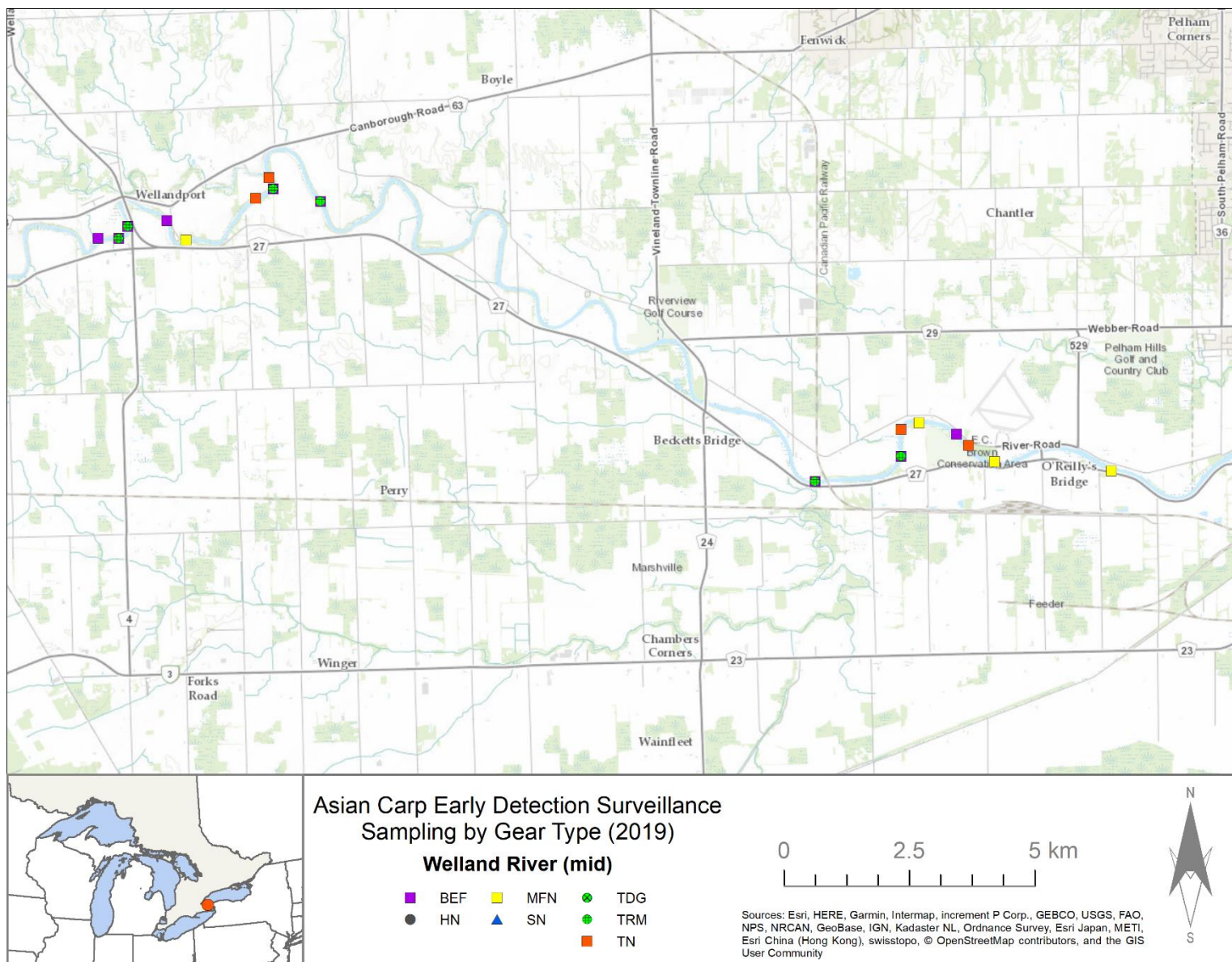


Figure A2.38 2019 Asian Carp Program early detection surveillance field sites in the mid Welland River.

APPENDIX 3: MAPS OF LARVAL ASIAN CARP SAMPLING LOCATIONS

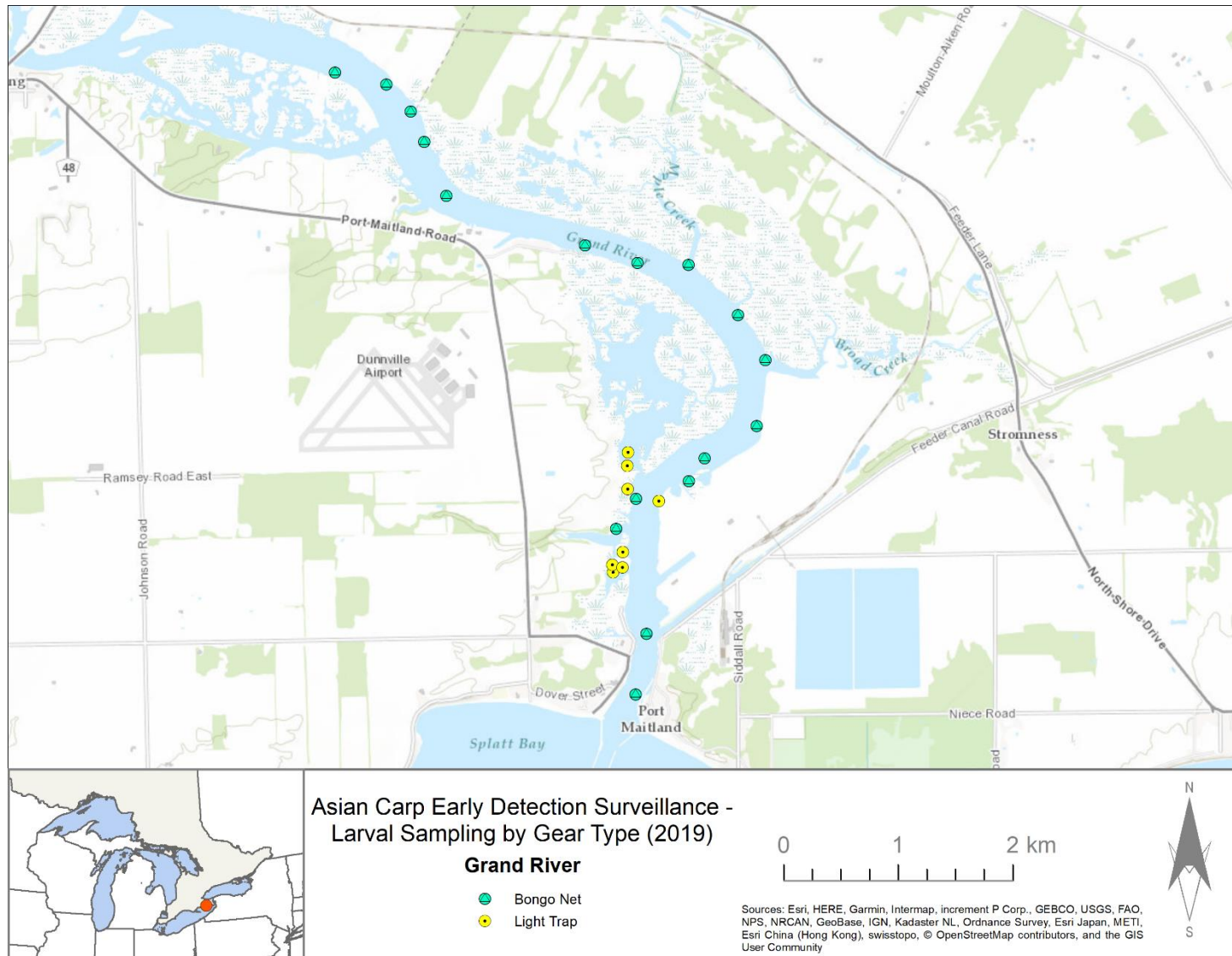


Figure A3.1 2019 Asian Carp Program larval early detection surveillance field sites in the Grand River.

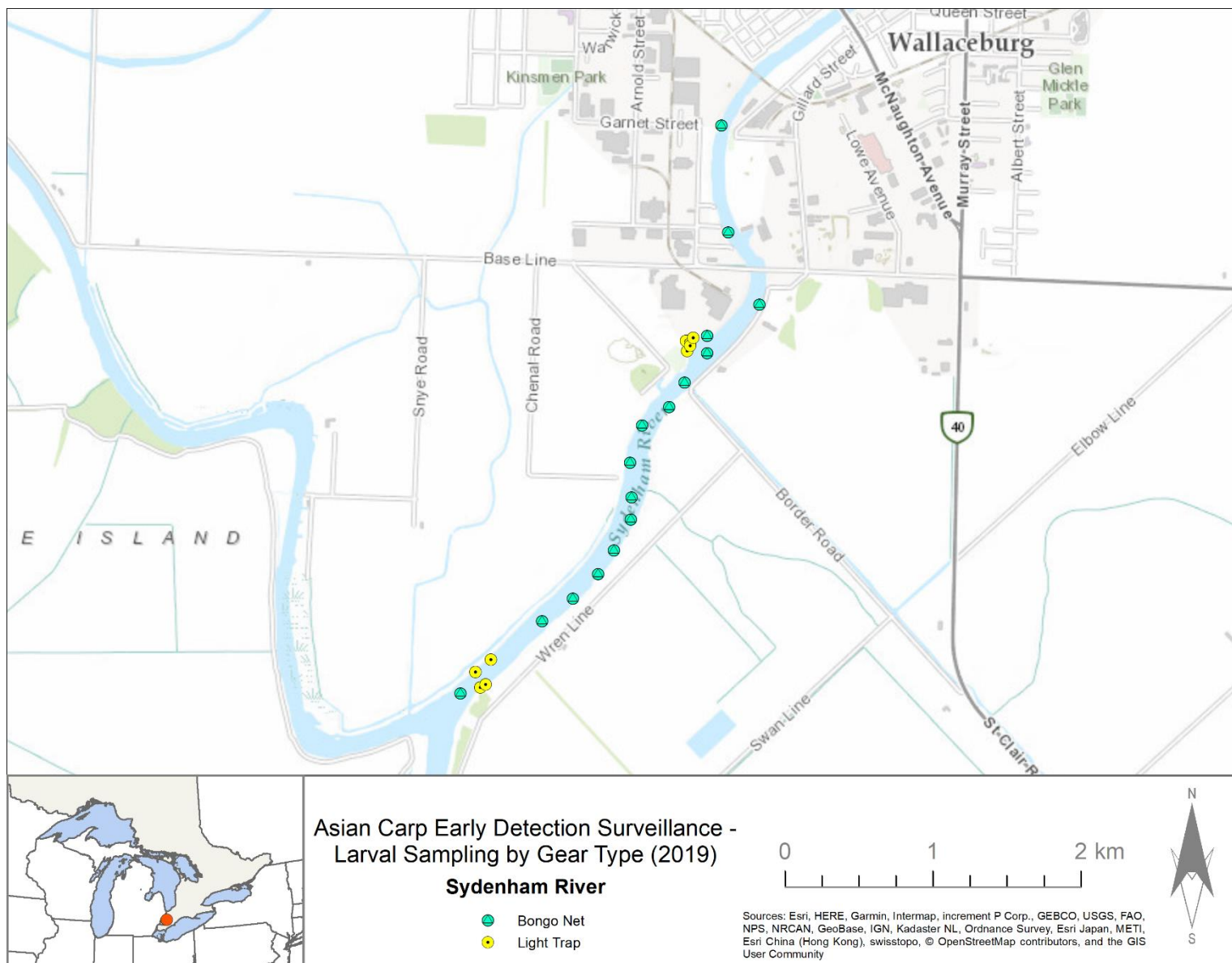


Figure A3.2 2019 Asian Carp Program larval early detection surveillance field sites in the Sydenham River.

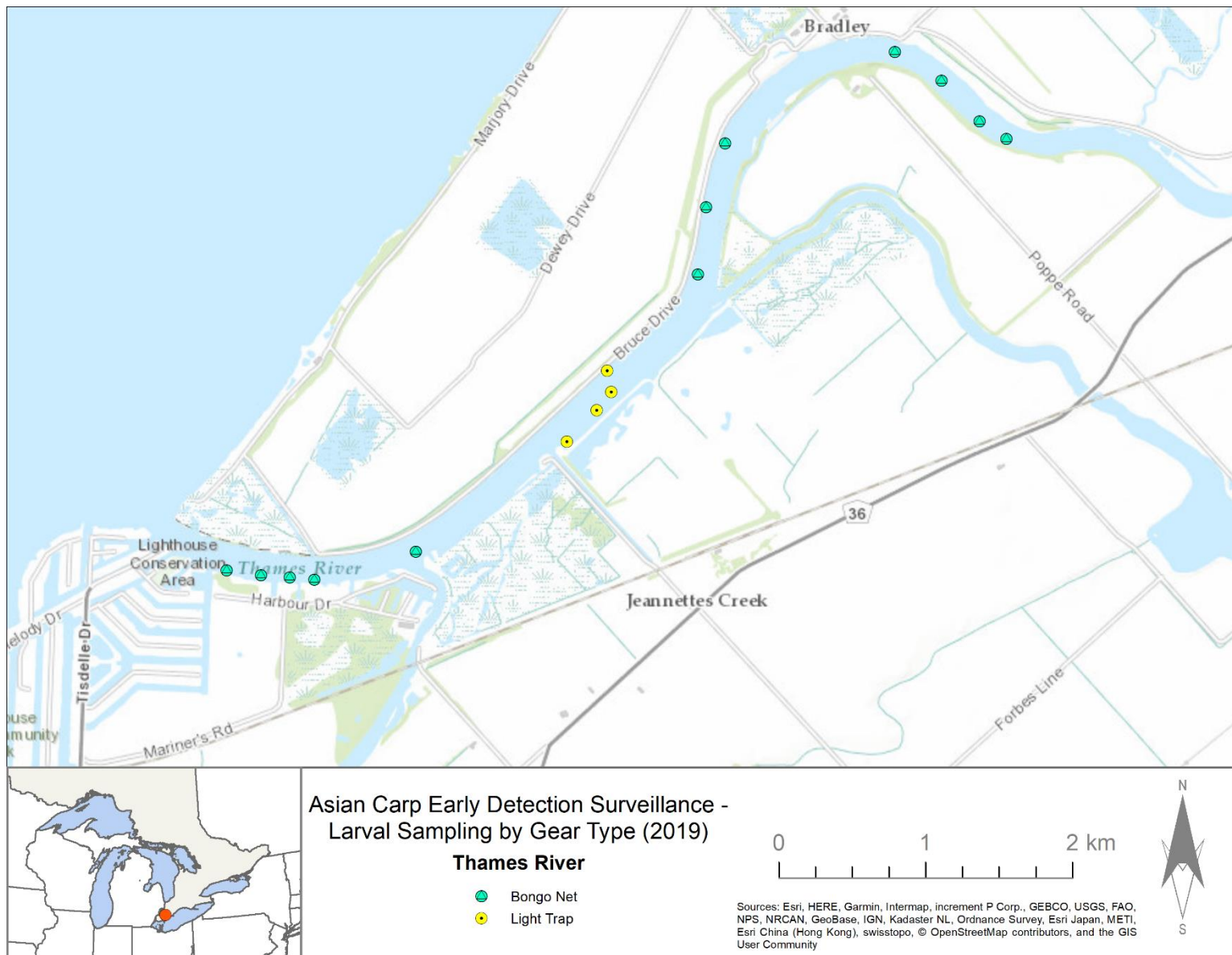


Figure A3.3 2019 Asian Carp Program larval early detection surveillance field sites in the Thames River.