Sub-Indicator: Coastal Wetland Plants

Overall Assessment

Status: Fair

Trends:

10-Year Trend (2013-2022): Unchanging

Long-term Trend (2011-2022): Unchanging

Rationale: Across all coastal wetlands of the Great Lakes basin, the overall average vegetation Index of Biotic Integrity (IBI) indicates that the vegetation is moderately impacted and we conclude status to be Fair. Wide differences in site quality exist between and within individual lakes. Wetlands in Lakes Huron, Michigan, and Superior generally harbor Fair or Good wetland plant communities with lower numbers of Poor sites, whereas wetlands in Lakes Erie and Ontario tend to be of more uniformly Poor quality, with only scattered high quality Fair or Good sites. With respect to trends, the long-term trend for all wetlands in the basin combined indicates low interannual variability and no directional change over the past 12 years (Figure 1). The pattern of vegetation change within individual lakes demonstrates higher variability but still low interannual variability and no directional trends for any lakes over the past 12 years, resulting in trend assessments of Unchanging (Figure 2).

Lake-by-Lake Assessment

Lake Superior

Status: Good

10-Year Trend (2011-2020): Unchanging

Long-term Trend (2011-2020): Unchanging

Rationale: On average, coastal wetland vegetation in Lake Superior is in Good condition, with an average overall IBI score of 0.74 from the most recent survey of 86 wetland sites in the CWMP project. Among these sites, 61/86 sites (71%) are considered in Good condition, while only 7/86 sites (8%) are considered in Poor condition. Poor quality sites tend to be located in or near urban centers. Individual Lake Superior wetland IBI scores are mapped and summarized in Figure 3. The highest quality wetlands in Lake Superior tend to be barrier-protected poor fens, with these wetlands supporting habitat specialists with high conservatism values. Since 2011, the overall lake-wide mean IBI score has fluctuated between 0.71 and 0.82 with no substantial directional change or trend, therefore, the trends are assessed as Unchanging (Figure 2).

Lake Michigan

Status: Fair

10-Year Trend (2011-2020): Unchanging

Long-term Trend (2011-2020): Unchanging

Rationale: On average, coastal wetland vegetation in Lake Michigan is in Fair condition, with an average overall IBI score of 0.59 from the most recent survey of 98 wetland sites in the CWMP project. Among these sites, 27/98 (28%) are considered in Good condition, 46/98 (47%) in Fair condition, and 25/98 (26%) in Poor condition. The

higher quality wetlands include open lacustrine, riverine, and barrier-protected wetlands in the northern part of the lake and are associated with surrounding forest cover (Figure 4). Riverine wetlands, especially those in the south with extreme urban and agricultural nutrient enrichment, are among those with the lowest quality. Many wetlands in the Green Bay, WI region have experienced similar severe wetland degradation resulting from long-term agricultural and urban nutrient enrichment and more recent low water levels and associated invasion by *Phragmites australis*. Restoration efforts in this region are improving wetland plant condition. High Lake Michigan water levels in 2014 through 2019 have resulted in erosion of wetland vegetation from the more exposed open lacustrine marshes. The drop in water levels since 2020 have resulted in a dramatic increase in wet meadow species diversity, especially in lacustrine wetlands, although this diversity does not always impact IBI scores. Since 2011, the overall lake-wide mean IBI score has fluctuated between 0.53 and 0.63 with no substantial directional change or trend, therefore, the trends are assessed as Unchanging (Figure 2).

Lake Huron (including St. Marys River)

Status: Good

10-Year Trend (2011-2020): Unchanging

Long-term Trend (2011-2020): Unchanging

Rationale: On average, coastal wetland vegetation in Lake Huron is in Good condition, with an average overall IBI score of 0.71 from the most recent survey of 225 wetland sites in the CWMP project. Lake Huron has the greatest number of wetlands sites surveyed in the CWMP project, with 75 sites more than in the second-most lake, Lake Ontario. Among these sites, 148/225 (66%) are considered in Good condition, 58/225 (26%) in Fair condition, and 19/225 (8%) in Poor condition. Individual Lake Huron and St. Marys River wetland IBI scores are mapped and summarized in Figure 5. Sites in the northern and eastern portion of Lake Huron tend to be higher quality barrier-protected, lacustrine, and riverine wetlands that reflect surrounding forest cover and management. The drop in water levels since 2020 has resulted in a dramatic increase in wet meadow species diversity, especially in lacustrine wetlands in the northern part of Lake Huron, although this diversity does not always impact IBI scores. In Saginaw Bay and on the southern shore of Lake Huron, extensive plowing, raking, and mowing during recent low water periods has led to vast areas of native wetland vegetation in open lacustrine wetlands being replaced by *Phragmites australis* and *Typha* x *glauca*. This long-term change was documented by observed changes between surveys conducted in the mid-1990s and those conducted between 2011-2015 (Carson et al., 2018). During the recent extended low-water conditions, *Phragmites australis* has expanded lakeward beyond native emergent vegetation on Ontario's Bruce Peninsula and eastern shoreline of Lake Huron, although perhaps recent high-water conditions will erode these extensive *Phragmites* beds, although erosion of *Phragmites* beds has not been observed on Saginaw Bay. Loss of emergent vegetation has also occurred in wetlands bordering the St. Marys River, the connecting river between Lakes Superior and Huron during the 1999 to 2013 low-water conditions, probably the result of both winter ice and ship wakes on exposed sediments and vegetation beds. This long-term change is based on surveys conducted in the late 1980s, mid 1990s (summarized in Minc 1997), and between 2011 and 2015. Another major invasive plant that now occupies large stretches of Saginaw Bay and the St. Marys River is European frogbit (*Hydrocharis morsus-ranae*), which has continued to expand coverage even in recent high-water years (Monks et al., 2019). Surveys since the last report have shown an expansion of European frogbit into wetlands along the entire Lake Huron coast, including many barrier-protected wetlands not sampled as part of this study. Wetlands in eastern Georgian Bay are susceptible to nutrient enrichment from runoff through shallow soils or on exposed bedrock; in this area, increasing pressures from development and changing water levels are expected to have the greatest impacts in the near future. Since 2011, the overall lake-wide mean IBI score has

fluctuated between 0.67 and 0.73 with no substantial directional change or trend, therefore, the trends are assessed as Unchanging (Figure 2).

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

Status: Poor

10-Year Trend (2011-2020): Unchanging

Long-term Trend (2011-2020): Unchanging

Rationale: On average, coastal wetland vegetation in Lake Erie is in Poor condition, with an average overall IBI score of 0.42 from the most recent survey of 76 wetland sites in the CWMP project.. Among these sites, 3/76 (4%) are considered in Good condition, 15/76 (20%) in Fair condition, and 58/76 (76%) in Poor condition. Individual Lake Erie and St. Clair and Detroit River wetland IBI scores are mapped and summarized in Figure 6. Some of the higher quality sites are Presque Isle, Pennsylvania, and several large Ontario sites along the north shore, including Long Point, Turkey Point, Rondeau, and Point Pelee, while restoration activities have recently improved Metzger Marsh, Ohio. Overall, the coastal wetland plant communities of Lake Erie are also classified as Deteriorating based on historical data from 1975 in Lake Erie (Stuckey, 1989). In Lake Erie, riverine wetlands have slightly lower average quality than barrier-protected or lacustrine wetlands. From CWMP data collected since 2011, the overall lake-wide mean IBI score has fluctuated between 0.34 and 0.45 with no substantial directional change or trend, therefore, the trends are assessed as Unchanging (Figure 2).

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

Status: Poor

10-Year Trend (2011-2020): Unchanging

Long-term Trend (2011-2020): Unchanging

Rationale: On average, coastal wetland vegetation in Lake Ontario is in Poor condition, with an average overall IBI score of 0.42 from the most recent survey of 150 wetland sites in the CWMP project. Among these sites, 3/150 (2%) are considered in Good condition, 23/150 (15%) in Fair condition, and 124/150 (83%) in Poor condition. Low IBI scores are a result of the dominance by invasive cattails (*Typha angustifolia* and *Typha* x *glauca*) and other invasive species. Individual Lake Ontario and Niagara and Upper St. Lawrence River wetland IBI scores are mapped and summarized in Figure 7. There is a slight increase west to east in vegetation condition, due largely from high levels of urbanization in the western portion of the basin. Since 2011, the overall lake-wide mean IBI score has fluctuated between 0.39 and 0.46 with no substantial directional change or trend, therefore, the trends are assessed as Unchanging (Figure 2).

Status Assessment Definitions

Lake Assessment Scale for IBI

The Great Lakes Coastal Wetland Monitoring program uses a rotating panel survey design, with wetlands surveyed in a five-year cycle (Uzarski et al. 2016). The prior cycles included 2011-2015 and 2016-2020, and the third (current) cycle is partially completed; we include data from the first two years (2021 and 2022) of the current cycle. For the purposes of lake-wide status reported here, we define status as the average wetland IBI score using the most recent survey of each wetland site.

Reference (Good): 0.83-1.0

Mildly Impacted (Good): 0.67-0.82

Moderately Impacted (Fair): 0.50-0.66

Moderately Degraded (Poor): 0.33-0.49

Degraded (Poor): 0.25-0.32

Extremely Degraded (Poor): 0-0.24

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

Trend Assessment Definitions

Improving: Average IBI scores per lake have demonstrated a significantly positive linear regression with average annual change (slope) of at least 1.5% of IBI units annually over the time period (i.e. for a trend of at least +15% over a 10-yr time period).

Unchanging: Average IBI scores per lake have demonstrated a non-significant linear regression over the time period, and the annual change is less than 10% of the lake-wide long-term mean.

No Trend: Average IBI scores per lake have demonstrated a non-significant linear regression over the time period, and the annual change is greater than 10% of the lake-wide long-term mean.

Deteriorating: Average IBI scores per lake have demonstrated a significantly negative linear regression with average annual change (slope) of at least 1.5% of IBI units annually over the time period (for a trend of at least -15% over a 10-yr time period).

Undetermined: Data are not available to report on a trend, potentially including a lack of pre-existing benchmark data of the measures.

Note: At this time, the assessment scales used to define categories Improving, Unchanging, Deteriorating, and No Trent are based on best professional judgment. Work is ongoing to develop defensible scales that incorporate statistical analysis.

Endpoints and/or Targets

The vegetation IBI is known to be affected by several natural factors, including wetland geomorphic type, lake, and geographical location in addition to human effects (Dybiec et al. 2020). Statistical analyses to parse these components of variation and develop assessment endpoints using data from the Coastal Wetland Monitoring Program (CWMP) are in progress and not completed at this time.

Sub-Indicator Purpose

The purpose of this sub-indicator is to assess the quality of the vegetation as an integral component of the condition of coastal wetlands.

Ecosystem Objective

Coastal wetlands throughout the Great Lakes basin are influenced by coastal manipulations and the input of sediments, nutrients, and pollutants. About half of coastal wetlands have been lost basin-wide since pre-settlement. Remaining wetlands should be dominated by native vegetation with low numbers of invasive plant species at low levels of coverage. Conservation of these 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 objectives.

This sub-indicator best supports work towards General Objective #5 of the 2012 Great Lakes Water Quality Agreement that states the Waters of the Great Lakes should "support healthy and productive wetlands and other habitats to sustain resilient populations of native species."

Methods

This sub-indicator incorporates information on the presence, abundance, and diversity of aquatic macrophytes within Great Lakes coastal wetlands as reported from the Great Lakes Coastal Wetland Monitoring Program (CWMP, Uzarski et al. 2016). The CWMP project utilizes a rotating panel survey design whereby the entire panel of wetlands is stratified by lake and surveyed over a five-year cycle. Since 2011 when the project began, full survey cycles have been completed in 2011-2015 and 2016-2020, and we are currently working towards completion of the third cycle. All data from 2011-2022 are included here.

In the CWMP wetland vegetation survey methodology, aquatic plants from each wetland were sampled from three transects perpendicular to depth contours crossing wetland vegetation zones during July and August. The number of vegetation zones varies depending on each particular wetland. Operationally-defined vegetation zones are wet meadow, emergent vegetation, and submergent vegetation. Plant abundance data collected in 1-m^2 quadrats along the transects are used to calculate the vegetation IBI (Dybiec et al. 2020).

The vegetation IBI incorporates 4-5 metrics that are calibrated individually for the three wetland zones (wet meadow, emergent, submergent) and then combined to achieve an overall site-level IBI. Component metrics include relative cover of *Carex* spp., relative cover of introduced/invasive species, relative cover of turbidity and sedimentation tolerant species, relative cover species with Coefficient of Conservatism (C) >5, and the total mean C of all observed species. Further details are included in Dybiec et al. (2020).

Thresholds on the IBI score have been used to define wetland vegetation condition categories for use in regular reporting from the CWMP project (Table 1). For the purposes of this sub-indicator report, we have mapped the CWMP condition categories onto Good, Fair, and Poor categories as defined in Table 1.

To characterize the pattern of change and potential trends in mean indicator values through time, we calculated simple linear regression of the IBI means vs. year. We concluded a trend to be significant if two criteria were met: 1) the regression had a *p*-value lower than 0.05 and 2) the average rate of annual change over the entire time series, i.e. the slope of the regression, was at least 1.5% (positive or negative) of the mean lake-wide IBI value (translating to at least a 15% change over a 10-year time period). Across all lakes, the average annual change in

lake-wide IBI means is about 5% per year, meaning that even in the absence of trend the lake-wide IBI can be expected to fluctuate by 5% from year to year. A 15% change over 10 years was determined to be substantially outside the range of normal variability.

Although our methods to describe status and trends have changed to incorporate more recent techniques, our conclusions are substantially unchanged from prior sub-indicator reports.

Discussion

Across the entire Great Lakes basin, the state of the wetland plant community is quite variable, ranging from Good to Poor depending primarily on local land use history, nearshore management, and the prevalence of invasive plant species. Plant communities in some wetlands have deteriorated rapidly in the last decade due to extremely low water levels that have allowed invasion and dominance by non-native species. With water levels rebounding in 2014-2019, it will be critical to continually evaluate how these wetlands respond. In many areas throughout the basin, wetland restoration activities have been undertaken over the past 10 years, especially targeting wetlands dominated by invasive plants. For example, the Canadian Wildlife Service managed over 700 hectares of invasive *Phragmites australis* on Lake Erie at the Big Creek and Long Point National Wildlife Areas (near Port Rowen, Ontario) from 2019 to 2023.

Short and long-term trends in wetland condition based on plants have not been well-established in the Great Lakes. Almost all wetlands in Lake Erie, Lake Ontario, and the Upper St. Lawrence River are degraded by nutrient enrichment and sedimentation, while wetlands in Lake Ontario and the Upper St. Lawrence River are further degraded by water-level control. Probably the strongest demonstration of this is the prevalence of broad zones of cattails, reduced submergent diversity and coverage, and prevalence of non-native plants, including common reed (*Phragmites australis*), reed canary grass (*Phalaris arundinacea*), purple loosestrife (*Lythrum salicaria*), curly pondweed (*Potamogeton crispus*), Eurasian milfoil (*Myriophyllum spicatum*), frogbit (*Hydrocharis morsus-ranae*), and water chestnut (*Trapa natans*).

In the remaining Great Lakes (Lake Huron, Lake Michigan, Lake Superior, and their connecting rivers), intact, diverse wetlands can be found for most geomorphic wetland types. However, low water conditions in the 2000s resulted in the explosive expansion of common reed and hybrid cattail (*Typha* x *glauca*) in many wetlands, especially in Lake St. Clair and southern Lake Huron, including Saginaw Bay (Albert and Brown 2008) as well as Green Bay in Lake Michigan. In at least a couple northern Lake Huron wetlands, hybrid cattail was noted to be expanding in the extremely high water levels that were simultaneously causing die back of native emergent plant.

One of the disturbing trends is the expansion of frogbit, a floating plant that forms dense mats capable of eliminating submergent plants, from the St. Lawrence River and Lake Ontario into Lake Erie, Lake St. Clair, Lake Huron, and the St. Marys River. Since our last report, frogbit has expanded to several sites in Lake Michigan (Rutherford et al., 2022) and is present in most coastal wetlands along the west shoreline of Lake Huron. In addition, our sampling has shown water chestnut from about 10% of sites in Lake Ontario, although it has not expanded substantially during the last three years of this survey. A new, potentially concerning invader in Lake Ontario is *Stratiotes aloides*, which has been observed for a number of years in the Trent River and recently has been documented in the Bay of Quinte.

Studies in the northern Great Lakes have demonstrated that non-native invasive species like common reed, reed canary grass, and purple loosestrife have become established throughout the Great Lakes but that the abundance of these species is low, often restricted to only local disturbances such as docks and boat channels. It appears that undisturbed marshes are not easily colonized by these species. However, as these species become locally

established, seeds or fragments of plants may be able to establish themselves when water-level changes create appropriate sediment conditions. Hybrid cattail (*Typha x glauca*) expansion has also been recently documented in northern Lakes Michigan and Huron and the St. Marys River (Lishawa et al., 2010).

Linkages

Water-level fluctuation

Great Lakes water levels fluctuate greatly from year-to-year. Either an increase or decrease in water level can result in changes in numbers of species or overall species composition in the entire wetland or in specific zones. Such changes make it difficult to monitor change in plant community composition over time. Changes are especially prevalent in two zones: the wet meadow, where grasses and sedges may disappear in high water or new annuals may appear in low water, and in shallow emergent or submergent zones, where submergent and floating plants may disappear when water levels drop rapidly. Recent studies indicate that prolonged periods of low water favor rapid expansion of invasive species like *Phragmites australis* (Albert and Brown, 2008; Lishawa et al., 2010; Wilcox, 2012). In addition, water levels of Lakes Superior and Ontario are regulated, which has altered plant community dynamics. This is most obvious in Lake Ontario, where cattails have largely displaced sedge/grass meadow (Wilcox et al., 2008). Extreme high water conditions in 2018 and 2019 have resulted in wide-spread erosion of the vegetation in both the emergent and the meadow zones, with both zones being eliminated or greatly reduced in area in many open lacustrine wetlands. Lower water levels since 2020 have resulted in dramatic recovery of the meadow zone in terms of both zone width and diversity in Lakes Michigan and Huron. Protected lacustrine and riverine wetlands have displayed changes in species composition resulting from high water conditions, but most have not been heavily damaged by wave action. While our sampling of barrier-protected wetlands has been less intensive than in lacustrine and riverine wetlands, it has been observed that the outer barriers in many barrier-protected wetlands has been eliminated by storm waves, resulting in burial of vegetation in swales behind the outermost barrier by sand and gravel in some cases.

Lake levels are expected to increase in variability, with more extreme highs and lows becoming possible with changes in average temperatures. Lake-level projections indicate a slight upward trend relative to long-term averages on all lakes in the second half of the century (Lam and Dokoska, 2022). A study by ECCC found that more frequent instances of extreme wetland loss were predicted with higher lake levels where surrounding upland land use (e.g., transportation infrastructure, residential development) or topography (e.g., steep slopes) limited landward wetland migration (ECCC, 2022), emphasizing wetlands' increased sensitivity to further watershed development.

Lake-wide alterations

For the southern lakes, most wetlands have been dramatically altered by both intensive agriculture and urban development of the shoreline. Alterations of coastal wetland especially in the wet meadow and upper emergent zone will lead to drier conditions which may allow non-native species to establish.

Agriculture

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 (reed canary grass), destruction of inland wet meadow zone by plowing and diking, and addition of herbicides. In the southern lakes, Saginaw Bay, and Green Bay, agricultural sediments have resulted in highly turbid waters that support few or no submergent plants.

Urban and residential shoreline development

Urban and residential shoreline 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 all wetlands have been lost along the shoreline.

Mechanical alteration of shoreline

Mechanical alteration takes a diversity of forms, including diking, ditching, dredging, filling, shoreline hardening, and disking and plowing of coastal vegetation by private landowners. 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. Disking (harrowing) and plowing of coastal wetlands continued through 2011 in exposed coastal marshes along Saginaw Bay, Grand Traverse Bay, and on islands within the St. Clair River delta.

Introduction of non-native 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. Non-native animals have also been responsible for increased degradation of coastal wetlands. One of the worst invasive species has been common carp, whose mating and feeding habits result in loss of submergent vegetation in shallow marsh waters. The most prevalent non-native plants include common reed (*Phragmites australis),* reed canary grass (*Phalaris arundinacea*), purple loosestrife (*Lythrum salicaria*), curly pondweed (*Potamogeton crispus*), and Eurasian milfoil (*Myriophyllum spicatum*). Low water conditions have resulted in an explosive expansion of common reed in many wetlands, especially in Lake St. Clair and southern Lake Huron, including Saginaw Bay (Albert and Brown 2008). The recent rediscovery of a non-native macroalgae, starry stonewort (*Nitellopsis obtusa*), is of conservation concern because of its long-term establishment since the 1970s and its current distribution within better quality wetlands in northeastern Lake Ontario as well as wetlands in Saginaw Bay, Lake St. Clair, and the Detroit River. Starry stonewort grows rapidly, reducing habitat value and clogging boat propellers.

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	https://www.greatlakeswetlands.org/Home.vbhtml		

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 characteristic presence and abundance of coastal wetland native plants has been adequately documented across the Great Lakes basin by the Great Lakes Coastal Wetland Monitoring Program (CWM), whose URL is attached above. An addition, most regional wetland types have been adequately described in existing studies (Minc, 1997; Minc and Albert, 1998; Albert and Minc, 2001; Albert et al., 2006; Lemein et al., 2017). The changes in species composition and dominance related to Great Lakes water-level fluctuations have not been adequately determined for many regional wetland types. This is an important task, as natural water-level fluctuations can introduce changes in wetland vegetation that could falsely be attributed to either increased wetland degradation or improved management. Laboratory studies are also needed to identify wetland plant species response to different types of degradation, including turbidity, sedimentation, heavy metal and organic chemical introduction, pH change, erosion, exotic plant competition, and increased herbivory by non-native fauna.

Additional Information

**The CWMP was funded by the Great Lakes Restoration Initiative 2011-2025 to implement statistically sound basin-wide monitoring of select physical and biotic components (Uzarski et al., 2016) and the program's funding has been extended to include 2021-2025. This binational program involved a consortium of universities and agencies with the goal of producing scientifically-defensible information on status and trends of Great Lakes coastal wetlands. As of 2015, the majority of coastal wetlands ≥4 ha with a surface water connection to the lakes have been surveyed at least once since 2011. Data from 2011-2022 were included in the analysis reported here. In each wetland, data from up to three wetland zones (wet meadow, emergent, submergent) are included if all zones are present.

It has been estimated that approximately half of the coastal wetlands have been lost basin wide, but this estimate does not include degraded wetlands, just those that have been lost by shoreline hardening or complete erosion of vegetation from an area. There is no agreed on approach to providing a more accurate estimate for several reasons, the most important of which are 1) The original land surveys, the basis of many original plant community area estimates, did not consistently reference herbaceous wetland vegetation along the shoreline, 2) Emergent wetland

vegetation is not easily seen in aerial photos limiting the use of 1930s and 1940s early aerial photos to estimate original wetland sites, and 3) the earliest Great Lakes-wide surveys of coastal wetlands were conducted in the late 1970s and early 1980s, well after most of the coastal wetland destruction had occurred due to a combination of shoreline hardening, dredging, agricultural planting, and destruction by invasive fish (primarily carp).

While no Great Lakes-wide surveys of coastal wetland with a focus on vegetation were conducted before the 1980s, cluster analyses of physical and vegetation data from field surveys conducted in the 1980s and 1990s identify several distinct native plant communities, as well as some plant communities dominated by invasive plants, that show strong relationships to regional sediment, and hydro-geomorphic conditions (Minc, 1997; Albert and Minc, 2001; Albert et al., 2006) that can justifiably be used as the basis for assuming there are predictable regional wetland vegetation types or communities. Vegetation sampling from the CWMP (Uzarski et al., 2016) was utilized to update the distribution of native and invasive dominated plant communities (Lemein et al., 2017).

Cattails have been noted as a major source of degradation because the expansion of cattails into wetlands following nutrient enrichment and water-level manipulation had been documented in numerous studies (Prince and D'Itri, 1985; Stuckey, 1989; Wilcox, 1993; Minc, 1997; Wilcox et al., 2008; Lishawa et al., 2010; and Robert Humphreys, refuge manager for MI DNR), personal communications). The native cattail in Great Lakes coastal wetlands was *Typha latifolia* (common or wide-leaved cattail) a species that was limited in distribution by characteristic fluctuations in Great Lakes water levels. *Typha angustifolia* (narrow-leaved cattail) has expanded into Great Lakes wetlands, where it tolerates deeper water levels than common cattail, expanding its range rapidly through the eastern U.S. and the Midwest along roadside ditches (Carson et al., 2018; Bansal et al., 2019). Common and narrow-leaved cattails hybridized, forming *Typha* x *glauca* (hybrid cattail), a larger and more aggressive plant that along with narrow-leaved cattail created broad, dense monocultures that did not meet the habitat needs of many native waterbirds and waterfowl. The dense mats of narrow-leaved and hybrid cattails were also able to float in drowned river mouth wetlands, eliminating important fish habitat as well.

Damage to Great Lakes wetlands by non-native invasive plants during the most recent low-water event (1999-2013 in Lakes Michigan and Huron) is considered to be linked to anthropogenic degradation because all of the invasive plants that have expanded dramatically into Great Lakes coastal wetlands were introduced into the Great Lakes by humans and respond aggressively to agricultural and urban nutrient enrichment and/or sedimentation. Earlier surveys of Great Lakes wetlands in low-water conditions in the 1980s and 1990s documented existing large-scale or localized expansions of these invasive plants in Lakes Ontario, Erie, and Lake St. Clair, but the expansion of these same plants was much greater than the extended low-water conditions in Lakes Huron and Michigan between 1999 and 2013. Prior to the 1970s, our most aggressive invasive plants (*Phragmites australis*, *Typha angustifolia*, *Typha* x *glauca*, *Lythrum salicaria*, *Hydrocharis morsus-ranae*, etc.) that respond to low-water conditions were not widespread along the Great Lakes shoreline, but since the early 1970s and into the future prolonged periods of low-water can be expected to result in at least localized expansions of invasive wetland plants.

Baseline condition in biological or restoration studies has typically been based on characteristic native flora and fauna in an ecosystem. Several examples of wetlands with no extensive populations of invasive plants were inventoried during 2011-2015 (Uzarski et al., 2016) and provide the basis for defining baseline condition and providing a goal for restoration. These high-quality wetlands will remain the basis for monitoring wetland condition and guiding restoration efforts, even if it is determined in the future that returning degraded wetlands to these conditions is impossible.

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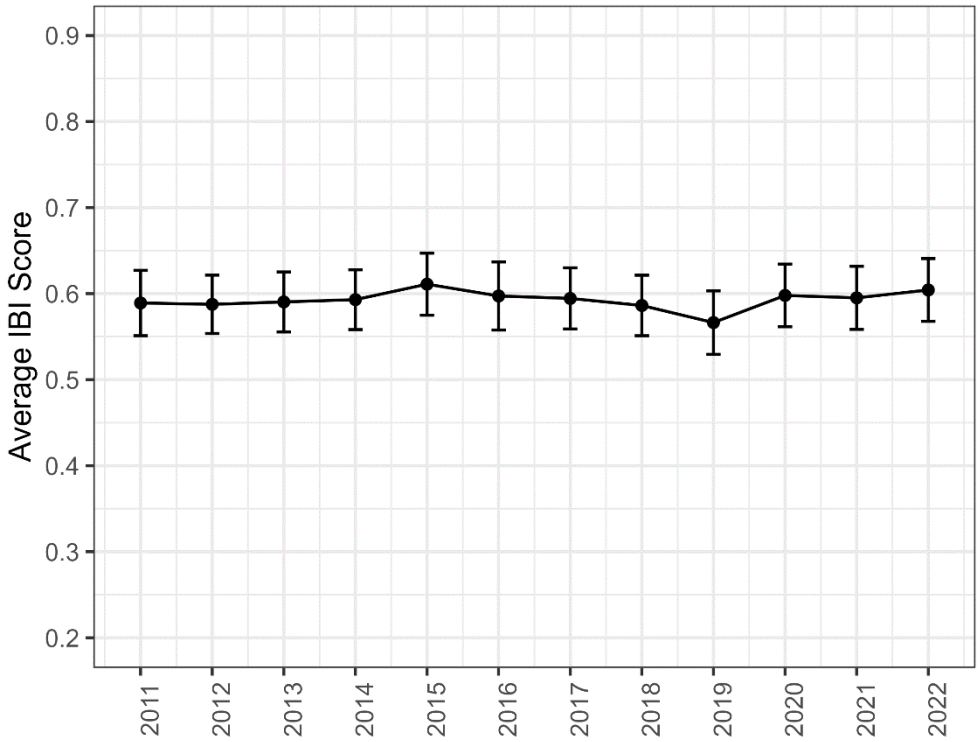
Source: GLRI Coastal Wetland Monitoring Program.

Site-level IBI	CWM Condition Rating	SOGL Condition Rating
0 < x < .25	Extremely Degraded	Poor
0.25 ≤ x < 0.33	Degraded	Poor
0.33 ≤ x < 0.50	Moderately Degraded	Poor
0.50 ≤ x < 0.67	Moderately Impacted	Fair
0.67 ≤ x < 0.83	Mildly Impacted	Good
>0.83	Reference	Good



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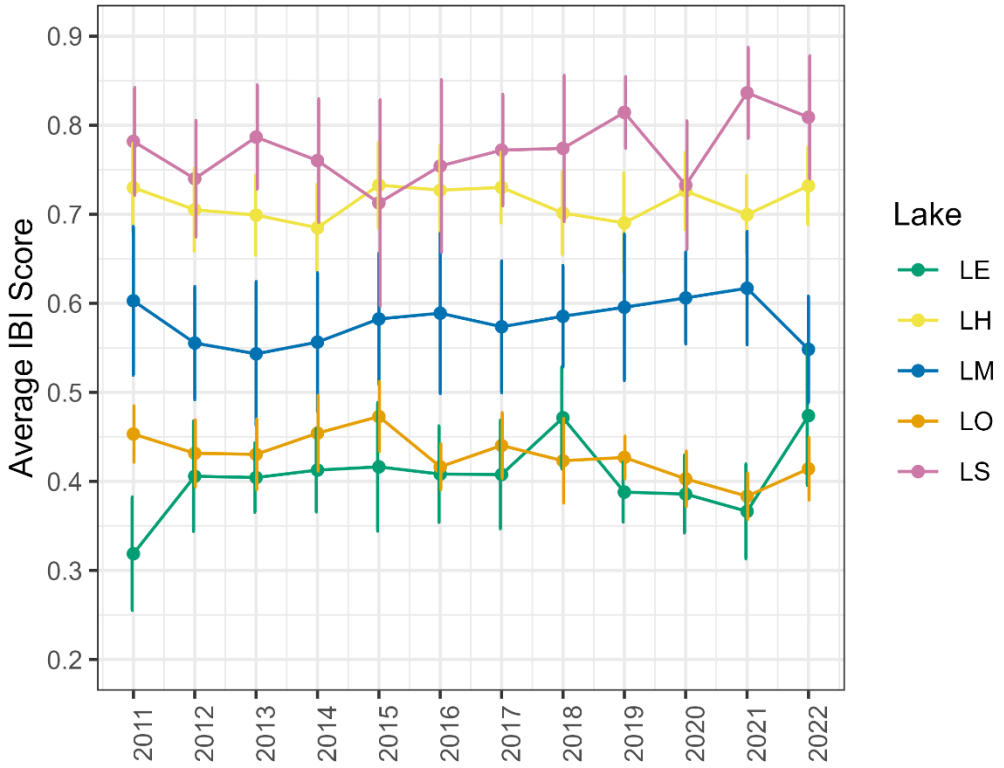

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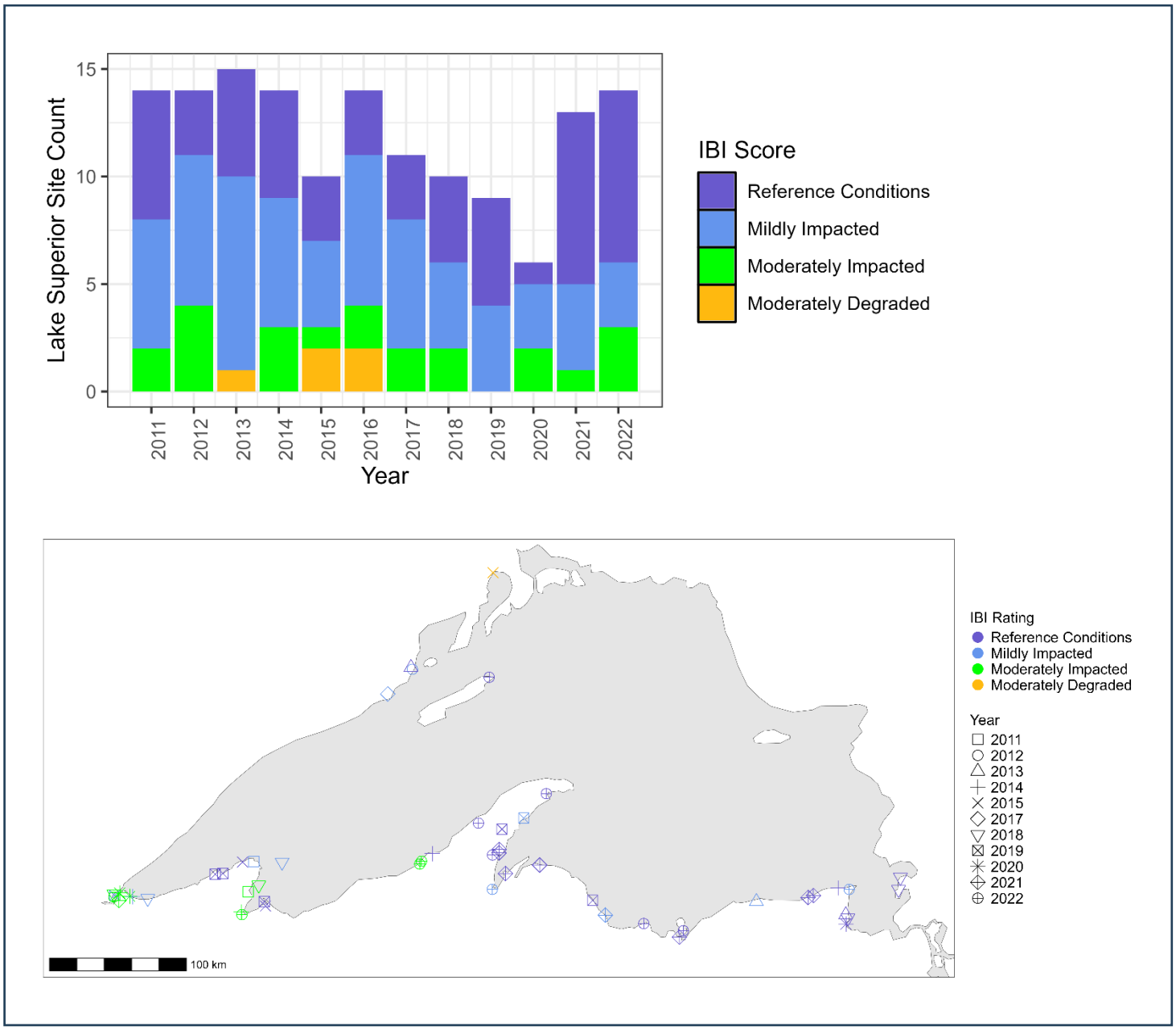

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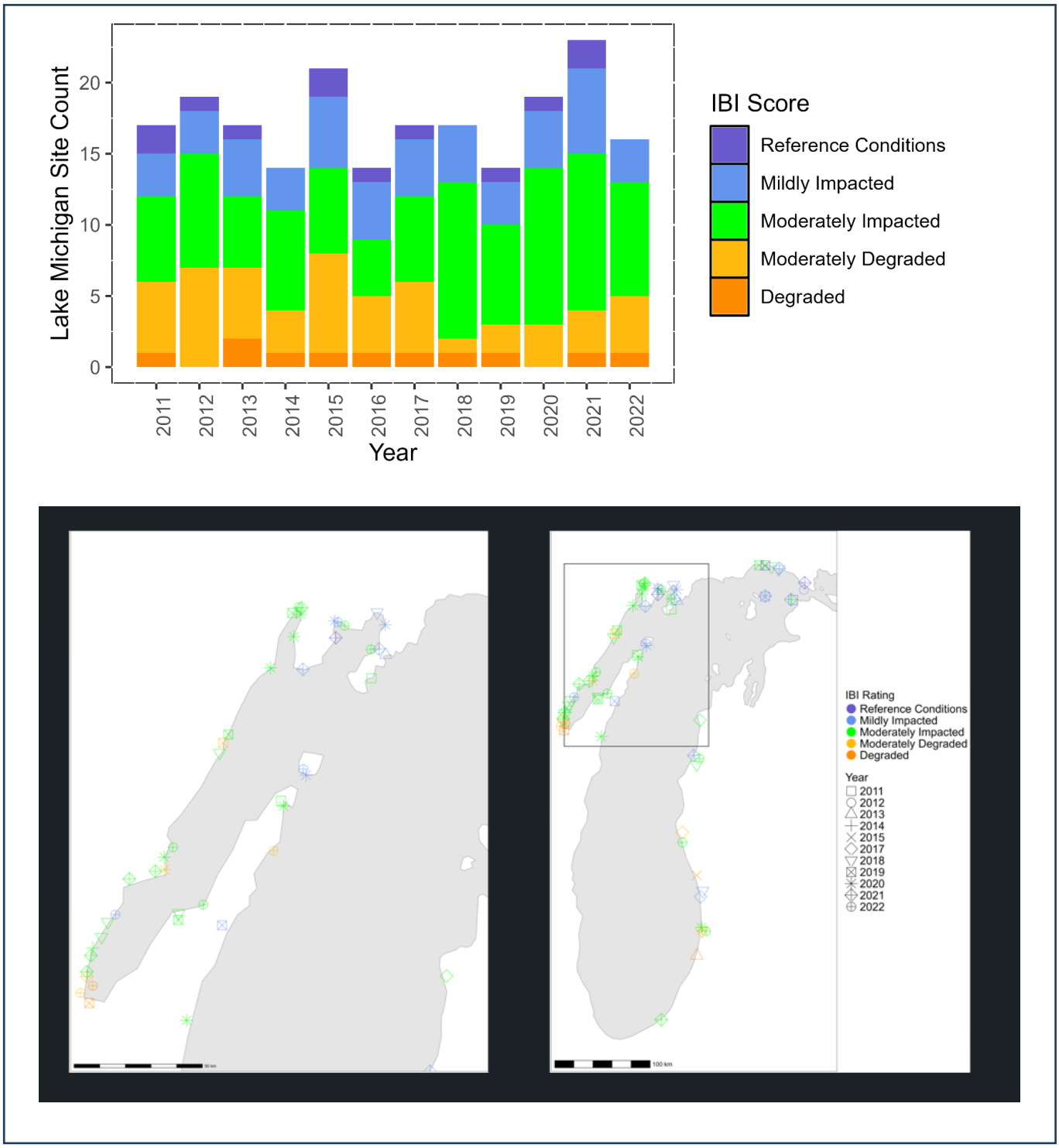

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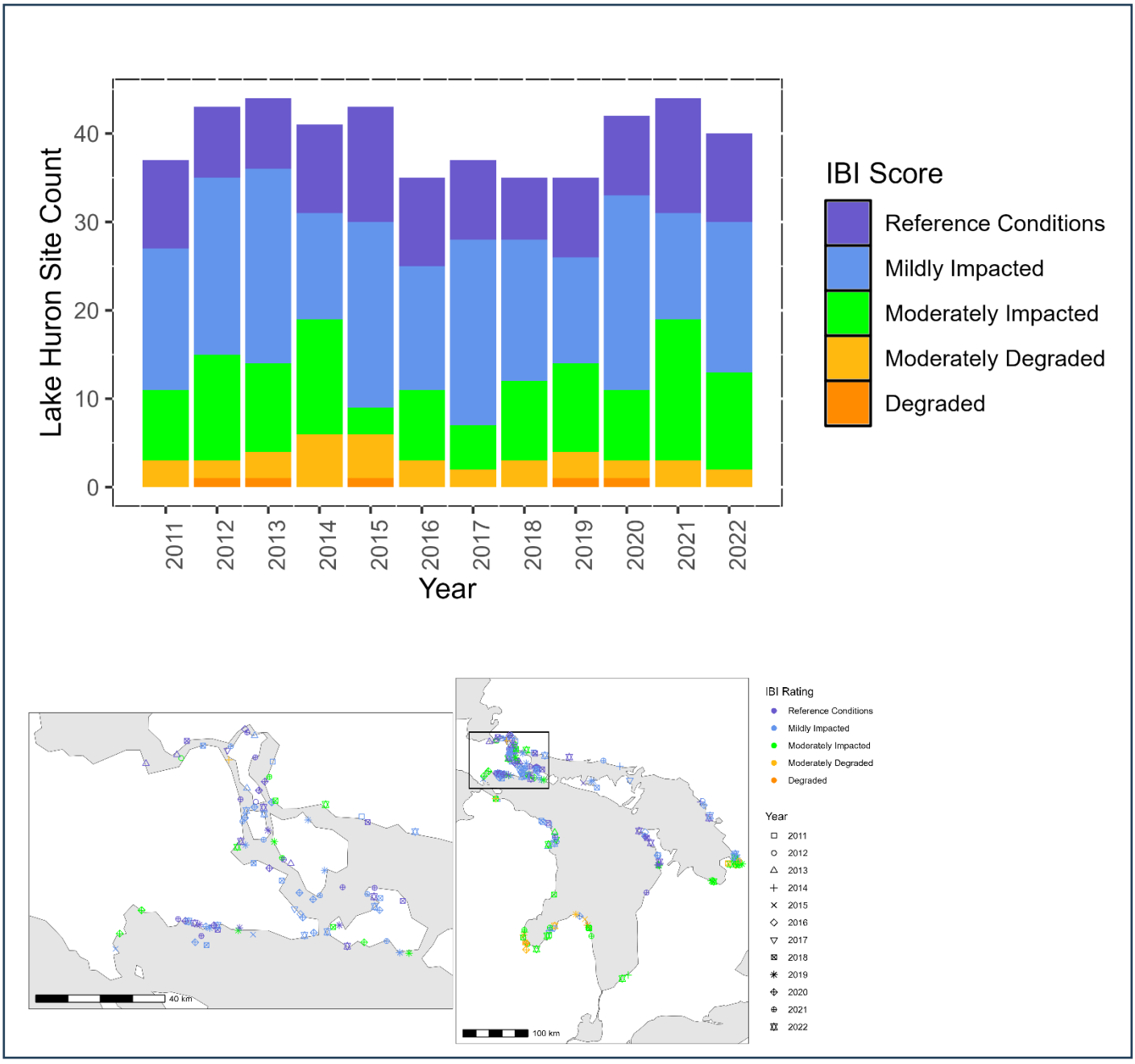

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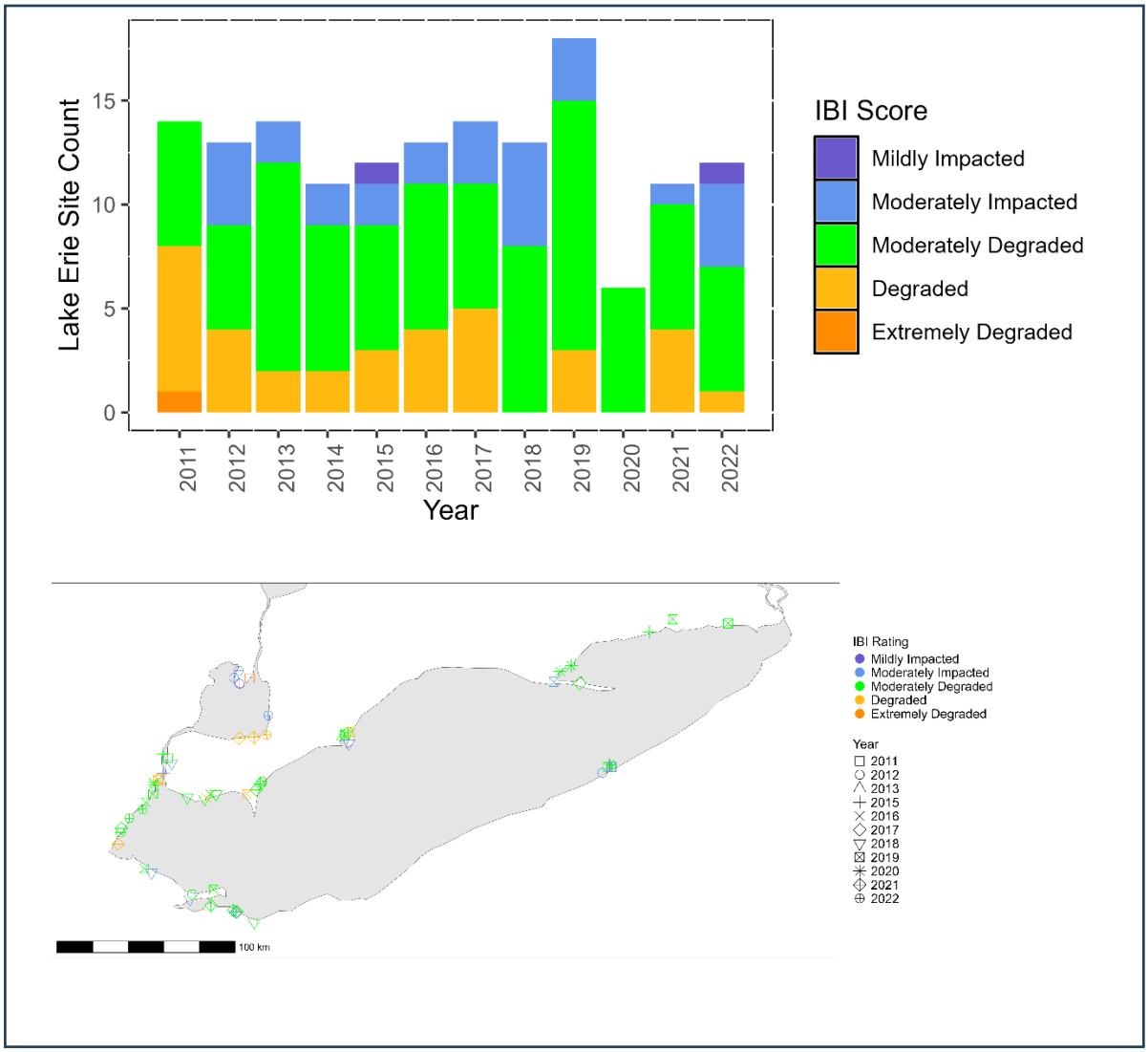

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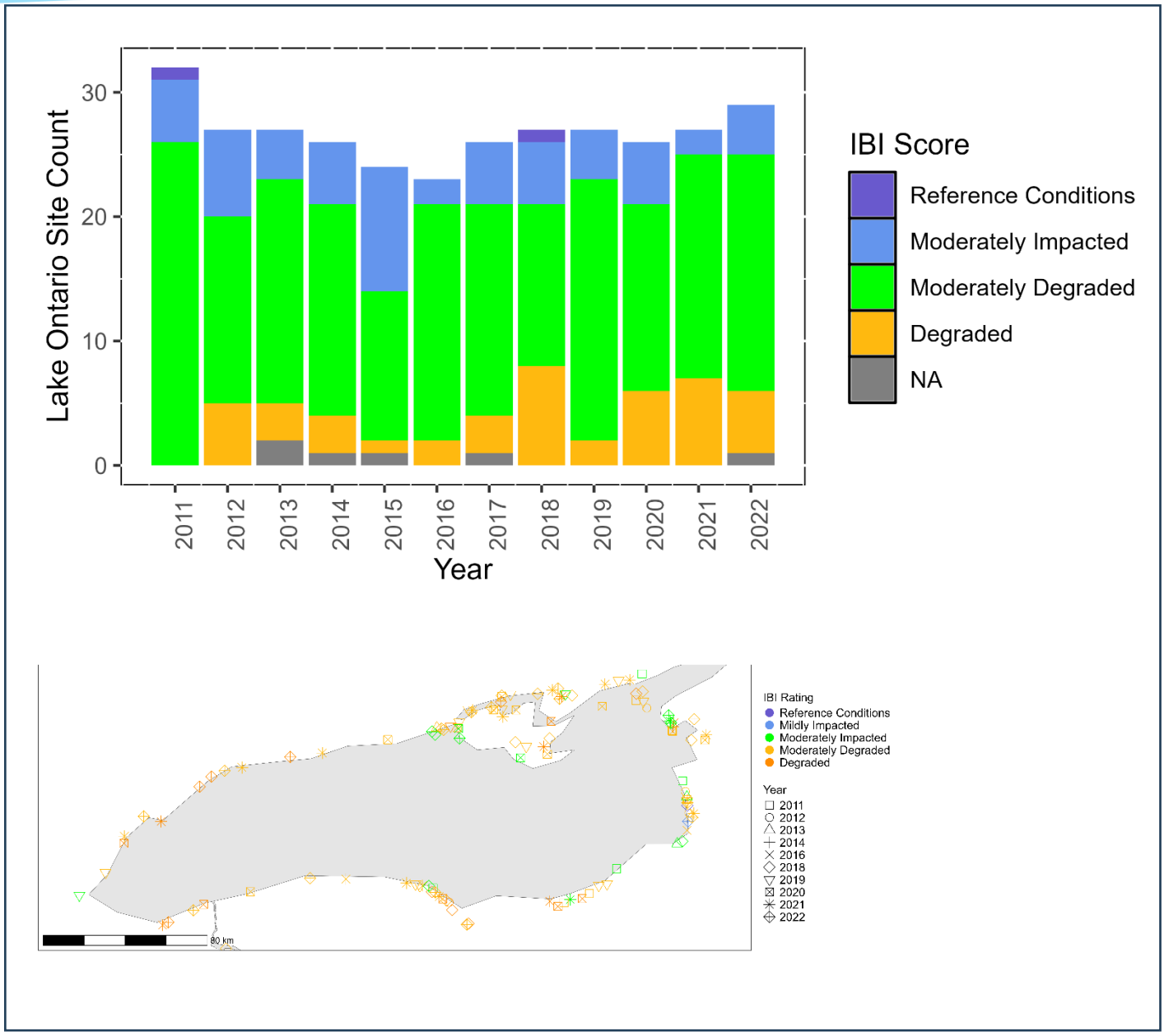

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