State of the Lakes Ecosystem Conference 1996

Background Paper

INFORMATION AND INFORMATION MANAGEMENT

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Notice To Readers

This Background Paper is one of a series of such papers that were prepared to provide a concise overview of the status of the nearshore conditions in the Great Lakes. The information they present has been selected as representative of the much greater volume of data. They therefore do not present all research or monitoring information available. The Papers were prepared with input from many individuals representing diverse sectors of society.

The Papers provided the basis for discussions at SOLEC 96. Participants were encouraged to provide specific information and references for use in preparing the final post-conference versions of the Papers. Together with the information provided by SOLEC discussants, the Papers have been incorporated into the 1997 State of the Great Lakes report, which provides key information required by managers to make better environmental decisions.

Acknowledgments

The authors would like to thank the contributing authors and reviewers for their input and guidance. They would also like to thank all those who took the time to complete and return the nearshore questionnaire. Special thanks goes to Simone Rose of Environment Canada for her efforts in compiling Appendix 4 and for her overall assistance with the report.

1.0 Introduction

The focus for the State of the Lakes Ecosystem Conference (SOLEC) 1996 is the nearshore zone of the Great Lakes. Nearshore ecosystems are complex and dynamic with many measurable parameters. The nearshore area is extremely important to overall ecosystem function. It is the most productive zone within each of the Great Lakes and is the area most affected by human activity. Nearshore zones include embayments, tributaries and tributary mouths, marshes and other wetlands, and dunes. Their size and ever-changing nature create a challenge for their study and understanding. Yet timely access to accurate environmental information is critical for making wise decisions to ensure nearshore ecosystem protection and management, and the promotion of environmental stewardship.

To make informed decisions about the Great Lakes nearshore, we must have ready access to reliable data/information that can be compared and shared effectively among partners and decision makers. From a technological perspective, an ecosystem approach requires an electronically based, integrated data-management system that enables interaction among disciplines and across geographic boundaries. The new environmental information-management systems allow this through improvements in data management, storage, and networking capabilities, together with new data-transfer, processing, and visualization tools.

1.1 Objectives

The objectives of the paper are the following:

- To provide an overview of nearshore information holdings and information systems, with a summary of information sources and content.
- To identify gaps and needs in nearshore information on the basis of a set of proposed indicators to measure and monitor the state of the nearshore.
- To examine how nearshore information is currently being managed.
- To examine the issues facing the management of nearshore information.
- To identify possible improvements in managing the information.

1.2 Scope

The scope of this paper includes both U.S. and Canadian Great Lakes nearshore information and data holdings from federal, state, and provincial agencies; non-government organizations; and academia.

1.3 Contributing Authors

Contributing authors to this paper represent federal, state, and provincial agencies and academia from around the Great Lakes basin. All contributing authors have some involvement with data or data management. For a complete list of contributing authors refer to Appendix 1.

2.0 Nearshore Information Definitions and Collection Methods

2.1 Definitions

2.1.1 Definition of Nearshore

SOLEC ’96 focuses specifically on the nearshore of the Great Lakes. The nearshore includes both the nearshore waters and the terrestrial zone along the shoreline. The nearshore waters begin at the shoreline or the lakeward edge of the coastal wetlands and extend offshore to the deepest lake-bed depth contour where the thermocline typically intersects with the lake bed in the late summer or early fall (Edsall and Charlton 1996). The nearshore terrestrial zone or “land by the lakes” (Reid and Holland 1996) is defined by the Lakes themselves. The physical changes wrought by the edge of the lakes and the local climatic effects of large water bodies exert huge influences on shoreline habitats. Land-by-the-lakes ecosystems may be as narrow as a beach that is weathered by wind and waves or they may extend several kilometres inland as part of contiguous forests or dune fields (Reid and Holland 1996). The nearshore zone, for the purposes of SOLEC ’96, also includes wetlands that are affected by variations in lake levels, and looks at how changing land use impacts on this zone.

2.1.2 Defining Nearshore Information

Data can be defined as the raw facts collected on a particular subject after some basic quality-controls have been applied to the collection process. In this case, the subject is the nearshore of the Great Lakes. Once data have been analysed, interpreted, and synthesized, they become information. For the purposes of this report, little to no distinction is made between data and information (although an emphasis has been placed on nearshore-related electronic databases). In this report, nearshore information relates to four topic areas: nearshore waters, nearshore terrestrial or “land by the lakes,” impacts of changing land use, and coastal wetlands. It also includes some information on a few data sets that do not fit neatly into any of these categories, for example, climate data.

The topic of nearshore waters includes information on fish and other aquatic species and their habitat, water quality, nearshore sediments, physical processes, and spills in the water. The topic of nearshore land includes information on nearshore topography, flooding and erosion, wildlife and wildlife habitat, and soils.

2.2 Methods of Determining the State of Nearshore Information

2.2.1 The Survey

A primary source of information for this paper was a questionnaire sent to a range of agencies and institutions around the basin on both sides of the border. Over 700 questionnaires were sent to Canadian federal, provincial, regional governments; non-government agencies; and academia. A total of 95 responses were received. Approximately 300 questionnaires were sent out to similar U.S. agencies, and 65 were completed and returned. In addition, the questionnaire was posted on the Internet and made available through Environment Canada's Great Lakes Information Management home page, U.S. (Environmental Protection Agency's) (EPA's) Web pages, and the Great Lakes Information Network (GLIN). The questionnaire, which was kept relatively short in the hope that this would generate a greater response rate, asked organizations to identify their nearshore databases and information holdings, and describe the purpose and content of the database. It also asked respondents to identify their nearshore information needs. Although the response rate appears low, this is misleading since many of the questionnaires were sent to individuals at the same agency and only one questionnaire was returned on behalf of that agency.

A copy of the questionnaire can be found in Appendix 2**.**

2.2.2 Literature Search

Other sources of information for this report were existing catalogues and directories of information holdings. Catalogues listing Great Lakes databases were the primary source of information. These are listed in Appendix 3. A full search of the Internet was also conducted using keywords such as Great Lakes, nearshore, coastal zone, coastline, shoreline.

3.0 State of Nearshore Information Holdings

There are numerous databases and information holdings pertaining to some portion of the nearshore environment. The purpose of this section is not to describe them all, but rather to touch on a few of the larger, more encompassing databases that deal with a significant portion of the Great Lakes nearshore. A detailed list of data and information holdings gathered for this report is provided in Appendix 4.

3.1 Nearshore Waters

3.1.1A Fish and Fish Habitat: Canadian Holdings

Nearshore Fish and Fish Habitat Database, Canadian Department of Fisheries and Oceans: The purpose of this database is to develop a knowledge of fish communities in the Great Lakes nearshore zone and to develop predictive models of fish attributes using habitat variables. The database includes information on exposed shorelines of Lake Erie and Lake Ontario and on the Bay of Quinte, Hamilton Harbour, and Severn Sound. (Survey Results 1996) [ID # 9, App. 4]

Ontario Fisheries Information System (FISHLIB), Ontario Ministry of Natural Resources: Information was obtained from aquatic habitat inventory surveys, commercial harvest reporting, commercial deck and port sampling, creel surveys, sport fishing diaries, sport fish sampling, index fishing surveys, fish stocking, observations of significant events, observation of critical habitats, habitat rehabilitation, harvest controls, and water body synopses. (Ontario Ministry of Natural Resources, 1996) [ID # 120, App. 4]

3.1.1B Fish and Fish Habitat: U.S. Holdings

Bad River, Lake Superior, and Lake Sturgeon Database, U.S. Fish and Wildlife Service: Ashland (Wisconsin) Fishery Resources Office maintains this database. Assessment information includes the distribution and movement, length, weight, girth, and habitat of juvenile lake sturgeon. Data from 1993 through 1995. [ID # 106, App. 4]

Eurasian Ruffe Surveillance Database, U.S. Fish and Wildlife Service: Ashland (Wisconsin) Fishery Resources Office maintains a program to detect the presence of ruffe and this database to monitor the presence or absence of ruffe, relative abundance of cohabiting fish species, length and age of ruffe, and length of subsample of other fish species. Geographic areas covered include South Shore of Lake Superior; Thunder Bay, Lake Superior; shipping harbours in Lake Huron and Lake Michigan; tributaries and harbours on the south shore of Lake Erie, and one in Lake Ontario. Annual Reports, 1992–1995, available for all five Great Lakes. [ID # 105, App. 4]
Great Lakes Commercial Fishing Database, National Biological Service (NBS), Great Lakes

Science Center, the National Marine Fisheries Service, and the Great Lakes states: This is a database of U.S. commercial fishing data for the Great Lakes. Daily catch records are prepared by states of Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania, and New York. [ID # 38, App. 4]

Great Lakes Research Vessel Catch System (RVCAT) Database, NBS, Great Lakes Science Center: This database contains a log of vessel activities during routine assessments on the waters of the five Great Lakes. The purpose of the database is to provide information on research and monitoring of fish population dynamics and to supply information to managers and scientists. [ID # 37, App. 4]

Chemical Contaminants Database, NBS, Great Lakes Science Center: This database contains information about fish tissue of four species archived in a deep freeze since 1970. The purpose of the database is to monitor the trends of contaminants in Great Lakes fish. [ID # 36, App. 4]

Lake Huron/Thunder Bay and Lake Erie/Crane Creek Fishery Database: The U.S. Fish and Wildlife Service's Aliena Fishery Resources Office maintains this database for the purpose of compiling Lake Huron and Lake Erie fish community data, other biota, and abiotic information. [ID # 104, App. 4]

Lake Michigan Creel Survey Database, Indiana Department of Natural Resources, Division of Fish and Wildlife: Lake Michigan Research database for developing harvest estimates for trout, salmon, bass, yellow perch, and other species; determining angler species preferences; determining length and age of fish harvested; and finding the occurrence of fin clips on salmonids. [ID # 26, App. 4]

Nearshore Fish Community in Indiana Waters of Southern Lake Michigan Database: Ball State University maintains this database to monitor trends in abundance and growth of nearshore fishes. This information has been collected from 1977 to the present. [ID # 1, App. 4]

Lake Erie Fishery Database, National Biological Service: Lake Erie Biological Station maintains a database on Lake Erie fish and other aquatic biota. [ID # 39, App. 4]

3.1.2A Other Aquatic Species: Canadian Holdings

Benthic Evaluation and Assessment of Sediment (BEAST), Environment Canada, National Water Research Institute: This database contains information on benthic invertebrate community structure (species level), sediment toxicity in the form of invertebrate species, and sediment geochemistry for the entire Canadian nearshore waters of the Great Lakes and Lake Michigan. (S Survey Results 1996) [ID # 30, App. 4]

3.1.2B Other Aquatic Species: U.S. Holdings

Long-Term Trends in Benthic Populations: The National Oceanic and Atmospheric Administration's Great Lakes Environmental Research Laboratory is determining trends in benthic populations in selected areas of the Great Lakes and the significance of and reasons for such trends. [ID # 48, App. 4]

Distribution of Zooplankton in Eastern Lake Michigan, Michigan Department of Natural Resources: The purpose of this database is to determine the abundance, taxonomy, and distribution of zooplankton in the nearshore waters of eastern Lake Michigan. [ID # 31, App. 4]

Biocriteria development to assess fish, macroinvertebrates, and periphyton communities in Lake Erie estuaries, harbors, and nearshore areas, Ohio Environmental Protection Agency: Existing environmental evaluation tools have been used to establish aquatic life and habitat goals for the areas under study, and to provide a base against which to measure the progress and effectiveness of Remedial Action Plans and Lakewide Management Plans for Lake Erie. [ID # 54, App. 4]

3.1.3A Water Quality: Canadian Holdings

Numerous water-quality studies have been conducted on the Great Lakes over the years, primarily to assess the problem of contaminants found in the Lakes. For Lake Ontario, data sources and descriptions are referenced in the "Lake Ontario Categorization Committee Report," 1993. Contaminant monitoring information includes open water and nearshore monitoring studies and point and non-point source studies of contaminants released to the Lakes. Ambient water column and fish tissue data are a primary source for water-quality data. Fish tissue data include sport fish and forage fish species such as young-of-the-year spottail shiners. Ambient data for sediments are also a source for water-quality data (Lake Ontario Categorization Committee 1993). Also included are data on drinking water and beach closures as indicators of water quality.

Great Lakes Water Quality STAR Database (Storage and Retrieval), Environment Canada: This database characterizes water quality in the Great Lakes. Information is collected to discover nutrients and contaminants in each Great Lake. Regular spring (isothermal) and summer (stratified) sampling cruises have been conducted since 1971 for nutrients, and since 1986 for contaminant data. (Survey Results 1996) [ID # 13, App. 4]

Great Lakes Contaminants Surveillance Program, Department of Fisheries and Oceans**,** Great Lakes Laboratory for Fisheries and Aquatic Sciences: This database contains information on contaminants in Great Lakes sport fish. (Ball 1995) [ID # 10, App. 4]

Juvenile Fish Biomonitoring Program and Database, Ontario Ministry of Environment and Energy: This program documents temporal and spatial trends in organochlorine contaminant levels in the nearshore waters of the Great Lakes from 1975 to 1994. (Suns, Hitchin, and Toner

1991) [ID # 100, App. 4]

Drinking Water Surveillance Program, Ontario Ministry of Environment and Energy: This program monitors drinking water quality of over 130 municipal drinking water systems in Ontario. Raw, treated, and distributed water-quality data are available. Approximately 200 parameters are analysed, including microbiological parameters, general and organic chemicals, metals, radionuclides, chemical dosage, flow ratios, field parameters, pH, turbidity, and plant processes. (Lake Ontario Categorization Committee 1993) [ID # 109, App. 4]

In-Place Pollutant Program, Ontario Ministry of Environment and Energy: The program assesses the extent and severity of sediment contamination through chemical analysis of the sediment and biota resident in the sediment. The parameters monitored are metals, PCBs and organochlorine pesticides, PAHs, and chlorophenols. (Jaagumagi and Persaud 1992) [ID # 116, App. 4]

Evaluation of Water, Sediment, and Benthic Invertebrates from Long-Term Sensing Sites, Ontario Ministry of Environment and Energy: An objective of the study was to monitor the spatial and temporal changes in environmental quality at nearshore locations in Lake Ontario. The report documents information on water, sediment, and benthos. The water samples were monitored for conventional water-quality parameters and trace metals. Surficial sediment was analysed for metals, PAHs, and organochlorine compounds. (Tarandus Associates Ltd. 1992) [ID # 94, App. 4]

Upstream/Downstream Water Quality Monitoring Program, Environment Canada, United States Environmental Protection Agency, New York State Department of Environmental Conservation, and the Ontario Ministry of Environment and Energy: This database involves the collection of ambient water and suspended sediment samples at the head (Fort Erie) and mouth (Niagara-on-the-Lake) of the Niagara River. (Niagara River Data Interpretation Group 1989) [ID # 50, App. 4]

Provincial Water Quality Monitoring Network, Ontario Ministry of Environment and Energy (OMOEE): The purpose of the database is to determine water-quality trends in Ontario, to ensure that provincial water-quality objectives are met for various uses, and to collect data for specific OMOEE programs and studies. Water-quality sample analysis typically includes routine water-chemistry results, such as nutrients, heavy metals, physical/chemical parameters, microbiology, and some toxic organics. (Ontario Ministry of Environment and Energy 1996a) [ID # 107, App. 4]

Great Lakes Datastore, Sample Information System, Ontario Ministry of Environment and Energy, Environmental Information and Systems Section: The purpose of the datastore is to store sample results from Ministry monitoring activities in the Great Lakes and connecting channels.

This database provides information on water, sediment, and biota. (Ontario Ministry of Environment and Energy 1996a) [ID # 97, App. 4]

Municipal Industrial Strategy for Abatement (MISA), Sample Result Datastore (SRDS) and Sample Result Datastore Oracle, Ontario Ministry of Environment and Energy: This program was established to reduce flow of toxic chemicals to Ontario receiving waters. Database includes industrial descriptor information, monthly summary effluent data from direct discharges, and data submitted from control orders and Certificates of Approval. (Ontario Ministry of Environment and Energy 1996a) [ID # 101, App. 4]

Bacterial Levels in Recreational Water, Health Canada, Great Lakes Health Effects Program: Existing bacterial levels have been gathered (*E. Coli* in Ontario) from public health units for public beaches bordering the Great Lakes. Bacterial levels data have been supplemented by a "beach postings" database produced annually by OMOEE and by information from each Health Unit. (Survey Results 1996) [ID # 62, App. 4]

3.1.3B Water Quality: U.S. Holdings

Wisconsin Groundwater Contamination Susceptibility Model/Database, Wisconsin Department of Natural Resources: The susceptibility of the state's groundwater to contamination from surface activities was estimated by overlaying those physical resource layers of importance in controlling water movement from the surface to the water table. Layers included in the model were soil characteristics, surficial deposits, bedrock type, depth to bedrock, and depth to water table. [ID # 117, App. 4]

Great Lakes ENVIROFACTS Database, EPA: This database contains relevant extracts about the Great Lakes from several EPA databases and serves as a prototype for EPA's ENVIROFACTS database. The individual databases contained in ENVIROFACTS are EPA's facility-oriented Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS), Toxic Release Inventory (TRI) system, Facility Index System (FINDS), and PCS databases, and the monitoring database, Resource Conservation and Recovery Information System (RCRIS). An interface to the nationwide ENVIROFACTS is currently under development. [ID # 75, App. 4]

Lake Michigan Mass Balance Database, EPA, Great Lakes National Program Office: This database will include project description, station descriptions, sample collection, sample analysis, results, and data quality information focusing on four major parameters: mercury, PCBs, atrazine, and trans-nanachlor. Samples were collected from the following media: air (ambient, dry deposit, precipitation), tributary mouths, open lake water, open lake sediment, and biota (predator fish, prey fish, and invertebrates). [ID # 95, App. 4]

Green Bay Mass Balance Database, EPA, Great Lakes National Program Office: This database

provides access to the results of the Green Bay Mass Balance Project, which focuses on four chemical groups: PCBs, cadmium, lead, and dieldrin. Media sampled include tributaries, point sources, atmosphere, non-point sources, sediment, water, food web, and groundwater. [ID # 94, App. 4]

Rouge River Program Office Sampling Data/Geographic Information System (GIS) Coverages: This database was developed by the Wayne County Rouge Program Office to support watershed management activities including modelling and non-point source studies. [ID # 112, App. 4]

SARA Title III–Emergency Planning and Community Right-to-Know Database: The Michigan Department of Environmental Quality SARA Title III Program Office maintains this database to help comply with the Emergency Planning and Community Right-to-Know Act of 1986. [ID # 28, App. 4]

U.S. Great Lakes Beach Closings Database, U.S. Environmental Protection Agency, Great Lakes National Program Office: Great Lakes bathing beaches in the U.S. are monitored to determine their environmental suitability for use by the public. The database is based on responses to the Survey of Great Lakes Bathing Beaches (1981 - 1994), conducted annually by the U.S. EPA's Great Lakes National Program Office. [ID # 97, App. 4 - U.S.]

3.1.4A Hydrology: Canadian Holdings

Surface Water Data for Ontario (HYDAT), Environment Canada: The database contains water-quality and sediment data, descriptive information, and geographical coordinates for all sites, period of operation for each site, and the type of hydrometric data collected. Data maintained in the system include daily and/or instantaneous information with respect to streamflow, water levels, suspended sediment concentration, sediment particle size, and sediment loads. (Environment Canada 1996a) [ID # 17, App. 4]

Catalogue of Historical Storm Surges on the Great Lakes, Ontario Ministry of Natural Resources: A study of Great Lakes storm surges was undertaken in 1988 to characterize the synoptic condition (principally wind) associated with historical extreme storm surges and to give some quantitative estimates of the probability of occurrences of these events. (Ontario Ministry of Natural Resources 1996) [ID # 117, App. 4]

3.1.4B Hydrology: U.S. Holdings

Great Lakes Hydrology and Ice Databases: This National Oceanic and Atmospheric Administration's Great Lakes Environmental Research Laboratory project develops and provides new or improved historical hydrometeorological and ice cover databases. This contributes to the

development of a GIS database of daily meteorological data for the United States, as well as some data for Canada. [ID # 46, App. 4]

Wisconsin Watersheds Database: The Wisconsin Department of Natural Resources (DNR) Statewide Watershed Boundary Geographic Data Layer was developed cooperatively by the WiDNR Bureau of Water Resources Management (WRM) and the WiDNR Geographic Services Section. [ID # 123, App. 4]

Natural Resources Conservation Service Mapping and Digitizing Watershed and Subwatershed Hydrologic Unit Boundaries: This service collects information and databases to use for management of renewable resources such as water, wildlife, and timber, and management of recreational facilities. [ID # 50, App. 4]

Great Lakes Water Levels: The U.S. Army Corps of Engineers, Detroit Districts Great Lakes Hydraulics and Hydrology Branch, in cooperation with its Canadian counterpart, provides coordinated forecasts of Great Lakes water levels for periods up to six months. To produce these forecasts, the branch maintains a database of real-time water level data from reporting gages owned and operated by the branch, the National Oceanic and Atmospheric Administration's (NOAA's) National Ocean Service (NOS), and the Canadian Hydrographic Service (CHS). [ID # 58, App. 4]

Wisconsin Hydrography GIS Database: The hydrography GIS data layer includes representations of surface water at scales of 1:100,000 and 1:24,000. The data custodian is the WiDNR Bureau of Water Resources Management. [ID # 122, App. 4]

Great Lakes Nearshore Hydrodynamics Database, National Oceanic and Atmospheric Administration, Great Lakes Environmental Research Laboratory: This database synthesizes the results of research studies on coastal hydrodynamics, biological processes, and water chemistry of the nearshore region and applies them to practical problems of coastal environmental management and planning. [ID # 47, App. 4]

3.1.5A Nearshore Sediments: Canadian Holdings

Great Lakes Sediment Database, Environment Canada, National Water Research Institute: The purpose of the database is to research nearshore erosion, sedimentation, and sediment budgets. This database includes information on Lakes Ontario and Erie, and parts of Lake Huron and

Georgian Bay. The database includes the nearshore bottom stratigraphy, grain size, and offshore bathymetry. (Survey Results 1996) [ID # 49, App. 4]

3.1.5B Nearshore Sediments: U.S. Holdings

U.S. Army Corps of Engineers (COE) Great Lakes Harbor and Lake Sediment Quality Database: The U.S. Army COE, Environmental Analysis and Engineering Branch, Environmental Analysis Section, developed this database to ascertain lake and harbour sediment quality for dredging, and open lake and confined disposal. [ID # 59, App. 4]

HazDat, the Agency for Toxic Substances and Disease Registry's Hazardous Substance Release/Health Effects Database, EPA**:** This database was developed to provide access to information on the release of hazardous substances from Superfund sites or from emergency events and on the effects of hazardous substances on the health of human populations. HazDat also contains data from the U.S. EPA's CERCLIS database. [ID # 76, App. 4]

Assessment and Remediation of Contaminated Sediments Program: This is an EPA/Great Lakes National Program Office five-year study and demonstration project relating to the appropriate treatment of toxic pollutants in bottom sediments. Five areas were specified in the Clean Water Act as requiring priority consideration in conducting demonstration projects: Saginaw Bay, Michigan; Sheboygan Harbor, Wisconsin; Grand Calumet River, Indiana; Ashtabula River, Ohio; and Buffalo River, New York. [ID # 90, App. 4]

Milwaukee Estuary Remedial Action Plan Sediment GIS Database, Center for the Great Lakes Studies/University of Wisconsin-Milwaukee, and the Wisconsin Department of Natural Resources: The purpose of the database is to assemble into a centralized database sediment contaminant information that supports sound decision-making regarding remediation or other treatment of contaminated sediments within the Milwaukee Estuary Area of Concern. [ID # 56, App. 4]

3.1.6A Spills: Canadian Holdings

Transport Canada Ship Source Pollution Incident Reporting System, Transport Canada, Marine Regulatory Directorate: The purpose of the database is to produce annual reports concerning ship source pollution incidents, to support prosecution of polluters, and to analyze causes of incidents. Data include the location, type of pollutant, quantity spilled, and action taken. The database covers all waters under Canadian jurisdiction. (Survey Results 1996) [ID # 143, App. 4]

3.1.6B Spills: Canadian and U.S. Holdings

Environmental Sensitivity Atlas and Associated Database, Environment Canada, U.S. Coast Guard, and the National Oceanic and Atmospheric Administration: This database includes shoreline habitat descriptions, biological and human-use resources, and standard base map

features at 1:50,000 scale. These atlases identify the sensitive areas along the coasts of the Great Lakes for use in hazardous material spill response. The atlases are designed for use in response to spills of hazardous materials by helping responders to identify which resources are at risk during a spill. (Snell et al. 1994) [ID # 43, App. 4 - Canadian, ID # 61, App. 4 - U.S.]

3.1.7A Nearshore Bathymetry: Canadian Holdings

Canadian Hydrographic Charts, Department of Fisheries and Oceans, Canadian Hydrographic Service: Nautical charts and related publications are supplied to users to ensure safe commercial and recreational shipping and boating. Hydrographic charts are available for all navigable waters within Canada's territorial limits (i.e., parts of the Atlantic, Pacific, and Arctic Oceans, the St. Lawrence River, the Great Lakes, and Hudson Bay). (Survey Results 1996) [ID # 7, App. 4]

3.1.7B Nearshore Bathymetry: U.S. Holdings

Computerized Bathymetry and Shorelines of the Great Lakes, National Oceanic and Atmospheric Administration, Great Lakes Environmental Research Laboratory: This database consists of bathymetric grid data and digitized shoreline data compiled for the five Great Lakes and Lake St. Clair. [ID # 45, App. 4]

3.2 Nearshore Terrestrial

3.2.1A Base Mapping/Topographic Data: Canadian Holdings

National Topographic Database (NTDB), Natural Resources Canada, Geomatics Canada: The database comprises digital vector data sets that extend over the Canadian land mass. The major topics covered are hydrography, road and transportation networks, infrastructures, vegetation, landforms, and relief. Each data set consists of one National Topographic System (NTS) unit at a scale of either 1:50,000 or 1:250,000. The NTDB provides a base of properly structured data (segmentation, mathematical closure, connection and sharing between entities) specifically designed and suited for GIS applications. (Natural Resources Canada 1996) [ID # 58, App. 4]

Digital Topographic Database (DTDB), Ontario Ministry of Natural Resources: This database includes a comprehensive information for the Ontario Basic Mapping (OBM) program. The contents include the geographic references of the topographic, cultural, and cadastral features of Ontario. These features include hydrography, vegetation, transportation, buildings, communication, parks, hypsography, Native reserves, and the township boundaries. (Survey Results 1996) [ID # 124, App. 4]

Great Lakes Remote Sensing Data, Provincial Remote Sensing Office: The office conducts technology and applications development projects, and mapping programs related to natural resource inventories in such fields as forestry, geology, agriculture, and land-use planning, through the analysis of airborne and spaceborne remote sensing. The office maintains a collection of LANDSAT satellite imagery for Ontario and a literature library, both of which may be used by the public. (Ontario 1996) [ID # 130, App. 4]

Coordinated Great Lakes Physical Data, Environment Canada, Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data: The committee published coordinated physical data of the Laurentian Great Lakes in its May 1977 report. The report describes the source material and methods used to measure water areas, land areas, volume, shoreline lengths, and general Great Lakes dimensions. (Environment Canada 1996a) [ID # 38, App. 4]

3.2.1B Base Mapping/Topographic Data: U.S. Holdings

Superfund National Priority List (NPL) Site Boundaries for the United States, U.S. Environmental Protection Agency, Office of Information Resources Management: This provides Geographical Information System applications with a valuable data layer for base mapping of NPL boundaries and environmental impact analysis. [ID # 99, App. 4]

USEPA Reach File Version 1.0 (RF1) for the Conterminous United States (CONUS), U.S. Environmental Protection Agency: This ARC/INFO coverage is intended for general water resources applications within the GIS user community. It was created to replace the earlier U.S. Geological Survey translations of Reach. Linking multiple databases to Reach can be accomplished by the Reach indexing process. [ID # 87, App. 4]

Level III Ecoregions of the Conterminous United States (USECO), U.S. Environmental Protection Agency: USECO provides polygon coverage of the Level III Ecoregions. Refinements of ecoregion and sub-region definitions and locating sets of reference sites were conducted in collaboration with the U.S. EPA's regional offices and the state resource management agencies. These are designed to serve as a spatial framework for environmental resource management. This coverage provides a valuable data layer for ARC/INFO polygon coverage in an Albers projection. [ID # 78, App. 4]

3.2.2A Flooding and Erosion: Canadian Holdings

Canadian Great Lakes Coastal Zone Database, Environment Canada: The purpose of the database is to view the Great Lakes environment in an integrative manner to identify and analyse those areas susceptible to fluctuating water levels, flooding, and erosion. The database is housed in a GIS and includes the Canadian shoreline, a land-use overlay, a bathymetry overlay, and the

100-year floodline/erosion hazard lines. (International Joint Commission 1989) [ID # 25, App. 4]

Canadian Great Lakes Shoreline Classification Database, Environment Canada: This database was used in assessing the impact that changes in lake level ranges would have on erosion at given locations. Each of 2,000 reaches is classified according to geomorphic type, proportion of shoreline that has been protected from flooding and/or erosion, and subaqueous/nearshore composition. (Note: This database has a complementary U.S. counterpart.) (Levels Reference Study Board 1993) [ID # 24, App. 4]

Canada/Ontario Flood Damage Reduction Program, Environment Canada and the Ontario Ministry of Natural Resources: The data set was developed to reduce flood damage and risk of loss of life along Ontario rivers and lakes by mapping flood-risk areas where development should be discouraged. Map attributes contain topographic map features that include contours, wooded areas, buildings, roads, wetland symbols, usual water extent of rivers, regulatory flood line, point elevations, and georeferences. (Environment Canada 1996a) [ID # 26, App. 4]

Canada/Ontario Great Lakes Erosion Monitoring Program Final Report, Government of Canada and Province of Ontario: The program monitored and assessed erosion on the Great Lakes Canadian shoreline from 1973 to 1980 at 162 sites, intended to represent the entire erodible shore from Port Severn on Georgian Bay to Kingston on Lake Ontario. (Boyd 1981) [ID # 141, App. 4]

Coastal Zone Atlas and Canada/Ontario Great Lakes Shore Damage Survey, Ontario Ministry of Natural Resources and Environment Canada: The nature and extent of damages during a period of high lake levels were surveyed, along with shoreline characteristics, and preliminary recommendations were made. These recommendations were aimed at more effective shoreline management. The results are presented graphically in this coastal zone atlas and discussed in detail in a technical report of the survey. (Boulden 1976) [ID # 28, App. 4]

Littoral Cell Definition and Sediment Budget for Ontario's Great Lakes: This study addresses the littoral cell definition (an area under the continuous influence of specific longshore currents) and sediment budget for Ontario's Great Lakes. Objectives of the study include defining the limits of littoral cells and estimating subcells (for all of Ontario's Great Lakes shorelines), estimating sediment budgets for the littoral cells, and identifying areas that warrant further detailed studies. (Ontario Ministry of Natural Resources 1996) [ID # 118, App. 4]

3.2.2B Flooding and Erosion: U.S. Holdings

Shore Protection Information: The U.S. Army COE Detroit District's "Low Cost Shore Protection: A Property Owner's Guide"; "Low Cost Shore Protection: A Guide for Local Government Officials," and "Low Cost Shore Protection: A Guide for Engineers and Contractors," include information pertinent to these groups, as well as lists of information sources and government agencies. These reports are the latest products of the U.S. Army COE's

long-term commitment to coastal planning and engineering. [ID # 57, App. 4]

Wisconsin Floodplain Zoning Database: The Wisconsin DNR Bureau of Water Regulation and Zoning is the custodian for the Floodplain Zoning geographic data layer. The Federal Emergency Management Agency (FEMA) produced the hard-copy Flood Insurance Report. The WiDNR Bureau of Water Regulation and Zoning is prepared to assist other Wisconsin counties in developing digital floodplain maps that more accurately match improved base and topographic mapping. [ID # 121, App. 4]

Lake Erie Shoreline Erosion Control Structures Database: The Ohio Department of Natural Resources, Division of Engineering developed this database to maintain records and track installation of erosion control structures along Lake Erie's shoreline. Database attributes include applicant's name and address; proposed type and material of structure; project location; U.S. Army COE permit number; and dates that application was received and permit granted. [ID # 52, App.4]

Annual Coastal Monitoring of Beach and Nearshore Changes at North Point Marina, Illinois Coast of Lake Michigan, Illinois Department of Conservation: The purpose of this database is to monitor beach and nearshore accretion and erosion near the newly constructed (1987) North Point Marina. This database will be used to assist in remedial action and mitigation of adverse impacts. [ID # 7, App. 4]

3.2.3A Wildlife and Wildlife Habitat: Canadian Holdings

Survey of Migrant Waterfowl on the Great Lakes, Environment Canada, Canadian Wildlife Science Division: Surveys are conducted to establish spatial and temporal distribution of use of the Great Lakes shoreline by migrating waterfowl. The database includes counts of waterfowl species, or species group, in standardized shoreline sectors from the Quebec border to Tobermory on Lake Huron. [ID # 20, App. 4]

Christmas Bird Count, National Audubon Society: Teams or "parties" of birdwatchers find, count, and report as many birds as possible within a 24 km (15 mile) diameter circle, of which an estimated 20–25 touch the Canadian Great Lakes shoreline. Each Christmas Bird Count is

organized locally, usually by the area naturalist club, and the data collected are sent to the National Audubon Society in the U.S. (Cadman 1995) [ID # 78, App. 4]

Atlas of Colonial Waterbirds Nesting on the Canadian Great Lakes, Environment Canada, Canadian Wildlife Service: This five-part atlas includes information on cormorants, gulls, and island-nesting terns on Lake Superior, Lake Huron (1989), and the lower Great Lakes (1990) and on marsh nesting terns on Lake Huron and the lower Great Lakes (1991). It also includes data on

herons and egrets in the Great Lakes system from 1989 to 1991. (Blokpoel and Tessier 1993) [ID # 21, App. 4]

Atlas of Contaminants in Eggs of Fish-Eating Colonial Birds of the Great Lakes, Environment Canada, Canadian Wildlife Service: Each year, beginning in 1970, eggs were collected from fish-eating colonial waterbirds from 50 colonies throughout the Great Lakes to measure the levels of chlorinated hydrocarbons and lipid concentrations present in these eggs. The purpose of the study was to understand the temporal and spatial trends in environmental contaminant levels in biota of the Great Lakes. The atlas is organized in two parts: by contaminant and by locations. Summaries currently exist for the time periods of 1970-88 and 1989-92. (Bishop et al. 1992) [ID # 52, App. 4]

Wildlife Toxicology Database, Environment Canada, Environmental Conservation Branch: Research has been conducted on topics of wildlife concern, such as the effects of toxic chemicals on the bald eagle, the herring gull, amphibians, and species of birds that inhabit fields and orchards. This type of wildlife research and monitoring activity is vital to understanding the biological impact of activities that affect environmental sustainability. (Environment Canada 1996a) [ID # 41, App. 4]

Marsh Monitoring Program, Environment Canada and the Long Point Bird Observatory: The goal of the program is to have routes located throughout the Great Lakes basin monitored annually on a long-term basis by volunteer surveyors. The information gained will provide needed baseline data on habitat associations and population changes of indicator species, such as marsh birds and amphibians. (Cadman 1995) [ID # 27, App. 4]

3.2.3B Wildlife and Wildlife Habitat: U.S. Holdings

Wildlife Mortality Information System Database (WILDMORT): NBS, National Wildlife Health Center, Madison, Wisconsin, maintains this database to describe and understand the status and trends of the nation's biota and to provide that information to decision makers in a form that allows them to assess biological consequences of various policies and management practices. The database provides a historical record of wildlife mortality in the United States and can be used to identify trends/cycles in disease outbreaks and to provide information for management activities. [ID # 40, App. 4]

Wisconsin Department of Natural Resources Deer Management Units Database: The Wisconsin DNR is the custodian for the WiDNR statewide Deer Management Unit data layer, which includes state and local roads, hydrography, railways, and county boundaries. Attribute data include polygon unit codes and boundary codes for line features. [ID # 115, App. 4]

North American Bird Banding Program Database, NBS, Population Inventory and Monitoring Bird Banding Lab: Maintains records of all birds banded in North America and

records of all North American banded birds recovered. Purpose of database is to provide information on avian survival, movement, and behaviour. Applications include promulgating hunting regulations, monitoring populations, restoring endangered species, studying effects of environmental contaminants, and addressing issues of human health, safety, and economy. [ID # 41, App. 4]

Annual Herpetological Index Database, maintained by the NBS: Purpose of the database is to catalogue current herpetological publications for use by researchers and managers. [ID # 35, App. 4]

Ohio Natural Heritage Data Base: The Ohio Department of Natural Resources, Division of Natural Areas and Preserves, developed this database to help identify and protect Ohio's rare species and unique natural features. About 68 percent represent Ohio locations for rare plants, 22 percent are records for rare animals, and the remaining 10 percent include records for high-quality plant communities, unique geologic features, breeding/non-breeding animal concentrations, and other miscellaneous features. [ID # 53, App. 4]

3.2.4A Soils: Canadian Holdings

Digital Soils Database, Ontario Ministry of Agriculture, Food and Rural Affairs Resources and Planning Branch: The database differentiates various soil types and contains information on their physical and chemical composition along with specific landscape features for each soil unit. Coverage has been referenced to the UTM grid (NAD27), on the 1:50,000 NTS sheets, although original survey scale varies for each county. Digital coverage exists at the county level for most of Southwestern Ontario. (Survey Results 1996) [ID # 92, App. 4]

3.2.4B Soils: U.S. Holdings

Wisconsin Soils Database: The database contains available statewide Wisconsin soils data. The Wisconsin State Soil Geographic Database (STATSGO) is maintained by the U.S. Department of Agriculture (USDA), Soil Conservation Service (SCS), Soils Section in Madison, but can also be obtained through the WiDNR. [ID # 69, App. 4]

The USDA/Natural Resources Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO), the most detailed level of digital soils data, is currently under development. Information about the content and status of SSURGO data, County/Project Area soils data, as well as a variety of other GIS data, can be accessed via the NRCS Node to the NSDI (National Spatial Data Infrastructure). [ID # 68, App. 4]

Groundwater Contamination Susceptibility Model: This model was designed to be used primarily for regional, multi-state, river basin, state, and multi-county resource planning,

management, and monitoring. The USDA/NRCS maintains information on soil components, layers, and other related information. The tabular data primarily provide information about map unit acreage, the proportionate extent of soil components in each map unit, and soil properties and interpretation data. [ID # 70, App. 4]

GCSM-Related Soils Database: The information in these data sets was developed specifically for the Groundwater Contamination Susceptibility Model (GCSM) for Wisconsin. The Wisconsin STATSGO is recommended for general use. Metadata is available for soils data layers in a form consistent with the Federal Geographic Data Committee's Content Standard for Digital Geospatial Metadata. Metadata structure information is available describing the format and structure of metadata provided. [ID # 114, App. 4]

3.3 Impacts of Changing Land Use

3.3A Impacts of Changing Land Use: Canadian Holdings

Inventory and Assessment of Land Uses and Shoreline Management Practices, Environment Canada, Environmental Services Branch: The inventory was collected in an effort to review and assess patterns of shoreline uses and shoreline management practices on the Canadian shoreline of the Great Lakes–St. Lawrence River basin. The investigation of land use included an inventory and assessment of existing land uses and an investigation of past land-use changes and projected future trends. (Ecologistics Limited 1992) [ID # 44, App. 4]

Natural Heritage Information System (NHIS): This database provides information on locations and sites of protected areas (parks, Areas of Natural and Scientific Interest (ANSI), International Biological Program Sites, environmentally sensitive areas, land protected by non-governmental organizations and conservation authorities, rare species and their habitats, and species at risk). (Ball 1995) [ID # 119, App. 4]

National Conservation Areas Database, Environment Canada, Environmental Reporting: Areas protected by federal and provincial governments, conservation authorities, and many non-government agencies. (Ball 1995) [ID # 29, App. 4]

Protected Areas and Areas of Natural and Scientific Interest Databases, Ontario Ministry of Natural Resources, Natural Heritage Policy Branch: This is a series of databases including the Ontario Provincial Parks database, Conservation Areas Guide, Parks and Other Provincially owned Protected Natural Areas Database, and ANSI database. (Ball 1995) [ID # 123, App. 4]

3.3B Impacts of Changing Land Use: U.S. Holdings

Wisconsin Land Use and Land Cover Digital Database: The U.S. Geological Survey (USGS)

has produced a digital representation of land use and land cover called "Land Use and Land Cover Digital Data." Surface features are classified into 24 categories, which can be generalized into 6 major classes. Minimum area size for inclusion in the database was 4 hectares (10 acres) for urban and water features and 16 hectares (40 acres) for all others. [ID # 71, App. 4]

Rural Land Cover Vegetation Mapping GIS Data Set: This is currently under development by WiDNR and other partners cooperating in WISCLAND (Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data). [ID # 113, App. 4]

Predicting Consequences of Land Management Practices on Water Quality: The U.S. Department of Agriculture, Agriculture Research Service, conducts research in watershed engineering, soil management, water management, and air pollution control. [ID # 63, App. 4]

Agricultural Conservation and Environmental Programs: The U.S. Department of Agriculture, Agricultural Stabilization and Conservation Service, maintains information and data on its four major conservation programs: 1) agricultural conservation programs to support conservation practices that solve soil, water, energy conservation and other environmental problems; 2) Water Bank Program to conserve water and preserve and improve migratory waterfowl habitat; 3) Forestry Incentives Program to encourage development of non-industrial private forest lands; and 4) Rural Clean Water Program to control agricultural non-point source pollution and improve water quality in rural areas. [ID # 62, App. 4]

Management of National Forest System Great Lakes Basin Lands for the Sustained Yields of Renewable Resources: The U.S. Department of Agriculture, Forest Service, collects information and databases about water, wildlife, timber, and recreational facilities. [ID # 64, App. 4]

Natural Resources Conservation Service National Resources Inventory: Assessments are completed at five-year intervals. The inventory contains information on wetlands, land use, and erosion patterns. Most of the information is summarized by state or major land resource areas. [ID # 65, App. 4]

The Michigan Resource Inventory Program (MRIP) Database: This database has been developed within the Land and Water Management Division, Michigan Department of Natural Resources (MDNR). This effort is also known as the Michigan Resource Information System (MIRIS). [ID # 33, App. 4]

3.4 Coastal Wetlands

3.4A Coastal Wetlands: Canadian Holdings

Ontario Wetland Map Series, Federation of Ontario Naturalists: Data consist of 125 map sheets covering Southern Ontario. They show location and boundaries of all wetlands in 1982; all wetland losses since European settlement; and more recent wetland losses and gains. Subcategories of marsh and swamp areas, and losses and conversion of uses were also identified to provide comprehensive regional-scale coverage of wetland extent and conversion in Southern Ontario in order to assist wetland policy and program decisions and provide a baseline for future monitoring. (Environment Canada, Canadian Wildlife Service 1995) [ID # 56, App. 4]

Wetland Evaluation Information Management System: Contains data required for Ontario Wetland Evaluation System, including selected ecological, social, and hydrological parameters of individual wetlands and wetland complexes. Also contains documented occurrences of rare, threatened, endangered, and significant species for the wetland or wetland complex (Environment Canada, Canadian Wildlife Service 1995) [ID # 125, App. 4]

Lake Erie Basin Wetlands Digital Maps, Environment Canada, Environmental Services Branch: The purpose of this database is to identify significant wetlands in the Canadian Lake Erie basin that are potentially threatened by surface water contamination and to regionally target the rural non-point sediment sources where remedial programs would be most effective. Data sets required for this study included wetland location, wetland significance, locations of contaminant sources, and estimates of the likelihood of a contaminant reaching a wetland. (Environment Canada, Canadian Wildlife Service 1995) [ID # 45, App. 4]

Wetland, Agricultural Land Use, and Waterfowl Database, Ducks Unlimited Canada: The database was designed to help plan improvements to habitat and intensively farmed areas of the Great Lakes-St. Lawrence River waterfowl zone in Southern Ontario. This project compiled mapped data on agricultural type, wetland extent, and resident waterfowl populations, as background to build an effective waterfowl management plan tailored to regional differences. (Environment Canada, Canadian Wildlife Service 1995) [ID # 12, App. 4]

Historical Coastal Wetland Database, Environment Canada, Canadian Wildlife Service, and Snell and Cecil Environmental Research: The main focus was to analyse changes in wetland quality, quantity, value, and function due to water-level fluctuations for six specific sites (St. Clair Marsh, Lake St. Clair; Big Creek-Holiday Beach, Lake Erie; Rondeau Shores, Lake Erie; Turkey Point, Lake Erie; Oshawa Second Marsh, Lake Ontario; and Presqu'ile Marsh, Lake Ontario). Five to seven different years of air photos were used to identify and map up to 14 different classes of vegetation communities and up to 18 adjacent land-use types. (Environment Canada, Canadian Wildlife Service 1995) [ID # 22, App. 4]

3.4B Coastal Wetlands: U.S. Holdings

Interactions of Biotic and Abiotic components in Great Lakes Wetlands and Nearshore Aquatic Habitats, U.S. Geological Survey-National Biological Service and the U.S. Fish and Wildlife Service: This database investigates the interactions between abiotic components in the nearshore zone and the biotic communities they support. [ID # 110, App. 4]

National Wetlands Inventory Maps and Metadata Database, U.S. Fish and Wildlife Service: This database is used to track the status of wetland mapping by the National Wetlands Inventory (NWI). Most of the database's maps correspond to 7.5 minute quad maps and are at a scale of 1:24,000. The database is used to track mapping and map updating efforts, and to produce maps showing the status of wetland mapping. The database is updated weekly. [ID # 102, App 4]

3.5 Other (Canadian and U.S. Holdings)

3.5.1 Weather and Climate Data

Ontario Meteorological and Climatic Data, Environment Canada, Environmental Services Branch: Measurements of hourly temperature, dew point, precipitation, visibility, cloud height, amount and opacity, wind direction and speed, barometric pressure and the three-hour pressure tendency are made by human observers at 34 stations, near the ground, in Ontario. Measurements of the upper air are made at two stations. Most of the elements measured at the staffed stations are also recorded automatically through electronic equipment at 60 additional stations. (Environment Canada 1996a) [ID # 47, App. 4 - Canadian]

Stability Array (STAR) Meteorological Stations for the Conterminous United States, U.S. Environmental Protection Agency: The dataset summarizes National Weather Service data for meteorological stations. Data for STAR meteorological stations includes joint frequencies of six windspeeds, 16 wind directions, and six stability classes. These data elements were recorded on an hourly basis for each station and stored in yearly files for use on EPA's Graphical Exposure Modeling System. [ID # 83, App. 4 - U.S.]

3.5.2 Air

Integrated Atmospheric Deposition Network Database, U.S. Environmental Protection Agency: Monitoring (1990 to the present) of regional trends in toxics deposited in the Great Lakes via the atmosphere, made up of five master sites and eleven satellite stations. They are located on land between 1 and 5 km (between 0.6 and 3 miles) from the lake. Monthly concentrations of atmospheric deposition are measured in vapour, rain/snow, and particles.

Compounds measured are PCBs, PAHs, some pesticides such as aldrin, dieldrin, DDT, lindane, and some metals including lead, arsenic, and cadmium. (Survey Results 1996) [ID # 77, App. 4 - U.S.]

Great Lakes Regional Air Toxics Emissions Inventory, U.S. Environmental Protection Agency and the air regulatory agencies of the eight Great Lakes states: This inventory will be used to: 1) successfully implement the key provisions of the *Great Lakes Toxic Substances Control Agreement*, and 2) assess the atmospheric deposition to the Great Lakes under the efforts of the U.S. EPA's Great Waters Program. [ID # 89, App. 4 - U.S.]

3.5.3 Nearshore Ecosystem

Wisconsin Department of Natural Resources GIS Database: The purpose of this database is to provide tools for spatial data management and analysis for use in departmental policy evaluation, decision-making, program management, and operations. WiDNR also provides certain GIS data-sharing services to the public as required under Wisconsin's Open Records Law. [ID # 116, App. 4 - U.S.]

Wisconsin Dam Inventory Database: The WiDNR Bureau of Water Regulation and Zoning (WRZ) is the custodian for the state's dam inventory, which is maintained in tabular form in an ORACLE database. The inventory contains locational information for over 3,500 large and small dams in Wisconsin, but does not include detention ponds or dams located away from a waterway. The dam inventory database contains a variety of attributes regarding dams, such as owner and contact information, nearest town downstream, county, stream name, hazard rating, emergency planning status, height, size, water volume, and DNR inspection history. Dam inventory data are available from the bureau custodian. [ID # 120, App. 4 - U.S.]

Michigan Department of Environmental Quality GIS Database: The Environmental Response Division effectively determines, evaluates, and controls risk to the environment and to the health, safety, and welfare of Michigan's citizens by carrying out cleanup or other response activities at sites of environmental contamination by promoting redevelopment of contaminated sites and by developing and managing information about chemicals in the environment. [ID # 29, App. 4 - U.S.]

Wisconsin State Forest Stands Database: The Wisconsin DNR Bureau of Forestry is the custodian for the State Forest Stand Map geographic data layer, with coverage available for Wisconsin's six major state forests: Northern Highland American Legion, Brule River, Flambeau River, Black River, Kettle Moraine South and North. The database contains over 25 items, such as site index, primary cover type, primary cover size, board feet per acre, cords per acre. [ID # 118, App. 4 - U.S.]

The National PLANTS Database, USDA/NRCS: This database provides a single source of standardized information about plants. PLANTS standardized information permits scientists and other persons interested in plants across disciplines to freely exchange accurate plant-related information. The purpose of the PLANTS database system is to provide plant information to NRCS's natural resource conservation efforts, NRCS clients, cooperating agencies, and the public. [ID # 67, App. 4 - U.S.]

Forest Inventory and Analysis: The U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station, Forest Inventory and Analysis research unit began to map forest land distributions for the United States. The project was performed in support of the Forest and Rangeland Renewable Resources Planning Act 1993 Assessment Update program to provide information on current forest and rangeland conditions. [ID # 66, App. 4 - U.S.]

4.0 Nearshore Data Needs and Gaps

The previous section identifies existing data and information for the nearshore zone of the Great Lakes. It does not, however, indicate the value of these databases for assessing the state of the nearshore ecosystem, nor does it address what information is needed but not available.

In order to measure or monitor the state of the nearshore in terms of the health of aquatic and terrestrial communities and the physical, chemical, and biological habitat, and to examine the stressors that affect them (such as exotic species and human activities together with underlying socio-economic aspects), a set of indicators were proposed at SOLEC '94. These indicators were expanded and built upon in an International Joint Commission (IJC) report titled "Indicators to Evaluate Progress under the Great Lakes Water Quality Agreement" (International Joint Commission 1996).

In addition, the lead authors of four SOLEC reports for SOLEC '96 have attempted to develop indicators specifically for the nearshore of the Great Lakes. On the basis of the indicators suggested by these authors and on those in the IJC report, the following section attempts to identify data needs and gaps in the information needed to measure and monitor the nearshore ecosystem. The tables that follow (Tables 1-4) identify the proposed indicators and the data needed to measure these indicators (taken from the respective SOLEC papers, Edsall and Charlton 1996, Reid and Holland 1996, Maynard and Wilcox 1996, Rivers and Thorp 1996 and from International Joint Commission 1996). Using the information provided above in section 3.0, we have attempted to identify data gaps for each indicator specified and to rate how well the existing information meets the indicator's data requirements.

Please note that the purpose of this section is not to evaluate the indicators proposed, but rather to determine the status of the information required to measure these indicators. In many cases indicators are chosen or used because information exists.

The following tables identify the indicator, and the data needed to measure the indicator. The table also includes a column which gives a rating of how well the data needs are being met. A "good" rating indicates that data is universally available in a usable form; "fair" indicates the basic data are available but that there are significant gaps in the data or the data is out of date. A "poor" rating indicates that the data is not available at all or is severely deficient. Finally the table includes a "Data Gaps" column which identifies major known gaps to the data requirements.

4.1 Nearshore Waters Indicators and Identified Data/Information Needs and Gaps

Table 1 Nearshore Waters

Desired Outcome	Indicators	Data Needed	Rating	Data Gaps
Healthy human populations	Fish consumption advisories	· Contaminant levels in edible fish and wildlife. · Total number of sport or commercial species that have advisories. · Total geographic area that is restricted for commercial fishing because of fish consumption advisories.	Fair	No basin-wide application of standardized fish consumption advisories exists. Limited amounts of data are available.
	Beach closings, measured in median number of consecutive days closed for a given year	· Beach closings based on the measurement of the following: · coliform count · turbidity · phosphorus concentrations · aesthetics · beach characteristics	Fair	No standardized reporting method of beach status by geographic unit (e.g., beach number). Such a standard would permit better interpretation of local and basin-wide trends. Limited amounts of data are available.
	Drinking water purity	· Bacterial count in treated drinking water. · Reports of human illness or infectious diseases due to consumption of treated water. · Number of warnings of water consumption limitation. · Incidence of taste and odour problems in treated water, based on public surveys and complaints, measurement of biomass, biomass composition and/or chlorophyll. · Reports of spill, process upsets, and other incidents that release anthropogenic chemicals into the raw water supply that could threaten a drinking water treatment plant. · Concentration of anthropogenic chemicals in the raw water. · Treatment-plant closures. · Amount of treatment at the plant.	Good	Very little information on taste and odour. Data on bacteria levels and many chemicals are available form the Drinking Water Surveillance Program and H_2O treatment plants. Data on some chemicals is of limited use due to high detection levels.

Table 1 Nearshore Waters (continued)

Desired Outcome	Indicators	Data Needed	Rating	Data Gaps
Healthy human populations (cont.)	Acute human illness associated with locally high levels of contaminants and/or Chronic human illness associated with long-term exposure to low levels of contaminants	· Number of times established standards for microbial, chemical, and radiological contamination were exceeded. Measurements include bacterial counts at public beaches and number of beach-day closings. · Number of people affected by waterborne microbial diseases. · Toxic substance levels in human tissue, especially those of exposed populations (e.g., fish eaters). · Toxic contamination levels in human breast milk. · Number of exceedances of established air quality standards. · Hospital admissions for acute respiratory distress of young children.	Poor to Fair	Available references agree that more research must be done specifically to study the effects of environmental stresses on human health, particularly with respect to the effects of long-term exposure to complex mixtures of low levels of toxic contaminants (International Joint Commission 1996). A limited amount of human health information is available.
Healthy fish and wildlife	Status of exotic species	· Cumulative number of exotic species introduced. · Distribution and abundance of exotic species in nearshore waters. · Annual control costs. · Effect on the ecosystem of exotic species.	Fair	More quantitative and reliable information on the effects of each exotic species on native species and communities is required. More information on other potential invading species is needed to help develop strategies to prevent their entry and establishment. Better status information and better control methods are required.

Table 1 Nearshore Waters (continued)

Desired Outcome	Indicators	Data Needed	Rating	Data Gaps
Healthy fish and wildlife (cont.)	Status of native species and their habitats	· Number and abundance of endangered native species, including fish, waterfowl, plants and invertebrates. · Presence and abundance of selected native indicator species representative of unimpaired ologotropic and mesotrophic habitats in the nearshore waters (e.g., lake trout, burrowing mayfly). · Quantity and quality of particular habitat types (e.g., wetlands and spawning habitat for desirable native species). · Fish harvest statistics vs. spawning vs. biomass levels. · Toxic contaminant levels in selected fish species and in selected fish-eating birds. · Ambient phosphorus concentrations in the nearshore water and sediment of the Great Lakes.	Fair	Nearshore aquatic habitat classification and mapping.
Virtual elimination of persistent toxic substances	Levels of persistent toxic chemicals	· Quantities of persistent toxic substances produced, used, and disposed of. · Total loadings of persistent toxic substances in the Great Lakes system. · Concentration of persistent toxic substances in non-biological ecosystem compartments (water, sediment).	Fair	
	Concentrations of persistent toxic substances in biota	· Concentrations of persistent toxic substances in top predator fish and fish-eating birds. · Biochemical measures of changes in cellular or subcellular processes within individual organs or tissues of an organism. · Measurable changes in the development, behaviour, reproductive success, or survival of species (e.g., tumours, other visible deformities).	Fair	

Table 1 Nearshore Waters (continued)

Desired Outcome	Indicators	Data Needed	Rating	Data Gaps
Absence of excess nutrient loading, leading to cultural eutrophication	Dissolved oxygen depletion of bottom waters	· Ambient phosphorus concentrations in selected areas of the Great Lakes nearshore. · Phosphorus loading and effluent information for point and non-point sources. · Ambient water dissolved oxygen concentrations.	Fair	
	Water clarity/algal blooms	· Identified algal blooms from remote-sensing and satellite imagery. · Reports of nuisance algal growth. · Beach closings due to excessive algal growth.	Fair	

Sources: For Indicators, Edsall and Charlton 1996.
For Data Needed, modified from International Joint Commission 1996.

4.2 Land by the Lakes Indicators, Data Needs and Gaps

The nearshore terrestrial paper, "Land by the Lakes," identifies three tiers of indicators of overall ecosystem health.

Table 2 Land by the Lakes

Desired Outcome	Indicators	Data Needed	Rating	Data Gaps
A diversity of coastal physical features and unique biological components within ecoregions	Representation of significant coastal physical features and biological diversity within ecoregions	· A uniform classification system that provides biodiversity, stressor, and stewardship activity information in addition to physical descriptors. · Community and species inventories throughout the basin.	Fair	In the U.S., state Natural Heritage Programs are continuing to inventory unique areas in Ohio and New York, where little field work has thus far been done. In other states, inventories continue on a local basis. Ecoregional classification completed for Michigan, Minnesota, and Wisconsin. In Canada - community classification under development (Bakowsky and Lee, 1996; Racey et al., 1995, etc.); inventories incomplete.
Preservation of significant coastal ecological communities and species	Summary of stewardship activities and stressors	· Basinwide pre-European settlement biological data to provide a basis for comparison with the present landscape. · Inventories of all significant ecological communities and their components and functions. · Analyses of stressors and sources of stress affecting significant ecological communities. · Analyses of quantity and quality of protection efforts.	Poor	In the U.S., Michigan Natural Features Inventory mapping pre-European settlement data; information spotty for other states; inventories for some communities complete in some states (Michigan Lakeplain Prairie communities); stressors and sources of stress being analysed by The Nature Conservancy Great Lakes Office for several communities; no current analysis of protection efforts; no comprehensive analysis for the coastal region.

Table 2 Land by the Lakes (continued)

Desired Outcome	Indicators	Data Needed	Rating	Data Gaps
Preservation of significant coastal ecological communities and species (cont.)	Balance of stewardship activities and stressors (cont.)			In Canada, little pre-European settlement data mapped; inventories incomplete, particularly in northern Lake Superior; no current analysis of stressors, sources of stress, or protection efforts.
Overall ecosystem health	Loss of significant ecological communities and species	· Inventories of significant shoreline ecological communities and species.	Poor	
	Interruption of shoreline processes by lake edge armouring	· Analyses of effects of shoreline processes by lake edge armouring.	Fair	
	Representation of coastal biodiversity within parks and protected areas	· Measurement of biodiversity in parks and protected areas.	Poor	
	Gains in biodiversity investment areas protected	· Measurement of biodiversity investment area protection efforts.	Poor	

Source: Reid and Holland 1996.

4.3 Coastal Wetlands

Table 3 Coastal Wetlands

Desired Outcome	Indicators	Data Needed	Rating	Data Gaps
Preservation of wetland area	Land-use changes, encroachment /development basin-wide.	· Remote-sensed imagery (aerial photographs, satellite imagery) over time to determine changes in landscape and encroachment on wetlands. (e.g., conversion of wetlands to agricultural, urban, and industrial land uses; upland development; shoreline development; deforestation; road construction; dam construction).	Good	For some locations, imagery is available for numerous years, but is expensive to purchase for large areas. For other locations, imagery is limited.
	Landscape stressors	· Road density in the wetland watershed. · Extent of shoreline modification. · Changes in the status of protective barriers. · Proximity to navigable channels and recreational boating activity. · Hydrologic connectivity with the lake.	Good	Although data are largely available, the analysis of such data has been limited.
	Wetland size, abundance, and susceptibility to threats along its border	· Digital wetland data from remote-sensed data in a geographic information system (GIS) to determine: · changes in wetland area over time · number of wetlands within a given area · ratio of area to perimeter of wetland · Areas protected under the North American Wildfowl Management Plan. · Ongoing inventory and status summary.	Fair	Digital wetlands mapping is available only for some parts of the Great Lakes shoreline.
Wetland quality	Flooding and dewatering of wetland	· Water level data. · Ground elevations. · Nearshore bathymetry.	Fair	Detailed nearshore bathymetry especially in the 0 to 2 metre (6.5 feet) range.

Table 3 Coastal Wetlands (continued)

Desired Outcome	Indicators	Data Needed	Rating	Data Gaps
Wetland quality (cont.)	Protection from erosive forces	· Sediment supply in the littoral drift. · Substrate type and particle size. · Fetch. · Exposure to wave attack. · Shoreline slope.	Fair to good	Data are available in some areas; not in others.
	Levels of persistent toxic chemicals	· Concentration of nutrients and toxic substances in sediments,including carbon, total particulate nitrogen, ammonium, nitrate-nitrite, soluble reactive phosphorus, organic contaminant, and heavy metals. · Nearshore water quality determinations of turbidity, total suspended solids, total organic carbon, total particulate carbon, ammonium, nitrate-nitrite, total phosphorus, soluble reactive phosphorus, dissolved oxygen pH, alkalinity, conductivity, temperature, organic contaminants, and heavy metals.	Fair	Some data are available for specific sites of interest, but are largely lacking elsewhere.
Healthy habitat	Status of plant communities	· Extent and percentage of each major vegetation type. · Changes in vegetation types over time. · Plant species richness. · Species dominance (percentage cover) of plant taxa. · Growth form of plant communities. · Presence of detrital plant material.	Fair to good	Some data are available for specific sites of interest, but are largely lacking elsewhere.
	Status of individual plant taxa	· Presence or absence of rare taxa. · Presence or absence of invasive species. · Expansion or spread of invasive species.		Inventories are available in Michigan and Ohio, but largely lacking elsewhere. No data on expansion or spread.

Table 3 Coastal Wetlands (continued)

Desired Outcome	Indicators	Data Needed	Rating	Data Gaps
Healthy fish and wildlife	Status of species typical of a Great Lakes wetland	· Presence or dominance of species tolerant of degraded environmental conditions (e.g., percent of turbidity-tolerant fish). · Stability of a faunal community productivity as measured in biomass of fish or emergence rate of aquatic insects. · Population survival and mortality. · Ratios of guilds or traits (e.g., pelagic vs. benthic fish ratio, predator vs. prey ratio).	Fair	Some data are available for specific sites of interest, but are largely lacking elsewhere.
	Status of exotic species	· Cumulative number of exotic species introduced. · Distribution and abundance of exotic species in nearshore waters. · Annual control costs. · Effect of exotic species on the ecosystem.	Poor	More quantitative and reliable information on the effect of each exotic species on native species and communities is required. More information on other potential invading species is needed to help develop strategies to prevent their entry and establishment. Better status information and better control methods are required.
	Concentrations of persistent toxic substances in biota	· Concentrations of persistent toxic substances in top predator fish and fish-eating birds. · Biochemical measures of changes in cellular or subcellular processes within individual organs or tissues of an organism. · Measurable changes in the development, behaviour, reproductive success, or survival of species (e.g., tumours, other visible deformities).	Fair	Some data are available for specific sites of interest, but are largely lacking elsewhere.

Source: Maynard and Wilcox 1996.

4.4 Impacts of Changing Land Use

Table 4 Impacts of Changing Land Use

Desired Outcome	Indicators	Data Needed	Rating	Data Gaps
Efficient urban development	Urban population densities	· Urban populations per area.	Good	
	Suburban land conversion	· Land conversion rates.	Fair	
	Centre town economy	· Fiscal condition/vacancies/etc.	Fair	
	Brownfields	· Number and area.	Fair	
	Recreation opportunity	· Number and area of parks.	Good	
	Energy Use	· Energy usage per capita.	Good	
	Waste created	· Residential and industrial waste.	Good	
	Wastewater quality	· Loadings of nutrients and toxics	Fair	
	Industrial water use	· Volume per facility/per capita	Good	
	Residential water use	· Volume per household	Good	
	Traffic congestion	· Time spent commuting	Fair	
	Transit use	· Public transit commuting rates	Good	

Table 4 Impacts of Changing Land Use (continued)

Desired Outcome	Indicators	Data Needed	Rating	Data Gaps
Human Health Protection	Air-pollution levels	· Particulates and ozone levels.	Fair	
	Beach closings	· Median number of consecutive days beach closed for a given year. Measurements are based on the following: · coliform count · turbidity · phosphorus concentrations · aesthetics · beach characteristics	Fair	
	Land fill capacity	· Percent capacity left in landfills around the Great Lakes.	Fair	
	Stormwater quality	· Loading of nutrients and toxics.	Poor	
	Sewage quality	· Loadings of nutrients and toxics.	Fair	
	Pollution-prevention programs	· Industrial and municipal programs.	Poor	
	Respiratory illness	· Illness and mortality incidences.	Fair	
	Fish advisories	· Contaminant levels in edible fish and wildlife. · Total number of sport or commercial species that have advisories. · Total geographic area that is restricted for commercial fishing because of fish consumption advisories.	Good	
	Outdoor recreation	Opportunities and participation	Fair	

Table 4 Impacts of Changing Land Use (continued)

Desired Outcome	Indicators	Data Needed	Rating	Data Gaps
Non-Human Resource Health Protection	Wetland Habitat	· Remote-sensing data showing number and percentage increases or decreases of wetland area over time.	Fair	
	Agriculture and natural land loss	· Area lost to rural development.	Fair	
	Wildlife populations	· Species and populations	Fair	
	Forest clearing	· Cutting rates.	Fair	
	Forest replant and renewal	· Successful forest replanting rates.	Fair	
	Mineral extraction	· Estimated rates of depletion.	Fair	
	Fisheries pressure	· Fishing restrictions. · Number of catch.	Good	
	Hunting pressure	· Hunting restrictions.	Good	
	Hardening of land surface	· Area of roads and buildings	Poor	
	Municipal pesticide/fertilizer use	· Application rates	Fair	
	Agriculture pesticide/fertilizer use	· Application rates	Good	
	Conservation tillage	· Area practicing no-till.	Fair	
	Groundwater quality	· Area/number of contaminated wells.	Poor	
	Contaminated sites	· Improvement or degradation of existing contaminated sites. · Increases or decreases in number of contaminated sites.	Poor	
	Cottage/2nd home	· Occupation per coastal area.	Fair	

Source: Rivers and Thorp 1996.

4.5 Information Indicators

The following table on assessing the data (Table 5) is intended to give a general idea of how well nearshore information needs are being met overall. Four indicators have been used: data coverage, data time frame, data applicability, and data usability.

Data coverage refers to how well the data cover the Great Lakes nearshore area. If a lot of data are available for the entire Great Lakes shoreline, the rating is "good." If data cover only a small portion of the Great Lakes shoreline, the rating is "poor."

Data time frame refers to how recent the data are. Ongoing monitoring programs that collect data on a regular basis are considered "good." Data that are fairly recent but need updating are considered "fair"; and old data are considered "poor."

Data applicability refers to how well data can be used to measure the indicators discussed throughout section 4.0. If a lot of data are available and applicable to one or more indicators, this is considered "good." If data can be used in support of measuring indicators, the rating is "fair," and if the data do not measure any of the indicators identified, they are considered "poor."

The final indicator, data usability, refers to how well the data can be used across disciplines. If data can be used for more than one purpose and have cross-discipline applications, the rating is "good." If the data are specific to a discipline, the rating is "fair." If the data are collected for one unique study and have no use beyond that one study, the rating is "poor."

4.5.1 Status of Information - General Findings

As is apparent from Appendix 4, a large amount of data is applicable to the nearshore of the Great Lakes. However, how much these data tell us about the state of the nearshore is debatable. Since there are at this point no set indicators for measuring the state of the nearshore, data have generally been collected on an as-need basis by individual agencies. International studies such as those done for the International Joint Commission have provided major steps forward in data coverage. But unless the data-collection efforts are repeated, the data quickly become out of date. Continuous monitoring programs provide the best long-term data for comparison over the years; however, a number of these programs seem to have been ended in recent years.

Table 5 Assessing the Data

Desired Outcome	Indicator	Rating	Basis for Rating
Data to measure all indicators	Data coverage	Fair	Only a few data sets cover the entire Great Lakes shoreline. Most are Lake or site specific. Data collected for international studies (e.g., IJC studies or Lakewide Management Plan studies) generally have the best data coverage.
	Data time frame	Fair	Some long-term monitoring programs have excellent up-to-date data, such as the water level information. Large data sets collected on a one-time basis (e.g., shoreline classification) are becoming out of date.
	Data applicability	Fair	Most data sets have some applicability to the indicators described above. If they cannot be used directly, they can be used in support of measuring the indicator.
	Data usability	Fair	This is a mixed bag. Some data are usable for a wide range of uses, whereas others are specfic to particular studies.

5.0 Nearshore Information Management

The first half of this report concentrated on information and data pertaining to the nearshore of the Great Lakes. For this information to be of value, it needs to be readily available, reliable, and shared effectively among partners. Managing all the data gathered for the nearshore is not a simple task. Multiple agencies collect, analyze, and store information pertaining to the Great Lakes. Today's electronic technology should facilitate identification and access of data sources, and assembly of information. This section will explore some of the common issues in the management of nearshore information.

5.1 Definition of Information Management

Simply stated, information management involves the collection, storage, manipulation, and transfer of information and data. For the purposes of this report, information management is considered synonymous with data management. Data management includes the following (revised from Environment Canada 1996b):

1. creating and maintaining standards for collecting data,
2. documenting/cataloguing the data,
3. storing/archiving data,
4. accessing data,
5. integrating data,
6. securing and protecting data,
7. stewardship of data,
8. providing methods for disseminating the data.

It does not include actually observing data, nor deciding how the information should be portrayed, visualized, or packaged.

5.2 Nearshore Information Management Issues

A number of issues have an influence on nearshore information management. These issues become more complex given the large area of the Great Lakes and the large number of agencies, organizations, institutions, and levels of government involved. The issues have been categorized according to the eight functions included in the definition of data/information management.

5.2.1 Data Collection Issues

As is apparent from section 3.0 of this report, numerous agencies each gather information about some component of the nearshore on both sides of the border. For this information to be used to assess the state of the nearshore, it is important that the information gathered can be compared over time and across disciplines, agencies, and countries.

Homogeneity of Data

Homogeneity, or similarity or uniformity, of data sets is important for the comparison of data sets. If data are collected at a similar location, using similar methodology, at a similar time each year, such data can be compared over the years for changes. If, however, the data are collected using different methodologies from one year to the next, comparisons of these data would be difficult.

Inconsistencies are introduced as a result of different methodologies, standards, and collection techniques. In many cases these inconsistencies are a result of improvements made to collection and/or analytical techniques. For example, improvements to water sampling techniques made over the years have allowed scientists to detect traces of chemicals that could not be measured in the past. These inconsistencies must be assessed by all users and, if significant, must be taken into account to eliminate bias or false conclusions.

Compatibility Among Disciplines

There are numerous disciplines collecting data for various purposes around the Great Lakes. Generally data are collected by a discipline for a specific purpose. Trying to use data gathered by different disciplines may not always be possible. For example, data have been collected on the geomorphology of the shoreline, the level of shore protection, and the subaqueous or nearshore bottom make-up. This database is a valuable resource for engineers assessing the potential impact of water-level fluctuation along the Great Lakes shoreline; however, it may not be appropriate for wetlands biologists for the study of nearshore habitats, since the database identifies only the portion of the wetland that actually comes in contact with the shoreline and does not include the area back from the shoreline. Certain agencies have primary responsibility for setting standards and development methods for various areas of data. It is only reasonable to assume that these agencies will generally consider their own data needs first and foremost.

Compatibility Among Agencies

Different agencies adopt different methodologies for collecting and analysing data. Often, these differences are sufficient to prevent the combining or even comparing of data sets. For example, a study conducted by Environment Canada and U.S. EPA (Esterby and Bertram 1993) compared monitoring data of eight water-quality parameters of three ship laboratories on the central basin of Lake Erie in August 1985. The study found significant differences, ranging from 30 to nearly 100 percent of the mean between the three ship laboratories for all but one of the parameters measured. Differences such as these must always be taken into account when comparing data.

Standards, Guidelines, and Units

Standards and guidelines are often established to help alleviate some of the compatibility and homogeneity issues described above. Standards and guidelines can be established for the way information is collected, stored, updated, and retrieved. Standards can be helpful if everyone agrees to adopt the same standard or, failing that, if differences between standards are adequately documented so that users are aware of the limitations. To date, there are very few examples of set standards for collecting data pertaining to the nearshore of the Great Lakes.

5.2.2 Documenting/Cataloguing of Data (Metadata)

The amount of data generated and stored by applications today presents serious challenges to users of data. For researchers to make effective use of vast quantities of stored data, they need more information about data content, such as that typically provided in an abstract of a document. Large quantities of data become unmanageable if the user has no way of knowing what the content of the data is, where to find it, or how to use it. The ability of scientists to make use of these large data sets will depend on the ability to access and manage data intelligently and efficiently.

5.2.3 Medium of Storage/Archiving

How information is stored and managed can be as important as the data itself. Data that are not stored will be lost. Information management systems provide some method of organizing, storing, and maintaining information. An information management system can range from a system that manages office documents to a complex relational database management system.

From survey results, it is clear that many, if not most, of the agencies collecting data about the Great Lakes make use of some form of electronic database management system. There is, however, considerable diversity in the types of systems used. In some cases, the information has been stored on a centralized mainframe using a relational database such as Oracle (e.g., Environment Canada's STAR— Storage and Retrieval database). In other cases, the data are stored on a PC in whatever database management system the researcher is comfortable with (e.g., dBase, Access, Paradox). Often the data are stored in a spreadsheet format such as Lotus or Excel, and in many cases, especially with historical information, the data are stored on a shelf in hard copy (printed paper) format only.

No set guidelines for data storage, back-up, or maintenance exist among most of the agencies compiling nearshore data. As a result, it is not uncommon for databases to have been lost or misplaced over the years, especially when a department was reorganized or key personnel retired or left. This ad hoc method of data management also makes it very difficult to keep track of information sources, even within departments, let alone within the Great Lakes community.

5.2.4 Availability and Access

Availability of, and accessibility to, data and information are other issues. All the data in the world may have been collected at great expense, but they are worthless if they are inaccessible. Availability constraints enforced by an agency may restrict the use of data, or data simply may not be accessible as a result of poor information management or format constraints. Other

restrictions to data access may result from the cost or ownership of the data. In addition, often

research scientists who are using particular sets of data for publishing purposes are unwilling to share the data with others.

Format Constraints

Although technology has in many ways improved our ability to manage information, it has also created a number of access constraints. Because technology is changing at such a rapid rate, data saved on a particular system one year may quickly become inaccessible if the technology changes and the data stored are not upgraded to the new system. For example, in the late 1980s, Environment Canada began developing a Great Lakes Coastal Zone database. Due to a lack of funding and changes in personnel, this database was never completed. The data that do exist are stored in a GIS format that is no longer accessible by today's systems. Until the data are converted to the new system, they cannot be accessed. This is not an isolated case. Considerable data have been stored on old backup tapes that can no longer be read by today's computer systems, and in many cases data are stored by an agency in a format that cannot be easily read by another agency using another system (e.g., SPANS GIS files are not easily read by ARC INFO).

Ownership/Propriety/Right-to-Use

The question of who owns the data can be a grey area. If one agency gathers the initial information, another agency adds to it and manipulates the data, and another agency buys the manipulated information, who has the rights to the data? Today's technology makes it very easy to transfer and manipulate data. For example, Environment Canada purchased digital topographic maps from another federal agency to use as base mapping for its shoreline sensitivity database. The agency that provided the topographic information claimed rights to any royalties generated by the database. This issue held up the project for over a year and has yet to be resolved. These questions of ownership of digital data have been, and will undoubtedly continue to be, an issue for the legal system. However, partnership arrangements for sharing data that respect the policies of the partner agency may solve this issue. If such partnerships are not arranged, data can become inaccessible if the assigned owner of the data is not able or willing to disseminate the information.

Along the same line are issues pertaining to the right to use data. Some data are very sensitive in nature—for example, human health information— and cannot be distributed freely. In these cases, very strict restrictions are placed on who has the right to use the data.

Commercialization/Revenue Questions

The question whether data, especially data collected with the use of public funds, should be free or not is a continuing debate. So uneven are the current views that, at present, a person wishing to obtain information may have to buy it from one agency, but find the same or similar data offered for free by another agency. This is becoming a particularly serious issue between U.S. and Canada since Canada is moving more towards a cost-recovery approach, whereas U.S. agencies have not adopted this approach. This issue is causing concern that valuable data are not being used because the agencies requiring the information cannot afford to buy it.

A workable, consistent approach must be found to share information that is needed for common purposes.

5.2.5 Data Integration

The integration of data has been an ongoing information management issue. One of the more recent methods of integrating data is to use Geographic Information Systems (GISs). GISs are computer-based systems that are used to store and manipulate spatial information. A GIS is designed to make the integration of diverse data sets easy. However, this capability also leads to a number of data management issues—for example, the issue of the context of the data. A GIS will allow its user to display information in various ways, by combining several layers of information. Sometimes this can portray information in a very misleading way. There are also problems associated with combining data sets. When one spatial data set is overlaid on another, the resulting information will generally be less accurate than the least accurate input data set. There is an implicit assumption that data shown together on a map meet a required level of accuracy; however, this is often not the case.

Integration is key to meaningful policy formulation and planning decisions. Yet to be useful in multiple applications, the data must be collected and automated according to specified and agreed upon standards, including geographic coordinates, that allow for this integration of data.

5.2.6 Security and Protection of Data

Securing and protecting data is yet another information management issue. Although it is important to make information available, this should not be done without proper assurance that the data will not be used improperly. In field work that involves collecting data from humans, for example, confidentiality is a key ethical issue. Storage and common access of data on humans requires additional caution. If data are accessed and used without proper quality control, this may result in decisions based on faulty data, which may lead to liability issues. It is important, therefore, that proper care be taken to secure and protect data and information, including proper documentation of the data, both to minimize the chances of the data being used for purposes for which they were not intended and to prevent data being used without the knowledge and understanding of their quality.

5.2.7 Data Stewardship

Once a database has been developed, the question arises of who should store and maintain the data. Storage and maintenance imply responsibility for the data and require the appropriate resources and corporate commitment. The question of who maintains the database is of particular importance when more than one agency has been involved in the development of the data and

requires access to the data. Data collected for the Lakewide Management Plans and the Remedial Action Plans are good examples. These programs involve numerous agencies at various levels on both sides of the border. Each agency has contributed some amount of funding or expertise and may require access to the data. No single agency controls the information, nor does any single

agency have the mandate and financial backing to be the custodian of the information. It becomes crucial, therefore, that each agency involved be committed to the long-term maintenance and access of the data it is responsible for.

5.2.8 Methods of Dissemination

Dissemination of data and information falls on the borderline of what might be considered information management. For the purposes of this paper, we will not consider how the information is packaged, visualized, or portrayed, but some discussion of the method of disseminating the information does seem appropriate.

Until very recently, data and information have generally been disseminated by a tape or diskette being sent by mail to the user. This method, although adequate, is time-consuming. For large data sets, using diskettes to disseminate data can be cumbersome simply due to the number of diskettes required (e.g., the Flood Damage Reduction Plan database is stored on 200 diskettes). Tapes store much more data and are adequate as long as the user has a similar tape drive. But the many versions of tapes on the market often create a problem for sharing data this way. Within the past five years, CD ROMs have been used more often for data dissemination. This medium is superior to the others in both the amount of data that can be stored and the compatibility of CD ROM drives. Even more recently, the use of the Internet's file transfer protocol (ftp) for data transfer has become more common. This is by far the fastest method of data transfer and dissemination. Large data sets can be transferred around the globe in a matter of minutes, depending on the bandwidth of the connecting lines. However, not all agencies have this capability, and even among those that do, not all individuals are aware of this method of data transfer. Moreover, clogging the Internet with huge data transfers violates one of the informal rules of Internet etiquette.

6.0 Significant Challenges and Opportunities

In section 5.0, we identified a number of information management issues. In this section, we will attempt to identify the key challenges that emerge from these issues and suggest opportunities for dealing with these challenges.

6.1 Agreed-Upon Indicators

Whether explicitly or implicitly, indicators have always been used to try to assess the state of the Great Lakes. Indicators are required for us to make some statement about the status of the Great Lakes nearshore and to gauge its relative improvement or degradation. However, a set of agreed-upon indicators for measuring the nearshore ecosystems does not currently exist. Agreed-upon indicators would help define and narrow the type of information that needs to be gathered and would enhance the value of the information for making decisions. The challenge is to agree on a set of indicators, along with the protocols for determining those indicators. Conferences such as the State of the Lakes Ecosystem Conference provide an opportunity to discuss and make progress in establishing a set of indicators.

6.2 Standardized Data-Collection Techniques

Once a set of indicators has been established, the next step is to agree upon some common data-collection methodologies. Standards and guidelines are necessary to ensure quality and consistency of data. They are needed, too, for the integration of data sets. But if standards are too restrictive, they will not be followed or enforced. The challenge is to develop a set of standards that provide the guidance necessary to ensure homogeneity and accuracy of data, yet that allow enough flexibility for individuality of a study.

6.3 Coordinating Data-Gathering Initiatives

Homogeneity and compatibility of data require organizations to carefully plan their data-gathering methodologies. Data collection does not come cheap and yet it is absolutely vital to understanding and making decisions on the conservation and protection of our ecosystems. A collection methodology that addresses the needs of varying disciplines and agencies is a cost-effective way of gathering information. Organizations need to look for ways of pooling their resources in their data-gathering initiatives. This type of endeavour has proven successful on the Niagara River, where four agencies on both sides of the border make use of data collected by Environment Canada under the Niagara River Toxics Management Plan. Using an agreed-upon methodology, all four agencies benefit from the data. In all partnership arrangements, however, it is extremely important that a custodian or custodians of the data be appointed to ensure the long-term maintenance and accessibility of the data by all partners.

6.4 Finding the Data

One of the major computing trends over the last 15 years has been the move from large centralized computers to distributed networks of computer systems. With the advent of PCs, data-processing tasks have moved from corporate mainframes right to the desktop and now to the laptop.

Computers and computer networks are spread through organizations, and computer data no longer reside on a single system under the control of a single database management system. Instead, data are spread across many different computer systems, each with its own method of database management. Although this trend has undoubtedly made it easier to compile and maintain databases, it has also created an environment in which organizations have literally lost track of who is collecting data, where, and how often. The sheer size of the Great Lakes and the myriad of organizations that collect and maintain data related to the Great Lakes is staggering. A key challenge is how to keep track of data and information that is so widely distributed.

One method of keeping track of information is through the use of metadata.

6.4.1 Metadata Standards

Metadata is the common term assigned to a summary or catalogue of information about data or information. Metadata can be considered data about data. The U.S. Federal Geographic Data Committee defines metadata as "data about the content, quality, condition, and other characteristics of data" (U.S. Federal Geographic Data Committee 1995).

With technology and performance issues gradually being resolved, the focus can now shift to the need for more information about the data to effectively manage and access it. Metadata allows the user to make more informed choices about what data to retrieve, while at the same time providing a method for managing large data sets.

Metadata provides a standard set of details about a data set or information holding. It provides a pointer to who has what and provides the context for an information holding. A metadata entry has a standard set of field entries, which may include some or all of the following:

Title
Author
Originator
Date
Description or Abstract
Subject List
Availability
Point of Contact

Efforts are underway in both Canada and the United States to develop some form of metadata standard for documenting data (e.g., Government Information Locator Service [GILS]). Agencies collecting and using information about the nearshore of the Great Lakes need to agree to use

metadata (even if the standards used are not identical) so that data and information can be found. If this metadata is made available on the World Wide Web on the Internet, it could provide regional access to information about nearshore data and information. The first step is to agree to develop the metadata.

6.5 Sharing/Accessing Data

Attempts to share data across platforms and operating systems have often proved futile because many proprietary systems simply do not talk to each other. The challenge is to provide access to information independent of the location of the data, the type of software used, or the capability of the network or operating system, while at the same time ensuring that data integrity and security is maintained.

The following subsections discuss a few of the opportunities for data sharing.

6.5.1 Common Data-Exchange Formats

In a perfect world, all agencies would store and maintain their information in common formats that could easily be transferred and integrated. This, however, will likely never be the case. With the number of agencies collecting nearshore information, the best that one could hope for is that the information could be converted to some standard exchange format. For example, most database management systems can save information as a .dbf file. Most GIS systems can save information as a .dxf file; most spreadsheet packages can save information as a .wk1 file; and most word processors can accept WP5.1 files. If a set of standard exchange formats such as these could be agreed upon, difficulties in transferring data between agencies could be minimized.

6.5.2 Using the World Wide Web

One of the single most technological phenomena to have hit this planet in the last decade is the explosion of the use of the Internet. The Internet, which is not one big network, but rather a network of networks all interlinked and talking to one another through a common communications protocol, has made it possible for anyone with a computer, a phone line, and a modem to be connected to people around the world. Information that once took days or weeks to transfer (if it could be transferred at all) can now be transported in a just a few seconds around the globe. This new trend opens up a world of opportunities for information exchange.

In the past three years, the number of users on the Internet has grown to over 40 million. This incredible increase in Internet use is largely due to the creation of the World Wide Web (WWW), which works over the Internet. The WWW provides seamless access to information through the use of hyperlinks. The WWW is easy to use and provides a mechanism for finding and retrieving information. What this means for information management is that organizations need post only one copy of a document or database on-line, and millions of people can have access to it. The WWW is a tool for sharing and archiving information and for linking information stored at various

locations. Potentially, the WWW could be used as a means of finding information about nearshore databases and even of accessing those databases, since files can be downloaded directly from the WWW. This method of data dissemination needs to be explored further as a way of sharing and accessing nearshore information.

6.5.3 Existing Great Lakes Networks

There are a number of Great Lakes networks in existence that already make use of the WWW—most notably the Great Lakes Information Network (GLIN). GLIN is a collaborative project of agencies and organizations in the binational Great Lakes region that links data, information, and people via the Internet. GLIN is a window to information about the Great Lakes and links to numerous partner Web pages throughout the region. Its uniform resource locator (URL) is <http://www.great-lakes.net/>. Two primary partners of GLIN are Environment Canada's Great Lakes Information Management Resource (GLIMR), which provides an index of Environment Canada's Great Lakes programs, publications, and databases <http://www.cciw.ca/glimr/>, and U.S.EPA's Great Lakes National Program Office (GLNPO) website <http://www.epa.gov/glnpo/>. GLIN, GLIMR and GLNPO are just a few examples of existing networks that could be used as a basis for developing a Great Lakes nearshore consortium of Web sites so that Great Lakes nearshore information could be easily found on the WWW.

7.0 Where Do We Go From Here?

The following is a summation of ideas presented throughout this report for suggested steps that could be taken to improve the management of nearshore information.

1. Adopt a set of common indicators and protocols for assessing the state of the Great Lakes nearshore ecosystems.

2. Develop some general guidelines and standards for collecting data on these indicators.

3. Identify target areas for data collection to minimize overlap and optimize the use of limited funds.

4. Look for partnership opportunities for data collection and appoint custodians for the long-term maintenance of that data.

5. Agree to document nearshore data and information using some form of metadata standard.

6. Agree on a set of common data-exchange formats.

7. Post metadata and, where possible, data on the World Wide Web.

8. Set up a consortium of nearshore partners over the World Wide Web through some established Web site such as the Great Lakes Information Network (GLIN) and the Great Lakes Information Management Resource (GLIMR).

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APPENDIX 1

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Appendix 1
Information and Information Management Paper
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APPENDIX 2

SURVEY QUESTIONNAIRE

Appendix 2: Survey Questionnaire

QUESTIONNAIRE
SOLEC 96 - NEARSHORE DATABASE / INFORMATION FORM

*Even if your organization does not have databases or information pertaining to the nearshore, we would still appreciate your input on questions **6** and **13**.*

1. Please identify a contact name for the information holding.

   Contact Name: _____

   Organization: _____

   Address: _____

   _____

   Telephone: _____ Fax: _____

   E-mail: _____

2. Please give a name or title to the database or information holding:

3. Please specify the agency (agencies) or organization(s) who are responsible for the database/information holding:

4. Please indicate the purpose for which your database/information holding was developed.

5. Please give a brief description of the database/information holding specifying the attributes associated with the database. (eg.plant species) (You may use the space below, or, attach a separate sheet)

6. Does your agency/organization have a World Wide Web or gopher site on the Internet?

( ) yes - please give URL:
( ) no
( ) under development - anticipated date on-line

If yes, is the database or information holding...

( ) described on-line - please give URL:
( ) accessible on-line - please give URL:

7. Is the database/information holding catalogued elsewhere in a hardcopy or electronic publication? Please specify:

8. Please idenfity what the database/information holding pertains to:

( ) Nearshore Waters
( ) Nearshore Terrestrial
( ) Land Use
( ) Coastal Wetlands
( ) Other, specify

9. When was the information gathered (start - end)?

10. How many data stations are involved (if pertinent) ?

11. What geographic area does the information cover? (be specific)

12. Please indicate the data storage format:

( ) paper - (in published or unpublished report - please give reference):
( ) word processor - software used?
( ) spreadsheet - software used?
( ) database management system (DBMS) - software used?
( ) geographic information system (GIS) - software used?
( ) other, please specify:

13. Please indicate any data/information that your agency requires that to your knowledge

does not exist, or cannot be accessed.

Form completed by: _____ Date: _____

Phone: _____

Thank you for your cooperation and input. Please fax or mail this completed questionnaire (ASAP) to:

Wendy Leger
Water Issues Division
Environment Canada
867 Lakeshore Road
Burlington, ON L7R 4A6

Phone: 905-336-4630
Fax: 905-336-4906
E-mail: wendy.leger@cciw.ca

P.S.

If you know of anyone outside your agency who you think this questionnaire should be sent to, please provide their name and address below. Thank you.

APPENDIX 3

LIST OF CATALOGUES, DIRECTORIES, AND WEB SITES

Appendix 3: List of Catalogues, Directories, and Web Sites

Canadian

Ball, Helen, Pisces Consultants. *Guidelines for Collecting Baseline Aquatic Habitat Data in the Great Lakes Areas of Concern.* Ontario Ministry of Natural Resources, 1995.

Environment Canada. Great Lakes Information Management Resource (GLIMR). World Wide Web site: http://www.cciw.ca/glimr/

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Snell, E., A. Baril, N. Patterson, and P. Cureton. *A Catalogue of Databases Related to Ontario Agro-Ecosystems.* Technical Report Series No. 195. Environment Canada, Canadian Wildlife Service, 1994.

United States

Great Lakes Commission. *Great Lakes Information Network,* World Wide Web site: http://www.great-lakes.net/

National Biological Service. *NBII Directory of Biological Data and Information.* 1996. World Wide Web site: http://www.nbs.gov/nbii/directory.html

NRCS Node to NSDI. The National Resources Conservation Service Node to the National Spatial Data Infrastructure. World Wide Web site: http://www.ncg.nrcs.usda.gov/nsdi_node.html

United States Census Data at Lawrence Berkley National Laboratory. 1995. Demographic data archive from the 1970, 1980, and 1990 U.S. censuses. World Wide Web site: http://cedr.lbl.gov/mdocs/LBL_census.html 10/14/95

United States, Environmental Protection Agency, Center for Environmental Statistics, Geographic Information Systems. 1996. *Access to Geographic Information Systems (GIS) Spatial Data Sites.* Includes Great Lakes Ecosystem Initiative. Federal, state, and local levels. World Wide Web site: http://www.epa.gov/ngispr/

United States Environmental Protection Agency. *Great Lakes National Program Office.* World Wide Web site: http://www.epa.gov/glnpo/

United States Environmental Protection Agency–Great Lakes National Program Office, and the Consortium for International Earth Science Information Network. *Great Lakes Regional Environmental Information System.* 1996. A regional environmental directory and data access system that provides services to the Great Lakes region. World Wide Web site: http://epaserver.ciesin.org:7777/

United States Fish and Wildlife Service. *Catalog of Automated Information Systems.* 1996. A reference of approximately 123 automated information systems owned by or used by the service. World Wide Web site: http://www.fws.gov/search/caisword.html

APPENDIX 4

GREAT LAKES NEARSHORE

INFORMATION HOLDINGS

NOTE: Appendix 4 is an abbreviated version of the information compiled. The full database, which was based on survey results and information gathered from other catalogues, includes ID #, title, purpose, description, WWW site (if it exists), catalogue name (if there is one), the topic area (nearshore waters, nearshore land, wetlands, land use), date gathered, # of stations, geographic area, storage format, agency responsible, contact (if given), telephone #, fax #, e-mail, and data needs.

The full database will be made available with the on-line version of this report. Copies of the full database will also be made available upon request from the SOLEC organizers:

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