Results of Fisheries and Oceans Canada's 2018 Asian Carp Early Detection Field Surveillance Program

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2019

RESULTS OF FISHERIES AND OCEANS CANADA'S 2018 ASIAN CARP EARLY DETECTION FIELD SURVEILLANCE PROGRAM

by

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In 2018, Fisheries and Oceans Canada's Asian Carp Program continued early detection surveillance for Asian carps in Canadian waters of the Great Lakes. A total of 1 162 field sites were sampled at 36 locations using seven gear types. These locations included 34 early detection sites and two scout sites. A total of 64 519 fishes were captured representing 90 species. Buffalo (*Ictiobus* spp.) and Common Carp (*Cyprinus carpio*) were used as surrogate species to assess the effectiveness of gear types. A total of 923 buffalo and 2 598 Common Carp were captured. Trammel nets, boat electrofishing and trap nets were most effective at capturing these surrogate species. An additional 165 field sites were sampled at four locations for larval fishes and eggs using two gear types. A total of 13 020 larval fishes were captured. No Asian carps were captured during the 2018 early detection surveillance efforts. Surveillance of Asian carps will continue in 2019, with an emphasis on the lower Great Lakes where the threat of arrival remains highest.

RÉSUMÉ

Colm, J., Marson, D. and Cudmore, B. 2019. Results of Fisheries and Oceans Canada's 2018 Asian Carp Early Detection Field Surveillance Program. Can. Manuscr. Rep. Fish. Aquat. Sci. 3168-1: vi + 69 p.

En 2018, 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. Au total, 1 162 sites sur le terrain ont été échantillonnés à 36 emplacements à l'aide de 7 types d'engins. Ces emplacements comprenaient 34 sites de détection précoce et 2 sites de reconnaissance. Au total, 64 519 poissons ont été capturés, représentant 90 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, 923 buffalos et 2 598 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, 165 autres sites sur le terrain ont été échantillonnés à 4 emplacements pour les larves et les œufs de poissons à l'aide de 2 types d'engins. Au total, 13 020 larves de poissons ont été capturées. Aucune carpe asiatique n'a été capturée pendant les travaux de surveillance et de détection précoce de 2018. La surveillance des carpes asiatiques se poursuivra en 2019, 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 worked to improve sampling protocols and identify early detection sites in areas considered suitable for Asian carps that can be sampled effectively with a suite of gear types. Asian Carp Program surveillance data summary reports like this one have been produced each year since 2013 identifying the changes in methods and locations that have taken place. As 2017 marked the fifth year of sampling, standard protocols have been realized, and methods and sampling 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, which will highlight major changes and updates to the program as well as present cumulative summaries from the previous five years 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 preventing 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 all four species of Asian carps. Large-bodied surrogate species, buffalo species (*Ictiobus* spp.) and Common Carp (*Cyprinus carpio*), that are widespread in the Great Lakes are used to assess the effectiveness of gear types and sampling techniques. 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. Surveillance sampling in 2018 took place from May 15th to October 25th in 36 waterbodies (34 early detection sites and two scout sites), including wetlands, tributary rivers and interconnected channels of the Great Lakes. A summary of results from the 2018 early detection surveillance sampling effort is presented here.

METHODS

To choose early detection sites, spatial modelling was conducted to identify areas in the Great Lakes most suited to Asian carps, specifically using variables important to their reproductive biology (Nicholas Mandrak, University of Toronto Scarborough, 1265 Military Trail, Toronto, Ontario, M1C 1A4, unpublished data). Large, productive wetlands around the basin were also selected for surveillance due to the abundance of food resources, particularly for Grass Carp. These locations were ground-truthed for habitat and sampling suitability, considering access, depth, substrate, vegetation density and waterbody size. This site selection process led to 36 early detection sites for Asian carp surveillance across all four Canadian Great Lakes (Figure 1).

Early detection surveillance sites were sampled using seven gear types: boat electrofishing, (mini) fyke nets, hoop nets, seine nets, tied-down gill and trammel nets and trap nets (additional details provided in Appendix 1). These gear types target 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. Additionally, it provides valuable baseline fish community data for the Great Lakes basin. Maps of 2018 sampling locations at the early detection surveillance sites and the two scout sites are found in Appendix 2. Sampling for larval fishes and eggs was also conducted using two gear types (bongo nets and light traps) in select high-risk locations in lakes Erie, Huron and Ontario (Appendix 3). Detailed descriptions of all gear types, the standardized effort and additional sampling parameters are found in Colm et al. (2019).

RESULTS

In 2018, the Asian Carp early detection field surveillance program sampled 1 162 sites in 36 waterbodies within Canadian waters of the Great Lakes basin. This covered 34 of the program's 36 early detection sites and two additional scouting sites. In total, 239 field sites were sampled in

12 Lake Huron waterbodies, 356 sites in eight waterbodies in the Huron-Erie Corridor, 428 sites in nine Lake Erie waterbodies, and 149 field sites in seven Lake Ontario waterbodies.

A total of 64 519 fishes were captured in 2018, representing 90 species (Table 1). The mean number of fishes and species per waterbody were 1 744 and 29, respectively. The mean number of fishes and species captured per site were 55 and six, respectively. The waterbody that yielded the greatest mean number of fishes per site sampled was Duffins Creek with 102 fishes; St. Clair River yielded the fewest, six fishes per site (Table 2). Ruscom River yielded the greatest mean number of species per site, nine; while St. Clair River yielded a mean of two species per site. Of the species captured, the most abundant were Gizzard Shad (*Dorosoma cepedianum*) totalling 15 297 fish (~23.7% of all fishes captured), Bluegill (*Lepomis macrochirus*) totalling 6 455 fish (~10.0%), Brown Bullhead (*Ameiurus nebulosus*) totalling 5 586 fish (~8.7%), Pumpkinseed (*Lepomis gibbosus*) totalling 3 961 fish (~6.1%) and Yellow Perch (*Perca flavescens*) totalling 2 960 fish (~4.6%) (Table 3).

An additional 165 field sites were sampled for larval fish and eggs. A total of 13 020 larval fishes weighing a total of 162 g were collected in the two gear types. Approximately 600 eggs were also collected in bongo nets (Figure 2).

Boat electrofishing was the most used gear type (406 sites), while the hoop net was the least used gear type (21 sites) (Table 4). The gear type that yielded the greatest mean number of fishes per site was the seine net, with approximately 133 fishes per site; hoop nets yielded the fewest, a mean of three fishes per site. Boat electrofishing captured the greatest mean number of species per site (nine); hoop nets, tied-down gill nets and trammel nets yielded a mean of two species per site (Table 4).

BOAT ELECTROFISHER

Boat electrofishing was conducted at 406 sites in all 36 waterbodies sampled. A total of 256 293 seconds of shocking were completed, with a mean of 631 seconds per site (Table 4). The greatest amount of electrofishing effort was conducted in the Thames River (21 547 seconds across 28 sites), while the least amount was conducted in the Pine River (1 275 seconds at two sites) (Table 5).

A total of 30 363 fishes were caught with this gear type, with a mean of 75 fishes per site sampled (Table 4). Eighty-three species were captured using boat electrofishing, with a mean of 9 species captured per site sampled. In total, 165 buffalo and 1 021 Common Carp were captured using boat electrofishing.

FYKE NET

Fyke nets were set at 272 sites in 34 waterbodies. Fykes were set for a total of 6 031 hours, with a mean of 22 hours per site (Table 4). The greatest amount of fyke net effort was conducted in the Grand River (446 hours across 21 sites); the least amount of fyke net effort, where used, was conducted around the Toronto Islands (37 hours at two sites) (Table 5).

In total, 11 092 fishes were captured in fyke nets, with a mean of 41 fishes per site (Table 4). Sixty-eight species were captured in fyke nets, with a mean of five species per site. Six buffalo and 53 Common Carp were captured in fyke nets.

HOOP NET

Hoop nets were set at 21 sites in five waterbodies. A total of 836 hours of hoop net sampling were completed, with a mean set time of 40.0 hours per site (Table 4). The greatest amount of hoop net sampling was conducted in the Thames River (397 hours across nine sites); the least amount of hoop net sampling, where used, was conducted in the Welland River (48 hours at two sites) (Table 5).

A total of 67 fishes representing 14 species were captured in hoop nets (Table 4). A mean of three fishes and two species were captured per site. No buffalo were captured in hoop nets, and one Common Carp was caught.

SEINE NET

Seine nets were used at 54 sites in 24 of the waterbodies sampled. A total of 152 hauls were completed, with an average of three hauls per site (Table 4). The most seining effort occurred in Rondeau Bay, with 18 hauls conducted across six sites; the least seining effort occurred in Duffins Creek, with one haul at one site (Table 5).

A total of 7 224 fishes were captured in the seine, with a mean of 133 fishes per site (Table 4). Seining captured the most fishes per site of any gear type. Fifty-seven species were captured while seining, with a mean of eight species per site. Five buffalo and 36 Common Carp were captured in seine nets.

TIED-DOWN GILL AND TRAMMEL NETS

Tied-down gill nets were used at 34 sites in 12 waterbodies. A total of 1 368 minutes of sampling occurred, with a mean of 40 minutes per site (Table 4). The most gill net effort was deployed in Long Point Bay, with a total of 313 minutes across six sites. The least gill net effort, where used, was deployed in the Mississagi River, with 40 minutes at one site (Table 5).

A total of 334 fishes were captured in tied-down gill nets, with a mean of 10 fishes per site (Table 4). Nine species were captured in tied-down gill nets, with a mean of two species per site A total of four buffalo and 276 Common Carp were caught with this gear type.

Trammel nets were used at 165 sites in 21 waterbodies. A total of 6 569 minutes of trammel net sampling were conducted, with a mean of 40 minutes per site (Table 4). The greatest amount of trammel net sampling was conducted on the Canard River (885 minutes across 19 sites); the least trammel sampling was conducted for 42 minutes at one site on the Bayfield River (Table 5).

In total, 1 234 fishes were captured in trammel nets, with a mean of seven fishes per site (Table 4). Seventeen species were captured with this gear type, a mean of two species per site. A total of 567 buffalo and 520 Common Carp were captured in trammel nets (Figure 5).

TRAP NET

Trap nets were set at 210 sites in 34 waterbodies sampled. A total of 4 613 hours of trap net sampling was completed, with a mean of 22 hours per site (Table 4). The greatest amount of trap net effort was conducted in Cedar Creek, with 384 hours of sampling across 17 sites. The least amount of trap net effort was 19 hours at one site around the Toronto Islands (Table 5).

A total of 14 205 fishes were caught in trap nets, with a mean of 68 fishes per site (Table 4). Forty-six species were captured in trap nets, with a mean of seven species per site. A total of 176 buffalo and 691 Common Carp were captured in trap nets.

SURROGATE SPECIES

A total of 3 521 surrogate fishes were captured in 2018 consisting of 923 buffalo and 2 598 Common Carp. The buffalo ranged in size from 29 to 965 mm total length, with a mean and median total length of 593 mm and 645 mm, respectively. The most buffalo were captured in the Thames River, where 369 were caught. Buffalo was captured in 16 of 36 waterbodies in all three Great Lakes sampled; however, in Lake Huron, it was only captured in the Ausable River. Common Carp ranged in size from 30 to 965 mm total length, with a mean and median total length of 602 mm and 637 mm, respectively. The most Common Carp were captured in Rondeau Bay totalling 325. Common Carp was captured in all but three waterbodies sampled (Magnetawan, Shebeshekong and Sturgeon rivers).

Trammel nets captured the most buffalo, a total of 567 (~61% of all buffalo captured) (Figure 6). Trap nets and boat electrofishing were also effective at capturing buffalo, with 176 (~19%) and 165 (~18%) captured in these gear types, respectively. Boat electrofishing captured the most Common Carp, with a total of 1 021 (~40% of all Common Carp captured). Trap nets and trammel nets were also effective gear types for capturing Common Carp, totalling of 691 (~27%) and 520 (20%) individuals captured, respectively.

ASIAN CARPS

No Asian carps were captured during the 2018 early detection surveillance work.

OTHER AQUATIC INVASIVE SPECIES

Other aquatic invasive fish species were captured during DFO's early detection surveillance work targeting Asian carps. This includes 529 Goldfish (*Carassius auratus*); 52 Goldfish x Common Carp hybrids (*Carassius auratus X Cyprinus carpio*); 950 Round Goby (*Neogobius melanostomus*); 415 Rudd (*Scardinius erythrophthalmus*); and 12 Tubenose Goby (*Proterorhinus semilunaris*) (Table 3).

LARVAL BONGO NETS

Bongo nets were deployed in four waterbodies at 55 sites in early summer (Table 6). Bongo nets were deployed for 9 900 seconds. A total of 10 611 larval fishes were captured, with a weight of 115.483 g. The most fishes were captured in the Thames River (8 338 fishes), while the Credit and Grand rivers yielded the fewest fishes with similar effort (28 and 60 fishes, respectively). Fish eggs were captured in 14 of the bongo nets in the Thames River and one in the Grand River

(Figure 6). Species identifications through genetic analysis are underway. Non-larval fish captured and released included one Logperch (*Percina caprodes*), one young-of-the-year Rock Bass (*Ambloplites rupestris*), two Spotfin Shiner (*Cyprinella spiloptera*) and three young-of-the-year Yellow Perch (*Perca flavescens*).

LARVAL LIGHT TRAPS

Light traps were deployed in four waterbodies at 110 sites in early summer (Table 6). Light traps were deployed for 7 131 minutes. A total of 2 409 larval fishes were captured, with a weight of 46.391 g. The most fishes were captured in the Grand River (1 027). Species identifications through genetic analysis are underway. Non-larval fish captured and released included six Brook Silverside (*Labidesthes sicculus*), one Golden Shiner (*Notemigonus crysoleucas*) and one centrarchid.

SUMMARY

In 2018, DFO's Asian Carp Program early detection surveillance crews sampled 36 waterbodies in the Great Lakes basin that are at high risk for entry of Asian carps. This included 34 early detection surveillance sites and two sites scouted for sampling suitability. 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 1 162 field sites were sampled and 64 519 fishes representing 90 species were captured. Additionally, two gear types were used to target Asian carp icthyoplankton (larval fish and eggs); another 165 field sites were sampled resulting in 13 020 larval fishes. No Asian carps were detected during the 2018 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 16th and eighth most abundant species captured, respectively, suggesting our methods are targeting large-bodied fishes effectively.

There were minimal changes in the gear types used for early detection surveillance in 2018. Large, six-foot hoop nets were not used in 2018 as they were too cumbersome to deploy. Both small three-foot and large five-foot hoop nets will continue to be used. The Asian Carp Program procured a custom-made Henley boat fitted with Halltech/Midwest Lake electrofishing equipment. The boat was designed to make deployment of trammel nets or tied-down gill nets easily pair with electrofishing. A new make of fyke nets were used in 2018 that differed in specifications from previous years. The 2018 fyke nets lacked turtle exclusion netting and funnels through the first several passageways, and the terminal funnel was delineated by a hard plastic ring that would greatly restrict the size of fish able to pass through. Both old and new styles of fyke nets were used in 2018 and, anecdotally, the newer models resulted in fewer fish captured. The program will return to fyke nets with the original specifications in 2019.

The Asian Carp Program conducted early detection surveillance in 34 of 36 early detection sites identified as highly suitable for Asian carps. The two early detection sites in Lake Superior

(Kaministiqua and Goulais rivers) were not visited in 2018 as Lake Superior remains lower priority than sites in the lower Great Lakes where Grass Carp have been detected and/or are reproducing (Lake Erie tributaries in US waters). These early detection sites will be visited when opportunity allows or when the threat to Lake Superior is increased. Two additional sites in the Great Lakes basin were sampled in 2018 due to increased risk. The St. Clair River was scouted for potential early detection surveillance as Grass Carp were detected nearby in both 2017 and 2018 by commercial fishers. Due to the fast flow in the St. Clair River, field sites were identified that would be suitable for sampling primarily with hoop nets and boat electrofishing. Some sites around the islands may also be suitable for trap nets and tied-down gill nets. Further scouting and sampling will take place in the St. Clair River in 2019. Lake Gibson (connected to the Welland Canal) was also sampled in 2018. Ten Grass Carp were captured in Lake Gibson by the Asian Carp Program in 2016 following the detection of one specimen by an angler. Lake Gibson is not considered an early detection site because of intermittent access issues; however, it will be sampled periodically, as allowed, as it has dense coverage of submerged macrophytes and provides suitable feeding habitat for Grass Carp. To note, more thorough sampling around the Toronto Islands (particularly the inner islands) was intended; however severe winds and wave action precluded access to those areas. They will be revisited in 2019.

No Asian carps were captured during early detection surveillance efforts; however, three Grass Carp were captured by commercial fishers in trap nets. Two were captured in Point Pelee in Lake Erie (May and July) and one in Point Edward in Lake Huron (July). All three were sterile individuals. These fish were captured in open waters of the Great Lakes that are difficult to target for surveillance; tributaries nearby will continue to be sampled.

In 2019, the Asian Carp Program will continue to conduct early detection surveillance for Asian carps across wetland and riverine habitats in the Great Lakes basin to protect Canadian waters from the threats posed by these invasive fishes.

ACKNOWLEDGMENTS

REFERENCES

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.

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.

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.

Wanner, G.A., and Klumb, R.A. 2009. Asian carp in the Missouri River: Analysis from multiple Missouri river habitat and fisheries programs. National Invasive Species Council materials. 10. http://digitalcommons.unl.edu/natlinvasive/10

TABLES

Table 1 Summary of the 2018 catch data for the Asian Carp Program's early detection surveillance.

Number of Sites	1 162
Number of Waterbodies	36
Total Number of Fishes Caught	64 519
Total Number of Species	90
Mean Number of Fishes per Waterbody	1 744
Mean Number of Fishes per Site	55
Maximum Number of Fishes per Site	792
Mean Number of Species per Waterbody	29
Mean Number of Species per Site	6
Maximum Number of Species per Site	21
Total Number of Asian carps	0
Total Number of Buffalo	923
Total Number of Common Carp	2 598

Table 2 Catch data by waterbody for the 2018 Asian Carp Program's early detection surveillance.

Waterbody Name	Number of Sites	Number of Fishes Captured	Mean Number of Fishes Captured per Site	Number of Species	Mean Number of Species per Site	Number of Buffalo	Number of Common Carp
Ausable River	70	4 832	69.03	45	6.04	10	161
Bayfield River	14	696	49.71	33	8.64	0	54
Big Creek	16	797	49.81	24	5.06	13	44
Big Otter Creek	26	506	19.46	25	3.35	2	48
Canard River	74	4 474	60.46	37	5.61	99	89
Cedar Creek	50	2 916	58.32	35	7.48	95	162
Coldwater River	35	1 562	44.63	26	6.69	0	28
Credit River	23	1 031	44.83	33	6.04	0	43
Detroit River	44	2 743	62.34	46	7.16	8	63
Duffins Creek	9	915	101.67	15	6.67	0	8
Frenchman's Bay	19	1 286	67.68	18	5.74	0	12
Grand River	83	5 743	69.19	45	7.61	12	65
Humber River	27	1 259	46.63	24	5.59	0	26
Jeanette's Creek	33	2 060	62.42	33	5.58	49	38
Jordan Harbour	37	2 838	76.70	32	6.76	9	307
Kettle Creek	15	209	13.93	31	5.13	1	19
Lake Gibson	17	350	20.59	27	5.47	9	22
Long Point Bay	64	3 712	58.00	41	6.28	0	78
Magnetawan River	10	233	23.30	21	5.80	0	0
Maitland River	24	836	34.83	33	5.54	0	45
Mississagi River	12	361	32.82	16	3.36	0	1
Nanticoke Creek	13	605	46.54	30	7.15	0	110
Nottawasaga River	12	412	34.33	19	5.58	0	15
Pine River	10	472	47.20	23	5.20	0	13
Rondeau Bay	64	4 872	76.13	39	6.97	72	325
Rouge River	24	1 375	57.29	24	6.54	0	96
Ruscom River	22	1 407	63.95	35	9.14	1	255
Sauble River	20	1945	97.25	36	8.20	0	14
Shebeshekong River	9	143	15.89	15	3.89	0	0
Spanish River	13	497	38.23	25	7.00	0	11
St. Clair River	12	70	5.83	17	2.33	0	27
Sturgeon River	10	452	45.20	21	5.00	0	0
Sydenham River	73	2 610	35.75	37	6.00	23	138
Thames River	82	7 272	88.68	41	5.91	369	171
Toronto Islands	10	344	34.40	16	4.30	0	6
Welland River	86	2 653	30.85	40	5.51	151	104

Table 3 Summary of the species captured during the 2018 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.

Species Name	Common Name	Number Captured	Status*
Alosa pseudoharengus	Alewife	277	
Anguilla rostrata	American eel	3	thr
Fundulus diaphanus	Banded Killifish	350	
Ameiurus melas	Black Bullhead	4	
Pomoxis nigromaculatus	Black Crappie	1 165	
Moxostoma duquesnei	Black Redhorse	56	thr
Notropis heterodon	Blackchin Shiner	122	
Rhinichthys atratulus	Blacknose Dace	2	
Notropis heterolepis	Blacknose Shiner	6	
Percina maculata	Blackside Darter	2	
Fundulus notatus	Blackstripe Topminnow	3	SC
Lepomis macrochirus	Bluegill	6 455	
Pimephales notatus	Bluntnose Minnow	1 990	
Amia calva	Bowfin	608	
Hybognathus hankinsoni	Brassy Minnow	1	
Labidesthes sicculus	Brook Silverside	115	
Ameiurus nebulosus	Brown Bullhead	5 586	
Ictiobus sp	buffalo	923	
Umbra limi	Central Mudminnow	86	
Campostoma anomalum	Central Stoneroller	3	
Ictalurus punctatus	Channel Catfish	2 654	
Oncorhynchus tshawytscha	Chinook Salmon	2	
Cyprinus carpio	Common Carp	2 598	
Luxilus cornutus	Common Shiner	1 121	
Semotilus atromaculatus	Creek Chub	5	
Notropis atherinoides	Emerald Shiner	2 689	
Pimephales promelas	Fathead Minnow	96	
Pylodictis olivaris	Flathead Catfish	5	
Aplodinotus grunniens	Freshwater Drum	374	
Notropis buchanani	Ghost Shiner	1 238	
Dorosoma cepedianum	Gizzard Shad	15 297	
Moxostoma erythrurum	Golden Redhorse	114	
Notemigonus crysoleucas	Golden Shiner	923	
Carassius auratus	Goldfish	529	
Carassius auratus X *Cyprinus carpio*	Goldfish X Common Carp hybrid	52	
Esox americanus vermiculatus	Grass Pickerel	8	SC
Moxostoma valenciennesi	Greater Redhorse	41	

Lepomis cyanellus	Green Sunfish	29	
Etheostoma blennioides	Greenside Darter	7	
Nocomis biguttatus	Hornyhead Chub	95	
Etheostoma exile	Iowa Darter	10	
Etheostoma nigrum	Johnny Darter	39	
Erimyzon sucetta	Lake Chubsucker	5	END
Salvelinus namaycush	Lake Trout	1	
Micropterus salmoides	Largemouth Bass	2 004	
Percina caprodes	Logperch	415	
Rhinichthys cataractae	Longnose Dace	1	
Lepisosteus osseus	Longnose Gar	726	
Notropis volucellus	Mimic Shiner	598	
Hiodon tergisus	Mooneye	9	
Esox masquinongy	Muskellunge	11	
Hypentelium nigricans	Northern Hog Sucker	28	
Esox lucius	Northern Pike	306	
Lepomis peltastes	Northern Sunfish	33	
Lepomis humilis	Orangespotted Sunfish	11	
Opsopoeodus emiliae	Pugnose Minnow	16	thr/SC
Notropis anogenus	Pugnose Shiner	10	thr/END
Lepomis gibbosus	Pumpkinseed	3 961	
Carpiodes cyprinus	Quillback	109	
Etheostoma caeruleum	Rainbow Darter	40	
Osmerus mordax	Rainbow Smelt	1	
Oncorhynchus mykiss	Rainbow Trout	2	
Nocomis micropogon	River Chub	1	
Moxostoma carinatum	River Redhorse	5	SC
Ambloplites rupestris	Rock Bass	1 118	
Notropis rubellus	Rosyface Shiner	206	
Neogobius melanostomus	Round Goby	950	
Scardinius erythrophthalmus	Rudd	415	
Petromyzon marinus	Sea Lamprey	1	
Moxostoma macrolepidotum	Shorthead Redhorse	199	
Ichthyomyzon unicuspis	Silver Lamprey	4	
Moxostoma anisurum	Silver Redhorse	159	
Micropterus dolomieu	Smallmouth Bass	485	
Cyprinella spiloptera	Spotfin Shiner	213	
Notropis hudsonius	Spottail Shiner	562	
Lepisosteus oculatus	Spotted Gar	36	end/THR
Minytrema melanops	Spotted Sucker	151	SC
Noturus flavus	Stonecat	2	
Luxilus chrysocephalus	Striped Shiner	20	
Noturus gyrinus	Tadpole Madtom	28	

Percopsis omiscomaycus	Trout-perch	9	
Proterorhinus semilunaris	Tubenose Goby	12	
Sander vitreus	Walleye	157	
Lepomis gulosus	Warmouth	4	end/SC
Morone chrysops	White Bass	288	
Pomoxis annularis	White Crappie	182	
Morone americana	White Perch	324	
Catostomus commersonii	White Sucker	703	
Ameiurus natalis	Yellow Bullhead	309	
Perca flavescens	Yellow Perch	2 960	
Ameiurus sp	bullhead	18	
Catostomidae	sucker family	265	
Moxostoma sp	redhorse	108	
Centrarchidae	sunfishes and basses family	2	
Pomoxis sp	crappie	2	
Lepomis sp	sunfishes	215	
Clupeidae	herring family	250	
Cyprinidae	minnow family	154	
Pimephales sp	minnow	9	
Etheostoma sp	darter	1	
Lepisosteus sp	gar	1	
Morone sp	temperate basses	1	
Unknown	Unknown	20	

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

Table 4 Summary of the catch data by gear type used in the 2018 Asian Carp Program's early detection surveillance.

Gear Type	Acronym	Total Effort	Mean Effort per Site	Effort Units	Number of Sites	Number of Waterbodies	Number of Fishes	Mean Number of Fishes per Site	Number of Species	Mean Number of Species per Site	Number of Buffalo sp.	Number of Common Carp
Boat Electrofishing	BEF	256 293	631.26	seconds	406	36	30 363	74.79	83	9	165	1 021
Fyke Net	MFN	6 031	22.17	hours	272	34	11 092	40.78	68	5	6	53
Hoop Net*	HN	836	39.80	hours	21	5	67	3.19	14	2	0	1
Seine Net	SN	152	2.81	hauls	54	24	7 174	132.85	57	8	5	36
Tied-down Gill Net	TDG	1 368	40.24	minutes	34	12	334	10.12	9	2	4	276
Trammel Net	TRM	6 569	39.81	minutes	165	21	1 234	7.48	17	2	567	520
Trap Net	TN	4 613	21.97	hours	210	34	14 205	67.64	46	7	176	691

*Hoop Size	Effort (hours)		Number of Sites	Number of Waterbodies	Number of Fishes	Mean Number of Fishes per Site	Number of Species	Mean Number of Species per site	Number of Buffalo	Number of Common Carp
Large 5' diameter hoop net	1 047		27	4	63	2.33	14	2.08	0	1
Small 3' diameter hoop net	319		8	3	4	0.50	4	1.00	0	0

Table 5 Summary of sampling effort by waterbody for boat electrofishing (BEF), fyke nets (MFN), hoop nets (HN), seine nets (SN), trammel nets (TRM), tied-down gill nets (TDG), and trap nets (TN) during the 2018 Asian Carp Program's early detection surveillance.

Waterbody Name	BEF Number of Sites	BEF Total Effort (seconds)	MFN Number of Sites	MFN Total Effort (hours)	HN Number of Sites	HN Total Effort (hours)	SN Number of Sites	SN Total Effort (hauls)	TDG Number of Sites	TDG Total Effort (minutes)	TRM Number of Sites	TRM Total Effort (minutes)	TN Number of Sites	TN Total Effort (hours)
Ausable River	25	14 928	17	384.17	0	0	1	3	0	0	13	571	14	320.20
Bayfield River	5	3 150	3	72.51	0	0	3	10	0	0	1	42	2	47.09
Big Creek	5	3 013	6	136.84	0	0	0	0	0	0	2	72	3	65.19
Big Otter Creek	9	5 435	7	143.18	3	126.80	0	0	4	98	0	0	3	60.98
Canard River	22	14 427	16	344.28	0	0	5	14	0	0	19	884.55	12	261.99
Cedar Creek	9	5320	10	245.31	0	0	1	3	2	65	11	183	17	384.17
Coldwater River	19	11 430	8	181.90	0	0	2	6	0	0	0	0	6	136.85
Credit River	9	5 263	4	92.30	0	0	2	5	0	0	3	148	5	105.70
Detroit River	23	14 083	8	176.65	2	92.63	1	3	0	0	4	90	6	130.97
Duffins Creek	4	2 400	4	78.08	0	0	1	1	0	0	0	0	0	0
Frenchman's Bay	9	6 000	6	120.51	0	0	1	3	0	0	0	0	3	58.84
Grand River	25	14 996	21	445.90	5	171.09	0	0	3	98	12	558	17	356.58
Humber River	11	6 605	7	153.11	0	0	1	3	0	0	3	168	5	113.59
Jeanette's Creek	10	6 240	10	240.52	0	0	0	0	0	0	5	233	8	191.21
Jordan Harbour	12	7 214	7	155.95	0	0	3	9	0	0	7	501	8	176.08
Kettle Creek	6	3 587	3	55.33	0	0	1	5	2	71	0	0	3	67.48
Lake Gibson	8	5 561	0	0	0	0	0	0	0	0	7	261	2	48.00
Long Point Bay	19	11 422	18	408.39	0	0	2	3	6	313	5	272	14	317.88
Magnetawan River	4	2 830	3	69.33	0	0	0	0	1	51	0	0	2	48.57
Maitland River	12	7 306	3	67.82	0	0	2	6	0	0	5	159	2	46.48
Mississagi River	5	4 370	4	100.08	0	0	0	0	1	40	0	0	2	49.93
Nanticoke Creek	4	2 405	6	124.12	0	0	0	0	1	204	0	0	2	32.13
Nottawasaga River	4	2 400	4	80.54	0	0	1	3	0	0	0	0	3	62.22
Pine River	2	1 275	4	88.18	0	0	3	5	0	0	0	0	1	21.25
Rondeau Bay	19	11 522	15	365.20	0	0	6	18	8	147	4	165	12	269.65
Rouge River	6	3 500	6	119.62	0	0	3	9	0	0	4	91	5	93.78
Ruscom River	11	6 790	4	97.87	0	0	3	9	0	0	1	97.80	3	72.01
Sauble River	7	4 506	4	79.66	0	0	4	11	3	123	0	0	2	34.70
Shebeshekong River	3	2 000	3	64.72	0	0	0	0	2	89	0	0	1	22.10
Spanish River	5	4 930	4	92.53	0	0	0	0	1	69	0	0	3	70.98

14

St. Clair River	7	4 200	0	0	0	0	0	0	0	0	5	172	0	0
Sturgeon River	3	1 800	3	69.55	0	0	1	3	0	0	0	0	3	71.78
Sydenham River	26	15 818	16	362.00	0	0	2	6	0	0	17	465	12	251.40
Thames River	28	21 547	16	355.06	9	397.37	2	5	0	0	14	741	13	293.78
Toronto Islands	7	4 205	2	37.15	0	0	0	0	0	0	0	0	1	18.52
Welland River	23	13 815	20	422.60	2	47.91	3	9	0	0	23	695	15	311.22

Table 6 Summary of larval fish and egg sampling during the 2018 Asian Carp Program's early detection surveillance.

Waterbody Name	Gear Type	Dates Sampled	Number of Sites	Effort	Units	Number of Fishes in Sample	Weight of Sample (g)
Ausable River	Bongo Net	23/07/2018-24/07/2018	7	1 260	seconds	2 185	15.94
Ausable River	Light Trap	23/07/2018-24/07/2018	33	2 110	minutes	430	3.91
Credit River	Bongo Net	10/07/2018-11/07/2018	12	2 160	seconds	28	0.57
Credit River	Light Trap	10/07/2018-11/07/2018	22	1 370	minutes	167	1.92
Grand River	Bongo Net	17/07/2018-18/07/2018	13	2 340	seconds	60	1.12
Grand River	Light Trap	17/07/2018-18/07/2018	24	1 750	minutes	1 027	13.25
Thames River	Bongo Net	26/06/2018-28/06/2018	23	4 140	seconds	8 338	97.85
Thames River	Light Trap	26/06/2018-28/06/2018	31	1 901	minutes	785	27.31
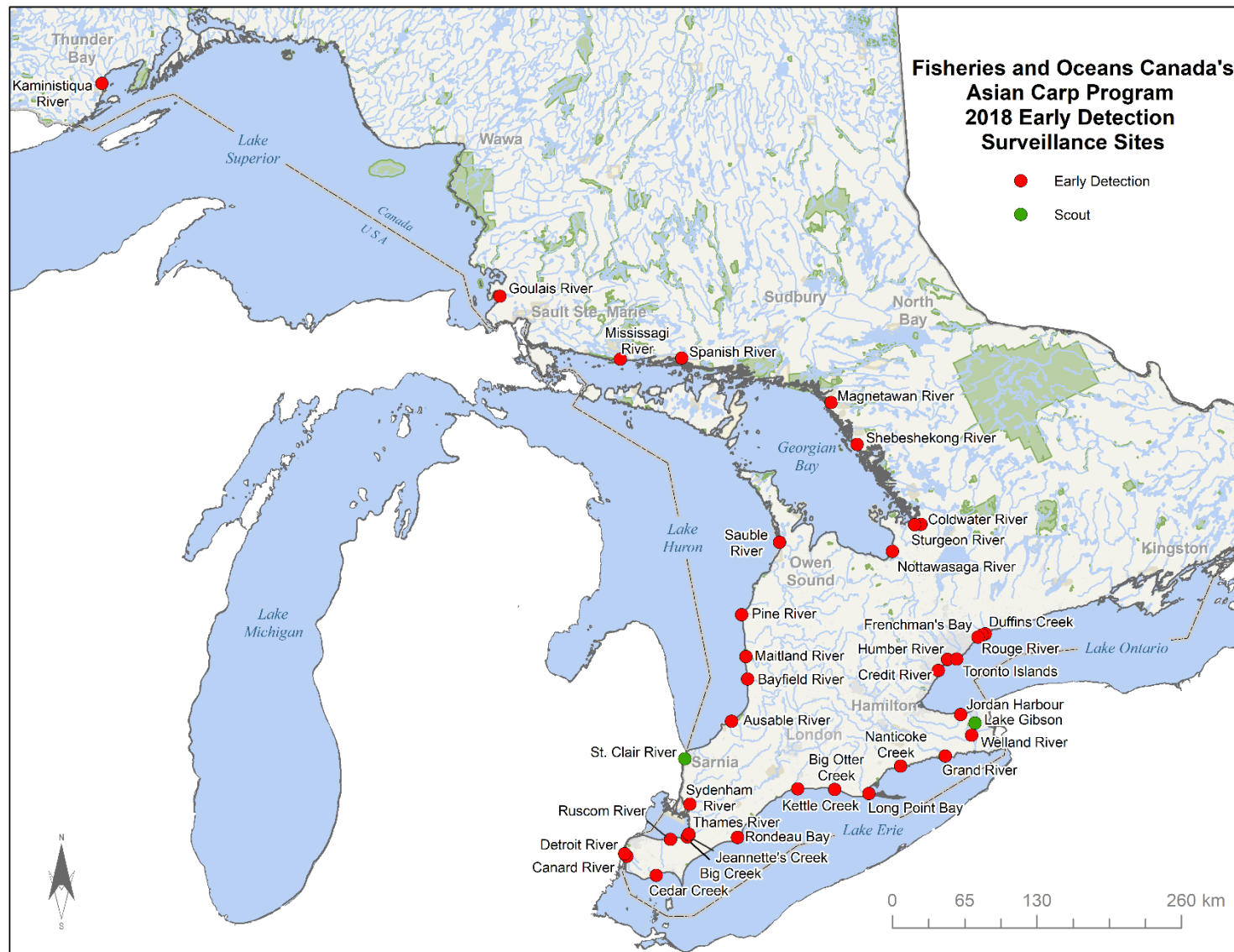
Figure 1 DFO's Asian Carp Program's early detection surveillance sites in Canadian waters of the Great Lakes.

Figure 2 Cod-end of a bongo net in the Thames River (28/06/2018) containing larval fishes and eggs.

APPENDIX 1: GEAR DESCRIPTIONS

Gear Type	Dimensions	Habitat	Standardized Effort	Notes
Boat Electrofishing	6.4-7.3 m (21-24') boat; 7.5 GPP; dual boom	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 of shocking	Operating with Smithroot or Halltech/Midwest Lake electrofishing parts
Fyke Net (mini)	3 mm (1/8") ace mesh; 0.61 m x 4.6 m (2'x15') lead; 0.61 m (2') hoops; 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
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	
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

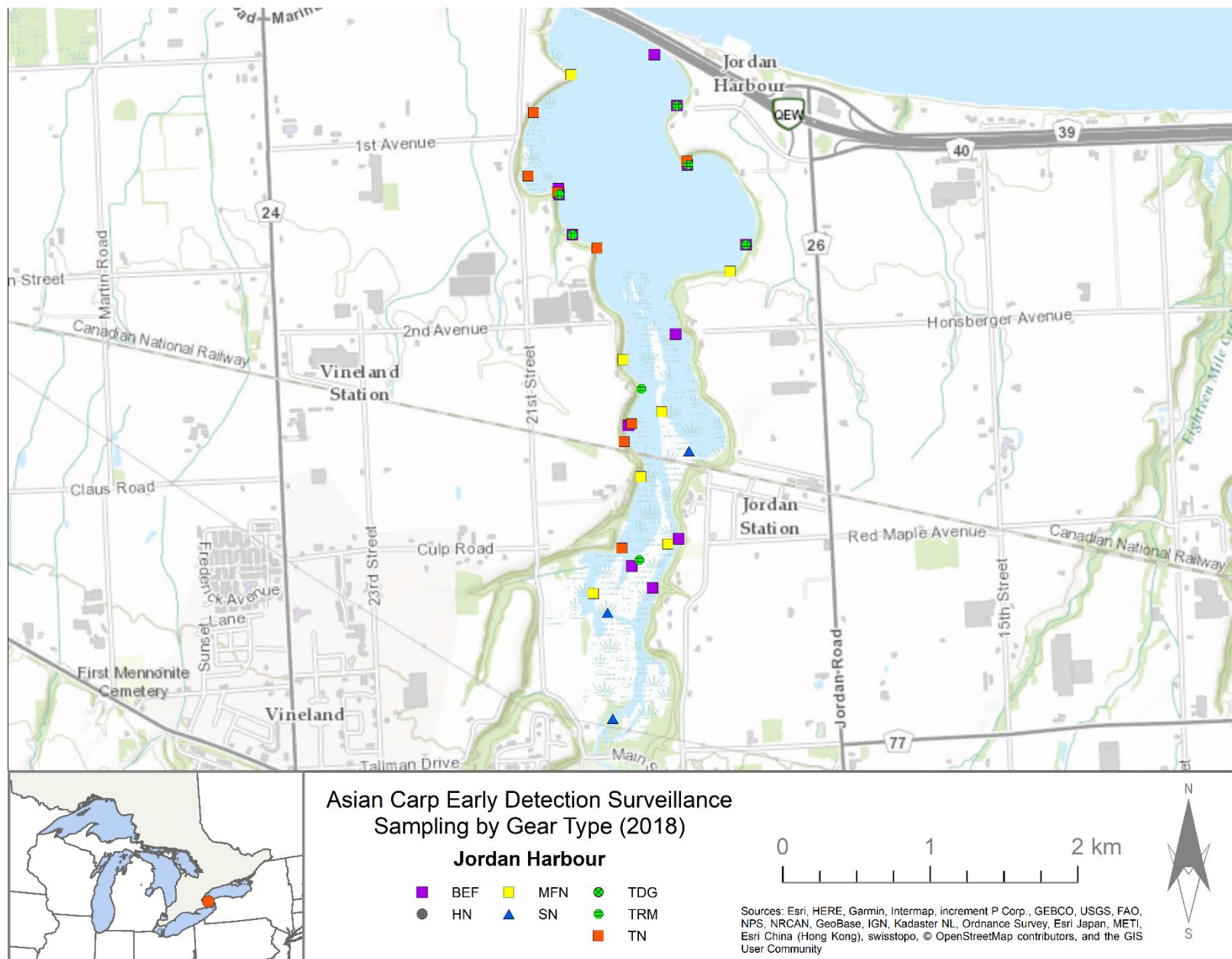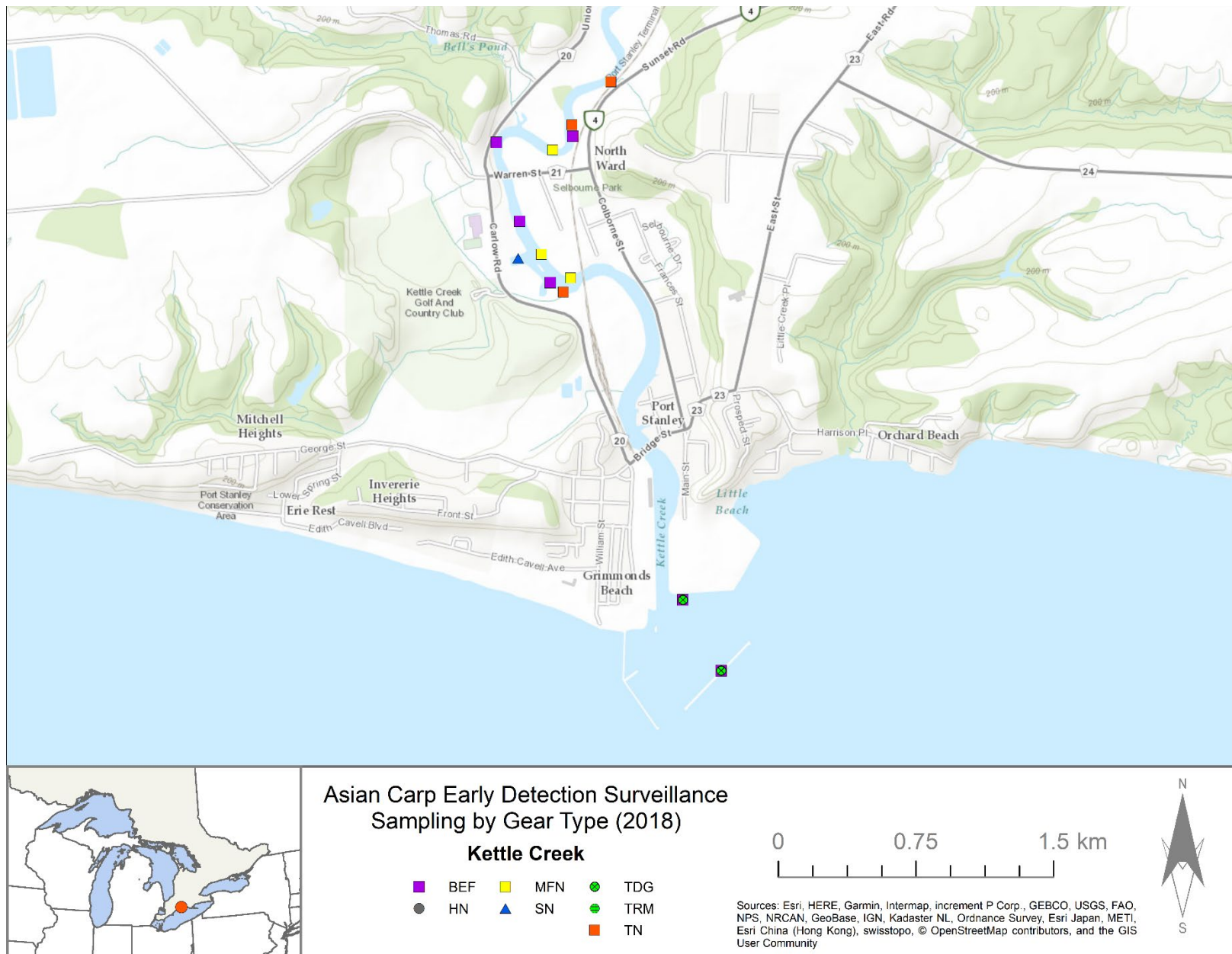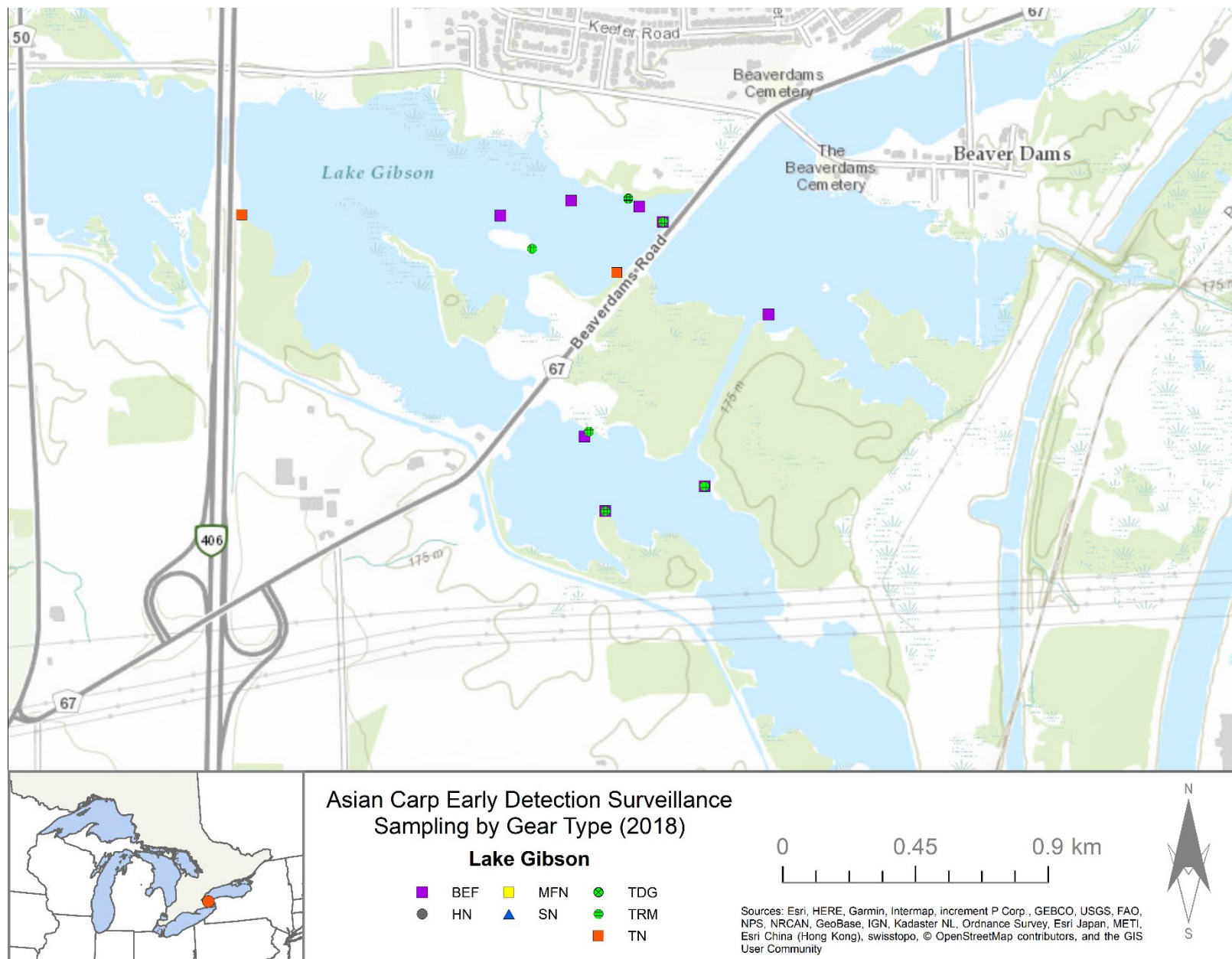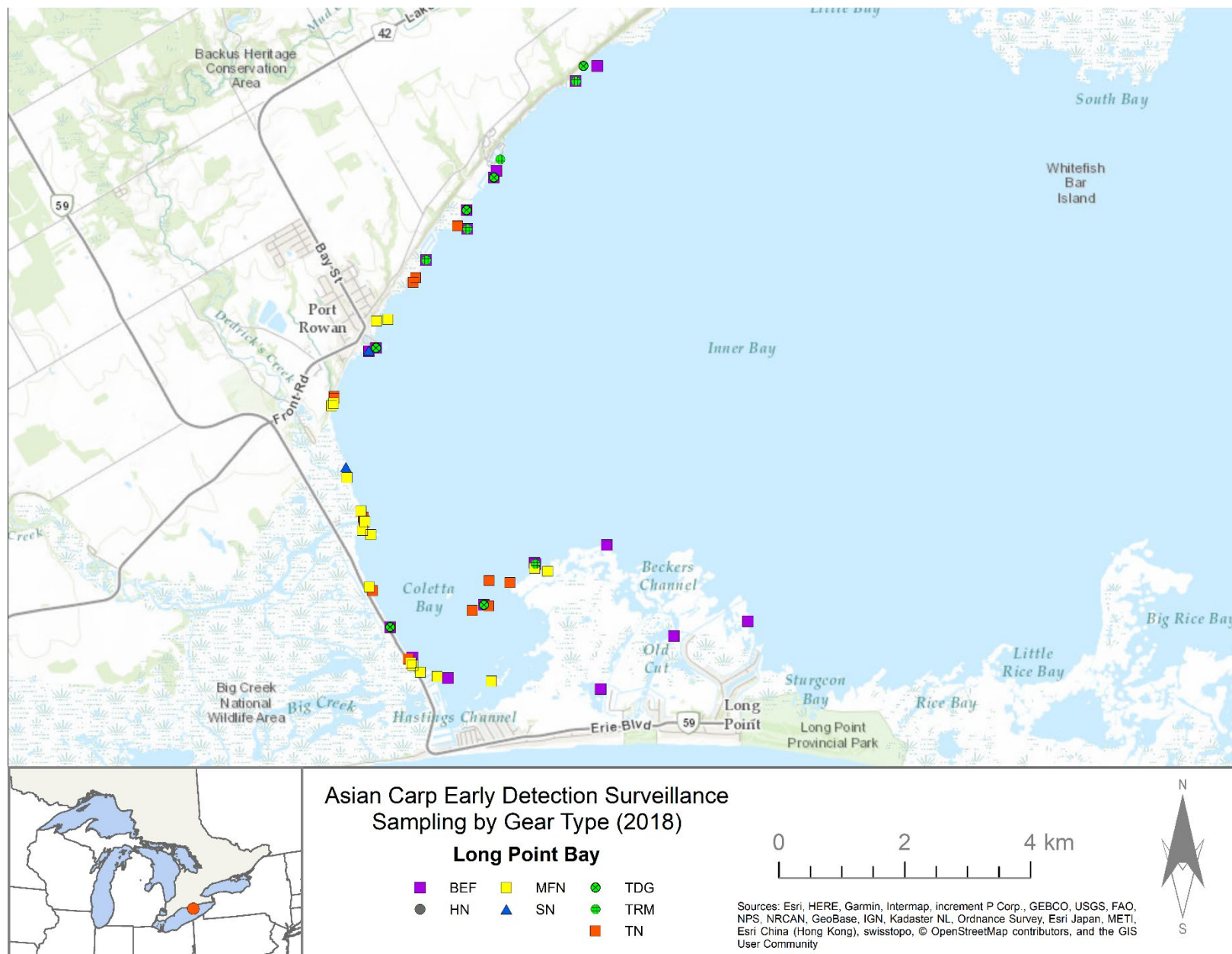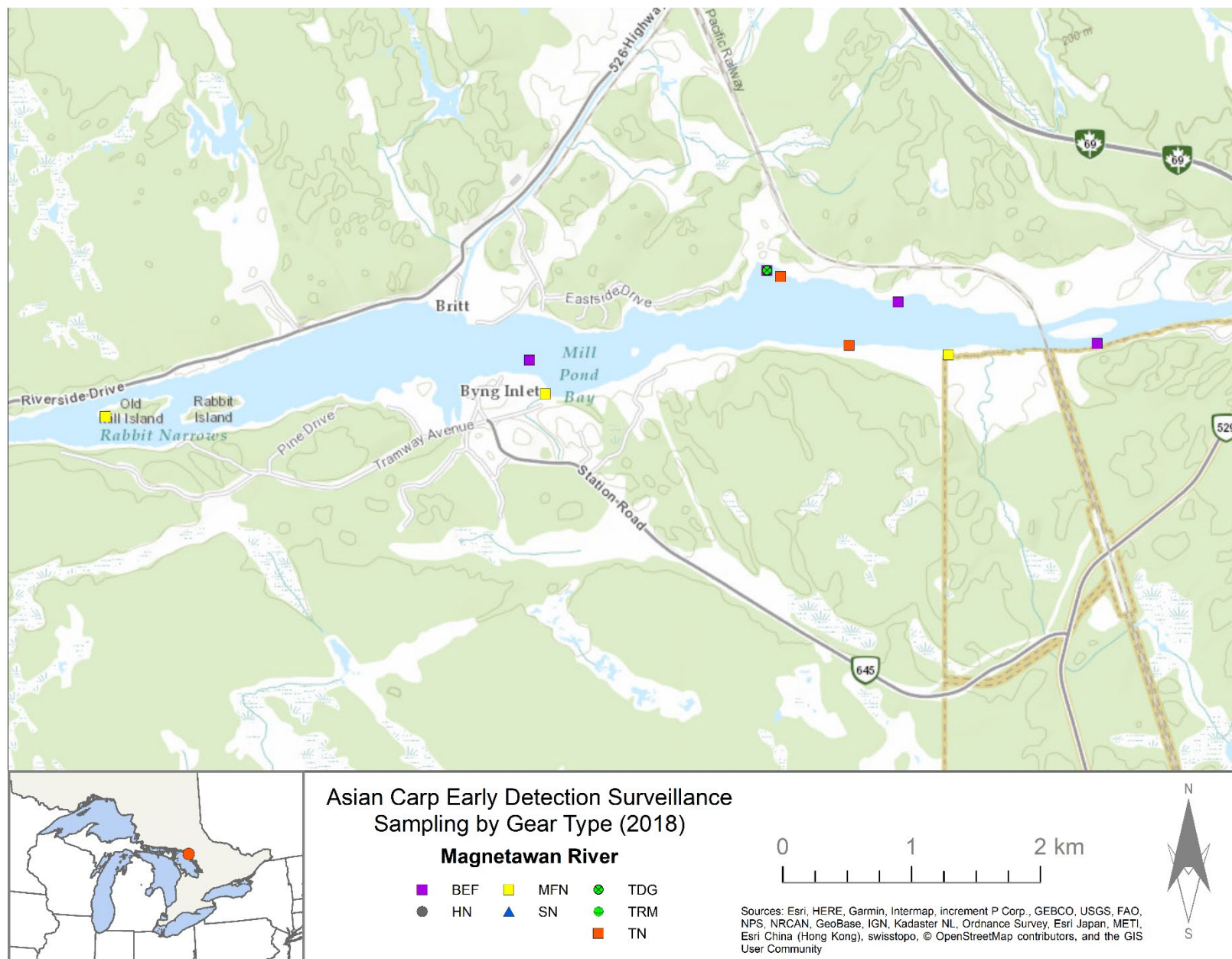# APPENDIX 2: FIELD SAMPLING SITE MAPS

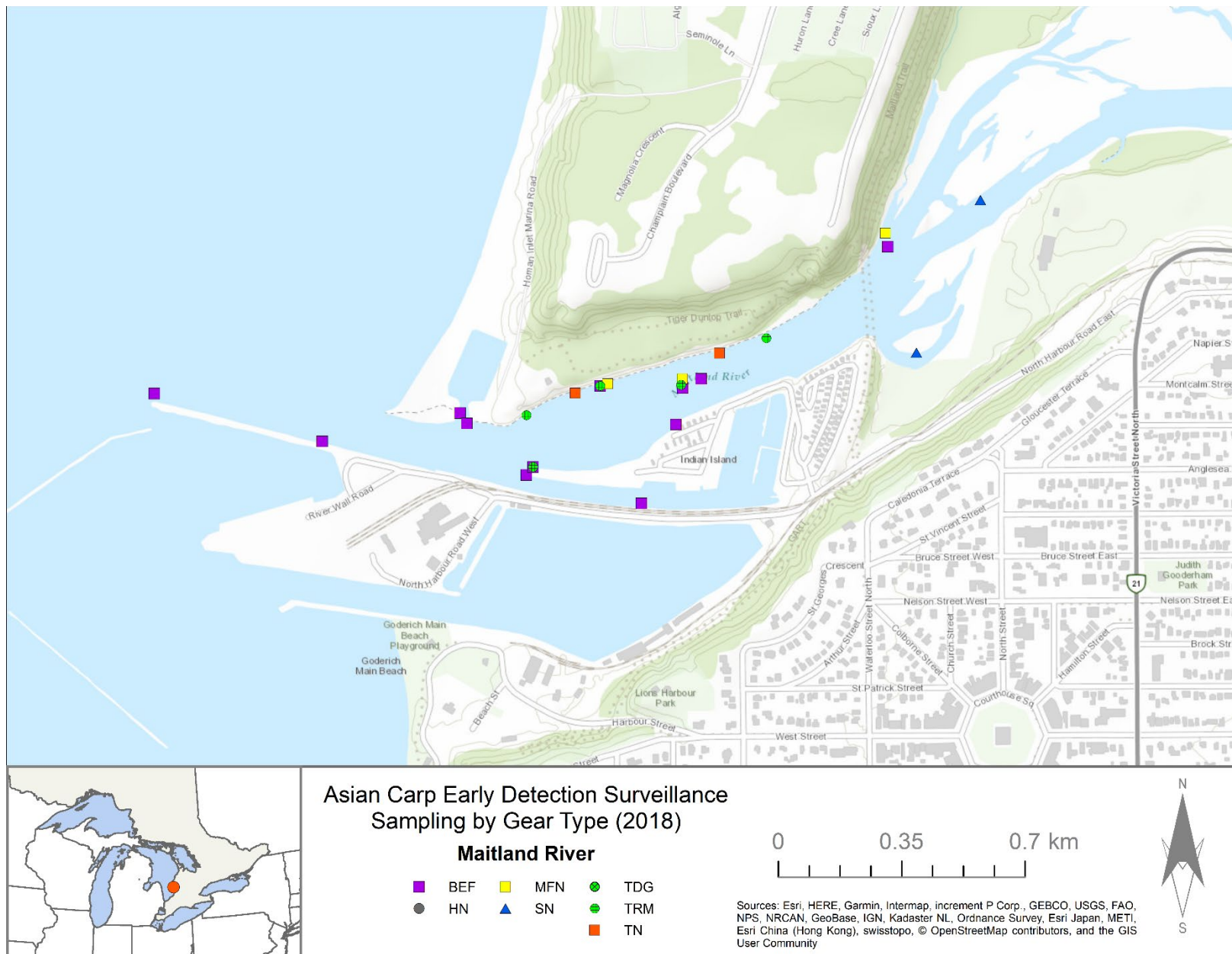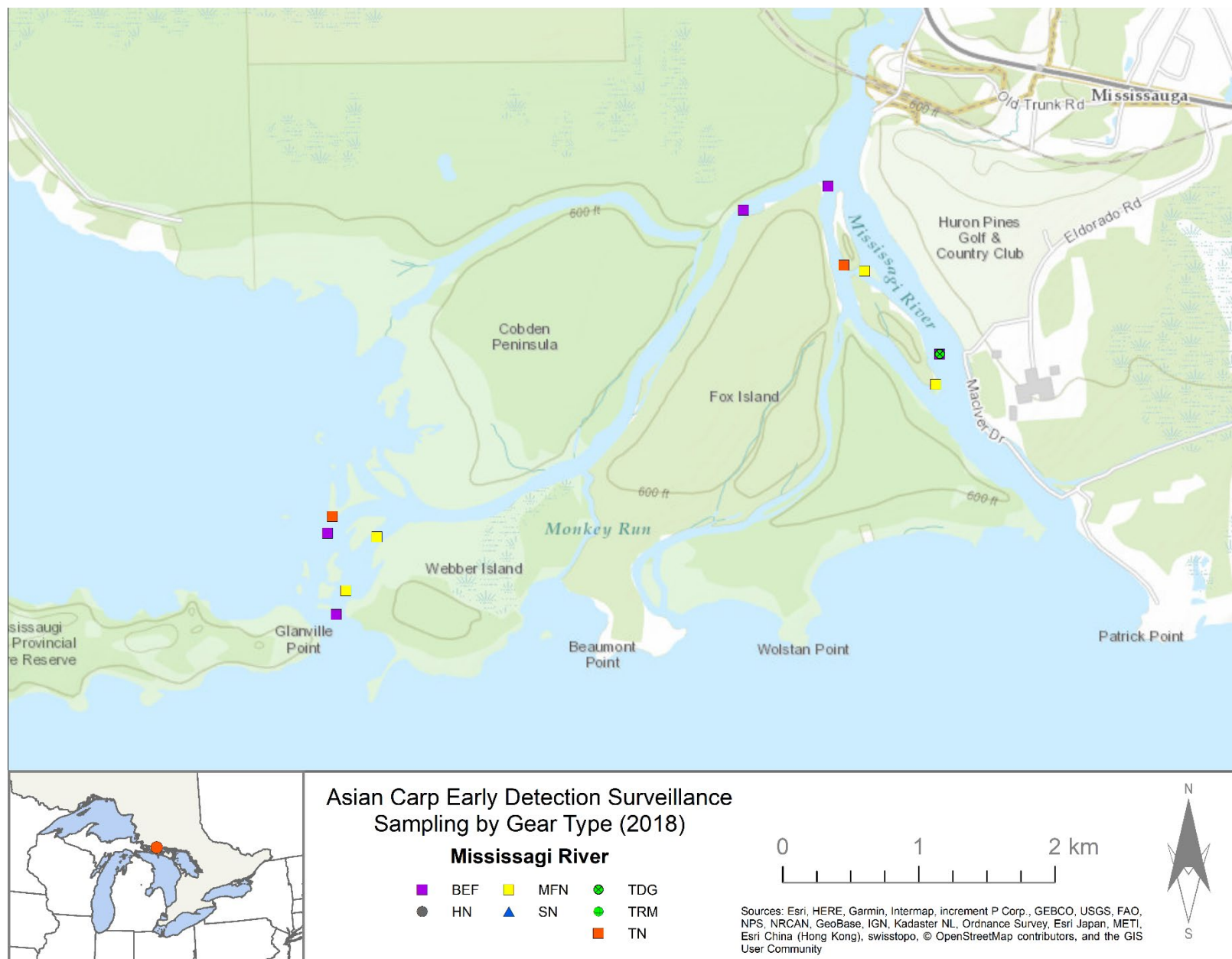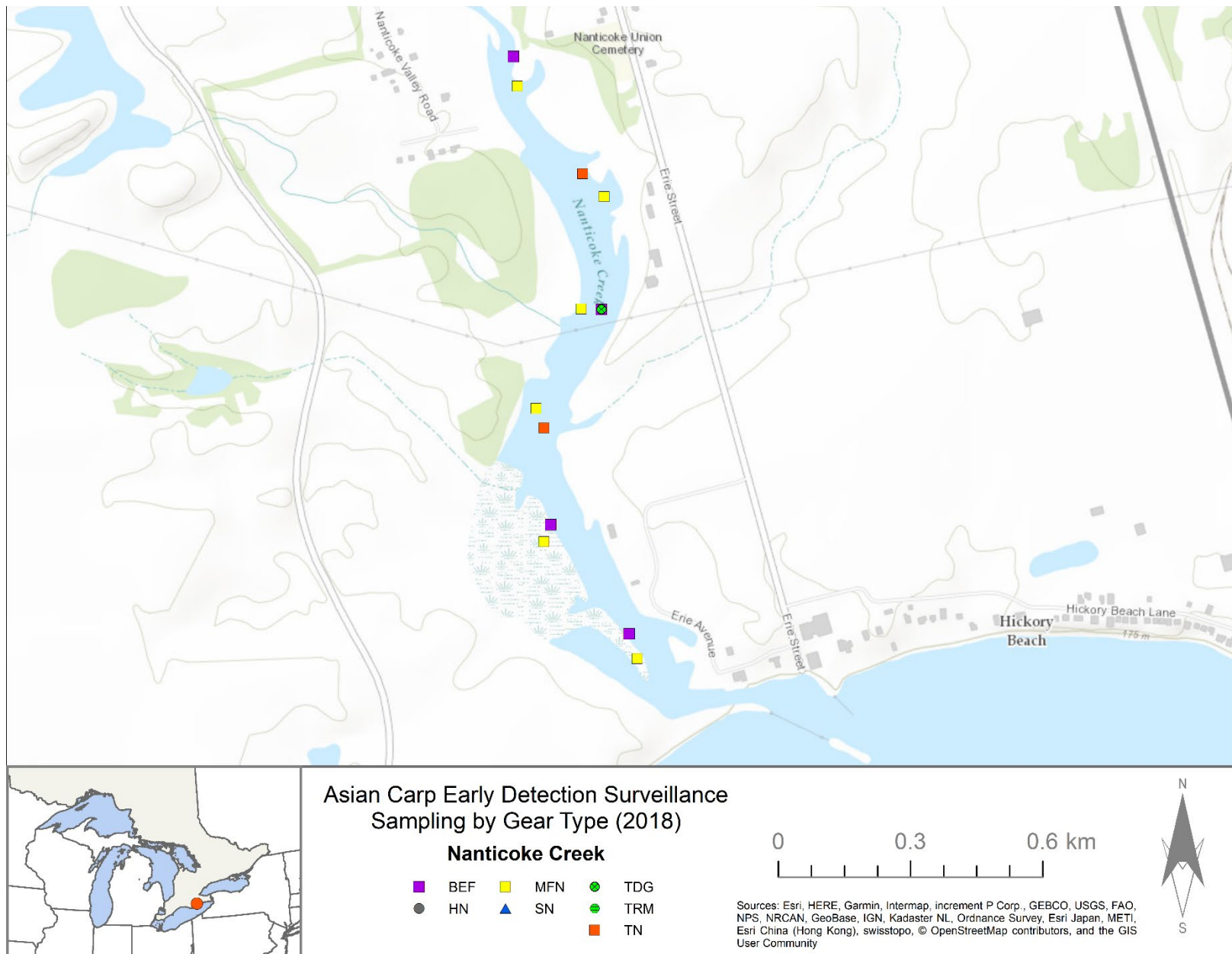**Figure A2.1 2018 Asian Carp Program early detection surveillance field sampling sites in Ausable River.**

Figure A2.2 2018 Asian Carp Program early detection surveillance field sampling sites in Bayfield River.
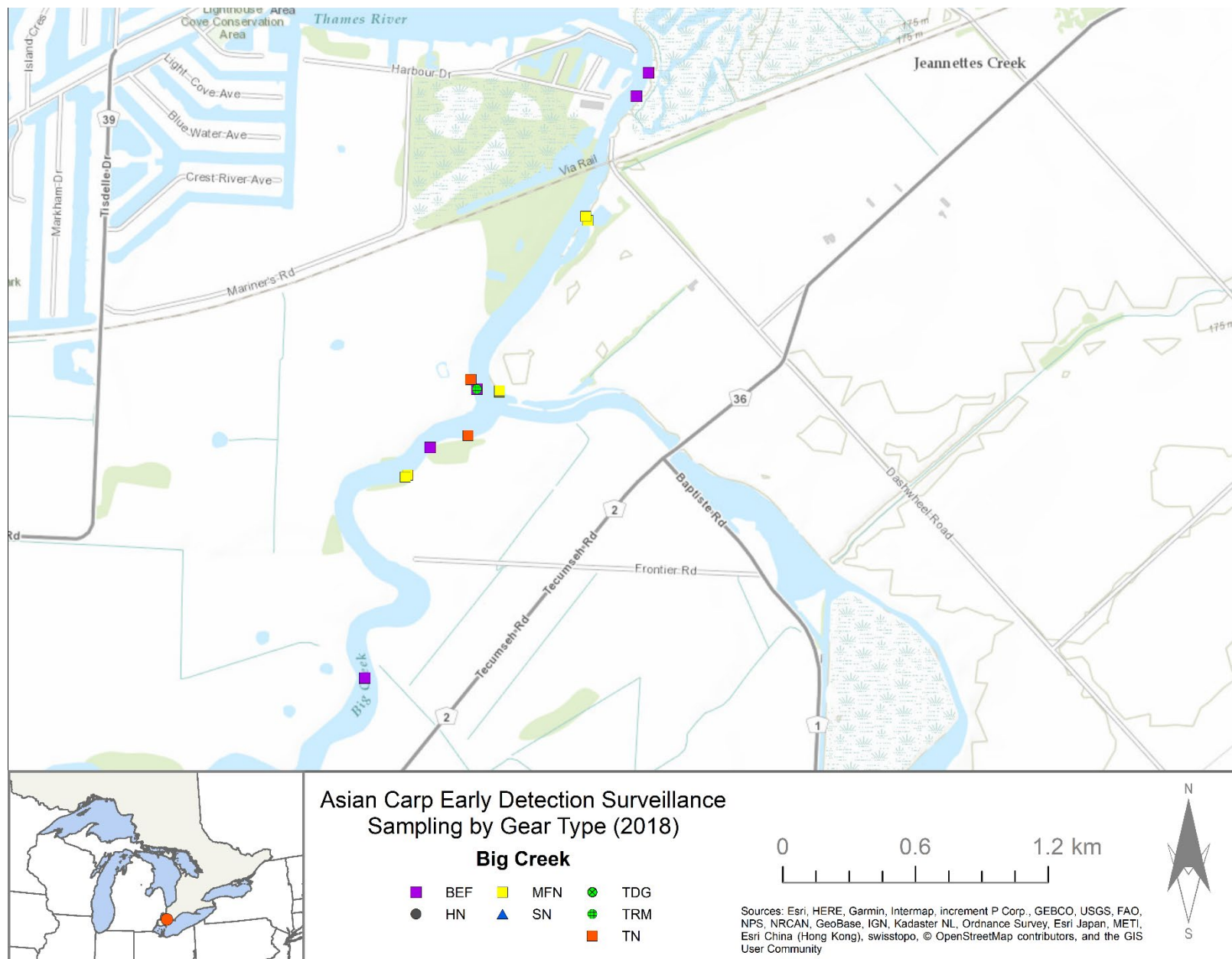
Figure A2.3 2018 Asian Carp Program early detection surveillance field sampling sites in Big Creek.
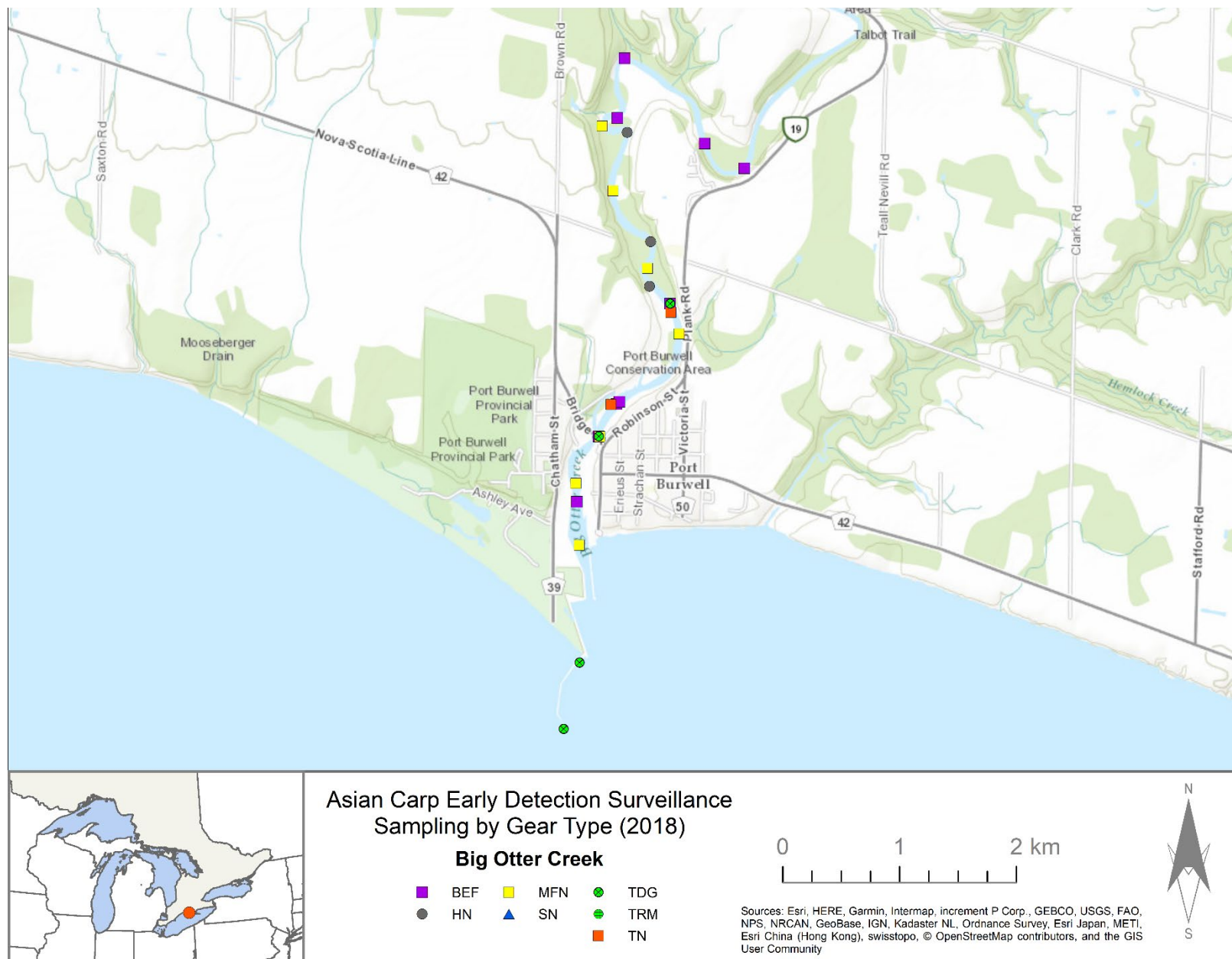
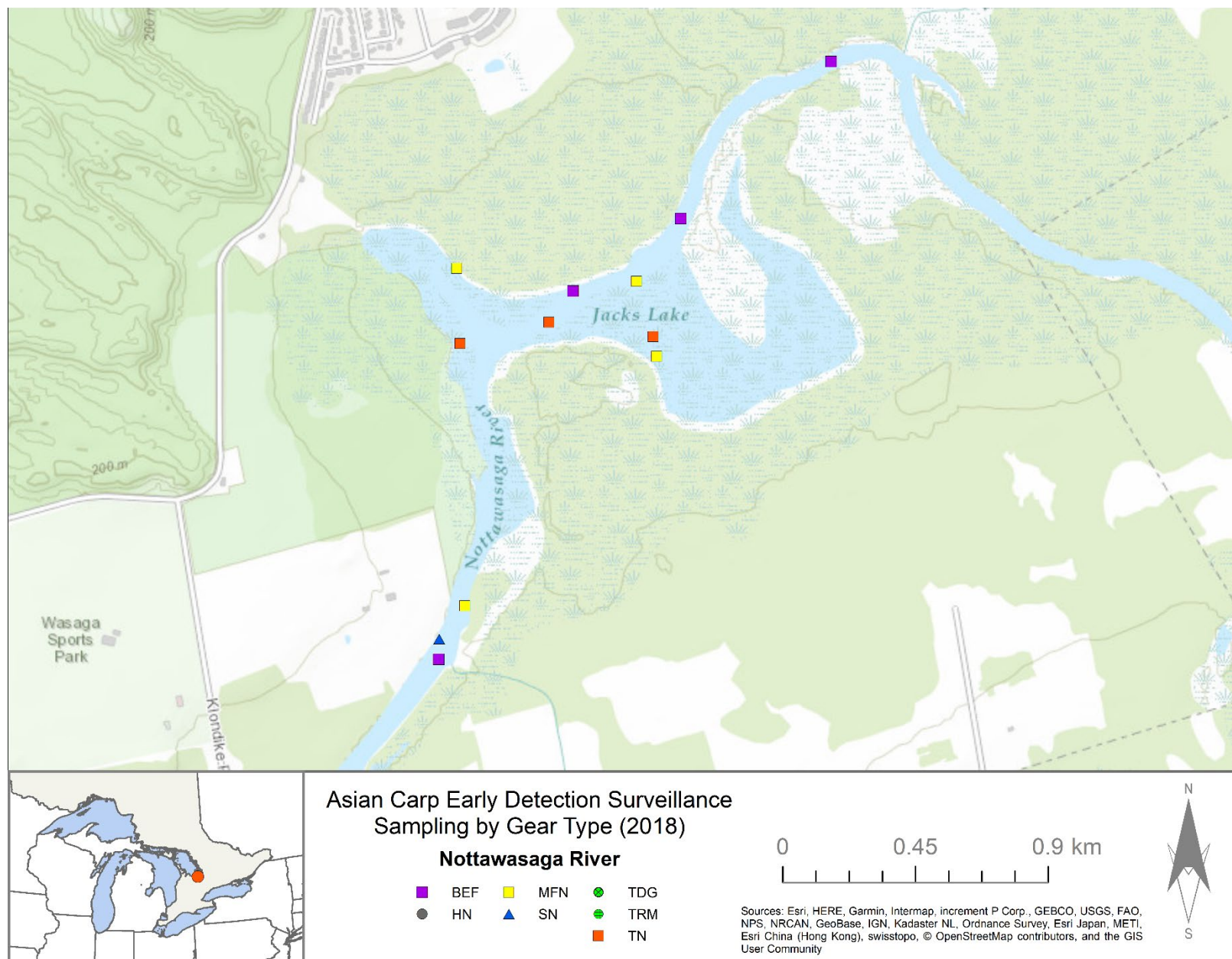**Figure A2.4 2018 Asian Carp Program early detection surveillance field sampling sites in Big Otter Creek.**
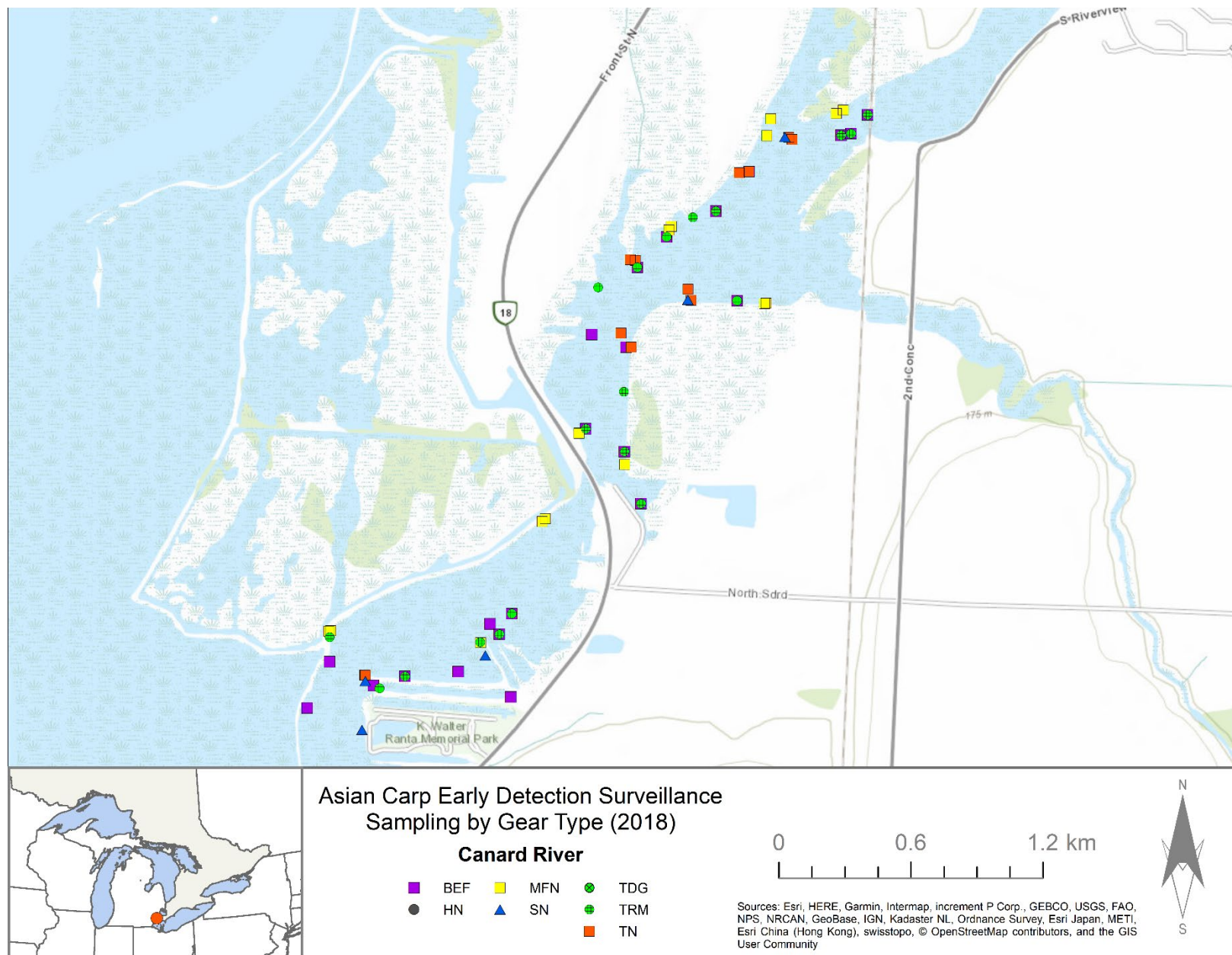
Figure A2.5 2018 Asian Carp Program early detection surveillance field sampling sites in Canard River.
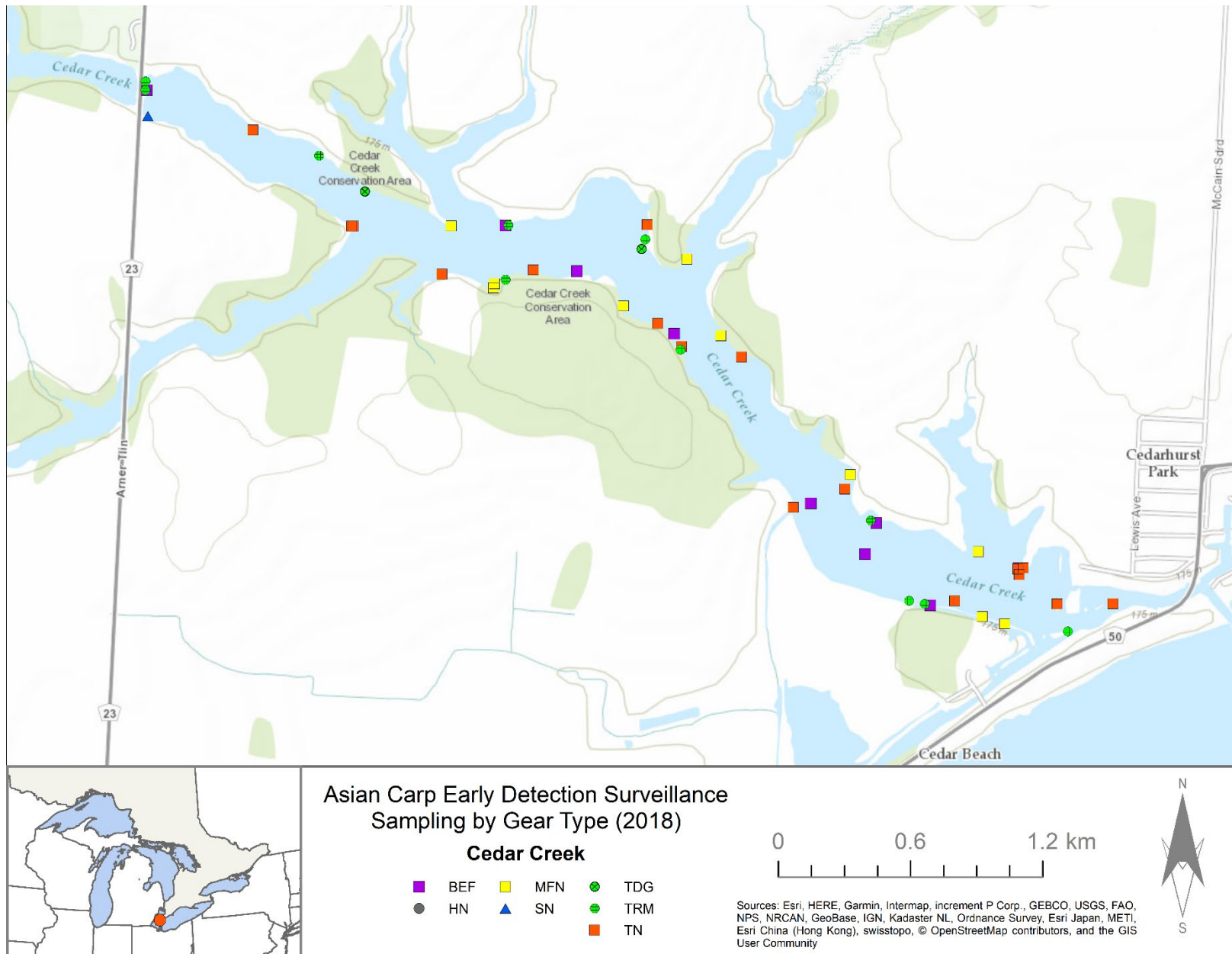
Figure A2.6 2018 Asian Carp Program early detection surveillance field sampling sites in Cedar Creek.
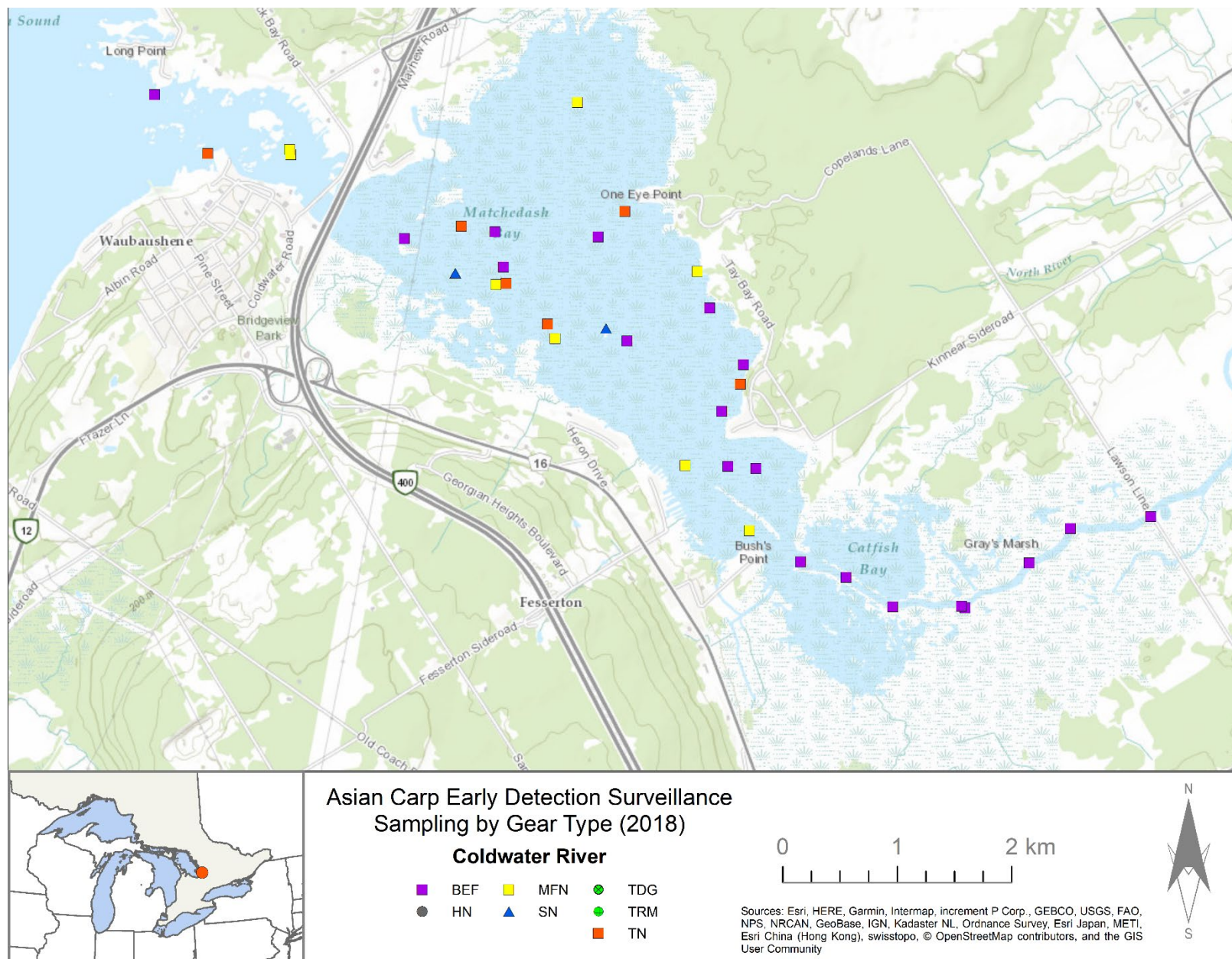
Figure A2.7 2018 Asian Carp Program early detection surveillance field sampling sites in Coldwater River.
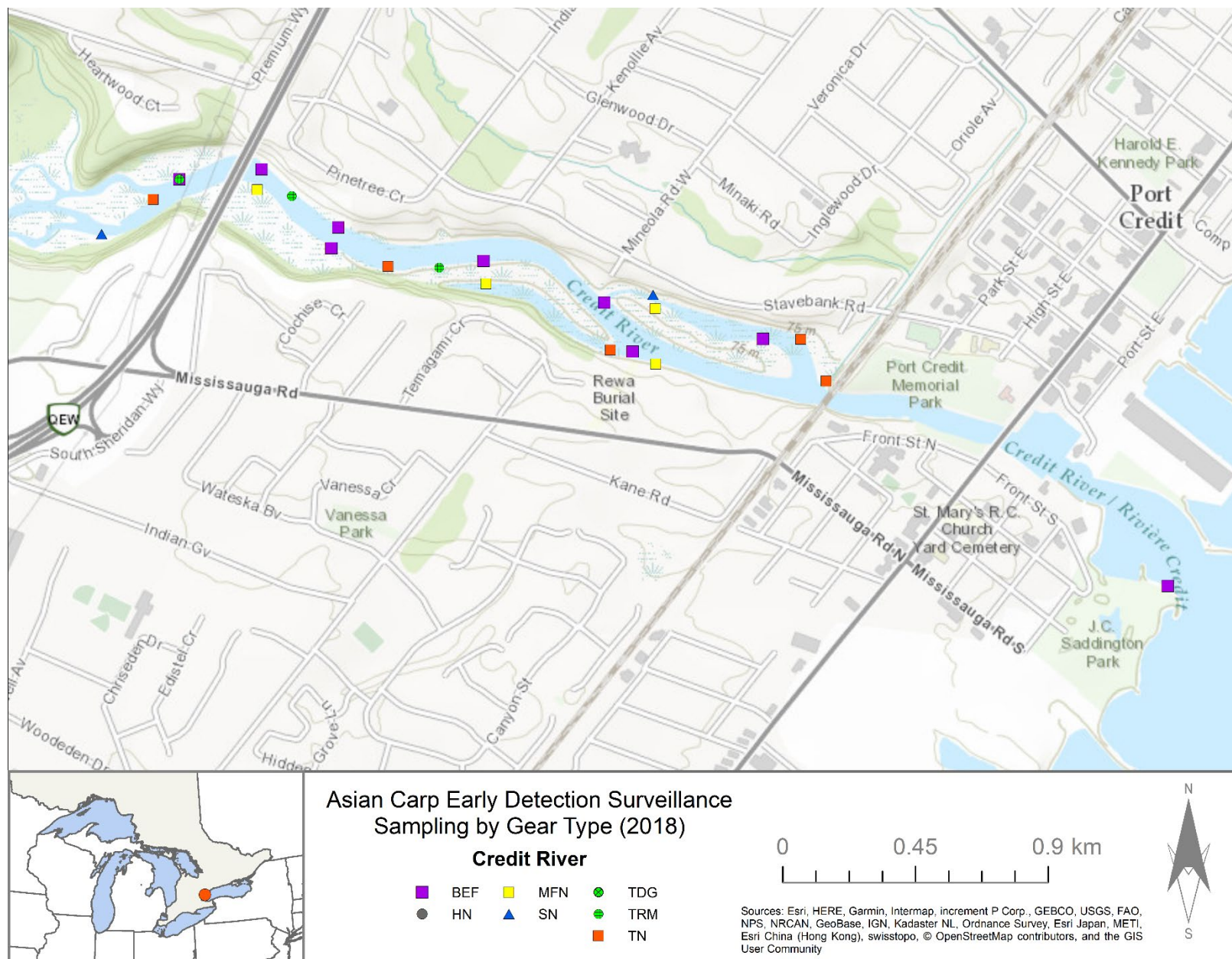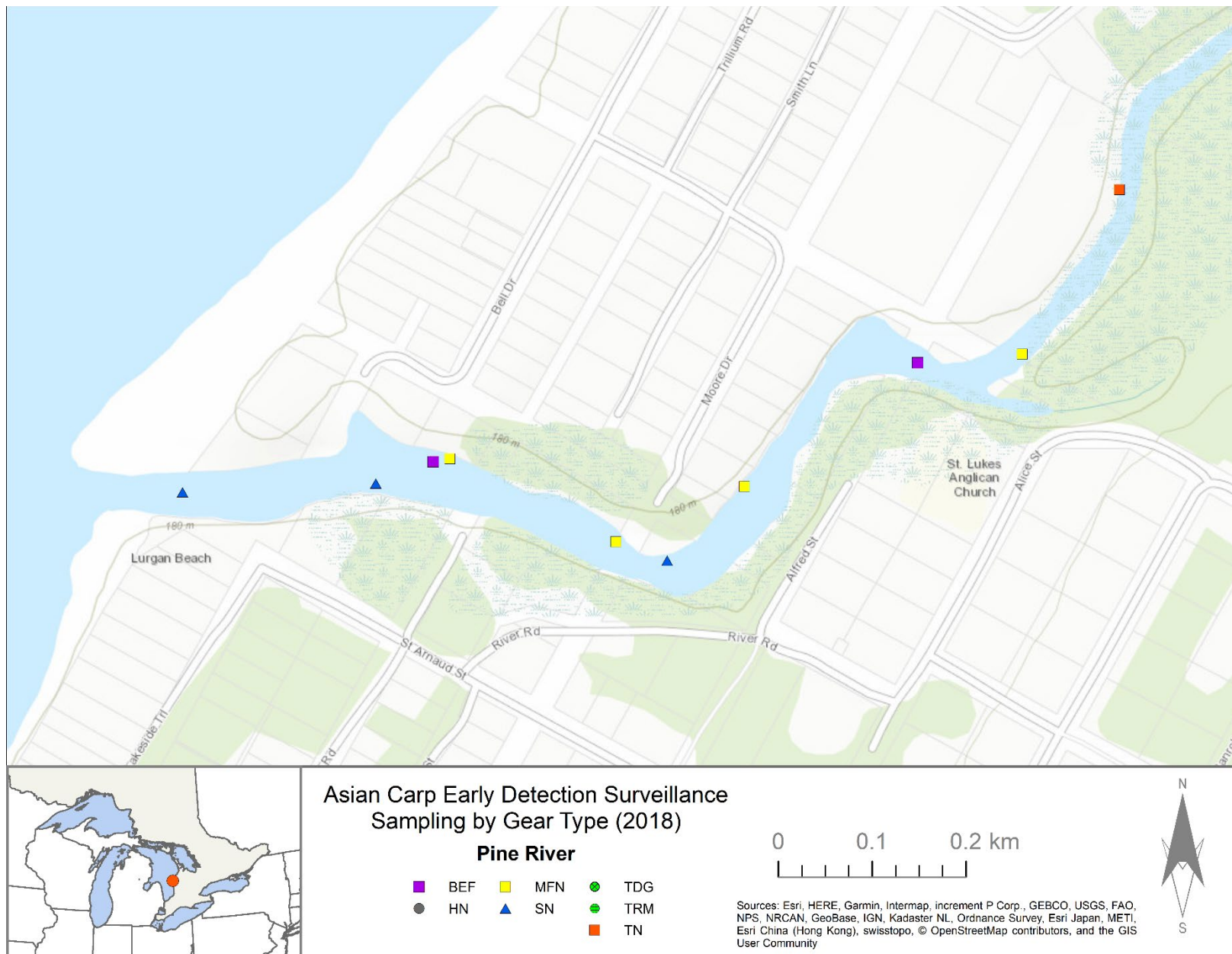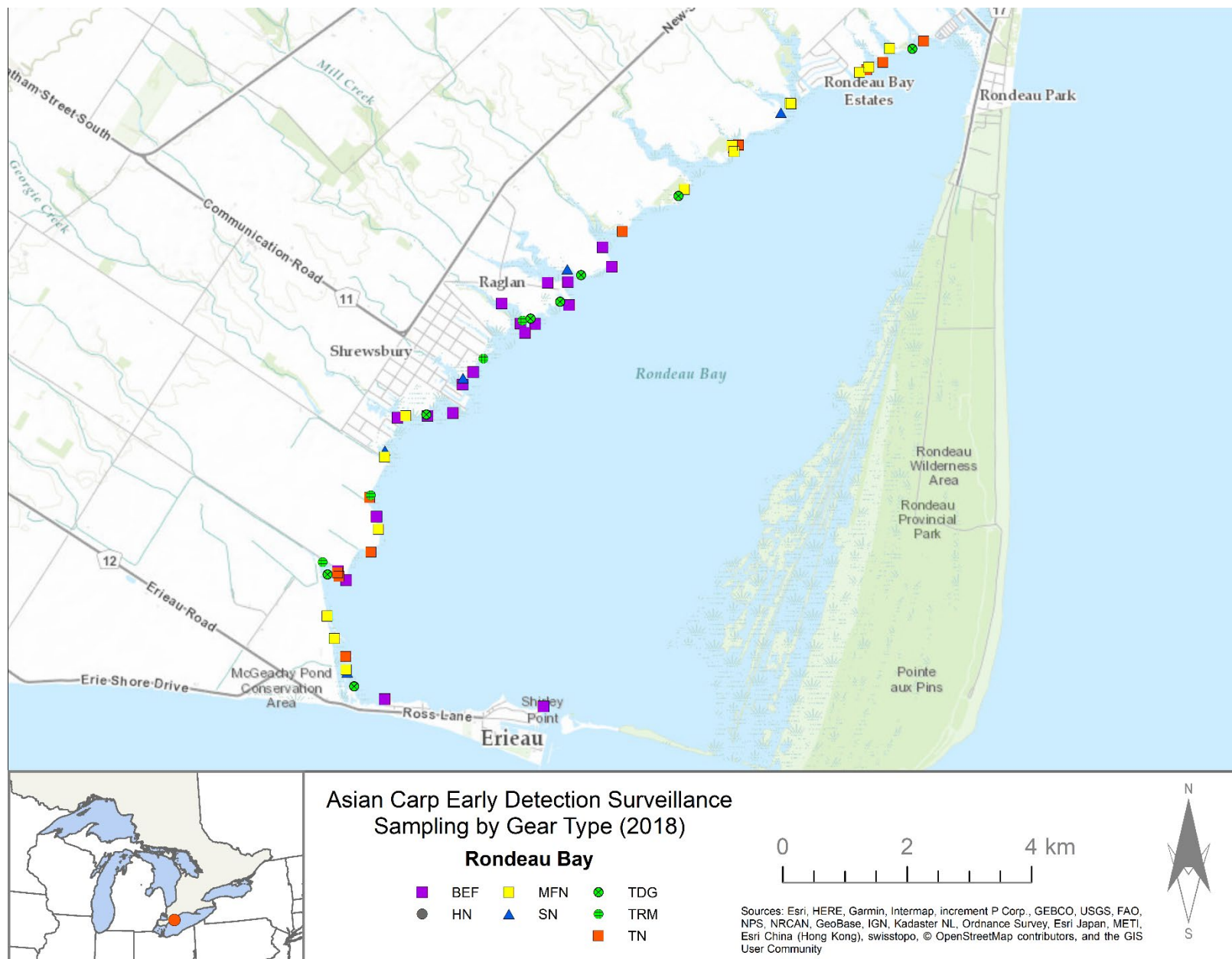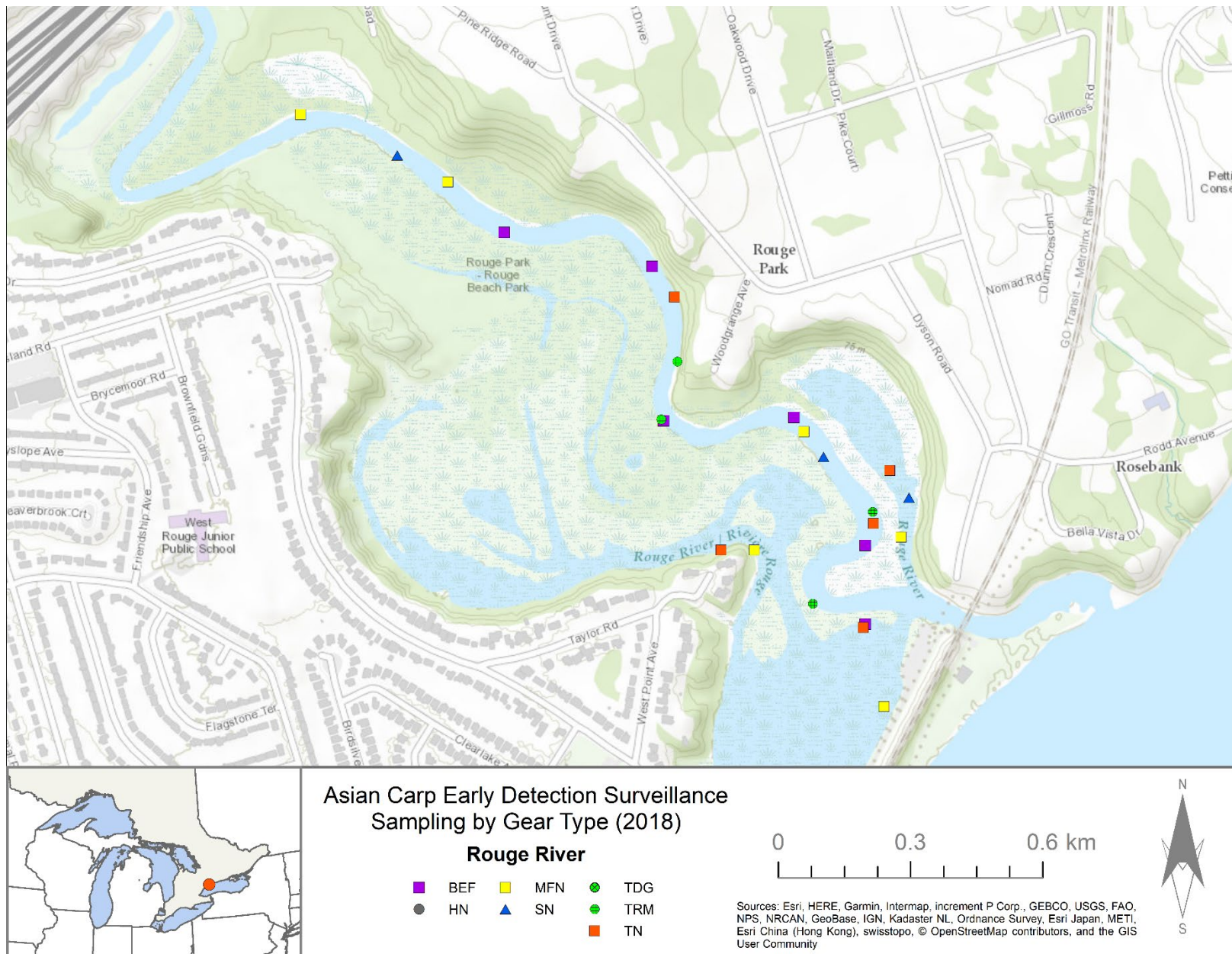
Figure A2.8 2018 Asian Carp Program early detection surveillance field sampling sites in Credit River.
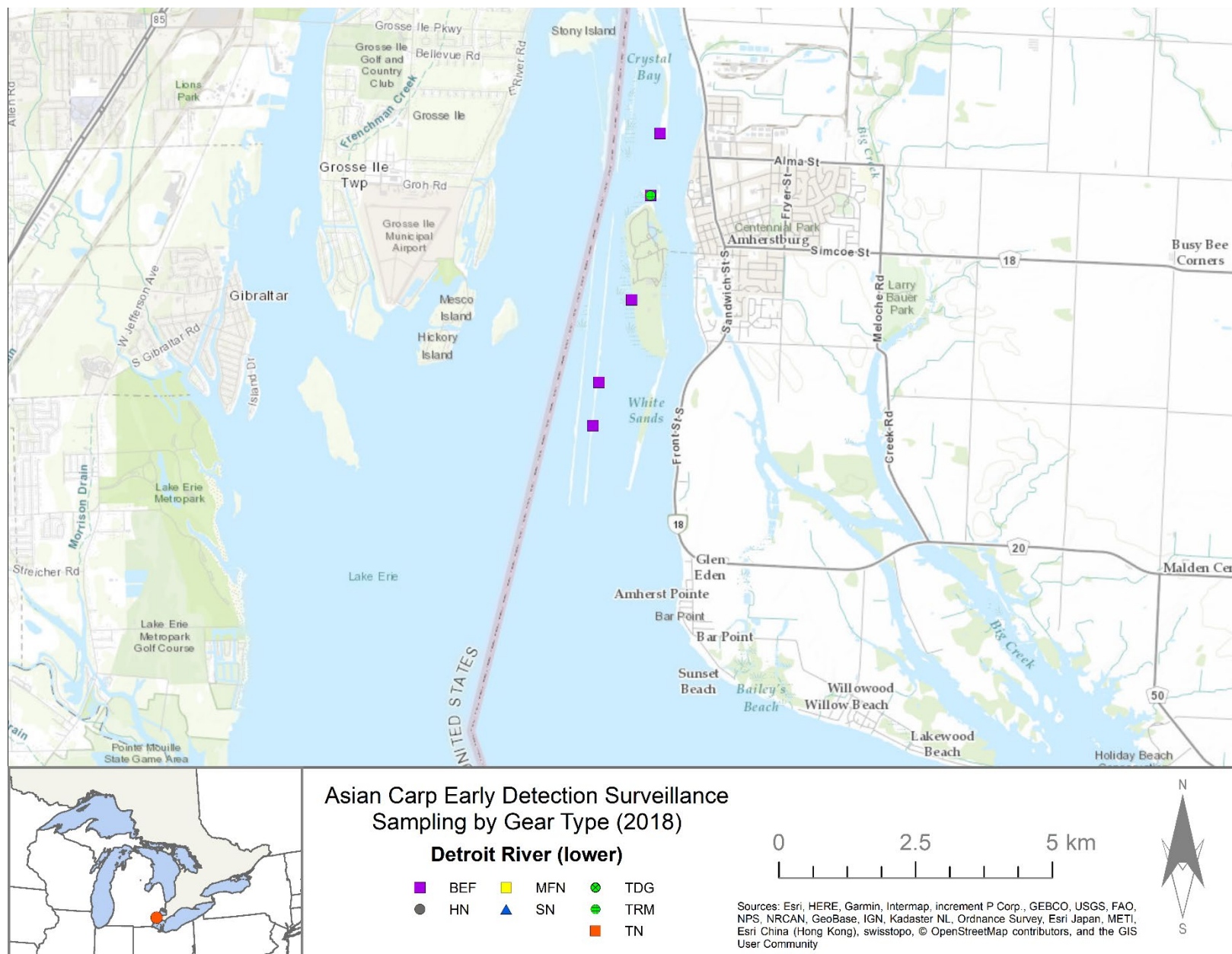
Figure A2.9 2018 Asian Carp Program early detection surveillance field sampling sites in the lower Detroit River.
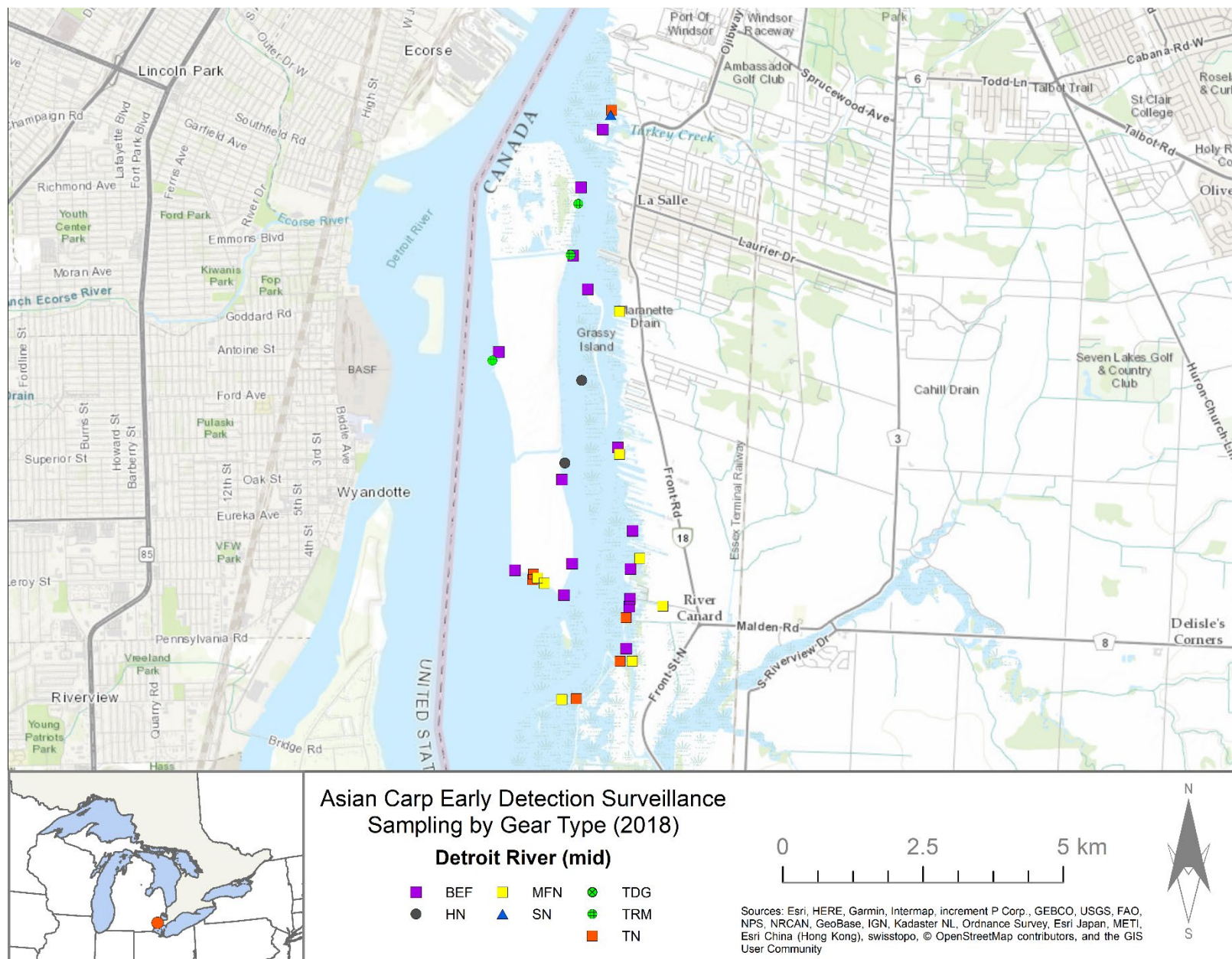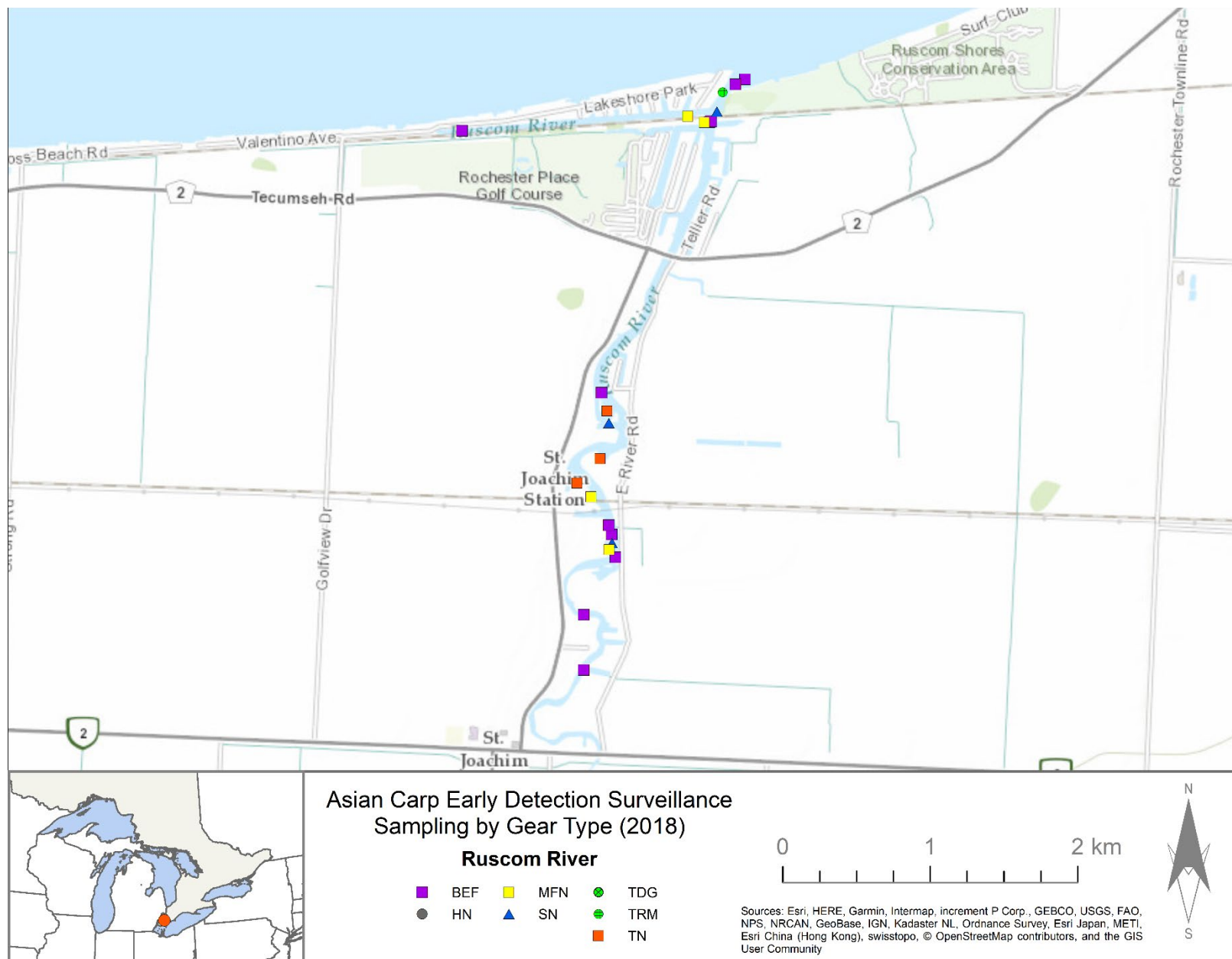
Figure A2.10 2018 Asian Carp Program early detection surveillance field sampling sites in the mid Detroit River.
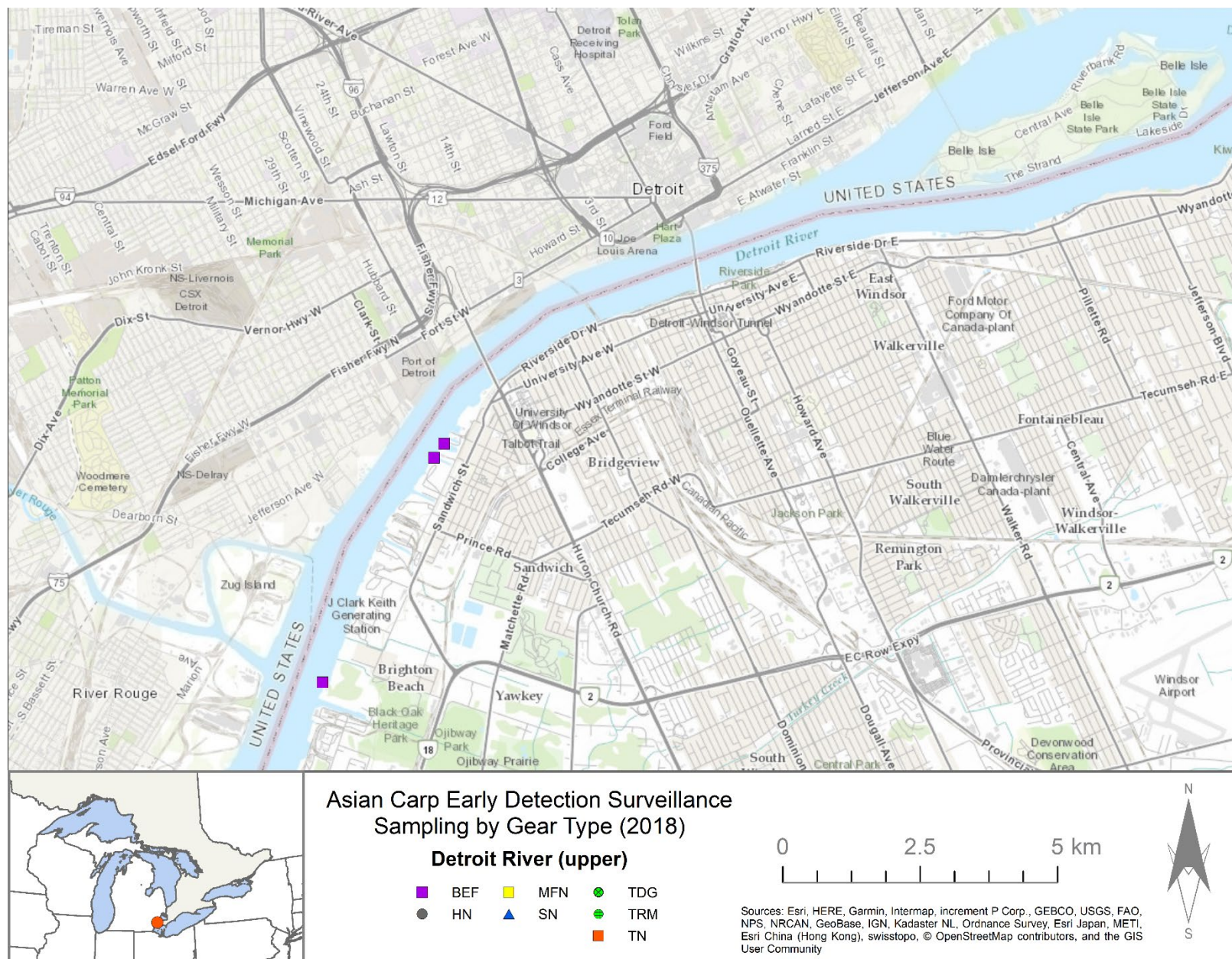
Figure A2.11 2018 Asian Carp Program early detection surveillance field sampling sites in the upper Detroit River.
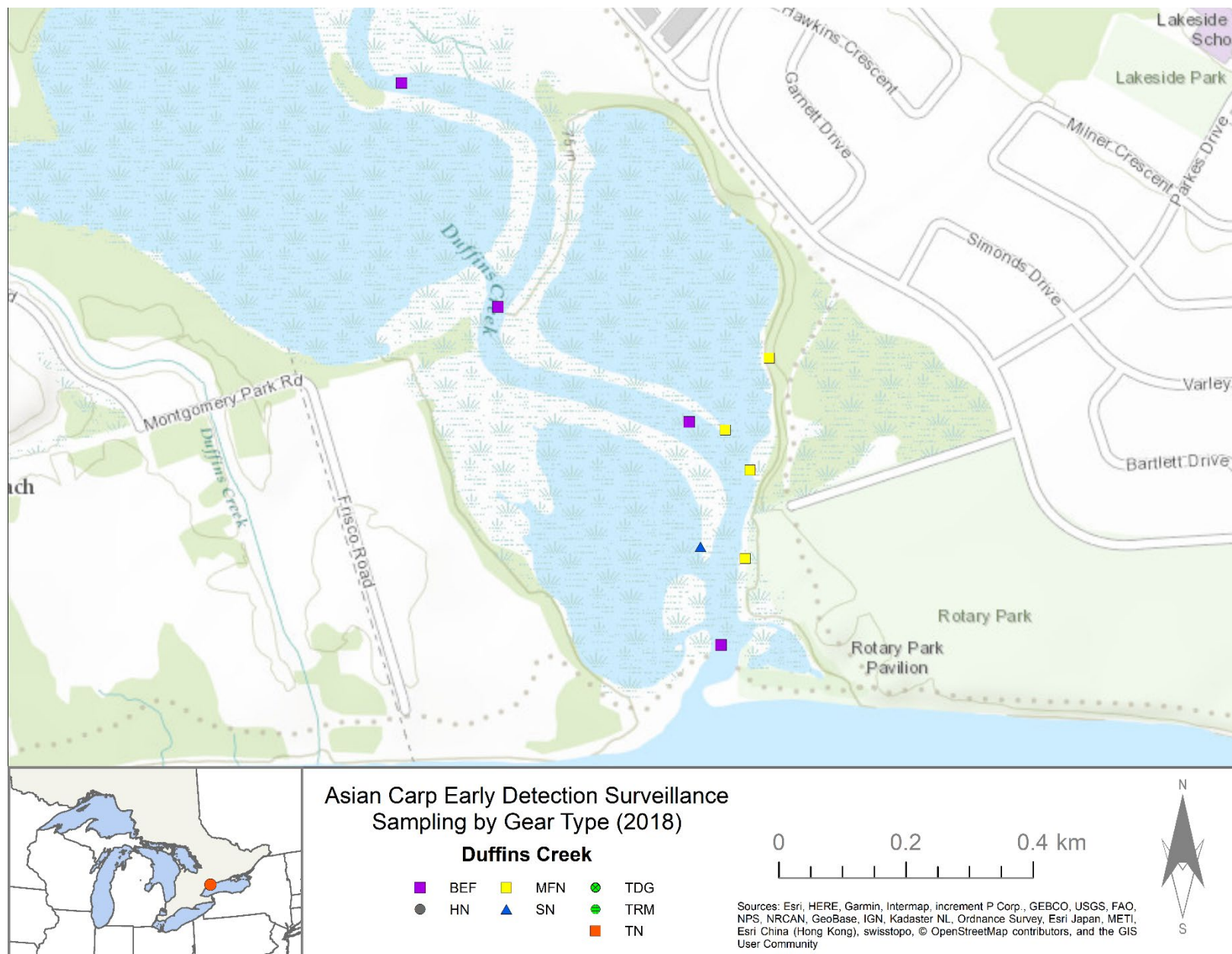
Figure A2.12 2018 Asian Carp Program early detection surveillance field sampling sites in Duffins Creek.

Asian Carp Early Detection Surveillance Sampling by Gear Type (2018)

Frenchman's Bay

■ BEF	■ MFN	● TDG
● HN	▲ SN	● TRM
■ TN		

0   0.35   0.7 km

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community
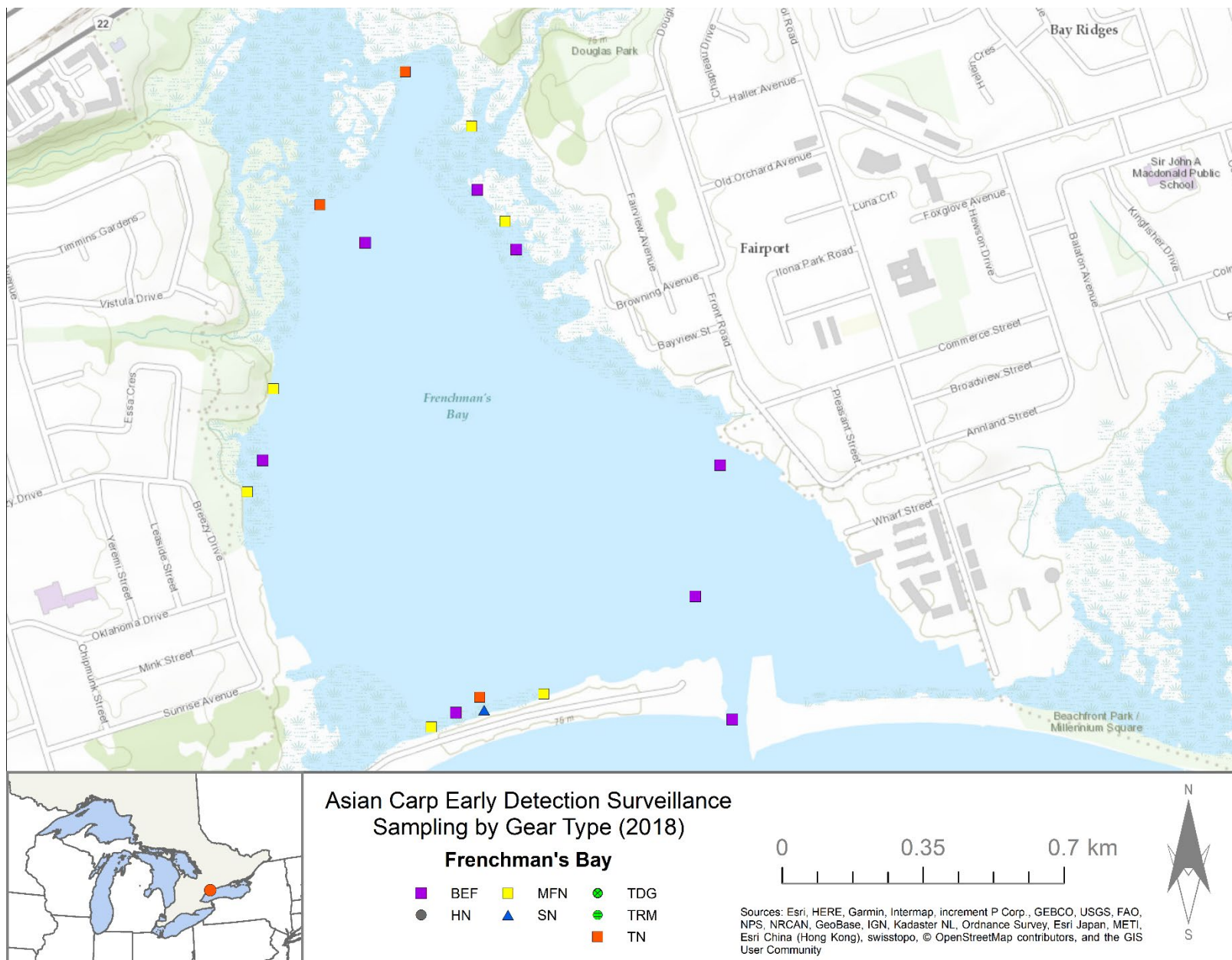
Figure A2.13 2018 Asian Carp Program early detection surveillance field sampling sites in Frenchman's Bay.
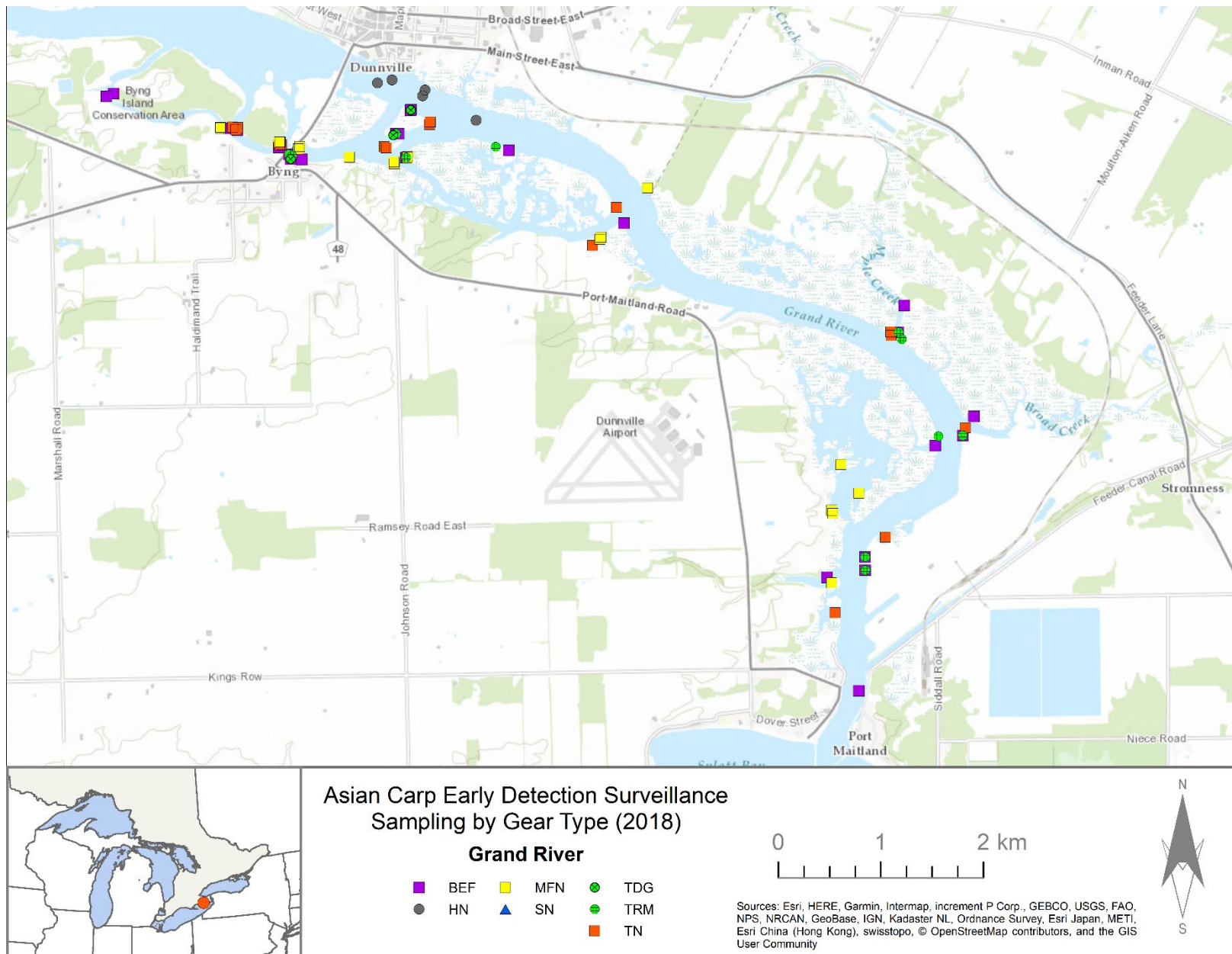
Figure A2.14 2018 Asian Carp Program early detection surveillance field sampling sites in Grand River.
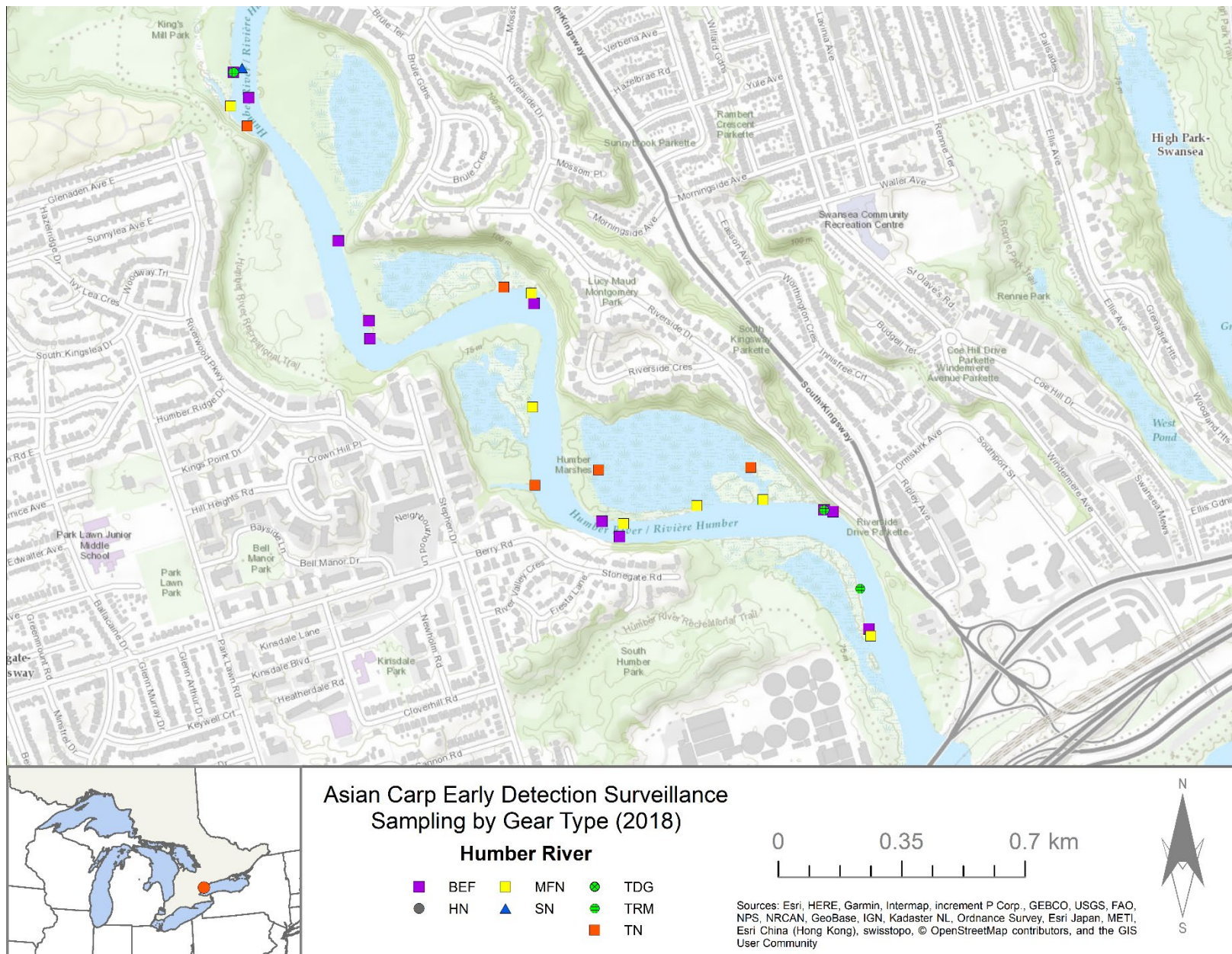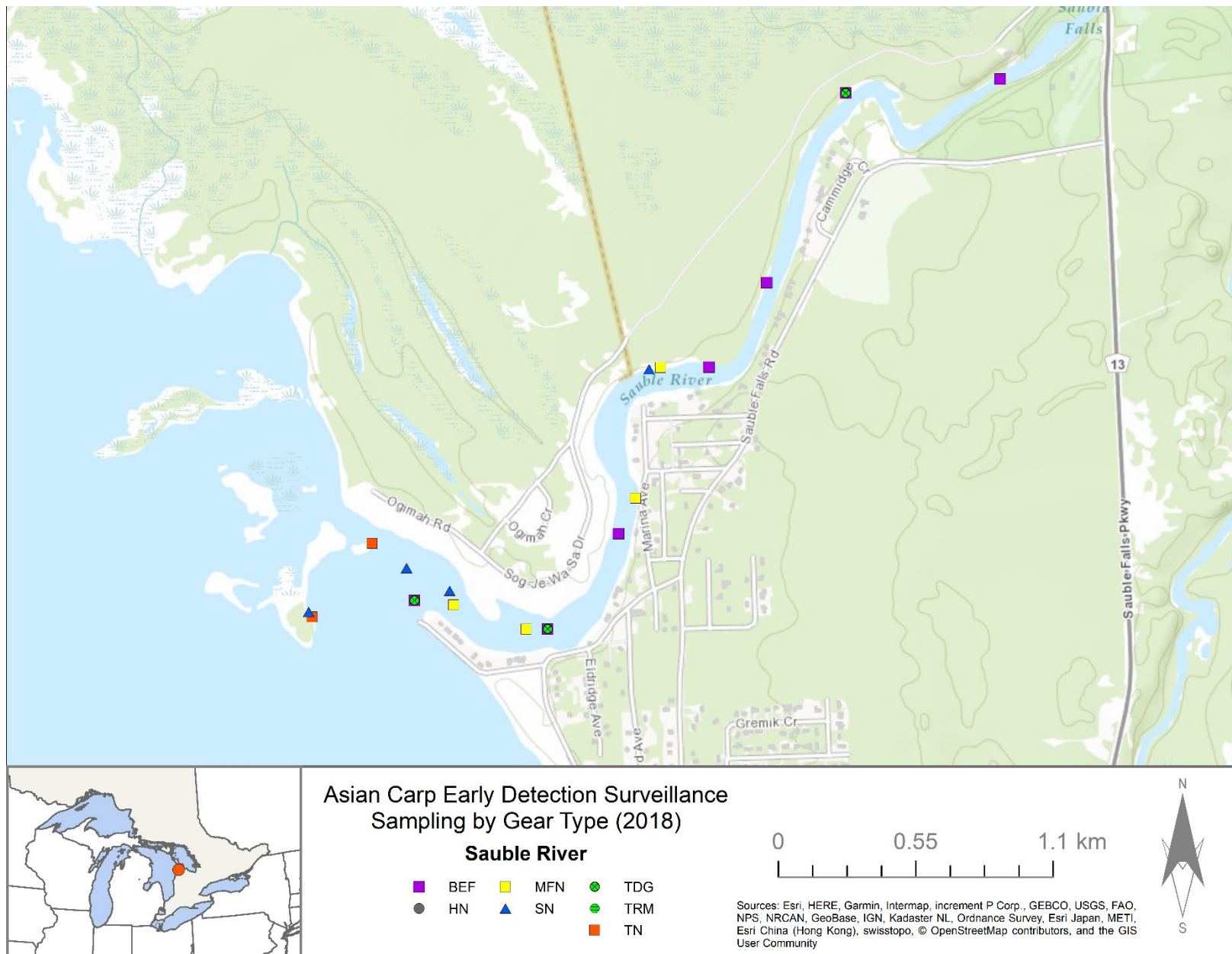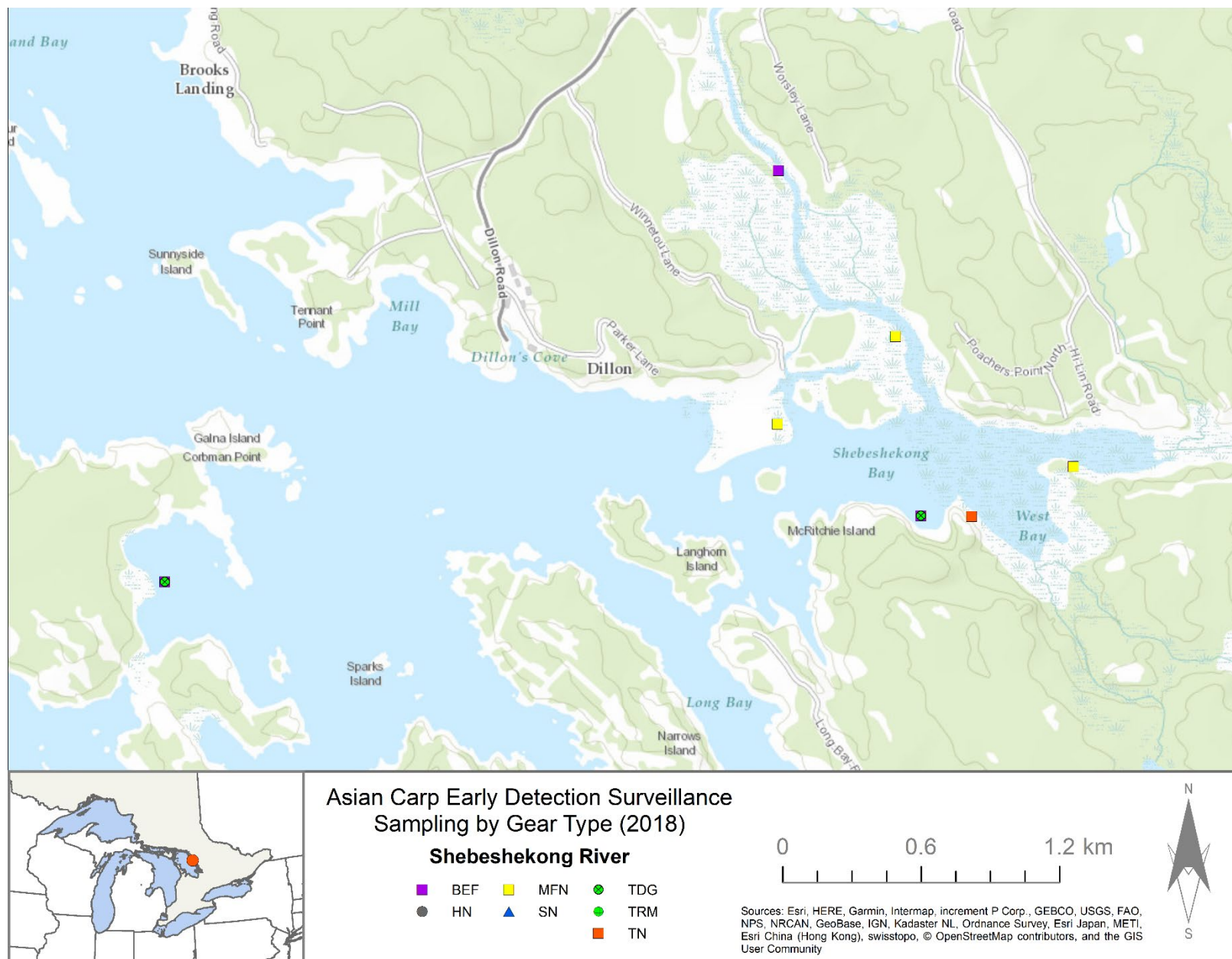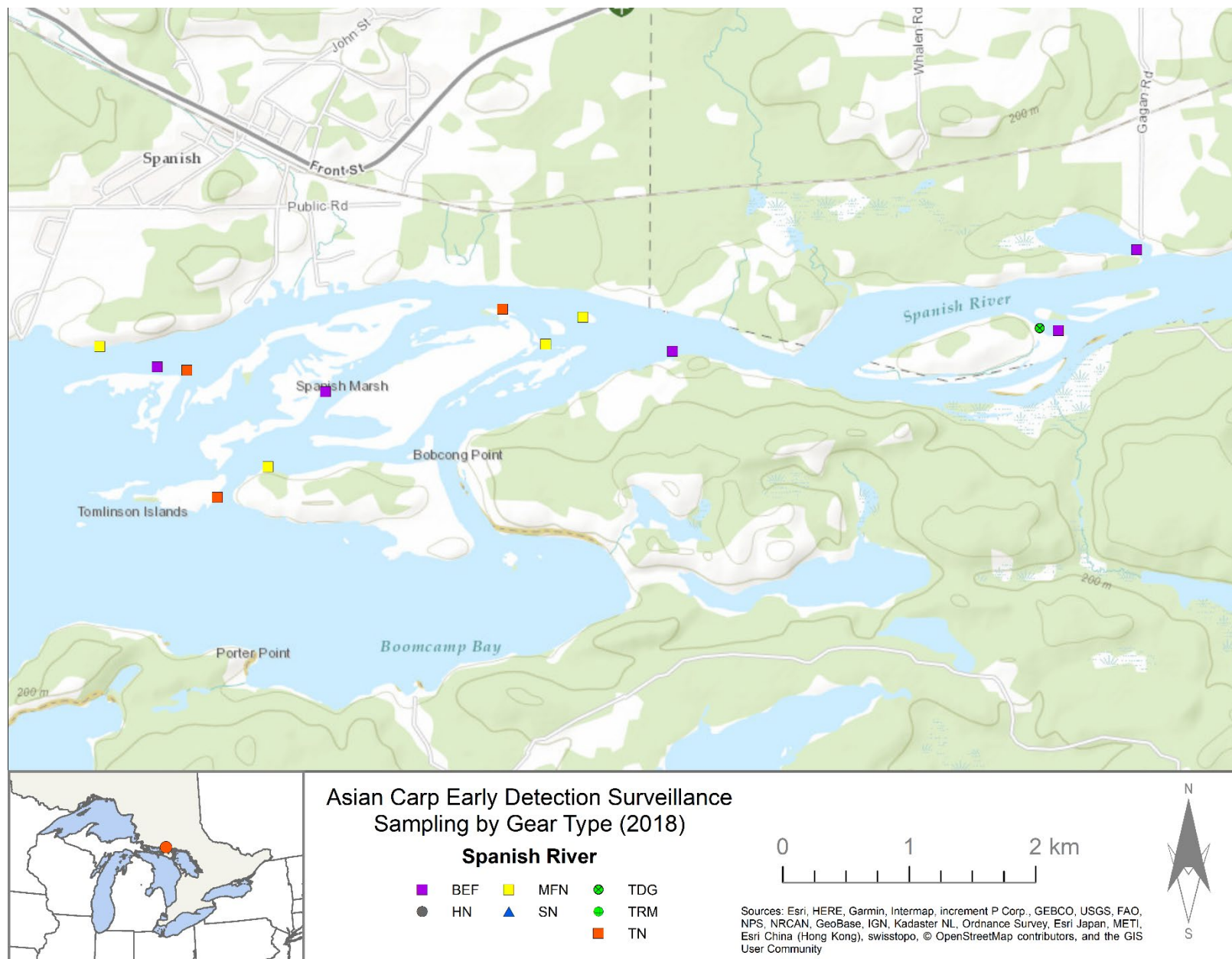
Figure A2.15 2018 Asian Carp Program early detection surveillance field sampling sites in Humber River.
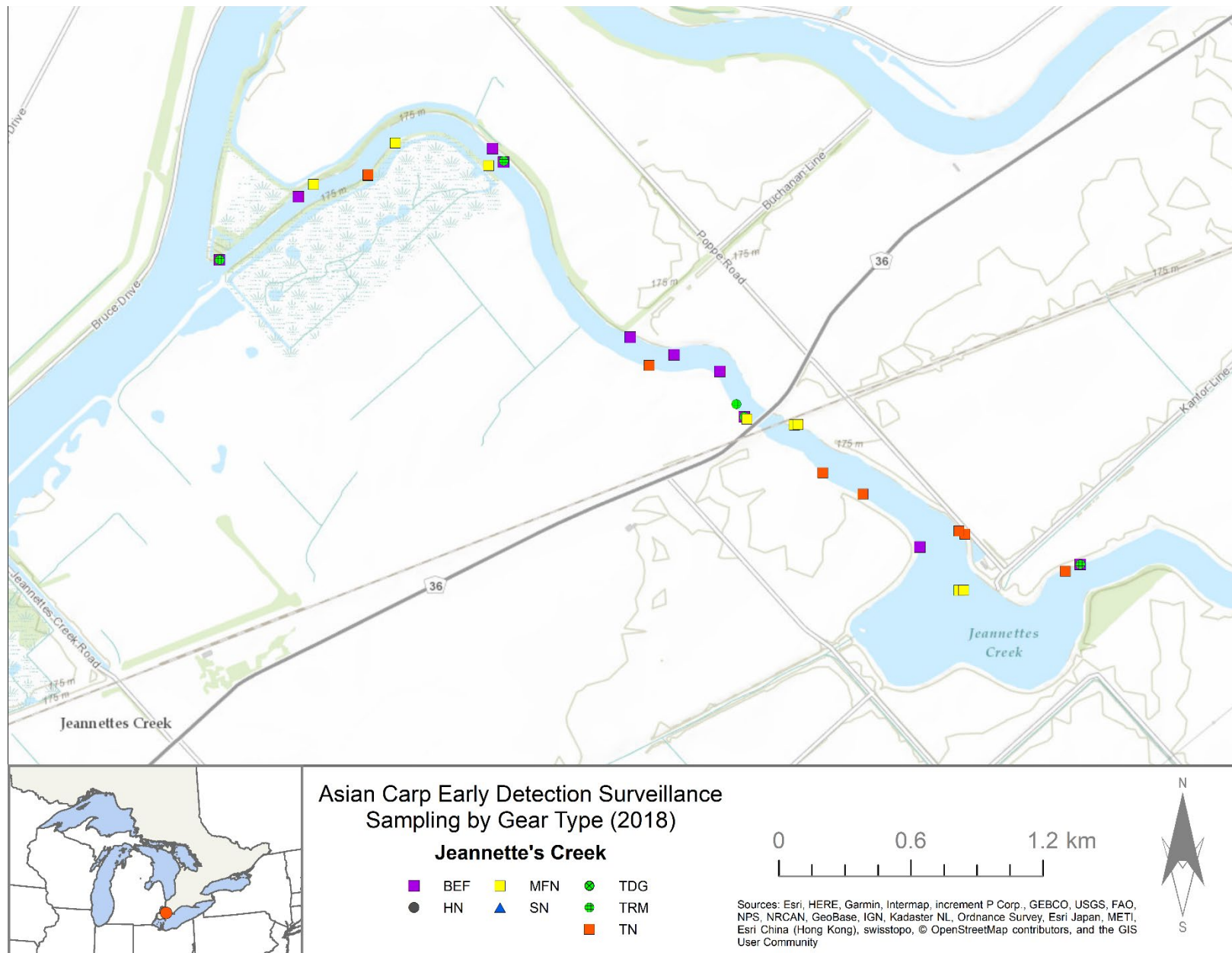
Figure A2.16 2018 Asian Carp Program early detection surveillance field sampling sites in Jeannette's Creek.

Figure A2.17 2018 Asian Carp Program early detection surveillance field sampling sites in Jordan Harbour.
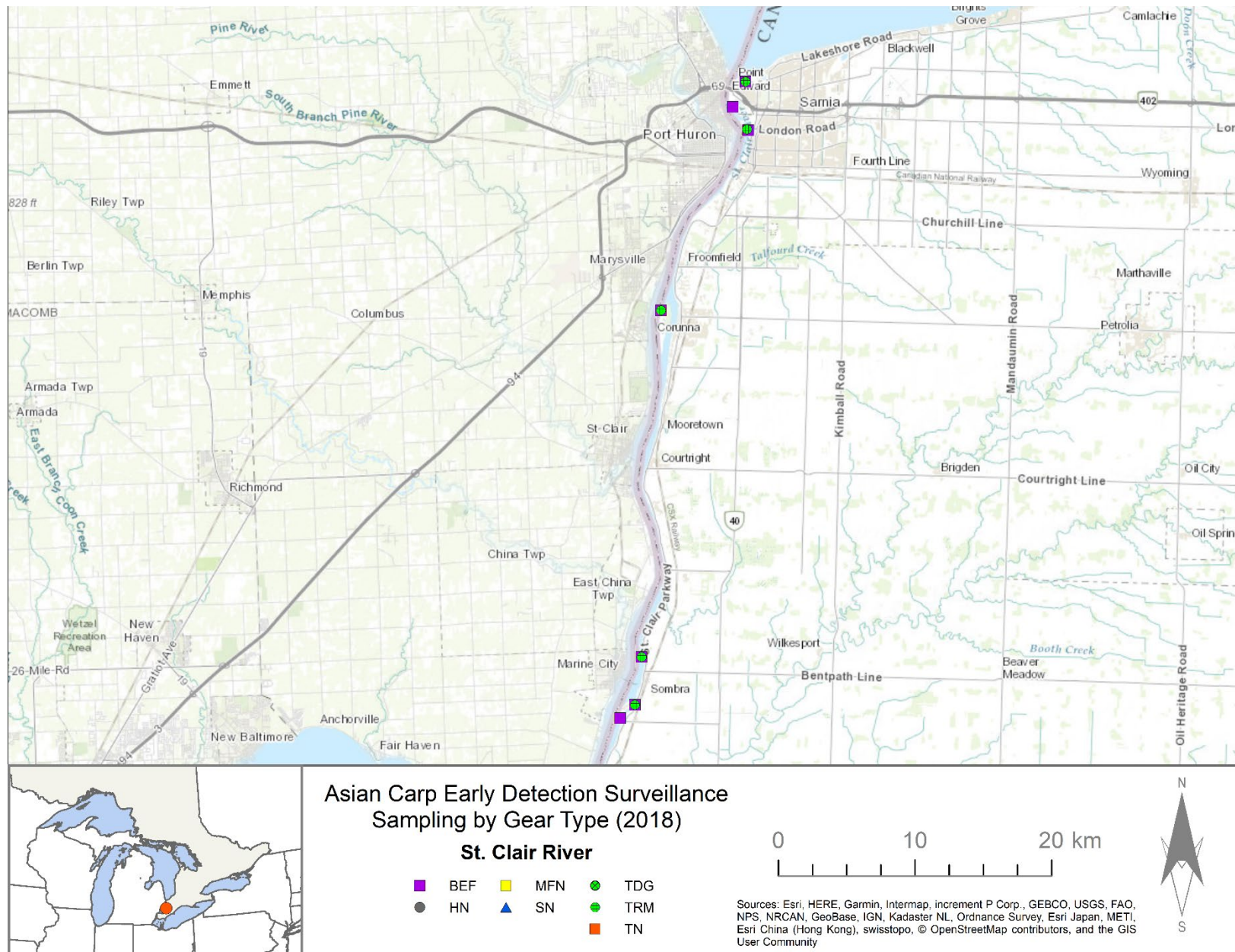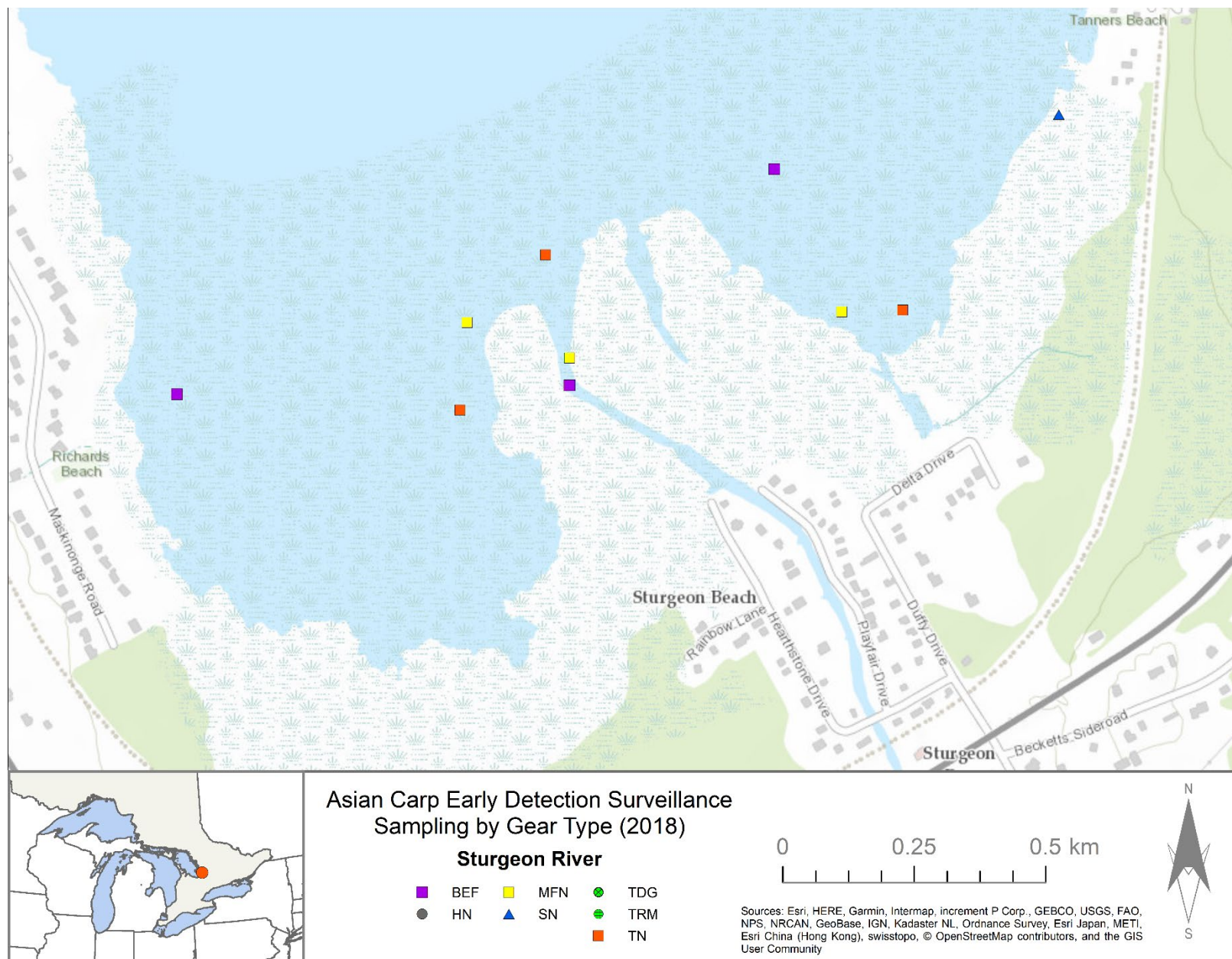
Figure A2.18 2018 Asian Carp Program early detection surveillance field sampling sites in Kettle Creek.

Figure A2.19 2018 Asian Carp Program early detection surveillance field sampling sites in Lake Gibson.

Figure A2.20 2018 Asian Carp Program early detection surveillance field sampling sites in Long Point Bay.

Figure A2.21 2018 Asian Carp Program early detection surveillance field sampling sites in Magnetawan River.

Figure A2.22 2018 Asian Carp Program early detection surveillance field sampling sites in Maitland River.

Figure A2.23 2018 Asian Carp Program early detection surveillance field sampling sites in Mississagi River.
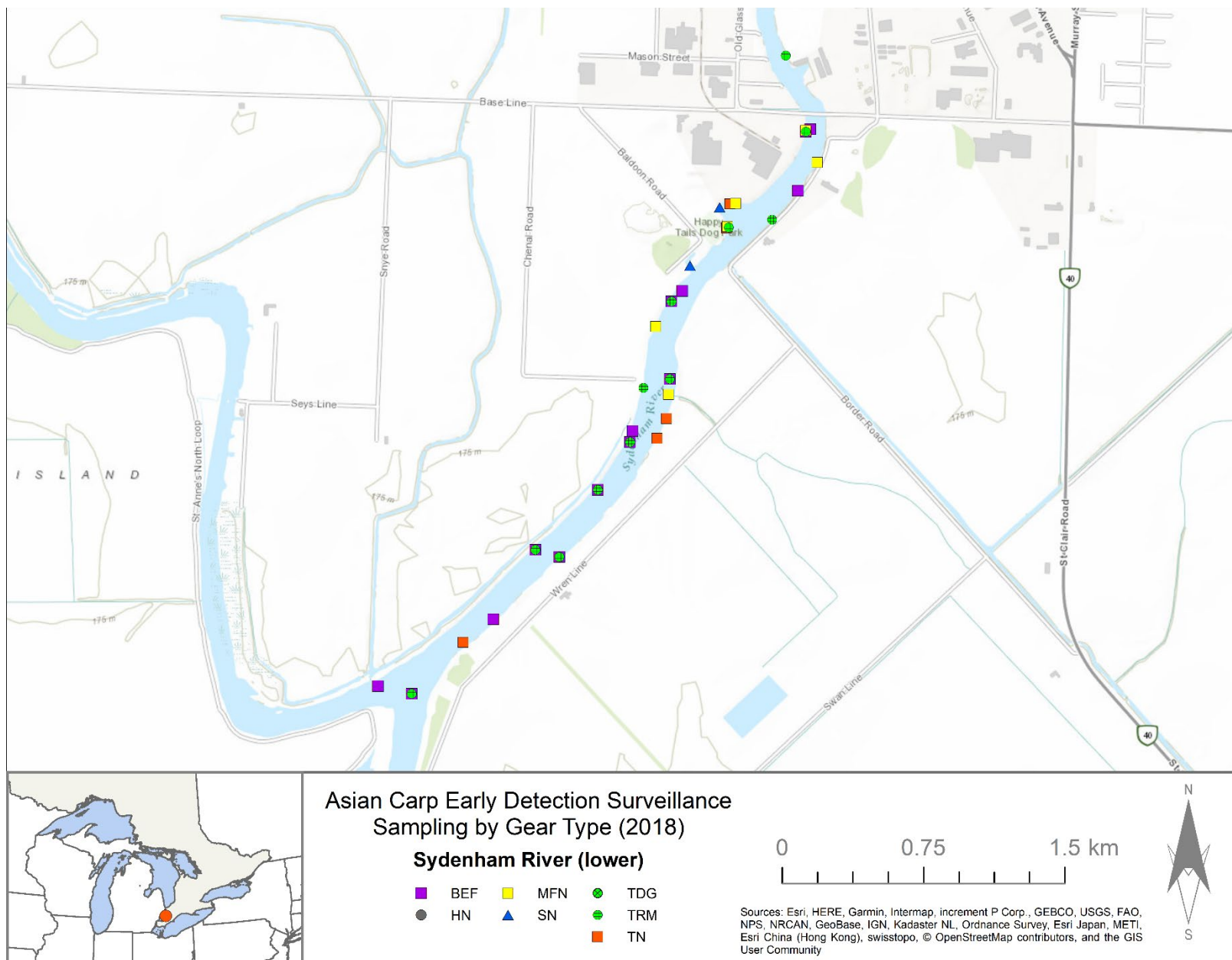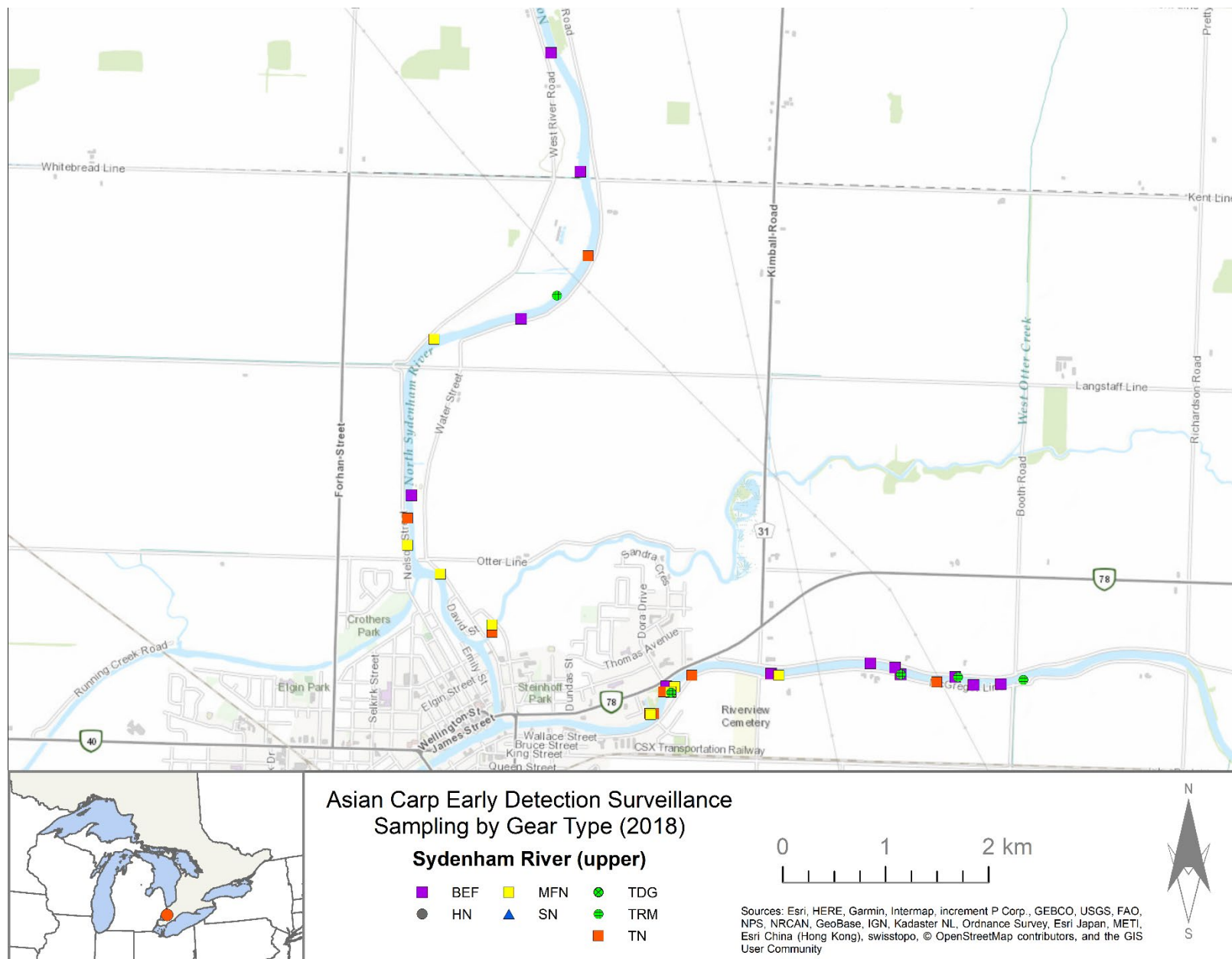
Figure A2.24 2018 Asian Carp Program early detection surveillance field sampling sites in Nanticoke Creek.

Figure A2.25 2018 Asian Carp Program early detection surveillance field sampling sites in Nottawasaga River.
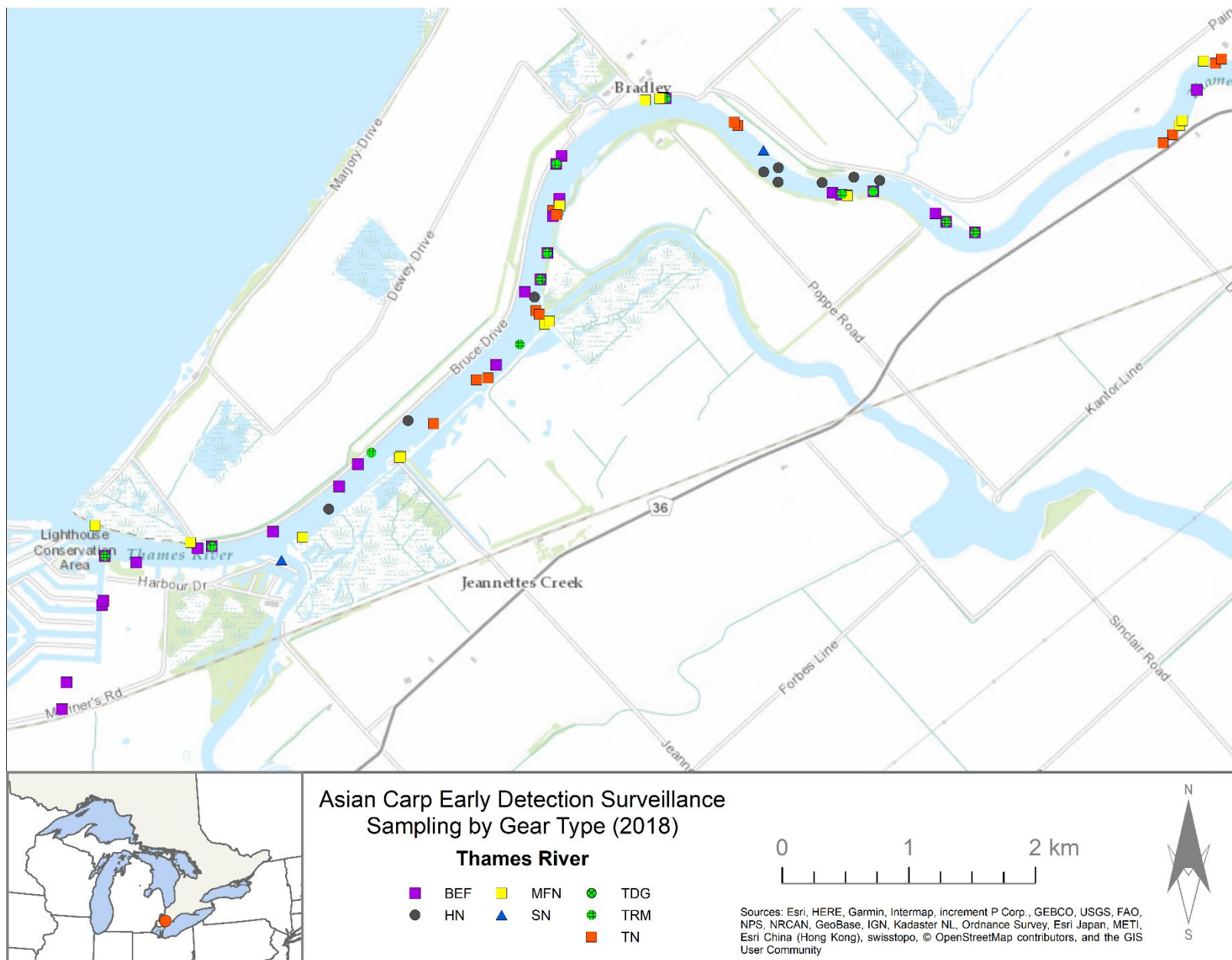
Figure A2.26 2018 Asian Carp Program early detection surveillance field sampling sites in Pine River.

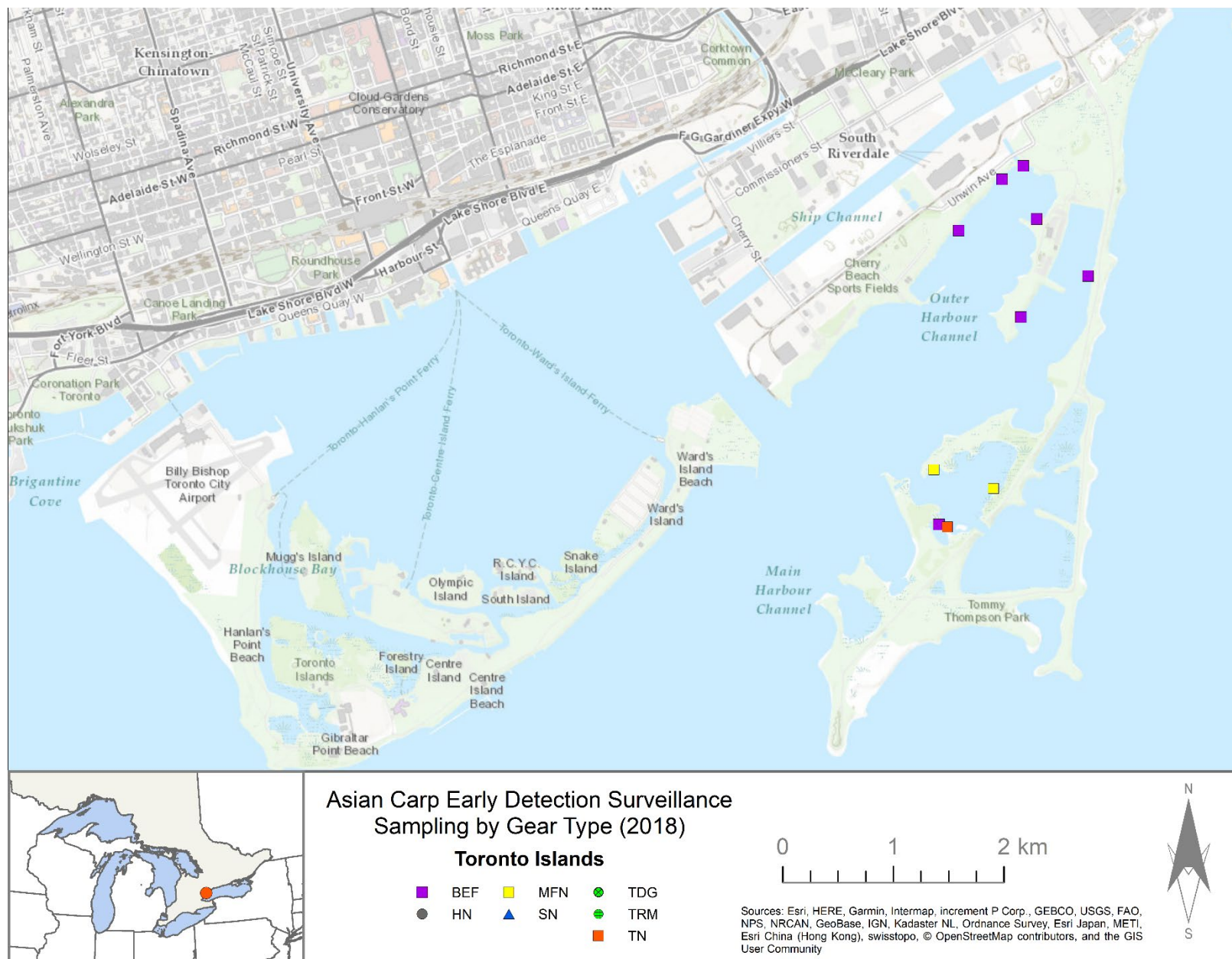**Figure A2.27 2018 Asian Carp Program early detection surveillance field sampling sites in Rondeau Bay.**

Figure A2.28 2018 Asian Carp Program early detection surveillance field sampling sites in Rouge River.

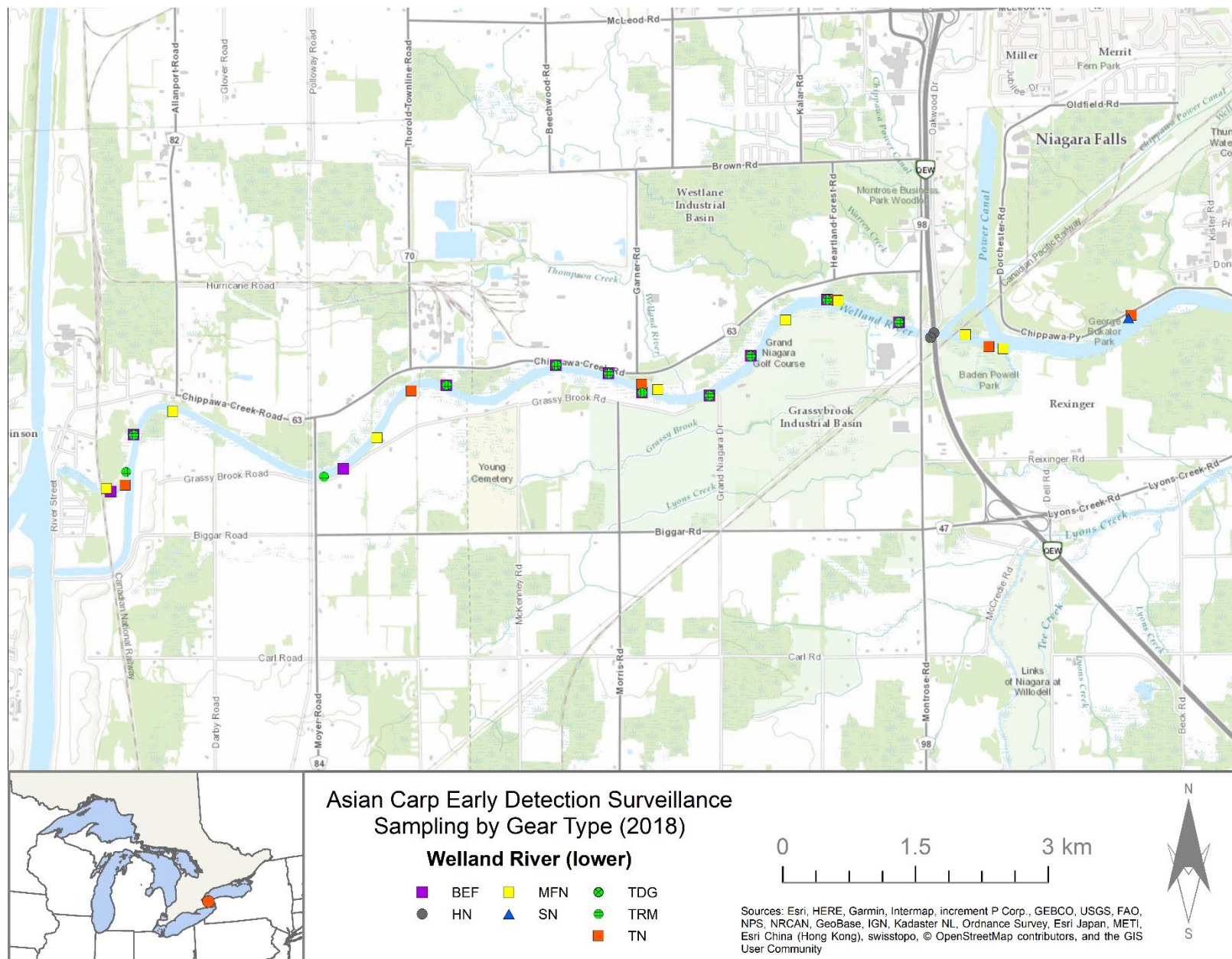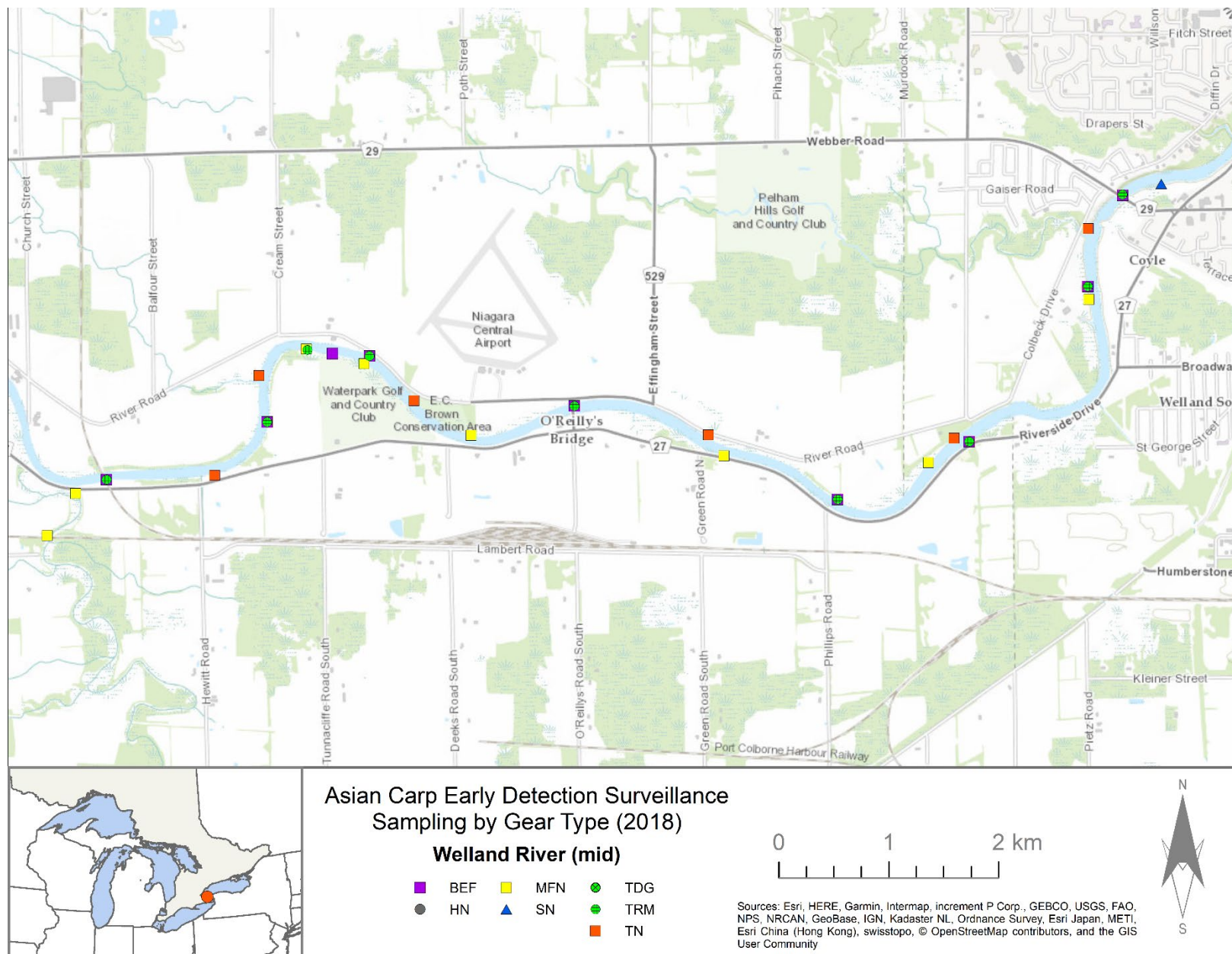**Figure A2.29 2018 Asian Carp Program early detection surveillance field sampling sites in Ruscom River.**

Figure A2.30 2018 Asian Carp Program early detection surveillance field sampling sites in Sauble River.

Figure A2.31 2018 Asian Carp Program early detection surveillance field sampling sites in Shebeshekong River.

Figure A2.32 2018 Asian Carp Program early detection surveillance field sampling sites in Spanish River.

Figure A2.33 2018 Asian Carp Program early detection surveillance field sampling sites in St. Clair River.

Figure A2.34 2018 Asian Carp Program early detection surveillance field sampling sites in Sturgeon River.

Figure A2.35 2018 Asian Carp Program early detection surveillance field sampling sites in the lower Sydenham River.

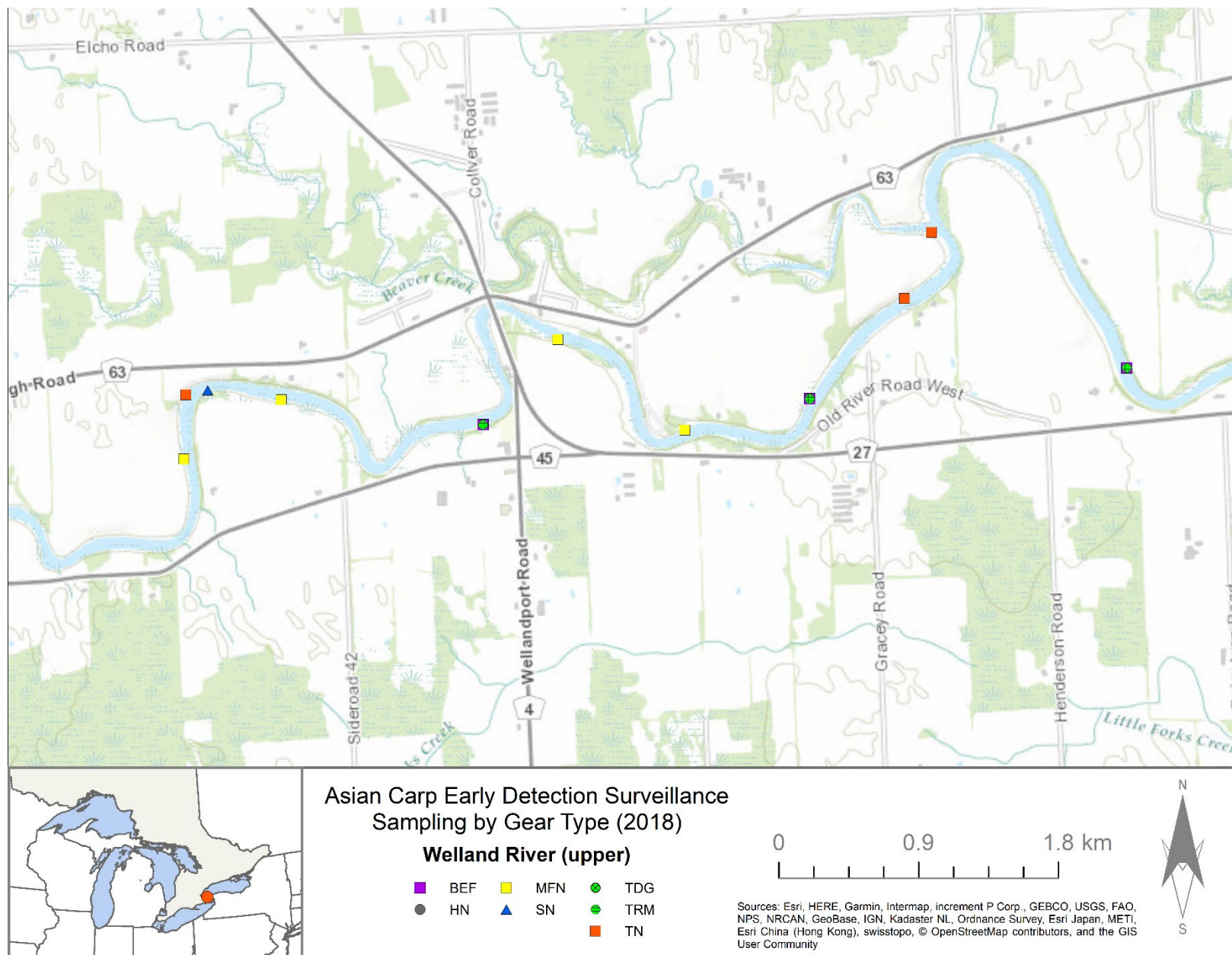**Figure A2.36 2018 Asian Carp Program early detection surveillance field sampling sites in the upper Sydenham River.**

Figure A2.37 2018 Asian Carp Program early detection surveillance field sampling sites in Thames River.

Figure A2.38 2018 Asian Carp Program early detection surveillance field sampling sites in the Toronto Islands.

Figure A2.39 2018 Asian Carp Program early detection surveillance field sampling sites in the lower Welland River.

Figure A2.40 2018 Asian Carp Program early detection surveillance field sampling sites in the mid Welland River.

Figure A2.41 2018 Asian Carp Program early detection surveillance field sampling sites in the upper Welland River.

APPENDIX 3: LARVAL FISH AND EGG SAMPLING LOCATION MAPS

Figure A3.1 2018 Asian Carp Program Early Detection Surveillance larval and egg sampling in Ausable River.
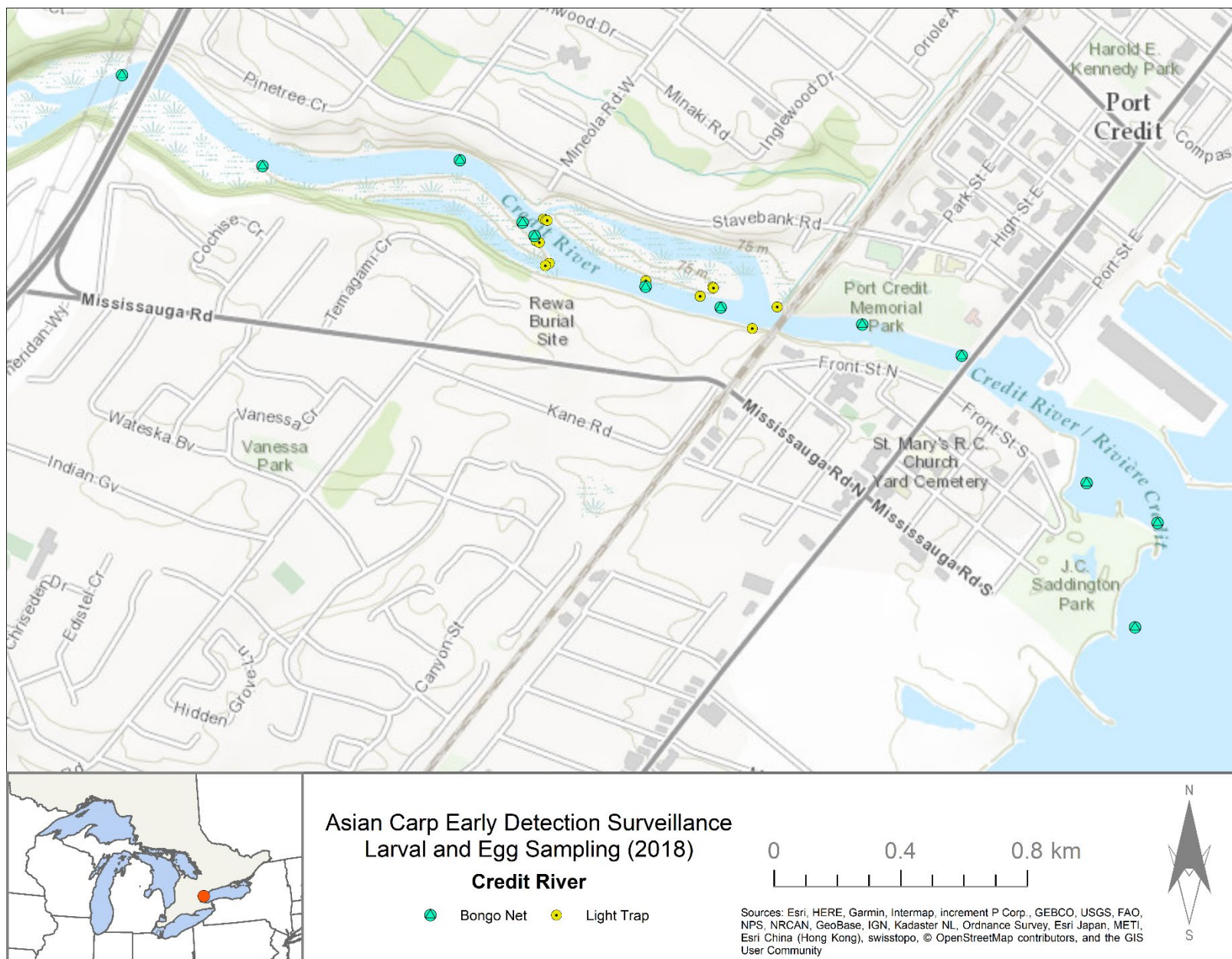
Figure A3.2 2018 Asian Carp Program Early Detection Surveillance larval and egg sampling in Credit River.
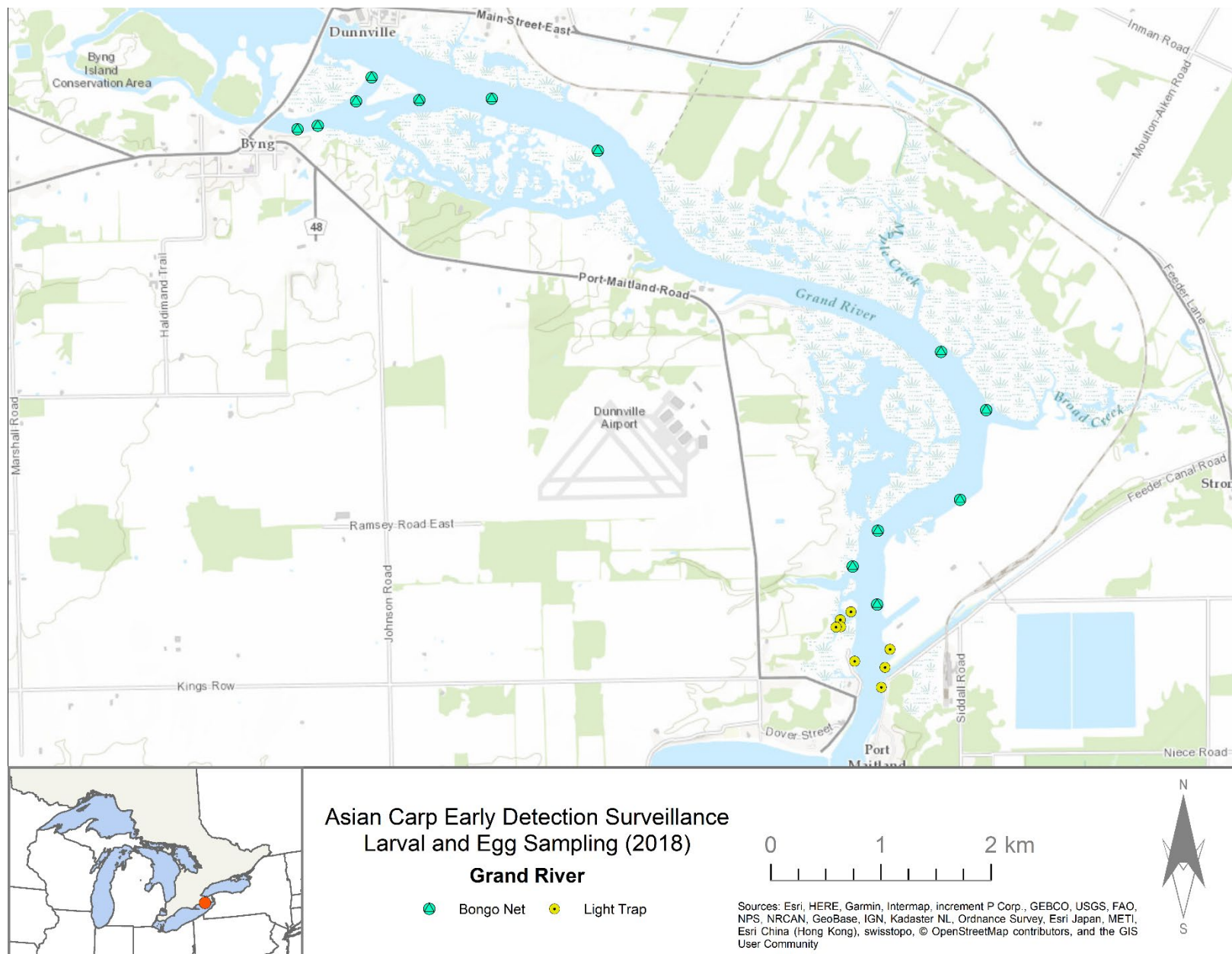
Figure A3.3 2018 Asian Carp Program Early Detection Surveillance larval and egg sampling in Grand River.
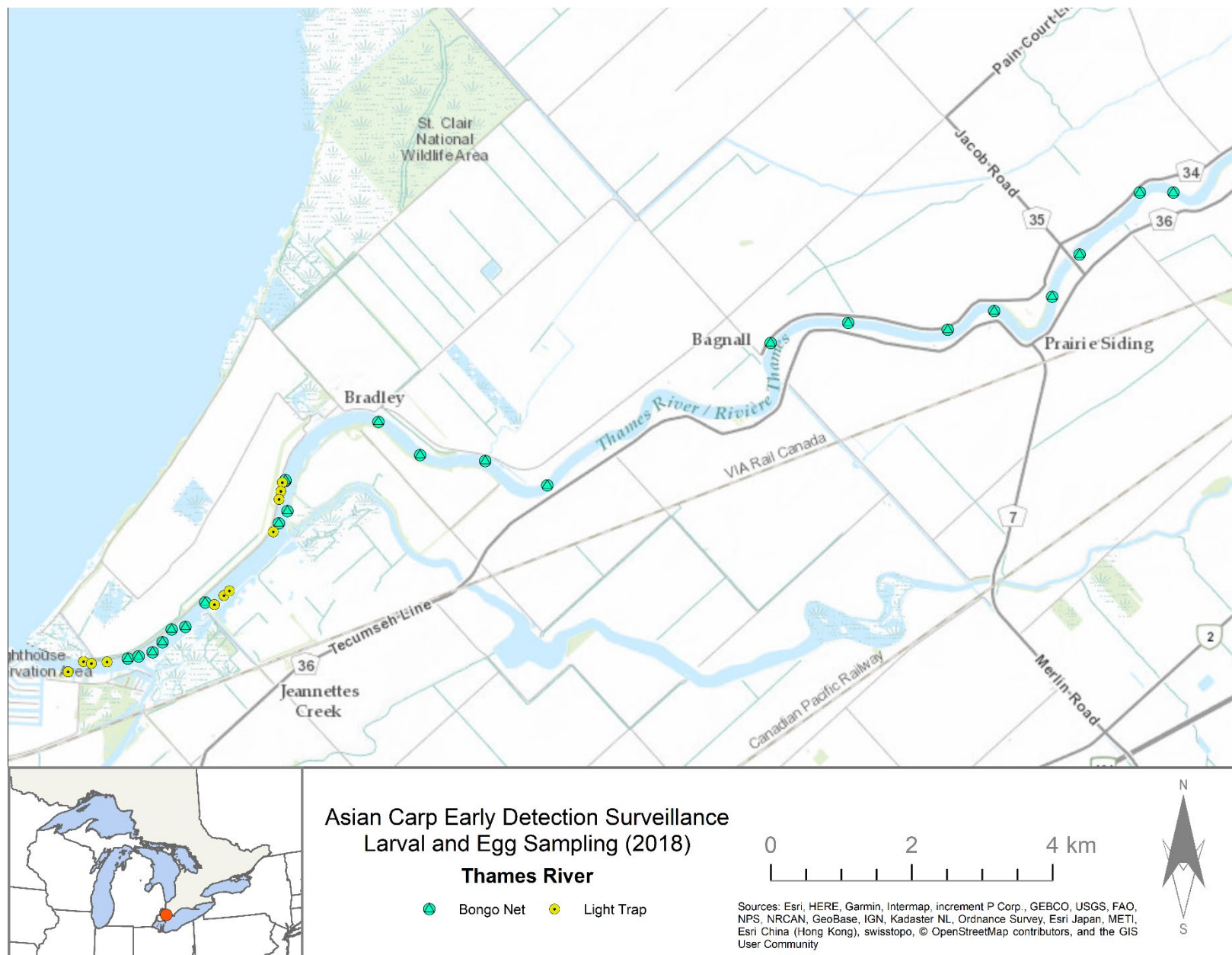
Figure A3.4 2018 Asian Carp Program Early Detection Surveillance larval and egg sampling in Thames River.