

**DEVELOPMENT OF A GREAT LAKES FISH DISTRIBUTION DATABASE
AND WEB-BASED ATLAS OF GREAT LAKES FISHES**

**GREAT LAKES FISHERY COMMISSION
COORDINATION ACTIVITIES PROGRAM**

FINAL REPORT

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Introduction

Fishes are probably the most important biological indicators of ecosystem health in the Great Lakes. Understanding changes in fish distributions over time and the processes responsible for these changes is essential to understanding and successfully managing Great Lakes aquatic ecosystems. A current distribution database and atlas for the whole basin is not available. The development of a standardized Great Lakes fish database and atlas is important for the development of sound management strategies to evaluate, conserve and protect Great Lakes ecosystems. The long-term goals of this project are: 1) to compile a single standardized, georeferenced fish distribution database for the Great Lakes and its tributaries; and, 2) to create a web-based Atlas of Great Lakes Fishes. The project will be undertaken in two phases. The current GLFC Coordination Activities Program grant funds the implementation of Phase 1 only.

Phase 1 (2002-3)

During Phase 1, sources of distributional data will be identified, data will be obtained from these sources where available, a species by grid (Great Lakes proper) and watershed database (tributaries) will be compiled, and an atlas based on this database will be developed for the Internet. Watersheds used will be 8-digit HUCs for the United States and tertiary watersheds for Canada. The Great Lakes proper will be subdivided based on management areas or bathymetry. The web-based atlas will allow queries by species, locality, conservation status, state or watershed, and will display data in shaded map and tabular format. Sources of distributional data will be identified through an e-mail questionnaire sent to biologists working at federal, state and provincial agencies, universities, and museums in the Great Lakes basin. The questionnaire will request information on contact person, nature of data available, and requirements, if any, for a data sharing agreement.

Phase 2 (2003-5)

A standardized, georeferenced database based on data from all sources will be completed during Phase 2. This database will include variables such as: scientific name, common name, locality description, latitude-longitude coordinates, watershed, date of capture, source, and if available, gear type, total numbers caught and CPUE. One of the greatest challenges will be to standardize the format of the source datasets and to georeference data lacking geographic coordinates. By the end of Phase 2, the web-based atlas will be upgraded to allow queries by species, watershed or geographic coordinates, and to display tables for selected shaded areas or selected dots on the maps.

Progress to Date

Distribution Database

Sources of distributional data were identified by examining the available literature and by sending an e-mail questionnaire to biologists working at federal, state and provincial agencies, universities, and museums in the Great Lakes basin. The distribution list of biologists contacted is in Table 1, and the questionnaire is in Appendix 1. In addition, I presented a poster outlining the project at the Lower Lakes Meeting and annual IAGLR conference in 2002. Despite repeated requests, I was not scheduled to give a presentation at the Upper Lakes Meeting in 2002.

Response to the questionnaire was low; however, a recent reminder e-mail has improved the response rate. A further reminder during the summer of 2004 resulted in 10 more responses and the addition of 179,840 records. The distribution database currently contains 348,484 georeferenced records in a standardized format (species, latitude longitude, watershed, source). This number represents a number lower than reported in previous reports (~407,000) as a result of removing all records from the St. Lawrence basin east of 45°N, and all duplicate records indentified through a thorough QA/QC of the database. Watersheds were assigned to each record using a spatial join between a watershed layer and point layer in ARCVIEW. A map of all of the distributional points (Figure 1), a map of native species richness by watershed (Figure 2), and a frequency histogram of species richness (Figure 3) indicate that the database provides relatively good coverage for most of the basin. However, additional data will be required to overcome spatial and temporal shortcomings.

Table 2 lists problems encountered during compilation of the initial database, and possible solutions to these problems. Data for the Great Lakes proper are particularly problematic for several reasons: 1) many are not georeferenced or assigned a grid number, but simply identified by landmark such as shoal or distance from mainland; 2) many are georeferenced to home port as opposed to actual location of capture; and, 3) many are only in hard copy format. These records must be corrected manually. Due to the problematic nature of existing records and overall paucity of records for the Great Lakes proper, mapping of records by subdivisions of each Great Lake was not undertaken.

Web Site

A GIS-based web site has been developed based on ARC/IML and Crystal Reports software. The web site allows the database to be queried to generate species lists by Great Lake, state/province or watershed (tertiary watersheds in Canada, 8-digit hydrologic unit codes in the United States). Lists can be generated for all species, or only for those species with a conservation listing with the listings summarized for all jurisdictions covered by the geographic area (i.e. Great Lake, state/province or watershed). The database can also be queried to generate species distribution maps. Species distributions are represented by shaded watersheds. The distribution of species in

the Great Lakes proper is represented by the shading of the whole lake rather than subdivisions of the lake due to the problems with data for the Great Lakes proper outlined above. Appendix 2 provides screen captures of each page in the web site, and of each major function.

The web site is currently hosted by a DFO Intranet site. However, to be available on the Internet, it will have to be hosted on another server due to the DFO firewall and bilingual policy. ARC/IML and Crystal Reports software will be required for the host server. As these are expensive licenses but do have substantial discounts for academic users, it is recommended that the web site be hosted at a university.

The mapping website is currently being moved to a server at the University of Guelph. Rob McLaughlin and I will combine my web atlas and his fish passage database on a single GLFC "satellite" web site at the University of Guelph. It is anticipated that this site will be functional in Spring 2005.

Workshop

Data holders and potential users of the web site were enthusiastic about its development, but were generally less enthusiastic about attending a workshop. Therefore, the proposed workshop was not held. However, an overview of the web site was presented at the Barrier Placement Protocol workshop in July 2003. Many of the attendees were data holders and provided useful feedback on the database and website.

Next Steps

Phase 1 is complete except for placing it on a server and mapping within each of the Great Lakes proper. It will be placed on the University of Guleph server in Spring 2005.

Phase 2 is feasible and would take at least two years to complete at a total cost of about \$100,000 (see Appendix 3 for draft budget).

Table 1. List of biologists sent the e-mail questionnaire. See Appendix 1 for questionnaire.

Name	Agency
Erin Damage	Ausable Bayfield Conservation Authority
	Canadian Museum of Nature
Faith McGruther	Chippewa-Ottawa Treaty Fishery Management Authority
Tom Gorenflo	Chippewa-Ottawa Treaty Fishery Management Authority
Amy McCune	Cornell University
Ed Mills	Cornell University
Lars Rudstam	Cornell University
Marci Meixler	Cornell University
Mark Bain	Cornell University
	Credit Valley Conservation Authority
Sam A. Stephenson	Department of Fisheries and Oceans
Richard Greenwood	Environmental Protection Agency
	Grand River Conservation Authority
Bill Mattes	Great Lakes Fish and Wildlife Indian Commission
Jim Schlender	Great Lakes Indian Fish and Wildlife Commission
Sherwin Watson-Leung	Halton Region Conservation Authority
Bruce Duncan	Hamilton Conservation Authority
Thomas Trudeau	Illinois Department of Natural Resources
Christine Mayer	Illinois Natural History Survey
Mike Retzer	Illinois Natural History Survey
Brian Breidert	Indiana Department of Natural Resources
Tom Simon	Indiana USGS
John Gunn	Laurentian University
Pat Chow-Fraser	McMaster University
Gary Towns	Michigan Department of Natural Resources
James Peck	Michigan Department of Natural Resources
John Schrouder	Michigan Department of Natural Resources
Kelley Smith	Michigan Department of Natural Resources
Mike Thomas	Michigan Department of Natural Resources
Paul Seelbach	Michigan Department of Natural Resources
Richard D. Clark, Jr.	Michigan Department of Natural Resources
Steven Scott	Michigan Department of Natural Resources
Dan Hayes	Michigan State University
Mike Jones	Michigan State University
Thomas Burton	Michigan State University
Thomas Coon	Michigan State University
Ted Halpern	Minnesota Department of Natural Resources
Doug Carlson	New York State Department of Environmental Conservation
Robert Lange	New York State Department of Environmental Conservation
Steven R. LaPan	New York State Department of Environmental Conservation
William J. Culligan	New York State Department of Environmental Conservation
Lee Ann Hamilton	Niagara Peninsula Conservation Authority
Stephen Brandt	NOAA
Leo Luong	Nottawasaga Valley Conservation Authority
Roger Knight	Ohio Department of Natural Resources
John Baird	Ohio Department of Transportation
Dave McLeish	Ontario Ministry of Natural Resources

Don Hector	Ontario Ministry of Natural Resources
Don MacLennan	Ontario Ministry of Natural Resources
Larry Halyk	Ontario Ministry of Natural Resources
Rick Salmon	Ontario Ministry of Natural Resources
Rob Steedman	Ontario Ministry of Natural Resources
Steve Gile	Ontario Ministry of Natural Resources
Tom Stewart	Ontario Ministry of Natural Resources
Ken Cullis	Ontario Ministry of Natural Resources
Les Stanfield	Ontario Ministry of Natural Resources
Cynthia J. A. Mitton	Ontario Ministry of Transportation
Jay Stauffer	Pennsylvania State University
Carrie Brower	Pennsylvania Fish and Boat Commission
Roger Kenyon	Pennsylvania Fish and Boat Commission
Wayne Myers	Pennsylvania State University
Erling Holm	Royal Ontario Museum
Heather MacKenzie	St. Clair Conservation Authority
Dave McNeill	SUNY
Don Stewart	SUNY - Syracuse
Neil Ringler	SUNY - Syracuse
Rosanne Fortner	The Ohio State University
Ted Cavender	The Ohio State University
Scott Jarvie	Toronto and Region Conservation Authority
Chris Castiglione	United States Fish and Wildlife Service
Janet Smith	United States Fish and Wildlife Service
Tom Busiahn	United States Fish and Wildlife Service
Donna Myers	United States Geological Survey
James H. Johnson	United States Geological Survey
Leon Carl	United States Geological Survey
Michael Burr	United States Geological Survey
Owen Gorman	United States Geological Survey
Richard Whitman	United States Geological Survey
Robert O'Gorman	United States Geological Survey
Walter Loope	United States Geological Survey
Joseph H. Elrod	United States Geological Survey
Roger Bergstedt	United States Geological Survey
Kevin Kane	University of Iowa
Dave Jude	University of Michigan
Ed Rutherford	University of Michigan
Doug Nelson	University of Michigan Museum of Zoology
Jay Hatch	University of Minnesota
Don Jackson	University of Toronto
Harold Harvey	University of Toronto
Nick Collins	University of Toronto
Carroll R. Norden	University of Wisconsin
Arthur Brooks	University of Wisconsin-Madison
John Schwindt	Upper Thames River Conservation Authority
Valerie Towsley	Upper Thames Valley Conservation Authority
Don Fago	Wisconsin Department of Natural Resources
William H. Horns	Wisconsin Department of Natural Resources

Table 2. Data problems encountered during compilation of initial database.

Problem	Proposed Solution
1. Accessing data	<ul style="list-style-type: none">• E-mail questionnaire.
2. Incomplete or erroneous georeferencing data, particularly for the Great Lakes proper	<ul style="list-style-type: none">• Identify and check outliers on species maps.• Use locality data to manually locate correct latitude-longitude with aid of digital atlas or gazetteer.
3. Lack HUC, watershed, grid codes	<ul style="list-style-type: none">• Spatial join in ARCVIEW
4. Old species names	<ul style="list-style-type: none">• Standardize species names based on latest AFS list. Create look-up table in MS Access.
	<ul style="list-style-type: none">• Manually input data.

Figure 1. Distribution of all records in the database.

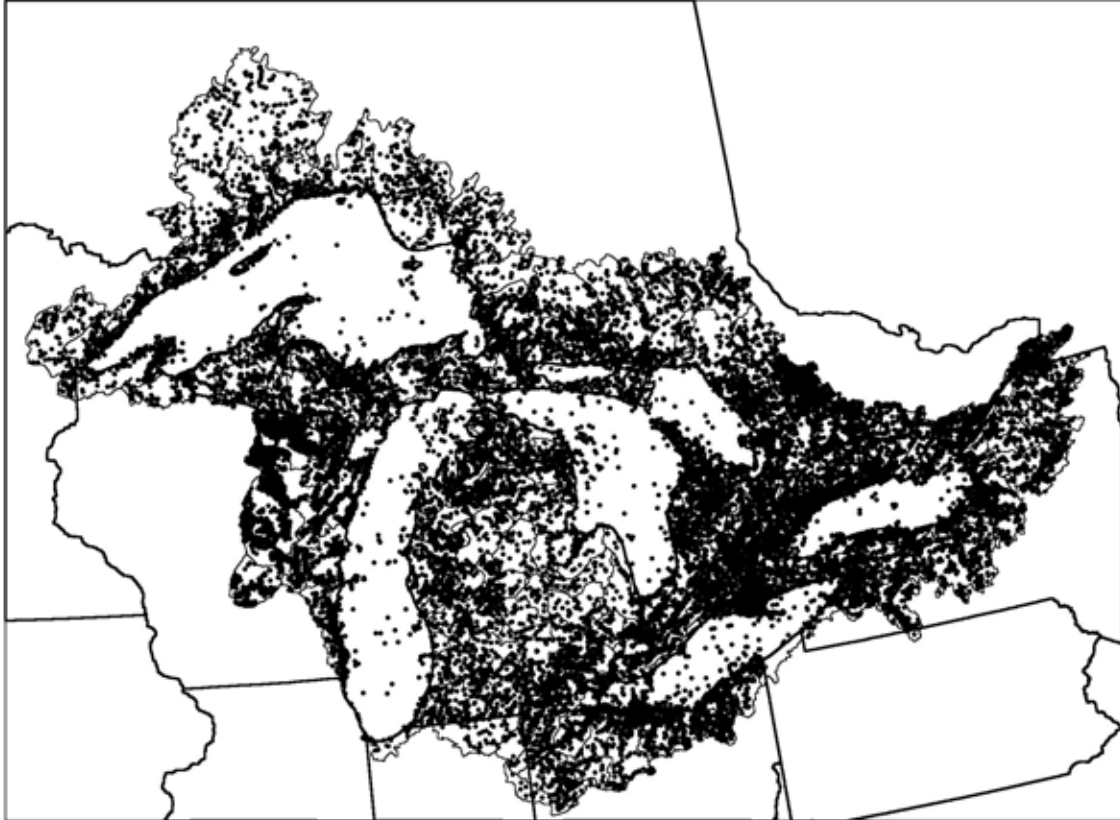


Figure 2. Species richness by watershed based on current database.

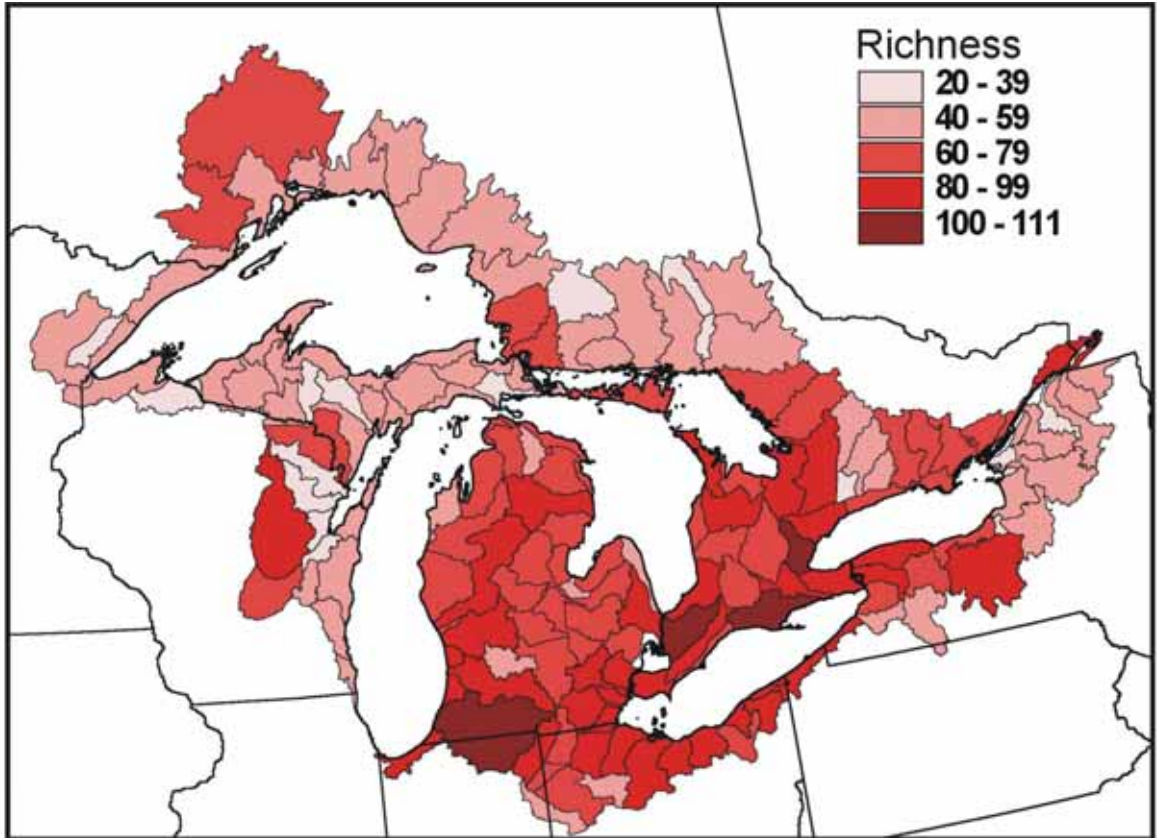
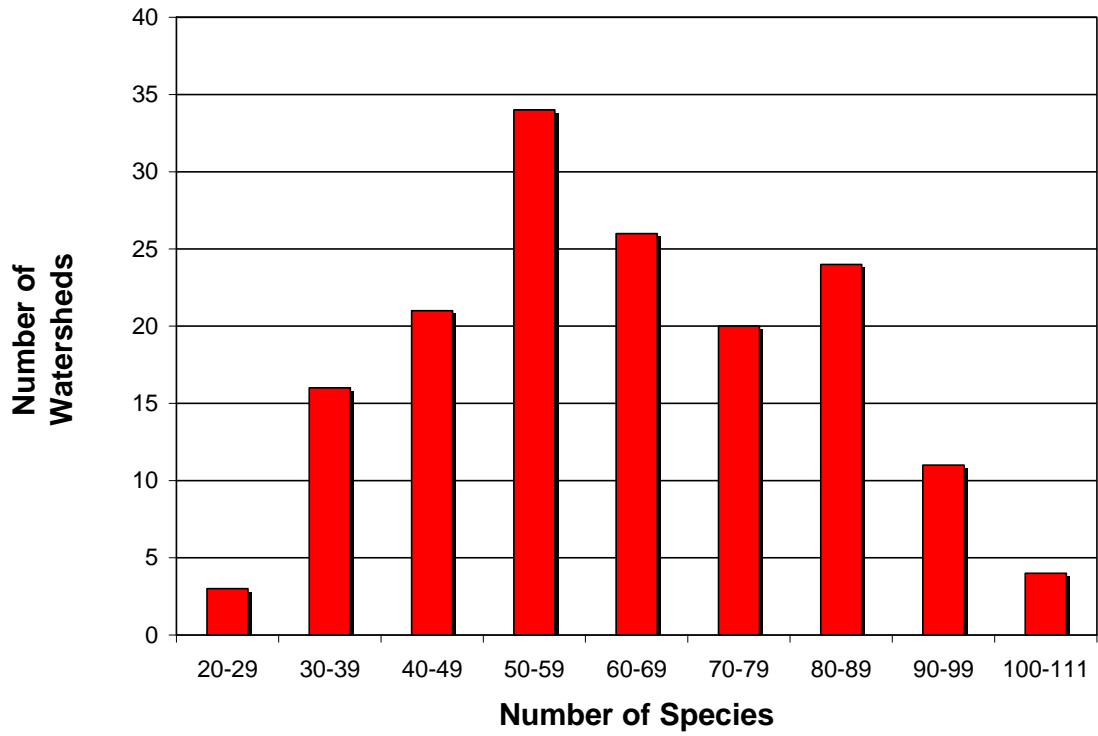


Figure 3. Frequency distribution of species richness by watershed.



Appendix 1 – Questionnaire sent to biologists working at federal, state and provincial agencies, universities, and museums in the Great Lakes basin.

Great Lakes Freshwater Fish Distribution Database Questionnaire

Please note that the purpose of this question is to determine the availability and extent of data for Great Lakes fishes. Completion of this questionnaire does not obligate the respondent in any way. Please fill out a separate questionnaire for each data base.

1A. Name of Institution:

1B. Name of Contact:

1C. Address of Contact:

1D. Telephone Number of Contact:

1E. E-mail Address of Contact:

2. Number of Great Lakes freshwater fish records available.

Format	# Records
Computerized	
Hard Copy	

3. Indicate the availability of required data for each record. Indicate numbers where possible.

Variable	None	Some	All
Scientific Name			
Waterbody Name			
Locality Description			
State			
Latitude-Longitude			
UTM			
Legal Description (T/R/S)			
USGS Hydrologic Unit Code (HUC)			
Date of Capture			

4. If some or all records are only in hard copy format, please answer the following questions.

A) If available, would funding facilitate the computerization of hard copy records?

B) Please estimate the amount of money required to computerize all hard copy records.

C) Please estimate the number of man hours required to computerize all hard copy records.

5. Please indicate availability of records for various projects.

Project	Available	Not Available
Web-based Atlas of Great Lakes Fishes (non-profit)		
Hard copy Atlas of Great Lakes Fishes (non-profit)		
Biogeographic Analyses (non-profit)		

6. Please note any conditions for use. Prior to sending data, data providers will be asked to sign a Data Sharing Agreement that explicitly states the intended uses of the data.

7. Please note digital format and media in which data are available (Access, Excel, QuattroPro or ASCII formats, FTP or diskette media preferred).

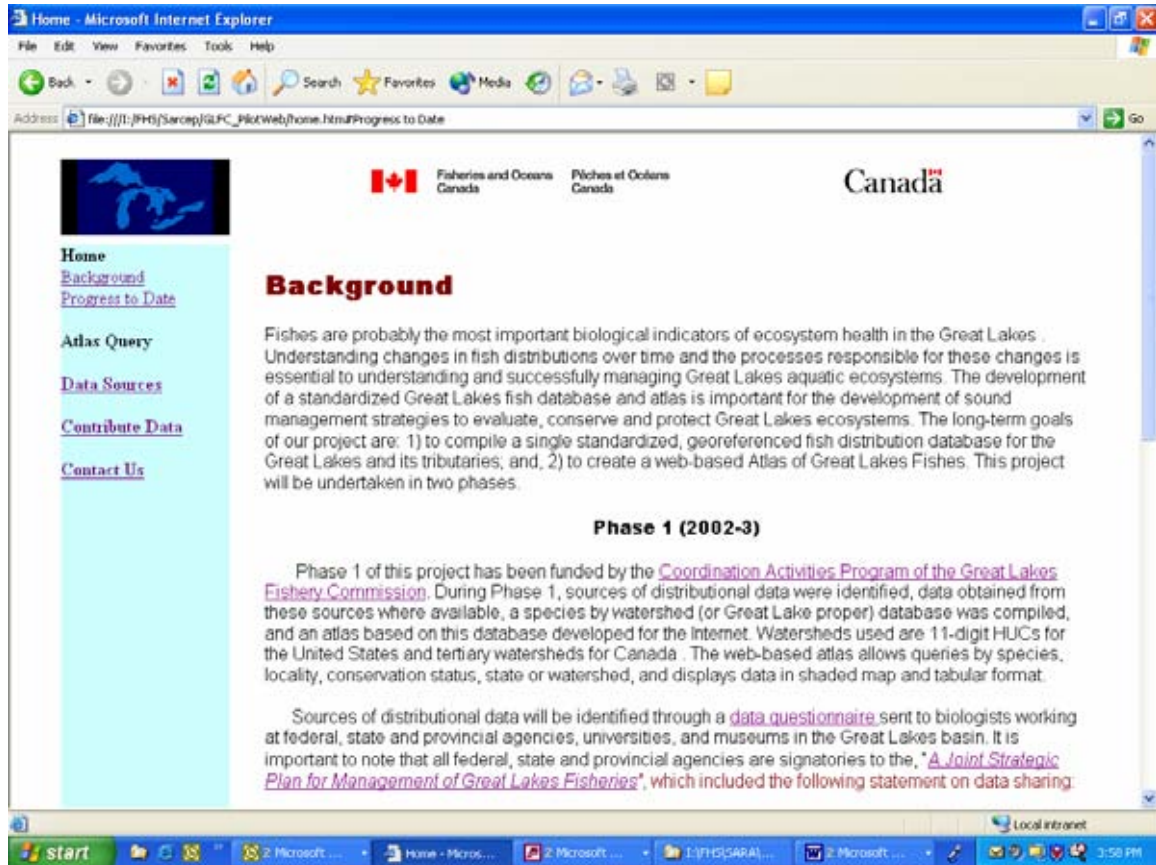
8. Would you be interested in attending a workshop to discuss the development and potential uses of the web-based atlas?

Please e-mail (preferred), snail mail or fax to:

Nicholas E. Mandrak
Research Scientist
Great Lakes Laboratory for Fisheries and Aquatic Sciences
867 Lakeshore Road
Burlington, Ontario
Canada L7R 4A6
Tel: 905-336-4842 Fax: 905-336-6437
mandrakn@dfo-mpo.gc.ca

Appendix 2. Screen captures of each page in the web site, and of each major function.

Home Page



Atlas Query Page

ArcIMS Viewer - Microsoft Internet Explorer

Disclaimer | Help | Contact Us

Great Lakes Fishery Commission

Protecting Our Fishery

Legend

- Great Lakes Drainage Basin
- Tertiary Watershed
- State / Provinces
- Basin
- Inflow
- Lake Erie
- Lake Huron
- Lake Michigan
- Lake Ontario

MAP LAYERS

Visible Active

- Major Roads
- Great Lakes Drainage Basin
- Tertiary Watershed
- State / Provinces

Great Lakes Species Report

Watershed	<input type="text"/>	Species Report	Conservation Report
Region	Lake Michigan	Species Report	Conservation Report
All Species	alewife	Distribution Map	Picture
Species at Risk	American brook lamprey	Distribution Map	Picture

Report Tool

Fisheries and Oceans Canada / Pêches et Océans Canada

Longitude: 88° 12' 2" West Latitude: 47° 28' 27" North

Local intranet

start Microsoft D... A:1 Microsoft Excel Internet Ex... Document - H... 5:10 PM

Atlas Query Page

Mapping Tools – zoom in/out; move around map; add symbols/text; identify watershed; identify latitude/longitude.

Queries: by region (Great Lake, state/province, watershed); by species. Both for all species and only species with conservation listing.

Reports: species by region; species distribution maps. Both for all species and only species with conservation listing.

Layers: watersheds; political boundaries; major roads; Great Lakes drainage basin. All can be turned off.

The screenshot displays the ArcIMS Viewer interface for the Great Lakes Fishery Commission. The main map shows the Great Lakes region (Lake St. Clair, Lake Erie, Lake Huron, Lake Michigan, and Lake Ontario) with a red outline indicating the Great Lakes Drainage Basin. The map is overlaid with various layers including watersheds, political boundaries (states/provinces), and major roads. The interface includes a navigation toolbar on the left, a legend on the right, and a 'MAP LAYERS' panel at the bottom right. Below the map is a 'Great Lakes Species Report' form with fields for Watershed, Region (set to Lake Michigan), All Species (set to alewife), and Species at Risk (set to American brook lamprey). The form includes buttons for 'Species Report', 'Conservation Report', 'Distribution Map', and 'Picture'. The footer of the page features the Canada logo and the text 'Fisheries and Oceans Canada / Pêches et Océans Canada'. The browser window title is 'ArcIMS Viewer - Microsoft Internet Explorer' and the status bar shows the coordinates 'Longitude: 80° 30' 56" West, Latitude: 42° 7' 8" North'.

Sample Query – Alewife Distribution

The screenshot shows the ArcIMS Viewer interface for the Great Lakes Fishery Commission. The main map displays the Great Lakes basin with a red outline indicating the Alewife distribution area. A dropdown menu is open over the map, listing various fish species, with 'alewife' selected. The interface includes a legend, map layers, and report tools.

Legend

- Major Rivers
- Great Lakes Drainage Basin
- Tertiary Watershed
- State / Province
- Basin
- Basin
- Lake Erie
- Lake Huron
- Lake Michigan
- Lake Ontario
- Lake St. Clair
- Lake Superior

MAP LAYERS

- Visible Active
- Major Rivers
- Great Lakes Drainage Basin
- Tertiary Watershed
- State / Province

Great Lakes Species Rep

Interstate

Region

All Species

Species at Risk

American brook lamprey
American eel
American shad
Arctic grayling
Atlantic salmon
Aurora trout
European flounder
Iowa darter
Banded darter
Banded killifish
Alewife
American brook lamprey

Species Report Conservation Report

Species Report Conservation Report

Distribution Map Picture

Distribution Map Picture

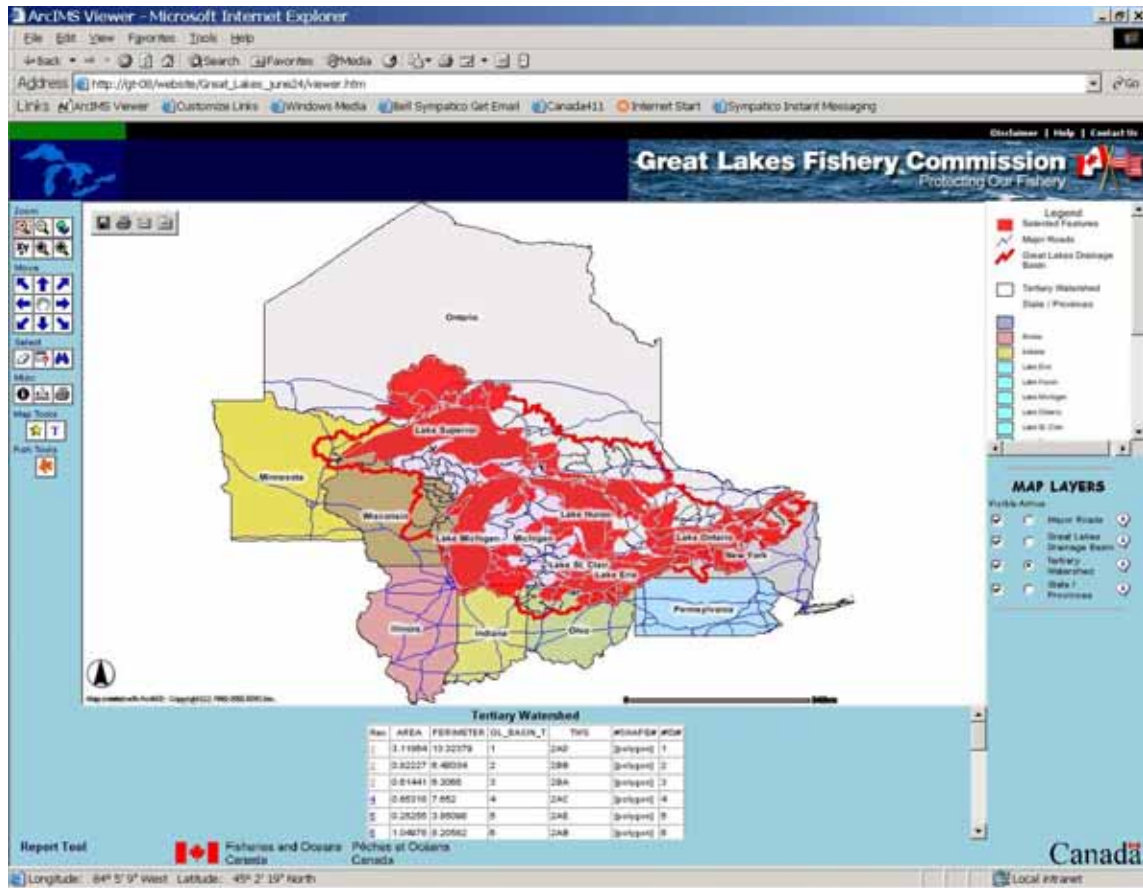
Report Tool

Fisheries and Oceans Canada / Pêches et Océans Canada

Canada

Local intranet

Sample Query – Alewife Distribution



Sample Report: All Species by Region (Watershed) 2GG

SAR_Launcher - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address: C:\mandrak\GLDatabase\Report\GL\html\2gg_spp_rep.htm

1 of 3

powered by crystal

 Fisheries and Oceans Canada Pêches et Océans Canada

All Species Report
Great Lakes Watershed Code: [2GG](#) Page 1 of 3

SCIENTIFIC NAME	COMMON NAME
<i>Alosa pseudoharengus</i>	alewife
<i>Lampetra appendix</i>	American brook lamprey
<i>Alosa sapidissima</i>	American shad
<i>Fundulus diaphanus</i>	banded killifish
<i>Ictalurus cyprinellus</i>	bigmouth buffalo
<i>Ameiurus melas</i>	black bullhead
<i>Pomoxis nigromaculatus</i>	black crappie
<i>Notropis heterodon</i>	blackchin shiner
<i>Rhinichthys atratulus</i>	blacknose dace
<i>Notropis heterolepis</i>	blacknose shiner
<i>Percina maculata</i>	blackside darter
<i>Fundulus notatus</i>	blackstripe topminnow
<i>Lepomis macrochirus</i>	bluegill
<i>Pimephales notatus</i>	bluntnose minnow
<i>Ameiurus calva</i>	bowfin
<i>Hybognathus hankinsoni</i>	brassy minnow
<i>Noturus mairius</i>	brindled madtom
<i>Labidesthes sicculus</i>	brook silverside
<i>Culaea inconstans</i>	brook stickleback
<i>Salvelinus fontinalis</i>	brook trout
<i>Ameiurus nebulosus</i>	brown bullhead
<i>Salmo trutta</i>	brown trout

Done Local intranet

start

Inbox - Micros... C:\mandrak\GL... 2 Microsoft ... Microsoft Excel... SAR_Launcher ... 12:06 PM

Sample Report: All Species with Conservation Listing by Region (Watershed) 2GG

SAR_Launcher - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address C:\mandrak\G\Database\Report\GtLkBasin\G_ntrn\2gg_Con_Rep.htm

1 of 18

 Fisheries and Oceans Canada Pêches et Océans Canada

Species Conservation Report
Great Lakes Watershed Code: 2GG Page 1 of 10

SCIENTIFIC NAME	COMMON NAME	Jurisdiction	Rank	System
<i>Acipenser fulvescens</i>	lake sturgeon	Canada	NAR	COSEWIC
		Canada	N	Nrank
		Global	O3	Orank
		Ontario	S3	Strank
<i>Alosa sapidissima</i>	American shad	Global	O5	Orank
		Ontario	SX	Strank
<i>Ambloplites rupestris</i>	rock bass	Canada	N5	Nrank
		Global	O5	Orank
		Ontario	S5	Strank
<i>Ameiurus marmoratus</i>	Marbled Hellbender	Jurisdiction	Rank	System

Done

start

Inbox - Micro... C:\mandrak\G... 2 Microsoft... SAR_Launcher... SAR_Launcher... Local intranet 12:08 PM

Data Sources Page

Data Sources HOME

Digital data have been acquired from the following agencies:

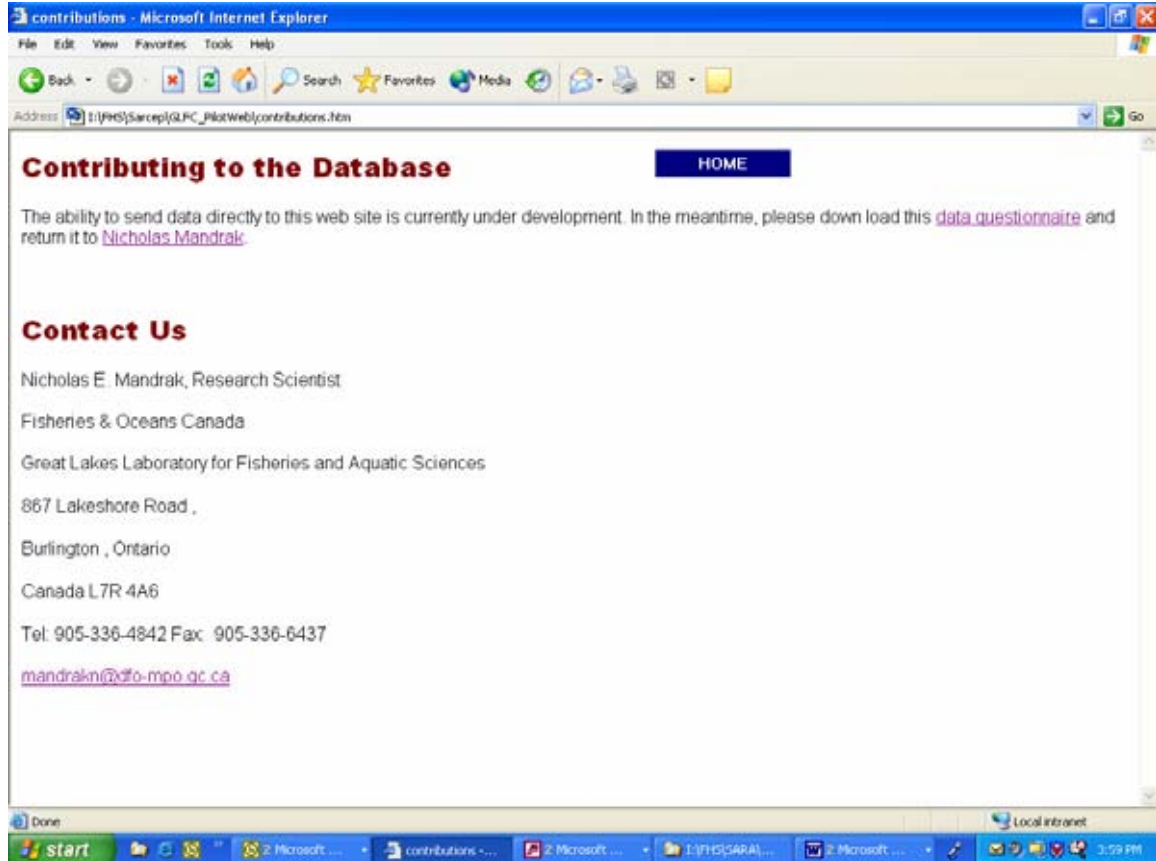
- [Bell Museum of Natural History, University of Minnesota](#)
- [Canada Department of Fisheries and Oceans](#)
- [Canadian Museum of Nature](#)
- [Great Lakes Fishery Commission \(BILD Project\)](#)
- Illinois Natural History Survey
- [Michigan Department of Natural Resources](#)
- [New York Department of Environmental Conservation](#)
- [Ohio Environmental Protection Agency](#)
- [Ontario Ministry of Natural Resources](#)
- [Royal Ontario Museum](#)
- [University of Michigan Museum of Zoology](#)
- [Wisconsin Department of Natural Resources](#)

Data were digitally derived from hard copy maps in the following sources:

- [Becker, G.C. 1903, Fishes of Wisconsin, University of Wisconsin Press, Madison, WI.](#)

http://www.bellmuseum.org/ Local intranet

Contributing/Contact Page



Appendix 3. Proposed budget for Phase 2.

BUDGET BREAKDOWN

I. Direct Costs

	Year 1	Year 2	Subtotal
A. Salaries and Wages			
FT technician`	\$35,000	\$35,000	\$70,000
website consultant	\$ 5,000	\$15,000	\$20,000
B. Maintenance and Operation			
1. Supplies (Computer Supplies, ESRI licence)	\$3,000	\$3,000	\$ 6,000
2. Travel	\$5,000	\$5,000	\$10,000
3. Communications	\$ 500	\$ 500	\$ 1,000
Total	\$48,500	\$58,500	\$107,000