2020 CANADIAN BASELINE COASTAL HABITAT SURVEY

Lake Erie

Technical Report

Canada

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This document describes the rationale, methodology and findings of a baseline habitat survey for the Canadian portion of the Lake Erie coastal ecosystem. This work addresses Canadian commitments pursuant to the Habitat and Species Annex of the 2012 Great Lakes Water Quality Agreement and the 2020 Canada-Ontario Agreement on Water Quality and Ecosystem Health.

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1.0 INTRODUCTION

The Great Lakes coastal ecosystem is comprised of wetlands, uplands, tributary confluences, and other highly productive and biologically diverse habitat that supports the life cycles of native plants and wildlife, including species at risk. The amenities or services that flow from these natural habitats are essential to the health of the waters of the Great Lakes and the people, communities, and economies that depend on them. Coastal habitats are interdependent and form a critical ecological linkage between the waters of the Great Lakes and the surrounding watersheds. Habitat abundance, condition, and change over time significantly influence the ecological health of the Great Lakes ecosystem.

Government, non-government agencies, and other organizations recognize that conserving coastal habitat is important and continue to protect, restore, and enhance these habitats and the native species they support. Conservation efforts in the Great Lakes basin are a patchwork of programs, policies, and initiatives led by multiple levels of government and non-government organizations. Conservation actions are most effective when guided by the best available information and knowledge. This technical report prepared by multiple agencies, summarizes the objectives, methods, and findings of the Canadian Great Lakes Baseline Coastal Habitat Survey for Lake Erie (herein referred to as the “Lake Erie Survey”). It complements the *2020 Canadian Great Lakes Baseline Habitat Survey – Highlights Report*.

Why a baseline habitat survey?

The Great Lakes ecoregion has the greatest diversity of species in Canada and is one of the most diverse ecoregions in North America in terms of ecological significance (Henson et al. 2005; Comer et al. 2003). A growing population, exploitation of natural resources, and many land-based threats, have resulted in the loss of more than 72 per cent of pre-settlement wetlands (DUC, 2010), more than 99 per cent of prairies and savannahs (Bakowsky and Riley, 1994), tributary spawning and nursery habitat for migratory fish (TNC, 2018), and coastal habitats (OMNRF, 2017), and the introduction of 188 non-native aquatic species (Sturtevant et al. 2019).

The amended 2012 Great Lakes Water Quality Agreement (GLWQA), and the Canada Ontario Agreement on Great Lakes Water Quality and Ecosystem Health 2021 (COA 2021, in draft), include provisions to address the needs of Great Lakes habitat and native species (Annexes 7 and 8). The purpose of the GLWQA Habitat and Species Annex is to contribute to the achievement of the general and specific objectives by conserving, protecting, maintaining, restoring, and enhancing the resilience of native species and their habitat, as well as by supporting essential ecosystem services. Canada and the United States (the Parties) have committed to *“conduct a baseline survey of the existing habitat against which to establish a Great Lakes Basin Ecosystem target of net habitat gain and measure future progress”.* Extensive efforts to restore and protect the Great Lakes coastal ecosystem have been made by many agencies, organizations, and stewardship groups, however governments have not yet established goals for net habitat gain or a method to assess progress over time (see section 2.0 for definition of net habitat gain).

Developing and applying consistent methods to assess and report on coastal ecosystems will help resource managers identify habitats in need of conservation action. It also facilitates developing goals, objectives, and targets, and enables reassessments to measure change and assess progress.

Intended use of the Lake Erie technical report

This technical report provides current quantitative information, and describes the data sources, assembly, and geospatial processing required to repeat the analysis. This document also describes the survey's scope, scale, and methodology, and presents results. In doing so, the technical report establishes a standardized approach so that future assessments can be replicated to track habitat net gain and or loss.

Resource management agencies, environmental non-governmental organizations, and local stewardship groups can use these survey results to establish local targets of net habitat gain and evaluate conservation success. The survey authors encourage stewardship groups to integrate additional information at an appropriate planning scale. The baseline information presented in this report can also help to identify priority places to restore, enhance, create, and protect habitat.

2.0 LAKE ERIE SURVEY SCOPE

The survey area ranges from Sarnia to the mouth of the Niagara River (Figure 2) and focuses on the diversity of habitat within the coastal margin, starting at the high water mark and stretching two kilometres inland. Coastal habitat features play a functional role in the ecology, water quality, and conservation needs of Lake Erie. The project scope is consistent with the primary data source, the Great Lakes Shoreline Ecosystems (GLSE) Classification and Mapping Project led by the Ontario Ministry of Natural Resources and Forestry (MNRF, 2019; Great Lakes Shoreline Ecosystem Inventory V 2.0 | Ontario GeoHub (gov.on.ca)). See Chapter 4.1 for more details on the survey boundaries.

The Lake Erie Survey provides a detailed summary of habitat types, and key information to establish a baseline, or benchmark, of habitat quantity, quality, condition, function, protection, and restoration. The Lake Erie Survey does not prescribe where and how much habitat to protect and/or restore, assess the cumulative impacts of anthropogenic stressors, or assess all aspects of ecological condition and threats to coastal habitat and native species.

Defining habitat, net gain, Lake Erie Survey components and measures
For the purpose of the Lake Erie Survey, habitat is defined as an area that supports the chemical, physical, and biological interactions and functions (connectivity, diversity and resilience) that are necessary for the life requirements of native species. The Lake Erie Survey aggregates reporting into four ecologically based habitat categories that are at the core of Great Lakes conservation planning. They contribute to Great Lakes health and biodiversity by supporting the life cycles of native species, maintaining and improving water quality and watershed hydrology, and providing social and economic benefits to Great Lakes residents. The following habitat types are assessed:

- wetlands
- uplands (i.e. terrestrial)
- tributaries
- inland lakes and ponds

Wetlands:
Assessing the current extent, richness, and condition of wetlands provides a baseline against which to measure conservation progress over time. OMNRF (2017) defines wetlands as “lands that are seasonally or permanently covered by shallow water as well as lands where the water table is close to or at the surface. The presence of abundant water has caused the formation of hydric soils and has favoured the dominance of either hydrophytic plants or water tolerant plants”. National and provincial Canadian based wetland classification systems typically recognize four major types of wetlands: swamps, marshes, bogs and fens (OMNRF, 2017; National Wetlands Working Group, 1997). Conserving wetlands is a priority as they provide many ecosystem services like water purification, protection from natural hazards, soil and water conservation, shoreline protection, and habitat for native species (Mahdavi et al. 2018). These benefits result from the natural hydrological and biogeochemical processes that occur within wetlands (Marton et al. 2015). Wetland ecosystems are critically important to biodiversity, including supporting a significant number of highly specialised, rare, or endangered species (Maltby, 2009). Coastal wetlands are important spawning and nursery habitats for Great Lakes fishes (Wilcox and Whillans, 1999; Montgomery et al. 2020). Lake Erie has a high diversity of wetland fishes and one of the highest concentrations of freshwater fishes at risk in the Great Lakes (Mandrak and Cudmore, 2010). Additionally, wetlands act as natural infrastructure in the

form of public assets, producing approximately $14 billion in economic benefits each year in Ontario (MNRF 2017; Troy and Bagstad, 2013). Wetland loss and degradation continues due to human activities, such as incompatible shoreline development, urbanization, conversion to agricultural lands, invasive species, water pollution, and climate change impacts.

Uplands (terrestrial):
In the context of the Lake Erie Survey, upland habitats of the coastal terrestrial ecosystem include all natural vegetation communities (except wetlands, tributaries, and inland lakes or ponds) within the survey area. An inextricable link exists between upland habitats and the biodiversity and health of the waters of the Great Lakes. Biomass and sediments are transferred from uplands into the nearshore ecosystem. Shoreline development and other modifications significantly impact the ecosystem's health, causing changes to habitat integrity, natural physical processes, and species assemblages (Dodd and Smith 2003, SOLEC 2009). This dynamic environment provides critical habitat for migratory birds (SOLEC 2009), and supports numerous endemic and globally rare species and coastal communities. Lake Erie's upland habitats are characterized by forests, sand beaches, dunes, tallgrass prairies, and savannahs. A survey of the current extent, richness, condition, function and protection of upland habitats provides a baseline against which to measure progress over time.

Tributaries:
Tributaries and the confluences of tributaries with nearshore waters of Lake Erie provide important biological functions like primary production, transport of nutrients and organic matter, heterogeneous habitat important to many native species assemblages and life stages, refugia, and predation opportunities (Larson et al., 2013). Fish often spawn and spend their early life stages in tributaries; some spend their entire lives in tributaries (Northcote 1984). High biodiversity persists in many tributaries despite the impacts of invasive species and point- and non-point source pollution, and sharp decreases in many native species' populations (Montgomery et al. 2020). Intensive modification of tributaries has taken place historically, and continues to this day due to farming, flood control, industrial water taking, and development. Canadians have converted many tributaries to open ditches or buried pipes for agriculture. The Ontario government has designated many of these as municipal drains under the provincial *Drainage Act* (Stammler et al. 2008). Changes in climate and land use impact tributary dynamics and condition; for example, they alter discharge rates, nutrient loads, tributary water plumes in the open lake, and extent of mixing zones in estuaries (Drouin and Soper, 2009).

Inland lakes and ponds:
Inland lakes and ponds are permanent aquatic ecosystems that occur across the landscape where water has accumulated from drainage or precipitation; they may have rock, mineral, or organic substrates (OMNRF, 2019). Small lakes and ponds are important to maintaining regional biodiversity and stability; they have a greater waterfowl species richness per unit area than large lakes (Downing, 2010; Elmberg et al. 1994). Additionally, small lakes and ponds promote enhanced regional biodiversity in aquatic birds, plants, amphibians, and invertebrates because of low fish biomass and high richness and abundance of aquatic plants (Scheffer et al. 2006). These habitats are widely distributed and vital for many species, including humans, and account for just over 3 per cent of the Earth's surface (Downing et al 2006). Human activity and demand for freshwater increasingly threatens these rare ecosystems (Dudgeon et al. 2006). Understanding the current extent of inland lakes and ponds provides a baseline against which to measure progress over time.

Achieving net habitat gain
The concept of a net gain in habitat emerged as a key principle in the 2012 Great Lakes Water Quality Agreement and in other conservation policies and strategies. To identify gains in net habitat, Canadians need baseline ecological data against which to measure progress. Building on the *Conducting a Survey of Great Lakes Habitat* report (ECCC, 2017), we define net habitat gain as any measurable improvement in habitat function. For the purposes of this survey, net habitat gain is defined as one or more of the following:

- increase in spatial extent of habitat
- increase in biodiversity
- improvement in ecological condition
- improvement in ecological function
- increase in protected lands
- restored habitats

The Lake Erie Survey consists of 18 measures and six components of net habitat gain (Table 1). For more detail, see *Chapter 4.2*.

Table 1: *Components and measures used in the Lake Erie Survey*

Components	Measures
Extent	•Extent of wetland •Extent of upland habitat •Extent of tributaries •Extent of inland lakes and ponds
Biodiversity	•Richness by wetland types •Richness by natural upland habitats •Richness of fish species •Species of conservation concern
Condition	•Phragmites abundance •Anthropogenic land use •Area of impervious land •Riparian vegetation buffers •Shore-perpendicular structures •Shoreline hardening
Function	•Tributary impedances •Coastal habitat connectivity
Protection	•Protected lands
Restoration	•Amount of restored habitat

Links with other policies, programs, and initiatives
Protecting and restoring biodiversity is crucial to safeguarding the environment for present and future generations. Canada was the first developed country to ratify the Convention on Biological Diversity (CBD, 1992), committing to national targets for biodiversity conservation in the Canadian Biodiversity Strategy (CBS, 1995). Canada adopted the Strategic Plan for Biodiversity and Aichi Targets (2011–2020) with outcomes for healthy, diverse ecosystems and viable populations of species. Canada has specific national targets for protecting land, recovering species, conserving wetland, adapting to climate change, reducing pollution, managing invasive species, improving biodiversity science and knowledge, and respecting and promoting traditional ecological knowledge (ECCC, 2016).

Currently, the Canada Nature Fund supports protecting Canada's ecosystems, landscapes, and biodiversity, including species at risk, by supporting actions that will help Canada achieve its goal of protecting at least 17 per cent of Canada's terrestrial areas and inland waters by 2020.

Many federal and provincial acts offer various levels of protection to Great Lakes habitat and native species (Species at Risk Act, Canada Wildlife Act, Migratory Birds Convention Act, Fisheries Act, Canada Environmental Assessment Act, Great Lakes Protection Act, Fish and Wildlife Conservation Act, Invasive Species Act, Endangered Species Act, etc.).

The IUCN's *World Conservation Strategy* identified wetlands as "one of the key life support systems on this planet, in concert with agricultural lands and forests". Canada formally acknowledged the value of wetland ecosystems when it signed the Ramsar Convention on Wetlands in 1971. Canada became the first national government to enact a wetland policy in 1991; this policy identified wetlands as a key life support system, providing vital ecological and socio-economic functions (Government of Canada, 1991).

Canadian federal and provincial agencies monitor and assess aquatic, wetland and terrestrial habitats as part of domestic (Area of Concern – Remedial Action Plans, Coastal Habitat Assessment and Monitoring Program, Eastern Habitat Joint Venture), binational (Great Lakes Coastal Wetlands Monitoring Program and the Cooperative Science and Monitoring Initiative (CSMI)), and international (International Joint Commission) programs and initiatives.

The CSMI is a binational effort instituted under the Science Annex of the GLWQA to coordinate science and monitoring activities in one of the five Great Lakes each year to generate data and information for environmental management agencies. The CSMI's enhanced science and monitoring activities are conducted in response to priorities established by the Lake Partnerships of the Great Lakes Water Quality Agreement Lakewide Management Annex.

Pursuant to the GLWQA, Canada, the United States, and their many partners, established a suite of nine indicators of ecosystem health, supported by 44 sub-indicators, to assess the state of the Great Lakes. State of the Great Lakes assessments support the binational identification of current and emerging challenges to water quality and ecosystem health, help Governments evaluate the effectiveness of programs and policies that address challenges, and help inform and engage others.

The Lakewide Management Annex of the 2012 GLWQA contains a commitment for the development of a "nearshore framework" to address ongoing and emerging challenges to the nearshore waters of the Great Lakes. The first component of this nearshore framework is a comprehensive assessment of nearshore waters for each Great Lake. Completion of the 2018 *Lake Erie Canadian Nearshore Assessment* provides the results for 15 regional units (ECCC, 2018). The Lake Erie Survey is a complementary effort that improves the understanding of the Great Lakes coastal ecosystem and provides additional information for conservation practitioners and resource management agencies.

The Great Lakes biodiversity conservation strategies summarized the health of, and threats to, Great Lakes biodiversity (Lake Ontario Biodiversity Strategy Working Group 2009; Franks Taylor et al. 2010; Pearsall et al. 2012; and Lake Superior Binational Program, 2015). This important information helped guide priority setting and implement conservation actions. The biodiversity conservation strategies helped to inform the lake specific Lakewide Action and Management Plans (LAMPs). LAMPs are binational ecosystem-based management strategies for protecting and restoring water quality. LAMPs are developed and implemented by government agencies around each Great Lakes, together known as Lake Partnerships. The analysis and spatial products of this Lake Erie Survey will also inform future LAMPs.

3.0 DATA SOURCES

The Lake Erie Survey uses the best available natural heritage information from Canadian provincial and federal resource management agencies. Where data gaps existed, the technical task team acquired new data through contracts with service providers. The remaining data gaps are identified in Chapter 6. All data sources used in the Lake Erie Survey are listed in Appendix B and Section 4.3 describes how they were used. Below is a brief description of select datasets used in the development of the Lake Erie survey:

Ducks Unlimited Canada – Pre-settlement Wetland Extent (c. 1800)
A predictive historic dataset that identifies areas in southern Ontario that are likely to have supported wetlands by using soil type and soil drainage datasets and digital elevation models. Using soil type and soil drainage does not adequately capture select coastal wetlands, but was used as a contextual narrative to describe wetland losses. The data layer was created in 2010 and characterizes pre-settlement wetland area, circa 1800

MNRF Natural Heritage Information Centre (NHIC) - Provincially Tracked Species Observations
The data layer is comprised of species information received at the NHIC in many different formats (web-based records, individual databases, paper records, etc.); converted into a format that can be mapped to the NHIC species observation data structure. The data layer is comprised of all observations up to 2020.

ECCC - Canadian Protected and Conserved Areas Database (CPCAD)
The Canadian Protected and Conserved Areas Database (CPCAD) contains the most up to date spatial and attribute data on marine and terrestrial protected areas and other effective area-based conservation measures (OECM) in Canada. It is compiled and managed by Environment and Climate Change Canada (ECCC), in collaboration with federal, provincial, and territorial jurisdictions. The data layer is current December, 2019.

MNRF - The Great Lakes Shoreline Ecosystems (GLSE) Project
The Great Lakes Shoreline Ecosystems (GLSE) Project led by the Ontario Ministry of Natural Resources and Forestry (MNRF, 2019; https://geohub.lio.gov.on.ca/datasets/great-lakes-shoreline-ecosystem-inventory-v-1-0-lake-erie) was the main source of data for the Lake Erie Survey. This project is an inventory and mapping initiative that classifies ecosystems within 2 km of Great Lakes' shorelines in Ontario. The dataset contains spatial boundaries of ecosites (unique habitat types), and related site, soil, and vegetation field data. Mapping and field sampling followed ecological classification and survey methods developed specifically for the GLSE.

The GLSE employs a hierarchical classification system whereby habitats are organized into ecological classes ranging from broad to specific in level of detail (e.g. natural down to coarse textured ash/elm swamp wetland respectively). Classification hierarchies used for this work include, from broadest to most specific, include: community class (e.g. forest), community series (e.g. deciduous forest), and ecosite (e.g. moist, coarse textured, sugar maple forest). An example of this classification, representative of Rondeau Provincial Park, is shown in *Figure 1*.

The technical task team extracted ecosite polygons and related community series, community class, and ecological field data from the GLSE geospatial digital data inventory. The team used these data to analyze many of the measures in the Lake Erie Survey.

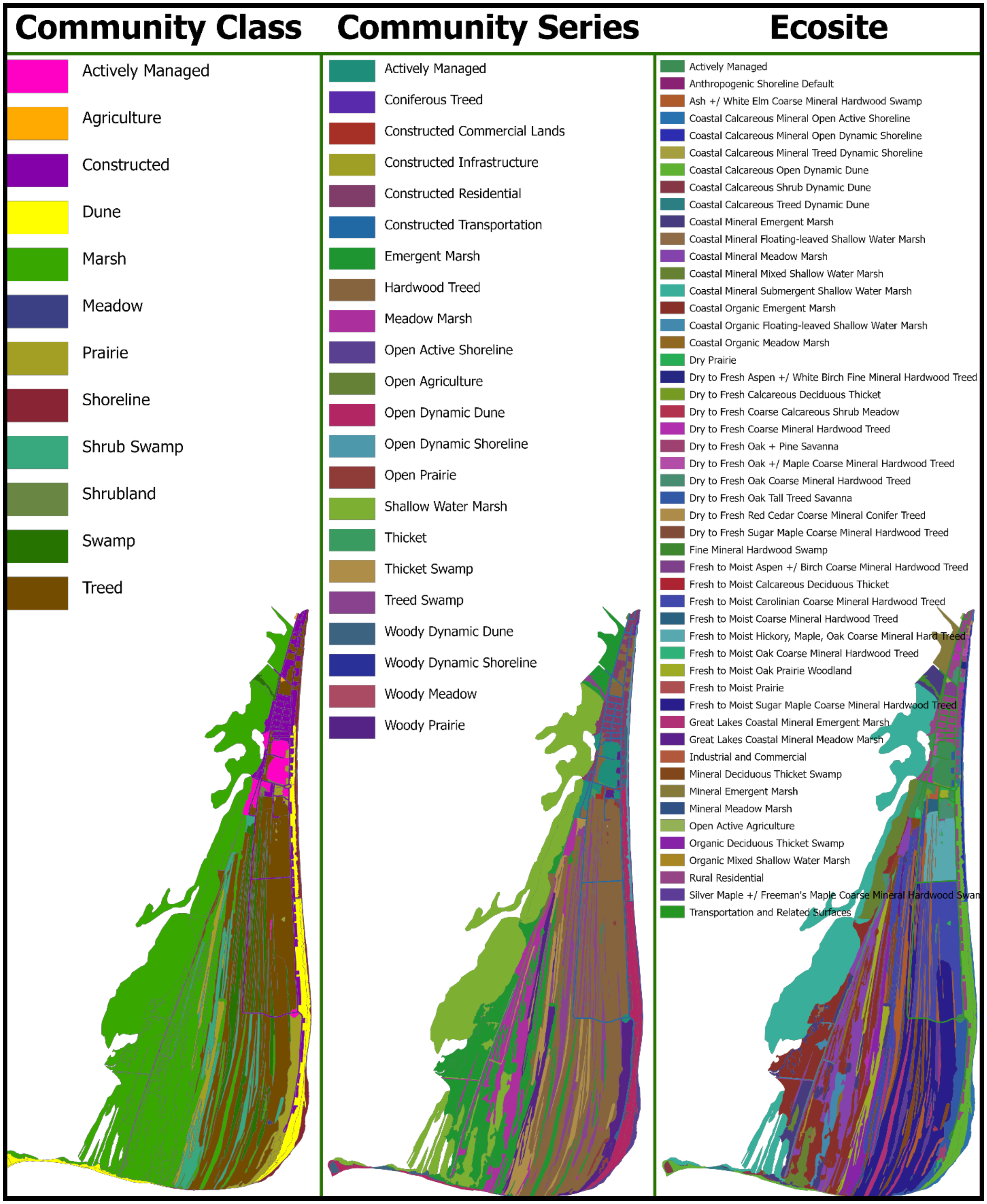

Figure 1: *Rondeau Provincial Park natural heritage data extracted from the Ministry of Natural Resources and Forestry - Great Lakes Shoreline Ecosystem*

4.0 METHODOLOGY

The Lake Erie Survey began in 2019 when Environment and Climate Change Canada, the Ontario Ministry of Natural Resources and Forestry, and the Department of Fisheries and Oceans developed a multi-agency technical task team. This team coordinated data assembly, information sharing, geospatial data analysis, and reporting. This work was carried out in the following sequence:

1. Delineated the coastal ecosystem into regional coastal units.
2. Selected key habitat types, defined net habitat gain, and identified components and quantitative measures to assess habitat.
3. Conducted spatial analyses and summarized results.
4. Shared findings.

4.1 DELINEATING COASTAL UNITS

The Coastal ecosystem was delineated into discrete coastal units based on hydrological, ecological and geophysical properties. To help with this, the GLSE shoreline and inland boundaries for Lake Erie were used to aid this process. Different shoreline boundary delineation methods were developed for areas directly adjacent to a great lake and areas along large inland rivers. These two methods are detailed below:

1. Orthophoto interpretation was used to delineate interfaces between water and bedrock, water and exposed substrates, water and vegetation, or water and anthropogenic surfaces.
2. All-time monthly mean maximum water level heights from 1918 to 2016 were used to estimate areas of probable lake influence along large rivers flowing into a great lake (e.g. Grand River). For Lakes Erie and St. Clair the Department of Fisheries and Oceans reported these as 175.14 and 176.04 metres referenced to International Great Lakes Datum 1985, respectively (http://www.tides.gc.ca/C&A/network_means-eng.html). A highly accurate and precise LiDAR Digital Elevation Model (DEM) (https://geohub.lio.gov.on.ca/datasets/mnrf::ontario-classified-point-cloud-lidar-derived?geometry=-122.592%2C40.316%2C-38.920%2C51.016) was then used to spatially map these elevations. All ecosystems along large rivers at these heights or lower were then identified and mapped using the method described for the first approach, except where natural or anthropogenic breaks in river flow were encountered (e.g. rapids, water control structures). In these cases, where the feature breaking the flow began below and extended above the maximum monthly mean height, the feature breaking flow was used to define the maximum up river extent of the shoreline.

Inland boundaries are consistent with the Great Lakes Shoreline Ecosystem Project, which includes a two-kilometre inland buffer following natural ecosystem features or boundaries from the aquatic and non-aquatic interface, not including islands. This represents an approximation of the 100-year flood line as well as wetlands, rivers and streams impacted by storm surge and the associated vegetation and wildlife.

Delineating the **alongshore boundaries** effectively separates each coastal unit. The team integrated three information sources to delineate these boundaries:

1. Lake Erie Nearshore Assessment - aquatic regional units developed through integrated modelling of nearshore bathymetry, substrate, and wave energy (Zuzek, 2018). The team used these units as a preliminary guide and intends end users to have access to regional nearshore and coastal habitat information.
2. Lake Erie basin Areas of Concern (AOC). The team used the St. Clair and Detroit River Area of Concern boundaries with some modification based on watershed hydrology.
3. Quaternary watershed hydrology and other biophysical factors. Where nearshore regional units and AOC boundaries could not be used, the MNRF produced a watershed data layer (Appendix B). Then, where applicable, the team used run-of-river catchment data to define coastal unit boundaries, and used Ontario soils classification and ecological land classification information to refine boundaries.

The Lake Erie Survey comprises of sixteen physiographically and ecologically unique coastal units (Table 2; Figure 2).

***Table 2**: Lake Erie coastal unit names and descriptions*

Unit number	Coastal unit name	Description
1	St. Clair River CDN	Consistent with the Area of Concern as defined by the GLWQA and with the nearest quaternary watershed boundaries.
2	Walpole Island/Delta	Maintains coastal wetlands, oak savannah, and remnant Carolinian habitats with the nearest quaternary watershed boundaries (also part of the St. Clair River CDN Area of Concern).
3	Lake St. Clair CDN	Defined by quaternary watershed boundaries.
4	Detroit River CDN	Consistent with the Area of Concern as defined by the GLWQA and with the nearest quaternary watershed boundary to the north and run-of-river catchment to the south-east.
5	Western Basin	North-western edge delineated using run-of-river catchment to encompass a shallow wetland complex and nearest quaternary watershed boundary in the east.
6	Point Pelee	Defined as one unit to preserve key ecological features, including globally significant coastal wetlands.
7	Point Pelee to Rondeau	Defined as one unit to preserve key ecological features, using quaternary watershed boundaries (both west and east).
8	Rondeau	Defined as one unit to preserve key ecological features, including coastal wetlands and associated ridge and swale complex.
9	Rondeau to Port Glasgow	Defined by quaternary watershed boundaries.
10	Port Glasgow to Port Stanley	Defined by quaternary watershed boundaries.
11	Port Stanley to Port Burwell	Defined by quaternary watershed boundaries.
12	Port Burwell to Long Point	Defined as one unit to preserve key ecological features, using quaternary watershed boundaries (both west and east).

Unit number	Coastal unit name	Description
13	Long Point	Defined as one unit to preserve key ecological features, using run-of-river catchment to preserve key ecological features, including Turkey Point.
14	Long Point to Port Dover	Defined as one unit, identified by largely erosional features, using run-of-river catchment to the west and quaternary watershed boundaries to the east.
15	Port Dover to Grand River	Defined by quaternary watershed boundaries.
16	Grand River to Niagara River	Defined by quaternary watershed boundaries.

Figure 2: Lake Erie coastal units (two-tone green shading to define each coastal unit) and Nearshore Framework regional units (outlined)

4.2 SELECTION OF COMPONENTS AND MEASURES

The technical task team selected four ecologically significant habitat categories, six components of net habitat gain, and 18 measures (Table 3). The habitat categories are: wetlands, uplands, tributaries, and inland lakes and ponds. The components are: extent, biodiversity, condition, function, protection, and restoration. The measures provide detailed information for quantitative analysis. While some measures are examined within habitat categories (e.g., extent), others are examined at the coastal landscape scale (Table 3). Analytical summaries were provided at the following two scales:

1. By coastal unit
2. Lakewide

Unit-by-unit data and contextual information were compiled to create lakewide summary data for the Canadian portion of Lake Erie's coastal ecosystem.

Table 3: *Lake Erie Survey key habitat categories, components of net habitat gain, and specific measures with descriptions.*

Category	Component	Measure	Description
Measures of net habitat gain that are assessed within the respective habitat categories			
Wetlands	**Extent**	**Wetland area by class**	Total area by: 1. Community class 2. Community series 3. Ecosite (Data catalogue only) 4. Coastal wetlands 5. Coastal wetlands by hydrogeomorphic type 6. Historical wetlands
	Biodiversity	**Richness of wetland classes**	Number of wetland classes by: 1. Community class 2. Ecosite
	Condition	**Phragmites abundance**	Total area and percentage area of *Phragmites australis* in wetlands
Uplands	**Extent**	**Upland habitat area by class**	Total area by: 1. Community class 2. Community series 3. Ecosite (Data catalogue only)
	Biodiversity	**Richness of natural upland classes**	Number of natural upland classes by 1. Community Class 2. Ecosite
	Condition	**Anthropogenic land use**	Percentage area and total area of anthropogenic development
		Impervious surface area	Percentage area and total area of imperviousness land
Tributaries	**Extent**	**Tributary length**	Total tributary length
	Biodiversity	**Richness of fish species**	Fish species biodiversity (represented by richness)
	Condition	**Riparian vegetation buffers**	Amount of vegetation present along the shoreline of each tributary
	Function	**Tributary impedances**	Identify number of impedances by: 1. Impedances that would have positive environmental benefit if removed 2. Sea lamprey barriers 3. Fish ladders
Inland Lakes and Ponds	**Extent**	**Area of lakes and ponds by class**	Total area by: 1. Community class 2. Community series 3. Ecosite (Data catalogue only)

Category	Component	Measure	Description
Measures of net habitat gain analyzed across all habitat categories and summarized for the entire coastal landscape			
Coastal Landscape	**Biodiversity**	**Species of conservation concern**	Number of species
	Condition	**Shore-perpendicular Structures**	Length and percentage of shore-perpendicular structures
		Shoreline hardening	Length and percentage of hardened shoreline
	Function	**Coastal habitat connectivity**	landscape fragmentation using effective mesh size
	Protection	**Protected and conserved areas**	Area protected and percentage of coastal unit protected
	Habitat restoration	**Canada Ontario Agreement (COA) habitat restoration projects**	Percentage area and total area of habitat restored through projects funded by COA between 2015 and 2019

4.3 QUANTITATIVE ANALYSIS

The technical task team used ArcMap to extract spatial data from the GLSE database and create a separate database containing all ecosite polygons in each coastal unit. This process is described below. For all other data sources step-by-step processes are described for each measure (sections 4.3.1-4.3.5). Note: All geospatial analyses and calculations were completed in ArcMap, using **NAD 83 UTM Zone 17N**.

GLSE spatial data extraction:

- Intersect the MNRF-GLSE ecosites with the Lake Erie coastal units
- Review the output shapefile to confirm each polygon is assigned to a coastal unit and an ecosite
- Use the dissolve tool on the output shapefile
    - Select the appropriate field ID's and ensure the following information is captured:
        - Coastal unit ID
        - Community class
        - Community series
        - Primary ecosite
        - Secondary ecosite
        - Area
- Update the "Area" field values to ensure the geometry is accurate for each polygon
- Export the results table
- Import table into program of choice
    - Query the data based on each measure

4.3.1 WETLANDS

A **coastal wetland** is defined as "*any wetland that is located on one of the Great Lakes or their connecting channels (Lake St. Clair, St. Marys, St. Clair, Detroit, Niagara and St. Lawrence rivers); or any other wetland that is on a tributary to any of the above-specified water bodies and lies, either wholly or in part, downstream of a line located 2 kilometres upstream of the 1:100 year flood line (plus wave run-up) of the large water body to which the tributary is connected*" (MNRF 2017). Great Lakes wetland scientists define coastal wetlands as wetlands that are or were hydrologically connected to the Great Lakes (Ingram et al. 2004) or those wetlands that are the direct result of physiographic landscape features unique to the Great Lakes such as tombolo associated ridge/swale complexes (Albert, 2003, Lee et. al, 2019). The Lake Erie Survey examines both **coastal wetlands** and **inland wetlands**. **Inland wetlands** are most common on floodplains along streams, in isolated depressions surrounded by dry land, along the margins of lakes and ponds, and in other low-lying areas where groundwater intercepts the soil surface or where precipitation sufficiently saturates the soil (EPA, 2018).

EXTENT:
<u>Wetland area by class</u>
Wetland extent measures the total area (in hectares) of all wetlands in each coastal unit. This measure summarizes the current area of all wetlands, the current area of coastal wetlands, and the historic area of all wetlands in each coastal unit. This measure can be reassessed and future wetland area (total area and area of different wetland types) can be compared to current wetland area to detect change. The technical task team used GLSE data to report on wetland extent in four categories:

1. Total area by community class
2. Total area of coastal wetlands *
3. Coastal wetlands by hydrogeomorphic type
4. Total area of historical wetlands **

* Coastal wetlands are wetlands with current or historical hydrological connection to the Great Lakes (Ingram et al. 2004) or those wetlands that are the direct result of physiographic landscape features unique to the Great Lakes such as tombolo associated ridge/swale complexes (Albert, 2003, Lee et. al, 2019)
** The team compared current wetland area to historic wetland area across the Canadian portion of Lake Erie using historical wetlands data provided by Ducks Unlimited Canada (Appendix B). Ducks Unlimited Canada used soil type and soil drainage to identify historic wetland areas. For methodology and detailed results, see *Southern Ontario Wetland Conversion Analysis – Final Report* by Ducks Unlimited Canada (2010).

Steps to complete analysis of total area by community class and coastal wetlands:
Query extracted GLSE data to summarize wetland extent

- Filter by coastal unit
- Filter "Community Class" to display wetland classes only.
    - Under the GLSE, wetland classes are identified as:
        - Marsh
        - Shrub swamp
        - Swamp
        - Bog
        - Fen

* ***Classes present vary by coastal unit***

- Sort data by ecosite, followed by community series
  - Community class will sort automatically.
  - All ecosites with "coastal" included in the naming convention are identified as coastal wetlands. (Example: *Coastal Emergent Marsh*)
- Summarize the data by the following:
  - Total area of each Community Class
  - Total area of each Community Series
  - Total area of all identified coastal wetlands
  - Total wetland area within the coastal unit
- Repeat for each coastal unit
- Summarize the results from all coastal units to create a lakewide summary.

Steps to complete analysis of coastal wetlands by hydrogeomorphic type:
Identify the coastal wetlands that intersect Lake Erie coastal units

- In ArcMap, export a shapefile of the Coastal Wetlands from the Lake Erie GLSE. Do this by selecting "Coastal" under the "*Coastal_In*" field.
- Intersect, the Great Lakes Coastal Wetland Inventory shapefile with the Coastal Wetlands shapefile.
- Use the Dissolve tool, to dissolve the intersected shapefile by Hydrogeomorphic type.
- Intersect the dissolved shapefile with the Lake Erie Coastal Units
- Re-calculate the area using the "Calculate Geometry" tool in the attribute table.
- Ensure the following fields are being captured within the shapefile.
  - wetland fields capture the following information:
    - Coastal unit ID
    - Hydrogeomorphic type
      - Lacustrine
      - Riverine
      - Barrier-protected
    - Area
- Export and use the attribute table to:
  - Sort by coastal unit
  - Summarize the data by the following:
    - Total area of coastal wetlands, by hydrogeomorphic type, by coastal unit
    - Total area of all coastal wetlands across all coastal units
  - For each coastal unit: *Divide the total area of coastal wetlands by the area for each hydrogeomorphic type*
- Summarize the results from all coastal units to create a lakewide summary.

Steps to complete analysis of total area of historical wetlands:

- In ArcMap, intersect DUC circa 1800's wetlands shapefile with the Lake Erie coastal units
- Export the output shapefile to confirm each wetland polygon is assigned to a coastal unit
- Use the dissolve tool on the output shapefile
  - Select the appropriate field's ensuring both the coastal unit and historical wetlands fields contain the following information:
    - Coastal unit ID
    - Wetland polygon information
    - Area
- Export and use attribute table to:

    - Sort by coastal unit
    - Summarize the data by the following:
        - Total area of historical wetlands by coastal unit
        - Total area of historical wetlands across all coastal units
- Determine the change in wetland extent from historical to present
    - Note: Historical wetlands data layer is based on soils and does not account for historical presence of shallow water marshes, therefore they are removed when comparing to present day.
    - For each coastal unit: *Total wetland area (minus shallow water marsh area) - historical wetland area = wetland loss or gain*
- Summarize the results from all coastal units to create a lakewide summary.

BIODIVERSITY:

Richness of wetland classes:

This measure assesses the richness of wetlands in each coastal unit. It provides baseline data on the number of ecosites present in each wetland class and complements the wetland extent measure. Wetland richness can be reassessed and future results can be compared to current results to detect changes. The technical task team assessed wetland richness using the following measure:

- Number of wetland classes, broken down by number of unique ecosites in each wetland class:
    - *Example*: *Coastal unit X: marsh (7 ecosites), swamp (5 ecosites)*

Steps to complete analysis:

Query extracted GLSE data to summarize wetland richness

- Filter by coastal unit
- Filter "Community Class" to display wetland classes only.
    - Under the GLSE, wetland classes are identified as:
        - Marsh
        - Shrub swamp
        - Swamp
        - Bog
        - Fen

    * *Classes present vary by coastal unit*
- Sort data by ecosite, followed by Community Series
    - Community Class will sort automatically.
- Summarize the data by the following:
    - Number of ecosites by Community Class
    - Number of ecosites by Community Series
    - Total number of ecosites in each coastal unit
- Repeat for each coastal unit
- Summarize the results from all coastal units to create a lakewide summary.

CONDITION:

Phragmites abundance

European Common reed, also known as Phragmites (scientific name *Phragmites australis* subsp. *australis*), dominates the wetland plant community in certain locations and has a significant negative impact on coastal wetlands' health and function. This species spreads rapidly, replacing diverse native species with dense monocultures, disrupting Ontario's sensitive wetland ecosystems and impacting at least 25 per cent of Ontario's species at risk (MNRF, 2017). This measure provides baseline data on the percentage of Phragmites within and adjacent to wetlands. Phragmites abundance can be reassessed and future results can be compared to current results to detect changes. The technical task team used data layers produced by the Michigan Tech Research Institute (MTRI) and MNRF to report on Phragmites abundance in two categories:

1) Total area of Phragmite*s*
2) Proportion of wetlands (within and adjacent) occupied by Phragmites

Steps to complete analysis:
Identify Phragmites stands that intersect Lake Erie coastal units

- In ArcMap, intersect MNRF and MTRI Phragmites shapefile with the Lake Erie coastal units
- Export the output shapefile to confirm each Phragmites polygon is assigned to a coastal unit
- Use the dissolve tool on the output shapefile
  - Select the appropriate field IDs ensuring both the coastal unit and Phragmites fields contain the following information:
    - Coastal unit ID
    - Phragmites polygon information
    - Area
- Export and use attribute table to:
  - Sort by coastal unit
  - Summarize the data by the following:
    - Total area of Phragmites by coastal unit
    - Total area of all Phragmites across all coastal units
- Extract wetland extent data from MNRF GLSE by coastal unit
  - See *Extent: Wetland area by class* for data processing steps.
- Determine the proportion of wetlands occupied by Phragmites
  - For each coastal unit: Total Phragmites area divided by total wetland area
- Summarize the results from all coastal units to create a lakewide summary.
  - Note: Phragmites are also found in roadside and agricultural drainage ditches, which are captured in this summary as part of the adjacent habitats.

4.3.2 UPLANDS

EXTENT:

Upland habitat area by class

Upland habitat extent measures the total area of all natural upland (terrestrial) habitat types in each coastal unit. Upland habitat extent can be reassessed, and future results can be compared to current results to detect changes in the total area of upland habitat and the area of each upland habitat type. The technical task team used GLSE data to report on upland habitat extent in two categories:

1) Total area by Community Class
2) Total area by Community Series

Steps to complete analysis:

Query GLSE data to summarize upland habitat extent

- Filter by coastal unit
- Filter "Community Class" by available natural (non-anthropogenic) upland classes only.
  - In the GLSE database, these classes are identified as:
    - Barren
    - Bluff
    - Cliff and Talus
    - Dune
    - Meadow
    - Prairie
    - Rockland
    - Shoreline
    - Shrubland
    - Treed

  * *Classes present vary by coastal unit*
- Sort data by ecosite, followed by Community Series
  - Community Class will sort automatically.
- Summarize the data by the following:
  - Total area of each Community Class
  - Total area of each Community Series
  - Total of all Community Classes by area within the coastal unit
- Repeat for each coastal unit
- Summarize the results from all coastal units to create a lakewide summary.

BIODIVERSITY

Richness of natural upland classes:

This measure assesses the richness of natural upland (terrestrial) habitats in each coastal unit and summarizes the number of ecosites in each upland class. It complements the upland habitat extent measure and can be reassessed; future results can then be compared to current results to detect changes in upland classes within each coastal unit. The technical task team used GLSE data to assess the richness of natural upland classes and report on:

- **Number of upland classes**, broken down by number of ecosites in each community class:
  - *Example*: *coastal unit X: Bluff (1 ecosite), Meadow (5 ecosites), Treed (12 ecosites)*

Steps to complete analysis:
Query GLSE data to summarize natural upland richness

- Filter by coastal unit
- Filter "Community Class" by available natural (non-anthropogenic) upland classes only.
    - In the GLSE database, these classes are identified as:
        - Barren
        - Bluff
        - Cliff and Talus
        - Dune
        - Meadow
        - Prairie
        - Rockland
        - Shoreline
        - Shrubland
        - Treed

    * ***Classes present vary by coastal unit***
- Sort data by ecosite, followed by Community Series
    - Community Class will sort automatically.
- Summarize the data by the following:
    - Number of ecosites by Community Class
    - Number of ecosites by Community Series
    - Total number of ecosites within each coastal unit
- Repeat for each respective coastal unit
- Summarize the results from all coastal units to create a lakewide summary.

CONDITION

<u>Area of land use</u>

Area of land use measures the amount of anthropogenic development in each coastal unit. This measure summarizes the percentage of anthropogenic development and can be reassessed, and future results can be compared to current results to detect changes in total area and percentage anthropogenic development by community class. The technical task team used GLSE data to assess the area of anthropogenic land use and reports on:

1) Total area of land use
2) Proportion of each coastal unit occupied by land use

Steps to complete analysis:
Query extracted GLSE data to summarize land use

- Filter by coastal unit
- Filter "Community Class" by anthropogenic classes only.
    - In the GLSE database these classes are identified as:
        - Actively managed
        - Agriculture
        - Constructed
        - Open water
            - Select only "*Open Aquatic*" Community Series
        - Unvegetated ephemeral
            - Select only "*Unvegetated Ephemeral Aquatic Storm-water Ponds and Water Treatment*" Community Series

    * *Classes present vary by coastal unit*

- Sort data by ecosite, followed by Community Series
    - Community Class will sort automatically.
- Summarize the data by the following:
    - Area by Community Class
    - Total area in each coastal unit
    - Proportion of land use by coastal unit
- Repeat for each coastal unit
- Summarize the results from all coastal units to create a lakewide summary.

Area of impervious surfaces

Area of impervious surfaces measures the amount of anthropogenic hardened surfaces. Anthropogenic surfaces are surfaces that don't absorb water; instead they cause rain or snow melt to run-off. Examples include roads, and residential and commercial dwellings. This measure can be reassessed, and future results can be compared to current results to detect change in the total area of impervious land. The technical task team used GLSE data to analyze imperviousness and report on:

1) Total area of impervious land
2) Proportion of each coastal unit occupied by impervious land

Steps to complete analysis:

Query GLSE data to summarize the area of impervious surfaces

- Filter by coastal unit
- Filter "Community Class" by impervious surfaces classes only.
    - In the GLSE database these classes are identified as:
        - Constructed

    * *Classes present vary by coastal unit*
- Summarize the data by the following:
    - Total area in each coastal unit
    - Proportion of impervious surfaces by coastal unit
- Repeat for each coastal unit
- Summarize the results from all coastal units to create a lakewide summary.

4.3.3 TRIBUTARIES

While all Great Lakes' tributaries contain important habitat for native species and provide important ecological functions and ecosystem services, it is beyond the scope of the Lake Erie Survey to examine all tributaries. Instead, we focus on the tributaries, or portions of tributaries, within the coastal unit boundaries. Table 4 lists the largest (in length and/or watershed area) or most significant (in terms of flow) tributaries flowing from Canada into Lake Erie. They were all included in these analyses. Some smaller and less significant tributaries were also included.

Table 4: *Selected Lake Erie tributaries used in the Lake Erie Survey*

Tributary	Discharge point	Origin
St. Clair River	Lake St. Clair	Lake Huron
Sydenham River		Headwaters
Thames River		Headwaters
Detroit River	Lake Erie – western basin	Lake St. Clair
Kettle Creek	Lake Erie – central basin	Headwaters
Catfish Creek		Headwaters
Big Otter Creek		Headwaters
Big Creek	Lake Erie – eastern basin	Headwaters
Lynn River / Black Creek		Headwaters
Nanticoke Creek		Headwaters
Grand River		Headwaters

EXTENT

<u>Tributary length</u>

Permanent and intermittent watercourses were included in the mapping and analyses of tributaries. Fields that did not appear to be actively farmed, and that had defined channels visible in the imagery were included as tributaries. Constructed open drains were included if a natural watercourse existed upstream of the drain segment; closed tiled drains were excluded. The technical task team noted limitations when delineating watercourses through urban and industrial areas; it was unknown whether natural watercourses had been buried in these areas. Professional judgement was used to accurately depict tributaries that influence the nearshore area. Gaps exist in this inventory and the team may revisit the measures used to assess habitat in tributaries before the second Lake Erie Survey.

The team mapped the physical extent in linear length of tributaries that contribute to each coastal unit and summarized the number of distinct features in and upstream of each coastal unit. The minimum, maximum and average length of all streams counted as tributaries inside the study area and in the watershed upstream of the study area was reported.

Steps to complete analysis:

Preliminary data preparation for analysis and map production.

For each coastal unit

- Use the "Select by Location" tool to identify and select all watersheds that overlap coastal units
    - To include additional watersheds manually selected them
- Create a field in the watershed layer that can capture coastal unit names or unique IDs to relate the watershed features to coastal unit features
- Use the "Select by Location" tool to select all watercourse features that are within the selected watersheds

    - Note: Use the Enhanced Watercourse layer from the Ontario Integrated Hydrology Data
- Create a field in the watercourse layer to store coastal unit names or unique IDs (similar to what was done to watershed layer) to create a relationship between watercourse features and coastal unit features
- Repeat this for all other BHS Coastal Unit features
- You can now query all data (coastal units, watersheds, and watercourses) based on coastal unit names or unique IDs

Converting watercourse features to tributary segments
Adjust watercourse segments to take stream order into account. This revises watercourse segments to meet the characteristics of tributaries needed for this analysis.

- Dissolve all watercourse features based on the field named "STRAHLER"
    - Note: Values in the STRAHLER field represent stream order for the watercourse.
- Once dissolved, select all features and explode. All features should now be segments broken up by Stream Orders. However, features that are forked off (e.g. two streams joining as one stream) are captured as one stream instead of two
- To split these single streams into two streams, find the start and end point for all watercourse features using the "Create Points on Lines" tool
- Use the "STRAHLER" field to query the Start/End point layer and the watercourse layer. Query the watercourse layer for STRAHLER = 1 and query the Start/End point layer for STRAHLER = 2
- Use the "Split Line at Point" tool to split single streams into two streams where they are forked off (where STRAHLER = 1)
- Repeat for next set of stream orders (e.g. query watercourse layer for STRAHLER =2 and Start/End point layer for STRAHLER = 3). Repeat until all watercourse features are processed
- Merge all the resulting shapes to create a final watercourse layer

Create maps and pull statistics

- Create maps for each coastal unit. To do this query each set of data based on coastal unit names or unique IDs
- To pull statistics (e.g. total, average, max, and min length) query the final watercourse layer for each coastal unit, then open the attribute table and right click on the "Shape Length" field and select "Statistics…"; this will open up a window with all the statistics. If the "Shape Length" field does not exist, create the field, then run "Calculate Geometry" to populate the field with each feature's length, then right click on the field and select "Statistics…"

BIODIVERSITY
<u>Richness of fish species</u>
Fish species biodiversity (represented by richness), was chosen to represent available habitat. Pronounced declines in freshwater biodiversity have been shown to occur as a result of reduced habitat quality, quantity, and connectivity (Montgomery et al. 2020), thus richness is a suitable indicator of habitat availability. Because of the five-year reporting cycle, 2014-2018 fish collection data were used for the 2019 measures.

The technical task team used all 2014-2018 survey data from DFO fish inventories, Asian Carp Monitoring, and the Species at Risk Program for the Lake Erie Basin for this analysis. The team used the dplyr package (v. 0.8.3) in the RStudio statistical environment (v. 3.6.1) to analyze the data.

Steps to complete analysis:
Calculation of species richness
- Use the intersect tool to select all data that intersect coastal units
- Remove individuals not captured in riverine habitat, as well as hybrids and individuals not identified to species
- Calculate species richness by coastal unit as the number of unique species
- Calculate search effort by coastal unit, where one unit of effort equals one net or one transect (see caveats below)

Caveats
Data are from a number of surveys, using various gear such as seine net, fyke net, and/or electrofishing. Each net or transect represents one unit of effort and effort differs among coastal units. Furthermore, catchability varies among gears and data from all gears were combined, following Montgomery et al. 2020. For an example of how catchability varies among gears see 5.6 Thames River Gear Comparison Study *in* Ontario Ministry of Natural Resources and Forestry 2019.

CONDITION
Riparian vegetation buffer
Assessing the extent of riparian vegetation is a well-documented way to assess the condition of a watercourse (Steedman 1987, Chase et al. 2016, SCRCA 2018). Research and practice support the conservation objective of each stream having a 30-metre wide vegetated zone along at least 75 per cent of its length (Environment Canada, 2013). The technical task team assembled spatial data and assessed the shoreline condition of Lake Erie tributaries using riparian vegetation. The team spatially analyzed tributaries in the Canadian Lake Erie basin to delineate, map, quantify, and report on riparian vegetation 50 metres along either side of the tributaries, and up to approximately two kilometres from the Lake Erie shoreline.

The objectives were to: delineate watercourses within coastal units (see above) that can support riparian buffers (i.e. are not entombed) and calculate the extent of riparian vegetation adjacent to the delineated watercourses. The team used Watercourses, Constructed Drains, and Tile Drainage Area datasets from Land Information Ontario for this analysis.

Steps to complete analysis:
Watercourse layer
- Use the Watercourses, Constructed Drains, and Tile Drainage Area layers
- Use ESRI World Imagery to verify watercourses
- Delineate watercourses less than five metres wide with a single line; delineate watercourses greater than five metres wide as two-sided lines aligning with the water's edge. If a watercourse widens to greater than five metres, represent it with a single line and a two-sided line joined at the point where the watercourse widens to greater than five metres. Create a centreline of all watercourses (one and two-sided delineations). Other criteria for delineating watercourses:
    - End watercourse lines at the points where they flow into marshes or open water wetland communities
    - Continue watercourses through ponded areas if they have inflows and outflows from these ponds

- ***Include:***
    - Permanent and intermittent watercourses visible in the imagery
    - Watercourses visible in the imagery but not present in the Land Information Ontario data
    - Watercourses that start prior to treed areas and continue beyond treed areas. These treed areas may be forests or treed swamps and watercourse channels are assumed to exist under the tree canopy
    - Agricultural fields that don't appear to be actively farmed and that have defined channels visible in the imagery
    - Constructed open drains if natural watercourses exist upstream of drain segments
- ***Exclude:***
    - Watercourses or channels between coastal unit boundaries. These are mainly in channels surrounding the Walpole Island/Delta unit. Assume these watercourses were considered part of the lake
    - Urban and industrial areas. Delineating watercourses in these areas has limits; no one knows if watercourses are buried in these areas so exclude them
    - Closed tiled drains

Vegetation cover layer

- Existing land cover and vegetation cover datasets were reviewed to establish the most accurate dataset to use in the vegetation analysis. Based on the information provided through Land Information Ontario and in the data specifications for the Southern Ontario Land Resource Information System (SOLRIS) 3.0 layer, the SOLRIS 3.0 layer provided the most current land cover data for Ontario. (Note: *GLSE was not considered because this analysis extends beyond the two kilometre inland boundary*)
- The SOLRIS 3.0 layer classifies vegetation into Class Names based on the Southern Ontario Ecological Land Classification System (Lee et al. 1998). For the vegetation cover layer, the vegetation was reclassified into five vegetation types: Other, wetland, woodland, scrubland, and meadow (Table 5). The vegetation types are based on similar ecological patterns and processes, as previously done for this area (SCRCA, 2014)

Table 5: *SOLRIS class names used to categorize vegetation types*

Other	11. Open Beach/Bar, 21. Open Sand Dune, 41. Open Cliff and Talus, 51. Open Alvar, 64. Open Bedrock, 170. Open Water, 193. Tilled, 201. Transportation, 202. Built Up Area-Pervious, 203. Built Up Area-Impervious, 204. Extraction-Aggregate, 205. Extraction*
Wetland	140. Fen, 150. Bog, 160. Marsh
Woodland	23. Treed Sand Dune, 43. Treed Cliff and Talus, 53. Treed Alvar, 65. Sparse Treed, 83. Tallgrass Woodland, 90. Forest, 91. Coniferous Forest, 92. Mixed Forest, 93. Deciduous Forest, 131. Treed Swamp, 191. Plantation, 192. Hedge Rows
Scrubland	52. Shrub Alvar, 135. Thicket Swamp
Meadow	81. Open Tallgrass Prairie, 82. Tallgrass Savannah, 250. Undifferentiated

- A QA/QC analysis was completed on the vegetation cover layer to quantify the accuracy of the vegetation cover layer and the subsequent reliability of the spatial analysis, and to determine if updated vegetation delineations are required to improve future analyses
- Fifty random points within the 50 m watercourse buffer layer were selected in each coastal unit. At each point, the vegetation cover type was verified through current imagery. The number of points with correct and incorrect identification of vegetation types were tallied to determine a percentage accuracy of the vegetation cover layer

Spatial analysis

- Buffer the watercourse layer by five metres, 30 metres, and 50 metres, using dissolved buffers with rounded ends
- Clip the vegetation cover layer to each watercourse buffer width (five metres, 30 metres, and 50 metres)
- Calculate the total area of the five metre and 30 metre buffers in each coastal unit. Likewise, calculate the total area covered by each vegetation type (woodland, scrubland, meadow, wetland, and other) in the five metre and 30 metre buffers in each coastal unit

FUNCTION

Tributary impedances

Connectivity generally refers to the degree to which the landscape facilitates or impedes movement among resource patches. Connections between a waterway and its floodplain (lateral connectivity), and between that waterway and the waterways upstream and downstream (longitudinal connectivity) of it, influence how sediments, nutrients, carbon, and animals move through a river system. These connections are therefore important to the health of waterways (Julian et al. 2016). Barriers to fish passage are varied and abundant in the Great Lakes' watersheds. According to the Nature Conservancy of Canada, due to these obstructions, less than 20 per cent of river and stream habitat in the basin is connected to the waters of the Great Lakes (Krause 2019).

The Lake Erie Survey reports on the current function of tributaries within Lake Erie's coastal ecosystem (i.e. first two kilometres upstream). The technical task team decided that connectivity is an appropriate measure to assess the function of tributaries that influence coastal units. The team selected 'hydrologic connectivity' (HC) as an indicator of function, where HC is defined as water-mediated fluxes of material, energy, and organisms within and among components, e.g., the channel, flood plain, alluvial aquifer, of the ecosystem. The team compiled data on possible barriers to HC in each of the 16 coastal units, verified the barriers to the degree possible, and used the results to estimate the proportion of impedances that are barriers to fish passage. This analysis will make it possible to prioritize and inform barrier-removal projects.

Steps to complete analysis:

List of barrier data sources used in this analysis:

1. MNRF Ontario Dam Inventory
2. MNRF Ontario Hydro Network (OHN) - Hydrographic Line
3. DFO/MNRF Barriers (Unpublished)
4. DFO Sea Lamprey Barriers (Unpublished)
5. MNRF Pumped Drain Connections
6. Road Crossings - MNRF Ontario Road Network (ORN) Segment With Address
7. Ontario Hydro Network (OHN) - Watercourse

The team standardized the attributes in each dataset that were required for the analysis by identifying and updating key fields. This helped the team complete further analyses and made it easier to merge the barrier datasets into a single spatial layer. Fields are listed in Table 6.

Table 6: *Attribute data compiled in the analysis of tributary barriers*

Attribute	Description
ID	Unique ID of the feature in the compiled data layer
NAME	Name associated with the barrier feature (where available)
SRC	Source of the barrier feature
UNIT_NAME	Coastal unit name
X	Longitude of the feature (in decimal degrees)
Y	Latitude of the feature (in decimal degrees)
BING_LINK	Hyperlink to the location of the barrier in Bing Maps
GOOGLE_LINK	Hyperlink to the location of the barrier in Google Maps

For most of the listed datasets, a simple process was used:

- standardize the attributes
- intersect the barrier and coastal unit layers

The team used the intersect tool in ArcGIS to spatially identify barriers in each defined area and thereby count the number of barriers in each coastal unit. We added two additional attributes to the record for each barrier location to link each location to Google Maps (GOOGLE_LINK) and Bing Maps (BING_LINK). These maps helped us review and QA/QC barrier locations. We did additional pre-processing steps on the Hydrographic Line and Road Crossings layers.

Hydrographic Line

The Hydrographic Line dataset stores natural and manmade features as 'lines'. These features include break walls, dams, and waterfalls. We extracted all features identified as dams that intersected the coastal units, thereby creating a new dataset of all line features in each coastal unit. We then used the mid-point location (latitude/longitude) of each dam to create the 'point' layer used in the analysis described above.

Road Crossings

We created a dataset to identify locations where roads cross streams and fish could have trouble passing (such as perched culverts). Our goal was to get a sense of how many road crossings each coastal unit has and assess options. We could do a more thorough assessment in partnership with other agencies, such as local municipalities or the Ontario Ministry of Transportation, and look specifically at other factors like road-crossing construction (e.g. concrete, metal), flows, and significant elevation changes. This would improve our ability to identify sites where fish may have trouble passing. We intersected the MNRF Ontario Road Network (ORN) Segment and the Ontario Hydro Network (OHN) watercourse layers for the analysis described above.

Error Estimate

We used Google Earth, ESRI imagery, published information, and expert opinion to closely inspect 10 per cent of barriers and then decide which barriers represent true disconnections in waterways. We counted the number of each, then used the sums to infer the proportion of barriers in each coastal unit that don't impede fish passage.

4.3.4 INLAND LAKES AND PONDS

This category contains two distinct community classes: “unvegetated ephemeral” and “open water” (MNRF 2019)
Unvegetated ephemeral aquatic communities occur where flooding has been excessive and lasted long enough to prevent vegetation from establishing, yet the substrate is seasonally, periodically, or unexpectedly exposed. Most of these features occur at the site scale where vernal pooling, seeps, and creek beds give rise to unvegetated wet conditions (MNRF 2019).

Open water aquatic sites are deep unvegetated ponds, lakes, creeks, streams, and rivers, where different ecological drivers select for floating algae, phytoplankton, and fish life (MNRF 2019).

EXTENT
Area of inland lakes and ponds
Extent measures the total area (in hectares) of all lakes and ponds in each coastal unit. This measure provides baseline data and can be reassessed. Future results can then be compared to current results to detect changes in the total area of lakes and ponds and in the areas occupied by each aquatic class. The technical tasked team used GLSE data and broke extent into two categories:

1) Total area by Community Class
2) Total area by Community Series

Steps to complete analysis:
Query the GLSE data to summarize the extent of lakes and ponds

- Filter by coastal unit
- Filter “Community Class” by available wetland classes only.
    - In the GLSE database, lake and pond classes are identified as:
        - Unvegetated ephemeral aquatic
        - Open water

  * ***Classes present vary by Coastal Unit***
- Sort data by ecosite, followed by Community Series
    - Community Class will sort automatically
- Remove all anthropogenic Community Series
    - “Unvegetated Ephemeral Aquatic Storm-water Ponds and Water Treatment”
    - “Open Aquatic”
- Summarize the data by:
    - Total area of each Community Class
    - Total area of each Community Series
    - Total area of lakes and ponds in each coastal unit
- Repeat for each coastal unit
- Summarize the results from all coastal units to create a lakewide summary

4.3.5 COASTAL LANDSCAPE

The coastal landscape encompasses all habitat types (wetlands, uplands, tributaries, and inland lakes and ponds). The technical task team chose measures that assess the coastal landscape as one entity and that assess interactions that occur within and among the different habitat types. Additionally, protection and restoration efforts rarely focus on a single habitat type. Rather, areas that perform (or could perform) functional roles in maintaining Great Lakes biodiversity like providing habitat to native species, improving water quality and watershed hydrology, and/or delivering social and economic benefits to Great Lakes residents are usually protected and/or restored.

BIODIVERSITY

Great Lakes species of conservation concern

Species diversity provides a valuable understanding of the overall health and function of ecosystems. This measure summarizes the number of species of conservation concern within each coastal unit. These include species at risk, and other provincially rare species. This measure complements the wetland and upland richness and extent measures. This measure can be reassessed and future data can be compared to current data to detect changes in the total number of species of conservation concern and the number in each coastal unit. The technical task team used data from the Provincially Tracked Species Observation layer and the Species Master List maintained by the MNRF Natural Heritage Information Centre to report on:

- Number of species of conservation concern in each Lake Erie coastal unit

Steps to complete analysis:

Use observation data in the Provincially Tracked Species Observation layer maintained by the Natural Heritage Information Centre:

- Select all observation records that intersect any coastal unit
  - Remove all low accuracy records (those with OBSERVATION MAPABLE = “No” and/or area greater than 314 ha)
  - Select all observation records with NHIC REVIEW STATUS of “EO Candidate” or “Processed – Linked to EO” or with a value in the EO_ID field. Such observation records have conservation value; they represent sightings with evidence of breeding or other important life processes.
  - Remove the portion of each observation record that extended over water
  - Calculated the area of each observation polygon
  - Union the observation records with the coastal units
- Remove all portions of observation records that are outside the coastal units
  - Use “Dissolve” to put the observation records back together
- Assess within each coastal unit
  - Calculate the area of each observation record that is within a coastal unit
  - Calculate the percentage area of each observation record that is within a coastal unit
  - Select all observation records that have more than 50 per cent of their areas in a coastal unit
  - Use the summarize function in GIS to create a list of species of conservation concern known from each coastal unit
- Join the summary table to the Species Master List table to create a table that includes species’ Species at Risk in Ontario List (SARO) statuses and provincial conservation status ranks (S-Ranks).

CONDITION
Sediment dynamics (sink, sources, and transport) are key natural process that help create and maintain coastal wetlands, especially barrier-protected wetlands. Shoreline hardening and development have altered sediment dynamics along much of the Great Lakes shoreline. This has negatively impacted coastal habitats by depriving them of natural sources of sediment, or eroding barriers, beaches, and other natural features that protect them. Identifying shore-perpendicular structures and shoreline hardening across the coastal ecosystem will improve Canadians' understanding of anthropogenic influences that cause changes in sediment dynamics.

Shore-perpendicular structures
Shore-perpendicular structures are prominent features that disrupt the alongshore transport of sand and gravel in nearshore areas (littoral drift). They include major ports, harbours, and jettied river mouths. The technical task team didn't include small barriers like groynes on private properties because they have limited impacts on sediment transport. Similarly, the team excluded barriers in embayments and connecting channels. The purpose of this measure is to establish a baseline number of shore-perpendicular structures in each coastal unit. To complete the analysis the team:

- Concentrated on large jetties and breakwalls that could impact sediment dynamics and wetland formation (especially barrier beaches).

Steps to complete analysis:
Identifying barriers:
- Barriers are perpendicular to the shoreline and at least 100 m long. They stretch from the shoreline to the offshore limit.
- Barriers are solid structures that trap and limit sediment movement along the shore.
- At locations that have two adjacent jetties (e.g. at a river mouth), digitize one jetty. The two structures act together to limit sediment transport, so shouldn't be double counted.
- Exclude:
  - Pile supported structures that do not impede sediment transport.
  - Structures in embayments since there is no significant alongshore sediment transport in these sheltered waters.

Digitizing the littoral barriers:
- In ArcMap, using South-west Ontario Ortho Photographs (SWOOP), digitize major artificial barriers to littoral drift. Barriers should be at least 100 m long and perpendicular to the shoreline.
- Intersect the shore-perpendicular structures shapefile with the coastal units to determine the number of structures in each coastal unit.

Shoreline hardening
The technical task team classified shorelines along the Canadian portion of Lake Erie (including the Huron-Erie corridor) as natural or hardened.

On a **natural shoreline** the nearshore, waters' edge, toe of bluff, backshore, or back of beach have no engineered or artificial structures. Rising and falling water levels result in natural changes in shoreline position. Wildlife can use and freely migrate between upslope and downslope areas. Natural vegetation communities, consistent with local conditions, are generally present along the shore.

On a **hardened shoreline** the nearshore, waters' edge, toe of bluff, backshore, or back of beach has been altered with engineered structures or artificial material (e.g. offshore breakwaters, lakefill, groynes, seawalls, revetments, dumped concrete rubble, artificial channels, dykes). Natural shoreline processes are altered, and native vegetation communities are generally absent.

This measure establishes a baseline length of hardened shoreline and proportion of hardened versus natural shoreline in each coastal unit. This measure can be reassessed, and future results can be comparted to current results to detect changes in the total length of hardened shoreline and the proportion of hardened versus natural shoreline.

Steps to complete analysis:

- Use SWOOP 2015 aerial imagery to analyze the shoreline and create a line shapefile that represents the shoreline boundary of the coastal units. Use a map scale of 1:2,000 or smaller (e.g. 1:5,000).
- Classify each line segments as 'natural' or 'hardened', and classify each line segment based on the exposure categories of 'lake', 'sheltered', or 'connecting channel'. For example, classify line segments within embayments and tributaries as having 'sheltered' exposure and line segments exposed to lake wave energy as having 'lake' exposure.
- Classify all line segments in the Huron-Erie corridor as 'connecting channel'.
- Export the shapefile attribute table to Excel to summarize and graph the data.

FUNCTION

Coastal habitat connectivity

Connectivity is the degree that landscapes allow species to move and natural ecological processes to occur across landscapes. This connectivity allows species to migrate, and move to feed, breed and respond to climate change. It also allows natural communities to maintain their ecosystem functions. Wetland and upland habitat connectivity were assessed together as many species required both habitats during their life cycles and connectivity across various types of natural cover is preferred.

The technical task team used the landscape measure effective mesh size (EMS) to assess habitat connectivity. Effective mesh size measures the average size of habitat patches and adjusts this by the probability that two points (i.e. organisms) chosen randomly are found in the same habitat patch (Jaeger 2000; OBC 2015). The algorithm assesses the effective habitat mesh size for one or more spatial summary features (e.g. hexagon) and reports on a continuous range from small to large where smaller effective mesh sizes equate to greater fragmentation or lower connectivity.

Coastal habitat connectivity measures the degree of fragmentation (or connectivity) of the landscape, using EMS in each coastal unit and within each contributing quaternary watershed. This measure provides baseline data and can be reassessed. Future results can then be compared to current results to detect changes in landscape fragmentation. The team used data from the Southern Ontario Land Resource and Information System (SOLRIS 2.1) to assess coastal habitat connectivity as:

1) Effective mesh size by coastal unit
2) Effective mesh size within contributing quaternary watersheds
3) Assigned Conservation Action Planning (CAP) rating by coastal unit *

* The Nature Conservancy developed the CAP process. It helps project teams develop effective conservation strategies and measures of success. In this process, ecological attributes are assigned standard viability ratings based on the acceptable range of variation (very good, good, fair, poor) that would allow them to persist over time (TNC, 2007).

Steps to complete analysis:

- SOLRIS is based on MNRF's ecological land classification (ELC) for southern Ontario (Lee et al, 1998). It is a land use inventory that supports several key provincial initiatives including: state of natural resources reporting (forestry, biodiversity), natural heritage features reporting (wetlands, woodlands), climate change reporting, and land use planning. Maintained on a consistent update cycle, SOLRIS is a standardized geospatial information layer that allows for reporting on changes in natural and anthropogenic features, such as wetland extent, forest afforestation/deforestation, habitat connectivity and built-up areas (impervious/pervious).
- The data are from the years 2000 to 2015 and are for ecoregions 7E, 6E and 5E (Growth Plan for the Greater Golden Horseshoe study area and an eastern Ontario extension to the Forest Resources Inventory boundary).
- Use the following formula to calculate effective mesh size:

$$m_{\text{eff}} = \frac{1}{A_{\text{total}}}\left(A_1^2 + A_2^2 + \ldots + A_i^2 + \ldots + A_n^2\right)$$

  where n = the number of patches, A_{total} = total area of the region investigated, and A_i = size of patch i (i = 1,2,3,…, n).
- Use the Effective Mesh Size (EMS) Toolbox to run a model designed to calculate the effective mesh size based on selected fragmented polygons and a single region polygon. This tool was developed for the Mixedwood Plains ecozone for Ontario state of biodiversity reporting (OBC 2015).
- Include all natural cover classes (values 11 – 192) from the Southern Ontario Land Resource and Information System (SOLRIS 2.1) (OMNRF, 2015).
- Don't include the Great Lakes shoreline boundary identified in the Ontario Hydro Network as natural cover. It's extensive size would skew the results to under-represent the level of fragmentation around the lake.
- Assign a raster value of 1 to all SOLRIS natural cover data and combine these data with the Lake Erie raster set to No Data and clipped to the Mixedwood Plains boundary.
- The tool uses 20-km hexagon grids across the area to assess natural cover and fragmentation across the landscape. Hexagons are often used in landscape analysis to reduce sampling bias from the edge effects of grid shapes.
- Select the hexagons that coincide with the coastal units and conduct a proportional analysis to determine the overall effective mesh size for each coastal unit.
- Select the hexagons that coincide with the quaternary watersheds that coincide with the coastal units and conduct a proportional analysis to determine the overall EMS for each quaternary watershed.
- The proportional analyses determine the effective mesh sizes for each coastal unit and determine what type of influence quaternary watersheds' effective mesh sizes may have on coastal units' effective mesh sizes.
- Assign a standard viability rating based on the acceptable range of variation (very good, good, fair, or poor).

PROTECTION

Protected and conserved areas

Habitat conservation through protected and conserved areas plays a critical role in Canada's efforts to preserve nature. Protected and conserved areas protect important parts of the Great Lakes ecosystem, maintain essential ecosystem services, safeguard habitat, and provide opportunities for tourism, recreation, and connections with nature. The International Union for Conservation of Nature (IUCN) defines a protected area as "a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural values (IUCN 2008)." The IUCN has developed seven categories to classify protected areas according to their management objectives. This classification is globally recognized and used to define protected areas and report on them (Dudley, 2008).

To assess protection, the team summarized data from the Canadian Protected and Conserved Areas Database (CPCAD; December 2019 dataset) for the Lake Erie basin and the survey area. The CPCAD contains the most up to date spatial and attribute data on marine and terrestrial protected areas, and effective area-based conservation measures (OECM) in Canada. This is a national database compiled and managed by Environment and Climate Change Canada, in collaboration with federal, provincial, and territorial jurisdictions (ECCC, 2020). The database only includes areas that have been assessed and recognized as meeting the standards under the IUCN classification system. This may include public or private areas; however, private lands were not included in the analysis due to data sharing restrictions. Future assessments may include privately owned protected and conserved areas if data restrictions are lifted. Private protected and conserved areas exist in the Great Lakes basin. Therefore, future assessments will likely show an increase in the total area of protected and conserved areas even if no new protected and conserved areas are created. The team used data from CPCAD to assess protection as:

- Area protected and percentage of coastal unit protected

Steps to complete analysis:

- The CPCAD is a publicly available national geospatial database with combined data from all Canadian jurisdictions.
- Data from the CPCAD (December 2019 version; ECCC 2020) were extracted for the Great Lakes basin. These data were further summarized for the Lake Erie Basin and then intersected and summarized for each coastal unit.
- Data are presented as total extent and relative extents (percentages) for the basin, survey area, and each coastal unit respectively.

RESTORATION

Canada Ontario Agreement (COA) habitat restoration projects

The Southern Ontario Land Resource Information System (SOLRIS) is a landscape-level inventory of natural, rural, and urban areas. It provides a standardized approach to describe ecosystems, and inventory and interpret land cover. The mapping legend for SOLRIS is based on southern Ontario and Great Lakes coastal ecological land classification materials (Lee et. al., 1998, Lee et. al., in prep.). A useful aspect of SOLRIS is the ability to monitor changes in the landscape through a change detection process developed by the Ministry of Natural Resources and Forestry. This process allows the province to measure habitat change between iterations of SOLRIS, at approximately 5 year intervals; to date SOLRIS inventories have been completed for the benchmark years of 2000, 2005, 2010, and 2015. Understanding habitat loss is important for governments to make decisions about where and how best to conserve biodiversity. Habitat gain is also detected through the reported changes, when a minimum of 0.5 hectares has been converted from non-vegetated to vegetated.

Scientists and analysts are now in the process of developing a method to detect net wildlife habitat gain in order to assist the province with measuring progress towards net habitat gain targets it has set through habitat strategies (OMNRF 2017). To date the most efficient, cost effective, comprehensive and accurate way to monitor gain is through a process known as multi-date automated normalized differenced vegetation index (NDVI) satellite image analysis. Acquiring and standardizing spatial data that include, at minimum, locations (coordinates) and types of past and current habitat restoration projects is crucial to the success of this process. This information provides the context needed to use known instances of habitat gain and extend the image information at those locations to area on the imagery that don't have known gain events. Information about restored habitat was obtained for stewardship projects that received funding from the MNRF between 2015 and 2020. Habitat restoration (i.e. gain) projects include one or more of the following activities:

- Planting native species
- Managing aquatic invasive species, including removing Phragmites
- Creating habitat, including excavating new wetlands
- Enhancing habitat, including creating nest boxes, re-designing tributaries to enhance biodiversity (altering creeks), and improving turtle nesting habitat

Data from MNRF funded habitat restoration projects that meet a variety of fish, wildlife, and ecosystem health objectives under the Canada Ontario Agreement for Great Lakes Water Quality and Ecosystem Health, Eastern Habitat Joint Venture, and/or 50 Million Trees program were standardized and combined into a single spatial layer to assess and report on the area of restored habitat. Only spatial data that showed habitat gain or enhancement were included. Government partners, including environmental non-governmental organizations, conservation authorities, and community groups carried out these habitat restoration projects.

While the SOLRIS habitat gain mapping and modelling process has yet to be fully defined, this exercise allowed analysts to lay out the steps necessary to include data from habitat restoration projects in the automated SOLRIS monitoring process.
The following abbreviated steps are required to complete this process:

- Integrate data collected using different approaches and data schemas into a common spatial format.
- Using ESRI ArcGIS, where possible, spatially select all habitat restoration projects in the survey area.
- Where data were not collected spatially, extract data using unique location names that was known to be in the survey area.
- Verify project locations and extent in ArcGIS by comparing spatial and/or tabular coordinate locations, areal extents, or location names.
- Remove duplicate information. Use ArcGIS to spatially identify overlapping projects. Refer to project reports for non-spatial products.
- Associate spatial data with coastal units automatically in ArcGIS. For projects with no spatial data, read project descriptions to determine which coastal unit each project is associated with.
  Filter out non-restoration activities such as the purchasing and protection of land. Use the following two criteria to select only habitat restoration activities:

    - Land already functioning as habitat but requiring maintenance work to maintain and/or improve functionality (e.g. improving water level control for duck breeding purposes, removing Phragmites)
    - Land that once provided wildlife habitat that, through restoration processes, has been restored to once again function in a wildlife habitat role. For example, land with altered drainage and vegetation that is returned to hydrological, soil, and vegetative conditions necessary to create wetland and offer associated wildlife and hydrological functions.
- Use Excel to calculate the total area of restored and enhanced habitat in each coastal unit.

5.0 RESULTS

Spatial data presented below are also available through a data catalogue, which has been made available through a web-based platform (Lake Erie Canadian Baseline Coastal Habitat Survey - Open Government Portal (canada.ca)). The data catalogue includes shapefiles for each measure and a KMZ file comprised of all measures. Each shapefile will enable users to view, analyse, and manipulate the information spatially through a Geographic Information System, and the KMZ file will allow users to view the same information visually through any open source computer program that renders a representation of Earth based primarily on satellite imagery.

Spatial data and results using GLSE

The GLSE classifies ecosystems at three levels. From broadest to most specific they are: community class, community series, and ecosite. The GLSE's Lake Erie data contains 18 community classes: actively managed, agriculture, barren, bluff, constructed, dune, marsh, meadow, open water, prairie, rockland, shallow water marshes, shoreline, shrubland, shrub swamp, swamp, treed, and unvegetated ephemeral.

The community series data breaks these communities into more specific units. For example, the community class called *treed* has seven community series: coniferous low treed, coniferous treed, coniferous treed swamp, hardwood low treed, hardwood treed, mixedwood low treed, and mixedwood treed.

Ecosites are even more specific; each ecosite represents an area that has consistent geology, soils, and vegetation. Ecosite boundaries were created by interpreting ecological patterns in imagery and air-photos at a 1:10000 scale. For example, along Ontario's portion of Lake Erie's coastal ecosystem two different ecosites are associated with the *coniferous low treed* community series (naturalized conifer low treed plantation and naturalized conifer low treed regeneration), and 52 different ecosites are associated with the *hardwood treed* community series.

5.1 WETLANDS

EXTENT:

Wetland area by class

Wetland extent varies across the survey area. With a total extent of 29,943 hectares, wetlands make up 20.02 per cent of the survey area. The largest proportions of wetlands occur in the Walpole Island/Delta and Long Point coastal units (Table 7). Similarly, the Walpole Island/Delta and Long Point units also have the largest areas of coastal wetlands (Table 8). All coastal units contain wetland habitats. Three coastal units do not contain coastal wetland habitats (Table 8). The proportion of wetlands by hydrogeomorphic type are 43% lacustrine, 46% riverine and 11% barrier-protected (Table 9). Historically, wetlands accounted for 52 per cent of the survey area (Table 10). The coastal units that have lost the largest areas of wetland since Europeans settled in the lower Great Lakes basin are Lake St. Clair CDN, Detroit River CDN, Western Basin, and Point Pelee to Rondeau. Coastal units between Rondeau and Long Point (9-12) contain small areas of naturally occurring wetlands (currently and historically).

***Table 7**: Summary results of wetland area by class (GLSE Community Class) in the survey area*

Unit number	Unit name	Area of wetland (ha)	Proportion of unit that is wetland (per cent)	Composition (area of each wetland type, in hectares)
1	**St. Clair River CDN**	**293.83**	**3.52**	Marsh (51.74), shrub swamp (14.19), swamp (227.9)
2	**Walpole Island/Delta**	**9,154.96**	**66.28**	Marsh (8,920.41), shrub Swamp (90.19), swamp (144.36)
3	**Lake St. Clair CDN**	**2,097.36**	**14.18**	Marsh (2,028.15), shrub swamp (0.86), swamp (68.35)
4	**Detroit River CDN**	**1,013.92**	**12.47**	Marsh (813.7), shrub swamp (40.75), swamp (159.47)
5	**Western Basin**	**1,168.68**	**11.9**	Marsh (811.41), shrub swamp (31.85), swamp (325.42)
6	**Point Pelee**	**927.18**	**21.15**	Marsh (862.39), shrub swamp (30.39), swamp (34.4)
7	**Point Pelee to Rondeau**	**353.39**	**3.31**	Marsh (179.42), shrub swamp (22.6), swamp (151.37)
8	**Rondeau**	**2,190.60**	**23.8**	Marsh (1,890.27), shrub swamp (114.07), swamp (186.26)
9	**Rondeau to Port Glasgow**	**80.88**	**1.49**	Marsh (12.6), shrub swamp (1.3), swamp (66.98)
10	**Port Glasgow to Port Stanley**	**332.22**	**3.89**	Marsh (10.76), shrub swamp (0.50), swamp (320.96)
11	**Port Stanley to Port Burwell**	**326.92**	**4.16**	Marsh (12.01), shrub swamp (14.31), swamp (300.6)
12	**Port Burwell to Long Point**	**137.80**	**3.09**	Shrub swamp (32.2), swamp (105.59)
13	**Long Point**	**9,102.89**	**60.56**	Marsh (8,657), shrub swamp (71.56), swamp (374.33)
14	**Long Point to Port Dover**	**49.00**	**1.50**	Marsh (8.96), shrub swamp (1.09), swamp (38.95)
15	**Port Dover to Grand River**	**376.49**	**3.29**	Marsh (157.74), shrub swamp (12.46), swamp (206.28)
16	**Grand River to Niagara River**	**2,337.63**	**16.22**	Marsh (651.28), shrub swamp (123.36), swamp (1,562.99)
Survey area		**29,943.77**	**20.02**	Marsh (25,067.84), shrub swamp (601.69), swamp (4,274.24)

Table 8: *Extent and proportion of coastal wetland in each coastal unit*

Unit number	Unit name	Area of coastal wetland (hectares)	Proportion of unit that is coastal wetland (per cent)
1	St. Clair River CDN	0.00	0.00
2	Walpole Island/Delta	8,314.28	60.19
3	Lake St. Clair CDN	1,787.89	12.09
4	Detroit River CDN	761.81	9.37
5	Western Basin	641.61	6.53
6	Point Pelee	841.72	19.2
7	Point Pelee to Rondeau	153.80	1.44
8	Rondeau	1,851.90	20.12
9	Rondeau to Port Glasgow	9.09	0.17
10	Port Glasgow to Port Stanley	0.49	0.01
11	Port Stanley to Port Burwell	1.76	0.02
12	Port Burwell to Long Point	0.00	0.00
13	Long Point	7,680.55	51.1
14	Long Point to Port Dover	0.00	0.00
15	Port Dover to Grand River	63.97	0.56
16	Grand River to Niagara River	223.00	1.55
Survey area		22,331.88	*14.93*

Table 9: *Coastal wetland extent by hydrogeomorphic type*

Unit number	Unit name	Lacustrine (ha)	Riverine (ha)	Barrier-protected (ha)
1	St. Clair River CDN	0	0	0
2	Walpole Island/Delta	0	8,126.55	0
3	Lake St. Clair CDN	872.62	184.71	633.89
4	Detroit River CDN	0	729.83	0
5	Western Basin	0.53	526.38	37.44
6	Point Pelee	0	21.93	782.27
7	Point Pelee to Rondeau	0	145.11	0
8	Rondeau	1,413.02	89.28	348.79
9	Rondeau to Port Glasgow	0	9.09	0
10	Port Glasgow to Port Stanley	0	0	0
11	Port Stanley to Port Burwell	0	0	1.17
12	Port Burwell to Long Point	0	0	0
13	Long Point	7,028.9	41.2	595.18
14	Long Point to Port Dover	0	0	0
15	Port Dover to Grand River	0	50.51	0
16	Grand River to Niagara River	0	214.32	8.18
Survey area		9,315.07	10,138.91	2,406.92

Table 10: *Historical (Circa 1800) extent and proportion of wetland in each coastal unit*

Unit number	Unit name	Area of wetland (ha)	Proportion of unit that is wetland (per cent)
1	**St. Clair River CDN**	**3,266.29**	***39.12***
2	**Walpole Island/Delta**	**12,877.70**	***93.23***
3	**Lake St. Clair CDN**	**13,874.97**	***93.83***
4	**Detroit River CDN**	**6,456.93**	***79.40***
5	**Western Basin**	**5,140.60**	***52.33***
6	**Point Pelee**	**3,156.50**	***72.01***
7	**Point Pelee to Rondeau**	**7,648.41**	***71.70***
8	**Rondeau**	**763.56**	***8.30***
9	**Rondeau to Port Glasgow**	**1,154.97**	***21.34***
10	**Port Glasgow to Port Stanley**	**240.01**	***2.81***
11	**Port Stanley to Port Burwell**	**650.80**	***8.27***
12	**Port Burwell to Long Point**	**1,289.84**	***28.93***
13	**Long Point**	**9,538.22**	***63.46***
14	**Long Point to Port Dover**	**341.93**	***10.49***
15	**Port Dover to Grand River**	**3,560.75**	***31.13***
16	**Grand River to Niagara River**	**7,514.42**	***52.15***
Survey area		**77,475.90**	***51.80***

BIODIVERSITY:

Richness of wetland classes

The survey area contains 63 wetland ecosites (unique habitat types). The Long Point unit has the highest number of wetland ecosites (48) and the Port Burwell to Long Point unit has the lowest number (4) (Table 11). The average number of wetland ecosites per coastal unit is 20; nine units contain more than the average. The survey area doesn't contain bog or fen ecosites.

Table 11: *Richness of wetland classes (GLSE community classes and ecosites)*

Unit number	Unit name	Richness of wetland classes (ecosites)
1	**St. Clair River CDN**	**10 ecosites: marsh (3), shrub swamp (1), swamp (6)**
2	**Walpole Island/Delta**	**26 ecosites: marsh (16), shrub swamp (1), swamp (9)**
3	**Lake St. Clair CDN**	**25 ecosites: marsh (17), shrub swamp (1), swamp (7)**
4	**Detroit River CDN**	**21 ecosites: marsh (13), shrub swamp (2), swamp (9)**
5	**Western Basin**	**25 Ecosites: Marsh (10) Shrub Swamp (5) Swamp (10)**
6	**Point Pelee**	**13 ecosites: marsh (7), shrub swamp (1), swamp (5)**
7	**Point Pelee to Rondeau**	**22 ecosites: marsh (8), shrub swamp (2), swamp (12)**
8	**Rondeau**	**26 ecosites: marsh (14), shrub swamp (2), swamp (10)**
9	**Rondeau to Port Glasgow**	**11 ecosites: marsh (4), shrub swamp (2), swamp (5)**
10	**Port Glasgow to Port Stanley**	**15 Ecosites: marsh (3), shrub Swamp (1), swamp (11)**
11	**Port Stanley to Port Burwell**	**15 ecosites: marsh (4), shrub swamp (2), swamp (9)**

Unit number	Unit name	Richness of wetland classes (ecosites)
12	Port Burwell to Long Point	4 ecosites: shrub swamp (1), swamp (3)
13	Long Point	48 ecosites: marsh (22), shrub swamp (4), swamp (22)
14	Long Point to Port Dover	12 ecosites: marsh (2), shrub swamp (1), swamp (9)
15	Port Dover to Grand River	21 ecosites: marsh (8), shrub swamp (3), swamp (10)
16	Grand River to Niagara River	27 ecosites: marsh (7), shrub swamp (2), swamp (18)
Survey area		63 ecosites: marsh (26), shrub swamp (6), swamp (31)

CONDITION:

Phragmites abundance

Phragmites australis is most abundant in the Walpole Island/Delta and Long Point units, covering 3,512 and 1,607 hectares, respectively (Table 12). The Walpole Island/Delta unit has the largest area of wetland, the largest area of coastal wetland, and the largest area of Phragmites. Walpole Island/Delta (38.37 per cent), Western Basin (35.1 per cent), and Lake St. Clair CDN (28.93 per cent) units have the largest proportions of Phragmites in relation to their total wetland areas. Phragmites covers 23.61 per cent of all wetlands in the survey area.

Table 12: *Area and proportion of Phragmites australis in wetlands*

Unit number	Unit name	Area of Phragmites (ha)	Proportion of wetlands (within and adjacent) occupied by Phragmites (per cent)
1	St. Clair River CDN	15.31	5.21
2	Walpole Island/Delta	3,512.46	38.37
3	Lake St. Clair CDN	606.80	28.93
4	Detroit River CDN	202.49	19.97
5	Western Basin	410.15	35.10
6	Point Pelee	177.97	19.19
7	Point Pelee to Rondeau	82.85	23.44
8	Rondeau	307.32	14.03
9	Rondeau to Port Glasgow	9.72	12.02
10	Port Glasgow to Port Stanley	0.00	0.00
11	Port Stanley to Port Burwell	0.65	0.20
12	Port Burwell to Long Point	0.22	0.16
13	Long Point	1,607.20	17.66
14	Long Point to Port Dover	0.29	0.59
15	Port Dover to Grand River	16.74	4.45
16	Grand River to Niagara River	118.69	5.08
Survey area		7,068.86	23.61

5.2 UPLANDS

EXTENT:

Natural upland habitat area by class

Natural upland habitat extent varies across the survey area. Natural upland habitats occupy 25,245 hectares of land, 16.88 per cent of the survey area. The Grand River to Niagara River unit has the largest area of natural upland habitat (3,547 hectares) and the Lake St. Clair CDN unit has the smallest area (371 hectares) (Table 13). The Lake St. Clair CDN unit also has the lowest proportion of natural upland habitat (2.51 per cent) in relation to its total area. The Long Point to Port Dover unit has the highest proportion of natural upland habitat (46.72 per cent).

Table 13: *Natural upland habitat area by class (GLSE community classes)*

Unit number	Unit name	Area of natural upland habitat (ha)	Proportion of unit that is natural upland habitat	Composition (area of each natural upland habitat type, in hectares)
1	St. Clair River CDN	1,331.13	15.94	Meadow (199.8), shoreline (0.51), shrubland (239.9), treed (890.93)
2	Walpole Island/Delta	1,657.26	12.00	Dune (1.01), meadow (458.04), prairie (175.85), shoreline (37.02), shrubland (2.89), treed (982.46)
3	Lake St. Clair CDN	371.64	2.51	Meadow (153.72), shoreline (2.13), shrubland (8.71), treed (207.08)
4	Detroit River CDN	669.12	8.23	Meadow (193.15), shoreline (2.33), shrubland (30.91), treed (442.73)
5	Western Basin	704.86	7.18	Bluff (14.08), dune (0.12), meadow (41.69), shoreline (46.48), shrubland (13.45), treed (589.05)
6	Point Pelee	496.22	11.32	Barren (0.03), dune (22.23), meadow (18.93), prairie (1.16), shoreline (45.86), shrubland (50.29), treed (357.71)
7	Point Pelee to Rondeau	849.31	7.96	Barren (0.31), bluff (99.97), meadow (58.09), shoreline (43.81), shrubland (53.12), treed (594.00)
8	Rondeau	949.91	10.32	Dune (103.34), meadow (3.70), prairie (97.46), shoreline (57.35), shrubland (13.19), treed (674.87)
9	Rondeau to Port Glasgow	1,384.33	25.58	Bluff (64.98), meadow (171.49), shoreline (20.53), shrubland (172.01), treed (955.33)
10	Port Glasgow to Port Stanley	3,099.15	36.32	Bluff (151.06), dune (5.07), meadow (74.72), shoreline (24.44), shrubland (36.73), treed (2,807.13)
11	Port Stanley to Port Burwell	2,492.04	31.68	Bluff (154.24), dune (23.74), meadow (43.61), shoreline (9.19), shrubland (54.49), treed (2,206.77)
12	Port Burwell to Long Point	1,154.47	25.89	Bluff (114.18), dune (3.19), meadow (67.68), shoreline (8.61), shrubland (9.20), treed (951.60)

Unit number	Unit name	Area of natural upland habitat (ha)	Proportion of unit that is natural upland habitat	Composition (area of each natural upland habitat type, in hectares)
13	**Long Point**	**2,656.11**	**17.67**	Bluff (0.11), dune (676.88), meadow (34.13), shoreline (184.10), shrubland (32.45), treed (1,728.44)
14	**Long Point to Port Dover**	**1,523.44**	**46.72**	Barren (0.59), bluff (33.95), dune (2.30), meadow (71.85), shoreline (12.85), shrubland (10.37), treed (1,391.52)
15	**Port Dover to Grand River**	**2,359.53**	**20.63**	Barren (0.61), bluff (2.03), dune (2.55), meadow (510.70), rockland (1.75), shoreline (107.51), shrubland (136.68), treed (1,599.73)
16	**Grand River to Niagara River**	**3,547.09**	**24.62**	Barren (8.97), bluff (7.81), meadow (221.77), rockland (1.08), shoreline (220.56), shrubland (459.81), treed (2,627.07)
Survey area		**25,245.61**	**16.88**	Barren (10.52), bluff (642.25), dune (840.44), meadow (2,323.06), prairie (274.47), rockland (2.83), shoreline (823.29), shrubland (1,324.16), treed (19,006.52)

BIODIVERSITY

Richness of natural upland classes

The survey area contains 214 natural upland ecosites (unique habitat types). The Grand River to Niagara River unit has the highest number of natural upland ecosites (99) and the Rondeau unit has the lowest (36) (Table 14). The average number of ecosites per coastal unit is 62; seven units contain more than the average.

Table 14: *Richness of natural upland classes (GLSE community classes and ecosites)*

Unit number	Unit name	Richness of natural upland classes (ecosites)
1	St. Clair River CDN	45 ecosites: meadow (11), shoreline (1), shrubland (3), treed (30)
2	Walpole Island/Delta	52 ecosites: dune (1), meadow (15), prairie (6), shoreline (4), shrubland (1), treed (25)
3	Lake St. Clair CDN	46 ecosites: meadow (13), shoreline (1), shrubland (3), treed (29)
4	Detroit River CDN	50 ecosites: meadow (10), shoreline (3), shrubland (3), treed (34)
5	Western Basin	60 ecosites: bluff (4), dune (1), meadow (6), shoreline (5), shrubland (6), treed (38)
6	Point Pelee	46 ecosites: barren (1), dune (5), meadow (5), prairie (1), shoreline (3), shrubland (3), treed (28)
7	Point Pelee to Rondeau	67 ecosites: barren (1), bluff (6), meadow (7), shoreline (5), shrubland (8), treed (40)
8	Rondeau	36 ecosites: dune (3), meadow (2), prairie (5), shoreline (3), shrubland (4), treed (19)
9	Rondeau to Port Glasgow	58 ecosites: bluff (8), meadow (8), shoreline (2), shrubland, (5), treed (35)
10	Port Glasgow to Port Stanley	70 ecosites: bluff (6), dune (3), meadow (5), shoreline (2), shrubland (4), treed (50)
11	Port Stanley to Port Burwell	70 Ecosites: Bluff (8) Dune (4) Meadow (6) Shoreline (4) Shrubland (5) Treed (43)
12	Port Burwell to Long Point	46 ecosites: bluff (7), dune (1), meadow (8), shoreline (3), shrubland (4), treed (23)
13	Long Point	77 ecosites: bluff (1), dune (6), meadow (7), shoreline (3), shrubland (5), treed (55)
14	Long Point to Port Dover	81 ecosites: barren (1), bluff (7), dune (2), meadow (10), shoreline (2), shrubland (5), treed (54)
15	Port Dover to Grand River	83 ecosites: barren (1), bluff (2), dune (1), meadow (9), rockland (1), shoreline (8), shrubland (5), treed (56)
16	Grand River to Niagara River	99 ecosites: barren (6), bluff (6), meadow (15), rockland (1) shoreline (10), shrubland (6), treed (55)
Survey area		214 ecosites: barren (6), bluff (8), dune (7), meadow (23), prairie (8), rockland (2), shoreline (14), shrubland (12), treed (134)

CONDITION

Area of land use

The survey area contains more land use (89,410 hectares or 59.78 per cent) than wetland, natural upland habitat, tributaries, and inland lakes and ponds (Table 15). The Lake St. Clair CDN unit has the largest area of anthropogenic land (11,652 hectares) and the Long Point to Port Dover unit has the smallest (1,680 hectares). More than 50 per cent of the area in 13 coastal units is anthropogenic land; in six of these, anthropogenic land occupies more than 75 per cent of the area.

Table 15: *Area and proportion of anthropogenic land*

Unit number	Unit name	Area of anthropogenic land (ha)	Proportion of coastal unit that is anthropogenic land (per cent)
1	**St. Clair River CDN**	**6,679.16**	**79.99**
2	**Walpole Island/Delta**	**2,122.65**	**15.37**
3	**Lake St. Clair CDN**	**11,652.03**	**78.80**
4	**Detroit River CDN**	**6,286.75**	**77.31**
5	**Western Basin**	**7,919.68**	**80.62**
6	**Point Pelee**	**2,698.23**	**61.56**
7	**Point Pelee to Rondeau**	**9,262.81**	**86.83**
8	**Rondeau**	**4,019.58**	**43.67**
9	**Rondeau to Port Glasgow**	**3,937.93**	**72.76**
10	**Port Glasgow to Port Stanley**	**5,063.40**	**59.34**
11	**Port Stanley to Port Burwell**	**4,989.90**	**63.44**
12	**Port Burwell to Long Point**	**3,152.04**	**70.69**
13	**Long Point**	**3,175.48**	**21.13**
14	**Long Point to Port Dover**	**1,680.36**	**51.53**
15	**Port Dover to Grand River**	**8,615.54**	**75.33**
16	**Grand River to Niagara River**	**8,155.20**	**56.59**
Survey area		**89,410.75**	**59.78**

Area of impervious surfaces

Impervious surfaces cover 26,678 hectares or 17.84 per cent of the survey area (Table 16). The Detroit River CDN unit has the largest area of impervious surfaces (5,025 hectares) and the Rondeau to Port Glasgow unit has the smallest (259 hectares). The Detroit River CDN unit is the only coastal unit comprised of more than 50 per cent impervious surfaces. The St. Clair River CDN and Lake St. Clair CDN units also have high proportions of impervious surfaces (45.5 per cent and 29.8 per cent respectively).

Table 16: *Area and proportion of impervious surfaces*

Unit number	Unit name	Area of impervious surfaces (ha)	Proportion of unit with impervious surfaces (per cent)
1	St. Clair River CDN	3,799.21	45.50
2	Walpole Island/Delta	488.44	3.54
3	Lake St. Clair CDN	4,406.12	29.80
4	Detroit River CDN	5,024.84	61.79
5	Western Basin	2,447.79	24.92
6	Point Pelee	762.20	17.39
7	Point Pelee to Rondeau	1,053.66	9.88
8	Rondeau	519.73	5.65
9	Rondeau to Port Glasgow	258.65	4.78
10	Port Glasgow to Port Stanley	444.94	5.21
11	Port Stanley to Port Burwell	757.49	9.63
12	Port Burwell to Long Point	369.50	8.29
13	Long Point	673.42	4.48
14	Long Point to Port Dover	527.70	16.18
15	Port Dover to Grand River	1,820.05	15.91
16	Grand River to Niagara River	3,324.37	23.07
Survey area		26,678.11	17.84

5.3 TRIBUTARIES

EXTENT

Tributary length

Within coastal units: The Walpole Island/Delta unit has the most tributaries and the longest total length of tributaries. The Point Pelee unit has the fewest tributaries and shortest total length of tributaries (Table 17).

Within contributing watersheds: The Grand River to Niagara River unit has the most tributaries, the Lake St. Clair CDN unit has the longest total length of tributaries, and the Point Pelee unit has the fewest tributaries and the shortest total length of tributaries.

(Note that the Point Pelee unit has the second-longest average tributary length, both within the coastal unit and within its contributing watershed)

Table 17: *Number and length of tributaries, within coastal units and within contributing watersheds*

Unit number	Unit name	Within coastal unit			Within contributing watershed		
		Number	Mean length (m)	Total length (m)	Number	Mean length (m)	Total length (m)
1	St. Clair River CDN	51	994	50,710	242	1,440	348,495
2	Walpole Island / Delta	775	606	469,879	2,508	1,330	3,334,767
3	Lake St. Clair CDN	334	763	254,676	3,416	1,160	3,962,315
4	Detroit River CDN	84	656	55,130	351	1,407	493,824
5	Western Basin	154	846	130,209	241	1,069	257,565
6	Pt Pelee	36	1,082	38,981	21	1,403	29,463
7	Pt Pelee to Rondeau	103	1,069	110,095	153	1,332	203,859
8	Rondeau	129	653	84,269	169	709	138,972
9	Rondeau to Pt Glasgow	229	590	135,159	195	836	163,012
10	Pt Glasgow to Pt Stanley	347	605	210,092	457	952	435,182
11	Pt Stanley to Pt Burwell	204	739	150,719	2,006	1,028	2,062,711
12	Pt Burwell to Long Point	71	817	57,999	284	879	249,538
13	Long Point	167	637	106,306	888	1,098	974,620
14	Long Point to Port Dover	42	1,094	45,957	70	1,126	78,827
15	Port Dover to Grand River	394	595	234,376	1,404	855	1,200,901
16	Grand River to Niagara River	144	856	124,685	4,070	827	3,367,813

**Note: Watershed statistics do not include streams that are within coastal units.*

BIODIVERSITY

Richness of fish species

The Port Dover to Grand River unit has the highest number of fish species and the highest search effort (Table 18). Conversely, the Port Glasgow to Port Stanley unit has the lowest number of species and the lowest search effort.

While many of the surveys used for this analysis are repeated annually (e.g. monitoring for Asian Carp), some may not be repeated within the next five years. Thus, current richness values may need to be adjusted if surveys conducted between 2019 and 2023 vary such that current values are not comparable to values that will be calculated when the Lake Erie Survey is repeated.

The technical task team recommends filling sampling gaps in coastal units that have no data or insufficient data. The Jaccard Index is good for identifying gaps in presence/absence data and can account for differences in search effort and gear (Montgomery et al. 2020; Ricotta et al. 2016).

Table 18: *Fish species richness (number of species) in tributaries by coastal unit*

Unit number	Unit name	Units of effort	Richness
1	**St. Clair River CDN**	**121**	**43**
2	**Walpole Island/Delta**	*	*
3	**Lake St. Clair CDN**	**178**	**49**
4	**Detroit River CDN**	**175**	**43**
5	**Western Basin**	*	*
6	**Point Pelee**	*	*
7	**Point Pelee to Rondeau**	**20**	**20**
8	**Rondeau**	*	*
9	**Rondeau to Port Glasgow**	*	*
10	**Port Glasgow to Port Stanley**	**127**	**48**
11	**Port Stanley to Port Burwell**	**1**	**7**
12	**Port Burwell to Long Point**	**11**	**25**
13	**Long Point**	*	*
14	**Long Point to Port Dover**	**59**	**40**
15	**Port Dover to Grand River**	*	*
16	**Grand River to Niagara River**	**502**	**66**

** No data available*

CONDITION

Riparian vegetation buffer

For all Canadian tributaries to Lake Erie, 52 per cent of the 30-metre riparian buffer is woodland, scrubland, meadow or wetland (Table 19). Woodland is the most common vegetation type, followed by meadow, wetland and scrubland. The Port Glasgow to Port Stanley and Port Burwell to Long Point units have the greatest relative amounts of vegetated areas in the 30 metre buffers (88 per cent); woodland is the most common vegetation type in both. The Port Dover to Grand River unit has the largest absolute area of vegetation in the 30-metre buffer (485 hectares). The Walpole Island/Delta unit has the smallest vegetated area in the 30-metre buffer.

The Port Dover to Grand River coastal unit had both the highest proportionate and absolute amount of meadow vegetation types within its 30-metre tributary buffer. The Western Basin coastal unit had both the highest proportionate and absolute amount of wetland vegetation types within its 30 m tributary buffer.

***Table 19:** Area (in hectares) of vegetation within the 30 metre riparian buffers in each coastal unit*

Unit number	Unit name	Total area of buffer (ha)	Total non-vegetated land	Total vegetated land	Woodland	Scrubland	Meadow	Wetland
1	St. Clair River CDN	243.94	97.51 (40%)	146.43 (60%)	88.34 (36%)	3.85 (2%)	50.64 (21%)	3.6 (1%)
2	Walpole Island/Delta	989.57	749.87 (76%)	239.69 (24%)	49.48 (5%)	0.36 (0.03%)	68.26 (7%)	121.59 (12%)
3	Lake St. Clair CDN	423.1	374.97 (89%)	48.09 (11%)	13.39 (3%)	8.32 (2%)	14.19 (3%)	12.19 (3%)
4	Detroit River CDN	111.16	71.04 (64%)	40.12 (36%)	0.68 (1%)	0	1.8 (2%)	37.64 (34%)
5	Western Basin	254.97	54.88 (22%)	200.09 (78%)	49.89 (20%)	2.64 (1%)	11.04 (4%)	136.52 (54%)
6	Point Pelee	44.18	30.28 (69%)	13.9 (31%)	1.68 (4%)	2.64 (6%)	1.58 (4%)	8 (18%)
7	Point Pelee to Rondeau	358.24	186.48 (52%)	171.76 (48%)	35.32 (10%)	18.42 (5%)	6.38 (2%)	111.64 (31%)
8	Rondeau	66.28	42.93 (65%)	23.35 (35%)	7.09 (11%)	3.15 (5%)	1.3 (2%)	11.81 (18%)
9	Rondeau to Port Glasgow	181.32	29.88 (16%)	151.44 (84%)	121.5 (67%)	0.14 (0.07%)	29.81 (16%)	0
10	Port Glasgow to Port Stanley	499.23	59.38 (12%)	439.86 (88%)	372.07 (75%)	1.19 (0.2%)	63.28 (13%)	3.32 (1%)
11	Port Stanley to Port Burwell	470.03	160.39 (34%)	309.65 (66%)	272.18 (58%)	0.06 (0.01%)	34.99 (7%)	2.42 (1%)
12	Port Burwell to Long Point	138.68	16.37 (12%)	122.3 (88%)	94.66 (68%)	0.34 (0.24%)	27.3 (20%)	0

Unit number	Unit name	Total area of buffer (ha)	Total non-vegetated land	Total vegetated land	Woodland	Scrubland	Meadow	Wetland
13	Long Point	143.75	35.35 (25%)	108.39 (75%)	47.61 (33%)	5.02 (3%)	26.64 (19%)	29.12 (20%)
14	Long Point to Port Dover	153.63	27.19 (18%)	126.44 (82%)	95.7 (62%)	0.4 (0.26%)	27.89 (18%)	2.46 (2%)
15	Port Dover to Grand River	830.62	345.36 (42%)	485.26 (58%)	167.26 (20%)	6.42 (1%)	273.91 (33%)	37.67 (5%)
16	Grand River to Niagara River	515.85	311.91 (60%)	203.94 (40%)	45.01 (9%)	2.82 (1%)	29.23 (6%)	126.88 (25%)
Survey area		5,424.5	2,593.79 (48%)	2,830.7 (52%)	1,461.85 (27%)	55.77 (1%)	668.25 (12%)	644.83 (12%)

The technical task team also assessed the area of vegetation in five metre riparian buffers around tributaries in each coastal unit (Table 20). Across the survey area, 45 per cent of the five-metre buffer is vegetated; woodland and wetland are the dominant vegetation types, each covering 18 per cent of the five metre buffer. Tributaries in the Long Point unit have the greatest proportion of vegetated land in their five metre buffers; woodlands occupy 76 per cent of this area. Tributaries in the Lake St. Clair CDN unit have the smallest proportion of vegetated land in their five metre buffers.

Like the results for the 30-metre buffer, tributaries in the Port Dover to Grand River unit have the largest proportion (28 per cent) and absolute amount of meadows (57 hectares) in their five metre buffers. Meadows also occupy 28 per cent of the five metre buffers in the St. Clair River CDN unit; however, the absolute amount of meadow (17 hectares) is much smaller. Finally, tributaries in the Western Basin unit have the largest proportion (81 per cent) and absolute amount (113 hectares) of wetland in their five metre buffers.

The team completed a QA/QC analysis on the vegetation cover layer to quantify the accuracy of the layer, assess the reliability of the spatial analysis, and determine if updated vegetation delineations area needed to improve future analyses. The estimated inaccuracies ranged from two per cent to 24 per cent throughout all coastal units. The Point Pelee (24 per cent) and Point Pelee to Rondeau (20 per cent) units have the highest estimated inaccuracies. The Walpole Island/Delta, Rondeau, Port Glasgow to Port Stanley, and Port Stanley to Port Burwell units have the lowest estimated inaccuracies, with two per cent each.

Table 20: *Area (in hectares) and composition of five metre riparian buffers*

Unit number	Unit name	Total area of buffer (ha)	Total non-vegetated land	Total Vegetated land	Woodland	Scrubland	Meadow	Wetland
1	St. Clair River CDN	62.17	24.04 (39%)	38.12 (61%)	18.81 (30%)	0.94 (2%)	17.45 (28%)	0.92 (1%)
2	Walpole Island / Delta	286.65	232.65 (81%)	54.02 (19%)	8.25 (3%)	0.04 (0.01%)	18.18 (6%)	27.55 (10%)
3	Lake St. Clair CDN	222.74	205.83 (92%)	16.91 (8%)	4.95 (2%)	2.95 (1%)	4.97 (2%)	4.04 (2%)
4	Detroit River CDN	73.75	57.24 (78%)	16.51 (22%)	0.19 (0.3%)	0	0.39 (1%)	15.93 (22%)
5	Western Basin	140.17	11.57 (8%)	128.6 (92%)	12.34 (9%)	1.26 (1%)	1.97 (1%)	113.03 (81%)
6	Point Pelee	24.52	17.98 (73%)	6.53 (27%)	0.34 (1%)	1 (4%)	0.49 (2%)	4.7 (19%)
7	Point Pelee to Rondeau	268.63	153.5 (57%)	115.13 (43%)	8.67 (3%)	12.41 (5%)	1.15 (0.4%)	92.9 (35%)
8	Rondeau	18.97	12.63 (67%)	6.34 (33%)	1.37 (7%)	0.93 (5%)	0.39 (2%)	3.65 (19%)
9	Rondeau to Pt Glasgow	35.22	6.23 (18%)	28.99 (82%)	23.65 (67%)	0.02 (0.1%)	5.32 (15%)	0
10	Port Glasgow to Port Stanley	111.08	13.96 (13%)	97.12 (87%)	81.83 (74%)	0.34 (0.3%)	13.79 (12%)	1.16 (1%)
11	Port Stanley to Pt Burwell	121.57	57.73 (47%)	63.84 (53%)	57.12 (47%)	0	6.22 (5%)	0.5 (0.4%)
12	Port Burwell to Long Point	29.99	2.9 (10%)	27.08 (90%)	22.24 (74%)	0.18 (1%)	4.66 (16%)	0
13	Long Point	106.05	7.23 (7%)	98.83 (93%)	80.39 (76%)	1.4 (1%)	5.12 (5%)	11.92 (11%)
14	Long Point to Port Dover	29.82	6.42 (22%)	23.4 (78%)	18.29 (61%)	0.08 (0.3%)	4.5 (15%)	0.53 (2%)
15	Port Dover to Grand River	199.66	93.37 (47%)	106.29 (53%)	34.21 (17%)	1.78 (1%)	56.51 (28%)	13.79 (7%)
16	Grand River to Niagara River	419.45	288.62 (69%)	130.84 (31%)	20.67 (5%)	0.8 (0.2%)	11.01 (3%)	98.36 (23%)
Survey area		2,150.43	1,191.91 (55%)	958.52 (45%)	393.3 (18%)	24.12 (1%)	152.13 (7%)	388.98 (18%)

FUNCTION

Tributary impedances

Tributaries in the Lake St. Clair CDN (39), Port Stanley to Port Burwell (25), and Walpole Island/Delta (19) units have the most impedances to fish passage. None of these coastal units have sea lamprey barriers.

The single impedance in the Detroit River CDN unit isn't a barrier to fish passage, thus this unit has no true impedances. Six other coastal units have three barriers or fewer (see Table 21).

The survey area has four sea lamprey barriers. Experts determine the locations and designs of these types of barriers; generally, they block adult sea lampreys and allow jumping fish to pass safely. Tributaries upstream of the coastal ecosystem (survey area), have significantly more impedances, both sea lamprey barriers and other types (pumped drains, hydropower dams, perched culverts, etc.).

Table 21: *Significant statistics about impedances to fish passage in Lake Erie coastal units*

Unit number	Unit name	Estimated impedances	Estimated error	Sea lamprey barriers	Impedances eligible for removal
1	St. Clair River CDN	5	1	0	4
2	Walpole Island/Delta	20	1	0	19
3	Lake St. Clair	50	11	0	39
4	Detroit River	1	1	0	0
5	Western Basin	8	4	0	4
6	Pt Pelee	3	1	0	2
7	Pt Pelee to Rondeau	5	3	0	2
8	Rondeau	5	1	0	4
9	Rondeau to Pt Glasgow	5	2	0	3
10	Pt Glasgow to Pt Stanley	14	8	0	6
11	Pt Stanley to Pt Burwell	36	11	0	25
12	Pt Burwell to Long Point	24	14	1	9
13	Long Point	20	18	1	1
14	Long Point to Port Dover	19	5	2	12
15	Port Dover to Grand River	5	1	0	4
16	Grand River to Niagara River	4	2	0	2
	Survey area	224	54	4	166

5.4 INLAND LAKES AND PONDS

EXTENT

Area of inland lakes and ponds

The extent of inland lakes and ponds varies dramatically across the survey area. With a total area of 4,628 hectares, inland lakes and ponds make up 3.09 per cent of the survey area (Table 22). The Rondeau unit has the largest area of inland lakes and ponds (2,040 hectares), representing 22.17 per cent of its area, and 44 per cent of the area of inland lakes and ponds in the survey area.

Table 22: *Area of inland lakes and ponds by class (GLSE community classes)*

Unit number	Unit name	Area of lakes and ponds (ha)	Proportion of unit that is lakes and ponds (per cent)	Composition (area of each GLSE community class associated with inland lakes and ponds, in hectares)
1	**St. Clair River CDN**	**24.76**	**0.30**	Open water (11.39), unvegetated ephemeral aquatic (13.37)
2	**Walpole Island/Delta**	**778.67**	**5.64**	Open water (766.52), unvegetated ephemeral aquatic (12.15)
3	**Lake St. Clair CDN**	**614.01**	**4.15**	Open water (614.01)
4	**Detroit River CDN**	**140.02**	**1.72**	Open water (140.02)
5	**Western Basin**	**17.64**	**0.18**	Open water (17.64)
6	**Point Pelee**	**251.73**	**5.74**	Open water (251.73)
7	**Point Pelee to Rondeau**	**189.98**	**1.78**	Open water (189.98)
8	**Rondeau**	**2,040.27**	**22.17**	Open water (2,040.27)
9	**Rondeau to Port Glasgow**	**0.52**	**0.01**	Open water (0.52)
10	**Port Glasgow to Port Stanley**	**24.55**	**0.29**	Open water (24.55)
11	**Port Stanley to Port Burwell**	**45.44**	**0.58**	Open water (45.44)
12	**Port Burwell to Long Point**	**8.36**	**0.19**	Open water (8.36)
13	**Long Point**	**73.5**	**0.49**	Open water (73.5)
14	**Long Point to Port Dover**	**3.13**	**0.10**	Open water (3.13)
15	**Port Dover to Grand River**	**68.86**	**0.60**	Open water (68.86)
16	**Grand River to Niagara River**	**346.11**	**2.40**	Open water (346.11)
Survey area		**4,627.64**	**3.09**	Open water (4,602.12), unvegetated ephemeral aquatic (25.52)

5.5 COASTAL LANDSCAPE

BIODIVERSITY

Great Lakes species of conservation concern:

The number of species of conservation concern per coastal unit varies across the survey area (Figure 3). The number within each pie chart reflects the number of species of conservation concern in that unit.

The sandspit shoreline segments have the highest numbers of species of conservation concern. The Long Point unit has the most species of conservation concern (121) (Table 23), followed by the Point Pelee (103) and Rondeau (102) units. These high numbers reflect the diversity of habitats on these sand spits; they have a combination of diverse wetlands, rare sand dunes, and Carolinian forests. The Detroit River CDN unit also has a high number of species of conservation concern (99), including 60 species of vascular plants, more than any other unit. Most of these plants occur in tallgrass prairies and savannahs near Windsor. The Rondeau and Long Point units have the most bird (23 each) and amphibian and reptile species (13 each). The Long Point unit also has the most mammal species (5) and the second highest number of vascular plant (57) and invertebrate species (17). The Lake St. Clair CDN and Point Pelee units have the most fish species (8 each). The Point Pelee unit also has the most species of invertebrates (20) and non-vascular plants and fungi (5). For a list of all species of conservation concern known from the survey area, *see Appendix C*.

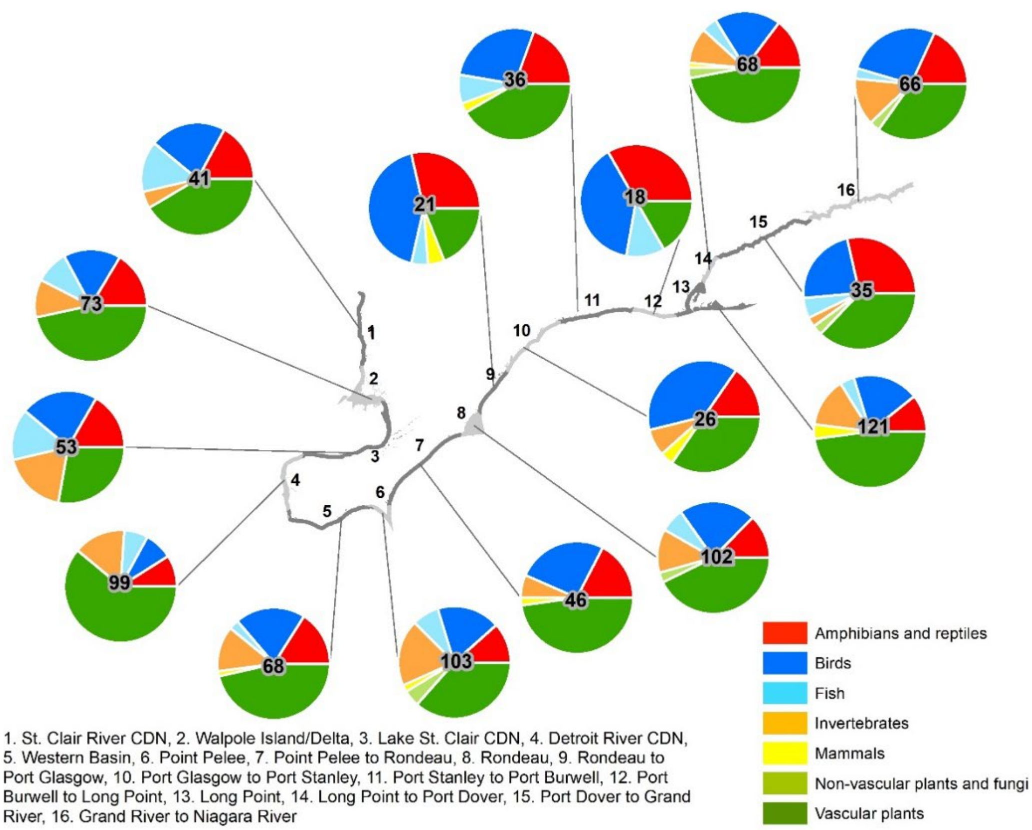

Figure 3: *Number of species of conservation concern by coastal unit, summarized by taxon*

__Table 23:__ Number of species of conservation concern, by taxon group, in each coastal unit

Unit number	Unit name	Amphibians and reptiles	Birds	Fish	Invertebrates	Mammals	Non-vascular plants and	Vascular plants
1	St. Clair River CDN	7	9	6	2	0	0	17
2	Walpole Island/Delta	12	12	7	8	0	0	34
3	Lake St. Clair CDN	9	12	8	10	0	0	14
4	Detroit River CDN	9	8	7	15	0	0	60
5	Western Basin	11	14	2	9	1	0	31
6	Point Pelee	12	19	8	20	2	5	37
7	Point Pelee to Rondeau	8	12	0	3	1	0	22
8	Rondeau	13	23	7	13	1	3	42
9	Rondeau to Port Glasgow	6	9	1	0	1	0	4
10	Port Glasgow to Port Stanley	4	10	0	2	1	0	9
11	Port Stanley to Port Burwell	7	10	3	0	1	0	15
12	Port Burwell to Long Point	6	7	2	0	0	0	3
13	Long Point	13	23	5	17	5	1	57
14	Long Point to Port Dover	10	13	3	7	1	2	32
15	Port Dover to Grand River	10	8	2	1	0	1	13
16	Grand River to Niagara River	12	18	2	9	0	2	23

CONDITION

Shore-perpendicular structures

The survey area contains 21 shore-perpendicular structures (Table 24). The Grand River to Niagara River unit has the most structures (5), followed by the Port Stanley to Port Burwell and Western Basin units with four each. Six coastal units do not contain shore-perpendicular structures over 100 m.

__Table 24:__ Number of shore-perpendicular structures greater than 100 metres in length by coastal unit

Unit number	Unit name	Number of structures
1	St. Clair River CDN	0
2	Walpole Island/Delta	0
3	Lake St. Clair CDN	2
4	Detroit River CDN	0
5	Western Basin	4
6	Point Pelee	1
7	Point Pelee to Rondeau	1
8	Rondeau	1
9	Rondeau to Port Glasgow	0
10	Port Glasgow to Port Stanley	0
11	Port Stanley to Port Burwell	4
12	Port Burwell to Long Point	0
13	Long Point	1

Unit number	Unit name	Number of structures
14	Long Point to Port Dover	1
15	Port Dover to Grand River	1
16	Grand River to Niagara River	5
Survey area		21

Shoreline Hardening

Across the Canadian Lake Erie shoreline (including the Huron-Erie corridor), over 477,817 metres (39.31 per cent) of shoreline is hardened (Table 25). The St. Clair River CDN and Detroit River CDN units have the largest proportions of hardened shorelines, with 90.14 per cent and 83.68 per cent respectively. Coastal units 9 to 12 have the shortest lengths and proportions of hardened shorelines. More than 50 per cent of the shoreline in five coastal units is hardened.

Table 25: *Length and proportion of natural and hardened shorelines across the survey area*

Unit number	Unit name	Hardened (m)	Hardened (per cent)	Natural (m)	Natural (per cent)
1	St. Clair River CDN	50,621.79	90.14	5,534.28	9.86
2	Walpole Island/Delta	25,683.58	13.94	158,525.34	86.06
3	Lake St. Clair CDN	52,717.57	66.38	26,698.87	33.62
4	Detroit River CDN	66,325.89	83.68	12,931.65	16.32
5	Western Basin	48,105.49	42.45	65,226.58	57.55
6	Point Pelee	12,439.51	42.45	16,862.17	57.54
7	Point Pelee to Rondeau	23,172.78	33.12	46,800.77	66.88
8	Rondeau	29,854.9	34.66	56,293.36	65.34
9	Rondeau to Port Glasgow	2,150.68	7.75	25,588.96	92.25
10	Port Glasgow to Port Stanley	2,925.27	6.75	40,397.94	93.25
11	Port Stanley to Port Burwell	4,017.18	10.50	34,224.23	89.50
12	Port Burwell to Long Point	1,977.72	7.30	25,102.33	92.70
13	Long Point	24,814.78	16.90	122,055.98	83.10
14	Long Point to Port Dover	6,515.15	34.66	12,284.33	65.34
15	Port Dover to Grand River	47,528.71	60.11	31,538.94	39.89
16	Grand River to Niagara River	78,965.56	57.86	57,519.93	42.14
Survey area		477,816.56	39.31	737,585.66	60.69

FUNCTION

Coastal habitat connectivity

The Walpole Island/Delta, Point Pelee, and Long Point units have high levels of connectivity (and low fragmentation), and include large natural areas (Table 26). Fragmented habitat in inland contributing watersheds threatens coastal habitat connectivity in the Walpole Island/Delta, Lake St. Clair, and Point Pelee units. The Point Pelee to Rondeau, Rondeau to Port Glasgow, and Port Dover to the Grand River units have high levels of fragmentation along their shorelines and within their contributing watersheds. For additional details, see Appendix D.

Table 26: *Coastal habitat connectivity (effective mesh size (EMS)) within coastal units and within contributing quaternary watersheds*

Unit number	Unit name	Effective mesh size within coastal unit (ha)	Effective mesh size within quaternary watersheds (ha)	CAP rating
1	St. Clair River CDN	14.08	71	Fair
2	Walpole Island/Delta	510.41	330.59	Good
3	Lake St. Clair CDN	87.06	31.39	Good
4	Detroit River CDN	19.62	13.06	Fair
5	Western Basin	26.35	27.63	Fair
6	Point Pelee	287.62	189.61	Good
7	Point Pelee to Rondeau	1.19	1.22	Poor
8	Rondeau	1.81	1.8	Fair
9	Rondeau to Port Glasgow	8.19	8.39	Poor
10	Port Glasgow to Port Stanley	13.43	16.05	Fair
11	Port Stanley to Port Burwell	17.73	15.88	Fair
12	Port Burwell to Long Point	18.21	37.24	Fair
13	Long Point	820.21	820.42	Good
14	Long Point to Port Dover	41.71	40.77	Poor
15	Port Dover to Grand River	7.25	10.19	Poor
16	Grand River to Niagara River	17.28	16.45	Fair

PROTECTION

Protected and conserved areas

Across the survey area, 10,372 hectares (6.93 per cent) of land and water is designated protected and conserved (Table 27). The majority (85 per cent) of protected and conserved areas are in the Long Point, Rondeau, and Point Pelee units. The protected and conserved areas are: national wildlife areas (3), national parks (1), provincial parks (12), and provincial conservation reserves (1) (Table 28).

Table 27: *Area and proportion of protected and conserved areas*

Unit number	Unit name	Area of protected and conserved areas (ha)	Proportion of unit that is protected or conserved (per cent)
1	St. Clair River CDN	0	0.00
2	Walpole Island/Delta	84.88	0.61
3	Lake St. Clair CDN	241.25	1.63
4	Detroit River CDN	36.29	0.45
5	Western Basin	0	0.00
6	Point Pelee	1,484.97	33.88
7	Point Pelee to Rondeau	205.64	1.93
8	Rondeau	3,130.51	34.01
9	Rondeau to Port Glasgow	174	3.21
10	Port Glasgow to Port Stanley	66.6	0.78
11	Port Stanley to Port Burwell	153.86	1.96
12	Port Burwell to Long Point	0	0.00
13	Long Point	4,209.08	28.00
14	Long Point to Port Dover	251.95	7.73
15	Port Dover to Grand River	171.01	1.50
16	Grand River to Niagara River	162.08	1.12
Survey area		10,372.12	6.93

Table 28: *Types of protected and conserved areas in the survey area*

Protected or conserved area type	Number
National wildlife area	3
National park	1
Provincial park	12
Provincial conservation reserve	1

RESTORATION

Habitat restoration projects

From 2015 to 2020, MNRF supported many projects in the Lake Erie basin that enhanced and/or restored over 1,800 hectares of habitat (Table 29).

Table 29: *Area of habitat restored between 2015 and 2020*

Unit number	Unit name	Restored area (ha)
1	St. Clair River CDN	67.29
2	Walpole Island/Delta	22.25
3	Lake St. Clair CDN	383.71
4	Detroit River CDN	15.93
5	Western Basin	420.66
6	Point Pelee	0.0
7	Point Pelee to Rondeau	31.01
8	Rondeau	24.63
9	Rondeau to Port Glasgow	76.45
10	Port Glasgow to Port Stanley	11.78
11	Port Stanley to Port Burwell	2.14
12	Port Burwell to Long Point	0.25
13	Long Point	565.00
14	Long Point to Port Dover	0.13
15	Port Dover to Grand River	17.84
16	Grand River to Niagara River	218.76
Survey area		1,857.83

6.0 CONCLUSIONS AND NEXT STEPS

Canadians can use the results of the Lake Erie Survey to better understand the extent, biodiversity, condition, function, and protection of habitat in wetlands, natural uplands, tributaries, and inland lakes and ponds. Regional and local conservation groups can use this information to: identify habitats to enhance, restore and protect, establish goals for net habitat gain, and inform conservation actions. To detect habitat change (loss or gain) over time, new habitat and species data will be needed.

The results of the Lake Erie Survey give Canadians reasons to be both optimistic and concerned about the quantity, quality, condition, and function of existing wetlands, uplands, tributaries, and the coastal landscape as a whole. Land use and conversion of natural areas to urban and agricultural areas has had a greater impact on the Canadian portion of Lake Erie's coastal ecosystem than any other stressor, contributing to a decline in wetland area since Europeans settled in the lower Great Lakes basin, reducing the area and richness of natural upland habitat, degrading tributaries, and fragmenting habitat.

The survey area stretches from Sarnia to the Niagara River, from the high-water mark to two kilometres inland. This area is 60 per cent anthropogenic land, 20 per cent wetland, 17 per cent natural upland habitat, and 3 per cent inland lakes and ponds. Forty per cent of the anthropogenic land is farmland; the other 20 per cent is urban and rural development. Wetlands (marshes, shrub swamps, and swamps) cover 29,944 hectares; there are no bogs or fens in the survey area. Seventy-five per cent of the wetland area is coastal wetland and 25 per cent is inland wetland. Forty-three pre cent of coastal wetlands are lacustrine, 46 per cent are riverine, and 11 per cent are barrier-protected. Seventy-five per cent of the natural upland habitat is forest. Forty-four per cent of the area of inland lakes and ponds is in the Rondeau unit.

The survey area supports:

- 63 different wetland habitat types.
- 214 different natural upland habitat types.
- 344 species of conservation concern (21 amphibians and reptiles, 35 birds, 17 fish, 52 invertebrates, seven mammals, 11 non-vascular plants and fungi, and 201 vascular plants), including 126 species at risk. Wetlands in the survey area support 198 of these species of conservation concern.

Across the survey area:

- Phragmites occupies 23 per cent of the wetland area. Phragmites is most abundant in the Walpole Island/Delta unit.
- fish species richness is highest in the Port Dover to Grand River unit. Field crews completed more inventories of fish species in some coastal units than in others. They completed the most inventories in the Port Dover to Grand River unit. The results reflect the number of inventories completed in each coastal unit.
- 52 per cent of the 30-metre buffer around tributaries is vegetated and woodland is the most common vegetation type.
- tributaries have a combined 166 barriers to fish passage. This number doesn't include the four sea lamprey barriers in the survey area. The Lake St. Clair CDN unit has the most barriers, while the Detroit River CDN unit has none.
- 39 per cent of the shoreline has been transformed through various forms of shore development (hardening), including 21 shore-perpendicular structures that could disrupt natural sediment processes that help create and maintain coastal habitat.

- four coastal units (Walpole Island/Delta, Lake St. Clair CDN, Point Pelee, and Long Point) have good habitat connectivity, eight (St. Clair River CDN, Detroit River CDN, Western Basin, Rondeau, Port Glasgow to Port Stanley, Port Stanley to Port Burwell, Port Burwell to Long Point, and Grand River to Niagara River) have fair habitat connectivity, and four (Point Pelee to Rondeau, Rondeau to Port Glasgow, Long Point to Point Dover, and Point Dover to Grand River) have poor habitat connectivity.
- protected and conserved areas cover 6.93 per cent of the land.
- habitat restoration projects funded by the MNRF restored more than 1,800 hectares of habitat between 2015 and 2020.

At the coastal unit level, the Long Point, Walpole Island/Delta, Rondeau, and Point Pelee units have the greatest diversity of habitats and the highest numbers of species of conservation concern. The Long Point, Rondeau, and Point Pelee units contain 85 per cent of the protected and conserved land in the survey area, while the Walpole Island/Delta and Long Point units contain the largest areas of wetlands and the largest areas of phragmites. The Detroit River CDN unit also stands out. It supports many species of conservation concern, has no barriers to fish passage, and has no shore-perpendicular structures greater than 100 m in length. It also has no protected or conserved areas, and 83 per cent of its shoreline is hardened.

MEASURING FUTURE PROGRESS

This is the first Lake Erie Baseline Coastal Habitat Survey. Future reassessments will build on available data and updates to natural heritage information. To detect habitat change (loss or gain) over time, the technical task team will assemble and synthesize new habitat and species data and complete reassessments based on data availability. When the team decides when to complete the next Lake Erie Survey, we will consider the timing of data collection for the Great Lakes Shoreline Ecosystem Project (MNRF), the Cooperative Science and Monitoring Initiative, and Lakewide Action and Management Plan development.

The Lake Erie Survey uses information from many sources and requires a mechanism for coordinating and storing data so that datasets are consistent and accessible, and comparisons can be made over time. Great Lakes science is quickly advancing; tools and methods for assessment regularly improve and new techniques emerge. Such innovations will improve our ability to assess the extent and condition of Lake Erie's coastal habitats. The technical task team should regularly review the survey methodology to ensure the best available science supports target setting and tracking.

Gaps

- Ephemeral ponds are not adequately captured since the GLSE only includes polygons larger than 0.5 hectares.
- Inconsistent fish sampling across coastal units.
- Private protected and conserved areas are currently not included in the Canadian Protected and Conserved Areas Database (CPCAD) due to data sharing restrictions. Also, some private protected area data is not accessible or georeferenced and cannot be assessed against the International Union for the Conservation of Nature categories for inclusion in the CPCAD. Thus, the protection measure likely underestimates current levels of protection. Future assessments using the CPCAD may include privately protected and conserved areas if data restrictions are lifted. Therefore, when we compare future data with current data, we may see an increase in the area of protected and conserved areas even if no new areas are created.

Recommendations

- Ensure all data sources used in this survey are updated prior to reassessment.
- Develop a “vegetation type” list associated with each ecosite. Once this list is finalized, update the biodiversity results in the first Lake Erie Survey.
- Consider including or improving the following measures:
  - Develop indices of biotic integrity for wetland fishes, birds, amphibians, and vegetation
  - Tributary connectivity: Identify barriers for removal.
- Map ecosites known to support the creation of ephemeral ponds.
- Some coastal units have no or insufficient fish sampling data. Fill these gaps.

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APPENDICES

APPENDIX A – GLSE Primary and secondary delineation data sources

Table A1: Primary interpretation and delineation data sources

Layer name	Description
Recent spring pre-leaf ORTHO's - (2013-2015)	20-30-centimetre resolution imagery. 2d backdrop for polygon interpretation, editing and coding.
Recent spring pre-leaf Stereo photos (2013-2015)	20-30-centimetre resolution imagery. 3d interpretation of tree species, vegetation heights and moisture regime aggregations (e.g. Fresh to Moist).
Summer Colour Infrared Air photos	Additional reference for polygon interpretation, editing and coding.
SoilSurveyComplex (OMAFRA)	Polygon used to derive soil texture (loam, sand, silt, clay, organic) and drainage (poor, well, rapid, imperfect) to determine soil texture for ecosite substrate.
QuaternaryGeology 50k (MNDM)	Polygon used to determine mode of deposition (e.g. glacial lacustrine plain) to aid in ecosite moisture regime designation and provide additional organic (i.e. peat/muck) feature mapping
SWOOP DSM and DEMs	3D pseudo representation of topography that can be viewed in 2D to aid alignment of interpretation and delineation of stereo dependent features (e.g. vegetation species/height breaks, topographically inferred moisture regime). Displaying the DEM or DSM with the hillshade option aids topographic interpretation
PrisimSweeps	Georeferenced prism sweep points following the FRI reporting format, used for interpretation calibration.
DataCards	GPS locations of GLSE ELC samples with links to GLSE ELC pdf scans of field survey sheets. Contains with paths to actual pdf scans for hyperlinking. Attribution for polygons intersecting these points should reflect the information in these samples.
Photos	Ground photo locations (GPS locations) with paths to actual photos for hyperlinking.

Table A2: Secondary interpretation and delineation data sources

Data layer themes	Description
Wetland_Evaluated	A compilation of field calibrated and desktop mapped wetlands as part of an extensive ground-based wetland evaluation process.
PCEO	Plant community element occurrence polygons mapping rare habitat communities (e.g. savannahs, prairies, alvars, dunes, wetlands).
Ontario Parks and Parks Canada ELC Mapping	Varies by park, polygon mapping attributed with varying levels of detail in ELC classification ranging from community series down to ecosite, possibly vegetation type.
ANSI	Polygonal information representative of Areas of Natural Scientific Interest.
Lake Ontario Coastal Wetland Mapping	Contains detailed wetland mapping to GLSE ecosite standard down to community class level for 16 wetlands along the coast of Lake Ontario. Also contains 6 cm summer ortho and digital stereo photography.
SOLRIS	The Southern Ontario Land Resource Information System is a orthophoto/satellite image/DEM based land cover map with classes reflecting southern Ontario ELC community series level classes.
Conservation Authority ELC Mapping	ELC mapping varies by conservation authority area, polygon mapping attributed with varying levels of detail in ELC classification ranging from community series down to ecosite.
Environment Canada Coastal Sensitivity Mapping	Line dataset attributed with the geological features (e.g. cliff, bedrock shelving) and substrates (rock, sand, cobble, gravel etc.) for the Great Lakes shoreline. Scale is 1:50,000.

APPENDIX B – Data sources

Table B1: Data name, source, production year, description, and data purpose used in the completion of the Lake Erie Baseline Habitat Survey

Name	Source	Year	Description	Purpose
Great Lakes Shoreline Ecosystem Land Classification (GLSE Wetlands)	Ontario Ministry of Natural Resources and Forestry https://geohub.lio.gov.on.ca/datasets/great-lakes-shoreline-ecosystem-inventory-v-1-0-lake-erie	2018	Inventory of Lake Erie shoreline (two-kilometres inland) ecosystems that incorporate standard delineation processes to the ecosite scale (1:10,000)	Coastal unit delineation; wetland, upland, and inland lakes and ponds extent; wetland and upland biodiversity
Quaternary Watershed	Ontario Ministry of Natural Resources and Forestry https://geohub.lio.gov.on.ca/datasets/mnrf::watershed-quaternary	2010	Quaternary watersheds are subdivisions of tertiary watersheds. This data layer includes all of the land that is drained by a watercourse and its tributaries	Coastal unit delineation; tributary extent
Run-of-River Catchment	Ontario Ministry of Natural Resources and Forestry (Unpublished)	2019	Fine scale tributary layer noting the flow direction and order of each tributary	Coastal unit delineation
Presettlement Wetland Extent (c. 1800)	Ducks Unlimited Canada (unpublished data)	2010	A predictive historic dataset that identifies areas in southern Ontario that are likely to have supported wetlands by using soil type and soil drainage datasets and digital elevation models	Wetland extent
Provincially tracked species observations	Natural Heritage Information Centre (NHIC), Ontario Ministry of Natural Resources and Forestry https://www.ontario.ca/page/get-natural-heritage-information	2020	Observations of provincially tracked species.	Species of conservation concern
Lake Erie Phragmites Data Layer	Ontario Ministry of Natural Resources and Forestry (published in LIO, currently unavailable in GEOHUB	2019	*Phragmites australis* data layer produced using both Michigan Tech Research Institute (MTRI) and MNRF	Phragmites extent within coastal units

Name	Source	Year	Description	Purpose
Ontario Integrated Hydrology Data (Enhanced Watercourse layer)	Ontario Ministry of Natural Resources and Forestry https://geohub.lio.gov.on.ca/datasets/mnrf::ontario-integrated-hydrology-oih-data	2012	Watercourses and linear features (natural and constructed) that describe various realizations of flowing water with enhanced information (e.g. flow direction, stream order). This is derived of Ontario Hydro Network Data.	Tributary extent; tributary condition
Fisheries and Oceans Canada (DFO) fish inventories	Unpublished	2014 - 2018	Fish community data collected via various methods focused on satisfying various research objectives for SARA-listed fishes, such as evaluating the distribution and abundance of species, determining species-habitat relationships, and better understanding the influence of threats and recovery actions.	Tributary biodiversity
DFO Asian Carp monitoring	2014: https://science-catalogue.canada.ca/record=4055499~S6 2015: https://science-catalogue.canada.ca/record=4065193~S6 2016: https://science-catalogue.canada.ca/record=4065198~S6 2017: https://science-catalogue.canada.ca/record=4075969~S6 2018: https://science-catalogue.canada.ca/record=4078932~S6	2014 - 2018	Fish community data collected while conducting early detection surveillance sampling between May and November each year. Methods include boat electrofishing, gill nets, trammel nets, hoop nets, fyke nets, trap nets, and bag seines	Tributary biodiversity
DFO Species At Risk Program	Unpublished	2014 - 2018	Observations of federally tracked species reported for SARA permit requirements. Various collection agencies and methods.	Tributary biodiversity

Name	Source	Year	Description	Purpose
Constructed Drain	Ontario Ministry of Agriculture, Food and Rural Affairs https://geohub.lio.gov.on.ca/datasets/constructed-drain	2020	Constructed drains are watercourses in the form of ditches, natural watercourses that have been modified to improve drainage, or buried tile systems.	Tributary condition
Tile Drainage Area	Ontario Ministry of Agriculture, Food and Rural Affairs https://geohub.lio.gov.on.ca/datasets/tile-drainage-area	2020	Locations of the agricultural tile drainage systems. These are represented as polygon features.	Tributary condition
Southern Ontario Land Resource and Information System (SOLRIS 3.0)	Ontario Ministry of Natural Resources and Forestry https://geohub.lio.gov.on.ca/datasets/0279f65b82314121b5b5ec93d76bc6ba	2019	SOLRIS is based on MNRF's ecological land classification (ELC) for southern Ontario (Lee et al, 1998). It is a land use inventory that provides a standardized geospatial information layer that allows for reporting on changes in natural and anthropogenic features.	Tributary condition
Ontario Hydro Network (Watercourse, 200k)	Ontario Ministry of Natural Resources and Forestry https://www.javacoeapp.lrc.gov.on.ca/geonetwork/srv/en/main.home?uuid=8f232f53-3488-422d-a6ac-8c653da1720e	2012	Watercourses and linear features (natural and constructed) that describe various realizations of flowing water	Tributary connectivity
Ontario Hydro Network (Hydrographic Line)	Ontario Ministry of Natural Resources and Forestry https://geohub.lio.gov.on.ca/datasets/mnrf::ontario-hydro-network-ohn-hydrographic-line	2019	There are three hydrographic feature classes: points, lines and polys. All may impede or be hazardous to water flow and/or navigation on a watercourse or waterbody. This data shows natural and manmade line features.	Tributary connectivity

Name	Source	Year	Description	Purpose
Ontario Dam Inventory	Ontario Ministry of Natural Resources and Forestry https://www.javacoeapp.lrc.gov.on.ca/geonetwork/srv/en/main.home?uuid=9a57609e-0047-4c3b-9100-c78a7d4cf614	2014	Point-based inventory of medium and large dams in Ontario; excludes small dams, small water control structures, beaver dams, water crossings, road embankments, locks, falls, rapids and culverts	Tributary connectivity
Ontario Road Network (ORN) Segment With Address	Ontario Ministry of Natural Resources and Forestry https://geohub.lio.gov.on.ca/datasets/mnrf::ontario-road-network-orn-segment-with-address	2020	The ORN is a province-wide geographic database of over 250,000 kilometres of municipal roads, provincial highways and resource and recreational roads.	Tributary connectivity
DFO/MNRF Barriers	Unpublished	2014 - 2018	Point-based inventory of medium and large dams.	Tributary connectivity
DFO Sea Lamprey Barriers	Unpublished	2014 - 2018	Sea Lamprey Control Centre Locations	Tributary connectivity
MNRF Pumped Drain Connections	Unpublished / Retired	2014 - 2018	Location of drain connections in Ontario's drainage systems. Drain Connections are artificial structures, represented as a point on a map that allow water to move from one drainage feature to the next.	Tributary connectivity
Southern Ontario Land Resource and Information System (SOLRIS 2.1)	Ontario Ministry of Natural Resources and Forestry https://geohub.lio.gov.on.ca/datasets/0279f65b82314121b5b5ec93d76bc6ba	2015	SOLRIS is based on MNRF's Ecological Land Classification (ELC) for southern Ontario (Lee et al, 1998). It is a land use inventory that provides a standardized geospatial information layer that allows for reporting on changes in natural and anthropogenic features.	Coastal habitat connectivity

Name	Source	Year	Description	Purpose
Southwestern Ontario Orthophotography (SWOOP) 2015	Ontario Ministry of Natural Resources and Forestry https://geohub.lio.gov.on.ca/datasets/62d2c0ed59954290b35900b9e1fd8d44	2015	This aerial project is part of a five-year plan (2013-2017) to acquire 20-centimetre resolution, leaf-off imagery across the province.	Shoreline hardening: shore-perpendicular structures
Lake Erie / Huron-Erie Corridor, Shoreline Classification:	ECCC 2020	2020	The Canadian shorelines of Lake Erie, Huron-Erie Corridor were classified into natural or hardened categories. The classification was based on the 2015 SWOOP orthophoto series that was collected for this area of interest.	Shoreline hardening: shore-perpendicular structures
Canadian Protected and Conserved Areas Database (CPCAD)	Environment and Climate Change Canada https://www.canada.ca/en/environment-climate-change/services/national-wildlife-areas/protected-conserved-areas-database.html	2019	CPCAD contains spatial and attribute data on marine and terrestrial protected areas and other effective area-based conservation measures (OECM) in Canada. Publically available national geospatial database with combined data from all Canadian jurisdictions.	Protection
Ontario Ministry of Natural Resources and Forestry Supported Habitat Restoration/Enhancement Project Data	Science and Research Branch and Resources Planning and Development Policy Branch, Ontario Ministry of Natural Resources, 300 Water Street, Peterborough, Ontario	2015 - 2019	Extent data standardized and summarized from project information provided by partners supported by OMNRF funding in the Lake Erie basin. Includes data from Ontario Eastern Habitat Joint Venture provided by Ducks Unlimited Canada.	COA habitat restoration achievements

APPENDIX C –Detailed results: Great Lakes species of conservation concern

Great Lakes species of conservation concern identified within the Lake Erie survey area:

Amphibians and reptiles

SCIENTIFIC NAME	COMMON NAME	S_RANK	G_RANK	SARA STATUS	SARO STATUS
Ambystoma hybrid pop. 1	Unisexual Ambystoma (Jefferson Salamander dependent population)	S2	GNA		END
Ambystoma jeffersonianum	Jefferson Salamander	S2	G4	END	END
Anaxyrus fowleri	Fowler's Toad	S2	G5	END	END
Apalone spinifera	Spiny Softshell	S2	G5	THR	END
Chelydra serpentina	Snapping Turtle	S4	G5	SC	SC
Chrysemys picta marginata	Midland Painted Turtle	S4	G5T5		
Clemmys guttata	Spotted Turtle	S2	G5	END	END
Emydoidea blandingii	Blanding's Turtle	S3	G4	THR	THR
Graptemys geographica	Northern Map Turtle	S3	G5	SC	SC
Heterodon platirhinos	Eastern Hog-nosed Snake	S3	G5	THR	THR
Lampropeltis triangulum	Eastern Milksnake	S4	G5	SC	NAR
Nerodia sipedon insularum	Lake Erie Watersnake	S2	G5T2	END	SC
Pantherophis gloydi pop. 2	Eastern Foxsnake (Carolinian population)	S2	G3TNR	END	END
Pantherophis spiloides pop. 2	Gray Ratsnake (Carolinian population)	S1	G4G5T1	END	END
Plestiodon fasciatus pop. 1	Common Five-lined Skink (Carolinian population)	S2	G5T2	END	END
Pseudacris maculata pop. 1	Western Chorus Frog - Great Lakes - St. Lawrence - Canadian Shield population	S3	G5TNR	THR	NAR
Regina septemvittata	Queensnake	S2	G5	END	END
Sistrurus catenatus pop. 2	Massasauga (Carolinian population)	S1	G3TNR	END	END
Sternotherus odoratus	Eastern Musk Turtle	S3	G5	SC	SC
Thamnophis butleri	Butler's Gartersnake	S2	G4	END	END
Thamnophis sauritus	Eastern Ribbonsnake	S4	G5	SC	SC

Birds

SCIENTIFIC NAME	COMMON NAME	S_RANK	G_RANK	SARA STATUS	SARO STATUS
Ammodramus henslowii	Henslow's Sparrow	SHB	G4	END	END
Antrostomus vociferus	Eastern Whip-poor-will	S4B	G5	THR	THR
Ardea alba	Great Egret	S2B	G5		
Asio flammeus	Short-eared Owl	S2N,S4B	G5	SC	SC
Aythya valisineria	Canvasback	S1B,S4N	G5		
Cardellina canadensis	Canada Warbler	S4B	G5	THR	SC
Chaetura pelagica	Chimney Swift	S4B,S4N	G4G5	THR	THR
Charadrius melodus	Piping Plover	S1B	G3	END	END
Chlidonias niger	Black Tern	S3B	G4G5		SC
Chordeiles minor	Common Nighthawk	S4B	G5	THR	SC
Colinus virginianus	Northern Bobwhite	S1	G4G5	END	END
Contopus virens	Eastern Wood-pewee	S4B	G5	SC	SC
Dolichonyx oryzivorus	Bobolink	S4B	G5	THR	THR
Empidonax virescens	Acadian Flycatcher	S2S3B	G5	END	END
Falco peregrinus	Peregrine Falcon	S3B	G4	SC	SC
Haliaeetus leucocephalus	Bald Eagle	S2N,S4B	G5		SC
Hirundo rustica	Barn Swallow	S4B	G5	THR	THR
Hydrocoloeus minutus	Little Gull	S1B	G5		
Hylocichla mustelina	Wood Thrush	S4B	G4	THR	SC
Icteria virens	Yellow-breasted Chat	S1B	G5	END	END
Ixobrychus exilis	Least Bittern	S4B	G4G5	THR	THR
Melanerpes erythrocephalus	Red-headed Woodpecker	S4B	G5	THR	SC
Nycticorax nycticorax	Black-crowned Night-heron	S3B,S3N	G5		
Parkesia motacilla	Louisiana Waterthrush	S3B	G5	SC	THR
Progne subis	Purple Martin	S3S4B	G5		
Protonotaria citrea	Prothonotary Warbler	S1B	G5	END	END
Rallus elegans	King Rail	S2B	G4	END	END
Riparia riparia	Bank Swallow	S4B	G5	THR	THR
Setophaga cerulea	Cerulean Warbler	S3B	G4	END	THR
Setophaga discolor	Prairie Warbler	S3B	G5		NAR
Sterna forsteri	Forster's Tern	S2B	G5		DD
Sturnella magna	Eastern Meadowlark	S4B	G5	THR	THR
Tyto alba	Barn Owl	S1	G5	END	END
Vireo griseus	White-eyed Vireo	S2B	G5		
Xanthocephalus xanthocephalus	Yellow-headed Blackbird	S2B	G5		

Fishes

SCIENTIFIC NAME	COMMON NAME	S_RANK	G_RANK	SARA STATUS	SARO STATUS
Acipenser fulvescens pop. 3	Lake Sturgeon (Great Lakes - Upper St. Lawrence River population)	S2	G3G4TNR		THR
Ammocrypta pellucida	Eastern Sand Darter	S2	G4	THR	END
Erimyzon sucetta	Lake Chubsucker	S2	G5	END	THR
Esox americanus vermiculatus	Grass Pickerel	S3	G5	SC	SC
Ichthyomyzon fossor	Northern Brook Lamprey	S3	G4	SC	SC
Ichthyomyzon unicuspis pop. 1	Silver Lamprey (Great Lakes - Upper St. Lawrence populations)	S3	G5TNR		SC
Lepisosteus oculatus	Spotted Gar	S1	G5	THR	END
Lepomis gulosus	Warmouth	S1	G5	SC	END
Lepomis peltastes pop. 2	Northern Sunfish (Great Lakes - Upper St. Lawrence populations)	S3	G5TNR		SC
Macrhybopsis storeriana	Silver Chub	S2	G5		THR
Minytrema melanops	Spotted Sucker	S2	G5	SC	SC
Moxostoma carinatum	River Redhorse	S2	G4	SC	SC
Notropis anogenus	Pugnose Shiner	S2	G3	END	THR
Notropis buchanani	Ghost Shiner	S2	G5		NAR
Noturus miurus	Brindled Madtom	S2	G5		NAR
Noturus stigmosus	Northern Madtom	S1	G3	END	END
Percina copelandi	Channel Darter	S2	G4		THR

Non-vascular plants and fungi

SCIENTIFIC NAME	COMMON NAME	S_RANK	G_RANK	SARA STATUS	SARO STATUS
Anaptychia crinalis	Hanging Fringed Lichen	S3	G5		
Bryoandersonia illecebra	Spoon-leaved Moss	S2	G5	END	END
Fissidens exilis	Pygmy Pocket Moss	S2	G3G4	SC	DD
Heterodermia obscurata	Orange-tinted Fringe Lichen	S1S3	G5?		
Hyperphyscia syncolla	Smooth Shadow-crust Lichen	S1S2	G3G5		
Parmotrema hypotropum	Powdered Ruffle Lichen	S2?	G5?		
Phaeophyscia hirsuta	Bristling Shadow Lichen	S2S3	GNR		
Rinodina bischoffii	A Lichen	S1	G4G5		
Thyrea confusa	Jelly-strap Lichen	S2	G3G5		
Viridothelium virens	A Lichen	S3	G4G5		
Xanthomendoza weberi	Bare-bottomed Sunburst Lichen	S2S3	GNR		

Mammals

SCIENTIFIC NAME	COMMON NAME	S_RANK	G_RANK	SARA STATUS	SARO STATUS
Cryptotis parva	Least Shrew	SH	G5		
Myotis leibii	Eastern Small-footed Myotis	S2S3	G4		END
Myotis lucifugus	Little Brown Myotis	S3	G3	END	END
Myotis septentrionalis	Northern Myotis	S3	G1G2	END	END
Perimyotis subflavus	Tricolored Bat	S3?	G2G3	END	END
Scalopus aquaticus	Eastern Mole	S2	G5	SC	SC
Taxidea taxus jacksoni	American Badger (Southwestern Ontario population)	S1	G5T4	END	END

Invertebrates

SCIENTIFIC NAME	COMMON NAME	S_RANK	G_RANK	SARA STATUS	SARO STATUS
Aeshna clepsydra	Mottled Darner	S3	G4G5		
Allogona profunda	Broad-banded Forestsnail	S1	G5		END
Ancistrocerus campestris		S1	GNR		
Asterocampa celtis	Hackberry Emperor	S3	G5		
Asterocampa clyton	Tawny Emperor	S3	G5		

SCIENTIFIC NAME	COMMON NAME	S_RANK	G_RANK	SARA STATUS	SARO STATUS
Bombus pensylvanicus	American Bumble Bee	S3S4	G3G4		
Callosamia angulifera	Tulip Tree Silk Moth	S1	G5		
Catocala serena	Serene Underwing	SH	G5		
Cicindela lepida	Little White Tiger Beetle	S2	G3G4		
Cyclonaias tuberculata	Purple Wartyback	S3	G5		
Danaus plexippus	Monarch	S2N,S4B	G4	SC	SC
Ellipes minuta	Minute Pygmy Mole Grasshopper	S3?	GNR		
Enallagma aspersum	Azure Bluet	S3	G5		
Enallagma basidens	Double-striped Bluet	S3	G5		
Epiaeschna heros	Swamp Darner	S2S3	G5		
Epioblasma torulosa rangiana	Northern Riffleshell	S1	G1	END	END
Epioblasma triquetra	Snuffbox	S1	G3	END	END
Erynnis persius persius	Eastern Persius Duskywing	SX	G5T1T3	END	EXP
Eumorpha achemon	Achemon Sphinx	S3	G4G5		
Euphyes dukesi	Duke's Skipper	S2	G3		
Euthyatira pudens	Dogwood Thyatirid	S2?	G5		
Haploa reversa	Reversed Haploa	S1?	G5		
Heterocampa subrotata	Small Heterocampa	S1?	G4G5		
Ischnura kellicotti	Lilypad Forktail	S1	G5		
Lampsilis fasciola	Wavy-rayed Lampmussel	S1	G5	SC	THR
Libellula semifasciata	Painted Skimmer	S2	G5		
Libellula vibrans	Great Blue Skimmer	S1	G5		
Ligumia nasuta	Eastern Pondmussel	S1	G4	END	END
Melanoplus differentialis	Differential Grasshopper	S3	G5		
Monobia quadridens		S2?	GNR		
Neocurtilla hexadactyla	Northern Mole Cricket	S2S3	GNR		
Obovaria subrotunda	Round Hickorynut	S1	G4	END	END
Ocyptamus costatus		S3	GNR		
Orthonevra nitida	Wavy Mucksucker	S3	GNR		
Patera pennsylvanica	Proud Globelet	S1	G4		END
Pleurobema sintoxia	Round Pigtoe	S1	G4G5	END	END
Potamilus alatus	Pink Heelsplitter	S3	G5		
Prays atomocella	Hoptree Borer	SNR	GNR		END
Pseudopomala brachyptera	Short-winged Toothpick Grasshopper	S2	G5		

SCIENTIFIC NAME	COMMON NAME	S_RANK	G_RANK	SARA STATUS	SARO STATUS
Ptychobranchus fasciolaris	Kidneyshell	S1	G4G5	END	END
Pyrrhia aurantiago	False Foxglove Sun Moth	S1	G3G4		
Quadrula quadrula	Mapleleaf Mussel	S2	G5	THR	THR
Rhionaeschna mutata	Spatterdock Darner	S2	G4		
Scudderia septentrionalis	Northern Bush Katydid	S3?	G3?		
Sphecius speciosus	Cicada Killer	S1S2	GNR		
Stylurus notatus	Elusive Clubtail	S2	G3		
Toxolasma parvum	Lilliput	S1	G5		THR
Trimerotropis maritima	Seaside Grasshopper	S3	G5		
Truncilla donaciformis	Fawnsfoot	S2	G5		END
Vespula vidua		S3	GNR		
Villosa fabalis	Rayed Bean	S1	G2	END	END
Webbhelix multilineata	Striped Whitelip	S2S3	G5		

Vascular plants

SCIENTIFIC NAME	COMMON NAME	S_RANK	G_RANK	SARA STATUS	SARO STATUS
Aesculus glabra	Ohio Buckeye	S1	G5		
Agalinis gattingeri	Gattinger's False Foxglove	S2S3	G4	END	END
Agalinis purpurea var. purpurea	Large-flowered Purple False Foxglove	S1	GNRTNR		
Agalinis skinneriana	Skinner's False Foxglove	S1	G3G4	END	END
Aletris farinosa	White Colicroot	S2	G5	THR	END
Allium cernuum	Nodding Onion	S2	G5		
Ammannia robusta	Scarlet Ammannia	S1	G5	END	END
Aplectrum hyemale	Puttyroot	S2	G5		
Arabis adpressipilis	Soft-haired Rockcress	S1	G5T4Q		
Arisaema dracontium	Green Dragon	S3	G5		SC
Aristida longespica var. geniculata	Kearney's Threeawn Grass	S2	G5T5?		
Aristida purpurascens	Arrowfeather Threeawn Grass	S1	G5		
Asclepias purpurascens	Purple Milkweed	S1	G5?		
Asclepias sullivantii	Prairie Milkweed	S2S3	G5		
Asclepias viridiflora	Green Cornet Milkweed	S2	G5		
Asimina triloba	Pawpaw	S3	G5		
Astragalus neglectus	Neglected Milk-vetch	S3	G4		

SCIENTIFIC NAME	COMMON NAME	S_RANK	G_RANK	SARA STATUS	SARO STATUS
Aureolaria flava	Smooth Yellow False Foxglove	S2?	G5		
Aureolaria pedicularia	Fern-leaved Yellow False Foxglove	S2?	G5		
Aureolaria virginica	Downy Yellow False Foxglove	S1	G5		
Baptisia tinctoria	Yellow Wild Indigo	S1S2	G5		
Bidens trichosperma	Crowned Beggarticks	S2	G5?		
Borodinia dentata	Toothed Rockcress	S1	G5		
Bouteloua curtipendula	Side-oats Grama	S2	G5		
Campsis radicans	Trumpet Creeper	S2?	G5		
Carex alata	Broad-winged Sedge	S1	G5		
Carex albicans var. albicans	White-tinged Sedge	S3	G5T5		
Carex amphibola	Eastern Narrow-leaved Sedge	S2	G5		
Carex annectens	Yellow-fruited Sedge	S2	G5		
Carex appalachica	Appalachian Sedge	S2S3	G4		
Carex conoidea	Field Sedge	S3	G5		
Carex festucacea	Fescue Sedge	S1	G5		
Carex frankii	Frank's Sedge	S2	G5		
Carex hirsutella	Hairy Green Sedge	S3	G5		
Carex juniperorum	Juniper Sedge	S1	G3	END	END
Carex meadii	Mead's Sedge	S2	G4G5		
Carex muskingumensis	Muskingum Sedge	S3	G4		
Carex nigromarginata	Black-edged Sedge	S1	G5		
Carex oligocarpa	Eastern Few-fruited Sedge	S3	G4G5		
Carex seorsa	Weak Stellate Sedge	S2	G5		
Carex squarrosa	Squarrose Sedge	S2	G4G5		
Carex suberecta	Prairie Straw Sedge	S2	G4		
Carex tetanica	Rigid Sedge	S3?	G4G5		
Carex willdenowii	Willdenow's Sedge	S1	G5		
Carya glabra	Pignut Hickory	S3	G5		
Carya laciniosa	Shellbark Hickory	S3	G5		
Castanea dentata	American Chestnut	S1S2	G4	END	END
Celtis tenuifolia	Dwarf Hackberry	S2	G5	THR	THR
Cerastium velutinum	Large Field Chickweed	S1S2	G5T4?		
Cercis canadensis	Eastern Redbud	SX	G5		
Chenopodium berlandieri var. bushianum	Bush's Goosefoot	S1S2	G5T4T5		

SCIENTIFIC NAME	COMMON NAME	S_RANK	G_RANK	SARA STATUS	SARO STATUS
Chenopodium foggii	Fogg's Goosefoot	S2?	G2G3		
Chimaphila maculata	Spotted Wintergreen	S2	G5	END	THR
Cirsium discolor	Field Thistle	S3	G5		
Corallorhiza odontorhiza	Autumn Coralroot	S2S3	G5		
Corallorhiza odontorhiza var. odontorhiza	Autumn Coralroot	S2	G5T5		
Corallorhiza odontorhiza var. pringlei	Pringle's Coralroot	S1S2	G5T2T4		
Coreopsis tripteris	Tall Tickseed	S1S2	G5		
Corispermum americanum	American Bugseed	S3?	G5?		
Corispermum hookeri	Hooker's Bugseed	S2?	G4G5		
Corispermum pallasii	Pallas' Bugseed	S2?	G4?		
Cornus florida	Eastern Flowering Dogwood	S2?	G5	END	END
Corydalis flavula	Yellow Corydalis	S1S2	G5		
Crocanthemum canadense	Long-branched Frostweed	S3	G5		
Cyperus flavescens	Annual Yellow Flatsedge	S2	G5		
Cyperus schweinitzii	Schweinitz's Flatsedge	S3	G5		
Cyperus subsquarrosus	Small-flowered Lipocarpha	S2?	G5	END	THR
Cypripedium candidum	Small White Lady's-slipper	S1	G4	END	END
Cystopteris protrusa	Lowland Brittle Fern	S2S3	G5		
Desmodium canescens	Hoary Tick-trefoil	S2	G5		
Desmodium rotundifolium	Round-leaved Tick-trefoil	S2	G5		
Dichanthelium clandestinum	Deer-tongue Panicgrass	S2	G5		
Dichanthelium dichotomum	Forked Panicgrass	S2	G5		
Dichanthelium sphaerocarpon	Round-fruited Panicgrass	S3	G5T5		
Digitaria cognata	Fall Crabgrass	S1?	G5		
Echinochloa walteri	Walter's Barnyard Grass	S3	G5		
Eclipta prostrata	False-daisy	S1?	G5		
Eleocharis engelmannii	Engelmann's Spikerush	S1	G4G5		
Eleocharis equisetoides	Horsetail Spikerush	S1	G4	END	END
Eleocharis geniculata	Bent Spikerush	S1	G5	END	END
Eleocharis quadrangulata	Square-stemmed Spikerush	S1	G5		

SCIENTIFIC NAME	COMMON NAME	S_RANK	G_RANK	SARA STATUS	SARO STATUS
Elodea nuttallii	Nuttall's Waterweed	S3	G5		
Euonymus atropurpureus	Eastern Burning Bush	S3	G5		
Eurybia divaricata	White Wood Aster	S2S3	G5	THR	THR
Eurybia schreberi	Schreber's Aster	S2	G4		
Euthamia caroliniana	Slender Fragrant Goldenrod	S1	G5		
Frasera caroliniensis	American Columbo	S2	G5	END	END
Fraxinus profunda	Pumpkin Ash	S2?	G4		
Fraxinus quadrangulata	Blue Ash	S2?	G5	SC	THR
Galium pilosum	Hairy Bedstraw	S3	G5		
Gentiana alba	White Prairie Gentian	S1	G4	END	END
Gentianella quinquefolia	Stiff Gentian	S2	G5		
Gleditsia triacanthos	Honey-locust	S2?	G5		
Gymnocladus dioicus	Kentucky Coffee-tree	S2	G5	THR	THR
Heuchera americana	American Alumroot	S1	G5		
Hibiscus moscheutos	Swamp Rose-mallow	S3	G5	SC	SC
Hieracium gronovii	Queen Devil Hawkweed	S2?	G5		
Hydrastis canadensis	Goldenseal	S2	G3G4	THR	THR
Hydrophyllum appendiculatum	Appendaged Waterleaf	S2	G5		
Hypericum prolificum	Shrubby St. John's-wort	S2	G5		
Hypoxis hirsuta	Eastern Yellow Stargrass	S2S3	G5		
Ipomoea pandurata	Big-root Morning Glory	S1	G5		
Juglans cinerea	Butternut	S2?	G3	END	END
Juncus acuminatus	Sharp-fruited Rush	S3	G5		
Juncus biflorus	Two-flowered Rush	S1	G5		
Juncus brachycarpus	Short-fruited Rush	S1	G4G5		
Juncus greenei	Greene's Rush	S3	G5		
Juncus marginatus	Grass-leaved Rush	S3	G5		
Justicia americana	American Water-willow	S2	G5	THR	THR
Krigia biflora	Two-flowered Dwarf-dandelion	S2	G5		
Lactuca floridana	Woodland Lettuce	S1S2	G5		
Lechea mucronata	Hairy Pinweed	S3	G5		
Lespedeza virginica	Slender Bush-clover	S1	G5	END	END
Liatris aspera	Rough Blazing-star	S2	G4G5		
Liatris cylindracea	Slender Blazing-star	S3	G5		
Liatris spicata	Dense Blazing-star	S2	G5	THR	THR

SCIENTIFIC NAME	COMMON NAME	S_RANK	G_RANK	SARA STATUS	SARO STATUS
Linum medium var. texanum	Texas Stiff Yellow Flax	S1	G5T5		
Linum sulcatum	Grooved Yellow Flax	S2S3	G5		
Linum virginianum	Woodland Flax	S2	G4G5		
Liparis liliifolia	Purple Twayblade	S2S3	G5	THR	THR
Lithospermum canescens	Hoary Puccoon	S3	G5		
Lithospermum caroliniense	Golden Puccoon	S3	G4G5		
Lithospermum incisum	Narrow-leaved Puccoon	S1	G5		
Lithospermum latifolium	Broad-leaved Puccoon	S2S3	G4		
Lithospermum parviflorum	Soft-hairy False Gromwell	S2	G4G5T4		
Ludwigia alternifolia	Bushy Seedbox	S1	G5		
Ludwigia polycarpa	Many-fruited Seedbox	S2	G4		
Lupinus perennis	Sundial Lupine	S2S3	G5		
Lycopus rubellus	Stalked Water-horehound	S3	G5		
Lythrum alatum	Winged Loosestrife	S3	G5		
Magnolia acuminata	Cucumber Tree	S2	G5	END	END
Mertensia virginica	Virginia Bluebells	S3	G5		
Monarda punctata	Spotted Beebalm	S1	G5		
Morella pensylvanica	Northern Bayberry	S1	G5		
Morus rubra	Red Mulberry	S2	G5	END	END
Muhlenbergia tenuiflora	Slim-flowered Muhly	S2	G5		
Nelumbo lutea	American Lotus	S2S3	G4		
Nuphar advena	Large Yellow Pond-lily	S3	GNR		
Nyssa sylvatica	Black Gum	S3	G5		
Oenothera gaura	Biennial Gaura	S3	G5		
Oenothera pilosella	Meadow Evening-primrose	S2	G5		
Opuntia cespitosa	Eastern Prickly-pear Cactus	S1	GNR	END	END
Oxypolis rigidior	Stiff Cowbane	S2	G5		
Packera pseudaurea var. semicordata	Streambank Groundsel	S2	G5T3T5		
Panax quinquefolius	American Ginseng	S2	G3G4	END	END
Peltandra virginica	Green Arrow Arum	S3	G5		
Persicaria arifolia	Halberd-leaved Smartweed	S3	G5		
Phegopteris hexagonoptera	Broad Beech Fern	S3	G5		SC
Phlox subulata	Moss Phlox	S1?	G5		

SCIENTIFIC NAME	COMMON NAME	S_RANK	G_RANK	SARA STATUS	SARO STATUS
Platanthera leucophaea	Eastern Prairie Fringed Orchid	S2	G2G3	END	END
Poa saltuensis ssp. languida	Weak Bluegrass	S3	G5T4Q		
Polygala incarnata	Pink Milkwort	S1	G5	END	END
Polygala verticillata	Whorled Milkwort	S3?	G5		
Polygonum tenue	Slender Knotweed	S2	G5		
Prunus pumila var. pumila	Great Lakes Sand Cherry	S3	G5T4		
Ptelea trifoliata	Common Hop-tree	S3	G5	THR	SC
Pycnanthemum tenuifolium	Slender Mountain-mint	S3	G5		
Pycnanthemum verticillatum var. pilosum	Hairy Mountain-mint	S1	G5T5		
Quercus prinoides	Dwarf Chinquapin Oak	S2	G5		
Quercus shumardii	Shumard Oak	S3	G5		SC
Ranunculus hispidus	Bristly Buttercup	S3	G5T5		
Ratibida pinnata	Gray-headed Prairie Coneflower	S3	G5		
Rosa setigera	Climbing Prairie Rose	S2S3	G5	SC	SC
Saururus cernuus	Lizard's-tail	S3	G5		
Sceptridium oneidense	Blunt-lobed Grapefern	S3?	G4		
Schoenoplectiella smithii	Smith's Bulrush	S2S3	G5?		
Scleria verticillata	Low Nutrush	S3	G5		
Senna hebecarpa	Wild Senna	S1	G5		
Silphium perfoliatum	Cup Plant	S2	G5		
Silphium terebinthinaceum	Prairie Rosinweed	S1	G4G5		
Sisyrinchium albidum	White Blue-eyed-grass	S1	G5?		
Smilax ecirrata	Upright Carrionflower	S3?	G5		
Smilax illinoensis	Illinois Carrionflower	S2?	G4?		
Solidago riddellii	Riddell's Goldenrod	S3	G5	SC	SC
Solidago rigida ssp. rigida	Eastern Stiff-leaved Goldenrod	S3	G5T5		
Solidago rigidiuscula	Stiff-leaved Showy Goldenrod	S1	G5T4	END	END
Sphenopholis obtusata	Prairie Wedge Grass	S1	G5		
Spiranthes magnicamporum	Great Plains Ladies'-tresses	S3?	G3G4		
Spiranthes ovalis	Oval Ladies'-tresses	S1	G5?		
Symphyotrichum dumosum	Bushy Aster	S2	G5		
Symphyotrichum praealtum	Willow-leaved Aster	S2	G5	THR	THR

SCIENTIFIC NAME	COMMON NAME	S_RANK	G_RANK	SARA STATUS	SARO STATUS
Symphyotrichum prenanthoides	Crooked-stem Aster	S2?	G4G5	SC	SC
Tephrosia virginiana	Virginia Goat's-rue	S1	G5	END	END
Thalictrum thalictroides	Rue-anemone	S3	G5		
Thaspium chapmanii	Chapman's Meadow-parsnip	S2?	GNR		
Tomostima reptans	Creeping Draba	S2S3	G5		
Tradescantia ohiensis	Ohio Spiderwort	S2	G5		
Triosteum perfoliatum	Perfoliate Horse-gentian	S1	G5		
Triphora trianthophoros	Nodding Pogonia	S1	G4?	END	END
Uvularia perfoliata	Perfoliate Bellwort	S1S2	G5		
Verbesina alternifolia	Wingstem	S3	G5		
Vernonia gigantea	Giant Ironweed	S1?	G5		
Vernonia missurica	Missouri Ironweed	S3?	G4G5		
Veronicastrum virginicum	Culver's Root	S2	G4		
Viola palmata	Palmate-leaved Violet	S2	G5		
Viola pedata	Bird's-foot Violet	S1	G5	END	END
Vulpia octoflora	Eight-flowered Fescue	S1S2	G5		
Zizania aquatica	Southern Wild Rice	S3	G5		

APPENDIX D –Detailed results: Coastal habitat connectivity

The CAP (Conservation Action Planning) is a process developed by The Nature Conservancy that guides project teams to develop effective conservation strategies and measures of success. Within this process, ecological attributes can be assigned a standard viability rating that is based on the acceptable range of variation (very good, good, fair, poor) that would allow it to persist over time (TNC, 2007).

Standard Definitions of viability ratings:

- **Very good** - Ecologically desirable status; requires little intervention for maintenance.
- **Good** - Indicator within acceptable range of variation; some intervention required for maintenance.
- **Fair** - Outside acceptable range of variation; requires human intervention.
- **Poor** - Restoration increasingly difficult; may result in extirpation of target.

Coastal habitat connectivity relative rating based on the CAP process definitions

Unit number	Unit name	Rating	Comment
1	St. Clair River CDN	Fair	St. Clair River CDN has more fragmented shoreline areas within the coastal unit and has more opportunities for connectivity inland within its contributing watershed.
2	Walpole Island/Delta	Good	Walpole Island/Delta has larger areas of natural cover and includes coastal habitat connectivity within the coastal unit but fewer opportunities for connectivity within its contributing watershed.
3	Lake St. Clair CDN	Good	Lake St. Clair CDN has larger areas of natural cover and includes coastal habitat connectivity within the coastal unit but fewer opportunities for connectivity within its contributing watershed.
4	Detroit River CDN	Fair	Detroit River has some areas of coastal habitat connectivity within the coastal unit and some opportunity for connectivity within its contributing watershed.
5	Western Basin	Fair	The Western Basin has some areas of coastal habitat connectivity within the coastal unit and some opportunity for connectivity within its contributing watershed.
6	Point Pelee	Good	Point Pelee has larger areas of natural cover and includes coastal habitat connectivity within the coastal unit but fewer opportunities for connectivity within its contributing watershed.
7	Point Pelee to Rondeau	Poor	Point Pelee to Rondeau has fragmented shoreline areas and fewer opportunities for habitat connectivity within the coastal unit and inland with its contributing watershed.
8	Rondeau	Fair	Rondeau has areas of coastal habitat connectivity within the coastal unit but some limitations to terrestrial connectivity around Rondeau Bay as well as fewer opportunities for connectivity within its contributing watershed.

Unit number	Unit name	Rating	Comment
9	Rondeau to Port Glasgow	Poor	Rondeau to Port Glasgow has fragmented shoreline areas and fewer opportunities for habitat connectivity within the coastal unit and inland with its contributing watershed.
10	Port Glasgow to Port Stanley	Fair	Port Glasgow to Port Stanley has some areas of coastal habitat connectivity within the coastal unit and some opportunity for connectivity within its contributing watershed.
11	Port Stanley to Port Burwell	Fair	Port Stanley to Port Burwell has some areas of coastal habitat connectivity within the coastal unit and some opportunity for connectivity within its contributing watershed.
12	Port Burwell to Long Point	Fair	Port Burwell to Long Point has more fragmentated shoreline areas within the coastal unit and has more opportunities for connectivity inland within its contributing watershed.
13	Long Point	Good	Long Point has larger areas of natural cover and includes coastal habitat connectivity within the coastal unit and within its contributing watershed.
14	Long Point to Port Dover	Poor	Long Point to Port Dover has fragmented shoreline areas and fewer opportunities for habitat connectivity within the coastal unit and inland with its contributing watershed.
15	Port Dover to Grand River	Poor	Port Dover to Grand River has fragmented shoreline areas and fewer opportunities for habitat connectivity within the coastal unit and inland with its contributing watershed.
16	Grand River to Niagara River	Fair	Grand River to the Niagara River has some areas of coastal habitat connectivity within the coastal unit and some opportunity for connectivity within its contributing watershed.