Sub-Indicator: Coastal Wetland Invertebrates

Overall Assessment

Status: Fair (2020-2022)

Trends:

10-Year Trend (2013-2022): No Trend

Long-term Trend (2011-2022): No Trend

Rationale: As of 2022, the majority of wetlands were not classified as degraded based on their Indices of Biotic Integrity (IBI) scores. From 2013 to 2022 the number of sites placed in the degraded categories (extremely degraded, degraded, and moderately degraded) remained between 14% and 30% of all sites that received macroinvertebrate IBI scores each year across the Great Lakes basin. There has been no consistent increase or decrease in any of the of IBI classifications at the basin level or the mean IBI score within lakes (Figures 1 and 2) over the past ten years However, there is high variability in the data resulting in No Trend. There is still a low percentage of samples in Lakes Ontario and Erie that are associated with IBI scores (~5%, Table 1). Development of macroinvertebrate IBIs for additional vegetation zones is in the works which will bring up those percentages.

Lake-by-Lake Assessment

Lake Superior

Status: Fair (2020-2022)

10-Year Trend (2013-2022): No Trend

Long-term Trend (2011-2022): No Trend

Rationale: The vast majority of Lake Superior coastal wetlands are not in the degraded categories based on IBI scores for both the 10-year and long-term trends (Figures 3 and 4). From 2013 to 2022 the percentage of wetland sites in the degraded categories has remained between 0% and 30% of Lake Superior sites that received macroinvertebrate IBI scores annually. In 2015, 2016, 2017, 2019 and 2020 no sites were categorized as reference condition. The year 2020 may not be representative of the entire lake because some sites weren't sampled due to safety concerns with the Covid-19 pandemic.

Lake Michigan

Status: Fair (2020-2022)

10-Year Trend (2013-2022): No Trend

Long-term Trend (2011-2022): No Trend

Rationale: The majority of Lake Michigan coastal wetlands are not in the degraded categories based on IBI scores for both the 10-year and long-term trends (Figures 5 and 6). From 2013 to 2022 the percentage of sites in the degraded categories (moderately degraded, degraded, extremely degraded) has remained between 0% and 58% of the Lake Michigan sites that received macroinvertebrate IBI scores. There continues to be no sites categorized as extremely degraded. There is no obvious change in the proportion of the sites in the degraded categories overtime with high variability resulting in No Trend. The year 2020 may not be representative of the entire lake because some sites weren't sampled due to safety concerns with the Covid-19 pandemic.

Lake Huron (including St. Marys River)

Status: Fair (2020-2022)

10-Year Trend (2013-2022): No Trend

Long-term Trend (2011-2022): No Trend

Rationale: The majority of Lake Huron coastal wetlands are not in the degraded categories based on their IBI scores for both the 10-year and long-term trends (Figures 7 and 8). From 2013 to 2022 the percentage of sites in the degraded categories (moderately degraded, degraded, extremely degraded) has remained between 0% and 35% of the Lake Huron sites that received macroinvertebrate IBI scores. There is no trend in the average site IBI score for the lake, although in the past several years most of the sites are consistently in the middle range of site quality (moderately degraded, moderately impacted, mildly impacted). Approximately a third of the Lake Huron sites are located in the St. Mary's River. These river sites have a comparable range of site quality (moderately degraded to reference) to other areas in northern Lake Huron (Figure St. Mary's).

Lake Erie (including St. Clair-Detroit River Ecosystem)

Status: Undetermined (2020-2022)

10-Year Trend (2011-2022): Undetermined

Long-term Trend (2011-2022): Undetermined

Rationale: Status and trends could not be determined for Lake Erie as only 10 samples (5% of sampling events, Table 1) had the required vegetation zones for IBI calculations in the previous 12 years.

Lake Ontario (including Niagara River and International section of the St. Lawrence River)

Status: Undetermined (2020-2022)

10-Year Trend (2011-2022): Undetermined

Long-term Trend (2011-2022): Undetermined

Rationale: Status and trends could not be determined for Ontario as only 17 samples (5% of sampling events, Table 1) had the required vegetation zones for IBI calculations in the previous 12 years.

Status Assessment Definitions

Good: No wetlands are in the degraded categories but instead fall within reference conditions, mildly impacted, or moderately impacted.

Fair: The vast majority of the wetlands are not in the degraded categories.

Poor: The vast majority of the wetlands are in the degraded categories.

Undetermined: Data are not available or are insufficient to assess condition of the ecosystem components.

Trend Assessment Definitions

Improving: This metric increased in score for the majority of the sites.

Unchanging: This metric score did not substantially change for the majority of the sites.

No Trend: A sufficient amount of data are available but the trend is not statistically Improving or Deteriorating due to high variability in the data.

Deteriorating: This metric decreased in score for the majority of the sites.

Undetermined: Metrics do not indicate a clear overall trend, or data are not available to report on a trend.

Endpoints and/or Targets

The endpoint for this sub-indicator will need to be established, based on a literature search of current and historical data, if available, or from data gathered from measuring this sub-indicator. Data would be evaluated for patterns by lake, wetland type, and ecoregion, and then calibrated against the monitoring objectives based on the professional judgement of those with expertise in the field. An endpoint for this sub-indicator is not possible at this time, but the planned expansion of the macroinvertebrate IBI to additional vegetation zones will be an important step in establishing targets. Currently, researchers associated with the Great Lakes Coastal Wetland Monitoring Program are working to establish macroinvertebrate IBI scoring systems for wetlands that are dominated by common vegetation types, including *Typha*, *Phragmites*, and floating leaf species.

Sub-Indicator Purpose

The purpose of this sub-indicator is to assess the diversity of the invertebrate community, especially aquatic insects; to track the trends of Great Lakes coastal wetland ecosystem condition by measuring relative community composition of macroinvertebrates; and to infer water quality, habitat suitability, and biological integrity of Great Lakes coastal wetlands.

Ecosystem Objective

This sub-indicator best supports work towards General Objective #5 of the 2012 Great Lakes Water Quality Agreement which states that the Waters of the Great Lakes should “support healthy and productive wetlands and other habitats to sustain resilient populations of native species.
Coastal Wetland habitats are critical areas for many invertebrate species of ecological importance. Conservation of remaining coastal wetlands and restoration of previously destroyed wetlands are vital components of restoring the Great Lakes ecosystem and this sub-indicator can be used to report progress toward such an objective.”

Significant wetland areas in the Great Lakes system that are threatened by urban development, agricultural development and waste disposal activities should be identified, preserved and, where necessary, rehabilitated. Conducting monitoring activities will gather definitive information on the location, severity, extent, and frequency of degradation of aquatic habitat in coastal wetlands. This sub-indicator supports the restoration and maintenance of the chemical, physical and biological integrity of the Great Lakes basin and beneficial uses dependent on healthy wetlands (Annex 1 GLWQA). Wetland macroinvertebrate IBI scores can be used for identifying wetlands that have sensitive taxa or high diversity, and therefore, should be considered for preservation. IBI scores can also identify areas that are good candidates for restoration, for example, a wetland with a low IBI score that has other desirable qualities (high recreation potential, a diverse vegetative community, etc.) may benefit from interventions to improve water quality.

Methods

This sub-indicator uses the relative abundance and richness of sensitive taxa, tolerant taxa, and community diversity of aquatic macroinvertebrates in an index of biotic integrity to assess wetland condition. The IBI was developed originally by the Great Lakes Coastal Wetland Consortium (GLCWC) in 2002, published in 2004 (Uzarski et al. 2004) and protocols were finalized in 2008 (GLCWC 2008). In an effort to control for variation in macroinvertebrate communities due to natural differences in habitat structure, the IBI is based on macroinvertebrate sampling at the vegetation zone level. Currently, the IBI can be applied to wetlands that have mono-dominant zones of *Schoenoplectus spp.* (formerly *Scripus spp.*) and/or zones dominated by wet meadow species (*Poaceae* and *Carex spp.*). IBI metrics for other common vegetation zones including *Typha* and *Phragmites* are in development. Table 3 shows the IBI scoring system for the current published zones, which were used in this report. For more information on the development of the metrics used in the IBI see Uzarski et al 2004.

The scores presented here were calculated using the data collected through the Great Lakes Coastal Wetland Monitoring Program. A sub-set of all coastal wetlands that meet program size and hydrologic criteria are sampled each year, with the majority of qualifying sites sampled over a 5-year period. The annual site selection scheme is designed in order to capture lake, regional, and geomorphic variation within each year. In addition to the sites selected through the stratified selection scheme, a number of benchmark sites are sampled for either long term reference or to assist in restoration efforts. More information on the sampling design and data collection methods is found in the Great Lakes Coastal Wetland Monitoring Program Quality Assurance Project Plan (GLCWMP QAPP) at greatlakeswetlands.org/Sampling-protocols.

Macroinvertebrate samples are collected at three replicate locations within up to four mono-dominant vegetation zones (wet meadow, *Typha spp.*, *Phragmites*, Lily, *Schoenoplectus spp.*, submergent aquatic vegetation, etc.) in each wetland site. Invertebrates are collected by sweeping the water column and sediment with dip nets, placing net contents into gridded trays, and picking out the invertebrates in a set time in accordance with standard Great Lakes Coastal Wetlands Monitoring Program (GLCWMP) protocols, which can be found at greatlakeswetlands.org/Sampling-protocols. Invertebrates are preserved in ethanol and identified to a predetermined lowest operational taxonomic unit, which is genus for most insects, and family or order for most non-insects.

After identification, invertebrate data are uploaded into the project database housed at greatlakeswetlands.org. Metrics and IBI scores are calculated for each site that has *Schoenoplectus spp.* and/or wet meadow zones. Depending on which zones are present an IBI score between 1-6 and qualitative category “extremely degraded” to “reference” is calculated based on the sum of the scores of all zones compared to the total possible scores (GLCWMP QAPP).

Many sites that are sampled do not have *Schoenoplectus spp.* or wet meadow zones, and therefore, are not associated with an IBI score. For a lake to be assigned a status in this report at least 50% of the sites sampled by the GLCWMP needed to be given an IBI score, and to be assigned a trend at least 50% of the sites sampled each year needed to be associated with an IBI score.

Discussion

Coastal wetlands trap, process, and remove nutrients and sediment from Great Lakes nearshore waters. However, over half of all Great Lakes coastal wetlands have been destroyed by human activities and many remaining coastal wetlands suffer from anthropogenic stressors such as nutrient and sediment loading, fragmentation, invasive

species, shoreline alteration, and water level control, as documented by a binational Great Lakes-wide mapping project (Albert and Simonson 2004; Ingram and Potter 2004).

To restore/maintain the overall biological integrity of Great Lakes coastal wetlands, both biotic and physical function need to be represented through monitoring efforts. Coastal wetland macroinvertebrates are an important component to both wetland and pelagic food webs (Sierszen et al. 2014). Their community composition can carry signs of intermittent anthropogenic disturbances that may not be visible at the time of sampling. Macroinvertebrate communities often correlate with factors such as water depth, vegetation, and sediment type (Cooper et al. 2014) and vary greatly within a single wetland providing insight into the diversity of habitats present.

Since 2011 the GLCWMP has sampled approximately 200 wetlands annually, funded by the Great Lakes Restoration Initiative (GLRI) through 2025 (about $2 million per year). On average 120 of those are sampled for macroinvertebrates because they meet protocol requirements, are accessible to crews and are selected as part of the statistical sampling design. In 2020, 106 sites were sampled, 121 sites in 2021, and 117 sites in 2022. As of 2022, more than 600 distinct wetland sites have been sampled for macroinvertebrates, many have been sampled more than one time meaning that there have been over 1,400 macroinvertebrate sampling events in total. This report focuses on sampling events that occurred within the GLCWMP statistically designed sampling scheme, with 623 distinct wetland sites and 1,434 sampling events (Tables 1 and 2).

As of 2022, the average number of macroinvertebrate taxa (taxa richness) per site was 38 for Canadian sites and 37 for US sites, but wetlands with high richness had twice this number or more (Table 2). The average number of non-native invertebrate taxa in coastal wetlands was less than 1, with a maximum of no more than 5. It is important to note that the one-time sampling method used at coastal wetland sites may not be capturing all of the non-native taxa and it is not necessarily intended to. Furthermore, some non-native macroinvertebrates are very cryptic, may resemble native taxa, and may not yet be recognized as invaders to the Great Lakes.

Comparing taxa richness within lakes, Lake Ontario and Lake Erie the average taxa richness was approximately 33 and 34 respectively, while Lakes Huron and Michigan averaged approximately 40 and 39 taxa respectively, and Lake Superior 42 (Table 1). While Lake Ontario and Lake Erie have few sites with IBI scores, they appear to have consistently lower taxa richness. It is predicted that when IBI are developed for the vegetation zones that dominate these lakes (*Typha* spp.) that they will on average score lower than Lakes Huron, Michigan, and Superior.

Patterns are likely driven by differences in habitat complexity, which may in part be due to the loss of wetland habitats on Lakes Erie and Ontario from diking and water level control, respectively. There is little variability among lakes in non-native taxa occurrence, although Lakes Huron and Erie had wetlands with 4-5 non-native taxa, which was slightly higher than other lakes. In each lake, a portion of wetlands had only native taxa; however, as noted above, this does not necessarily mean that these sites do not harbor non-native macroinvertebrates.

Lakes Michigan and Huron both have a wide distribution of site quality. Both lakes have multiple degraded sites, but also the some of the most taxa rich sites and those with high IBI scores (Figure 6 and Figure 8). The maximum number of invertebrate taxa was higher in Lakes Huron and Michigan wetlands (>=80) than for the most invertebrate-rich wetlands in other lakes, which have a maximum closer to 70 taxa (Table 1).

Invertebrates are less mobile than fish and reflect a more localized scale of disturbance. Invertebrates are also associated with more zones that fish cannot access, and therefore, coastal wetland invertebrates and fish cannot be expected to show the same trends.

Many of the sites in Lakes Erie and Ontario only contained submersed aquatic vegetation, *Phragmites*, or *Typha* and therefore the IBIs cannot be used in those areas at this time, but scores for other zones will be available for all years of the project once IBIs for these vegetation zones are developed.

Linkages

Physical alteration and eutrophication of wetland ecosystems continue to be a threat to invertebrates of Great Lakes coastal wetlands. Both can promote establishment of non-native vegetation, and physical alteration can destroy plant communities altogether while changing the natural hydrology of the system. Invertebrate community composition is directly related to vegetation type and densities; changing either of these components will negatively impact the invertebrate communities.

Linkages to other sub-indicators in the indicator suite include:

- Hardened Shorelines – physical modifications to the shoreline have disrupted coastal and nearshore processes, flow and littoral circulatory patterns, altered or eliminated connectivity to coastal wetlands/dunes, and have altered nearshore and coastal habitat structure.
- Along many coastal wetlands, residential development has altered wetlands by nutrient enrichment from fertilizers and septic systems, shoreline alterations for docks and boat slips, filling, and shoreline hardening. Shoreline hardening can eliminate wetland vegetation, particularly during periods of high-water levels when vegetation communities cannot move landward. Robust vegetation stands are key for wetland macroinvertebrate habitat.
- Mechanical alteration takes a diversity of forms, including diking, ditching, dredging, filling, and shoreline hardening. With all of these alterations, non-native species are introduced by construction equipment or in introduced sediments. Changes in shoreline gradients and sediment conditions are often adequate to allow non-native species to become established (see below).
- Land Use – Agriculture degrades wetlands in several ways, including nutrient enrichment from fertilizers, increased sediments from erosion, increased rapid runoff from drainage ditches, introduction of agricultural non-native species and destruction of inland wet meadow zone by plowing and diking, and addition of herbicides.

  Great Lakes Wetland invertebrate communities have been shown vary with the percent agriculture in the surrounding watershed (Cooper et al. 2014) as well as with proximity to agricultural drainage ditches (Schock et al. 2014). It is currently hypothesized that nutrient and sediment pollution from agricultural runoff impact macroinvertebrate community structure by changing the food web structure or favoring tolerant taxa. Agricultural runoff may also promote the establishment of invasive vegetation like *Typha angustifolia* and *Phragmites australis* which also may impact aquatic macroinvertebrate structure.
- Urban development degrades wetlands by hardening shoreline, filling wetland, adding a broad diversity of chemical pollutants, increasing stream runoff, adding sediments, and increased nutrient loading from sewage treatment plants. In most urban settings, almost complete wetland loss has occurred along the shoreline. Because of this the impacts of urban or industrial development on coastal wetland macroinvertebrates is less understood.
- Impact of Aquatic Invasive Species – Non-native species are introduced in many ways. Some were purposefully introduced as agricultural crops or ornamentals, later colonizing in native landscapes. Others came in as weeds in agricultural seed. Increased sediment and nutrient enrichment allow many of the worst aquatic weeds to out-compete native species. Most of the worst non-native species are either prolific seed producers or reproduce from fragments of root or rhizome. The transformation of wetlands, like those in Saginaw Bay, from majority native *Schoenoplectus spp.* to majority invasive *Phragmites,* will have

changed physical habitat structure and food web dynamics. It has been shown that patches of invasive *Typha spp* have differences in macroinvertebrate community structure and lower total macroinvertebrate biomass relative to surrounding native vegetation in the same wetland complex, possibly due to changes in habitat complexity, water chemistry characteristics, or food web changes (Lawrence et al. 2016).

Non-native animals have also been responsible for increased degradation of coastal wetlands. The faucet snail (*Bithynia tentaculata*) is an example of a prolific macroinvertebrate invader of particular interest to U.S. Fish and Wildlife Service and others because it carries parasites that can cause disease and die-offs of waterfowl.

- Precipitation Amounts in the Great Lakes Basin – Change in atmospheric temperature will potentially affect the number of extreme storms in the Great Lakes region which may, in turn, affect coastal wetlands. Extreme storms would likely affect riverine systems the most through increased sediment movements, particularly in flashy watersheds. Increased sedimentation can interfere with respiratory organs of more sensitive macroinvertebrate taxa.
- Water Levels – Water level change has strong influences on Great Lakes habitat and biological communities associated with Coastal Wetlands. Lake levels have a major influence on undiked coastal wetlands and are basic to any analysis of wetland trends. Water levels influence the vegetation structure in wetlands which in turn structure the habitat available for macroinvertebrates. Altered water levels will also influence the spread of invasive plant species, such as *Phragmites*, that can take over native vegetation stands and alter habitat available to macroinvertebrates and other organisms.
- This sub-indicator links directly to the other sub-indicators in the Habitats and Species category, particularly the other Coastal Wetlands-related sub-indicators. Individual IBIs, such as the fish IBI used in this assessment, are useful as independent indicators, but evaluation of this indicator in combination with the other coastal wetland indicators is key to an overall assessment of Great Lakes coastal wetland health. This is because the different sub-indicators function and indicate anthropogenic disturbance at different spatial and temporal scales and have varying resolution of detection. See greatlakeswetlands.org/Sampling-protocols for details on indicator metrics.

Assessing Data Quality

Data Characteristics	Agree	Neutral or Unknown	Disagree	Not Applicable
Data are documented, validated, or quality-assured by a recognized agency or organization	X			
Data are from a known, reliable and respected generator of data and are traceable to original sources	X			
Geographic coverage and scale of data are appropriate to the Great Lakes Basin	X			
Data obtained from sources within the U.S. are comparable to those from Canada	X			

Uncertainty and variability in the data are documented and within acceptable limits for this sub-indicator report	X			
Data used in assessment are openly available and accessible	Yes	Data can be accessed at: greatlakeswetlands.org		

Notes on Accessing Data

Data can be accessed at www.greatlakeswetlands.org by requesting an account at the top of the webpage. The level of access being requested and description of how the data will be used is required.

Data Limitations

The greatest limitation to the Great Lakes coastal wetland macroinvertebrate indicator is that the current published index of biotic integrity only covers sites that have wet meadow or bulrush vegetation zones. Table 1 shows that only around half of all sampling events have an associated IBI score, and in Lake Erie and Lake Ontario the ratio is even lower. This has been even more problematic as high-water levels and colonization by invasive plant species both can lower the number of *Schoenoplectus* and wet meadow zones. This limitation is currently being addressed with efforts to expand the IBI to include other common vegetation zones, which is expected to be completed before the next indicator report.

Additional Information

The invertebrate IBI is a multi-metric indicator, developed from a composite of specific parameters ("metrics") used to describe the invertebrate community structure, function, and abundance. The IBI provides a rigorous approach that quantifies the biological condition of the invertebrate community based on data from wetlands across a gradient of anthropogenic disturbance and stratified by region and wetland type. It is important to note that the invertebrate IBI has been developed for coastal wetlands that are directly connected to the Great Lakes, not for those wetlands that are connected hydrologically via groundwater only.

Work to update and expand the macroinvertebrate IBI is underway. These efforts will expand the vegetation zones for which IBIs can be calculated and increase the number of wetlands that can be evaluated based on macroinvertebrate communities.

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Table 1. The number of distinct sites sampled, number of sampling events, number of sampling events related to IBI scores macroinvertebrate total taxa and non-native species found in Great Lakes coastal wetlands by lake. Mean, maximum, and minimum number of taxa per wetland. Data from wetlands sampled 2011 through 2022.

Source: Great Lakes Coastal Wetland Monitoring Program (CWMP)

Table 2. The number of distinct sites sampled, number of sampling events (includes repeat sampling of sites), total macroinvertebrate taxa in Great Lakes coastal wetlands, and non-native species; summary statistics by country. Data from wetlands sampled 2011 through 2022.

Source: Great Lakes Coastal Wetland Monitoring Program (CWMP)

Table 3. Indices of biotic integrity metrics for dense *Schoenoplectus*, sparse *Schoenoplectus*, and wet meadow zones.

Source: Uzarski et al. 2004

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Figure 2. The mean IBI score for Lakes Erie and Ontario (A), Lakes Michigan and Huron (B), and Lake Superior (C) from 2011 to 2022, error bars show 95% confidence interval. The highest possible score is 6 which indicates reference conditions, and lowest possible score is 1 which indicates extreme degradation. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).

Figure 3. The count of all Lake Superior sites that fall into each IBI category based on the aquatic macroinvertebrate community each year between 2011 and 2022, n=68. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).

Figure 4. The condition of coastal wetland aquatic macroinvertebrate communities from 2011 to 2022 across Lake Superior. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).

Figure 5. The count of all Lake Michigan sites that fall into each IBI category based on the aquatic macroinvertebrate community each year between 2011 and 2022, n=92. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).

Figure 6. The condition of coastal wetland aquatic macroinvertebrate communities from 2011 to 2022 across Lake Michigan. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).

Figure 7. The count of all Lake Huron sites that fall into each IBI category based on the aquatic macroinvertebrate community each year between 2011 and 2022, n=317. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).

Figure 8. The condition of coastal wetland aquatic macroinvertebrate communities from 2011 to 2022 across Lake Huron. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).

Figure 9. The count of all Lake Erie sites that fall into each IBI category based on the aquatic macroinvertebrate community each year between 2011 and 2022, n=10. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).

Figure 10. The condition of coastal wetland aquatic macroinvertebrate communities from 2011 to 2022 across Lake Erie. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).

Figure 11. The count of all Lake Ontario sites that fall into each IBI category based on the aquatic macroinvertebrate community each year between 2011 and 2022, n=34. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).

Figure 12. The condition of coastal wetland aquatic macroinvertebrate communities from 2011 to 2022 across Lake Ontario. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).

Last Updated

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Table 1. The number of distinct sites sampled, number of sampling events, number of sampling events related to IBI scores macroinvertebrate total taxa and non-native species found in Great Lakes coastal wetlands by lake. Mean, maximum, and minimum number of taxa per wetland. Data from wetlands sampled 2011 through 2022.

Source: Great Lakes Coastal Wetland Monitoring Program (CWMP)

	Total Macroinvertebrate Taxa						Non-native Taxa		
Lake	# Sites	# Samples	# Sam-ples w/IBI	Mean	Max	Min	Mean	Max	Min
Erie	75	182	10	34	69	12	1	5	0
Huron	212	509	97	40	80	12	1.4	4	0
Michigan	102	236	65	39	86	14	0.9	3	0
Ontario	145	324	17	33	71	12	1.1	4	0
Superior	89	183	68	42	71	15	0.2	2	0

Table 2. The number of distinct sites sampled, number of sampling events (includes repeat sampling of sites), total macroinvertebrate taxa in Great Lakes coastal wetlands, and non-native species; summary statistics by country. Data from wetlands sampled 2011 through 2022.

Source: Great Lakes Coastal Wetland Monitoring Program (CWMP)

Country	#Sites	#Samples	Mean	Max	Min	St. Dev
Overall						
Canada	217	473	38	76	13	11.1
U.S.	406	961	37	86	12	12.4
Non-natives						
Canada			0.6	4	0	0.9
U.S.			0.8	5	0	0.9

Table 3. Indices of biotic integrity metrics for dense *Schoenoplectus*, sparse *Schoenoplectus*, and wet meadow zones.

Source: Uzarski et al. 2004

Wet Meadow

Metric	*Score = 1*	*Score = 2*	*Score = 3*
Odonata richness (genera)	0	>0 to 3	>3
Relative abundance Odonata (%)	0 to <1	1 to 5	>5
Crustacea + Mollusca richness (genera)	<2	2 to 6	>6
Total richness (genera)	<10	10 to 18	>18
Relative abundance Gastropoda (%)	0 to 1	>1 to 25	>25
Relative abundance Sphaeriidae (%)	0	>0 to 3	>3
Evenness	0 to 0.4	>0.4 to 0.7	>0.7
Shannon diversity index	0 to 0.4	>0.4 to 0.9	>0.9
Simpson index	>0.3	>0.15 to 0.3	0 to 0.15

Schoenoplectus (Dense)

Metric	*Score = 0*	*Score = 1*	*Score = 3*	*Score = 5*	*Score = 7*
Odonata richness (genera)	NA	0	>0 to <1	1 to 2	>2
Relative abundance Odonata (%)	NA	0	>0 to <2	2 to 7	>7
Crustacea plus Mollusca richness (genera)	NA	0 to 2	>2 to 4	>4 to 6	>6
Total richness (genera)	NA	<10	10 to 14	>14 to 18	>18
Relative abundance Gastropoda (%)	NA	0	>0 to 2	>2 to 4	>4
Relative abundance Sphaeriidae (%)	NA	0	>0 to 0.05	>0.05	NA
Ephemeroptera + Trichoptera richness (genera)	NA	0	>0 to 3	>3	NA
Relative abundance Crustacea + Mollusca (%)	NA	<8	8 to 30	>30	NA
Relative abundance Isopoda (%)	0	>0 to 1	>1 to 10	>10 to 20	>20
Evenness	NA	0 to 0.4	>0.4 to 0.7	>0.7	NA
Shannon diversity index	NA	0 to 0.4	>0.4 to 0.9	>0.9	NA
Simpson index	NA	0.15 to 0.3	>0.15 to 0.3	0 to 0.15	NA

Relative abundance Amphipoda (%): If 40 to 60 and total score from Dense Schoenoplectus morphotype is 41 or greater, subtract 5; If 40 to 60 and total score from Dense Schoenoplectus morphotype is >41, then add 5.

Schoenoplectus (Sparse)

Metric	*Score = 1*	*Score = 3*	*Score = 5*	*Score = 7*
Odonata richness (genera)	0	>0 to <1	1 to 2	>2
Relative abundance Odonata (%)	0	>0 to <1	1 to 2	>2
Crustacea plus Mollusca richness (genera)	0 to 2	>2 to 4	>4 to 5	>5
Total richness (genera)	<8	8 to 13	>13 to 17	>17
Relative abundance Gastropoda (%)	0	>0 to 3	>3 to 5	>5
Relative abundance Sphaeriidae (%)	0	>0 to 0.05	>0.05	NA
Total number of families	0 to 7	>7 to 12	>12	NA
Relative abundance Crustacea + Mollusca (%)	<8	8 to 30	>30	NA
Evenness	0 to 0.4	>0.4 to 0.7	>0.7	NA

Shannon diversity index	0 to 0.4	>0.4 to 0.9	>0.9	NA
Simpson index	> 0.3	>0.15 to 0.3	0 to 0.15	NA

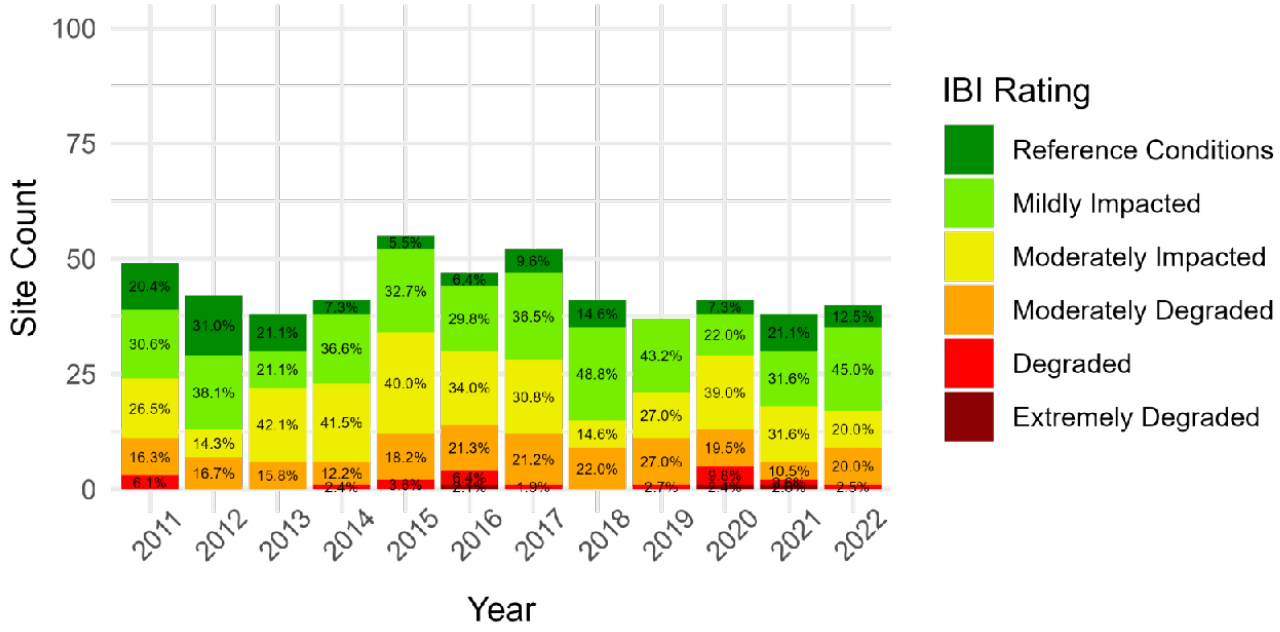

Figure 1. The count of all sites that fall into each IBI category based on the aquatic macroinvertebrate community each year between 2011 and 2022, n=521. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP)

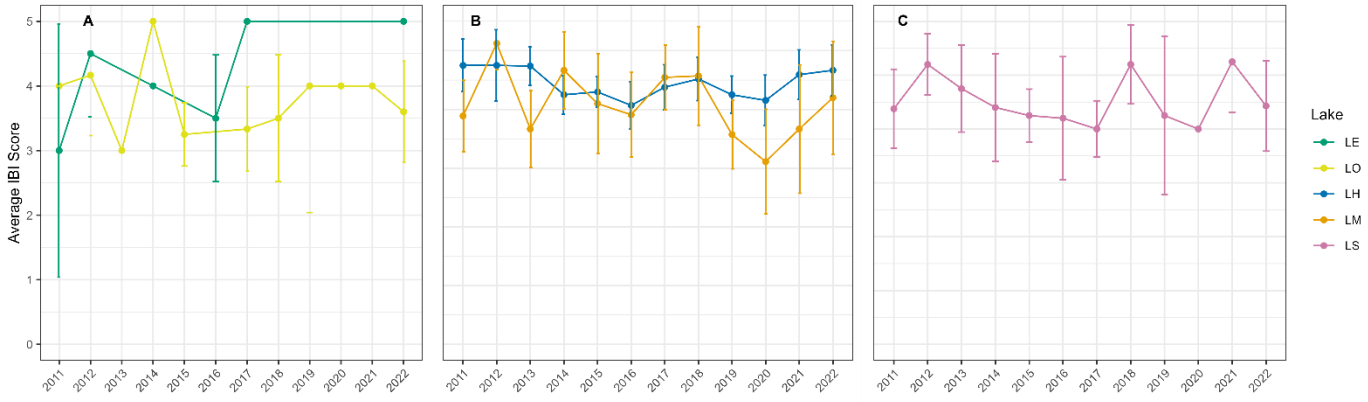

Figure 2. The mean IBI score for Lakes Erie and Ontario (A), Lakes Michigan and Huron (B), and Lake Superior (C) from 2011 to 2022, error bars show 95% confidence interval. The highest possible score is 6 which indicates reference conditions, and lowest possible score is 1 which indicates extreme degradation. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).

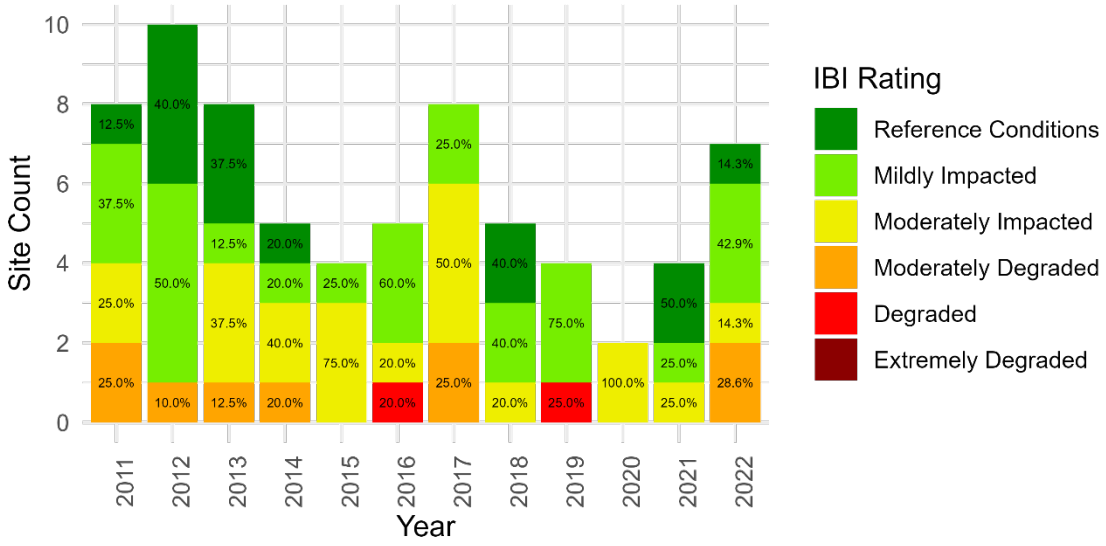

Figure 3. The count of all Lake Superior sites that fall into each IBI category based on the aquatic macroinvertebrate community each year between 2011 and 2022, n=68. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).

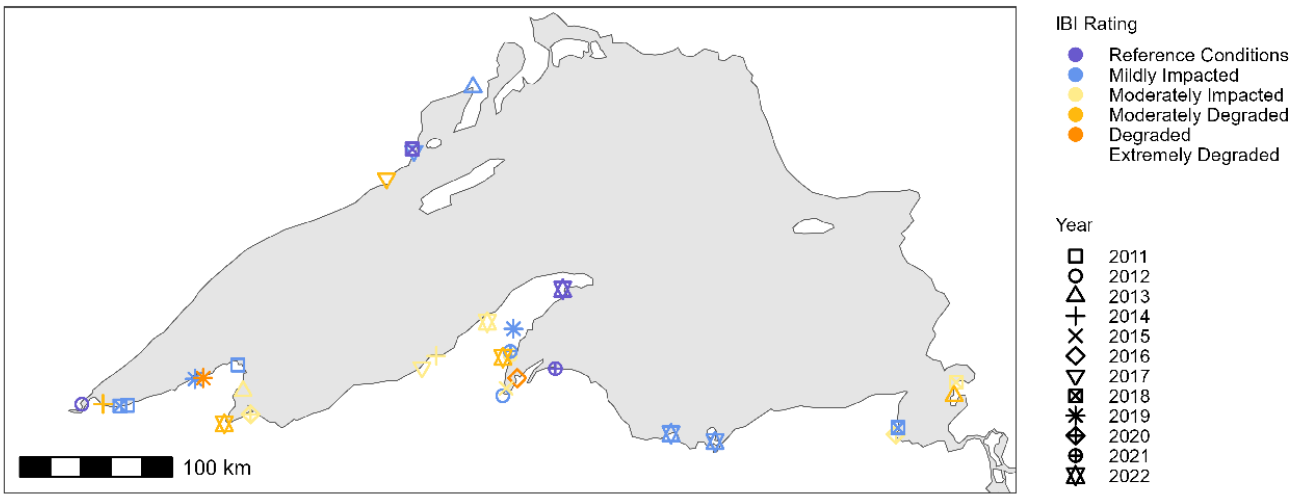

Figure 4. The condition of coastal wetland aquatic macroinvertebrate communities from 2011 to 2022 across Lake Superior. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).

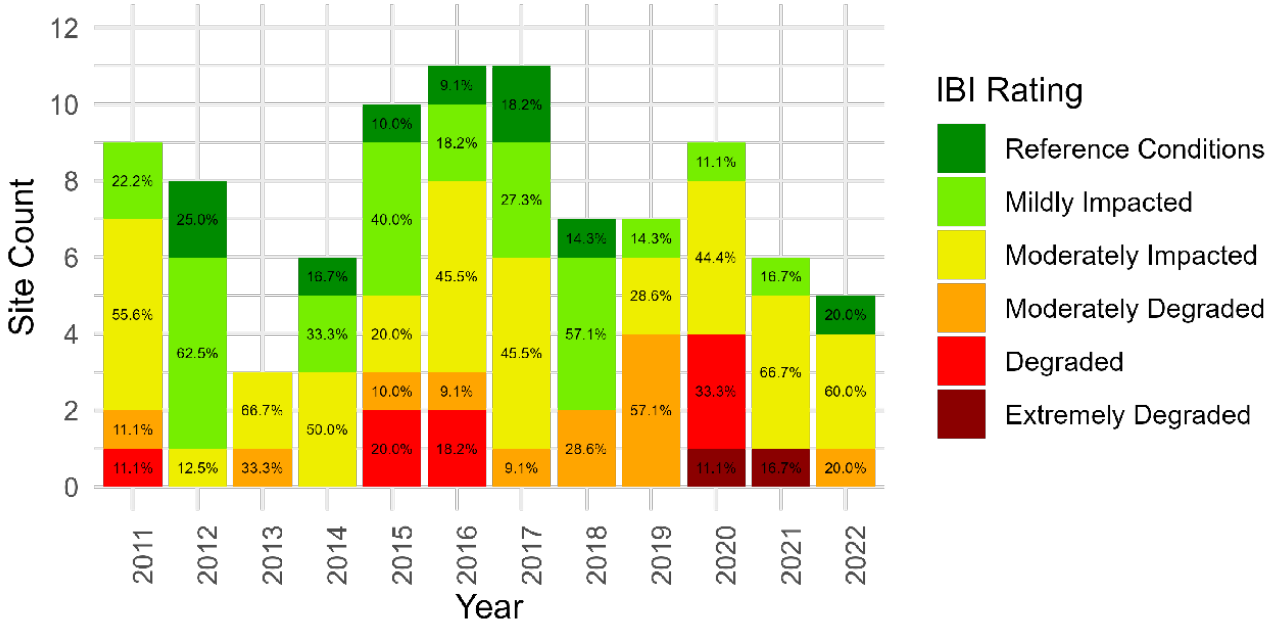

Figure 5. The count of all Lake Michigan sites that fall into each IBI category based on the aquatic macroinvertebrate community each year between 2011 and 2022, n=92. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).

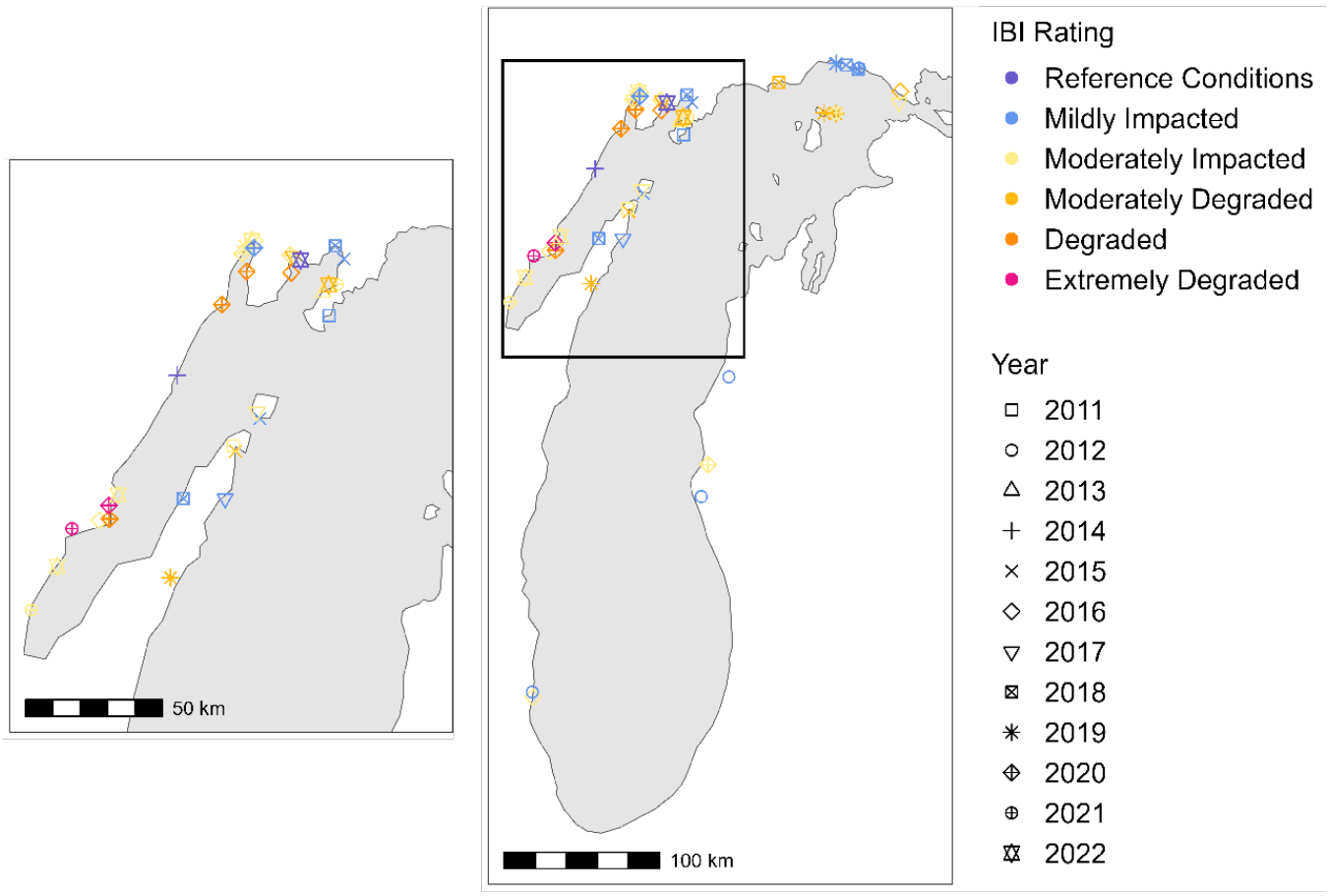

Figure 6. The condition of coastal wetland aquatic macroinvertebrate communities from 2011 to 2022 across Lake Michigan. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).

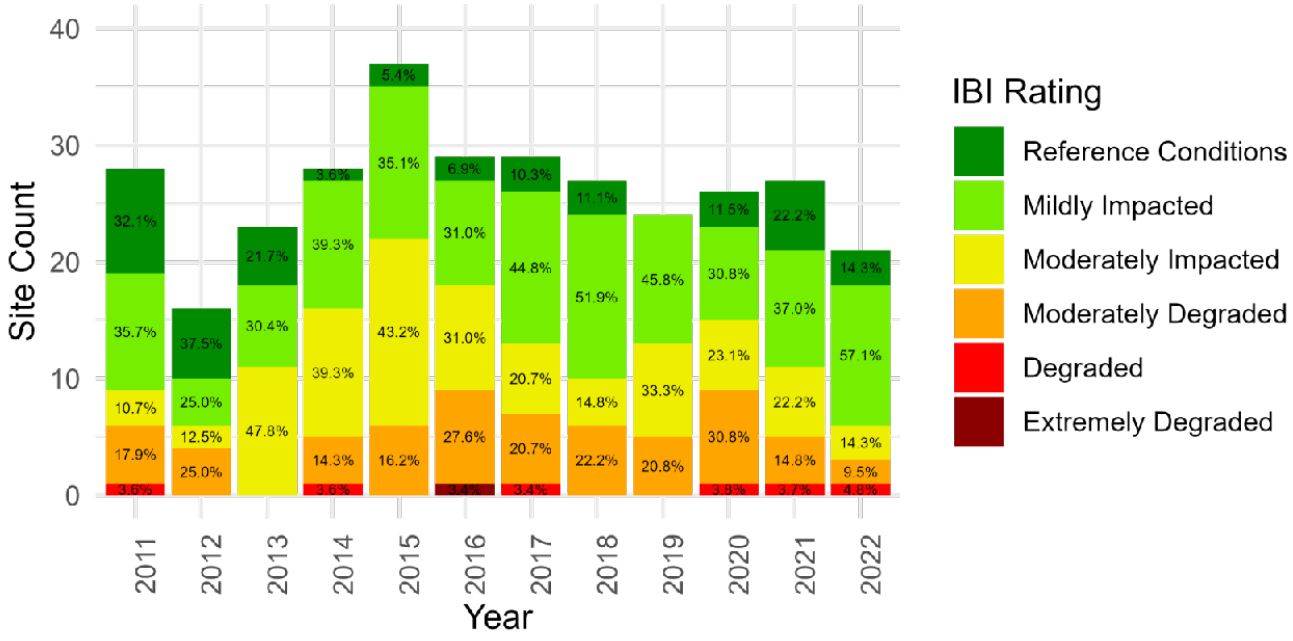

Figure 7. The count of all Lake Huron sites that fall into each IBI category based on the aquatic macroinvertebrate community each year between 2011 and 2022, n=317. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).

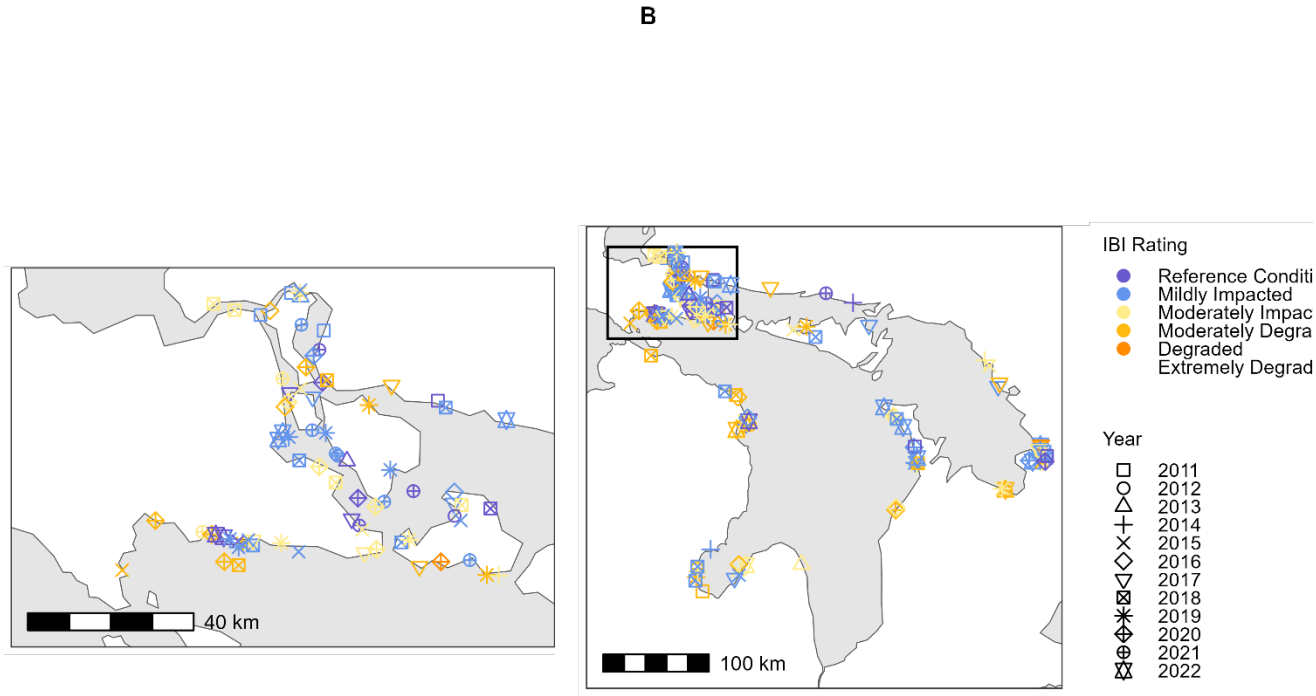

Figure 8. The condition of coastal wetland aquatic macroinvertebrate communities from 2011 to 2022 across Lake Huron. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).

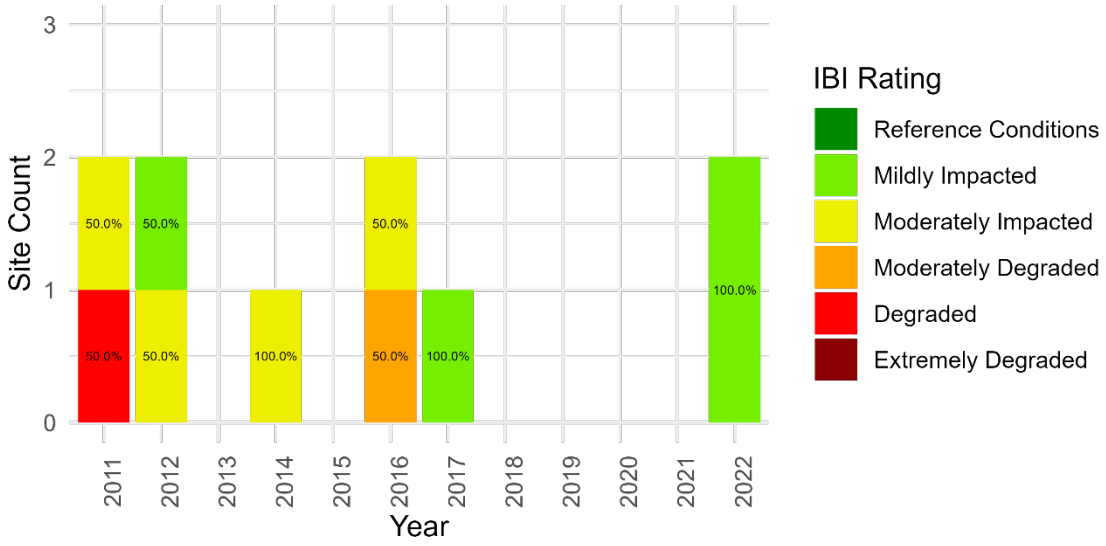

Figure 9. The count of all Lake Erie sites that fall into each IBI category based on the aquatic macroinvertebrate community each year between 2011 and 2022, n=10. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).

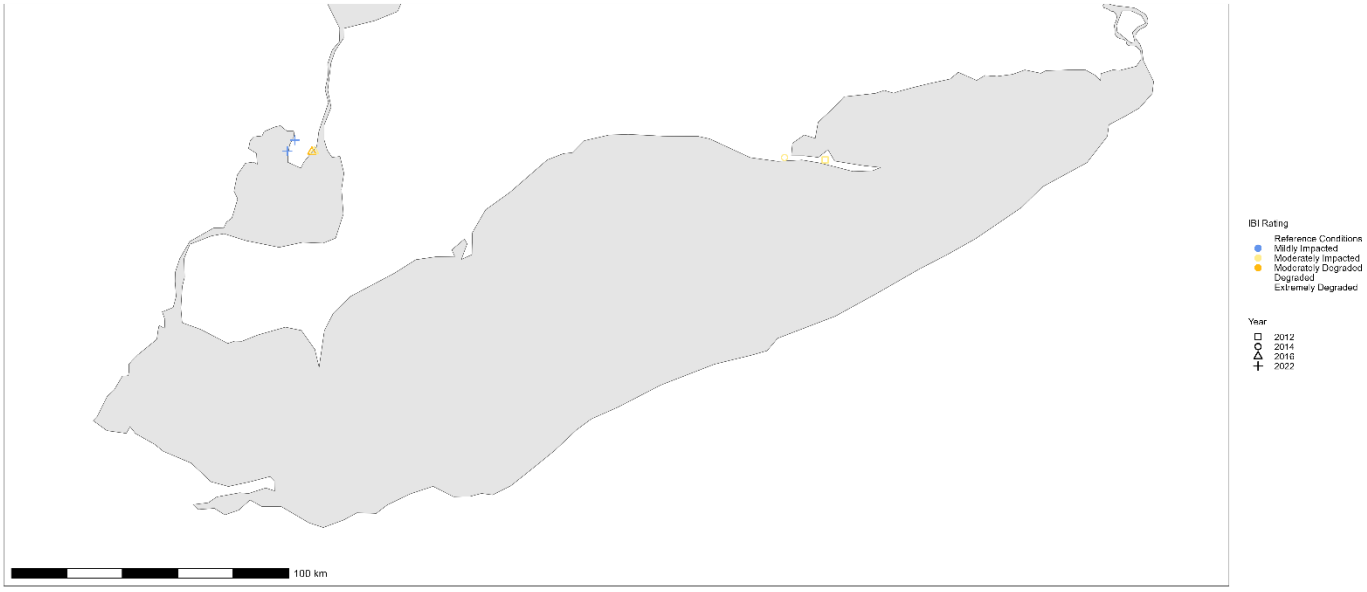

Figure 10. The condition of coastal wetland aquatic macroinvertebrate communities from 2011 to 2022 across Lake Erie. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).

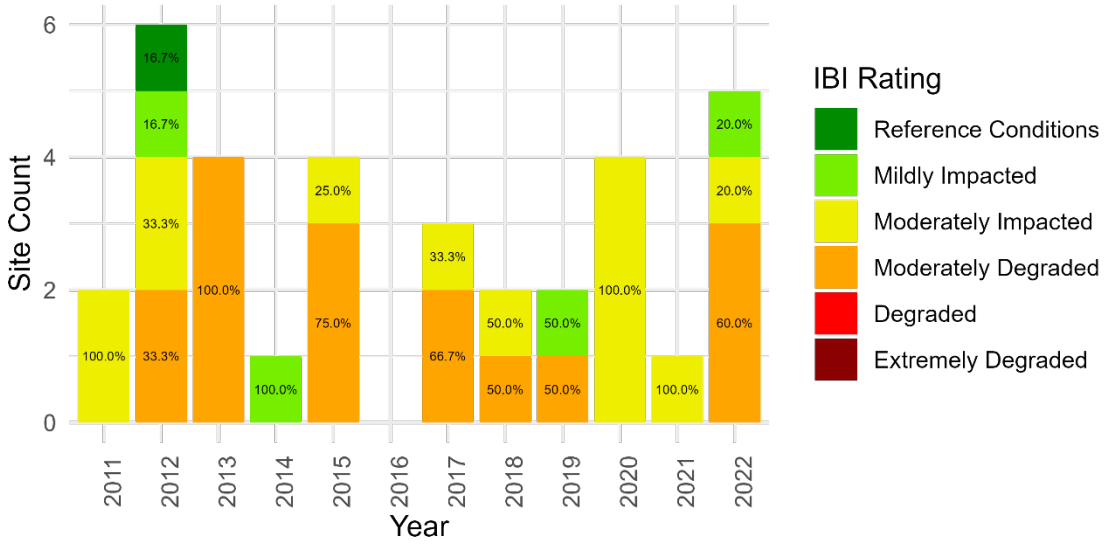

Figure 11. The count of all Lake Ontario sites that fall into each IBI category based on the aquatic macroinvertebrate community each year between 2011 and 2022, n=34. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).

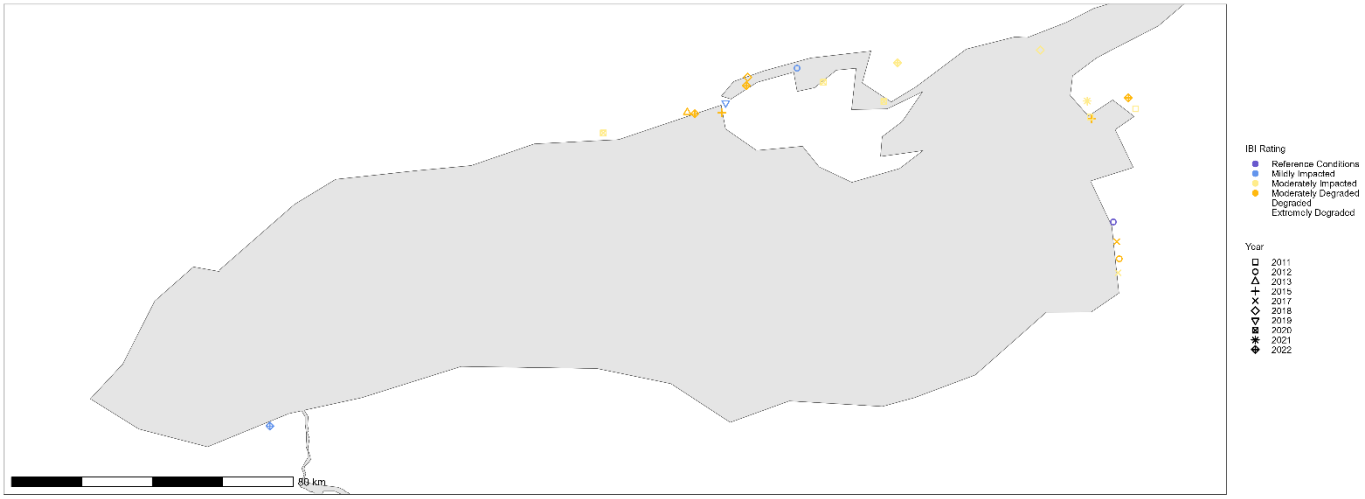

Figure 12. The condition of coastal wetland aquatic macroinvertebrate communities from 2011 to 2022 across Lake Ontario. Source: Great Lakes Coastal Wetland Monitoring Program (CWMP).