

A. PROJECT DESCRIPTION:

Project Title: A Model GIS Assessment of Nonindigenous Invasive Species in Michigan Waters

Business Organization:

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Abstract:

Nonindigenous aquatic invasive species (NIS) pose significant risks to the ecological and economic integrity of the Great Lakes-St. Lawrence system. The Great Lakes Commission proposes to develop and implement an Internet-based spatial database of NIS invasions within the state of Michigan in an effort to improve coordination among resource managers and thereby enhance prevention and control measures. The project will build on current NIS prevention and control work being conducted in the state, bringing together information from local, state and federal sources. In doing so, the database will provide timely, valid, reliable and practical information to assist managers and decision makers in implementing NIS prevention and control efforts within the state. Further, the project will identify unmet data and information needs that, once addressed, will enhance the validity, detail and utility of the spatial database.

B. WORK STATEMENT

Statement of the problem:

Nonindigenous aquatic invasive species (NIS) pose significant risks to the ecological and economic integrity of the Great Lakes-St. Lawrence system. Nationwide, control efforts for zebra mussels, purple loosestrife and sea lamprey alone are estimated to cost \$365 million/year (Pimental et al., 1999). The problem of NIS is second only to habitat loss as a factor causing significant declines in biodiversity. The Great Lakes Commission proposes to develop and implement an Internet-based spatial database of NIS invasions within the state of Michigan in an effort to enhance prevention and control measures, advance information and education activities, and improve coordination among resource managers. The project will build on current NIS management and control work being conducted in the state and the region, bringing together information from local, state and federal sources. In doing so, the database will provide timely, valid, reliable and practical information to assist managers and decision makers in implementing NIS prevention and control efforts within the state. Further, the project will identify unmet data and information needs that, once addressed, will enhance the validity, detail and utility of the spatial database. All of this will help limit the spread of established populations of NIS into uninfested waters, an objective outlined in Michigan's state management plan.

A spatial data layer for each of the major NIS species of concern within Michigan waters will be developed. Species include Eurasian watermilfoil, *Myriophyllum spicatum*; round goby, *Neogobius*

melanostomus; ruffe, *Gymnocephalus cernuus*; purple loosestrife, *Lythrum salicaria*; sea lamprey, *Petromyzon marinus*; spiny water flea, *Bythotrephes cederstroemi*; and zebra mussel, *Dreissena polymorpha*. The data and map layers will be contributed by various specialized agencies and organizations active within the region, including the Great Lakes Commission. The following have expressed a willingness to collaborate on the project by providing the necessary data for the relevant species:

Invasive Species:	Data Source Contact:
Eurasian Watermilfoil, Zebra Mussel (Inland waters)	Dennis Zimmerman Michigan Lake and Stream Association (MLSA) 716 E. Forest, P.O. Box 325, Lake George, MI 48633-0325
Round Goby	Dr. David Jude Great Lakes & Aquatic Sciences University of Michigan, Ann Arbor, Michigan 48109
Ruffe	Mark Dryer U.S. Fish and Wildlife Service, Fishery Resources Office 2800 Lake Shore Dr., E., Ashland, WI 54806
Purple Loosestrife	Mike Klepinger Michigan Sea Grant College Program, Michigan State University 334 Natural Resources Bldg., East Lansing, MI 48824
Sea Lamprey	Gavin Christie Great Lakes Fishery Commission 2100 Commonwealth Blvd., Suite 100, Ann Arbor, MI 48105
Spiny Water Flea	Dr. Henry Vanderploeg National Oceanic and Atmospheric Administration Great Lakes Environmental Research Laboratory 2205 Commonwealth Blvd., Ann Arbor, MI 48105
Zebra Mussel (Coastal waters)	Dr. Thomas Nalepa National Oceanic and Atmospheric Administration Great Lakes Environmental Research Laboratory 2205 Commonwealth Blvd., Ann Arbor, MI 48105

As the data sharing aspect of the project moves forward, additional partners and data sources may be identified. In addition, representatives from the Michigan Natural Features Inventory, the Great Lakes Science Center of the U.S. Geological Survey (USGS), and the Great Lakes Indian Fish and Wildlife Commission have also expressed interest in prospective project collaboration and coordination. The Florida Caribbean Science Center, which runs USGS's national invasive species mapping program, is also interested in collaborating on this project. Because of the Commission's established partnerships and proximity to the data source, this project will enhance USGS's mapping efforts by providing additional and more detailed NIS infestation information.

The Great Lakes Commission recognizes that data quality will vary somewhat by agency and topic. Several prospective issues have been identified and will be addressed to ensure the validity of project

outcomes. Three such considerations are:

Spatial accuracy – Most of the spatial reference layers available for the state of Michigan were developed at a scale of 1:24000 and will serve well for all but site-specific analysis or planning work. Species data, however, may vary significantly in the accuracy of its spatial coordinates; detailed comparisons between data from different sources or data for different species may therefore need to be qualified in some instances.

Vintage of the data – Collection intervals for some species data may at times make cross-species comparisons difficult. In addition, certain spatial reference layers are based on older paper maps. They are usable for general orientation, but may need to be supplemented with more detailed data when applied locally.

Completeness of coverage – The intensity of species data collection efforts may vary across the state. Care will be taken to differentiate areas that have not yet been subject to monitoring from those where no evidence of a particular NIS infestation was found.

To assist users in making informed decisions about any data quality issues that arise, a metadata file will be provided for each of the layers used in the mapping tool. This file, meeting the standards of the Federal Geographic Data Committee, will include information about the data source, spatial accuracy, vintage of the data, a key to the meanings of data entries, etc. The website will include a condensed version of this information as part of providing effective orientation to site visitors using the mapping tool.

The Great Lakes Commission has the capacity to accept data sets in a variety of formats. The preferred format is ArcView shapefiles, but formats such as CAD files, ArcINFO layers, individual database tables, Excel spreadsheets and several types of delimited text files can all be used to produce GIS data layers. The Great Lakes Commission will work with the data source contacts to evaluate the existing data and determine the most appropriate format for submission.

Once gathered, the data will be saved to a standard computer file format compatible with commercial geographic information system (GIS) software and matched to a set of reference map features, including political boundaries down to the county level, major roads, inland surface water features, and cultural features such as beaches and boat launch sites. These data layers will be incorporated into an Internet-based, live-mapping application with tools for zooming and panning, for turning reference features on or off as desired, and for choosing which NIS layers are displayed. This application will allow the user to emphasize and view a single species, selected species together, or all species at the same time. Mapping results will be printable for use in reports, planning efforts, and for general orientation. In addition, most of the data layers will be available for download to the user's computer, where they can be incorporated into GIS and analysis tools as part of other efforts.

There may be more than one agency or organization collecting data for a particular species. If this happens, project staff will turn to the data source contacts. The data source contacts were specifically chosen for their work regarding each species, and they will play a key role in the data evaluation process. Where multiple data sets are deemed appropriate for inclusion in this project, the user will be given a choice of several map layers for that species. One layer will highlight geographic areas (water bodies, survey units, etc.) where the species of interest has been located and provide users with an overview of what datasets exist for any given location. The user will then be able to overlay other layers drawn from individual datasets at his or her discretion, with each of these individual datasets being presented at its highest resolution.

The project will provide resource managers within the state and region access to valuable NIS mapping and analysis tools. The data developed for this mapping tool will provide a baseline of current NIS invasions, allowing managers to identify priority areas for prevention and control efforts. For example, by merging NIS data layers with regional data developed for other projects at the Great Lakes

Commission, managers will be able to view ports, marinas, and harbors where NIS infestations exist. These areas can then be targeted for increased outreach efforts aimed at limiting the spread of NIS from these facilities via recreational and commercial users. From another angle, the mapping tool will be able to highlight locations within Michigan where monitoring activity has shown an absence of NIS infestations. These areas, particularly those of pristine quality, could benefit from increased efforts to prevent the introduction and spread of NIS. The data layers also will help identify data gaps and determine where future monitoring efforts are needed, as well as highlighting redundant monitoring efforts. Finally, maps showing the presence of NIS at specific locations can be used in the development of strategies focused on removing new and isolated infestations and containing the primary infestation.

In addition to the state-specific technical aspects of the project, the proposed tasks will also address two broader goals. The first is to foster local, state/provincial and regional cooperation and collaboration regarding prevention and control of invasive species, pursuits already being advanced by numerous projects at the Great Lakes Commission. A single online GIS database for priority NIS infestations in Michigan will improve data sharing among local, state and federal agencies and eliminate redundant data collection. The second is the development of a predictive tool through the integration of data from multiple spatial and temporal zones across the entire Great Lakes region. The capacity to view a particular species throughout the region on a spatial and temporal level will provide resource managers with information on invasion patterns and the basis for predicting future NIS infestations. This information will enhance the formulation of timely responses to eradicate or control invasions in new areas. The Great Lakes Commission is in the process of developing a model rapid response plan that will facilitate effective use of this GIS framework. The database will also allow for the evaluation of the effectiveness of NIS management efforts. Thus, the Great Lakes Commission will seek additional funding to apply the database and Internet delivery model developed for this project to the other Great Lakes states and provinces and for other invasive species infestations within the state and region. Future grant applications to regional and national funding agencies will pursue additional funds to support monitoring efforts and provide regular updates to the database.

Invasive species mapping efforts do not promise to eliminate NIS and the problems they pose. However, these efforts will serve as a valuable planning tool to effectively use limited funds in the control of NIS infestations within the state of Michigan and the entire Great Lakes-St. Lawrence system.

Literature Review:

The proposed project will build upon and complement existing NIS prevention and control efforts. Further, it responds to recommendations supported in numerous regional policy statements and strategic plans the state of Michigan is party to. For example, the *Great Lakes Action Plan for the Prevention and Control of Aquatic Nuisance Species*, signed in 2001 by all Great Lakes governors and premiers, calls for the region's leadership to "act promptly and decisively to attain three goals: 1) prevent the unauthorized introduction of nonindigenous aquatic nuisance species; 2) limit the spread of established aquatic nuisance species within the region; and 3) minimize the harmful ecological, economic, social and public health impacts resulting from aquatic nuisance species already present." In addition, the proposed project responds to recommendations of the Great Lakes Panel on Aquatic Nuisance Species, the Great Lakes Commission's *Great Lakes Program to Ensure Environmental and Economic Prosperity*, and the U.S. Policy Committee's *Great Lakes Strategy*. Also, the project addresses unmet needs identified in an exhaustive research inventory and analysis conducted by the Great Lakes Panel several years ago.

The proposed project is also called for under the *Model Comprehensive State Management Plan for the Prevention and Control of Nonindigenous Aquatic Nuisance Species*, a document developed by the Great Lakes Panel on Aquatic Nuisance Species. A specific task of the Model Plan is to "establish/participate in monitoring programs that emphasize partnerships between federal/state/local agencies; business/industry; academic institutions; and resource user groups. The feasibility of various

technologies (e.g. Geographic Information Systems (GIS)) should be explored in designing such programs.”

The proposed project addresses a *Michigan ANS State Management Plan* goal to “provide resources and collaborative networks for research and monitoring activities regarding aquatic nuisance species in Michigan.” This goal is to be achieved by “augmenting data availability and collaboration among agencies, researchers and industry to increase the efficiency and usefulness of information and technology transfer in decision-making.” The Plan also calls for specific activities such as “coordinating data and mapping to improve availability and utility of information,” and “supporting collaboration on project and data sharing among research entities.”

The proposed project will complement several existing efforts being conducted by the Great Lakes Commission regarding rapid response and early detection. In conjunction with the Great Lakes Panel on Aquatic Nuisance Species, the Commission is in the process of developing a model rapid response plan for the region. A “rapid response” capability for newly discovered invasive species in the Great Lakes region will significantly enhance mitigation prospects and slow the spread of such species. In addition, the Great Lakes Commission will soon begin a pilot project concerning NIS early detection and monitoring efforts in the Lake Michigan basin. This project will determine the capacity of existing Lake Michigan basin monitoring programs to detect aquatic invasive species and provide recommendations for the development of a NIS early detection and monitoring program in the basin. The Model GIS Assessment project will augment both of these efforts by providing a spatial database of known locations of Michigan invasive species and a framework for adding new NIS introductions, as well as a geographic depiction of monitoring efforts within the state.

For the past several years, the U.S. Geological Survey has managed the *Nonindigenous Aquatic Species Information Resource*, a national repository for spatially based accounts of nonindigenous aquatic species. The Model GIS Assessment project will enhance USGS’s efforts by enabling online live mapping and making the data layers available for download to the user’s computer, where the layers can be combined with other information relevant to a particular location. Compared to USGS’s efforts, reference layers in the proposed project will have a higher resolution of data to be explored and indexed in greater detail. The project will also allow users to compare/overlay a variety of species, rather than only being able to view one species at a time, as is the case with the USGS Resource.

Methodology:

1) *Project Infrastructure and Scoping:* A multifaceted team comprised of Commission staff, selected representatives from Michigan’s NIS prevention and control community (e.g., Michigan Dept. of Environmental Quality’s Office of the Great Lakes, Michigan Sea Grant, Michigan’s ANS Action Team), and selected individuals from the Great Lakes Panel on Aquatic Nuisance Species who can offer a regional perspective will provide project oversight and be tasked with project scoping.

2) *Map and Data Library:* The data library developed for the project will consist of specialized data sets for each species (Eurasian watermilfoil, round goby, ruffe, purple loosestrife, sea lamprey, spiny water flea and zebra mussel). Project staff will acquire the majority of the data sets for the project through partnerships developed within the Great Lakes Panel on Aquatic Nuisance Species and the larger community of relevant agencies and organizations, as referenced above. Data sets not yet available in digital format will be created in-house. Basic geographic information for the state, such as hydrology, soils, political boundaries, and land use, is already available and will be made accessible to this project. Where they do not already exist, data sharing partnerships will be pursued with organizations and agencies within the state of Michigan and the Great Lakes basin. Formal agreements defining the extent to which the partner’s data may be presented online will be developed as needed.

GIS specialists at the Great Lakes Commission will orient all data layers to the same geographic projection so they can be examined in relationship with one another. The data sets will be searchable using database and mapping tools, but an indexing scheme also will be developed to facilitate using the on-line system as a tool for achieving an overview of the state according to locales and key themes. As much as possible, these data layers will be available for downloading to the user's computer. Should data sharing agreements prohibit distribution directly from the project's web pages, contact information will be provided so the user can request the data directly from the source agency.

3) Interface Design and Programming: The web interface will be designed to be comfortable and intuitive while allowing users from a variety of backgrounds to quickly download information on NIS infestations of interest. Overviews for each species will be offered as pre-compiled reference sets, and data will be organized both by theme and locale for initial presentation to the user. A data index tool will allow for other approaches to the data. The interface itself will be fully integrated into the Great Lakes Information Network (GLIN) site.

4) Internet GIS and Mapping Applications: The data analysis goals of the project call for map overlay capability, summarization tools for data within the layers being mapped, and output tools that allow users to produce maps showing the results of their work. These basic tools will be built into the map server that places the data onto the Internet. Users will be able to save their results to a local computer, print them, and otherwise incorporate them into projects.

5) Testing and Revisions: The mapping tools, web interface and data library will be fully tested prior to publication of the project on the Internet. The web site and data library will be housed on a fully equipped server maintained by the Great Lakes Commission.

6) Dissemination and User Community Awareness: Target users need to be made aware of the presence and application of the final product. A direct link to the tool will be established on GLIN, as will another link between this state-specific tool and regional data sets housed at Great Lakes GIS Online. Promotional efforts will be led by the Great Lakes Commission in collaboration with the Great Lakes Panel on Aquatic Nuisance Species, the Michigan Dept. of Environmental Quality, and other relevant state, local and regional entities. The Great Lakes Commission will also feature the project at presentations, stakeholder meetings and conferences and in its publications.

7) Grant Administration: Throughout the life of the grant, Commission staff will develop reports and financial statements to meet the administrative requirements of the grant.

Project Schedule

Project Begins	12/2002
Project Infrastructure and Scoping	12/2002
Data Partnerships Established	01/2003
Map and Data Library Populated	06/2003
Semiannual Report Submitted	06/2003
Interface Design and Programming Completed	07/2003
Internet GIS and Mapping Applications Developed	11/2003
Year One Annual Report Submitted	12/2003
Testing and Revisions	12/2003 - 2/2004
Dissemination/User Community Awareness	3/2004
Final Report Submitted	5/2004
Project End Date	5/2004

Description of Project Results and Final Products:

Final products will be featured in an online mapping tool housed on GLIN. The mapping tool and associated web site will include a spatial database of locations for NIS identified in Michigan as priority problem species, data exploration tools, summary information about each NIS, information about NIS control methods, and contact information for agencies involved in NIS prevention and control efforts. The individual map layers created for the project will be portrayed in the online mapping tool and also made available for download to local GIS packages. Agencies and organizations such as the Michigan Dept. of Environmental Quality, Michigan Dept. of Natural Resources, Michigan Sea Grant, U.S. Fish and Wildlife Service, U.S. Geological Survey, National Oceanic and Atmospheric Administration, Great Lakes Panel on Aquatic Nuisance Species, the Great Lakes Indian Fish and Wildlife Commission, as well as nonprofit organizations such as Michigan Lake and Streams Association, Michigan Natural Features Inventory, and The Nature Conservancy will be interested in the project's final products.

A direct link to the tool will be established on GLIN as will another link between this state-specific tool and regional data sets housed at Great Lakes GIS Online. Promotional efforts will be led by the Great Lakes Commission in collaboration with the Great Lakes Panel on Aquatic Nuisance Species, the Michigan Dept. of Environmental Quality, and other relevant state, local and regional entities. The Great Lakes Commission will also feature the project at presentations, stakeholder meetings and conferences and in its publications.

Following completion of the project, GLC staff will remain available to carry out minor edits to web page content and replace map data layers as new ones are made available by monitoring agencies. Map layers and the data tables associated with them will also be available to researchers and resource managers throughout the region via GLIN. Update efforts (e.g., pursuit of new data from project partners and others, revisions to mapping software, significant changes to web page content) will result from future projects and may lead to a broadened focus on NIS issues region wide. The Great Lakes Commission emphasizes that all work developed under the terms of this project will be maintained at some level on a continuing basis per the mandate of the Great Lakes Commission. Furthermore, project outcomes will provide the basis for additional project initiatives and proposals to be conducted by the Great Lakes Commission in conjunction with the Great Lakes Panel on Aquatic Nuisance Species. Project outcomes fulfill selected requirements of the Great Lakes Panel on Aquatic Nuisance Species as mandated under the National Invasive Species Act. Multiyear support for the Panel has been secured and project outcomes will therefore be maintained and employed over the long term.

Accompanying the mapping tool and associated website will be a project report that identifies data and information gaps encountered, and recommendations to address them in the interest of strengthening the tool in the future. Additionally, recommendations for long-term maintenance and use of the tool, including region-wide application, will be presented.

References:

A Great Lakes Action Plan for the Prevention and Control of Nonindigenous Aquatic Nuisance Species. 2001. (www.glc.org/ans/7-01GLactionplan.pdf)

Glassner-Shwayder, K. M. 1996. *A Model Comprehensive State Management Plan for the Prevention and Control of Nonindigenous Aquatic Nuisance Species* (developed under the auspices of the Great Lakes Panel on Aquatic Nuisance Species). Great Lakes Commission, Ann Arbor, Mich. (www.glc.org/projects/ans/modelssp.html).

Glassner-Shwayder, K. M. 1999. *Great Lakes Nonindigenous Invasive Species: A Briefing Paper for the U.S. Environmental Protection Agency*. Great Lakes Commission, Ann Arbor, Mich. (www.glc.org/ans/ansbriefing.html)

Pimental, D. L. Lach, R. Zuniga, D. Morrison. 1999. Environmental and Economic Costs Associated with Non-Indigenous Species in the United States. College of Agricultural and Life Sciences, Cornell University, Ithaca, New York.

Updating Michigan's Aquatic Nuisance Species Management Plan. July 1, 2002.
(www.deq.state.mi.us/documents/deq-ogI-ANSRecommendations.pdf)

C. CAPACITY AND PRINCIPAL INVESTIGATOR QUALIFICATIONS

Institutional Resources:

The Great Lakes Commission maintains a state of the art computer network with extensive data storage capacity. A full suite of GIS software is available for spatial data refinement, while the web development staff is backed by modern design and programming software. The Commission has its own web server and an in-house map server for use in placing the results of this project on the Internet. Further, it has a staff of experienced specialists well suited to successful conduct of the proposed project.

Prior Experience:

The Great Lakes Commission staff has a wealth of experience in developing regional models to assist Great Lakes jurisdictions in the implementation of particular aspects of NIS research, prevention and control. Examples, developed to support the work of the Great Lakes Panel on Aquatic Nuisance Species, include: 1) *A Model Comprehensive State Management Plan for the Prevention and Control of Nonindigenous Aquatic Nuisance Species* and 2) *Legislation, Regulation and Policy for the Prevention and Control of Nonindigenous Aquatic Nuisance Species: Model Guidance for Great Lakes Jurisdictions*. Michael Donahue will contribute to the project scoping activities, bringing expertise from his role as the President/CEO of the Great Lakes Commission to the project. Kathe Glassner-Shwayder will provide general oversight for the project, contributing extensive experience in the development of model NIS projects. Rita Straith will provide general administrative and support services for the project. Co-Principal Investigator Sarah Whitney will provide overall project coordination and organize the NIS content for the associated web pages. Whitney has provided support to the Great Lakes Panel on Aquatic Nuisance Species since joining the Great Lakes Commission in 2000.

In addition, the Great Lakes Commission has pioneered GIS and online mapping efforts for the Great Lakes region, including developing an online mapping tool to index hydrological and meteorological stations for NOAA's Great Lakes Environmental Research Laboratory, an online data directory for digital mapping resources available throughout the region, regional air pollution data summaries and oil spill contingency planning products. The Commission's GIS and web design staff, including Jonathon Colman, Stuart Eddy, Richard Garcia and Kevin Yam, will coordinate the GIS layers and develop the spatial database and online application for the project. Colman provides primary web design support for the Commission. Garcia has been heavily involved with GIS data development for the Commission's area contingency planning project. Co-Principal Investigator Eddy provides technical support to the Great Lakes GIS Online project and has significant GIS experience. Yam is a GIS specialist working on regional mapping efforts.