Application of a fish IBI to coastal wetlands in the St. Clair and Detroit River Areas of Concern

Jonathan D. Midwood, Erin Budgell, and David Reddick

Great Lakes Laboratory for Fisheries and Aquatic Sciences
Science Branch, Ontario and Prairie Region
Fisheries and Oceans Canada
867 Lakeshore Road
Burlington ON, L7S 1A1

2020

Canadian Technical Report of
Fisheries and Aquatic Sciences 3400

Fisheries and Oceans Canada | Pêches et Océans Canada

Canada

Canadian Technical Report of Fisheries and Aquatic Sciences

Technical reports contain scientific and technical information that contributes to existing knowledge but which is not normally appropriate for primary literature. Technical reports are directed primarily toward a worldwide audience and have an international distribution. No restriction is placed on subject matter and the series reflects the broad interests and policies of Fisheries and Oceans Canada, namely, fisheries and aquatic sciences.

Technical reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in the data base *Aquatic Sciences and Fisheries Abstracts*.

Technical reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page.

Numbers 1-456 in this series were issued as Technical Reports of the Fisheries Research Board of Canada. Numbers 457-714 were issued as Department of the Environment, Fisheries and Marine Service, Research and Development Directorate Technical Reports. Numbers 715-924 were issued as Department of Fisheries and Environment, Fisheries and Marine Service Technical Reports. The current series name was changed with report number 925.

Rapport technique canadien des sciences halieutiques et aquatiques

Les rapports techniques contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles, mais qui ne sont pas normalement appropriés pour la publication dans un journal scientifique. Les rapports techniques sont destinés essentiellement à un public international et ils sont distribués à cet échelon. II n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques de Pêches et Océans Canada, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports techniques peuvent être cités comme des publications à part entière. Le titre exact figure au-dessus du résumé de chaque rapport. Les rapports techniques sont résumés dans la base de données *Résumés des sciences aquatiques et halieutiques.*

Les rapports techniques sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre.

Les numéros 1 à 456 de cette série ont été publiés à titre de Rapports techniques de l'Office des recherches sur les pêcheries du Canada. Les numéros 457 à 714 sont parus à titre de Rapports techniques de la Direction générale de la recherche et du développement, Service des pêches et de la mer, ministère de l'Environnement. Les numéros 715 à 924 ont été publiés à titre de Rapports techniques du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 925.

Canadian Technical Report of
Fisheries and Aquatic Sciences 3400

2020

Application of a fish IBI to coastal wetlands in the St. Clair and Detroit River Areas of Concern

by

Jonathan D. Midwood, Erin Budgell, and David Reddick

Great Lakes Laboratory for Fisheries and Aquatic Sciences
Science Branch, Ontario and Prairie Region
Fisheries and Oceans Canada
867 Lakeshore Road
Burlington ON, L7S 1A1

Cat. No. Fs97-6/3400E-PDF ISBN 978-0-660-35902-1 ISSN 1488-5379

Correct citation for this publication:
Midwood, J.D., Budgell, E, and Reddick, D. 2020. Application of a fish IBI to coastal wetlands in the St. Clair and Detroit River Areas of Concern. Can. Tech. Rep. Fish. Aquat. Sci. 3400: vi + 23 p.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

ABSTRACT

Midwood, J.D., Budgell, E, and Reddick, D. 2020. Application of a fish IBI to coastal wetlands in the St. Clair and Detroit River Areas of Concern. Can. Tech. Rep. Fish. Aquat. Sci. 3400: vi + 23 p.

Fish community data collected using boat electrofishing and fyke netting were used to calculate fish index of biotic integrity (IBI) scores for coastal areas and weltands in the St. Clair River (SCR) and Detroit River (DR) Areas of Concern (AOC). For each system and gear type, IBI scores were compared with values derived at sites in the Walpole Island Delta (a regional reference area with comparatively low anthropogenic disturbance) to determine whether there was evidence of impairment within the AOC. Based on fyke net data, there were no significant differences in IBI score among wetlands in the SCR that had been restored (75.8 ± 5.7 [mean ± standard deviation]) or not restored (69.5 ± 7.4) relative to wetlands in the Walpole Island Delta (73.3 ± 7.9). An important caveat to this comparison is that the application of the IBI to fyke net data has not been fully validated, therefore comparisions should only be made within gear-types and values should not be used outside of this study without validation. A lack of difference between sites within the SCR AOC and Walpole Island Delta suggests that, from a fish IBI perspecitve, wetland conditions in the SCR AOC do not indicate impairment under Beneficial Use Impairment (BUI) #14 (*Loss of Fish and Wildlife Habitat*). Confirmation of this status from surveys of other biotic communities (e.g., submerged aquatic vegetation, marsh birds, and invertebrates) is recommended prior to delisting. Sampling at sites in the DR was primarily intended to establish baseline conditions pre-restoration; however, based on boat electrofishing data, no differences were found between IBI scores at DR sites (68.3 ± 14.8) and comparable sites in the Walpole Island Delta (66.5 ± 11.5). In addition to IBI scores, fish community data are also presented herein with generally high species richness in both DR (49 species) and SCR (up to 37 species) and multiple species at risk in both systems. A more thorough investigation of these community data may contribute to the assesment to BUI#3 (*Degradation of Fish and Wildlife Populations*) in the DR AOC and could also be used to validate fish habitat suitability models for both systems.

RÉSUMÉ

Midwood, J.D., Budgell, E, and Reddick, D. 2020. Application of a fish IBI to coastal wetlands in the St. Clair and Detroit River Areas of Concern. Can. Tech. Rep. Fish. Aquat. Sci. 3400: vi + 23 p.

Les données sur la communauté de poissons recueillies grâce à la pêche à l'électricité par bateau et la pêche au verveux ont été utilisées pour calculer les cotes de l'indice d'intégrité biotique (IIB) pour les zones côtières et humides dans les secteurs préoccupants (SP) de la rivière St. Clair (RSC) et de la rivière Détroit (RD). Pour chaque type de système et d'engin, les cotes d'IIB ont été comparées à des valeurs obtenues sur des sites du delta de Walpole Island (une zone de référence régionale où les perturbations anthropiques sont relativement faibles) afin de déterminer s'il y avait des signes d'altération dans les SP. Selon les données recueillies grâce à la pêche au verveux, aucune différence significative n'a été constatée dans les cotes d'IIB des zones humides de la RSC qui ont été restaurées (75,8 ± 5,7 [moyenne ± écart-type]) ou qui n'ont pas été restaurées (69,5 ± 7,4) en comparaison avec les zones humides du delta de Walpole Island (73,3 ± 7,9). Une mise en garde importante s'impose pour cette comparaison : l'application de l'IIB aux données recueilles grâce à la pêche au verveux n'a pas été pleinement validée; les comparaisons ne doivent donc être faites que pour les types d'engins et les valeurs ne doivent pas être utilisées à l'extérieur de la présente étude sans avoir été préalablement validées. L'absence de différence entre les sites des SP de la RSC et du delta de Walpole Island suggère que du point de vue de l'indice d'intégrité biotique du poisson, les conditions dans les zones humides dans les SP de la RSC ne présentent pas de signe d'altération aux termes de l'altération d'utilisation bénéfique (AUB) n^{o} 14 (disparition d'habitats de poissons et de la faune). Une confirmation de cet état par des enquêtes des autres communautés biotiques (p. ex. végétation aquatique submergée, oiseaux des marais et invertébrés) est recommandée avant le retrait de la liste. L'échantillonnage aux sites de la RD visait principalement à établir les conditions de référence préalables à la restauration; cependant, selon les données recueillies grâce à la pêche à l'électricité par bateau, aucune différence n'a été observée entre les cotes d'IIB sur les sites de la RD (68,3 ± 14,8) et les sites comparables dans le delta de Walpole Island (66,5 ± 11,5). En plus des cotes d'IIB, les données sur les communautés de poisson sont aussi présentées ici, et celles-ci révèlent une grande richesse en espèces pour la RD (49 espèces) et la RSC (jusqu'à 37 espèces) ainsi que plusieurs espèces en péril dans les deux systèmes. Une analyse plus approfondie de ces données sur les communautés pourrait contribuer à l'évaluation de l'AUB n^{o} 3 (dégradation des populations de poissons et d'espèces sauvages) dans les SP de la RD et pourrait aussi servir en vue de valider les modèles d'habitat propice du poisson pour les deux systèmes.

INTRODUCTION

Under the terms of the Great Lakes Water Quality Agreement, in 1987 the St. Clair River (SCR) and the Detroit River (DR) were identified as two of 43 Great Lakes Areas of Concern (AOC). Historical industrialization, urbanization, and intensified land use practices both along the margins of the rivers and within their watersheds were identified as the primary causes of their impairment, with nine beneficial use impairments (BUI) being identified in SCR and 12 in DR. In both systems, BUI #14 – *Loss of Fish and Wildlife Habitat* was identified as impaired, whereas in DR, the status of BUI #3 – *Degradation of Fish and Wildlife Populations* was originally designated as unimpaired but later changed to impaired (Briggs et al. 2012; DRCC 2013); BUI #3 in SCR was never listed as impaired. Fish habitat objectives in these systems have sought to protect remaining habitat and encourage the creation or remediation of aquatic habitat where possible. Relevant for this report, SCR delisting criteria for BUI #14 seek to have wetland quality either be ranked as "Good" based on a variety of indices of biotic integrity (IBI) or have wetland quality that is comparable to wetlands outside of the AOC. The criteria relating to habitat in DR is less specific, but still seeks to protect habitat and restore ecosystem function to priority areas through the remediation or improvement of these habitats.

For both AOCs, IBI are a key tool for the assessment of fish and wildlife communities and habitats. These indices integrate complex ecological or community data into a single metric or score that can more easily be tracked and understood. The Canadian Wildlife Service (CWS) is using IBI for macroinvertebrates, submerged aquatic vegetation (SAV), and marsh birds to assess the condition of wetlands in this AOC and inform on the SCR habitat BUI. Particular focus has been placed on the condition of remediated sites relative to other sites within SCR, as well as, sites outside of the AOC including locations within the DR (Croft-White 2018). While the macroinvertebrate IBI found no difference among wetlands, the SAV IBI suggested remediated sites were more degraded than reference areas (remediated sites were general categorized as being in "poor" condition based on the SAV IBI), primarily due to high levels of filamentous algae. Continued monitoring at these sites using these IBI is planned to determine whether the patterns observed in 2017 are consistent through time. These same IBI have also been used by CWS in DR wetlands, with SAV IBI scores being comparable to wetlands in the SCR AOC. The macroinvertebrate IBI scores showed slightly lower values in the DR and considerably lower values were detected for the marsh bird IBI assessment (Croft-White 2018). Collectively these results demonstrate the utility of IBI for assessing ecosystem condition in the DR and SCR AOCs.

A fish-based IBI (Minns et al. 1994) has been used to monitor conditions in other Great Lakes AOCs including Hamilton Harbour, Severn Sound, Toronto and Region, and the Bay of Quinte (Randall and Minns 2002; Boston et al. 2016; Hoyle et al. 2018). This IBI was designed to monitor ecosystem condition in littoral areas of the Great Lakes based on fish community data collected using standardized electrofishing surveys (Brousseau

et al. 2005). Spatially comprehensive field surveys of wetland fish communities were undertaken by Fisheries and Oceans Canada and Walpole Island First Nation within the Walpole Island Delta during the summer of 2015 using both electrofishing and fyke net sampling protocols. Similar surveys were undertaken in the SCR and DR AOCs in the summer of 2017 and again in the SCR AOC in 2018 and 2019. By applying the fish IBI to these data the relative condition of wetland and nearshore areas within the AOCs and the Delta can be determined. The objective of this report is to assess the habitat condition of selected wetland and nearshore areas in the SCR and DR AOCs using the fish IBI. Sites within the Walpole Island Delta will serve as reference locations for the surveys completed in both DR and SCR. This area was selected as a reference location based on its proximity to DR and SCR, relatively high scoring habitat metrics (e.g., SAV IBI), and the availability of fish community data that were collected using the same methods (i.e. fyke net and boat electrofishing; Gardner-Costa et al. in prep.). It is important to note that the fish IBI was not developed and has yet to be tested for fyke net data, therefore comparisons among sites are undertaken separately for electrofishing and fyke netting. Collectively these works will determine if wetlands within the SCR and DR AOCs are in comparable condition to reference wetlands (i.e., those within Walpole Island Delta) as assessed through the use of a fish-based IBI. These results should be integrated with efforts underway by CWS to ensure multiple IBI yield similar conclusions regarding aquatic habitat conditions.

METHODS

The methods used to sample fish communities using either electrofishing or fyke netting were consistently applied across sites and sampling years. As such, data collected by the Walpole Island First Nation and Fisheries and Oceans Canada during the summer of 2015 in the Walpole Island Delta should be comparable to data collected during summer 2017, 2018, and 2019. In 2017, eight sites in DR were surveyed with electrofishing and two sites, Canard River Marsh and Turkey Creek, were sampled using fyke nets due to depth limitations (Table 1; Figure 1). Fyke nets were used in all sites sampled in SCR in 2017 (N = 9), 2018 (N = 8), and 2019 (N = 7; Table 1; Figure 2). Running Creek was not sampled after 2017 since it was not part of the CWS wetland monitoring program and Stag Island could not be accessed in 2019 due to high water levels. For the 2015 surveys, 15 sites were surveyed using electrofishing and nine sites were surveyed with fyke nets in the Walpole Island Delta (Table 1; Figure 2). Details on these 2015 surveys, including information on substrate, water chemistry, plant communities, and SAV distributions can be found in Gardner-Costa et al. (in prep.).

Fyke nets (dimensions: 3.6 m long with 1.2 m x 0.9 m frames, lead is 7.6 m x 0.9 m with two wings 3.6 m x 0.9 m set at 45° angle from the net mouth, mesh size 4.8 mm) were set perpendicular to stands of emergent vegetation with the lead starting at the edge of the vegetation. An air gap (~10 cm) was maintained at the cod end to prevent turtles and other air breathing vertebrates from drowning. Nets were set for approximately 24-hrs to capture diel movements of fishes into and out of the emergent vegetation. There was variability in the number of nets set per site and this was largely dependent on the size of the site and, to a lesser extent, the number of nets that were available during the survey.

For electrofishing surveys, a Smith-Root SR20E electrofishing boat (length = 6.1 m, beam = 1.9 m) with an output of approximately 8 amperes was used. Surveys followed the protocol outlined in Brousseau et al. (2005) with 100-m transects run at approximately 1.5-m depth at a speed such that effort was approximately 300 shock seconds. All transects were surveyed at night (between sunset and sunrise). Similar to the fyke net surveys, there was variability in the number of transects completed at each site based on its size.

Fish were processed in the same manner regardless of whether they were captured using fyke nets or boat electrofishing. Captured fish were held in aerated tanks and then identified to species and their lengths (fork length ± 1 mm) and wet mass (g) were measured. For each fyke net or electrofishing transect, the first 20 individuals of each species were fully processed. Any additional individuals were counted and a batch mass was taken. Captured fish were released following processing, unless they could not be identified in the field or were required to be collected under the Species At Risk permitting requirements. In these instances, they were measured, weighed, sacrificed, and vouchered for later identification in the laboratory.

ANALYSIS

For each sampling event, the total catch and total species richness were determined and effort was reported as either “total shock-seconds” (electrofishing) or “total soak time” (hours; fyke netting). A fish-based IBI, which integrates 12 fish community-based sub-metrics (e.g., number of native fish species, percent piscivore biomass, number of turbidity intolerant species, etc.; Minns et al. 1994) into a single overall score to help ease reporting and dissemination to the public and stakeholders, was calculated for each sampling event (i.e., transect for electrofishing and net for fyke nets). The mean IBI score for each year (with standard deviation) was then determined for each sampling site as well as for each sampling site type (e.g., DR AOC, SCR AOC, SCR Restored, or Walpole Island Delta [further divided by gear type]). These sampling site types were assigned, where possible, based on previous surveys completed by CWS (Croft-White 2018). It is important to stress again that the fish IBI was developed using electrofishing data and has not previously been applied to fish community data derived from fyke netting. These two distinct gear and sampling approaches (active vs. passive) are known to target different components of the fish community with small schooling fishes often found in fyke nets (Hubert 1989) and more sedentary large predators captured with electrofishing (Bohlin et al. 1989; Reynolds 1989). Despite differences in the fish assemblage that is captured, previous applications of a fish-based index (Wetland Fish Index, Seilheimer et al. 2006) to electrofishing and fyke net data have yielded comparable index scores for the same site (Cvetkovic et al. 2012). That study, however, did not use the fish IBI used for the present assessment, therefore IBI scores derived from the fyke net surveys should be interpreted with caution and should not be compared to scores derived using electrofishing until a more complete evaluation of its efficacy for fyke net data is undertaken.

In order to test for differences between DR AOC sites and Walpole Island Delta sites (electrofishing) and among restored SCR AOC, un-restored SCR AOC, and Walpole Island Delta sites (fyke nets) a non-parametric Kruskal-Wallis rank sum test was used. This test was selected since the data did not meet the assumptions of normality and equal variance necessary for parametric statistical tests. When significant effects were found ($\alpha = 0.05$), post-hoc pairwise comparisons were conducted using a Wilcoxon rank sum test.

RESULTS

Detailed results relating to species richness and total catch for the Walpole Island Delta surveys are not presented here, but can be found in Gardner-Costa et al. (in prep.).

DETROIT RIVER

During the 2017 DR surveys, over 4000 fish representing 49 different species were captured (Table 2). This included several federally (F) and provincially (P) listed species at risk (Grass Pickerel [*Esox americanus*; F and P; special concern], Pugnose Minnow [*Opsopoeodus emiliae*; F special concern and P threatened], Spotted Sucker [*Minytrema melanops*; F and P; special concern]; and Northern Sunfish [*Lepomis peltastes*; P; special concern]). Commonly occurring species included Rock Bass (*Ambloplites rupestris*) and Yellow Perch (*Perca flavescens*), which were found at all sites; however, the most abundant species were Bluegill (*Lepomis macrochirus*), Largemouth Bass (*Micropterus salmoides*), and Gizzard Shad (*Dorosoma cepedianum*) with greater than 250 of each encountered throughout the survey (Table 2). In some instances, large catches of a single species drove overall abundance estimates (e.g., *Lepomis* spp. at Lower Canard or all Northern Sunfish being captured at Turkey Creek), therefore, species that had high overall abundance were not necessarily common (i.e., found across all sites). Total catch was also higher at DR sites surveyed using fyke nets compared to those surveyed using electrofishing (Table 2).

There was some variability in mean IBI scores among sites surveyed with electrofishing in the DR AOC and Walpole Island Delta, with the lowest scores at sites DFE_17 (30.8), WHB_15 (42.8), and WSA_15 (49.1) and highest value at DBI_17 (84.9; Figure 3). In contrast most other sites had IBI scores between 60 to 80 (Table 1). When the data were pooled, there was no significant difference in mean IBI score at sites in the DR AOC (68.3 ± 14.8; Kruskal-Wallis, $\chi 2(1) = 0.22$, $p = 0.64$) compared to those in the Walpole Island Delta (66.5 ± 11.5; Figure 3). The two sites in DR surveyed using fyke nets, CRB_17 and TKC_17, also had mean IBI scores comparable to those observed at sites surveyed using fyke nets in the Walpole Island Delta (Figure 4).

ST. CLAIR RIVER

Total catch in the St. Clair River was considerably higher in 2018 (8761) and 2019 (7281) compared to 2017 (3011), however, species richness was slightly lower (33 [2018] and 32 [2019] vs 37 [2017]). Higher total catches in 2018 and 2019 was largely driven by increased catch of centrarchids (e.g., Pumpkinseeds [*Lepomis gibbosus*],

Bluegill, and *Lepomis* spp.[likely young of the year of these species]; Table 3-5), although these species were abundant compared to the rest of the community in all years. Several federally and provincially listed species at risk were encountered during the study (Grass Pickerel, Pugnose Shiner [*Notropis anogenus*; F endangered and P threatened], Spotted Sucker; and Northern Sunfish), but Blackstripe Topminnow (*Fundulus notatus*; F and P; special concern) were only observed in 2017 and Lake Chubsucker (*Erimyzon sucetta*; F endangered and P threatened) in 2019 (Tables 3-5). Commonly occurring (i.e., detected at all sites) species included: Bluegill, Largemouth Bass, Pumpkinseed, Rock Bass and Yellow Perch (Tables 3-5).

Based on fyke net data, IBI scores were generally high (low of 59.6 [SRM_17] and a high of 88.6 [BAY_19]; Table 1; Figure 4) with no evidence for significant differences among restored (75.8 ± 5.7) or un-restored (69.5 ± 7.4) sites in the SCR AOC and those within the Walpole Island Delta (73.3 ± 7.9; Kruskal-Wallis, $\chi 2(2) = 4.41$, $p = 0.11$; Figure 4).

DISCUSSION

We found no evidence for differences in fish IBI scores for wetlands within the DR AOC or SCR AOC (either restored or un-restored) relative to reference wetlands in the Walpole Island Delta. For most sites sampled using either electrofishing or fyke nets, fish IBI scores generally fell between 60 to 80, which is higher than some Great Lakes Areas of Concern (e.g., Hamilton Harbour and Toronto and Region) and comparable to past surveys in the Bay of Quinte AOC (Hoyle et al. 2018) where fish communities targets have been achieved (Brousseau et al. 2011). For the few SCR and DR AOC sites that fell outside of this range, there were sites within the Walpole Island Delta that had comparable scores suggesting the observed variation in IBI score within the AOCs was also present in the Walpole Island Delta reference area. The sole exception was at the Fighting Island End electrofishing site, in the Detroit River (DFE_17) where the lowest electrofishing-based IBI score was observed. This lower value may be related to the open nature of this site since the fish IBI was originally derived for embayments (Minns et al. 1994). Other work with this protocol on open coast sites in Lake Ontario has similarly found naturally lower IBI scores (e.g., Bronte Shore and Port Dalhousie, Hoyle et al. 2018). Scores were generally consistent within sites that were surveyed over multiple years (e.g., SCR 2017-2019 fyke netting). Collectively these results suggest that, based on a fish IBI, wetlands within the DR and SCR AOCs are in comparable condition as wetlands in the Walpole Island Delta referance area.

To further validate these results, there are some additional steps that should be undertaken. Results derived from the fish IBI should be integrated with efforts by CWS to ensure multiple IBI yield similar conclusions regarding the condition of aquatic habitat. Multiple lines of evidence are critical since IBI based on other components of the biotic community that are also reliant on coastal wetlands (e.g., marsh birds, invertebrates) may indicate there is still an impairment under BUI #14, as is the case for the SAV IBI at some sites within the DR AOC (Croft-White 2018). The decision on delisting BUI #14 rests with the RAP committee, but in the opinion of the authors, as

many of the available IBI scores as possible should indicate healthy biotic communities in monitored coastal wetlands in the DR and SCR AOCs.

IBI scores represent an aggregation of fish community information that can mask differences in fish community composition (i.e., difference in species dominance, richness, or abundance). While these differences may be of less interest for BUI#14, they can reflect important community-based differences that are relevant for the assessment of BUI#3. Therefore, an evaluation of differences in fish community composition among DR AOC, SCR AOC, and Walpole Island Delta sites is warranted to ensure the higher-level summaries provided by an interpretation of IBI scores do not mask important species-specific variation that is driven by conditions within the AOC. This specific assessment seems only relevant to the DR AOC, since BUI#3 is not listed as impaired for the SCR AOC.

Since an assignment of a categorical quality to observed fish IBI scores has not been developed, it is not possible to evaluate whether SCR sites have met the target of having wetlands in “Good” condition from a fish community perspective. Such categorical evaluations have been applied to a SAV IBI (Grabas et al. 2012; Croft-White 2018) with scores from 0 to 20 indicating “Poor” conditions; 21 to 40 indicating “Fair” conditions; 41 to 60 indicating “Good” conditions; 61 to 80 indicating “Very Good” conditions; and 81 to 100 indicating “Excellent” conditions. It is important to further stress, however, that the appropriateness of this type of categorization has not been explored for the fish IBI applied in this report. In the short term, therefore, it is likely best to approach the assessment of this BUI by evaluating whether wetland quality within the AOC is comparable to reference wetlands outside of the AOC (e.g., in the Walpole Island Delta), as has been done in the present report.

While efforts within the SCR AOC were primarily driven by the desire to compare conditions within the AOC to those outside the AOC, in the DR AOC the primary objective of the 2017 survey was to collect baseline data on fish communities at proposed restoration sites. The methods outlined in the present report and baseline information on the fish community should be used in the future to evaluate the efficacy of restoration actions at these sites in DR. At this time additional sampling at select sites in the DR AOC is currently not expected, but may be beneficial to provide multi-year baseline data prior to undertaking any restoration action. Such a decision, however, will need be determined in consultation with DR RAP coordinators. Finally, if sites within the Walpole Island Delta will be used as reference areas in the future, it would be prudent to re-sample a subset of sites with both gear types used in the present report. This would not only provide greater temporal coverage on conditions in this reference area, but also facilitate a direct comparison in IBI scores derived using electrofishing and fyke netting, which could increase overall confidence in the as yet un-validated IBI scores derived using fyke nets.

ACKNOWLEDGEMENTS

This project would not have been possible without support from Walpole Island First Nation, thank you in particular to those who supported the 2015 field work: Clint Jacobs, Naomi Williams, Kennon Johnson, Heather Johnson, Tom Tooshkenig, Walden Shipman, Kyle Johnson, Joe Shipman, Mike Altiman, and Carl Smith. Similarly, thank you to Dave Reddick (2015, 2017) and Erin Budgell (2018 and 2019) for leading field work in the St. Clair and Detroit Rivers and also to those who assisted with these works: 2017 – Andrew Fernley, Abby Wynia, Sydney Wilkinson, Emily Marshall, and Filipe Aguiar; 2018 – Kyle Mataya; and 2019 – Jesse Gardner-Costa and Scott Blair. Finally, thank you to Richard Drouin, Stephen Marklevitz, and Jacob Brownscombe for reviewiing and commenting on drafts of this report. Funding for these works was provided by the Great Lakes Action Plan (Enivronment and Climate Change Canada).

REFERENCES

Bohlin, T., Hamrin, S., Heggberget, T.G., Rasmussen, G., and Saltveit, S.J. 1989. Electrofishing theory and practice with special emphasis on salmonids. Hydrobiologia. 173:9–43.

Boston, C.M., Randall, R.G., Hoyle, J.A., Mossman, J.L., and Bowlby, J.N. 2016. The fish community of Hamilton Harbour, Lake Ontario: Status, stressors, and remediation over 25 years. Aquat. Ecosyst. Health Manage. 19(2):206-218.

Briggs, T., Kok, S., Lafrance, C., and White, A. 2012. St. Clair River Area of Concern Canadian Remedial Action Plan Implementation Committee Work Plan 2007–2010: Summary of Accomplishments. St. Clair Region Conservation Authority.

Brousseau, C.M., Randall, R.G., and Clark, M.G. 2005. Protocol for boat electrofishing in near shore areas of the lower Great Lakes: transect and point survey methods for collecting fish and habitat data, 1988 to 2002. Can. Manu. Report Fish. Aquat. Sci. 2702.

Brousseau, C.M., Randall, R.G., Hoyle, J.A., and Minns, C.K., 2011. Fish community indices of ecosystem health: How does the Bay of Quinte compare to other coastal sites in Lake Ontario?. Aquat. Ecosyst. Health Manage. 14(1):75-84.

Croft-White, M. 2018. St. Clair River Area of Concern: Assessing the Condition of Restored Coastal Wetlands. Contractor Report for Canadian Wildlife Service.

Cvetkovic, M.C., Kostuk, K., and Chow-Fraser, P. 2012 Gear-type influences on fish catch and a wetland fish index in Georgian Bay Wetlands. N. Am. J. Fish. Manage. 32:313-324.

Detroit River Canadian Cleanup (DRCC). 2013. Pathway to Delisting: Detroit River Canadian AOC Delisting Strategy, 2013-2018. Publication No. 2, Essex, Ontario, Canada.

Grabas, G.P., Blukacz-Richards, E.A., and Pernanen, S. 2012. Development of a submerged aquatic vegetation community index of biotic integrity for use in Lake Ontario coastal wetlands. J. Great Lakes. Res. 38(2):243-250.

Hoyle, J.A., Boston, C.M., Chu, C., Yuille, M.J., Portiss, R., and Randall, R.G. 2018. Fish community indices of ecosystem health: How does Toronto Harbour compare to other Lake Ontario nearshore areas?. Aquat. Ecosyst. Health Manage. 21(3):306-317.

Hubert, W. A. 1989. Passive capture techniques. Pages 95–122 in L. A. Nielsen and D. L. Johnson, editors. Fisheries techniques. American Fisheries Society, Bethesda, Maryland.

Minns, C.K., Cairns, V.W., Randall, R.G., and Moore, J.E. 1994. An index of biotic integrity (IBI) for fish assemblages in the littoral zone of Great Lakes' areas of concern. Can. J. Fish. Aquat. Sci. 51(8):1804-1822.

Randall, R.G., and Minns, C.K. 2002. Comparison of a habitat productivity index (HPI)and an index of biotic integrity (IBI) for measuring the productive capacity of fish habitat in nearshore areas of the Great Lakes. J. Great Lakes. Res. 28(2):240-255.

Reynolds, L., Herlihy, A.T., Kaufmann, P.R., Gregory, S.V., and Hughes, R.M. 2003. Electrofishing effort requirements for assessing species richness and biotic integrity in western Oregon streams. N. Am. J. Fish. Manage. 23:450–461.

Seilheimer, T.S., and Chow-Fraser, P. 2006. Development and use of the Wetland Fish Index to assess the quality of coastal wetlands in the Laurentian Great Lakes. Can. J. Fish. Aquat. Sci. 63(2):354-366.

Table 1. Basic information on where and when each sampling event occurred and the type of gear used and effort (fyke = number of nets, electrofishing = number of transects). Sites area grouped based on their general location: Detroit River Area of Concern = DR AOC, Walpole Island Delta = Walpole, St. Clair River Area of Concern = SCR AOC, and restored in the SCR AOC = SCR RES. The mean (± standard deviation), minimum, and maximum, IBI scores for each sampling event are also shown.

Site Name	Grouping	Site Code	Sampling Date	Gear	Effort	Latitude	Longitude	Mean ± SD	Min	Max
Canard River	DR AOC	CRB_17	16/08/2017	Fyke Net	4	42.17242	-83.09368	75.9 ± 7.1	65.8	82.2
Turkey Creek	DR AOC	TKC_17	14/08/2017	Fyke Net	4	42.24586	-83.10525	80.4 ± 2.3	77.0	82.2
Boblo Dock	DR AOC	DBD_17	14/07/2017	Electrofishing	4	42.08635	-83.11283	69.3 ± 23.7	34.1	84.3
Boblo Island	DR AOC	DBI_17	13/07/2017	Electrofishing	4	42.09125	-83.11808	84.9 ± 6.0	78.8	93.0
Crystal Bay	DR AOC	DCB_17	14/07/2017	Electrofishing	4	42.11600	-83.11850	69.5 ± 7.0	61.4	76.5
Fighting Island End	DR AOC	DFE_17	13/07/2017	Electrofishing	4	42.19155	-83.11800	30.8 ± 8.6	23.5	43.2
Fight Island Side	DR AOC	DFS_17	12/07/2017	Electrofishing	4	42.21060	-83.12287	61.7 ± 9.0	50.3	70.5
Peche Island Channel	DR AOC	DPC_17	11/07/2017	Electrofishing	4	42.34790	-82.92820	70.9 ± 2.3	68.6	73.8
Peche Island Head	DR AOC	DPH_17	11/07/2017	Electrofishing	4	42.34720	-82.92217	73.6 ± 12.4	55.7	83.5
Peche Island Inner	DR AOC	DPI_17	10/07/2017	Electrofishing	4	42.34520	-82.92495	65.7 ± 26.0	28.8	89.9
Basset Channel	Walpole	WBC_15	30/07/2015	Electrofishing	20	42.52009	-82.57786	60.1 ± 22.5	0.0	85.4
Chematogan Bay	Walpole	WCB_15	06/08/2015	Electrofishing	5	42.49246	-82.52738	62.6 ± 9.8	50.5	76.6
Chematogan Channel	Walpole	WCC_15	04/08/2015	Electrofishing	21	42.54919	-82.53911	76.5 ± 11.4	51.1	93.2
Clubhouse Bay	Walpole	WCL_15	28/07/2015	Electrofishing	9	42.48244	-82.45837	69.9 ± 10.6	45.1	78.8
Grassy Island	Walpole	WGI_15	05/08/2015	Electrofishing	4	42.46122	-82.49137	58.6 ± 7.0	49.4	64.4
Goose Lake	Walpole	WGL_15	06/08/2015	Electrofishing	5	42.52120	-82.51934	78.3 ± 5.0	73.5	85.5
Horseshoe Bay	Walpole	WHB_15	27/07/2015	Electrofishing	6	42.51181	-82.59890	42.8 ± 21.4	0.0	58.6
Johnston Bay	Walpole	WJB_15	06/08/2015	Electrofishing	4	42.50268	-82.50467	66.4 ± 14.8	51.2	81.1
Johnston Channel	Walpole	WJC_15	07/08/2015	Electrofishing	11	42.48970	-82.50520	77.0 ± 11.4	48.4	86.8
Johnston Mouth	Walpole	WJM_15	06/08/2015	Electrofishing	5	42.47708	-82.52709	76.4 ± 18.2	48.3	91.2
Mud Bay	Walpole	WMB_15	28/07/2015	Electrofishing	5	42.48015	-82.46717	79.5 ± 4.6	75.0	85.6
Pocket Bay	Walpole	WPO_15	27/07/2015	Electrofishing	4	42.53180	-82.61764	74.2 ± 4.8	68.4	80.1
St. Anne's Bay	Walpole	WSA_15	28/07/2015	Electrofishing	1	42.48639	-82.47246	49.1 ±	49.1	49.1
Whitney Islands	Walpole	WWI_15	05/08/2015	Electrofishing	5	42.47178	-82.46600	59.7 ± 6.9	51.5	69.8
Bay Lodge	SCR RES	BAY_17	15/08/2017	Fyke Net	4	42.45975	-82.41113	72.2 ± 9.9	61.1	83.5
Bay Lodge	SCR RES	BAY_18	30/08/2018	Fyke Net	4	42.46161	-82.41074	82.3 ± 9.4	71.5	93.1
Bay Lodge	SCR RES	BAY_19	20/09/2019	Fyke Net	4	42.45953	-82.41061	88.6 ± 4.4	84.2	94.1
Casilco North	SCR RES	CSN_17	31/07/2017	Fyke Net	4	42.48899	-82.41789	65.4 ± 7.3	58.4	72.2
Casilco North	SCR RES	CSN_18	27/08/2018	Fyke Net	4	42.48859	-82.41832	75.8 ± 8.7	64.2	85.2

Site Name	Grouping	Site Code	Sampling Date	Gear	Effort	Latitude	Longitude	Mean ± SD	Min	Max
Casilco North	SCR RES	CSN_19	17/09/2019	Fyke Net	4	42.48853	-82.41835	76.9 ± 12.6	63.7	92.5
Casilco South	SCR RES	CSS_17	02/08/2017	Fyke Net	4	42.48089	-82.41514	73.0 ± 16.4	56.0	93.9
Casilco South	SCR RES	CSS_18	29/08/2018	Fyke Net	4	42.47993	-82.41499	78.4 ± 10.8	64.6	88.5
Casilco South	SCR RES	CSS_19	18/09/2019	Fyke Net	4	42.48042	-82.41432	78.2 ± 15.9	55.7	90.8
Griffore Marsh	SCR RES	GFM_17	28/06/2017	Fyke Net	4	42.52053	-82.41242	74.5 ± 16.5	51.2	87.3
Griffore Marsh	SCR RES	GFM_18	27/08/2018	Fyke Net	4	42.52405	-82.41171	67.6 ± 5.6	62.6	73.9
Griffore Marsh	SCR RES	GFM_19	24/09/2019	Fyke Net	4	42.51995	-82.41233	77.1 ± 7.9	66.3	85.3
Rex Club	SCR RES	REX_17	01/08/2017	Fyke Net	4	42.48472	-82.41654	74.9 ± 26.3	36.8	95.9
Rex Club	SCR RES	REX_18	28/08/2018	Fyke Net	4	42.48394	-82.41556	80.5 ± 12.4	64.8	93.9
Rex Club	SCR RES	REX_19	18/09/2019	Fyke Net	4	42.48539	-82.41717	72.0 ± 10.3	60.0	84.7
Moon Cove/Tic Tac	SCR AOC	MCT_17	14/08/2017	Fyke Net	4	42.44958	-82.41710	70.4 ± 11.3	55.4	81.9
Moon Cove/Tic Tac	SCR AOC	MCT_18	30/08/2018	Fyke Net	4	42.44928	-82.41756	74.6 ± 19.2	52.6	97.4
Moon Cove/Tic Tac	SCR AOC	MCT_19	19/09/2019	Fyke Net	4	42.44906	-82.41763	85.0 ± 2.6	83.0	88.8
Running Creek	SCR AOC	SRC_17	26/06/2017	Fyke Net	2	42.60493	-82.47028	63.2 ± 11.1	55.4	71.1
Snye River	SCR AOC	SRM_17	26/06/2017	Fyke Net	4	42.59959	-82.47772	59.6 ± 11.3	43.0	68.1
Bass Bay	Walpole	WBB_15	21/07/2015	Fyke Net	7	42.50399	-82.55982	80.0 ± 9.3	64.6	94.6
Chematogan Channel	Walpole	WCC_15	17/07/2015	Fyke Net	8	42.52880	-82.54850	77.3 ± 11.9	65.7	95.4
Little Bass Bay	Walpole	WLB_15	19/07/2015	Fyke Net	7	42.50168	-82.54885	78.4 ± 5.4	67.0	84.3
Little Strahns Bay	Walpole	WLS_15	10/08/2015	Fyke Net	4	42.53716	-82.57576	59.8 ± 8.4	51.1	70.1
Pocket Bay	Walpole	WPB_15	22/07/2015	Fyke Net	6	42.53345	-82.61348	77.3 ± 8.0	68.4	89.4
Snooks Lake	Walpole	WSL_15	11/08/2015	Fyke Net	6	42.52943	-82.56522	81.3 ± 7.0	72.4	89.5
Upper Johnston Marsh	Walpole	WUJ_15	12/08/2015	Fyke Net	6	42.55527	-82.44417	69.5 ± 15.2	51.5	94.4
Volkswagon Bay	Walpole	WVB_15	09/08/2015	Fyke Net	6	42.51069	-82.55563	74.4 ± 8.2	63.7	84.5
West Basset Braid	Walpole	WWB_15	10/08/2015	Fyke Net	2	42.52866	-82.57436	61.9 ± 6.3	57.4	66.4

Table 2. Total catch for each species at each site from summer 2017 Detroit River fish community surveys. The gear type used at each site (EF = electrofishing, FN = fyke net), total catch, and species richness (excluding hybrids and unidentified species) are also presented.

	Boblo Dock	Boblo Island	Crystal Bay	Fight. Island End	Fight. Island Side	Lower Canard	Peche Channel	Peche Head	Peche Inner	Turkey Creek
Gear	**EF**	**EF**	**EF**	**EF**	**EF**	**FN**	**EF**	**EF**	**EF**	**FN**
Bigmouth Buffalo					1					
Black Buffalo	7			1					12	
Black Crappie	1					22				1
Blacknose Shiner							1		1	
Bluegill	5		106			256		1	15	437
Bluntnose Minnow			2						1	4
Bowfin	3	2	1			2			8	8
Brook Silverside	2	3								
Brown Bullhead						4				6
Channel Catfish		1		1						
Common Carp	4	1	1	7	4	3		1	5	4
Common Carp x Goldfish	5	2	1		3					
Common Shiner		2	1							
Emerald Shiner		3			1		18	4		
Fathead Minnow									2	
Freshwater Drum	4	2		2	9	1	1	3		
Gizzard Shad		1	1	2	1	2				288
Golden Shiner									23	
Goldfish	2	1		1					1	
Grass Pickerel									2	
Greater Redhorse		1								
Green Sunfish						12				57
Hornyhead Chub	2	1								
Largemouth Bass	16		14	2	2	41		1	19	256
Lepomis spp.		1				919				237
Logperch			5		6			25		
Longnose Gar	2			1	5	7				
Mimic Shiner	10	71	2		124		2	14		
Mottled Sculpin								1		
Northern Hog-Sucker								2		

	Boblo Dock	Boblo Island	Crystal Bay	Fight. Island End	Fight. Island Side	Lower Canard	Peche Channel	Peche Head	Peche Inner	Turkey Creek
Gear	**EF**	**EF**	**EF**	**EF**	**EF**	**FN**	**EF**	**EF**	**EF**	**FN**
Northern Pike		1				2			1	4
Northern Sunfish										118
Pugnose Minnow						1				
Pumpkinseed	19		3			24			31	83
Rainbow Darter								1		
River Chub		9					1			
Rock Bass	11	22	35	1	3	1	9	5	13	63
Round Goby			1			1				5
Shorthead Redhorse	3	2	1		2		1	3		
Silver Redhorse	1	3			1					
Smallmouth Bass	3	35	2		3		7	16		
Smallmouth Buffalo				2						
Smallmouth Buffalo x Black Buffalo			1	1	2					
Spottail Shiner	1						5	2	9	
Spotted Sucker			4			3				9
Tubenose Goby										86
Walleye	1	11						1		
White Crappie						3				
White Sucker	7	3					1		4	
Yellow Bullhead						5				17
Yellow Perch	32	12	9	7	43	1	27	2	52	43
Total Catch	141	190	190	28	210	1310	73	82	199	1726
Species Richness	21	21	16	11	14	19	11	16	17	18

Table 3. Total catch for each species at each site from summer 2017 St. Clair River fish community surveys. All fish were collected using fyke nets. For each site, total catch and species richness (excluding hybrids and unidentified species) are also presented.

	Bay Lodge	Casilco Marsh	Casilco South	Griffore Marsh	Rex Club	Running Creek	Snye River	Stag Island	Tictac Point
Banded Killifish			1						
Black Buffalo						2	2		
Black Crappie	1			1	1				4
Blackchin Shiner	2				2				1
Blacknose Shiner	4			4		3	1	10	
Blackstripe Topminnow						1			
Bluegill	64	212	19	195	87	11	2	52	128
Bluntnose Minnow	8								
Bowfin	2		4	7	12		1		1
Brown Bullhead	1	1	2		6				2
Central Mudminnow							3	2	
Channel Catfish	1								
Common Carp		2		2	3				
Darter spp.						1			
Emerald Shiner							4		
Freshwater Drum				1					
Gizzard Shad		22	2		14				
Golden Shiner			1					1	
Grass Pickerel						1	1		
Green Sunfish	1			11		1	1	24	24
Largemouth Bass	32	175	18	5	92	2	5	2	48
Lepomis spp.	15	291	304		195				
Logperch	3								
Longnose Gar	2				1		1		
Northern Pike				1			1	2	1
Northern Sunfish					1				
Pugnose Shiner	1			31	1				
Pumpkinseed	15	254	22	30	19	3	6	139	50
Pumpkinseed x Bluegill								1	
Rock Bass	32	3	8	4	4	3	7	9	2
Round Goby			3						
Spottail Shiner	4		5						
Spotted Sucker				2		1	2		

	Bay Lodge	Casilco Marsh	Casilco South	Griffore Marsh	Rex Club	Running Creek	Snye River	Stag Island	Tictac Point
Tadpole Madtom				2		1		1	
Tubenose Goby	1			2			1		
White Perch	65								
Yellow Bullhead	2	4	7	1	19		2		6
Yellow Perch	12	3	2	3	4	1	25	4	6
Total Catch	268	967	398	302	461	31	65	247	273
Species Richness	20	9	13	17	15	12	17	11	12

Table 4. Total catch for each species at each site from summer 2018 St. Clair River fish community surveys. All fish were collected using fyke nets. For each site, total catch and species richness (excluding hybrids and unidentified species) are also presented.

	Bay Lodge	Casilco Marsh	Casilco South	Griffore Marsh	Rex Club	Snye River	Stag Island	Tictac Point
Gear	**FN**	**FN**	**FN**	**FN**	**FN**	**FN**	**FN**	**FN**
Banded Killifish	2	1	4					4
Black Bullhead								4
Black Crappie	1	5			2	1		10
Blackchin Shiner	1		1	1			17	3
Blacknose Shiner	15		35					
Bluegill	683	244	493	82	638	10	33	2439
Bluntnose Minnow	100		9		1	7		
Bowfin	4	4	10		7	1	1	3
Brook Silverside	2	3	9	4	3	23		1
Brown Bullhead	1		1	4	3			1
Central Mudminnow						1	1	
Common Carp			1	1	2			
Gizzard Shad		1						2
Golden Shiner	62	1	3	3	9	4	4	352
Grass Pickerel				1				
Green Sunfish		2						1
Hybrid Lepomis						1	41	
Largemouth Bass	24	219	15	48	60	5	4	281
Lepomis spp.			1	2		6	230	
Logperch	1							
Longnose Gar	5	1				1		1
Northern Pike				2		2	8	1
Pugnose Shiner						1		3
Pumpkinseed	85	310	84	81	312	3	137	1069
Rock Bass	112	6	33	3	16	10		2
Round Goby		4	1		1			
Spottail Shiner	51					6		
Spotted Sucker	1			1		1	1	
Tadpole Madtom		1				1	1	
Tubenose Goby	2					1		
White Crappie				1				
Yellow Bullhead	8			2	3	2		9

Gear	Bay Lodge FN	Casilco Marsh FN	Casilco South FN	Griffore Marsh FN	Rex Club FN	Snye River FN	Stag Island FN	Tictac Point FN
Yellow Perch	7	1	2	3	4	10	7	21
Total Catch	1167	803	702	239	1061	97	485	4207
Species Richness	20	15	15	15	14	19	11	19

Table 5. Total catch for each species at each site from summer 2019 St. Clair River fish community surveys. All fish were collected using fyke nets. For each site, total catch and species richness (excluding hybrids and unidentified species) are also presented. Stag Island was not sampled in 2019 as the site could not be safely accessed.

	Bay Lodge	Casilco Marsh	Casilco South	Griffore	Rex Club	Snye River	Tictac Point
Gear	**FN**	**FN**	**FN**	**FN**	**FN**	**FN**	**FN**
Banded Killifish	1	1			2		1
Black Crappie	13	10	3	2	3	1	7
Blackchin Shiner	10		8				13
Blacknose Shiner	11		36				
Bluegill	901	1253	295	98	185	10	2488
Bluntnose Minnow	119		29	2	6		2
Bowfin	5	1	4	5	4	4	2
Brook Silverside	77	314	15	57	7		6
Channel Catfish				1			
Common Carp	3	1			1		
Emerald Shiner				4			
Gizzard Shad	4	42	9	2	5		4
Golden Shiner	9	38		1	2	1	75
Goldfish					1		
Green Sunfish			1			1	
Lake Chubsucker						49	
Largemouth Bass	16	111	29	9	39	23	17
Logperch	7	25	1		2		1
Longnose Gar			1				
Northern Pike		2		1		1	
Pugnose Shiner	4			1			10
Pumpkinseed	84	168	53	13	32	5	117
Rock Bass	86	8	25		12	5	31
Round Goby		2	3		6		1
Spotfin Shiner					1		
Spottail Shiner	3			18			
Spotted Sucker		1	1	9		1	
Tadpole Madtom	1		1	1	1		1
Tubenose Goby	1		1	1		1	2
White Perch			1	1	5		
Yellow Bullhead	1		2	4	1	1	4
Yellow Perch	62	226	37	5	24	7	26

	Bay Lodge	Casilco Marsh	Casilco South	Griffore	Rex Club	Snye River	Tictac Point
Gear	**FN**	**FN**	**FN**	**FN**	**FN**	**FN**	**FN**
Total Catch	1356	1977	518	230	315	103	2782
Species Richness	21	16	21	20	20	14	19

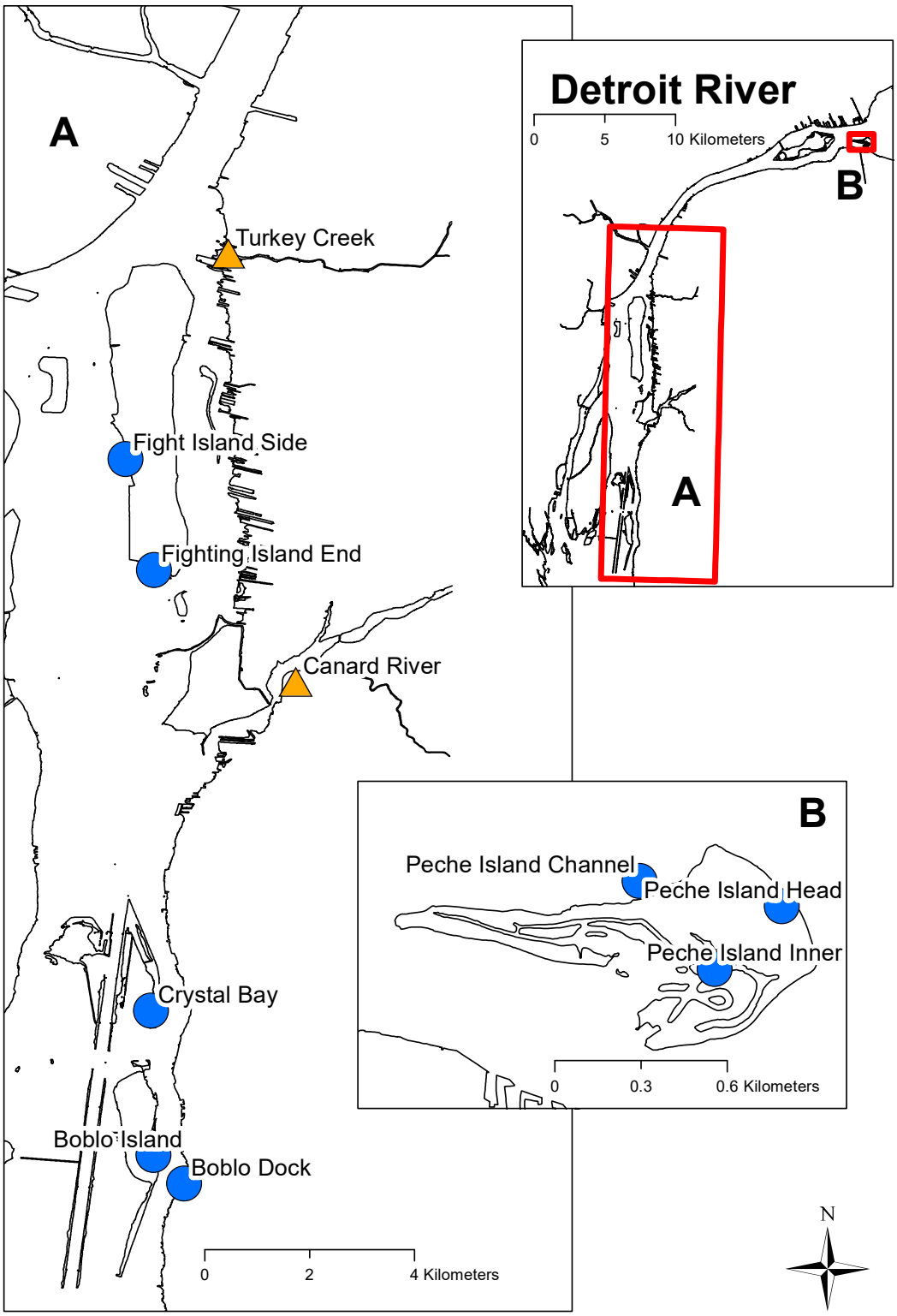

Figure 1. Location of sampling sites in the Detroit River Area of Concern. Sites are coded based on the gear used during the survey (electrofishing = blue circle, fyke netting = orange triangle).

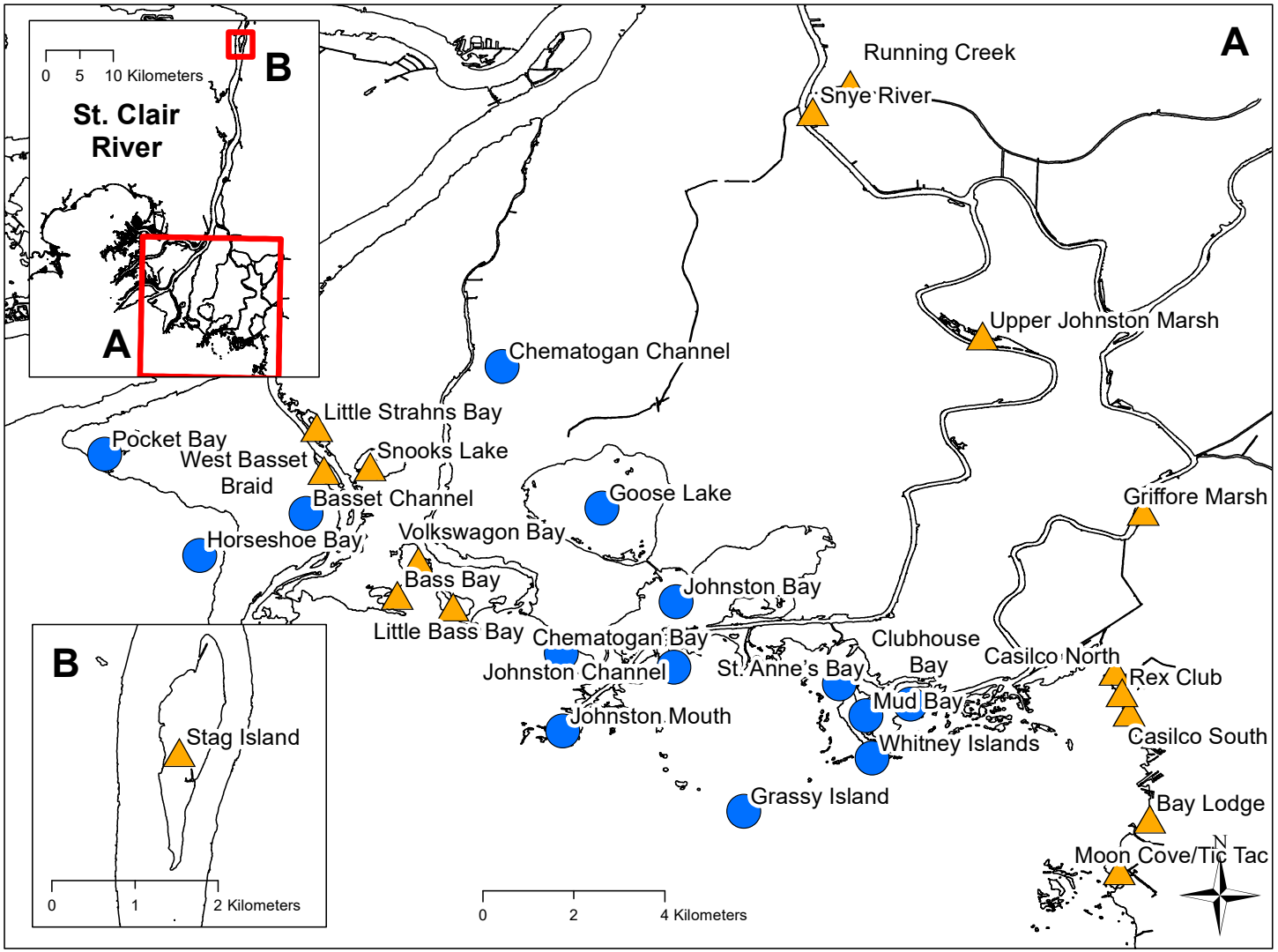

Figure 2. Location of sampling sites in the St. Clair River Area of Concern and Walpole Island Delta. Sites are coded based on the gear used during the survey (electrofishing = blue circle, fyke netting = orange triangle).

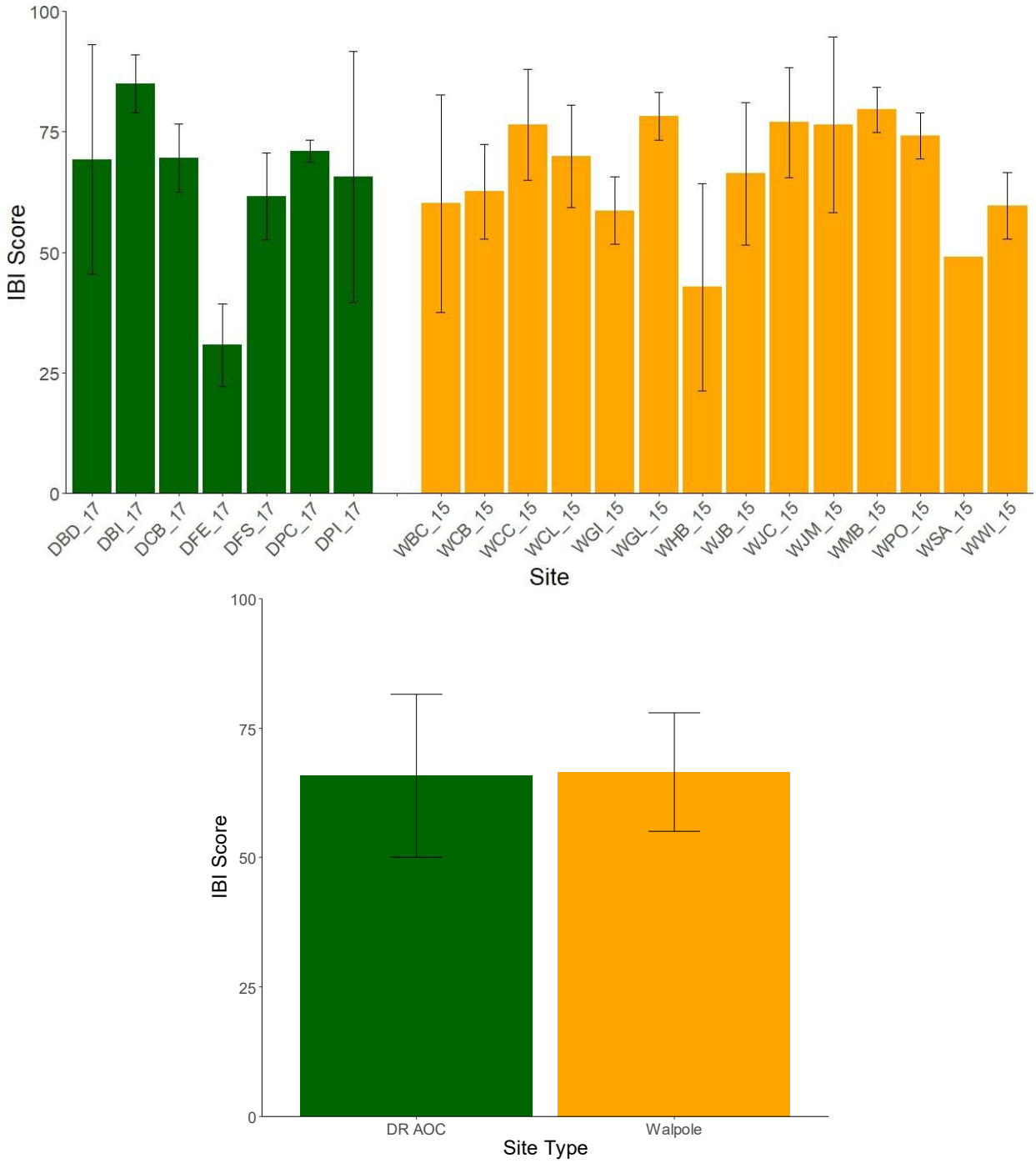

Figure 3. Mean Index of Biotic Integrity (IBI) score (with standard deviation[SD]) for each site surveyed using electrofishing in the Detroit River Area of Concern (green) and Walpole Island Delta (yellow; top panel). Overall mean IBI score (with SD) for each group surveyed using electrofishing in the Detroit River Area of Concern (green) and Walpole Island Delta (yellow; bottom panel).

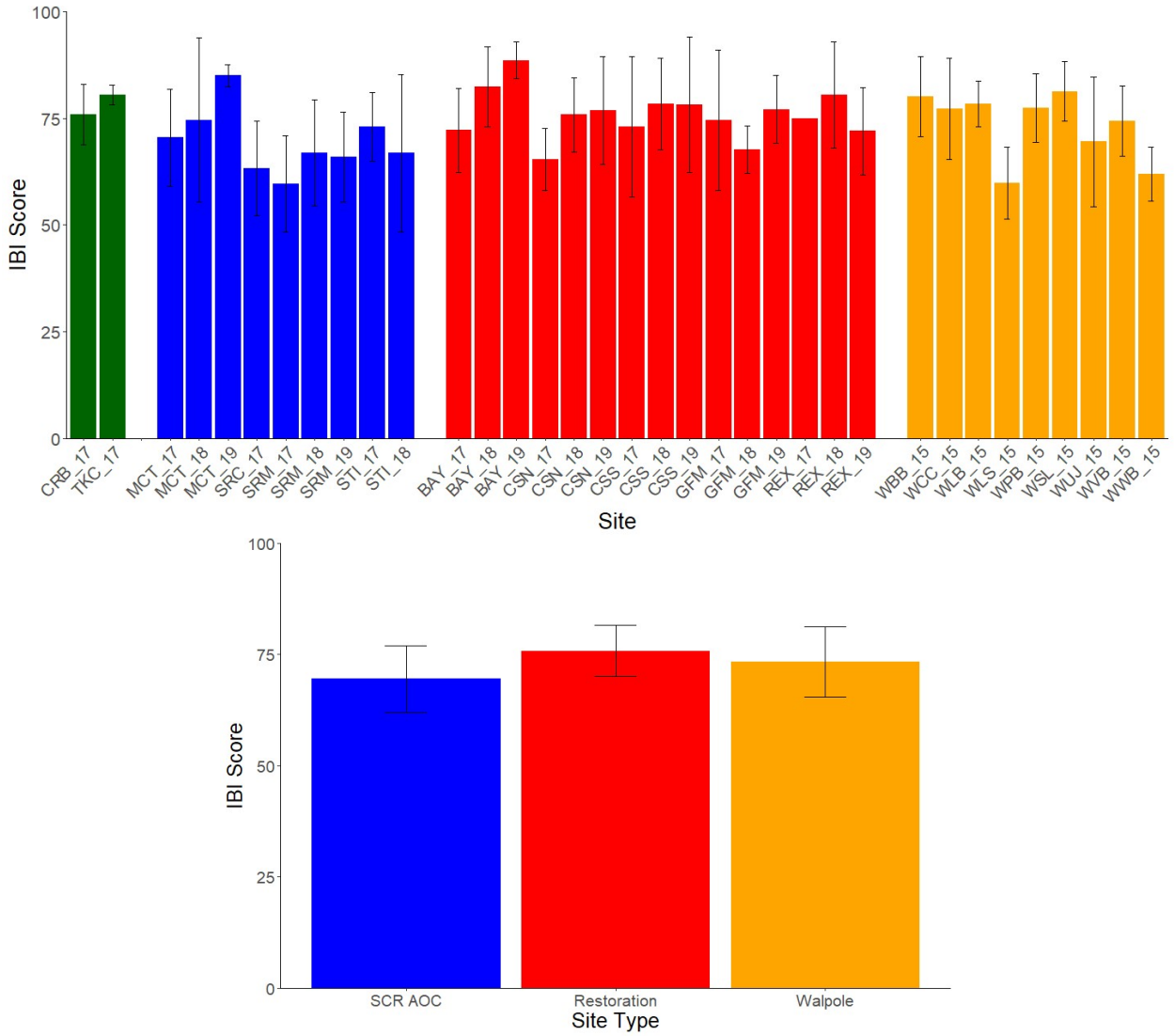

Figure 4. Mean IBI score (with standard deviation[SD]) for each site surveyed using fyke nets in the Detroit River Area of Concern (green), St. Clair River Area of Concern (blue), restored sites in the St. Clair River Area of Concern (red), and Walpole Island Delta (yellow; top panel). Overall mean IBI score (with SD) for each group surveyed using fyke nets (bottom panel, colour patterns are the same as the top panel).