Regional Freight Information Resources for Market Opportunities in the Great Lakes Maritime Transportation System

Phase I Report

By

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Executive Summary

The ***Great Lakes Maritime Research Information Clearinghouse*** (***GLMRIC***) is a web-based system devoted to the acquisition, storage, management, analysis and exchange of data between analysts, decision makers, and related stakeholders in the Great Lakes Region . The system, still under development, is envisioned to serve as a resource for market research, public policy decision analysis, and economic development. It is designed to serve as a resource for drawing the link between maritime freight movements, economic viability, and environmental quality throughout the Great Lakes and St. Lawrence Seaway. This project is one component of a wider long-term effort to develop and manage this comprehensive data repository and information clearinghouse for intermodal transportation throughout the Great Lakes Region.

The objective of this particular project concentrates on the acquisition of data and the development of analytical tools to assist users in defining market opportunities for shippers and carriers. These data are delivered on the project web page and in *Midwest FreightView*, a distributed GIS data delivery system accessed through the project web page and managed by the project team. The work in this project contributes to the development of this system by providing updated accurate data and analytical tools (*i.e.*, routing, geographic accessibility, identification of market opportunities) that are essential for identifying market segments that can be effectively served by the Great Lakes Maritime Transportation System (GL MTS).

This report documents this project in terms of goals and objectives for the data repository, development of market research tools, and the delivery of information on the project web site. However, many of the outcomes and deliverables from this project are best shown on the project web page and in the GIS data delivery system (*Midwest FreightView*) accessed at the following address: http://www.maritime.utoledo.edu. Users can access this site for general information related to the project; access to the GIS data delivery system, however, must be obtained through a request for a user ID and password. Contact information for the project team to request access to the site is provided on the project web page.

Introduction

The ***Great Lakes Maritime Research Information Clearinghouse*** (***GLMRIC***) is a computer-based system devoted to the acquisition, storage, management, analysis and exchange of data between analysts and decision makers within maritime community in the Great Lakes region (http://maritime.utoledo.edu). The work described in this report is one component of a wider-ranging project to develop a comprehensive data repository and information clearinghouse for both the maritime industry in the Great Lakes and for intermodal freight transportation throughout the region. This system is envisioned to serve as a central focus for diverse interests within the industry and is designed to support the promotion of sustainable maritime transportation in the region. The project team has developed a central web location for the dissemination of data to support public policy decision analysis, providing data for identifying market opportunities for shippers, receivers and carriers in the region, and for drawing linkages between maritime freight movements, economic viability, and environmental quality throughout the Great Lakes and St. Lawrence Seaway.

In addition to the acquisition, management, and delivery of data to the maritime community, the project team has also developed a set of prototype analytical tools for evaluating intermodal transportation opportunities in the Great Lakes Region; these tools will be incorporated within the system to model vessel flows and intermodal transshipments of commodities within the region. These tools can be used not only for planning shipment routes, but also in planning efforts to relieve congestion on the highway system and ultimately to promote efficiency, reduce transportation costs, and minimize environmental impacts. In addition, the system is envisioned to seek market opportunities for the GL MTS by providing data and analytical tools to identify potential origins and destinations of freight traffic that can move through the system. One such application of these combined data sources and tools is to identify opportunities for short sea shipping between U.S. and Canadian ports within the lakes themselves as a means to relieve highway and rail congestion. In addition, market opportunities exist for diverting international trade from gulf and east coast ports into the GL MTS through the seaway. In both cases, detailed market research is essential to identifying which market segments can be economically and efficiently served by the GL MTS (Vonderembse, 2007). Such efforts are not possible, however, without accurate and current data focused on the status of the transportation infrastructure, vessel and commodity flows, patterns of economic activity and the location and size of markets for commodities and goods shipped through the system. Thus, a significant portion of this project was also devoted to the acquisition of current and accurate data resources to enable users to identify market opportunities for the maritime industry in the Great Lakes Region.

This project has thus focused on the design and implementation of a prototype system devoted to supporting analyses dealing with such issues as vessel flows and commodity movements, identifying potential origins and destinations for freight movements through the maritime system, and providing the necessary detailed information for evaluating the economic impact of great lakes shipping, optimizing intermodal connections, and short sea shipping. The resulting product is a multidimensional web-based delivery system with the following functions:

- A detailed data repository for vessel movements, port functions, commodity flows, economic activities and environmental impacts, etc.
- A GIS data viewer for advanced users to view and analyze a variety of data,
- An information delivery site for maps, tables, graphics, text and other features,
- An information clearinghouse and centralized data facility to furnish links to other information resources, private vendors furnishing commercial products, and government agencies,
- A data exchange to support user inquiries and furnish information on demand.

This system can be viewed at http://www.maritime.utoledo.edu. The site has been launched and will be continuously updated over the next phases of the project.

Data Collection, Development of the Project Web Site and Analytical Tools

Much of this project focused on acquiring data on facilities and freight flows, with mixed success. Considerable effort was devoted to acquiring flow data in greater detail with respect to commodities, origins and destinations, and vessel characteristics, and the project team was

successful in obtaining international vessel calls through the USACE Port Entrances and Clearances database. However, less success was achieved in tracking domestic freight movements.

The project team also expanded efforts to acquire detailed and complete regional economic data for the system. In particular, the county-based IMPLAN ES202 data set was purchased and incorporated into the system. Given the volume of the database, only selected portions of the database devoted strictly to the generation of freight traffic have been added to the reporting system to date, and only three-digit NAICS categories were posted on the site. However, additional data can be posted or supplied upon request. A more complete documentation of the database contents is available on the project web page.

The project site was also developed to accommodate a wide range of users extending between casual browsers and "basic mappers" to more experienced GIS and database analysts. Though still in the development stage, some basic information resources in the form of prepared maps, graphics, tables and text are published and available on an atlas page on the project web site. Access to these resources are free and unlimited. Elsewhere, additional tools are available on a limited access site featuring analysis and display options, database software, and spreadsheets. These can be accessed in the *Midwest FreightView* data viewer. *Midwest FreightView* is built on a *Citrix Metaframe* installation with a customized *ArcView GIS* application. (See the Appendix for snapshots of the data viewer.) All operations are carried out on the Toledo Server—the users' computers simply act as a terminal. Advanced users can access this data viewer through the home page of the GLMRIC website. However, access to the GIS data delivery system must be obtained through a request for a user ID and password. Contact information for the project team to request access to the site is provided on the project web page.

In this project the research team undertook the task of completely revamping the original html website with new .net technology to offer users greater functionality within this resource. A snapshot of the front page of the project web page is shown in Figure 1. Specific tasks undertaken with respect to the project web site included an expansion of the GLMRIC data library and clearinghouse functions. A library function in the form of a data clearinghouse that reviews and summarizes data from diverse sources--both public and commercial—was initiated to provide links for users to branch to from the site. Development of this resource is in its latter stages and will soon be available to users. A complete data documentation index is also now listed in the system. The documentation units are consistent with maritime and other transportation industry standards. An atlas page was also created where graphic interface files were incorporated to show the visual effects of increased traffic congestion on the highway system over time using the annual average daily truck traffic data and projections. This demonstration reiterates the importance of capitalizing on short sea shipping opportunities by diverting freight flows from overly congested highways to the underutilized Great Lakes system.

In other efforts, the USACE maritime transportation network was merged to the regional highway and rail networks at dock points in an effort to develop a prototype network linking freight movements and simulated cargo flows between modes at key transshipment points. The landside networks are also linked to county centroids in an effort to provide opportunities to link freight movements between counties on the transportation network. This network is currently undergoing testing to assure that cargo movements can be simulated accurately through the

Figure 1. Revised Home Page – GL Maritime Research Information Clearinghouse

system. Ultimately this network is envisioned to provide a framework for relating freight movements to the regional economy and to assist in planning of freight movements through the entire freight transportation system.

The project team also acquired a county-to-county distance table from the Oak Ridge National Laboratory's Center for Transportation Analysis (ORNL CTA) that incorporates distances and impedances by mode (highway, rail and water) between every pair of counties within the US. These tables were transformed into a set of random access files that enables quick access of distances and travel costs between county pairs as a means to compute geographic accessibility to and from ports, transport costs to and from locations containing facilities (*e.g.*, manufacturing plants, warehouses, intermodal terminals, *etc.*), identifying catchment areas around ports, and in identifying potential markets for transportation facilities. The project team applied its prototype accessibility software tools to this set of data for implementation in Midwest *FreightView*. Initial development of additional analytical tools including routing and location analysis software was also undertaken, but will be completed in later phases of the project. A brief display of the accessibility software is provided in the appendix.

Conclusion

The combined vision of The University of Toledo University Transportation Center, the Great Lakes Maritime Research Institute (GLMRI), the Center for Freight Infrastructure Research and Education (CFIRE), the project team, and our partners in the great lakes maritime community has led to the version of the Great Lakes Maritime Research Information Clearinghouse system presented in this report. To date, the project has produced a multidimensional data gateway system that will support the following functions:

- A detailed data repository for vessel movements, port functions, commodity flows, economic activities, and environmental impacts, *etc*.;
- A GIS data viewer for advanced users to view and analyze a variety of data;
- An information delivery site for maps, tables, graphics, text and other features in the form of the ***Atlas of Great Lakes Maritime Commerce***;
- A data exchange to support user inquiries and furnish information on demand;
- Assembly of data and report information among different Geographic areas of impacts and jurisdictions (*e.g*., States and Provinces, Congressional districts, Cities, Counties, Ports, *etc*.);
- Establishment of a communication link within the system (*e.g*., email access) for regional stakeholders to request specific information to be posted on the site. This function was agreed upon as essential if the information delivery was to be successful;
- Establishment of a system for data exchange to analysts in maritime agencies and organizations; also develop a site in the system for analysts within the region to publish the results of their analysis—particularly with regard to public policy issues of interest to the great lakes maritime community; and
- Development of a library function in the form of a data clearinghouse that reviews and summarizes data from diverse sources--both public and commercial--and provide links for users to branch to from the site.

The resulting product, accessed at http://www.maritime.utoledo.edu, is designed to provide stakeholders in Great Lakes maritime commerce with a comprehensive centralized resource for data and information. When fully implemented into *Midwest FreightView* it will be used to model vessel flows and transshipments of commodities within the region as a means to relieve congestion on the highway system and ultimately to promote efficiency, reduce transportation costs, and minimize environmental impacts. The data available in this system and its associated query and analytical tools will also enable users to more effectively identify those market opportunities for the GL MTS, such as short sea shipping and identifying opportunities to divert international trade from gulf and east coast ports into the GL MTS through the seaway. Users of the system can also identify locations of potential origins and destinations of freight traffic within the region that can be routed through Great Lakes ports. In addition, this system can enable transportation analysts to identify opportunities to use the Great Lakes Maritime Transportation System to divert traffic away from landside modes as a means to relieve highway and rail congestion.

Finally, it should be emphasized that the project reported here is part of a work in progress; the wider project conducted by the research team will continue to be devoted to the acquisition of

data and the development of analytical tools necessary to build this system into a useful resource for freight analysts in the region. Continuous improvement of the information delivery system will remain a major objective as this resource evolves in the coming months and years. The project team will strive to maintain an open dialog with the members of the industry to assure success in this endeavor.

Reference Cited

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Dissemination of Results: GL MTS

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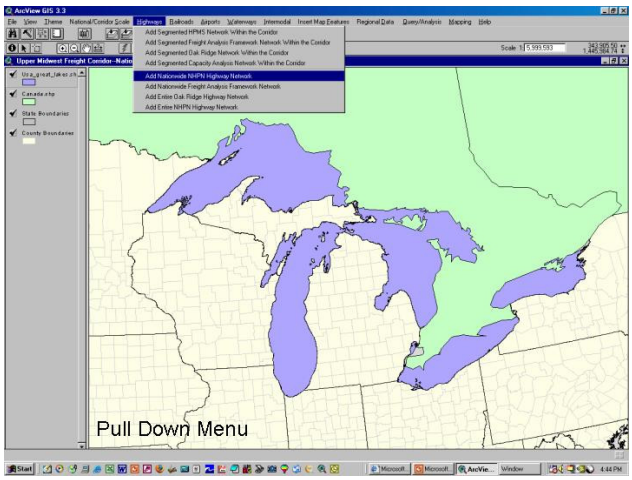
APPENDIX

Sample of Map Output from *Midwest FreightView*
Great Lakes Maritime Database
And Detailed Data Listing



Example 1: Basic Mapping Functions

Figure A.1
Initial display for the user Interface in ***Midwest FreightView***. User activates pull down menu to open the highway network in the Great Lakes Region

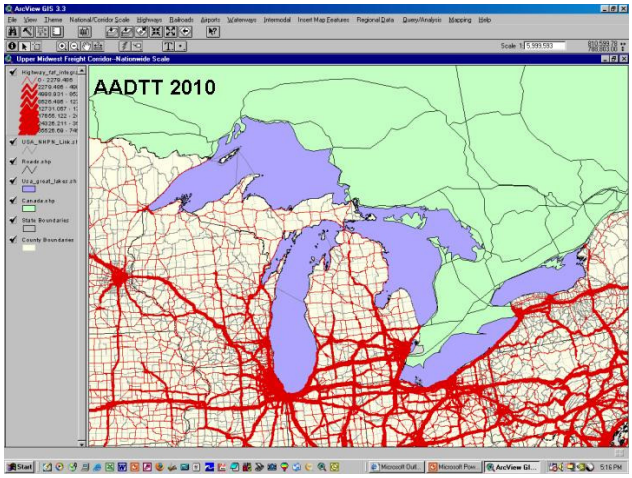
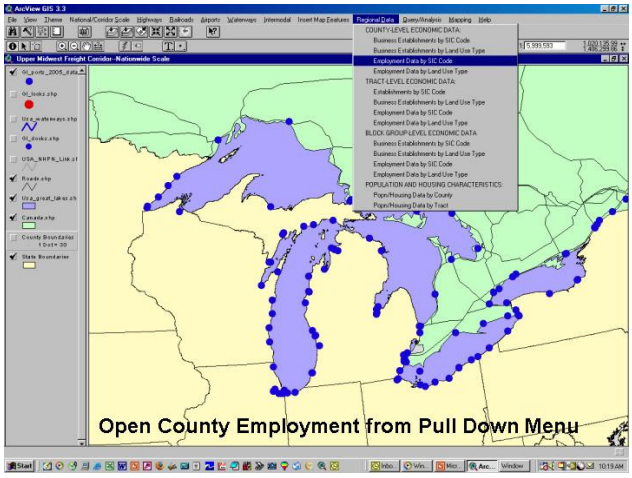


Figure A.2
MWFV provides users with the ability to highlight specific features in the display. In this case, interstate highways are highlighted according to projected 2010 Average Annual Daily Truck Traffic
(Source: FAF).



Example 2: Linking the Great Lakes Maritime Transportation System to the Regional Economy.

Figure A.3
User activates pull down menu to open the regional employment database. In this case, the user is opening employment data by census tract.

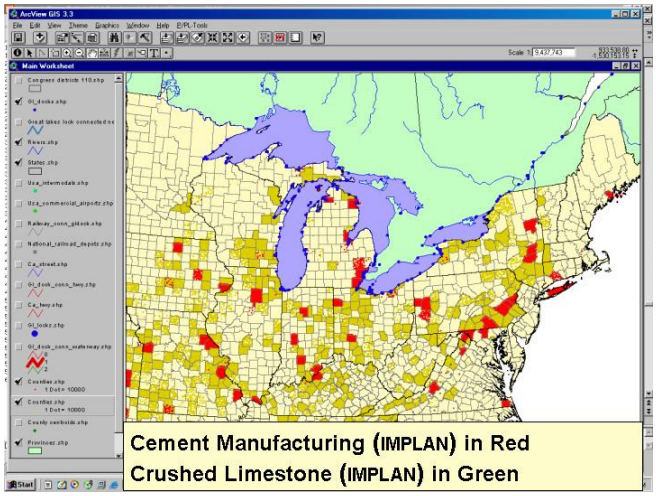


Figure A.4
MWFV displays a dot distribution map of cement manufacturing employment and Crushed Limestone Production alongside Great Lakes dock locations.

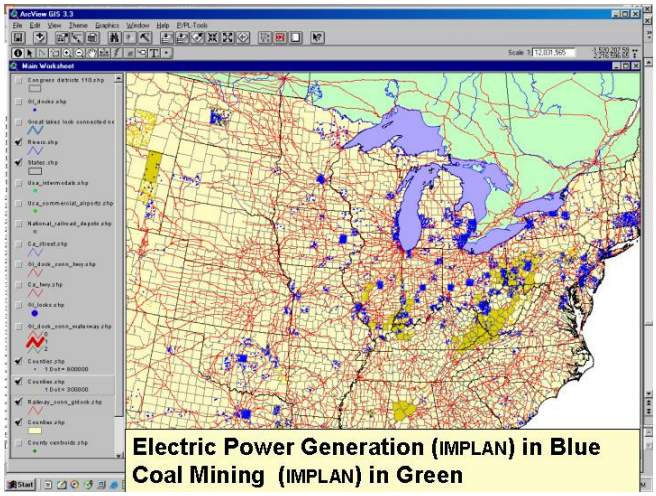


Figure A.5
MWFV displays the distribution of coal mining employment and fossil fuel electric power generation within the Midwest superimposed on the rail network.

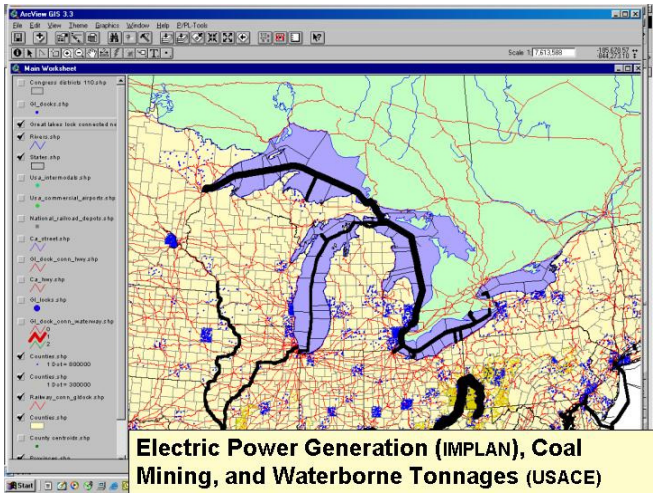
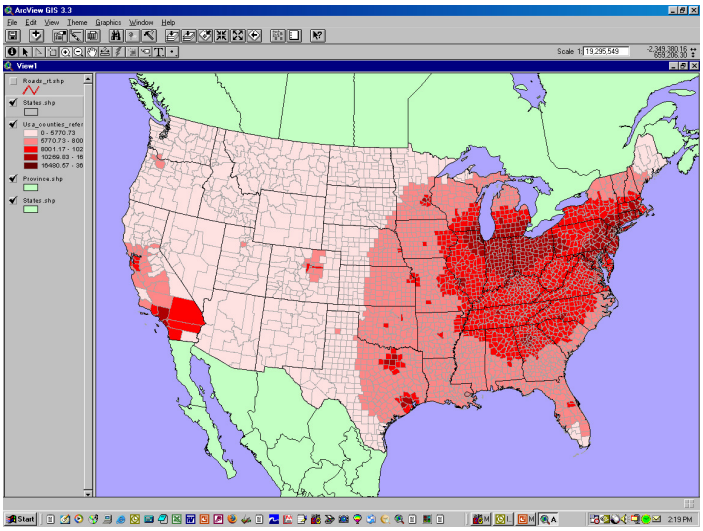


Figure A.6
MWFV now displays the distribution of coal mining employment and fossil fuel electric power generation within the Midwest and the flow of coal over the waterway system.



Example 3: Software Output Accessibility Measures in the Lakes Maritime Transportation System

Figure A.7

MWFV now displays the results from newly-developed data analysis software. The map at the left displays the density of ***wholesale trade*** activity in the US by county. This density map shows the proximity of wholesale distributors relative to each county weighted by employment. Those regions in the darkest colors have the greatest accessibility to wholesale trade in the U.S.

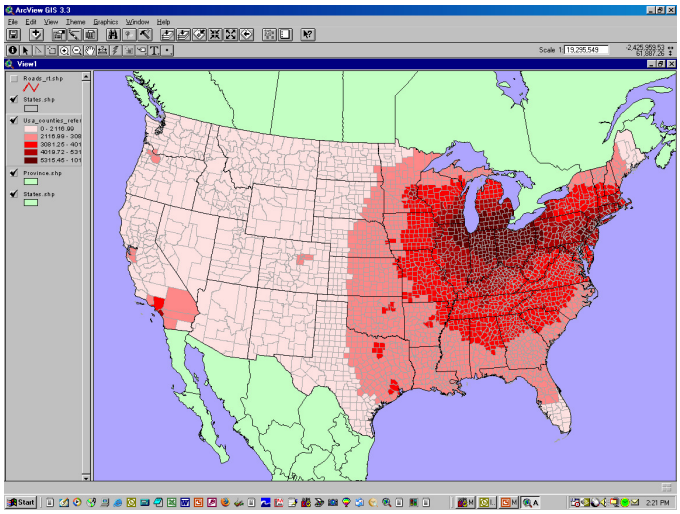


Figure A.8

MWFV now uses the same software to display the density of ***heavy equipment manufacturing by county***. This density map shows the proximity of heavy equipment manufacturers relative to each county weighted by employment. Those regions in the darkest colors have the greatest accessibility to this sector in the U.S.

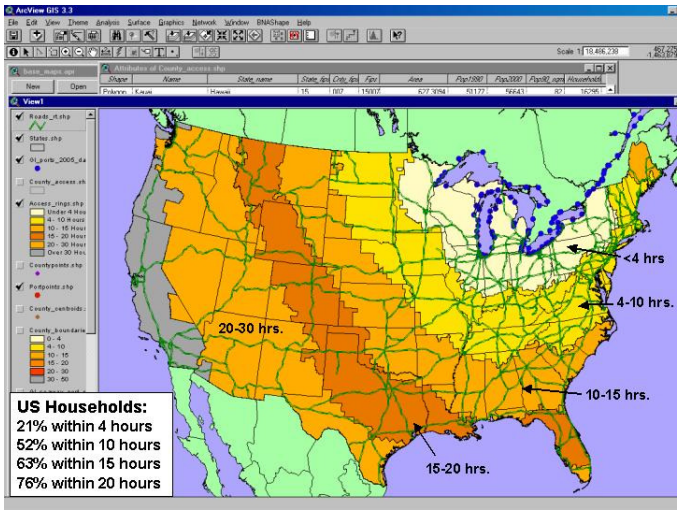


Figure A.9
Accessibility from Great Lakes Ports to National Market

Another example of output from recently developed data analysis software in MWFV. Travel Time to US households from their nearest Great Lakes Ports by Highway.

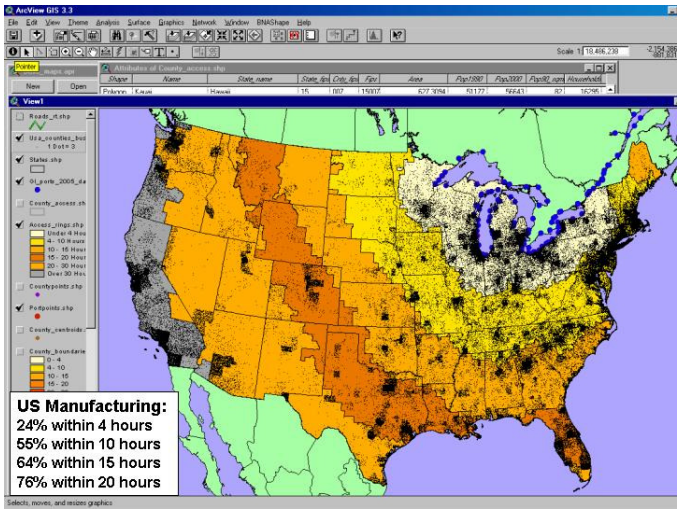


Figure A.10
Accessibility from Great Lakes Ports to National Manufacturing

Another example of output from recently developed data analysis software in MWFV. Travel Time to manufacturers from their nearest Great Lakes Ports by Highway.

Example 4: Software User Interface of Prototype Accessibility Measure Software

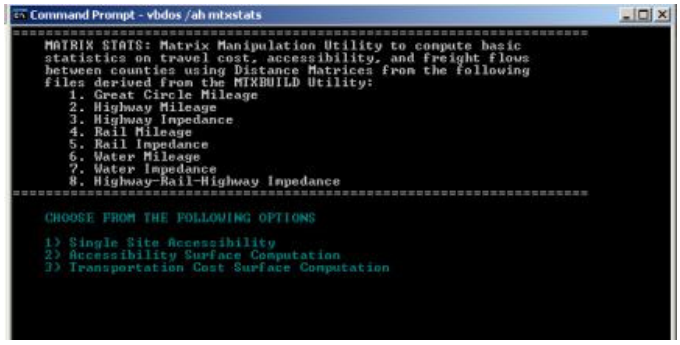


Figure A.11 Opening Program View
A view of the accessibility software interface. User chooses accessibility display definition from menu. Note modal matrices and impedance tables at top of display.

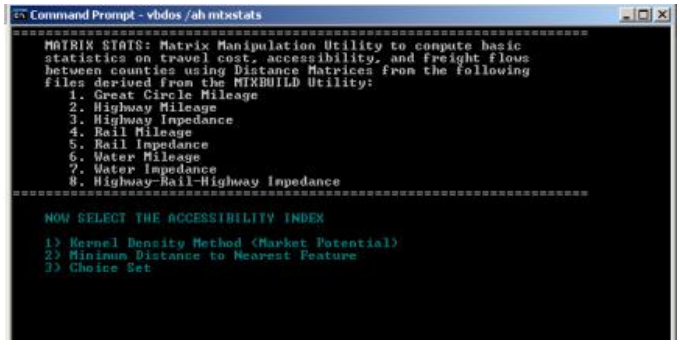


Figure A12. Accessibility Measure
Second program display prompts user choice of accessibility measure.

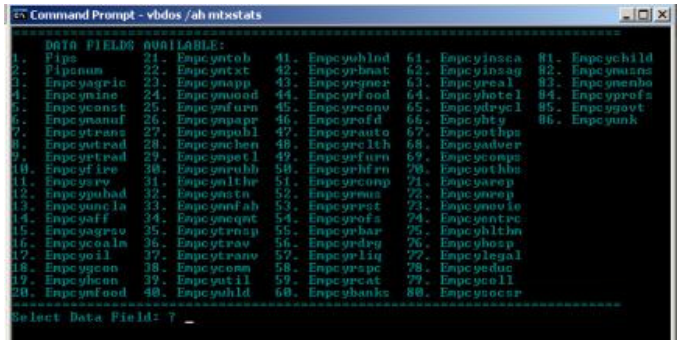


Figure A13. Variable Choice
Third program display prompts user choice of variable to measure numerator of accessibility index..

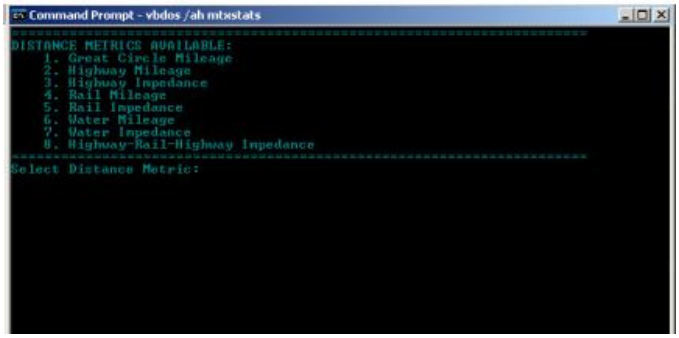


Figure A14. Mode Choice
Fourth program display prompts user choice of mode to measure spatial separation in the form of raw mileage on the network or mileage and impedance on the network. Program executes following this prompt. Maps showing output from this program appear in Figures A7-A10.

Specific data assembled into the centralized data repository currently include the following:

1. Intrastate Employment patterns for each commodity type by SIC, NAICS, (Demographics Plus, Inc. *Business Counts Database*);
2. Population and Socioeconomic data representing Market Demand within the region;
3. Port Locations—U.S. (BTS National Transportation Atlas);
4. Dock Locations (Army Corps of Engineers) and attributes;
5. Waterway Network—Great Lakes and Inland Waterways (Army Corps of Engineers);
6. Baseline 2002 commodity flows through the Saint Lawrence Seaway and Great Lakes System obtained from the FHWA Freight Analysis Framework estimated from 2002 Commodity Flow Survey Data.
7. Population and Socioeconomic data representing Market Demand within the region (U.S. Census)
8. Port Locations—U.S. (BTS National Transportation Atlas);
9. Dock Locations (Army Corps of Engineers) and attributes:
10. Waterway Network—Great Lakes and Inland Waterways (Army Corps of Engineers)
11. Baseline 2002 commodity flows through the Saint Lawrence Seaway and Great Lakes System obtained from the FHWA Freight Analysis Framework estimated from 2002 Commodity Flow Survey Data. This data set provided the research team with a skeleton framework upon which to add subsequent flow data.
12. Employment by NAICS Classification among Counties and MSAs in Study Region (Source: BLS ES/202);
13. Lock Locations and lock performance statistics—U.S. side;
14. Weather Station Data (NOAA, to approx. 60 Miles Inland);
15. Updated US Highway Network that combines the HPMS and ORNL Network attributes and includes speeds and estimated travel times on links;
16. Integrated Network—Great Lakes Waterway, Highway, Rail linked to Commercial Docks, Locks (Army Corps of Engineers);
17. MARAD Annual Vessel Movements (1994-2004);
18. Import/Export Flows (Great Lakes East Coast and Gulf Ports);
19. FAF Zones and Centroids;
20. FAF2 OD Flows (National and Regional Scale);
21. Satellite Imagery / Aerial Photography of Dock Facilities;
22. Vessel Inventory—Great Lakes Fleet;
23. Updated Canadian Rail and Highway Networks.