Development of a Coastal Wetlands Database for the Great Lakes Canadian Shoreline

Final Report to: The Great Lakes Commission
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Table of Contents

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1.0 Introduction

The need for a comprehensive database of wetlands in the Great Lakes basin has been well documented. Despite numerous initiatives, wetland area and quality is declining. Information on wetlands is required by many government and non-government agencies interested in wetland conservation and restoration. Past strategies for conservation and management have been constrained due to limited resources. Current management strategies have come to rely heavily on digital tools to assist and maximize conservation efforts. For areas of regional scale and greater, digital tools can provide consistency in management implementation that would otherwise be expensive and hard to obtain. However, the currency, comprehensiveness and standardization of digital data remains to be a significant limiting factor to management and reporting. This is magnified for areas that cross political borders as they are often subjected to differing protocols in collection and implementation.

The *Great Lakes Coastal Wetland Inventory* for the Canadian shoreline was initiated by the Great Lakes Coastal Wetland Consortium (GLCWC) as a bi-national endeavour to create a single classified inventory of all coastal wetlands of the Great Lakes Basin. The inventory is built upon the most comprehensive coastal wetland data currently available. It contains the spatial extents, hydrogeomorphic classification, name, centroid position and area measurement for all identified coastal wetlands of the Great Lakes basin. Data on system imposing hydrological modifiers has also been collected. Hydrogeomorphology dictates wetland delineations per criteria developed by the Great Lakes Coastal Wetlands Consortium (GLCWC) working group. The U.S collaboration provides seamless consistency in the data product assisting management of the Great Lakes as a system, rather than political entities. The bi-national inventory provides a standard reference for the Great Lakes wetland community and be the foundation for all subsequent Consortium work.

2.0 Project Objectives

The project objectives were:

1. To create a single, comprehensive inventory of all coastal wetlands on the Canadian shoreline of the Great Lakes basin.
2. To create a standardized criteria for wetland hydrogeomorphic classification and to apply it to each wetland in the database
3. To identify hydrological modifiers imposing on wetland system
4. To estimate an area for each identified coastal wetland

3.0 Project Design Issues

3.1 Determination of Project Study Area

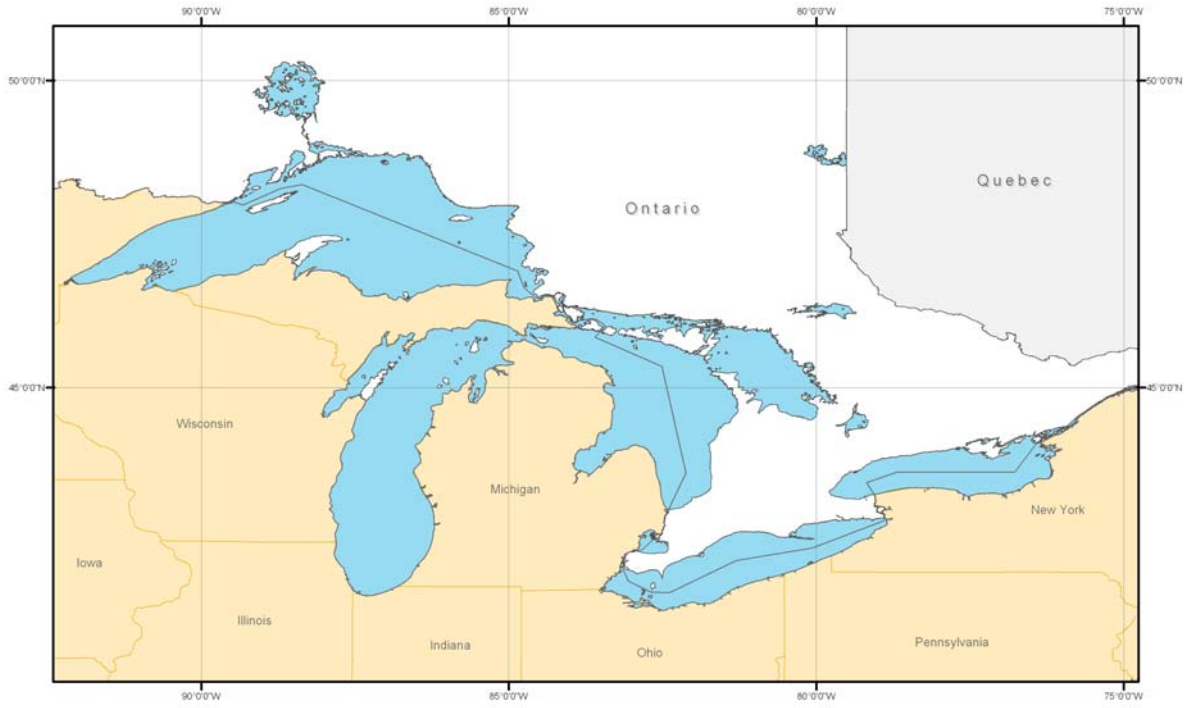


Figure 1. The U.S. and Canada border through the Great Lakes basin.

For the purposes of this project, the scope of the study area was limited to wetlands of the Great Lakes and its connecting channels that currently and/or historically maintained a hydrological connection to it.

The longitudinal limits of the study area extend from the US border on the northwest shoreline of Lake Superior to the Cornwall Dam on the St. Lawrence River (-89^{o} W to -72^{o} W). The latitudinal range extended from Middle Island, an island south of Pelee Island and just north of the US border on Lake Erie, to the northern shoreline of Lake Superior into the inlet of Nipigon River (41^{o} N to 49^{o} N). The political separation of the Great Lakes between the U.S and Canada is outlined in Figure 1.

3.1.2 Examine Inventory and Gap Analysis

The GLCWC compiled and examined the current coastal wetland inventory for the Canadian shoreline, and determined its completeness as it relates to overall Consortium requirements. The determination was based on past experience with existing datasets and preliminary gap analyses, but also identifies and evaluates other existing datasets that GLCWC may not have received i.e. updated Ontario Wetland Evaluation data from the OMNR Natural Resource Values Information System (NRVIS). The current Great Lakes Canadian shoreline coastal wetland inventory contains information collected by GLCWC from the NRVIS Evaluated Wetland layer and projects such as *The Ontario Great Lakes Coastal Wetlands Atlas*, WIRENet, and SOLEC reports.

A gap analysis was completed and recommendations were developed to address these gaps in the inventory for the Canadian shoreline. All agreed upon recommendations were implemented in cooperation with the U.S. wetland inventory team and the GLCWC.

3.1.3 Experts Workshop and Protocol Development

An experts workshop was held in April 2004, in partnership with the U.S. project lead and the GLCWC to finalize a standardized hydrogeomorphic coastal wetland classification system. This classification was applied to each coastal wetland.

The workshop also:

- defined what is to be included as a coastal wetland,
- reviewed some remaining "grey areas" in the classification scheme,
- clarified the attributes to be used in assigning wetland types,
- determined minimum acceptable data standards for use when reviewing potential data sets,
- clarified the rules to be used in delineating wetland complexes,
- defined specific criteria for delineating the upper extent (inland) of coastal wetlands, and
- reached a consensus on the approach to be used in the classification exercise by key Consortium partners.

The workshop was to ensure that the end product is a compatible bi-national coastal wetland dataset produced using standardized protocols.

3.1.4 Determination of Upper Limit of Lake Hydrological Influence

Topography is used to determine the upper and lower extents of coastal wetland boundaries as to meet criterion defining a coastal wetland. Landscape contours can approximate the upper extent, where upland is separated from wetland. The upper limit is determined from documented historical influence of the lake, through fluctuating water levels. A maximum floodplain describes the level (in meters) to where water will rise as a result of a given rain or natural event. The Canadian Hydrological Service (CHS) has detailed records of historical mean and maximum water levels for each basin from and can be downloaded from their website at:
http://biachss.bur.dfo.ca/danp/tidal_e.html
Water level data from 1918 to 2000 were used to determine a lake specific, maximum flood level. CHS historic water levels reference the International Great Lakes Datum 85 (IGLD85) vertical datum. For compatibility with the OMNR topographic spot height data, the historic high water level values were converted from IGLD 85 datum into CGD 28 datum. The conversion is completed using the equation:

$$CGD = IGLD - [\text{Conversion Factor}]$$

Each Lake has its own basin specific conversion factor published by the Canadian Hydrological Service. A maximum flood elevation was calculated for each lake basin in IGLD 85, the conversion factor and the flood plain referenced in CGD 28 (Table 1).

The maximum flood elevation value specific to each Great Lake is used in conjunction with known topographical heights of the basin to reference an upper extent of Great Lakes influence on coastal wetlands. The study area was limited to the upper extent of the Great Lakes flood plain. All wetlands beyond the maximum flood plain boundary were not included in the database unless they were determined continuous with wetland that lay within the lake influence boundary.

Table 1. Monthly Great Lakes Water Level Averages, from 1918 to 2000

	Water Level(m)				Upper Extent of Flood Plain (m)	IGLD85 to CGD	Flood Plain (m),
Lake	Avg	StDev	Min	Max	IGLD 85 Datum	Conversion factor	CGD 28 Datum
Lake Superior	183.432	0.184	182.72	183.91	184.00	0.31	183.60
Lake Michigan/ Lake Huron	176.483	0.390	175.58	177.50	178.00	0.273333333	177.23
Lake St Clair	175.0233232	0.403032545	173.88	175.96	176.00	0.011666667	175.95
Lake Erie	174.1451016	0.377308816	173.18	175.04	175.00	0.006666667	175.03
Lake Ontario/ Upper St Lawrence	74.75068089	0.355665444	73.74	75.76	76.00	0.02	75.74

Canadian Hydrological Service

3.2 Data Acquisition

This project utilized a number of different datasets from different sources. Separate treatment was required to transform the datasets into relational database format. For further details of all datasets used and created in this project, please refer to the Coastal Wetland Inventory metadata. (Appendix 1)

- *The Ontario Great Lakes Coastal Wetland Atlas: A Summary of Information (1983-1997)* was published as a document with supplementary electronic spreadsheets in March 2003. It is a summary of information for previously identified Ontario Great Lake's coastal wetlands and identifies data gaps in all existing information sources. Its supplementary MS Excel spreadsheets include wetland centroid XY positions in zone specific, UTM coordinates. The data was acquired through Environment Canada, Canadian Wildlife Service, Ontario Region.
- Colour Infrared (CIR) Photography was obtained by the Ontario Ministry of Natural Resources in hardcopy form as 1:10 000, 10.5" x 10.5" colour prints. All photos were taken in the summer months and vary between the years of 1994 and 2002. These photos were available for the Great Lake's entire southern basin, extending to the southern half of Lake Huron (to the district border of Parry Sound, Ontario).
- Forest Resource Inventory (FRI) Photography was obtained by the Ontario Ministry of Natural Resources (OMNR) in hardcopy form as 1:20 000, 10.5" x 10.5" black and white prints. All photos were taken in the summer months and vary between the years of 1986 and 1994. Theses photos were available for the upper Great Lakes to supplement the CIR photo coverage. Photos were obtained for coastal wetlands north of Parry Sound, Ontario to US border on Lake Superior's northwest shore.
- Digital Indian Remote Satellite (IRS), 5-meter panchromatic images for the Canadian shoreline of Lake St. Clair, including Walpole Island, St. Mary's River, including Manitoulin Island, and for Long Point on Lake Erie were provided by OMNR. These images were obtained as orthorectified .tif and .twf files.
- Long Point Wetland polygon coverage in UTM zone 17, NAD83 was produced by the Canadian Wildlife Service and Adaptation and Impact Research Group of Environment Canada and is copyright Her Majesty the Queen in Right of Canada, Department of the Environment.
- OMNR NRVIS digital base data were also acquired and included 7 Geographic Unit Types (GUT) and their associated tables. Data were obtained in coverage format with associated

linker attribute tables in .dbf format. All data were collected at 1:10 000 and were provided in zone specific UTM, NAD 83. Brief descriptions of each GUT are as follows:

- **Evaluated Wetlands.** A polygon coverage separated into three extents: Northwest, Northeast and South Central Ontario. All wetlands in this coverage have been evaluated and field verified (as per evaluation date) in accordance with the *Ontario Wetland Evaluation System* (Ontario Ministry of Natural Resources." Ontario Wetland Evaluation System, Southern Ontario Manual. 3rd Edition" March 1993.).The wetland evaluation reports are the most detailed and consistent surveys available for wetlands in Ontario. There is a two hectare minimum for this data.
- **Waterpoly.** A polygon coverage digitized from the Ontario Base Mapping Program, as part of the 1:10 000 OBM Drainage. It was obtained in OMNR District specific coverages and recognizes wetland from open water areas. It also provided the best representation of the Great Lakes shoreline.
- **Waterline.** A line coverage digitized from the Ontario Base Mapping Program, as part of the 1:10 000 OBM Drainage. It was obtained in OMNR District specific coverages.
- **Road Segment.** A line coverage digitized from 1:10 000 Ontario Base Maps. Obtained in OMNR District specific coverages, it represents linear transport features and recognizes primary, secondary and tertiary roads.
- **Railway.** A line coverage digitized from 1:10 000 Ontario Base Maps. It was obtained as a seamless provincial coverage.
- **Utility Lines.** A line coverage digitized from 1:10 000 Ontario Base Maps. It was obtained from the OMNR as a seamless provincial coverage.
- **Spot Heights.** A point coverage digitized from 1:10 000 Ontario Base Maps. It was obtained in OMNR District specific coverages and represents land topological heights (z values)

3.3 Data Preprocessing

3.3.1 Ontario Coastal Wetland Atlas Centroid Processing

The coastal wetlands centroid positions are provided in zone specific MS Excel spreadsheets. They reference and identify both known evaluated coastal wetlands and other high likelihood coastal wetlands. Each spreadsheet was converted into a .dbf file and imported into ArcGIS 8.2. The 'Display XY Data' function in ArcMap was used for the import and digital point data was saved as a shapefile. Each zone specific shapefile was reprojected into zone 18 and merged into one coverage using ArcMap's Geoprocessing Tool. The resultant dataset were starting point locations of known coastal wetlands on the Great Lakes.

3.3.2 NRVIS Data Processing

Each NRVIS data coverage and their many associated attribute linker tables were imported into ArcGIS 8.2. The attribute tables were joined based on relationships defined in their metadata (Standard NRVIS Interchange Format Version 2.0 Class Breakdown (SNIF Report)) and the NRVIS, Technical Reference Guide for End-Users (April 2000).

3.3.3 Flood Plain Processing

OMNR Spot Height data describes the topographical heights (z value) of land. From these a 1m contour coverage was created to reference the Great Lakes maximum flood plain. The data is OMNR District specific so, to reduce processing time, the data for each district was clipped using a 2km buffer of the Great Lakes shoreline. The clipped data were then merged together to create a seamless coverage. Both the 'clip based on another layer' and the 'merge' function were completed using the Geoprocessing Tool of ArcMap. Contours were created using the 'Surface Analysis' tool of the Spatial Analyst extension of ArcGIS 8.2. The previously calculated, basin

specific flood plain values in CGD datum were used as reference values to query out the flood plain of each Great Lake basin. The end result is five, basin-specific contour line shapefiles referencing their specific flood plain level. This provides a spatial reference of the upper limit of lake influence on surrounding wetlands.

3.3.4 Air Photo Image Georeferencing

Wetlands that do not have suitable digital polygon data, have been generated by delineating the wetland boundary using standardized air photo interpretation techniques (Owens and Hop 1995) and on-screen digitizing functionality of ArcGIS 8.2.

Air photos for these identified wetlands were scanned into digital image format and the image(s) georeferenced to the NRVIS data using the following criteria:

- a total of no less than 5 Ground Control Points (GCP) must be used in photo registration
- GCPs must be selected from permanent positions (e.g., road crossings, railways, utility lines)
- GCPs must be selected and referenced at a scale of 1:500
- The RMS error generated must be less than 0.5

All world files (.wld) and RMS error text files have been maintained with the image metadata. These georeferencing criteria are consistent with protocol utilized by the OMNR in creation of the digital evaluated wetland polygon layer, and assist in maintaining data integrity though the developing coastal wetland dataset. For detailed information on NRVIS spatial accuracy please see the NRVIS Guide for End Users. For further details on the georeferencing specifics, please refer to the Coastal Wetland Inventory metadata (Appendix 1).

3.3.5. Project Metadata

Complete QA/QC and complete metadata compilation for all digital files is based on the U.S. Federal Geographic Data Committee (FGDC) standards. Appendix I contains a complete list of metadata for the NRVIS Data and Coastal Wetland Atlas Centroid Data used in this project. Refer to the *Data Quality, Source Information* section of the Coastal Wetland Inventory metadata. All RMS errors generated in the air photo image georeferencing (based on NRVIS GCPs) can be obtained from Environment Canada, Canadian Wildlife Service, Ontario Region.

4.0 Project Methodology

This section outlines the methodology used to address the project objectives. The data usage, processes and file naming conventions involved in creating the final product are outlined in Figure 2. In this figure, rectangles represent GIS data layers, diamonds represent processes and squares represent non-GIS layers.

4.1 Objective 1: Creation of Coastal Wetland Inventory Database

4.1.1 Database Implementation

A new, empty polygon coverage was created in ArcCatalog of ArcGIS 8.2 in UTM zone18, NAD 83 projection. The polygon attribute table for this dataset was decided upon during the expert's workshop. For an example of the attribute table please refer to Appendix II. For attribute descriptions, definitions and coding please refer to the coastal wetland inventory metadata (Appendix 1).

For internal use, linker ID fields were added to the database to maintain relationships with all utilized data sources and their metadata, including all air photos, Evaluated Wetland polygon coverage and Coastal Wetland Atlas Centroids. These table associations will not be included in

the final dataset, but will be maintained in-house as supplementary metadata. Due to the size of the project extent, a geodatabase was created to house the project. A geodatabase allows edit caches to be created to speed up editing processing time. The empty coastal wetland inventory coverage was imported into this geodatabase. Next, all previously identified coastal wetlands were added. The following describes this process:

- **Add Coastal Evaluated Wetlands**

Perform a spatial query to select all OMNR Evaluated Wetland Polygons where a Coastal Wetland Atlas Centroid has been identified. Use Load Objects function of ArcGIS 8.2 to transfer spatial and attribute data of the Evaluated Wetland Polygons into the new empty Coastal Wetland Inventory polygon coverage.

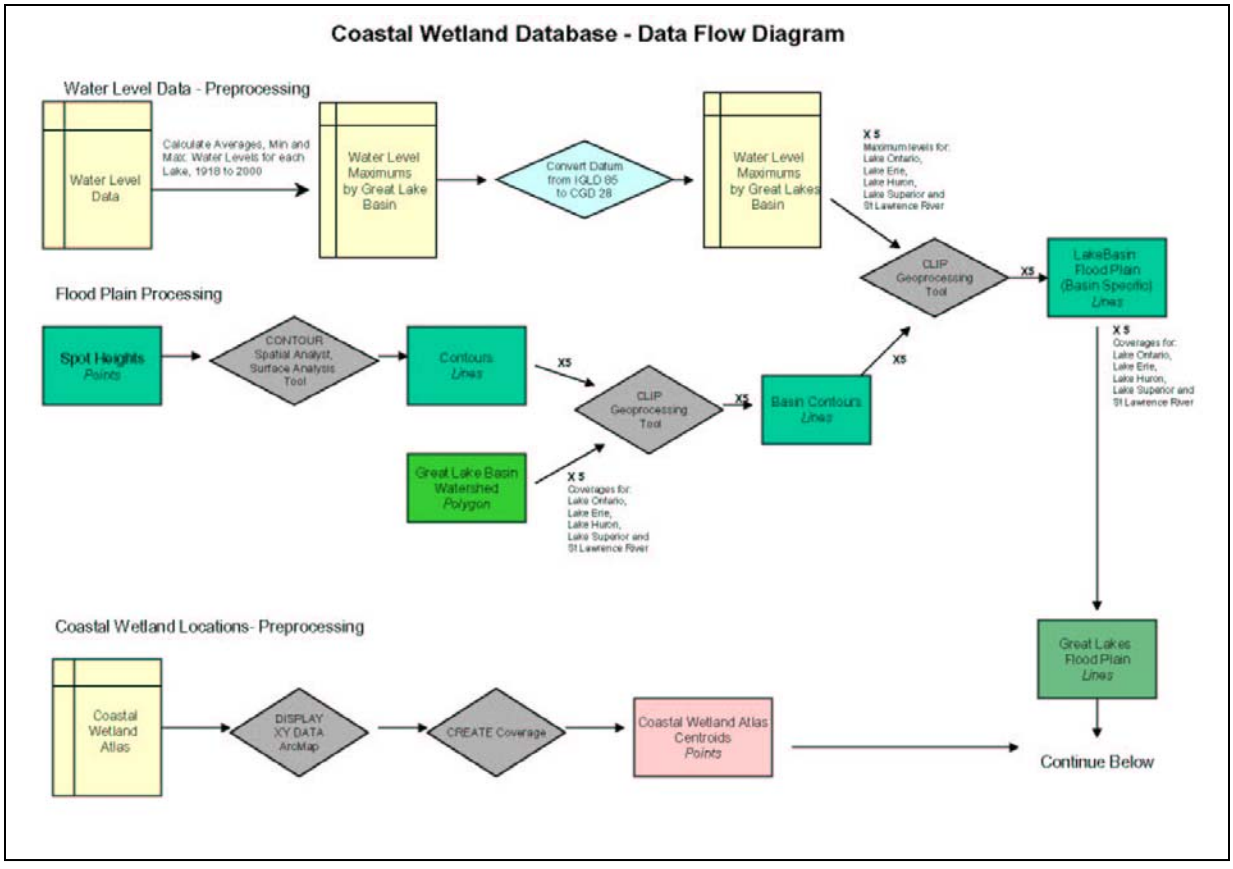
- **Add Coastal Unevaluated Wetlands**

Perform a spatial query to select all OMNR Waterpoly polygons where a Coastal Wetland Atlas Centroid has been identified. Use Load Objects function of ArcGIS 8.2 to transfer spatial and attribute data into the Coastal Wetland Inventory polygon coverage.

- **Add Other Potential Coastal Wetlands**

Perform a spatial query to select all OMNR Evaluated Wetland Polygons that lie within a 2 km distance of the Great Lakes Shoreline. Reselect this selection for polygons greater than 2 hectares (20 000m^3) to satisfy the minimum mapping unit for this project. Use Load Objects function of ArcGIS 8.2 to transfer spatial and attribute data of the Evaluated Wetland Polygons into the Coastal Wetland Inventory polygon coverage.

Perform a spatial query to select all OMNR Waterpoly polygons that lie within a 2 km distance of the Great Lakes Shoreline. Reselect this selection for polygons greater than 2 hectares (20 000m^3) to satisfy the minimum mapping unit for this project. Use Load Objects function of



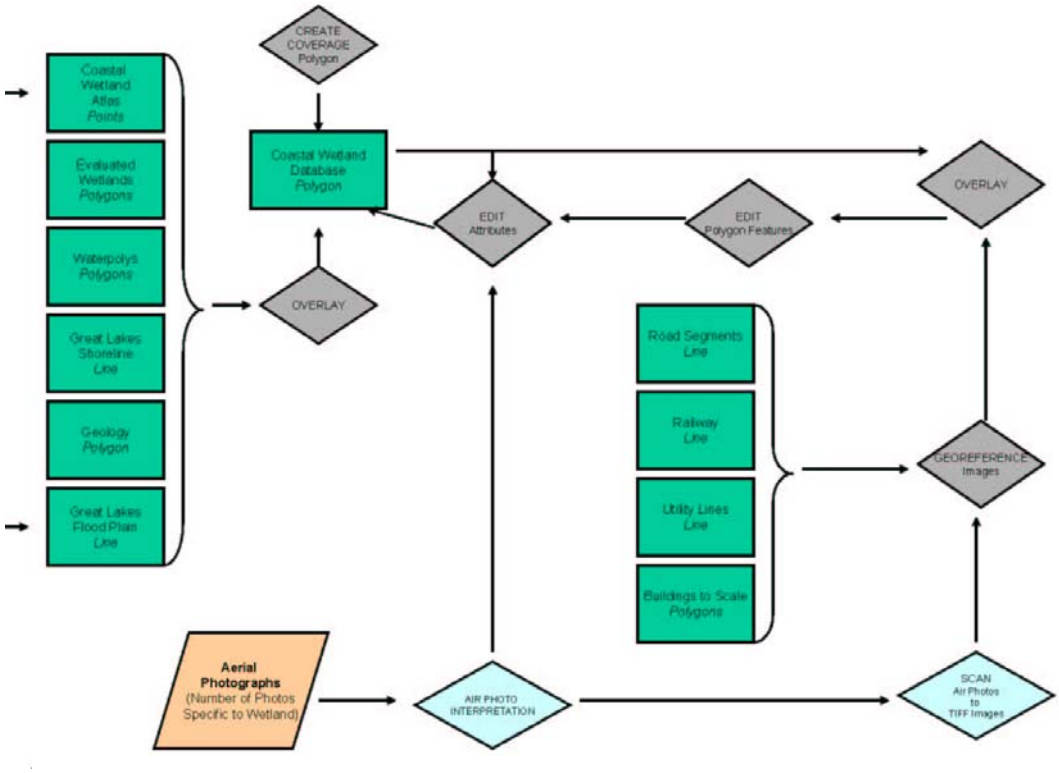


Figure 2. Data Flow Diagram for Coastal Wetland Inventory Development

ArcGIS 8.2 to transfer spatial and attribute data of the Evaluated Wetland Polygons into the Coastal Wetland Inventory polygon coverage

- **Add Long Point Wetland Complex**

Long Point is an extensive wetland and data availability provided a current, verified boundary for the wetland. This coverage was added to the dataset using the Load Objects function of ArcGIS 8.2. A Merge polygon function was used so that every wetland extent will be confirmed, updated, added or deleted as necessary for coastal designation. This designation is provided by an expert in the field, supplemented through air photo interpretation.

4.1.2 Wetland Boundary Digitization

Where coastal wetlands have been identified but do not have suitable digital polygon data, the wetland boundary and corresponding area were generated through delineation. The preferred method due to time and project constraints was to complete this digitally using scanned and georeferenced air photos to provide a digital tablet to on-screen digitize the coastal wetland boundary. The digitizing was completed along side the use of a stereoscope to confirm land features and in accordance with standardized air photo interpretation techniques (Owens and Hop,1995).

For complete digitizing and data registering standards, please see the *Logical_Consistancy_Report* of the Coastal Wetland Inventory metadata (Appendix 1). The criteria standards are consistent with the protocol utilized by the OMNR in the creation of the

evaluated wetland polygons, and assisted the maintenance of data integrity though the developing coastal wetland dataset. Further detailed information on NRVIS spatial accuracy can be obtained from the NRVIS, Technical Reference Guide for End Users (April,2000)
The final dataset coverage was cleaned of topological errors using ArcInfo 8.2.

4.2. Objective 2: Great Lakes Coastal Wetland Hydrogeomorphic Classification

4.2.1 Wetland Hydrogeomorphic Classification Schema

The classification schema was decided and agreed upon by the Great Lakes Coastal Wetlands Consortium Working Group, and is to be submitted to the Journal of Great Lakes Research for publication. The classification recognizes 19 wetland types including 5 Barrier Beach, 4 Lacustrine, 3 Riverine and 7 Riverine Channel systems. The document can be viewed in its entirety in Appendix III.

4.2.2 Wetland Hydrogeomorphic Typing

Every coastal wetland in the database is hydrogeomophically typed as per the *Great Lake's Wetland Hydrogeomorphic Classification Schema* (Appendix III). The designation was made by air photo interpretation. In conducting this classification on a wetland-by-wetland basis, certain rules and/or assumptions were used: 1) It is assumed that all coastal wetlands of the Great Lakes will meet the criteria of at least one of the hydrogeomorphic classifications listed. 2) If a wetland was complex with more than one hydrogeomorphological feature, the existing wetland polygon is split to best represent each individual feature. A new wetland name is given to each hydrogeomorphic type. In a complexed and or evaluated wetland system, each hydrogeomophically typed wetland is given the name of the wetland complex followed by a number, sequentially from west to east 3) In cases, where anthropogenic alteration has disrupted the hydrology of the system, the wetland hydrogeomorphic classification is to best represent its original connection to the lake, before alteration occurred.

4.3 Objective 3: Identification of System Hydrological Modifiers

A list of potential modifiers on a wetland system was agreed upon at the expert's workshop. The list includes 8 scenarios: dykes, dams, road construction, dredging, jetty, filled, waste and/or sewage and marina. The modifiers are noted as a presence/absence (yes or no, Boolean attribute) in the polygon attribute table and are determined concurrently with the previous two objectives through air photo interpretation.

4.4 Objective 4: Determination of Coastal Wetland Area

Wetland area was generated automatically upon topography creation. This area was converted into hectares. Total wetland area consists of the sum of all wetland polygons that define its boundary.

5. 0 Project Results and Discussion

The Canadian Coastal Wetland Inventory identifies 1077 hydrogeomophically distinct coastal wetlands along its shoreline. These wetlands combine to total 63,706 Hectares of coastal wetland. Table 2. summarizes the wetland total area for each hydrogeomorphic type as per Great Lake basin and each of its connecting channels and Figure 3. provides an example of the digital product.

Table 2. Total Coastal Wetland Area in Hectares, for the Canadian Shoreline

Hydrogeomorphic Wetland Type	Great Lake Basin										
	DR	LKE	LKH	LKO	LKS	LSC	NR	SCR	SLR	SMR	Grand Total
BL	81.56587794	988.3304131	2299.926246	2091.456888	554.2747029			10.91930977	420.1191032	674.1989145	7120.791455
BLS		323.3130804	450.0469509	166.888707			5.783187616		4.354082026		950.3860079
BWI		804.3119133		46.45120897							850.7631223
BWR		80.76197623	1821.085873	0.991815161	197.7040904					8.713702642	2109.257457
LOE		37.03019215	71.40395008	1147.200039	376.8044338	27.1840474			24.93733127	184.06241	1868.622404
LOS		45.36241038	17.72306352	89.98245312		1825.117133				115.9262313	2094.111291
LPP		41.12606902	5174.157147	2784.317601	587.126638				40.16832864		8626.895783
LPS		6533.249953	58.80084502	179.6112798					7.763827583	29.69155635	6809.117461
RCD								7850.029457			7850.029457
RCOE									1437.434045	374.0653597	1811.499404
RCOS	295.8066175						4.824141154		1419.439696	16.7195878	1736.790042
RCPE								19.96933734	1655.550572	3095.763985	4771.283895
RCRB	97.89778168										97.89778168
RCRO	23.02117895						0.452022076	3.038154747	1525.696814	408.3189155	1960.527085
RCSS										45.9153723	45.9153723
RDB		2361.471985	1745.302312	868.3351156	12.17559619				30.1396793		5017.424688
RDE			965.9171512		73.62434361						1039.541495
RDO		202.5180505	3574.895751	4401.987205	434.1052664	113.2910016	218.9492106				8945.746485
Grand Total	498.2914561	11417.47604	16179.25929	11777.22231	2235.815071	1965.592182	230.0085615	7883.956259	6565.603478	4953.376035	**63706.60069**

Code	Hydrogeomorphic_Type
BL	Barrier-Protected, Beach Lagoon
BLS	Successional Barrier Beach Lagoon
BLT	Barrier Beach,Tombolo
BWI	Barrier-Protected, Sand-Spit Swales
BWR	Barrier-Protected, Ridge and Swale Complex
LOE	Lacustrine, Open Embayment
LOS	Lacustrine, Open Shoreline
LPP	Lacustrine, Protected Embayment
LPS	Lacustrine, Sand-Spit Embayment
RDO	Riverine, Open, Drowned River-Mouth
RCD	Riverine, Channel, Delta
RCOE	Riverine, Channel, Open Embayment
RCOS	Riverine, Channel, Open Shoreline
RCPE	Riverine, Channel, Protected Embayment
RCRB	Riverine, Channel, Barred, Drowned River-Mouth
RCRO	Riverine, Channel, Open, Drowned River-Mouth
RCSS	Riverine, Channel, Sand-Spit Embayment
RDB	Riverine, Barred, Drowned River-Mouth
RDE	Riverine, Delta

Code	Lake Basin
DR	Detroit River
LKE	Lake Erie
LKH	Lake Huron
LKO	Lake Ontario
LKS	Lake Superior
LSC	Lake St. Clair
NR	Niagara River
SCR	St. Clair River
SLR	St. Lawrence River
SMR	St. Mary's River

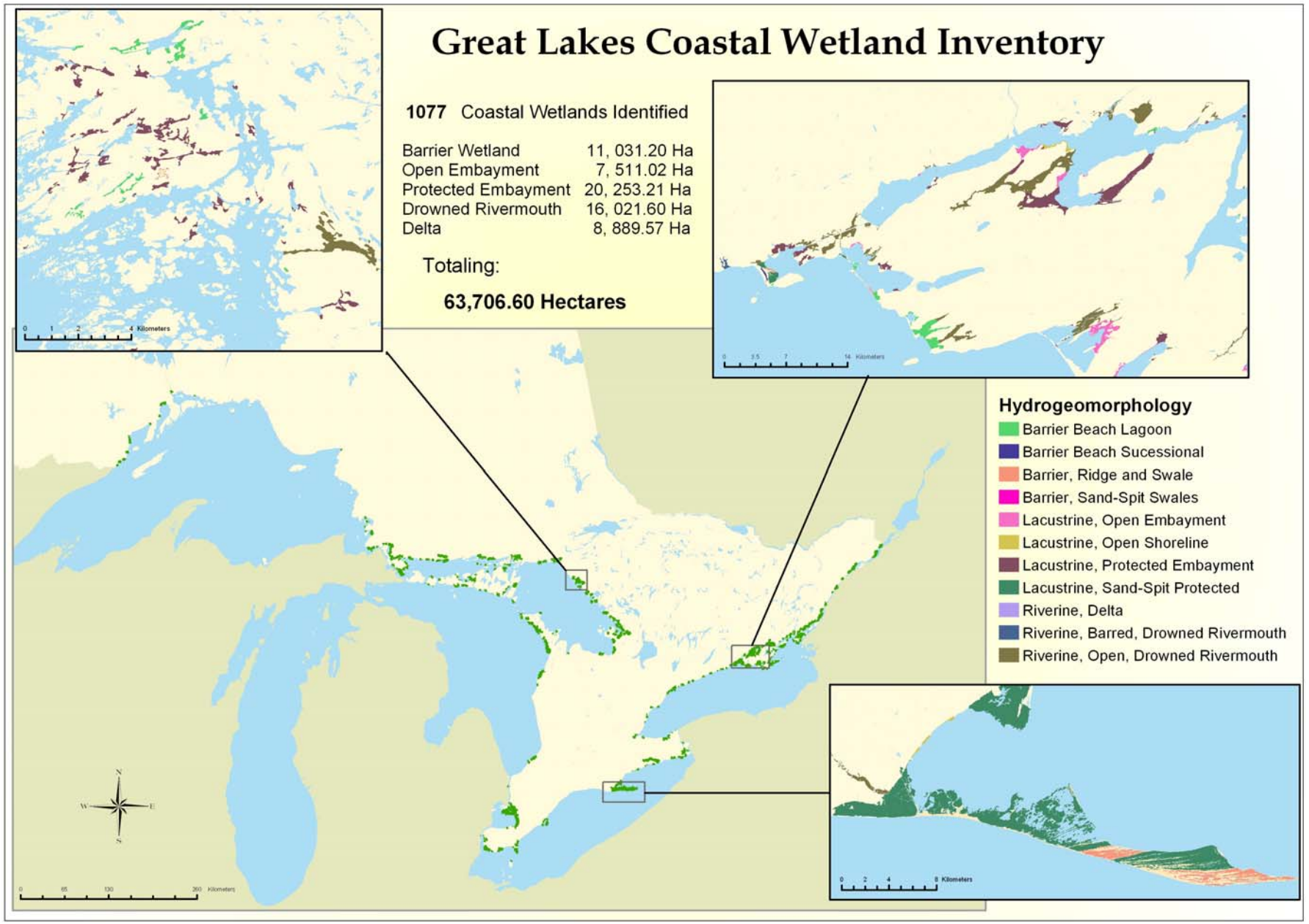


Figure 3. Example of Coastal Wetland Inventory digital product

Lake Huron contains the greatest area of coastal wetlands with 16,179.25 Ha (25.40%), followed by Lake Ontario with 11,777.22 Ha (18.49%), Lake Erie with 11,417.42 Ha (17.92%) and Lake Superior with 2,235.82 Ha(3.51%). Lake Huron was expected to contain the greatest amount of coastal wetland area, due to its size, geology, morphology and lesser degree of urban encroachment than the lower Great Lakes of Erie and Ontario. Limited data availability had compromised the wetland data for the upper Great Lakes. Even though the greatest amount of wetland area was identified in Lake Huron, it is expected that the actual wetland area for Lake Huron and Lake Superior is much higher than what is currently identified.

The Great Lakes exhibited diversification in hydrogeomorphic types, reflective of geography and geology (Table 2). The connecting channels of the St. Lawrence River and St. Mary's River contained 10 different hydrogeomophically typed wetlands. Lake Ontario and Lake Erie both contain 9 different types. This reflects the higher geological variability in the lower Great Lakes than the hard, exposed granite of the upper Great Lakes. The connecting channels of St. Lawrence and St. Mary's contain areas of lacustrine and riverine features and this provides a greater diversification in hydrogeomorphic wetland types.

On a basin level, the wetland types can provide insight into the influence of the surrounding area. The wetlands of Lake Erie are highly influenced by sand processes. In Lake Erie both the *lacustrine, sand-spit protected embayments* and the *riverine, barred, drowned rivermouth* make up 77.9% of the wetlands found in its basin. Combine this total with the 19.24% of *barrier-beach* systems, and almost all of Lake Erie's wetlands are accounted for. Lake Huron and Lake Superior wetlands are predominately *protected embayments*. Sand processes are limited to selected regions of their basins, mostly comprised of jagged, granite outcroppings. Of the total coastal wetland area, *riverine, open, drowned rivermouth* systems comprised the greatest amount of wetland area at 9,043.64 Ha, with almost half of its total (49.21%) residing in Lake Ontario. The high area is product of continuous wetland extending up river from the lake. The total riverine wetland may not all be under lake influence, but the continuity of the wetland is important to capture in the data as well to reflect individual system functions.

The second largest hydrogeomorphic wetland type on the Canadian shore of the Great Lakes are the *lacustrine, protected embayments* at 8, 626.90 Ha, followed by *riverine, channel deltas* at 7, 850.03 Ha of wetland. The deltaic area is predominately due to the large St.Clair River Delta that enters into Lake St. Clair, and Lake Huron dominates the total amount of *protected embayment* wetlands. Lake Huron and Lake Superior account for 95.71% of the total amount of *barrier-protected, ridge and swale complex* found in the inventory, which is indicative of the isostatic rebound and changing shoreline with water level fluctuations. Many of these unique wetland types are lost in the lower Great Lakes due to agricultural and urban development.

The dataset displays the severe fragmentation and desecration of wetlands in some regions of the lower Great Lakes. Data is extensive in the lower Great Lakes and most of the persisting coastal wetlands are accounted for in this project. The fragmentation is not result of data gaps in theses areas. Figure 4. displays the extensiveness of urban encroachment in the Golden Horseshoe on Lake Ontario.

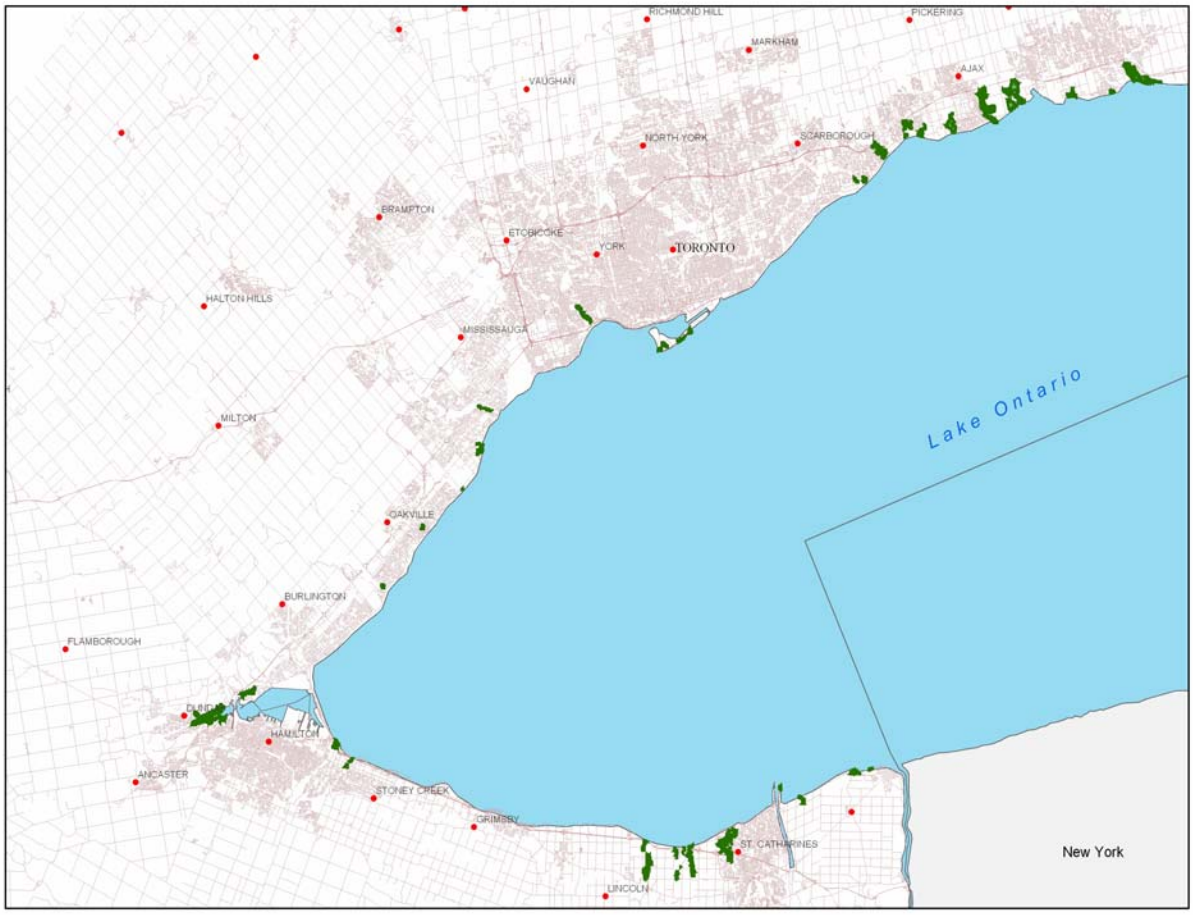


Figure 4. Coastal Wetland Fragmentation, Golden Horseshoe, Lake Ontario.

5.0 Issues and Limitations to Coastal Wetland Inventory Dataset

5.1 Completeness

The area extent of this undertaking was ambitious. The original project concept was to provide a digital coverage for the wetlands coastal wetlands inventoried in the *Ontario Coastal Wetland Atlas, A Summary of Information (1984-1999)*. However, the experts meeting set standard to the definition of a coastal wetland, and the intricate hydrogeomorphic wetland classification was developed. The outcome was the need for an "as detailed as possible" digital product. To complete this in the time allocated, required more man hours than originally budgeted. Time restrictions prevented further investigations into areas of missing data.

The variability in available wetland data reflects the urban focus of wetland work. Current data for the Great Lakes north of Parry Sound is limited. The shoreline is too extensive to obtain photo coverage for its entire length. Photo coverage was limited to areas of previously identified wetlands in the data inventory and gap analysis process. Therefore, newly identified wetlands were limited to what could be verified on acquired photos. The number of wetlands for Lake Superior and Lake Huron is expected to be higher than what is currently captured in this dataset. Georgian Bay contains number of large archipelagos along its shoreline and lake influence will extend to the many protected wetlands they contain. There was not sufficient photo coverage of the Lake Huron archipelagos and many wetlands off the shore of Massasauga Provincial Park, Parry Island First

Nation and in the Georgian Bay Islands National Park, are not captured. Figure 5. displays an island archipelago found on Lake Huron. The dark green polygons represent identified coastal wetland areas. The morphology of this area suggests that a number of wetlands with hydrological connection to the lake were not included in this evaluation.

To add to the extensiveness of island shoreline is the discrepancy as to what is actually lake shoreline. The OMNR waterpoly data which displays most islands and shoreline was referenced with *The Great Lakes Sensitivity Atlas for Lake Huron's Canadian Shoreline (including Georgian Bay)* (Environment Canada 1994) to confirm the shoreline. This may have omitted potential coastal wetlands. For example, the *Sensitivity Atlas* does not include the lower portions of Port Severn, which enters into Georgian Bay. As no wetlands had been identified in the *Ontario Coastal Wetland Atlas* for this area, limited photo coverage was obtained but coastal influence extends into the Severn River. Future updates, may want to give priority to the upper Great Lakes, with focus on these areas. Remote sensing techniques may provide more efficient ways of capturing this data than air photo interpretation.

The lower Great Lakes have extensive datasets available and photo coverage was acquired for most of the shoreline. The Coastal Wetland Inventory is very comprehensive from Lake St Clair to the Cornwall Dam on the St Lawrence River.

5.2 Wetland Lower Extents

The lower extent of the wetland has been delineated as to the amount of visible wetland in the air photo interpretation. A limitation to air photo interpretation, most submerged aquatic plants are not reflected in the wetland lower boundary. The Ontario Wetland Evaluation System defines the lower extent of the wetland to occur at a water level of 2m. Improvements in bathymetry data can provide more accurate open water portions of coastal wetlands.

5.3 Hydrogeomorphic Classification

All coastal wetlands in the database were classified as to the hydrogeomorphic classification schema provided by the GLCWC. Some key issues that arose while using this schema are as follows:
1) The classification schema accounts for all general types of wetlands one would expect to find in the Great Lakes basin, but the fact is, not all wetlands fit these 'typical' descriptions in the classification. Many systems have anthropogenic alterations and no longer resemble the original hydrological connection to the lake. In these situations, the wetland was classified in accordance to its hydrogeomorphic connection prior to the alteration, and all system modifiers were noted in the attribute table. This should be considered when making area estimates of wetland types. For example, a dyked wetland that was once an *open embayment* wetland is now quite extensive, resembling more of a *protected embayment* wetland, than the fringing wetland it was, if left unaltered.
2) A number of wetland systems could be typed into one or more hydrogeomorphic classifications. The GLCWC decided to include a secondary classification for the wetlands, which is provided for in the attribute table. Systems such as *barred, drowned rivermouths*, which have created large lagoons at their mouths and only a small portion of the riverine wetland is classified as coastal, will be typed primarily as a *riverine, barred, drowned rivermouth* and secondarily typed as a *barrier beach lagoon*. However, these classifications are a matter of scale and subjective. In some instances primary vs secondary classification are arguable and field investigation is required to verify.

3) The classification schema separates out all wetlands of connecting channels, so that a *lacustrine, open embayment wetland* can be given different consideration from a *riverine, channel, open embayment* wetland. However, there were coastal stretches within the connecting channels containing wetlands that were more lake-like than channel-like. Many times, this was due to anthropogenic influence, e.g. a control structure, which changes the shape and expanse of the wetland. The secondary classification may be used to denote the lacustrine feature of the wetlands. As stated previously, wetland classification prior to alteration may skew true wetland area estimates of one type to another and needs to be considered in certain analyses.
4) The Great Lakes have many intermittent drainage ditches entering into the basin. These were not considered riverine systems and could not be classified as such. However, on a small scale, these drains may resemble small riverine wetlands. Most drains entered into an embayment and thus, were classified as part of a continuous embayment wetland.
5) Occasionally, there were discrepancies between the OMNR's Evaluated Wetland boundaries and the air photo interpretation. In most cases, the evaluated polygon was accepted, as per the protocol, and classified to best ability. New polygons were delineated to reconcile wetland boundaries in cases where wetland evaluations were completed before orthorectified base data was available or where the CIR photo was more recent than the wetland evaluation.

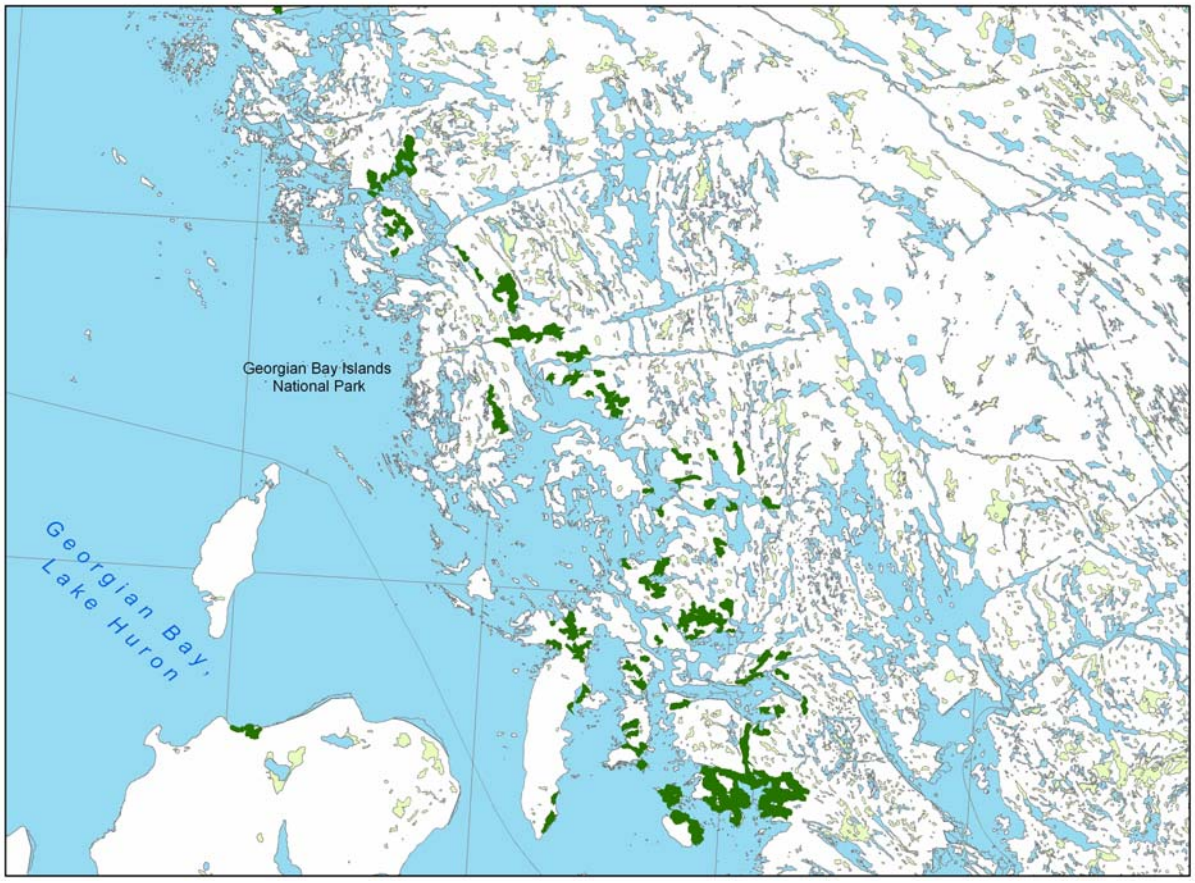


Figure 5. Island Archipelago of Georgian Bay, Lake Huron.
Dark green polygons represent the Coastal Wetland Inventory

6) Each wetland was classified hydrogeomophically by an expert through air photo interpretation. In a few cases, no air photos were available or had incomplete coverage. In these situations, a classification was estimated using other map products and it was noted in the comments that the site was not photo verified.

For further information on data limitations, accuracy and standards, please refer to the dataset metadata (Appendix 1).

6.0 Project Expenditures

Ontario Ministry of Natural Resources (US$)

Category	Detail	Project Budget	Previous Invoice	Amount Due Final Invoice
Personnel (salaries)				
Benefits				
Supplies and Materials	Data Acquisition: Air photos, NRVIS data layers, Geomatics Service Centre processing fees, etc.	$16.5K	$ 5.7 K (Colour IR Photos I) $ 2.3 K (FRI)	$ 2.18 K (Colour IR Photo II)
Travel		$2K	$ 0.4 K	
Contractual	Contract staff to identify, order and organize FRI air photos	$8K	$ 1.1 K	
Other direct costs	Workshop Financial processing fee	$5K $3.5K		
Other indirect costs				
	Total for OMNR	**$35K**	**$ 9.5 K**	**$2.18 K**
**Monetary value of in-kind work – Personnel-salaries*		*$12 K*	*$ 7 K*	*$ 5 K*

Canadian Wildlife Service (US$)

Category	Detail	Amount	Previous Invoice	Amount Due Final Invoice
Personnel (salaries)	Air photo interpretation and GIS data processing/creation	$24K	$18 K	$6K
Benefits		$4K	$2.5K	$1.5K
Supplies and Materials				

Travel		$2K	$1.5K	$0.5K
Contractual				
Other direct costs				
Other indirect costs	CWS support and admin.	$3K	$2K	$1K
	Total for CWS	**$33K**	**$24K**	**$9K**
**In-kind (CND):* *Personnel (salaries)* *Equipment*		 *$25K* *$5K*	 *$15K* *$5K*	 *$10K* -

7.0 Conclusion

The *Great Lakes Coastal Wetland Inventory* is a comprehensive classified inventory for Great Lakes coastal wetlands of the Canadian shoreline. It is an extensive database from the lower Great Lakes and is complete for all previously identified wetlands in the upper Great Lakes. The source data compilation and creation of new data meets all standards set before project commencement and all wetland boundaries are true as to the most current source available. It provides an estimate of coastal wetland area for the entire Great Lakes basin that was not previously attainable.

Although this is the most comprehensive data available, it is already dated. Ideally, all the wetlands in the basin would be evaluated using the OMNR Wetland Evaluation System. Further investigations into remote sensing techniques and rapid evaluation techniques may prove beneficial to capture overlooked wetlands and update existing data, especially areas of extensive islands and convoluted shoreline of portions of the upper Great Lakes. Additional information, such as near-shore bathymetry and land use would also compliment this dataset and future analyses.

The Great Lakes Coastal Wetland Consortium (GLCWC) idea and support of a bi-national product will incorporate this dataset into a seamless coverage for the entire Great Lakes basin. Future monitoring, management and conservation activities for the Great Lakes now have a consistent base dataset that enables consideration the system as a whole and regional distribution of wetland types, rather than fragments or separate political entities. It will provide a standard reference for the Great Lakes wetland science and conservation community and be the foundation for all subsequent Consortium work.

8.0 References

Environment Canada and Ontario Ministry of Natural Resources. March 2003. *The Ontario Great Lakes Coastal Wetland Atlas: A Summary of Information (1983 - 1997),* Canadian Wildlife Service, Ontario Region, Environment Canada, Conservation and Planning Section-Lands and Waters Branch; and Natural Heritage Information Center, Ontario Ministry of Natural Resources.

Environment Canada. 1994a. *Environmental Sensitivity Atlas for Lake Erie (Including the Welland Canal) and Niagara River Shorelines.* Prepared By: Environment Canada-Environmental Protection Branch (Ontario Region), Canadian Coast Guard, United States Coast Guard-District 9, United

States National Oceanic and Atmospheric Administration. Minister of Supply and Services Canada, Toronto.

Environment Canada. 1994b. *Environmental Sensitivity Atlas for Lake Huron's Canadian Shoreline (including Georgian Bay).* Prepared By: Environment Canada- Environmental Protection Branch (Ontario Region). Minister of Supply and Services Canada, Toronto.

Environment Canada. 1994c. *Environmental Sensitivity Atlas for the St. Clair River, Lake St. Clair and Detroit River Shoreline.* Prepared By: Environment Canada- Environmental Protection Branch (Ontario Region), Canadian Coast Guard, United States Coast Guard-District 9, United States National Oceanic and Atmospheric Administration. Minister of Supply and Services Canada, Toronto.

Environment Canada. 1994d. *Environmental Sensitivity Atlas for the St. Lawrence River Shorelines.* Prepared By: Environment Canada-Environmental Protection Branch (Ontario Region), Canadian Coast Guard, United States Coast Guard-District 9, United States National Oceanic and Atmospheric Administration. Minister of Supply and Services Canada, Toronto.

Environment Canada. 1994e. *Environmental Sensitivity Atlas for the St. Marys River Shorelines.* Prepared By: Environment Canada-Environmental Protection Branch (Ontario Region), Canadian Coast Guard, United States Coast Guard-District 9, United States National Oceanic and Atmospheric Administration. Minister of Supply and Services Canada, Toronto.

Environment Canada. 1993a. *Environmental Sensitivity Atlas for Lake Superior's Canadian Shoreline.* Prepared By: Environment Canada-Environmental Protection Branch (Ontario Region), Canadian Coast Guard, United States Coast Guard-District 9, United States National Oceanic and Atmospheric Administration. Minister of Supply and Services Canada, Toronto.

Environment Canada. 1993b. *Environmental Sensitivity Atlas for Lake Ontario's Canadian Shoreline.* Prepared By: Environment Canada-Environmental Protection Branch (Ontario Region), Canadian Coast Guard, United States Coast Guard-District 9, United States National Oceanic and Atmospheric Administration. Minister of Supply and Services Canada, Toronto.

Ontario Ministry of Natural Resources. April 2000. *NRVIS, Technical Reference Guide for End-Users, Ontario Digital Geographic Database(ODGD) Natural Resources Values and Information (NRVIS) Guide.* Ontario Ministry of Natural Resources, Ontario.

Ontario Ministry of Natural Resources. 1993. *Ontario Wetland Evaluation System, Southern Ontario Manual. 3rd Edition*. Ontario Ministry of Natural Resources, Peterborough, Ontario.

Owens, T. and K. D. Hop. 1995. Long Term Resource Monitoring Program standard operating procedures: Field station photo interpretation. National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, August 1995. LTRMP 95-P008-2. 13 pp. + Appendixes A-E.

APPENDICIES

APPENDIX I

Coastal Wetland Inventory for the Canadian Shoreline

Metadata also available as .smgl file for ArcCatalog

Metadata:

Identification_Information:

Citation:
Citation_Information:
Originator: Joel Ingram
Originator: Nancy Patterson
Originator: Krista Holmes
Publication_Date: February 2004
Title: Coastal Wetland Inventory for the Canadian Shoreline
Edition: 1st
Geospatial_Data_Presentation_Form: vector digital data
Other_Citation_Details:
This is the Canadian data portion of a seamless bi-national coastal wetland inventory for the Great Lakes and its connecting channels.
Online_Linkage: <http://www.glc.org/wetlands/inventory_classification.html>
Description:
Abstract:
The Great Lakes Coastal Wetland Inventory for the Canadian shoreline was developed by the Great Lakes Coastal Wetland Consortium (GLCWC) as a bi-national endeavour to create a single classified inventory of all coastal wetlands of the Great Lakes Basin.
The inventory was built upon the most comprehensive coastal wetland data currently available. It contains the spatial extents, hydrogeomorphic classification, name, centroid position and area measurement for all known coastal wetlands of the Great Lakes basin. Hydrological modifiers imposing on each system are also identified. Hydrogeomorphology dictates wetland delineations per criteria developed by the Great Lakes Coastal Wetlands Consortium (GLCWC) working group.
This inventory is a compilation of best-available sources on coastal wetlands of the Great Lakes and connecting channels. It was built off 'The Ontario Great Lakes Coastal Wetland Atlas'. Published in March 2003, this document summarizes all known data to-date for coastal wetlands and identifies numerous data gaps in the current information. Where available OMNR's digital Evaluated Wetlands polygon data provides the spatial extents for digital wetland boundaries. Data gaps have been filled in using air photograph interpretation following National Biological Service guidelines, and digitization techniques following GLCWC guidelines.
The resultant dataset will provide the foundation of an interactive, standardized database to assist scientists with the future protection and management of basin wetlands. The U.S collaboration provides seamless consistency in the data product assisting management of the Great Lakes as a system, rather than political entities. The bi-national inventory provides a new standard reference for the Great Lakes wetland community.

Purpose:
To create a single, hydrogeomorphically classified inventory of all coastal wetlands for the Great Lakes Canadian shoreline. This inventory will be built on the most comprehensive coastal wetland data currently available and incorporate a standard classification process. It will be the foundation upon which all subsequent Great Lakes Coastal Wetlands Consortium (GLCWC) work will be based.
Supplemental_Information:
The Ontario Great Lakes Coastal Wetland Atlas: A Summary of Information (1983 - 1997), Environment Canada and Ontario Ministry of Natural Resources. March 2003

Owens, T. and K. D. Hop. 1995. Long Term Resource Monitoring Program standard operating procedures: Field station photo interpretation. National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, August 1995. LTRMP 95-P008-2. 13 pp. + Appendixes A-E.

Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 1987
Beginning_Time: summer months
Ending_Date: 2001
Ending_Time: summer months
Currentness_Reference:
Source aerial photography date, OMNR wetland evaluation date, ground condition
Status:
Progress: Complete
Maintenance_and_Update_Frequency: As needed
Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate: -89.767760
East_Bounding_Coordinate: -74.303293
North_Bounding_Coordinate: 49.773838
South_Bounding_Coordinate: 41.342172
Keywords:
Theme:
Theme_Keyword: wetland
Theme_Keyword: coastal
Theme_Keyword: hydrogeomorphic classification
Theme_Keyword: freshwater
Theme_Keyword: open embayment
Theme_Keyword: protected embayment
Theme_Keyword: barrier beach
Theme_Keyword: drowned river mouth
Theme_Keyword: open shoreline
Theme_Keyword: sand spit embayment
Theme_Keyword: sand spit swales
Theme_Keyword: ridge and swale
Theme_Keyword: tombolo
Theme_Keyword: delta
Theme_Keyword: Great Lakes Wetlands Consortium
Theme_Keyword: Coastal Wetland Atlas
Theme_Keyword: bi-national
Place:
Place_Keyword: Great Lakes
Place_Keyword: Ontario
Place_Keyword: Lake Superior
Place_Keyword: Lake Huron
Place_Keyword: Lake St Clair

Place_Keyword: Lake Erie
Place_Keyword: Lake Ontario
Place_Keyword: St Lawrence River
Place_Keyword: Niagara River
Place_Keyword: Detroit River
Place_Keyword: St Mary's River
Place_Keyword: St Clair River
Place_Keyword: Georgian Bay
Place_Keyword: Canada
Access_Constraints: None
Use_Constraints: None
Point_of_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Joel Ingram
Contact_Organization: Canadian Wildlife Service,Ontario Region, Environment Canada
Contact_Position: Wetlands Monitoring Biologist
Contact_Address:
Address_Type: mailing and physical address
Address: Environment Canada
Address: ECB/CSD/CWS, Ontario Region
Address: 4905 Dufferin Street
City: Downsview
State_or_Province: Ontario
Postal_Code: M3H 5T4
Country: Canada
Contact_Voice_Telephone: (416) 739-5843
Contact_Facsimile_Telephone: (416) 739-5845
Contact_Electronic_Mail_Address: joel.ingram@ec.gc.ca
Hours_of_Service: 8:00am to 4:00pm
Contact_Instructions: call, email or write
Data_Set_Credit:
The funding for this project was through the Great Lakes Coastal Wetlands Consortium (GLCWC)
Security_Information:
Security_Classification: Unclassified
Security_Handling_Description:
Some wetland information may be considered sensitive, and as such may have restrictions placed on access.
Native_Data_Set_Environment:
Microsoft Windows 2000 Version 5.1 (Build 2600) Service Pack 1; ESRI ArcCatalog 8.2.0.700
Cross_Reference:
Citation_Information:
Originator: Environment Canada
Originator: Ontario Ministry of Natural Resources
Publication_Date: March 2003
Title:
The Ontario Great Lakes Coastal Wetland Atlas: A summary of Information (1983-1997)
Edition: 1st
Geospatial_Data_Presentation_Form: document
Cross_Reference:
Citation_Information:
Originator: Ontario Ministry of Natural Resources
Publication_Date: April, 2000
Title:

NRVIS, Technical Reference Guide for End-Users, Ontario Digital Geographic Database(ODGD) Natural Resources Values and Information (NRVIS) Guide.
Geospatial_Data_Presentation_Form: document, on-line publication
Other_Citation_Details:
Details of OMNR data used in this project can be found in this publication.
Online_Linkage: <http://www.lio.mnr.gov.on.ca/ogdedescription.cfm>
Online_Linkage:
<http://www.lio.mnr.gov.on.ca/spectrasites/internet/lio/media/documents/ODGDV3.pdf>
Online_Linkage:
<http://www.lio.mnr.gov.on.ca/lioweb/land_info/warehouse-overview.asp>

Data_Quality_Information:
Attribute_Accuracy:
Attribute_Accuracy_Report:
Accuracy issues related to individual attributes in the dataset are discussed below.
Quantitative_Attribute_Accuracy_Assessment:
Attribute_Accuracy_Value: Hydrogeomo
Attribute_Accuracy_Explanation:
There were a few key issues with the hydrogeomorphic classification schema provided by the GLCWC:
1) The classification schema developed accounts for all general types of wetlands one would expect to find in the Great Lakes basin, but the fact is, not all wetlands fit these 'typical' descriptions in the classification. Many systems have anthropogenic alterations and no longer resemble the original hydrological connection to the lake. In these situations, the wetland was classified in accordance to its hydrogeomorphic connection prior to the alteration, and all system modifiers were noted in the attribute table. This should be considered when making area estimates of wetland types. For example, a dyked wetland that was once an open embayment wetland is now quite extensive, resembling more of a protected embayment wetland, than the fringing wetland it was, if left unaltered.
2) A number of wetland systems could be typed into one or more hydrogeomorphic classifications. The GLCWC decided to include a secondary classification for the wetlands, which is provided for in the attribute table. Systems such as barred, drowned rivermouths, which have created large lagoons at their mouths, and only a small portion of the riverine wetland is classified as coastal, will be typed primarily as a riverine,barred,drowned rivermouth and secondarily typed as a barrier beach lagoon. However, these classifications are a matter of scale and subjective. What are primary vs secondary in the classification is arguable.
3) The classification schema separates out all wetlands of connecting channels, so that a lacustrine, open embayment wetland can be given different consideration from a riverine, channel, open embayment wetland. However, there were coastal stretches within the connecting channels containing wetlands that were more lake-like than channel-like. Many times, this was due to anthropogenic influence, e.g. a control structure, which changes the shape and expanse of the wetland. The secondary classification may be used to denote the lacustrine feature of the wetlands. As stated previously, wetland classification prior to alteration may skew true wetland area estimates of one type to another and needs to be considered in certain analyses.
4) The Great Lakes have many drainage ditches entering into the basin. These are not riverine systems and could not be classified as such. However, on a small scale, these drains most resemble small riverine wetlands. Most drains entered into an embayment and thus, were classified as part of a continuous embayment wetland.
5) Occasionally, there were discrepancies between the OMNR's Evaluated Wetland boundaries and the air photo interpretation. In most cases, the evaluated polygon was accepted, as per the protocol, and classified to best ability. In cases where the discrepancies could be concluded beyond a doubt that there was serious error with the wetland boundary (e.g. including large non-wetland areas, omitted large wetland areas or seriously shifted), the evaluated wetland boundary was altered through air photo interpretation, re-digitized and classified accordingly.
6) Each wetland was classified hydrogeomophically by an expert through air photo interpretation. In a few cases, no air photos were available or had incomplete coverage. In these situations, a classification was estimated and it was noted in the comments that the site was not photo verified.

Quantitative_Attribute_Accuracy_Assessment:
Attribute_Accuracy_Value: WETLAND_NA
Attribute_Accuracy_Explanation:
The Wetland name is as determined by "The Ontario Great Lakes Coastal Wetland Atlas: A summary of Information (1983-1997)" March 2003, where available. This is, in most cases, the same name as recorded in the OMNR Evaluated Wetlands. For all newly identified wetlands, the naming scheme is as follows: 1. Gazetteer names are used where available 2. Proper names are used where available (e.g. Lynde Creek). 3. When wetlands are not named, the name of the area is used (e.g. Grenadier Island Wetlands). 4. When proper names and area names are not available, the direction from a nearby landmark is used (e.g. North of Sheephead Point). 5. When multiple wetlands are identified within a complex, and/or within close proximity, they are numbered from west to east (e.g. Riverside Marsh 1, Riverside Marsh 2)

A couple of issues arose in using this schema 1) Multiple names for the same wetland 2) Spelling discrepancies e.g. Mill Wetland, Mills Wetland, Mill's Wetland. 3) No close land feature from which to associate a name

In the afore listed scenarios, the Atlas centroid data was given first priority. Where an atlas centroid was not available, the evaluated wetland name was used. Where neither of these primary data layers are available, National Topological Survey (NTS) map sheets were used to derive a name.

4) Some MNR complexed wetlands were very large and could have been split into entities e.g. a creek portion and an embayment portion. In this case, the MNR evaluated wetland name as a complex was given priority and the entity names, where applicable, are identified in the comments.

Quantitative_Attribute_Accuracy_Assessment:
Attribute_Accuracy_Value: Area
Attribute_Accuracy_Explanation:
Limitation include:

Conceptual Constraints
* any subjectivity in GLCWC hydrogeomorphic classifications
* OMNR wetland evaluation date
* the wetland evaluation process protocol limits wetland size to be greater than 2 hectares

Digitizing Constraints
* the limitations in using aerial photography (1:10 000 and 1:20 000)
* scanning resolution for transparencies; 0.39m ground pixel
* RMS error in orthorectification process, must be less than 0.5m
* the wetland evaluation process protocol limits wetland size to be greater than 2 hectares
* Software limitations

Logical_Consistency_Report:
Polygon topology exists because vector polygons created and cleaned in ArcInfo 8.2

Quality assessment was made of all data before it was utilized to guarantee it meets quality standards for the project.

Evaluated Wetland Standards:

This project builds off of existing NRVIS Evaluated Wetland data which was derived from Wetland Evaluation records. These are the most detailed surveys currently available for wetlands in Ontario. The Wetland Evaluation reports were collected from OMNR District Offices and range from 1983 to 1997. The data consists of polygon features designated as wetland through the Ontario Wetland Evaluation System. All data in the evaluations were interpreted and field verified. The NRVIS data standards for horizontal accuracy in this dataset is +/-5 meters In the Ontario Wetland Evaluation Process, wetlands smaller than 2 hectares will not be evaluated, the wetland boundary was drawn where 50% of the plant community consists of upland species and a 2 meter depth contour (at low water) was used to define the

deep water boundary between wetland and open water. (Ontario Ministry of Natural Resources."Ontario Wetland Evaluation System, Southern Ontario Manual. 3rd Edition" March 1993.)

Digitizing and Data Registration Standards for the Great Lakes Coastal Wetland Inventory

Where coastal wetlands have been identified but do not have suitable digital polygon data, the wetland boundary and corresponding area will be generated through delineation. The preferred method due to time and project constraints was to complete this digitally. Accuracy performance criteria are essential when digitizing to reduce the error introduced during conversion of 3-D real world objects into 2-D map objects. The peer group and project leads have accepted the accuracy criteria for this conversion as follows:
1) Air photos for identified wetlands will be scanned into digital image format that produces an obtainable minimum resolution. For the 1:10 000 and 1:20 000 scanned photos must produce an acceptable sub meter pixel resolution. For 1:10 000 photos, scanning the image at 600dpi will produce a pixel of approximately 0.4m. The 1:20 000 photos will also be scanned at 600dpi, due to data storage constraints, and will produce a pixel resolution of 0.8m.
2) The quality of the scanned imagery, including the evenness of contrast and brightness ranges, should be radiometrically colour-balanced across the wetland area to assist in the photo mosaic.
3) The georegistration of image-to-ground coordinates will be done using ArcGIS 8.2.
4) All images will be compiled using the 6 Degree Universal Transverse Mercator (UTM) projection expressed in meters, with appropriate UTM zone specified. The horizontal datum will be North American Datum Adjustment 1983(NAD 83).
5) For the purpose of establishing ground control points (GCP), high precision network data will be derived from the OMNR's Natural Resources Values Information System (NRVIS), provided in ARC/INFO export interchange format. Coverages of permanent positions, including roads, railways and utility lines, are most effective for use in determining GCPs. Wherever possible transport features (e.g. road intersections) should be selected.
6) The accuracy of GCPs is absolutely critical. The images must have a Root Mean Square (RMS) error within a measured positional accuracy of +/- 5 meters, with the corresponding RMS text files saved to confirm this result.
7) As georeferencing accuracy is contingent to the base data and to the scale of the photo, the RMS standard has been set to best meet the areas within the investigating extent.
8) The GCPs should be well distributed throughout the photo rather than clustered together, with a minimum of 5 points collected. Where photos are mosaiced together for complete wetland coverage, there should be at least 3 tie points per adjacent photo. Each GCP must be selected and referenced at a scale of 1:500 9) All georeferenced photos will be saved to CD in a .tiff or .sid format and be accompanied by the tiff world file (.twf) or sid world file (.swf) accordingly, and the RMS text file.

These criteria are consistent with the protocol utilized by the OMNR in the creation of the evaluated wetland polygons, and assisted the maintenance of data integrity though the developing coastal wetland dataset. For more detailed information on NRVIS spatial accuracy please see the NRVIS Guide for End Users.

Each coastal wetland identified was classified hydrogeomorphologically. The classification schema was decided and agreed upon by the Great Lakes Coastal Wetlands Consortium Working Group. In conducting this classification on a wetland-by-wetland basis, certain rules and/or assumptions were made:
1) It was assumed that all coastal wetlands of the Great Lakes will meet the criteria of at least one of the hydrogeomorphic classifications listed.
2) If a wetland was complexed with more than one hydrogeomorphological type, the existing wetland polygon was split to best represent each individual. A new wetland name was given to each hydrogeomorphic type. In a complexed and or evaluated wetland system, each hydrogeomophically typed wetland was given the name of the wetland complex followed by a number, sequentially from west to east
3) In cases, where anthropogenic alteration has disrupted the hydrology of the system, the wetland

hydrogeomorphic classification was to best represent its original connection to the lake, before alteration occurred.
4) Coastal wetlands must reside within the lake specific, historic high water level contour, as recorded by the Canadian Hydrological Service. If a continuous wetland extends outside of this boundary, it will also be included in the Inventory.

A basin flood plain provides a reference to the upper extent of the coastal wetland located in that basin. The flood plain is a maximum average of a fluctuating boundary and is therefore, by nature not very accurate. It is not to be used as a definitive boundary but as a guide of reference to a possible upper extent. The extent delineation will occur after air photo interpretation and will be based on the natural wetland continuum. A continuous wetland was included in this Coastal Wetland Inventory in its entirety but where it was not continuous, the flood plain provides the upper limit of what is to be included with the wetland complex.

Completeness_Report:
This project builds upon pre-existing data. and is in accordance to the Federal Geographic Data Committee's (FGDC) National Spatial Data Infrastructure (NSDI) standards (www.fgdc.gov). Only data that meets the predetermined quality standard were considered.

Wetland Boundary Delineation

The polygon extents in the coastal wetland database were provided by the OMNR and were mostly accepted as true. Spatial editing and/or the creation of new data, only occurred in 3 cases:
1) the absence of a digital wetland boundary
2) splitting/removing the non-continuous upper extents of an existing wetland boundary because it is not considered coastal and
3) complexed wetlands whose current boundaries need to be split into hydrogeomorphological entities. Hydrogeomorphic types and descriptions are outlined in the classification schema developed by D. A. Albert, J. Ingram, T. Thompson and D. Wilcox, on behalf of the Great Lakes Coastal Wetland Consortium (GLCWC). See below: "Great Lakes Hydrogeomorphic Classification Schema".

Images were necessary for the classification. The OMNR has colour IR photos at a scale of 1:10 000, taken in the summer months between the years of 1994 and 2000. They were available for the entire southern basin of the Great Lake's extending to the southern half of Lake Huron.The CIR coverage ended just north of the Parry Sound district border The northern basin had to be compensated with an alternative image source. Forest Resource Inventory (FRI) black and white contact prints provided this alternative. They were available for the remaining coastal wetlands of the basin at a scale of 1:20 000. These photos were also all taken during summer months, but their date range is a littler older, from 1986 to 1994. The scale and quality of the FRI's still allowed for proper geomorphic classification of the wetland and between these two sources, there was full coverage of the Great Lake's basin with relative consistency.

All acquired photos were analyzed in analog form with the assistance of a stereoscope. In cases where the digital wetland boundary polygons did not exist for identified coastal wetlands, or significant spatial alterations needed to occur, the aerial photos were scanned into digital format and georeferenced to OMNR NRVIS data. This provided a digital tablet from which to on-screen digitize the coastal wetland boundary in ArcGIS 8.2. Delineation of the wetland boundary was generated using standardized air photo interpretation techniques (Owens and Hop 1995) and was limited to wetland areas greater than 2 hectares. The 2 hectare minimum is consistent with the OMNR's evaluated wetland polygon data.

In areas where large wetland complexes exist it was more efficient and thus, cost-effective to obtain satellite imagery than aerial photos. Such areas include St. Clair Marsh Wetland Complex, Wapole Island in Lake St.Clair and Long Point Wetland Complex in Lake Erie. For these areas, digital 5m panchromatic imagery and 15m multispectral imagery was obtained through the OMNR.

The Coastal Wetland Inventory is considered complete for the entire Great Lakes basin. However, there is potential for updates in the upper Great Lakes. Data gaps were very extensive for Lake Superior and

north Lake Huron. This dataset accounted for all data gaps outlined in the March 2003 publication "Coastal Wetland Atlas, A Summary of Information (1983-1997)" and photo coverage was received for all these areas. However, if a potential wetland lay outside of the obtained photo coverage, it would not be included in the dataset. Due to the extensiveness of island archipelagos and rocky outcroppings found in these areas, it is most likely that coastal wetlands greater than 2 hectares are missing from the final dataset. Future updates, may want to give priority to these areas. The lower Great Lakes have extensive datasets available and photo coverage extended for the entire shoreline. The Coastal Wetland Inventory is believed to be complete from Lake St Clair to the Cornwall Dam on the St Lawrence River.

A workshop held in partnership with U.S. project leads and the GLCWC, created the following peer accepted hydrogeomorphic coastal wetland classification for the Great Lakes. It is to be submitted for peer review into the Journal of Great Lakes Research (International Association for Great Lakes Research (IAGLR))

Great Lakes Hydrogeomorphic Classification Schema

By D. A. Albert, J. Ingram, T. Thompson, D. Wilcox, on behalf of the Great Lakes Coastal Wetland Consortium (GLCWC)

SEE APPENDIX III

Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report:
Horizontal accuracy for the Evaluated Wetland polygon layer is estimated to be on the order of +/- 5 meters (NRVIS, Technical Reference Guide for End-Users, Ontario Digital Geographic Database(ODGD) Natural Resources Values and Information (NRVIS) Guide. April 2000)

The horizontal accuracy of all newly digitized polygons is based on the control data and methodology used to extract and position control points on the image. The OMNR base data used in the rectification process has a horizontal accuracy of +/- 5 meters. All photo registration RMS error was maintained to less tha 0.5m. Text files have been saved for verification.

The positional accuracy of the data set has not been tested under the National Standards for Spatial Data Accuracy.

Vertical_Positional_Accuracy:
Vertical_Positional_Accuracy_Report: Not Applicable
Lineage:
Source_Information:
Source_Citation:
Citation_Information:
Originator:
Owens, T. and K. D. Hop. National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin,
Publication_Date: August 1995
Title:
Long Term Resource Monitoring Program standard operating procedures: Field station photo interpretation.
Geospatial_Data_Presentation_Form: document
Other_Citation_Details: LTRMP 95-P008-2. 13 pp. + Appendixes A-E.
Type_of_Source_Media: Published Paper
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: Aug 1995
Source_Currentness_Reference: publication date

Source_Citation_Abbreviation: Photo Interpretation
Source_Contribution:
Provided the guidelines to air photo interpretation, the standard used in this project.
Source_Information:
Source_Citation:
Citation_Information:
Originator: OMNR/ IJC
Publication_Date: Ranges between 1994 to 2002
Publication_Time: Summer months
Title: Colour Infrared Aerial Photographs
Geospatial_Data_Presentation_Form: remote-sensing image
Other_Citation_Details:
All colour infrared aerial photography used in this project was obtained from the OMNR. The photos were taken in the summer months between the years of 1994 and 2002. These photos were available for all of the Great Lake's southern basin, extending to the southern half of Lake Huron (to the district border of Parry Sound, Ontario).
Source_Scale_Denominator: 10 000
Type_of_Source_Media: Colour Infrared Aerial Photographs
Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 1994
Ending_Date: 2002
Source_Currentness_Reference: ground condition
Source_Citation_Abbreviation: Aerial Photos1
Source_Contribution:
Colour infrared aerial photography was used, where available, to confirm and/or create wetland boundary extents and to classify the hydrogeomorphiology of each coastal wetland of the Great Lakes. Boundary and hydromorphic classification was completed by an expert using air photo interpretation standard techniques.
Source_Information:
Source_Citation:
Citation_Information:
Originator: National Air Photo Library, Ottawa, Canada
Publication_Date: Ranges between 1986 and 1994
Publication_Time: summer months
Title: Black and White Aerial Photography
Geospatial_Data_Presentation_Form: remote-sensing image
Other_Citation_Details:
Back and white FRI aerial contact prints were taken between 1986 and 1994 at a scale of 1:20 000
Source_Scale_Denominator: 20000
Type_of_Source_Media: Forest Resource Inventory (FRI) Aerial Photos
Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 1986
Ending_Date: 1994
Source_Currentness_Reference: ground condition
Source_Citation_Abbreviation: Aerial Photos2
Source_Contribution:
Black and white FRI aerial photography was used to confirm and/or create wetland boundary extents and to classify the hydrogeomorphic type of each coastal wetland of the upper Great Lakes, where colour infrared aerial photography was not available. The photography was interpreted by an expert to determine a wetland boundary and wetland hydromorphic classification.
Source_Information:

Source_Citation:
Citation_Information:
Originator: Environment Canada and Ontario Ministry of Natural Resources
Publication_Date: March 2003
Title:
The Ontario Great Lakes Coastal Wetland Atlas: A Summary of Information (1983 - 1997)
Edition: 1st
Geospatial_Data_Presentation_Form: document
Other_Citation_Details:
Also contains supplementary MS Excel spreadsheet containing wetland attribute data and centroid point position.
Type_of_Source_Media: Published Document / Electronic Spreadsheet
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: March 2003
Source_Currentness_Reference: publication date
Source_Citation_Abbreviation: Coastal Wetland Atlas
Source_Contribution:
A summary of information for known Ontario Great Lake's coastal wetlands. This publication includes wetland centroid XY positions and identifies data gaps in all existing data sources. It provides a thorough background assessment to build the digital Coastal Wetland Inventory.
Source_Information:
Source_Citation:
Citation_Information:
Originator: Ministry of Natural Resources
Publication_Date: April 2003
Title: Evaluated Wetlands (Wetland Unit)
Geospatial_Data_Presentation_Form: vector digital data
Other_Citation_Details:
Evaluated Wetlands (boundaries and attributes) are designated through the Ontario Wetland Evaluation System (3rd ed. OMNR March 1993.). Data represents a time frame from October 1997 to December 1999 and coverage was obtained in three sections: northwest,northeast and south central Ontario.

More information can be found in the report: "NRVIS, Technical Reference Guide for End Users", OMNR. April 2000.

Online_Linkage:
http:www.lio.mnr.gov.on.ca/lioweb/land_info/warehouse-overview.asp
Source_Scale_Denominator: 10000
Type_of_Source_Media: e00 file, digital data
Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: October 7 1997
Ending_Date: December 14 1999
Source_Currentness_Reference: publication date
Source_Citation_Abbreviation: Evaluated Wetlands
Source_Contribution:
The OMNR Evaluated Wetland Polygon Data was the foundation data for this dataset. Coastal wetland coverage was extensive for the lower Great Lakes and variable for the upper Great Lakes. The most current version of this dataset was utilized in this project (June 2003)
Source_Information:
Source_Citation:
Citation_Information:
Originator: Ministry of Natural Resources

Publication_Date: November 1996
Title: Waterpolys (OBM Drainage)
Geospatial_Data_Presentation_Form: vector digital data
Other_Citation_Details:
This polygon coverage was digitized from the Ontario Base Mapping (OBM) program, as part of the 1:10 000 OBM drainage. The data was obtained in OMNR district specific coverages. It recognizes potential wetland and open water areas of drainage, and has detailed digitization of islands and shoreline.

More information can be found in the report: "NRVIS, Technical Reference Guide for End Users", OMNR. April 2000.

Online_Linkage:
<http://www.lio.mnr.gov.on.ca/spectrasites/internet/lio/media/documents/ODGDV3.pdf>
Source_Scale_Denominator: 10000
Type_of_Source_Media: e00, digital polygon data
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 1995
Source_Currentness_Reference: publication date
Source_Citation_Abbreviation: Waterpolys
Source_Contribution:
A secondary dataset. It assisted in the identification of potential wetland locations and their boundaries.
Source_Information:
Source_Citation:
Citation_Information:
Originator: Ministry of Natural Resources
Publication_Date: October 2000
Title: Spot Height
Geospatial_Data_Presentation_Form: vector digital data
Other_Citation_Details:
Land topography heights (z-values) digitized from 1:10 000 OBM map tiles. Obtained in OMNR district specific coverages

More information can be found in the report: "NRVIS, Technical Reference Guide for End Users", OMNR. April 2000.

Source_Scale_Denominator: 10000
Type_of_Source_Media: e00, digital point data
Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: January 1977
Ending_Date: January 1996
Source_Currentness_Reference: publication date
Source_Citation_Abbreviation: Spot Heights
Source_Contribution:
Spot height data was used to generate 1m contours. Both the contour lines and original spot height data were used as a general frame of reference for the high water boundary of each Great Lake basin. The historic high water levels, along with the hydrology of the system was used to separate coastal wetlands from non-coastal wetlands.
Source_Information:
Source_Citation:
Citation_Information:
Originator: Ministry of Natural Resources
Publication_Date: October 2000
Title: Road Segment

Geospatial_Data_Presentation_Form: vector digital data
Other_Citation_Details:
Digitized from the OBM mapping program and updated in localized areas with the FRI mapping program. Obtained in OMNR District specific coverages. It represents linear transport features and recognizes primary, secondary and tertiary roads. More information can be found in the report: "NRVIS, Technical Reference Guide for End Users", OMNR. April 2000.

More information can be found in the report: "NRVIS, Technical Reference Guide for End Users", OMNR. April 2000.

Source_Scale_Denominator: 10000
Type_of_Source_Media: e00,digital line data
Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: January 1977
Ending_Date: January 1996
Source_Currentness_Reference: publication date
Source_Citation_Abbreviation: Road Segment
Source_Contribution:
The permanent roads of this NRVIS layer was used as supplementary data in georeferencing of digital air photos.
Source_Information:
Source_Citation:
Citation_Information:
Originator: Ministry of Natural Resources
Publication_Date: October 2000
Title: Railway (OBM Transport Lines)
Geospatial_Data_Presentation_Form: vector digital data
Other_Citation_Details:
Data digitized as part of the OBM Base Mapping Program. Obtained as a seamless provincial coverage.

More information can be found in the report: "NRVIS, Technical Reference Guide for End Users", OMNR. April 2000.

Source_Scale_Denominator: 10000
Type_of_Source_Media: e00, digital line data
Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: January 1977
Ending_Date: January 1996
Source_Currentness_Reference: publication date
Source_Citation_Abbreviation: Railway
Source_Contribution: Supplementary data for georeferencing digital air photos.
Source_Information:
Source_Citation:
Citation_Information:
Publication_Date: October 2000
Title: Utility Line
Geospatial_Data_Presentation_Form: vector digital data
Other_Citation_Details:
Linear utility features digitized as part of the OBM Base Mapping Program. Obtained from OMNR as a seamless provincial coverage.

More information can be found in the report: "NRVIS, Technical Reference Guide for End Users", OMNR. April 2000.

Source_Scale_Denominator: 10000
Type_of_Source_Media: e00, digital line data
Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: January 1977
Ending_Date: January 1996
Source_Currentness_Reference: publication date
Source_Citation_Abbreviation: Utility Line
Source_Contribution: Supplementary data for georeferencing digital air photos.
Source_Information:
Source_Citation:
Citation_Information:
Originator: The Canadian Hydrographic Service, Central and Arctic Region
Publication_Date: December 2003
Title: Great Lakes Historic Water Levels
Geospatial_Data_Presentation_Form: tabular digital data
Other_Citation_Details:
Lake monthly mean water levels from 1918 to 2000. Data measured in meters and vertical datum referenced to IGLD 1985. Obtained online form the Canadian Hydrological Service, Central and Arctic Region.
Online_Linkage: <http://biachss.bur.dfo.ca/danp/historical_e.html>
Type_of_Source_Media: online, tabular data
Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: January 1918
Ending_Date: December 2003
Source_Currentness_Reference: publication date
Source_Citation_Abbreviation: Great Lakes Historic Water Levels
Source_Contribution:
Provided the reference high water level for each Great Lake's basin. A benchmark to separate coastal from non-coastal wetlands
Source_Information:
Source_Citation:
Citation_Information:
Originator: OMNR
Publication_Date: 1998/08/12
Title: Indian Remote Satellite Imagery 1
Geospatial_Data_Presentation_Form: remote-sensing image
Other_Citation_Details:
Images obtained as orthorectified 5-meter panchromatic in .tif and .twf format. Images were not contrast stretched.
Source_Scale_Denominator: 5-meter resolution
Type_of_Source_Media: Digital panchromatic image in .tif format
Source_Citation_Abbreviation: IRS_1
Source_Contribution:
Supplementary imagery for the large wetlands of St. Clair Marsh including the St. Clair River delta and Long Point Wetland. To assist in digitization and/or hydrogeomorphic classification of these wetlands.
Source_Information:
Source_Citation:
Citation_Information:
Originator: OMNR
Originator: Space Imaging LLC
Publication_Date: 1996/08/29

Title: Indian Remote Satellite Imagery 2
Geospatial_Data_Presentation_Form: remote-sensing image
Other_Citation_Details:
Image obtained as orthorectified 5-meter panchromatic in .tif and .twf format. Images were not contrast stretched.
Source_Scale_Denominator: 5-meter resolution
Type_of_Source_Media: Digital panchromatic image in .tif format
Source_Citation_Abbreviation: IRS_2
Source_Contribution:
Supplementary imagery for the large wetlands of St. Mary's River. To assist in digitization and/or hydrogeomorphic classification of these wetlands.
Source_Information:
Source_Citation:
Citation_Information:
Originator:
Adaptation and Impacts Research Group, Meteorological Service of Canada, Environment Canada
Title: Long Point
Geospatial_Data_Presentation_Form: vector digital data
Other_Citation_Details: Polygon coverage obtained in UTM,zone 17, NAD 83 format.
Source_Scale_Denominator: 1:10 000
Type_of_Source_Media: ArcInfo Coverage
Source_Citation_Abbreviation: Long_Point
Source_Contribution:
Provided the digital boundary for Long Point Wetland on Lake Erie.
Process_Step:
Process_Description:
The published document entitled "The Ontario Great Lakes Coastal Wetland Atlas: A summary of information (1983 - 1997) consolidated and evaluated all available coastal wetland data. It identifies a UTM zone specific centroid position for these wetlands. Supplementary digital spreadsheets of this data were available with the publication. The MS Excel zone specific spreadsheets are imported into ArcGIS 8.2. The 'display XY data' function in ArcMap was used for the import. This digital point data was saved as a zone specific shapefile. Each shapefile was reprojected into zone 18 and merged into one coverage using ArcMap's Geoprocessing Tool. The resultant dataset are starting point locations of known coastal wetlands of the Great Lakes.
Source_Used_Citation_Abbreviation: Coastal Wetland Atlas
Process_Date: April 2003
Source_Produced_Citation_Abbreviation: Coastal Wetland Atlas Centroids
Process_Step:
Process_Description:
To meet the criterion defining a coastal wetland, topography was used to determine the upper and lower extents of the coastal wetland boundary. Landscape contours can approximate the upper extent, where upland is separated from wetland, based on documented historical influence of the lake through fluctuating water levels. The maximum floodplain describes the level (in meters) to where water will rise as a result of a given rain or natural event. The Canadian Hydrological Service (CHS) has detailed records of the historical mean and maximum water levels for each basin from 1918 to 2003. All data in this range, was used to determine a lake specific, maximum floodplain. The CHS historic water levels reference the International Great Lakes Datum 85 (IGLD85) vertical datum. For compatibility with the OMNR spot height data, the historic high water level values were converted from IGLD 85 datum into CGD 28 datum using a lake specific conversion factor. The conversion factors can be obtained from CHS. The output is a maximum flood plain value for specific to each Great Lake. This was used in conjunction with known topographical spot heights of the basin to reference an upper extent of Great Lakes influence on coastal wetlands. The study area was limited to the upper extent of the Great Lakes flood plain. All wetlands beyond the maximum flood plain boundary were not included in the database unless they were determined continuous with wetland that lay within the lake influence boundary.
Source_Used_Citation_Abbreviation: Great Lakes Historic Water Levels

Source_Used_Citation_Abbreviation: Spot Height
Process_Date: April 2003
Source_Produced_Citation_Abbreviation: GL Flood Plain reference
Process_Step:
Process_Description:
OMNR Spot height data describes the topological heights (z value) of land at a scale of 1:10 000 and was used to create a 1m contour coverage. The spot height data is OMNR District specific, so to reduce processing time the data for each district was clipped using a 2km buffer of the Great Lakes shoreline. The clipped data was then merged together to create a seamless coverage. Both the 'clip based on another layer' and the 'merge' function are completed using the Geoprocessing Tool of ArcMap. Contours are created using the 'Surface Analysis' tool of the Spatial Analyst extension of ArcGIS 8.2. The previously calculated, basin specific flood plain values in CGD datum were used as reference values to query out the flood plain for each Great Lake basin, each saved to a shapefile The end result was five, basin-specific contour line shapefiles referencing each Great Lake flood plain level. Each provided a spatial reference of the upper limit of lake influence on surrounding wetlands.
Source_Used_Citation_Abbreviation: Spot Heights
Process_Date: June 2003
Source_Produced_Citation_Abbreviation: GL Contours
Source_Produced_Citation_Abbreviation: GL Flood Plains
Process_Step:
Process_Description:
Create a new project workspace. Import into workspace all spatial data sources from which the final product will derive information from. Ensure all data was in compatible spatial reference. Reproject as necessary (Reprojection Tool in ArcToolbox). Overlay all data sources in a new GIS project. Create new empty Coastal Wetland Inventory coverage in NAD 83, UTM Zone 18. This is to be the final product when complete. Define attributes in polygon attribute table.
Source_Used_Citation_Abbreviation: GL Flood Plains
Source_Used_Citation_Abbreviation: Spot Heights
Source_Used_Citation_Abbreviation: Evaluated Polygons
Source_Used_Citation_Abbreviation: Waterpolys
Source_Used_Citation_Abbreviation: Great Lakes Shoreline
Source_Used_Citation_Abbreviation: Coastal Wetland Centroids
Source_Used_Citation_Abbreviation: Peat
Source_Used_Citation_Abbreviation: Geology
Process_Date: June 2003
Source_Produced_Citation_Abbreviation: Coastal Wetland Inventory
Process_Step:
Process_Description:
All coastal wetlands will be delineated and classified by CWS staff through air photo interpretation, using the final Consortium classification system agreed to at the experts workshop. Where available, wetland evaluation polygon data will be used to identify wetland boundaries and generate coastal wetland area estimates. For wetlands that do not have suitable digital polygon data, the wetland boundary and corresponding area will be defined using standardized air photo interpretation techniques (Owens and Hop 1995) and delineated using the on-screen digitizing capabilities of ArcMap. See "Digitizing and Data Registration Standards for the Great Lakes Coastal Wetland Inventory" in the Logical_Consistancy_Report of this metadata for georeferencing and digitization standards.
Source_Used_Citation_Abbreviation: Aerial Photos
Source_Used_Citation_Abbreviation: Aerial Photos 1
Process_Date: June - Dec 2003
Process_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Krista Holmes
Contact_Organization: Canadian Wildlife Service, Ontario Region. Environment Canada
Contact_Position: Wildlife Conservation Biologist

Contact_Voice_Telephone: (416) 739-5971
Contact_Facsimile_Telephone: (416) 730-5845
Contact_Electronic_Mail_Address: krista.holmes@ec.gc.ca
Hours_of_Service: 8:30am to 4:30pm, Mon - Fri
Process_Step:
Process_Description:
Select all OMNR Evaluated Wetland Polygons where a Coastal Wetland Atlas Centroid has been identified. Add to this selection all Evaluated Wetland polygons that lie within a 2 km distance of the Great Lakes Shoreline. Use Load Objects function of ArcGIS 8.2 to transfer spatial and attribute data of the Evaluated Wetland Polygons into the new empty Coastal Wetland Inventory polygon coverage. Every wetland extent will be confirmed, updated, added or deleted as necessary for coastal designation. This designation was provided by an expert in the field, supplemented through air photo interpretation.
Source_Used_Citation_Abbreviation: Coastal Wetland Atlas
Source_Used_Citation_Abbreviation: Evaluated Wetlands
Source_Used_Citation_Abbreviation: Photo Interpretation
Process_Date: June 2003
Process_Step:
Process_Description:
The OMNR Waterpoly layer depicts polygon extents where wetlands have been designated on 1:10 000 OBM Map sheets. It provides a spatial boundary for unevaluated wetlands and will fill some data gaps in the Evaluated Wetland polygon data. Perform a spatial query to select all OMNR Waterpoly polygons where a Coastal Wetland Atlas Centroid has been identified. Use Load Objects function of ArcGIS 8.2 to transfer spatial and attribute data into the Coastal Wetland Inventory polygon coverage. Perform a spatial query to select all OMNR Waterpoly polygons that lie within a 2 km distance of the Great Lakes Shoreline. Reselect this selection for polygons greater than 2 hectares (20 000m3) to satisfy the minimum mapping unit for this project. Use Load Objects function of ArcGIS 8.2 to transfer spatial and attribute data of the Evaluated Wetland Polygons into the Coastal Wetland Inventory polygon coverage. All unevaluated wetlands added to the final dataset were verified through air photo interpretation. If photo coverage was not available for the wetland, the polygon was not included in the dataset.
Source_Used_Citation_Abbreviation: Waterpolys
Source_Used_Citation_Abbreviation: Evaluated Wetlands
Source_Used_Citation_Abbreviation: Coastal Wetland Atlas
Process_Date: June - Dec 2003
Process_Step:
Process_Description:
Where digital wetland polygon data does not exist, air photos provide a template to delineate and digitize a wetland boundary. The photo(s) of the wetland are scanned into digital image format and georeferenced to NRVIS data in ArcGIS 8.2. (as outlined in the Digitizing and Data Registration Standards).The photos are brought into the GIS in .tif format and registered to OMNR permanent feature data e.g. roads, using the georeferencing toolbar in ArcMap. This tool provides coordinate information to the photo so that it is rotated and registered to a real-world position. It also provides RMS accuracy information. The RMS must be less than 0.5 to meet the project's Digitizing and Data Registration Standards. All RMS error text files were saved with the photo's georeferencing information. The corresponding georeferenced image provides a digital tablet from which to create a wetland boundary polygon. This was completed through on-screen digitizing along side the use of a stereoscope to confirm land features, in accordance with standardized air photo interpretation techniques(Owens and Hop,1995). For complete digitizing and data registering standards, please see Logical_Consistancy_Report of the Coastal Wetland Inventory metadata. The criteria standards are consistent with the protocol utilized by the OMNR in the creation of the evaluated wetland polygons, and assisted the maintenance of data integrity though the developing coastal wetland dataset. For more detailed information on NRVIS spatial accuracy please see the NRVIS Guide for End Users
Source_Used_Citation_Abbreviation: Coastal Wetland Inventory
Source_Used_Citation_Abbreviation: Photo Interpretation
Source_Used_Citation_Abbreviation: Aerial Photos1
Source_Used_Citation_Abbreviation: Aerial Photos2

Source_Used_Citation_Abbreviation: Road Segment
Source_Used_Citation_Abbreviation: Railway
Source_Used_Citation_Abbreviation: Utility Line
Process_Date: June - Dec 2003
Process_Step:
Process_Description:
Every coastal wetland in the databaset is hydrogeomophically typed as per the Great Lakes Wetland Hydrogeomorphic Classification Schema (See "Completness_Report" of this metadata). The designation will be made by an expert in the field, supplemented through air photo interpretation. Each coastal wetland was verified and where needed, complexes split into hydrogeomorphic individuals. Wetlands were renamed where needed to reflect hydrogeomorphic designation. In the case of complexes, the wetland name remains the same but now includes a number (in west to east sequence) to reflect the hydrogeomorphic entity. In the final dataset, each wetland extent reflects its connection to the lake and is classified accordingly.
Source_Used_Citation_Abbreviation: Aerial Photos1
Source_Used_Citation_Abbreviation: Aerial Photos2
Source_Used_Citation_Abbreviation: Photo Interpretation
Source_Used_Citation_Abbreviation: Coastal Wetland Inventory
Process_Date: June - Dec 2003
Process_Step:
Process_Description:
Modifiers are noted as a presence/absence (yes or no, Boolean attribute) in the polygon attribute table upon air photo interpretation of the wetlands. The list of modifiers includes 8 scenarios: dykes, dams, road construction, dredging, jetty, filled, waste and/or sewage and marina
Source_Used_Citation_Abbreviation: Aerial Photos1
Source_Used_Citation_Abbreviation: Aerial Photos2
Source_Used_Citation_Abbreviation: Air Photo interpretation
Source_Used_Citation_Abbreviation: Coastal Wetland Inventory
Process_Date: June - Dec 2003
Process_Contact:
Contact_Information:
Contact_Person_Primary:
Process_Step:
Process_Description:
The completed coverage was edited in ArcEdit, a component of ArcInfo Workstation 8.2. It was corrected for arc, node and label errors and was given clean polygon topology using the 'clean' function. It was exported into interchange file format (.e00).
Source_Used_Citation_Abbreviation: Coastal Wetland Inventory
Process_Date: December 2003
Process_Step:
Process_Description:
Wetland area was generated automatically upon topography creation. This area was converted into hectares.
Source_Used_Citation_Abbreviation: Coastal Wetland Inventory
Process_Date: Dec 2003
Process_Step:
Process_Description: Metadata was created.
Source_Used_Citation_Abbreviation: Coastal Wetland Inventory
Process_Date: January 2004
Process_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Krista Holmes
Contact_Organization: Canadian Wildlife Service, Ontario Region
Contact_Position: Wildlife Conservation Biologist

Contact_Address:
Address_Type: mailing and physical address
Address: Environment Canada
Address: ECB/CSD/CWS, Ontario Region
Address: 4905 Dufferin Street
City: Downsview
State_or_Province: Ontario
Postal_Code: M3H 5T4
Country: Canada
Contact_Voice_Telephone: (416) 739-5971
Contact_Facsimile_Telephone: (416) 739-5845
Contact_Electronic_Mail_Address: krista.holmes@ec.gc.ca
Hours_of_Service: 8:00am to 4:30pm, Mon. to Fri.
Contact_Instructions: call, email or write.
Process_Step:
Process_Description: Metadata imported.
Source_Used_Citation_Abbreviation: C:\DOCUME~1\kristah\LOCALS~1\Temp\xml28.tmp
Process_Step:
Process_Description: Metadata imported.
Source_Used_Citation_Abbreviation: C:\DOCUME~1\kristah\LOCALS~1\Temp\xml34.tmp
Process_Step:
Process_Description: Metadata imported.
Source_Used_Citation_Abbreviation: C:\DOCUME~1\kristah\LOCALS~1\Temp\xml3B.tmp
Cloud_Cover: variable

Spatial_Data_Organization_Information:
Indirect_Spatial_Reference: Georeferenced Aerial Photography
Direct_Spatial_Reference_Method: Vector
Point_and_Vector_Object_Information:
SDTS_Terms_Description:
SDTS_Point_and_Vector_Object_Type: Complete chain
Point_and_Vector_Object_Count: 34222
SDTS_Terms_Description:
SDTS_Point_and_Vector_Object_Type: Label point
Point_and_Vector_Object_Count: 16105
SDTS_Terms_Description:
SDTS_Point_and_Vector_Object_Type: GT-polygon composed of chains
Point_and_Vector_Object_Count: 16105
SDTS_Terms_Description:
SDTS_Point_and_Vector_Object_Type: Point
Point_and_Vector_Object_Count: 4

Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:
Planar:
Grid_Coordinate_System:
Grid_Coordinate_System_Name: Universal Transverse Mercator
Universal_Transverse_Mercator:
UTM_Zone_Number: 18
Transverse_Mercator:
Scale_Factor_at_Central_Meridian: 0.999600
Longitude_of_Central_Meridian: -75.000000
Latitude_of_Projection_Origin: 0.000000
False_Easting: 500000.000000
False_Northing: 0.000000

Planar_Coordinate_Information:
Planar_Coordinate_Encoding_Method: coordinate pair
Coordinate_Representation:
Abscissa_Resolution: 0.005998
Ordinate_Resolution: 0.005998
Planar_Distance_Units: meters
Geodetic_Model:
Horizontal_Datum_Name: North American Datum of 1983
Ellipsoid_Name: Geodetic Reference System 80
Semi-major_Axis: 6378137.000000
Denominator_of_Flattening_Ratio: 298.257222

Entity_and_Attribute_Information:
Detailed_Description:
Entity_Type:
Entity_Type_Label: cwa_glcwc_can.pat
Entity_Type_Definition:
"Wetlands are defined as lands that are seasonally or permanently flooded by shallow water as well as lands where the water table is close to the surface; in either case the presence of abundant water has caused the formation of hydric soils and has favoured the dominance of either hydrophytic or water tolerant plants". In addition to the Southern Ontario Wetland Evaluation definition of wetland, this inventory further restricts inclusion to coastal wetlands, those wetlands that are hydrologically connected to the lake by overland flow and that are at least partially situated below the historic high lake level.
Entity_Type_Definition_Source:
Ontario Wetland Evaluation System, Southern Manual. 3rd Edition. Ontario Ministry of Natural Resources. March 1993, Revised May 1994.
Attribute:
Attribute_Label: FID
Attribute_Definition: Internal feature number.
Attribute_Definition_Source: ESRI
Attribute_Domain_Values:
Unrepresentable_Domain:
Sequential unique whole numbers that are automatically generated.
Attribute:
Attribute_Label: Shape
Attribute_Definition: Feature geometry.
Attribute_Definition_Source: ESRI
Attribute_Domain_Values:
Codeset_Domain:
Unrepresentable_Domain: Coordinates defining the features.
Attribute:
Attribute_Label: AREA
Attribute_Definition: Area of feature in internal units squared.
Attribute_Definition_Source: ESRI
Attribute_Domain_Values:
Unrepresentable_Domain: Positive real numbers that are automatically generated.
Attribute:
Attribute_Label: PERIMETER
Attribute_Definition: Perimeter of feature in internal units.
Attribute_Definition_Source: ESRI
Attribute_Domain_Values:
Unrepresentable_Domain: Positive real numbers that are automatically generated.
Attribute:
Attribute_Label: CWA_GLCWC_CAN#
Attribute_Definition: Internal feature number.

Attribute_Definition_Source: ESRI
Attribute_Domain_Values:
Unrepresentable_Domain:
Sequential unique whole numbers that are automatically generated.
Attribute:
Attribute_Label: CWA_GLCWC_CAN-ID
Attribute_Definition: User-defined feature number.
Attribute_Definition_Source: ESRI
Attribute_Domain_Values:
Attribute:
Attribute_Label: WETLAND_NA
Attribute_Definition:
The wetland name is as defined by "The Ontario Great Lakes Coastal Wetland Atlas: A summary of Information (1983-1997)" March 2003, where available. This is, in most cases, the same name as recorded in the OMNR Evaluated Wetlands. The Evaluated Wetland polygon name was used for wetlands the Atlas did not identify. Any unidentified wetlands will be named by the OMNR Evaluated Wetland polygon layer if it exists, or else by a locational reference e.g. Brown's Bay Wetland. In the case of a complexed wetland, each isolated wetland will be given the name of the complex and numbered consecutively east to west. See Attribute_Accuracy_Report of this metadata for further details.
Attribute_Definition_Source: User Defined
Attribute_Domain_Values:
Range_Domain:
Attribute_Units_of_Measure: Hectares
Attribute:
Attribute_Label: HYDROGEOMO
Attribute_Definition:
Primary hydrogeomorphic classification (BL = barrier protected lagoon, BLS = Successional Barrier Beach Lagoon, BLT = Barrier Beach Tombolo, BWI = Barrier Protected, Sand-Spit Swales, BWR = Barrier Protected, Ridge and Swale Complex, LOE = Lacustrine, Open Embayment, LOS = Lacustrine, Open Shoreline, LPS = Lacustrine, Sand-Spit Protected Embayment, LPP = Lacustrine, Protected Embayment, RCD= Riverine Channel, Delta, RCOE = Riverine Channel, Open Embayment, LCOS = Riverine Channel, Open Shoreline, RCPE = Riverine Channel, Protected Embayment, RCRB = Riverine Channel, Barred, Drowned River-Mouth, RCRO = Riverine Channel, Open, Drowned River-Mouth, RCSS = Riverine Channel, Sand-Spit Protected Embayment, RD = Riverine, Delta, RDB = Riverine, Barred, Drowned River-Mouth, RDO = Riverine, Open, Drowned River-Mouth)
Attribute_Definition_Source:
D. A. Albert, J. Ingram, T. Thompson, D. Wilcox, on behalf of the Great Lakes Coastal Wetland Consortium (GLCWC). Great Lakes Coastal Wetlands Classification (Revision Schema (July 2003; original November 2001))
Attribute:
Attribute_Label: HYDROGEO_1
Attribute_Definition:
Secondary hydrogeomorphic classification, used where multiple hydrogeomorphic types drive the wetland system. (BL = barrier protected lagoon, BLS = Successional Barrier Beach Lagoon, BLT = Barrier Beach Tombolo, BWI = Barrier Protected, Sand-Spit Swales, BWR = Barrier Protected, Ridge and Swale Complex, LOE = Lacustrine, Open Embayment, LOS = Lacustrine, Open Shoreline, LPS = Lacustrine, Sand-Spit Protected Embayment, LPP = Lacustrine, Protected Embayment, RCD= Riverine Channel, Delta, RCOE = Riverine Channel, Open Embayment, LCOS = Riverine Channel, Open Shoreline, RCPE = Riverine Channel, Protected Embayment, RCRB = Riverine Channel, Barred, Drowned River-Mouth, RCRO = Riverine Channel, Open, Drowned River-Mouth, RCSS = Riverine Channel, Sand-Spit Protected Embayment, RD = Riverine, Delta, RDB = Riverine, Barred, Drowned River-Mouth, RDO = Riverine, Open, Drowned River-Mouth)
Attribute_Definition_Source:

D. A. Albert, J. Ingram, T. Thompson, D. Wilcox, on behalf of the Great Lakes Coastal Wetland Consortium (GLCWC). Great Lakes Coastal Wetlands Classification (Revision Schema (July 2003; original November 2001))
Attribute:
Attribute_Label: DYKES
Attribute_Definition:
An anthropogenic modifier currently impacting the system. Simple recognition of its existance as Yes (Y), No (N) or Null ( )
Attribute_Definition_Source: User-defined
Attribute:
Attribute_Label: DAMS
Attribute_Definition:
An anthropogenic modifier currently impacting the system. Simple recognition of its existance as Yes (Y), No (N) or Null ( )
Attribute_Definition_Source: User-defined
Attribute:
Attribute_Label: ROAD_CONST
Attribute_Definition:
An anthropogenic modifier currently impacting the system. Simple recognition of its existance as Yes (Y), No (N) or Null ( )
Attribute_Definition_Source: User-defined
Attribute:
Attribute_Label: DREDGING
Attribute_Definition:
An anthropogenic modifier currently impacting the system. Simple recognition of its existance as Yes (Y), No (N) or Null ( )
Attribute_Definition_Source: User-defined
Attribute:
Attribute_Label: JETTY
Attribute_Definition:
An anthropogenic modifier currently impacting the system. Simple recognition of its existance as Yes (Y), No (N) or Null ( )
Attribute_Definition_Source: User-defined
Attribute:
Attribute_Label: WASTE_SEWA
Attribute_Definition:
An anthropogenic modifier currently impacting the system. Simple recognition of its existance as Yes (Y), No (N) or Null ( )
Attribute_Definition_Source: User-defined
Attribute:
Attribute_Label: DITCH_CONS
Attribute_Definition:
An anthropogenic modifier currently impacting the system. Simple recognition of its existance as Yes (Y), No (N) or Null ( )
Attribute_Definition_Source: User-defined
Attribute:
Attribute_Label: MARINA
Attribute_Definition:
An anthropogenic modifier currently impacting the system. Simple recognition of its existance as Yes (Y), No (N) or Null ( )
Attribute_Definition_Source: User-defined
Attribute:
Attribute_Label: FILLED
Attribute_Definition:

An anthropogenic modifier currently impacting the system. Simple recognition of its existance as Yes (Y), No (N) or Null ( )
Attribute_Definition_Source: User-defines
Attribute_Domain_Values:
Enumerated_Domain:
Enumerated_Domain_Value: None
Attribute:
Attribute_Label: LK_BASIN
Attribute_Definition:
The Great Lake basin or Great Lake channel basin to which the wetland resides (SLR = St. Lawrence River, LKO = Lake Ontario, LKE = Lake Erie, NR = Niagara River, DR = Detroit River, LSC = Lake St. Clair, SCR = St. Clair River, LKH = Lake Huron, SMR = St. Mary's River, LKS = Lake Superior)
Attribute_Definition_Source: User Defined
Attribute:
Attribute_Label: COMMENTS
Attribute_Definition:
Further description of the wetland not incorporated into other attributes.
Attribute_Definition_Source: User Defined
Attribute:
Attribute_Label: X_CENTROID
Attribute_Definition: UTM easting coordinate of the wetland polygon's centroid
Attribute_Definition_Source: Computed
Attribute:
Attribute_Label: Y_CENTROID
Attribute_Definition: UTM northing coordinate of the wetland polygon's centroid
Attribute_Definition_Source: Computed
Attribute:
Attribute_Label: HECTARES
Attribute_Definition: Area of the wetland polygon in hectares
Attribute_Definition_Source: Computed

Distribution_Information:
Distributor:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: Canadian Wildlife Service
Contact_Person: Joel Ingram
Contact_Position: Wetlands Monitoring Biologist
Contact_Address:
Address_Type: mailing and physical address
Address: CWS/CSD/ECB, Environment Canada
Address: 4905 Dufferin Street
City: Downsview
State_or_Province: Ontario
Postal_Code: M3H 5T4
Country: Canada
Contact_Voice_Telephone: (416) 739-5843
Contact_Electronic_Mail_Address: joel.ingram@ec.gc.ca
Hours_of_Service: 8:00am to 4:30pm EST, Mon to Fri
Contact_Instructions: Call, email or write
Resource_Description:
Digital database containing spatial and descriptive information for all of the coastal wetlands of the Great Lakes and its connecting channels, for the Canadian side. Data set is to be merged with data created by US partners for a complete bi-national Coastal Wetland inventory for the Great Lakes. Descriptive information includes, hydrogeomorphologic classification of the wetland, wetland name, centroid

position and area in hectares. Also included are identified hydrological modifiers currently imposing on the system.
Distribution_Liability:
Although these data have been processed successfully on a computer system at the Canadian Wildlife Service of Environment Canada, they are provided "as is" and no warranty, expressed or implied, is made regarding the accuracy or utility of the data on any other system or for general or scientific purposes, nor shall the act of distribution constitute any such warranty. This disclaimer applies both to individual use of the data and aggregate use with other data. It is strongly recommended that these data are directly acquired from the Canadian Wildlife Service and not indirectly through other sources which may have changed the data in some way. It is also strongly recommended that careful attention be paid to the contents of the metadata file associated with these data. Environment Canada shall not be held liable for improper or incorrect use of these data described and/or contained here in. Mention of trade names or manufacturers does not imply Canadian endorsement of commercial products.
Standard_Order_Process:
Digital_Form:
Digital_Transfer_Information:
Transfer_Size: 32.756
Fees: None
Ordering_Instructions: Contact Joel Ingram

Metadata_Reference_Information:
Metadata_Date: 20040205
Metadata_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Krista Holmes
Contact_Organization: Canadian Wildlife Service
Contact_Position: Wildlife Conservation Biologist
Contact_Address:
Address_Type: mailing and physical address
Address: ECB/EC
Address: 4905 Dufferin Street
City: Downsview
State_or_Province: Ontario
Postal_Code: M3H 5T4
Country: Canada
Contact_Voice_Telephone: (416) 739 - 5971
Contact_Facsimile_Telephone: (416) 739-5845
Contact_Electronic_Mail_Address: krista.holmes@ec.gc.ca
Hours_of_Service: 8:00am to 4:30pm EST, Mon to Fri
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: FGDC-STD-001-1998
Metadata_Time_Convention: local time
Metadata_Extensions:
Online_Linkage: <http://www.esri.com/metadata/esriprof80.html>
Profile_Name: ESRI Metadata Profile
Metadata_Extensions:
Online_Linkage: <http://www.esri.com/metadata/esriprof80.html>
Profile_Name: ESRI Metadata Profile

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APPENDIX II

AREA	PERIMETER	CWA_GLCWC_	CWA_GLCWC1	WETLAND_NA	HYDROGEOMO	HYDROGEO_1	DYKES	DAMS	ROAD_CONST	DREDGING	JETTY	WASTE_SEWA	DITCH_CONS	MARINA	FILLED	LK_BASIN	COMMENTS	X_CENTROID	Y_CENTROID	HECTARE
129955.84938400000	3951.52285937000	5426	2967	Hibou Conservation Area Wetlands 2	BL				Y							LKH		467.56791480000	4956513.54719000000	12.995584984
4734.94156906000	298.64087337700	5427	2968	Hibou Conservation Area Wetlands 2	BL				Y							LKH		218.98064550000	4956670.63987000000	0.473494159
9747.71259472000	568.84809691600	5434	2972	Hibou Conservation Area Wetlands 2	BL				Y							LKH		903.33525700000	4956438.09078000000	0.974771254
352548.45461300000	5034.87176875000	6355	6578	Hill Island East	RCPE				Y							SLR		4542.49558500000	4912682.18445000000	35.254845413
1233.13740344000	147.56152222900	6356	6579	Hill Island East	RCPE				Y							SLR		4018.63963700000	4913046.23400000000	0.123313743
17041.55880870000	1618.86490356000	6357	6580	Hill Island East	RCPE				Y							SLR		4992.79182000000	4912657.45061000000	1.704155886
34120.23701790000	1748.20448328000	6359	6582	Hill Island East	RCPE				Y							SLR		4560.52522300000	4912850.78646000000	3.412023707
3112.46680249000	233.25517658200	6362	6585	Hill Island East	RCPE				Y							SLR		4512.36954000000	4912805.23546000000	0.311246682
651.45646148900	96.65109889100	6363	6586	Hill Island East	RCPE				Y							SLR		4616.61258300000	4912786.95669000000	0.065145641
1262.12745714000	192.29084379500	6367	6590	Hill Island East	RCPE				Y							SLR		4643.66281700000	4912692.17313000000	0.126212747
195533.62937600000	5021.77079020000	6369	6592	Hill Island East	RCPE				Y							SLR		4203.39187900000	4912321.63347000000	19.553362976
3304.13243902000	227.38487254800	6370	6593	Hill Island East	RCPE				Y							SLR		4197.64089400000	4912608.70877000000	0.330413249
4602.53928542000	259.31610347900	6372	6595	Hill Island East	RCPE				Y							SLR		4560.19720900000	4912586.56402000000	0.460253925
605.36387832500	95.62923526190	6374	6597	Hill Island East	RCPE				Y							SLR		4343.63415100000	4912541.33866000000	0.060536386
7237.41147426000	307.64752567400	6377	6600	Hill Island East	RCPE				Y							SLR		4638.32045700000	4912484.25197000000	0.723741144
2133.20473531000	175.41235157100	6384	6607	Hill Island East	RCPE				Y							SLR		4345.42709000000	4912382.93525000000	0.213320475
6677.58406654000	514.00527212700	6387	6610	Hill Island East	RCPE				Y							SLR		4284.50219200000	4912315.19407000000	0.667758406
6172.69326197000	366.59294364200	6388	6611	Hill Island East	RCPE				Y							SLR		4147.25079700000	4912307.86531000000	0.617269322
3045.92396991000	280.89585257400	6394	6617	Hill Island East	RCPE				Y							SLR		3936.60049600000	4912249.29020000000	0.304592399
1893.96015706000	251.59735189400	6401	6624	Hill Island East	RCPE				Y							SLR		3897.77607000000	4912188.07837000000	0.189396017
19941.40759370000	940.79283593500	6402	6625	Hill Island East	RCPE				Y							SLR		4293.37826300000	4912091.68417000000	1.994140753
16328.07552410000	710.70648349100	6413	6090	Hill Island East	RCPE				Y							SLR		4008.30672500000	4912096.53118000000	1.632807554
1787.16573860000	259.18222139400	6425	6648	Hill Island East	RCPE				Y							SLR		4297.24390300000	4911969.98182000000	0.178716578
1605.56840926000	164.34536555500	6463	6686	Hill Island West	RCPE				Y	Y						SLR		2414.76749900000	4911186.25556000000	0.160556849
15522.27321380000	654.61906362400	6466	6689	Hill Island West	RCPE				Y	Y						SLR		2369.56382800000	4911100.54307000000	1.552227323
357.45499604900	104.34536661600	6467	6690	Hill Island West	RCPE				Y	Y						SLR		2343.22299800000	4911165.08025000000	0.035745496
1538.71248430000	174.49111773600	6471	6694	Hill Island West	RCPE				Y	Y						SLR		2293.11922900000	4911101.11117000000	0.153871244
9922.54842705000	663.00595273700	6476	6637	Hill Island West	RCPE				Y	Y						SLR		2344.40709500000	4910909.24279000000	0.992254847
1399.13347047000	209.46327798200	6477	6638	Hill Island West	RCPE				Y	Y						SLR		2237.05260100000	4911040.42623000000	0.139913340
3062.89360362000	211.10103141400	6478	6639	Hill Island West	RCPE				Y	Y						SLR		2336.36433200000	4911033.72441000000	0.306289363
5663.94104993000	371.17459763300	6480	6695	Hill Island West	RCPE				Y	Y						SLR		2296.23876000000	4911004.47794000000	0.566394109
705.74842368100	120.29350745600	6481	6696	Hill Island West	RCPE				Y	Y						SLR		2062.27317400000	4911026.91536000000	0.070574843
6616.71001005000	468.47073571000	6483	6698	Hill Island West	RCPE				Y	Y						SLR		2001.18121800000	4910977.38859000000	0.661671000
20836.84633370000	654.88808760800	6485	6700	Hill Island West	RCPE				Y	Y						SLR		2218.76472600000	4910939.37713000000	2.083684633
289.12663251200	97.67161240830	6487	6703	Hill Island West	RCPE				Y	Y						SLR		1700.67578800000	4910980.42271000000	0.028912662
109489.96231200000	3371.65476823000	6489	6705	Hill Island West	RCPE				Y	Y						SLR		2188.13344400000	4910761.84324000000	10.948996212
27573.35344760000	827.99961130700	6495	6711	Hill Island West	RCPE				Y	Y						SLR		2488.97090100000	4910784.98317000000	2.757335347
1688.27267146000	209.66315543600	6499	6715	Hill Island West	RCPE				Y	Y						SLR		2385.46264600	4910818.031	0.168827266

Example of the Coastal Wetland Inventory Polygon Attribute Table

APPENDIX II

Great Lakes Coastal Wetlands Classification

First Revision (July 2003; original November 2001)

By D. A. Albert, J. Ingram, T. Thompson, D. Wilcox, on behalf of the Great Lakes Coastal Wetland Consortium (GLCWC)

Great Lakes coastal wetlands can be separated into three specific systems based on their dominant hydrologic source and current hydrologic connectivity to the lake. These systems are different than those defined by the National Wetlands Inventory (NWI) (Santos and Gauster 1993). NWI defines three *systems*, Lacustrine, Riverine, and Palustrine. All of these NWI systems can have *classes (Aquatic bed* or *Emergent)* that are included within our wetland classification, but many of the classes are not wetland classes but hydrologic or substrate classes, such as *rock bottom, unconsolidated bottom, unconsolidated shore,* or *open water.*

Each wetland polygon mapped for the GLCWC will be given a four character code. The first character (---) will for the *hydrologic system*. The second character (---) will be for the *geomorphic* type. The third and fourth characters (----) are further *geomorphic modifiers*.

Lacustrine (L---) system wetlands are controlled directly by waters of the Great Lakes and are strongly affected by lake-level fluctuations, nearshore currents, seiches and ice scour. Geomorphic features along the shoreline provide varying degrees of protection from coastal processes. Lacustrine, as defined by NWI, would also include dammed river channels and topographic depressions not related to Great Lakes. NWI does not consider wetlands with trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% cover; in contrast we consider these vegetation cover classes to be included within our lacustrine wetlands, focusing our classification on the lacustrine formation process. NWI only considers wetlands larger than 8 hectares (20 acres), while we include smaller wetlands. NWI will include wetlands smaller than 8 hectares if a) a wave formed or bedrock features forms part or all of the shoreline or has a low water depth greater than 2 meters in the deepest part of the basin.

Riverine (R---) system wetlands occur in rivers and creeks that flow into or between the Great Lakes. The water quality, flow rate and sediment input are controlled in large part by their individual drainages. However, water levels and fluvial processes in these wetlands are influenced by coastal processes because lake waters flood back into the lower portions of the drainage system. Protection from wave attack is provided in the river channels by bars and channel morphology. Riverine wetlands within the Great Lakes also include those wetlands found along large connecting channels between the Great Lakes with very different dynamics than smaller tributary rivers and streams. NWI excludes palustrine wetlands, which they define as dominated by trees, shrubs, persistent emergents, and emergent mosses or lichens, from riverine systems. In contrast, we include all of these types of vegetation within our riverine system.

Barrier-Protected (B---) system wetlands have originated from either coastal or fluvial processes. However, due to coastal processes the wetlands have become separated from the Great Lakes by a barrier beach or other barrier feature. These wetlands are protected from wave action but may be connected directly to the lake by a channel crossing the barrier. When connected to the lake, water levels in these wetlands are determined by lake levels, but during seiche related water-level fluctuations, wetland water levels are tempered by the rate of flow through the inlet. During isolation from the lake, groundwater and surface drainage to the basin of the individual wetland provides the dominant source of water input, although lake level may influence groundwater flow and, hence, wetland water levels. Inlets to protected wetlands may be permanent or ephemeral. Nearshore processes can close off the inlet from the lake. The ability of the nearshore processes

to close the inlet is related to the rate of sediment supply to the shoreline, grain size and sorting of sediment, type and duration of nearshore processes, lake level elevation and rate of change, and discharge rate of water exiting the inlet. The greater part of most of these wetlands would be classified by NWI as palustrine system, with small water bodies or streams within the wetland possible being classified as inclusions of either lacustrine or riverine system.

Within these hydrologically based systems, Great Lakes coastal wetlands can be further classified based on their geomorphic features and shoreline processes.

1) Lacustrine System (L---)
{tc \l4 "1) Lacustrine System**}**
Open Lacustrine (LO--)
{tc \l5 "Open Lacustrine **}**These lake-based wetlands are directly exposed to nearshore processes with little or no physical protection by geomorphic features. This exposure results in little accumulation of sediment vegetation development to relatively narrow nearshore bands. Exposure to nearshore processes results in little to no organic sediment accumulation, and variable bathymetry, ranging from relatively steep profiles to more shallow sloping beaches.

Open Shoreline. (LOS-) Typically characterized an erosion-resistant substrate of either rock or clay, with occasional patches of mobile substrate. The resultant expanse of shallow water serves to dampen waves which may result in sand bar development at some sites. There is almost no organic sediment accumulation in this type of environment. Vegetation development is limited to narrow fringes of emergent vegetation extending offshore to the limits imposed by wave climate. Some smaller embayments also fit into this class due to exposure to prevailing winds; most of these have relatively narrow vegetation zones of 100 meters or less. Examples include Epoufette Bay and xxx in the Bay of Quinte on Lake Ontario. Mapping of *open shoreline* wetlands will be restricted to those that were identified by either Herdendorf et al. (1981a-f) or NWI. Many *open shorelines* do not have large enough areas of aquatic plants to be identified from aerial photography.

Open Embayment. (LOE-) This can occur on gravel, sand, and clay (fine) substrate. The embayments are often quite large – large enough to be subject to storm-generated waves and surges and to have established nearshore circulation systems. Most bays greater than three or four kilometers in diameter fit into this class. These embayments typically support wetlands 100 to 500 meters wide over wide expanses of shoreline. Most of these wetlands accumulate only narrow organic sediments near their shoreline edge. Saginaw Bay, St. Martin Bay, Little Bay de Noc, Green Bay, and Black River Bay all fit in this category.

Protected Lacustrine (LP--)
{tc \l5 "Protected Lacustrine**}**This wetland type is also a lake-based system, however it is characterized by increased protection by bay or sand-spit formation. Subsequently, this protection results in increased sediment accumulation, shallower off-shore profiles and more extensive vegetation development than this type's open lacustrine counterpart. Organic sediment development is also more pronounced.

Protected Embayment. (LPP-*)* Many stretches of bedrock or till-derived shorelines form small protected bays, typically less than three or four kilometers in width . These bays can be completely vegetated with emergent or submergent vegetation. At the margins of the wetlands there is typically 50 to 100 cm of organic accumulation beneath wet meadow vegetation. Examples include Duck Bay and Mackinac Bay in the Les Cheneaux Islands on Lake Huron, Matchedash Bay on Lake Huron, and Bayfield Bay on Wolfe Island in Lake Ontario.

Sand-Spit Embayment. (LPS-) Sand spits projecting along the coast create and protect shallow embayments on their landward side. Spits often occur along gently sloping and curving sections of shoreline where there is a positive supply of sediment and sand transport is not impeded by natural of man-made barriers. These wetlands are typically quite shallow. Moderate levels of organic soils are typical, similar to those found in other protected embayments. Examples include Pinconning Marsh on Saginaw Bay, Dead Horse Bay on Green Bay, and Long Point on Lake Erie.

2) Riverine System (R---)

Drowned River-Mouth (RD--)
The water chemistry of these wetlands can be affected by both the Great Lakes and river water, depending on Great Lakes water levels, season, and amount of precipitation. These wetlands typically have deep organic soils that have accumulated due to deposition of watershed-based silt loads and protection from coastal processes (waves, currents, seiche, etc.). The terms “estuarine” or “fresh-water estuarine” have been used by some researchers (Herdendorf et al. 1981a) as alternatives to *drowned river-mouth*.

Open, Drowned River-Mouth. (RDO-) Some drowned river-mouths don’t have barriers at their mouth, nor do they have a lagoon or small lake present where they meet the shore. The wetlands along these streams occur along the river banks and their plant communities are growing on deep organic soils. Examples include the West Twin River on the Wisconsin shore of Lake Michigan, the Kakagon River on the Wisconsin shore of Lake Superior, and the Greater Cataraqui River on the Ontario shore of Lake Ontario.

Barred, Drowned River-Mouth. (RDB-) Most streams that are considered drowned river-mouths actually have a barrier that constricts the stream flow as it enters the lake. Very often, a lagoon forms behind the barrier. However unlike barrier beach wetlands, these wetlands maintain a relatively constant connection to the lakes. These lagoons seldom support large wetlands (possibly as the result of earlier destruction of the wetland by human management). The vegetation is concentrated where the stream enters the lagoon (if present), but can extend several kilometers upstream, typically forming a fringe of emergent and submergent vegetation along the edges of the channel. Organic deposits are often greater than two meters thick. Examples include the Betsie, Pentwater and Manistee Rivers in Lake Michigan, and Duffins Creek in Lake Ontario.

Connecting Channel (RC--)
{*tc \l2 "*Connecting Channel ***}***This wetland type includes the large connecting rivers between the Great Lakes; the St. Marys, St. Clair, Detroit, Niagara, and St. Lawrence Rivers. These wetlands are distinctive from the other large river wetlands (drowned river mouth) by their general lack of deep organic soils and their often strong currents. The St. Marys and St. Lawrence contain some of the most extensive fringing shoreline and tributary drowned river mouth wetlands in the Great Lakes, while those along the Detroit and Niagara have been largely eliminated or degraded. The Detroit River still has major beds of submergent aquatic plants, as does shallow Lake St. Clair. Connecting channels contain several types of wetlands, each with their own code. These include open shoreline (Connecting Channel, open shoreline (RCOS)), open embayment (Connecting Channel, open embayment (RCOE)), protected embayment (Connecting Channel, protected embayment (RCPE)), sand-spit embayment (Connecting Channel, sand-spit embayment (RCSS)), open drowned river mouth (Connecting Channel, open drowned river mouth (RCRO)), barred drowned river mouth (Connecting Channel, barred drowned river mouth (RCRB)), and deltaic (Connecting Channel, delta (RCDE)), which will be noted as subtypes in the attribute tables of wetlands.
{tc \l2 "This wetland type includes the large connecting rivers between the Great Lakes; the St. Marys, St. Clair, Detroit, Niagara, and St. Lawrence Rivers. These wetlands are distinctive from the other large river wetlands (drowned river mouth) by their general lack of deep organic soils and their often strong currents. The

St. Marys and St. Lawrence contain some of the most extensive fringing shoreline and tributary drowned river mouth wetlands in the Great Lakes, while those along the Detroit and Niagara have been largely eliminated or degraded. The Detroit River still has major beds of submergent aquatic plants, as does shallow Lake St. Clair.
}
Delta (RD--)
{tc \l5 "Delta**}**Deltas formed of alluvial materials, both fine and coarse, support extensive wetlands that extend out into the Great Lake or connecting river. These are extensive wetlands, typically with 30 to 100 cm of organic soils associated with their wet meadow zone, and often with deep organics occupying abandoned distributary channels and interdistributary bays. Two examples are the St. Clair River and Munuscong River (bordering the St. Marys River) deltas.

3) Barrier-Enclosed (B---)
{tc \l5 "3) Barrier-Protected **}**
Barrier Beach Lagoon (BL--)
{tc \l5 "Barrier Beach Lagoon**}**These wetlands form behind a sand barrier. Because of the barrier, there is reduced mixing of Great Lakes waters and the exclusion of coastal processes within the wetlands. Multiple lagoons can form and water discharge from upland areas and incoming drainages may also contribute significantly to the water supply. These wetlands are common at the east end of Lake Ontario and also on the Bayfield Peninsula in western Lake Superior. Thick organic soils characterize these wetlands in Lake Superior and in many, but not all, of the Lake Ontario wetlands. Examples of barrier beach lagoon wetlands include Second Marsh, North Sandy Pond, and Round Pond of Lake Ontario and Bark Bay, Siskiwit Bay and Allouez Bay of Lake Superior. In addition to barrier beach lagoons, *tombolo* are present in selected areas of the Great Lakes. These are defined as islands attached to the mainland by barrier beaches, some of which consist of one or two lagoons with deep organic soils. This feature may also be classified in the swale complex category depending upon the dominant geomorphological features. Small barrier beach lagoons often are completely dominated by vegetation, with no open water remaining; such completely vegetated barrier beach lagoons will be called Successional Barrier Beach Lagoons and will be coded BLS-.

Swale Complexes (BS--)
{tc \l5 "Swale Complexes**}**There are two primary types of swale complex wetlands – those that occur between recurved fingers of sand spits and those that occur between relict beach ridges. These are known respectively as *sand-spit swales* (BWI-) and *ridge and swale complexes* (BWR-) (also referred to as dune and swale and strandplain). The former are common within some of the larger sand spits of the Great Lakes, primarily Presque Isle and Long Point on Lake Erie and Whitefish Point on Lake Superior. Numerous small swales are separated from the Great Lakes, often becoming shrub swamps with shallow organic soils. Within these sand-spit formations, there are often embayments which remain attached to the Great Lakes, thus maintaining their herbaceous flora.

Ridge and swale complexes are composed of a series of barrier beaches separated by narrow swales. These systems commonly occur in embayment where there is a high supply of sediment are form in response to quasi-periodic fluctuations in lake level. For many of these complexes, only the first couple of swales are in direct hydrologic connection to the lake, but in some, like Pte. Aux Chenes along northern Lake Michigan, the connection continues for hundreds of meters. Organic soil depths are quite variable, as is the vegetation, which ranges from herbaceous to swamp forest. Another example is the Ipperwash Inter-dunal Wetlands Complex on Southern Lake Huron, Ontario.

A rare, third type of swale complex may include *tombolo*. While some are classified as barrier beach features (BLT-), others consist more dominantly of a series of beach ridges (BWR-) with small swales and shallow organic soils, and could thus be classified as a ridge and swale complex.

System Modifiers of Naturally Occurring Great Lakes Wetlands

The hydrology and/or geomorphology of all Great Lakes coastal wetlands have been impacted by human activities within the Great Lakes basin. These impacts are through whole lake regulation, watershed alteration or activities within the wetland itself (i.e. diking, dredging and in-filling). Direct modification of the hydrological connection with the lake results in different hydrologic and wetland community responses to Great Lake events (e.g. high/low water level) than would be observed/expected by wetlands in the same classification. Identification of human modifiers in naturally occurring coastal wetlands is important to understanding coastal processes and response to change and thus should be noted when classification is undertaken. System modifiers will not be coded, but will be listed in an attribute table.

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