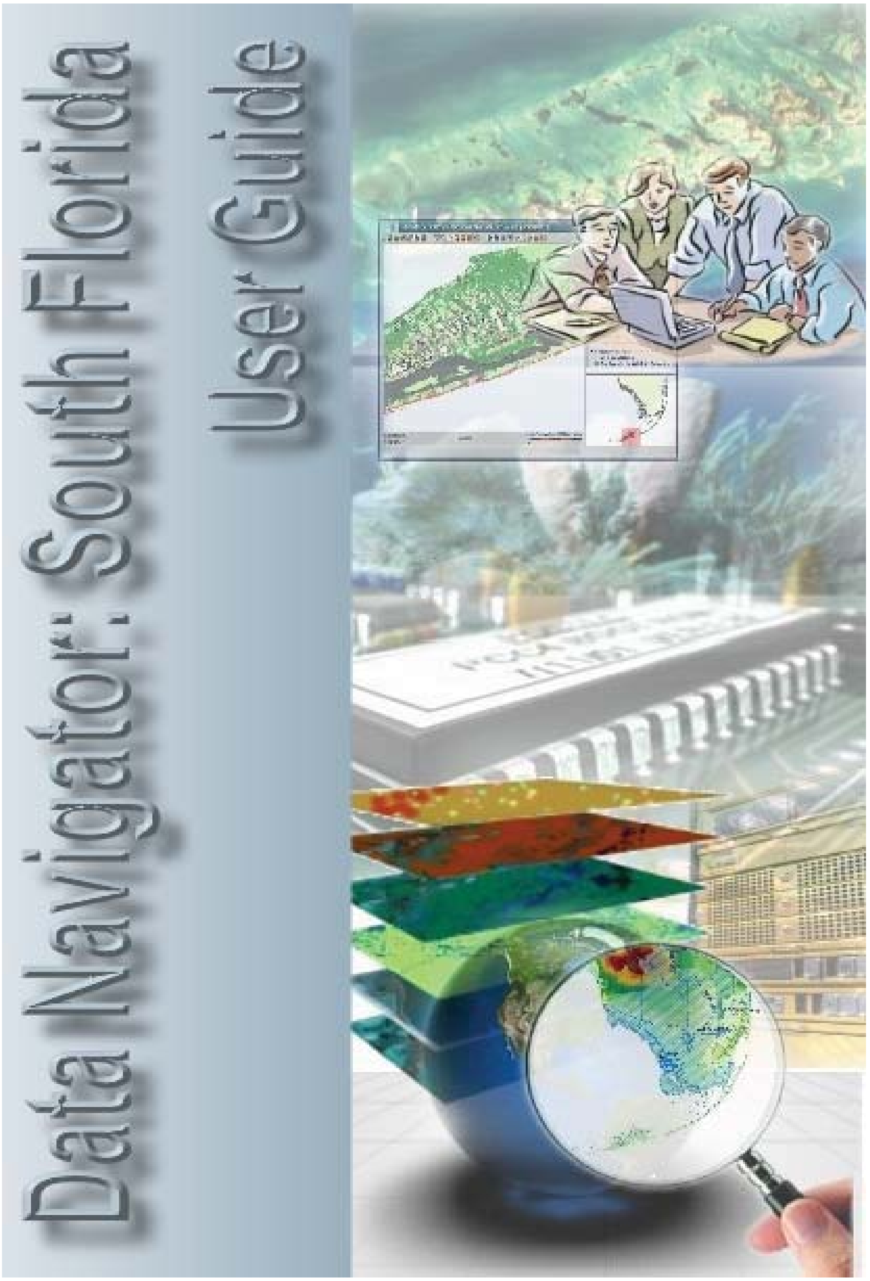

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Data Navigator (South Florida): User Guide
(Rev. 1)

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DISCLAIMER

Table of Contents

Overview

Figure 1. Complex reef ecosystems such as coral reefs are very vulnerable to changes in the environment (Source: NOAA).

Coral reefs are among the most complex ecosystems on Earth, with the highest known phylogenetic diversity subject to a great range of stochastically driven disturbances (Birkeland 1997; Figure 1). However, coral reefs are declining in many parts of the world because of the cumulative and inter-active impacts of disturbances, including, but not limited to, over-harvesting of coral and reef organisms, global change, land-based pollution runoff, and physical damage from boats, divers and various fishing practices. One of the results of this onslaught is the apparent decline of ecological resilience (Done 1992) over the last two decades. Coral reefs that are perturbed by hurricanes, bleaching or other damaging events seem to be increasingly likely to experience a phase shift to macroalgal dominance rather than recovering to former states of coral dominance (Littler and Littler 1997, Hughes 1997, McManus et al. 2000). Ecological resilience on a damaged reef is controlled, in part, by the rates of recruitment of corals, macroalgae, and herbivorous organisms to the specific areas of a reef that have been disturbed. This recruitment is highly influenced by eddies and differential flow patterns of ocean waters as they flow across specific reef features. Thus, understanding resilience at the whole-reef scale requires understanding the interactions of topography and hydrodynamics as they affect recruitment, as well as the spectrum of factors affecting post-settlement survival.

Applying this understanding to decision-making requires that these relationships be considered in management planning. Nearly every management intervention impacts local economies and the quality of life of reef-dependent people. These impacts can then lead to a change in local compliance with regulations and the overall feasibility of a given management strategy. Thus, a good management decision is one that lies in the overlap of what is ecologically, economically, socially and politically sustainable. The more these feasibility and sustainability state spaces can be delineated prior to the implementation of management interventions, the more effective the management strategy will be.

Regulations affecting human use of coral reefs are often extremely difficult to enforce. Probably due largely to both socioeconomic and geographical constraints, reef management is frequently undertaken with insufficient enforcement personnel and limited resources for analyzing and monitoring water pollution, sedimentation, and rates of extraction. Long, complex coastlines adjacent to reef systems can hide land-based sources of pollution, landings for poached organisms, and even the perpetrators of violations. Thus, effective management often requires balanced programs of economic incentive, participatory planning, and public information campaigns. Appropriate targeting of these activities requires understanding: (i) the characteristics and dispersion of relevant social and economic groups and activities; (ii) the nature of economic dynamics and social networks; and (iii) their relationships to coral reef access and resources.

The management of coral reef ecosystems is enormously challenging. Coral reef managers have to take into consideration the complexities of handling large stakeholder communities and a dearth of knowledge concerning relevant human-environment cause and effect relationships. Improving the management of these systems is of vital importance.

The Florida Keys National Marine Sanctuary (FKNMS) includes 9,600 km^2 of coastal waters. Each year it attracts approximately 3 million tourists, who spend about $1.2 billion (Causey 2002), and it is important for both sport and commercial fisheries. During the period 1996 to 2000, these reefs lost 38% of their coral cover (Porter et al. 2002). The causes have been diverse – storms, bleaching and subsequent death of corals during El Niño periods of warm weather, coral breakage due to boat groundings, coral diseases, sea urchin die-offs, eutrophication, overfishing and many others (Porter and Porter 2002). The majority of management decision-making for coral reefs in the region involves spatially-explicit analyses. Some have occurred primarily in shallow areas, some only in the north, central or southern portions, and some in scattered areas along the length of the reef system.

Figure 2. NCORE research in the Florida Keys

Several hundred research projects have been commissioned by the state and federal governments to investigate particular aspects of the problems facing the region (Figure 2). Each study has been funded on the promise that the resulting information would be useful or vital to the management of the reef system. In some cases, this has been true. However, it has generally not been practical to assemble all of the information available on the Keys that are relevant to making a management decision and to use it to optimal effect in guiding the decision. Not only is the information patchily distributed across the range of what is needed, but the information that exists is widely scattered, sometimes in language accessible only to specialists, and rarely in a form that supports spatially-explicit analyses of problems and potential solutions.

Decision support has been defined in a variety of ways. We use the term to describe any system that provides ready access to information and analyses of information useful in making a decision. The concept has been best developed in business management science, sometimes under the rubric “operations research.” The first book on the latter subject was published in 1957 (Churchman et al. 1957). One recent textbook that traces its origins to this work is Anderson et al. (2000). However, it uses the title “*An Introduction to Management Science: Quantitative Approaches to Decision Making*” implying that decision support is synonymous with management science. The methods described in that book include linear programming, project scheduling, inventory models, waiting line models, simulation, formal decision analysis, multi-criteria decision approaches, forecasting, Markov processes, and dynamic programming. Other authors include methods that have evolved from artificial intelligence research (Friedman-Hill 2003), including neural networks, fuzzy logic analysis and expert systems (also known as rule-based programming).

Because of the importance of ready access to information, both databases and Geographic Information Systems (GIS) are decision support tools. There are many definitions but in its most simple form, GIS combines layers of information about entities in the real world (such as coral reefs, dive sites, ocean depth, or park locations) with computer hardware, software, and users in order to understand spatially-explicit relationships. In most cases, GIS allows people to visualize and analyze data in the form of maps rather than complex databases- these maps can be powerful tools for making real world decisions such as where to place a restaurant, or how much law enforcement is needed to protect a certain area in a city.

There is increasing emphasis on incorporating decision analysis capabilities into GIS. GIS is widely used in environmental management, including in coral reef management, and is arguably the most useful decision support tool yet developed for such purposes. The purpose of this project is to build on the capabilities of GIS for the integration of scientific knowledge in support of the management of the Florida Keys.

GIS carries with it a stigma from its early days of being complicated and requiring special expertise in order to put it to good use. Increasingly, GIS has become simpler to operate for basic mapping of well-defined static data layers. However, GIS has far greater potential as a decision tool rather than a means for only displaying static data (Figure 3). Suppose one wishes to map all coral reefs falling within 10 km of a major port. Or, perhaps one wishes to weigh a computed factor for many reefs against their distance from land masses, each with levels of sedimentation to be calculated by a formula involving deforestation, rainfall and slope. The global Reefs at Risk analysis (Bryant 1998) was based on four such models (erosion, ports, fishing, coastal populations), each of which resulted in a computed layer and all of which were combined in a weighted analysis for the final map layer – a map of potential problems with coral reefs around the world.

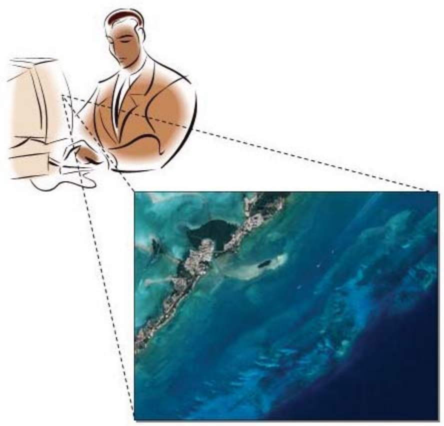

Figure 3. GIS and related information systems remains to be the most effective and valuable tool to managers.

This kind of analysis currently requires considerable expertise. For an innovative and extremely large-scale analysis such as the *Reefs at Risk* study, it would be difficult to avoid the need for such technical expertise, particularly given the novelty and range of possible approaches to take. However, for a decision support tool designed for a specific reef system

such as the one presented here for the Florida Keys, one could identify a wide range of potentially useful ways of combining layers, and then developing a rule-based system to guide the user through the process of accessing and interpreting maps commonly used to address a particular problem. The objective would not be to eliminate expertise in the field of coral reef management. Rather, it would be to minimize the need for specialized training in order for coral reef managers and others to use the GIS to full advantage while also maximizing the efficiency at which resource managers conduct their research.

Presented in the following is an Internet-based GIS, the *Data Navigator* for South Florida, that demonstrate the concept.

The Approach

The primary objective of the *DNav* is to provide information in support of decision-making in the Florida Keys using advances in GIS technologies. While making the software as easy as possible to use effectively, the initial version of the *DNav* will seek to fulfill most of the criteria used by Massam and Wang (2002). Architecturally, the *DNav* will be developed using a multi-tier system approach. This will include the development of the data layers, network, data processing layer and graphic user interface (Figure 4).

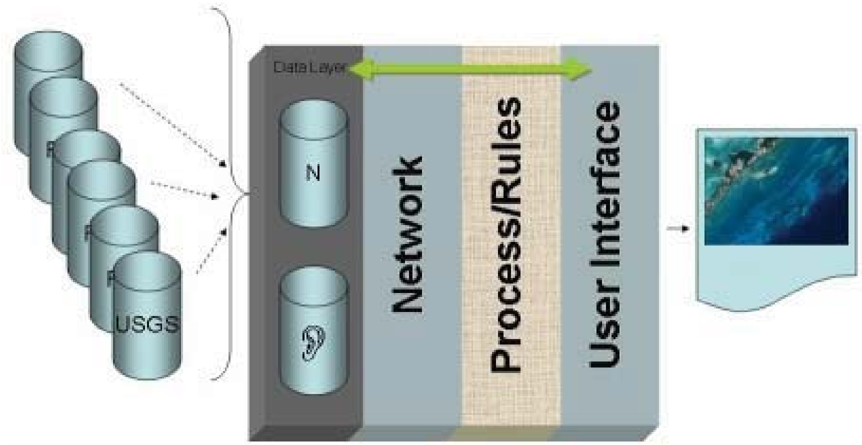

Figure. 4. Multi-tier architecture of the *DNav*.

Data Layer

There are many electronic maps available in existing collections (e.g. FWRI, FIU, USGS, NOAA, FGDL), as well as geo-referenced census figures collected by state and federal agencies about the Keys (e.g. septic systems, businesses, roads, ports and marinas). Most recently, a new 1000-page volume of articles describing research on the Everglades, Florida Bay and the FKNMS (Porter and Porter 2002) has been published augmenting the data sets currently in circulation for research and application to management. A vast majority of these data and results from studies in these ecosystems are available for incorporation into the *DNav* with little modification or correction

required. Many of these datasets are already online in hundreds of individual websites.

Currently, in the initial version of the *Data Navigator: South Florida* (*DNav*), a substantial amount of published data and corresponding metadata have been compiled onto one system to facilitate data retrieval. Through unstructured surveys/interviews conducted in the region with field managers and scientists, a separate database has been designed and developed to archive the GIS-related field experiences gained through years of management practice. This will include a table listing the maps normally retrieved or used when addressing an issue (see *Processing Layer* below) that can be modified as the need arises.

Network Layer

The Internet has become the primary means of distributing and exchanging data among computers. While there is much to be desired with regards to the speed in accessing the data and the streaming of large images the advantages of using the Internet for wide distribution of data outweigh the disadvantages.

Technology vendors (e.g. Microsoft, Sun Microsystems, 3Com) can no longer advocate strength over alternatives offered by other vendors. The choice of network infrastructure has evolved to become more of an issue related to: (i) after-sale competence services; (ii) ease of installation and maintenance; (iii) a company's long-term stability; (iv) compatibility with programming technologies such as support for Java2/VB scripts, ActiveX components, Active Server Pages (ASP), ISAPI (Internet Server Application Program) filtering technology; and (v) compatibility with other technologies that might be used in the development and updating of the system such as Common Gateway Interface (CGI) and Server-Side Include (SSI) programs – to name a few. The widespread application of the Microsoft operating systems for desktop computers (client-side) makes the Microsoft 2003 Advanced Server operating system and the bundled Internet Information Server (IIS) a reasonable choice for the *DNav* network.

There are many options to serve digital maps as image files. Since most of the data available on the Internet are published using Environmental Systems Research Institute (ESRI) Shapefile data format, ESRI Internet Map Server (IMS) will be used to ensure compatibility.

Processing Layer

The results of the unstructured interviews with particular attention to recurring and anticipated future problems have been compiled, classified, grouped and presented in a diagram (e.g. Figure 5). The diagrams will be translated into a table (e.g. Table 1) to identify maps that managers and scientists have used in the past and importantly, could have used had appropriate information been more readily available.

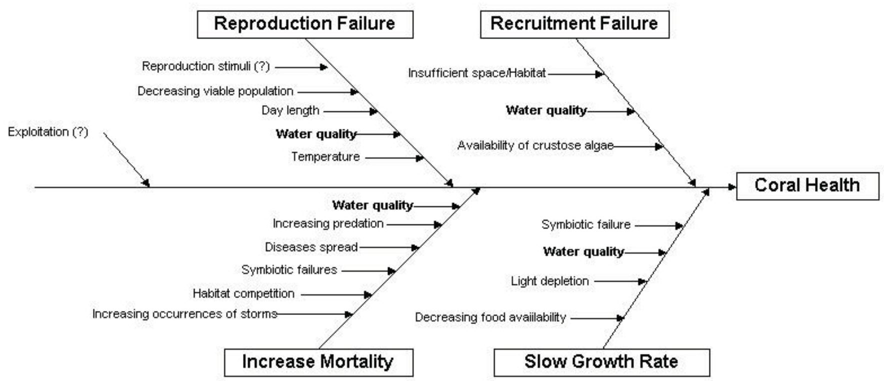

Figure 5. An example of a fish-bone cause-effect diagram generated during initial interviews with resource managers in addressing coral health issues.

Using the map list (archived as a database), rules will be programmed on what maps to load and on what sequence (if applicable) to best tackle identified management problem using the approach of a typical best-practice guide. These maps will be cross-linked with expert notes and other applicable animated files, metadata, and supplemental information documents (see *User Interface Layer* below).

User Interface Layer

The design of the user interfaces will be guided by extensive consultation and testing with potential users. The interface will be designed to be fully web-based using Java technology whenever applicable and as an option, using Hypertext Transfer Markup Language (HTML). However, for simplicity and reliability, all data will be centrally located on a single server in this version of the decision-support tool. (see *The System* below for details).

Table 1. Partial translation of Figure 2 to identify the specific maps that should be accessed.

EFFECTS	CAUSES	EXPERT NOTES	MAPS
1. Recruitment Failures			
	1.1. Insufficient space/habitat	1.1.1. Careful monitoring of the habitats, most specially the seagrasses.	1.1.1.1. Time series of seagrass covers
			1.1.1.2. Hindcast model of seagrass cover
		1.1.2. Monitoring of invasive species	1.1.2.1. Occurrences of known invasive species
		1.1.3. Careful monitoring of human-structures that encrouges onto the habitats, which limits the expansion and normal recruitments;	1.1.3.1. Time series of human-structures in the marine area
			1.1.3.2. Sedimentation rates/TDS
	1.2. Degradation of water quality	1.2.1. Careful monitoring of water-quality	1.2.1.1. Nitrate concentration
			1.2.1.2. Dissolved oxygen
			1.2.1.3. Occurrences and concentration of pathogens
			1.2.1.4. Temperature
			1.2.1.5. Salinity

(...more...)

The System

System Requirements

The Internet-based user interface and JavaScript functions that work behind the interface are modifications of ESRI's published templates. It was designed to work seamlessly on Microsoft IE (ver. 6.0.x) browser that supports JavaScript. The system interactively communicates with ESRI's Internet Map Server (IMS) and other online databases. To facilitate this action, the browser in use should have the Java browser plug-in to use the full potential of the system. However, the Java version requires a specific Java2 runtime engine to work. Only J2RE versions 1.4.0 to 1.4.2 (inclusive) are supported. Moreover, installing the latest ArcExplorer (version 9.x) also results in data retrieval problems from the IMS. For these reasons, an HTML version was developed in cases where Java plug-ins cannot be installed or systems with conflicting Java versions were installed.

In the following sections, the Java logo and the HTML tag will be used to guide readers through the respective viewer types. If you are not interested in using the Java Viewer, you may skip all message boxes with the Java logo and vice-versa for the HTML version. Although it is not necessary to read the instructions for both viewers, users are encouraged to read both sections in order to make a better decision as to which type of viewer to use for a given objective.

Java — The Java logo indicates that the message inside the box pertains only to the Java Viewer.

<HTML> The HTML tag indicates that the message inside the box pertains only to the HTML Viewer.

The authors recommend the following minimum computer specifications:

- Internet connection speed of 56Kbps;
- Operating System: Microsoft Windows 2000/XP;
- Pentium 233 MHz (or equivalent); and
- Display resolution: 1024 x 768 pixels.

Java — Visit the Sun Microsystems website (http://java.sun.com/j2se/1.4.2/download.html) to download the required Java plug-in software (J2RE) and instructions on how to install the software.

User Interfaces

There are three main user interfaces to the *DNav*: (i) *Introductory* page; (ii) *Overview Frames* and (ii) *Interactive Frames*. The *Introductory* page introduces the tool (Figure 6-❶) and provides a link (Figure 6-❸) to start the *DNav* and loads the *Overview Frames* (Figure 7 and 8) and links (Figure 6-❷) to other online documents: (1) a link to a simple to read document that introduces the basic concepts in GIS; and (2) link to a PDF version of this user guide.

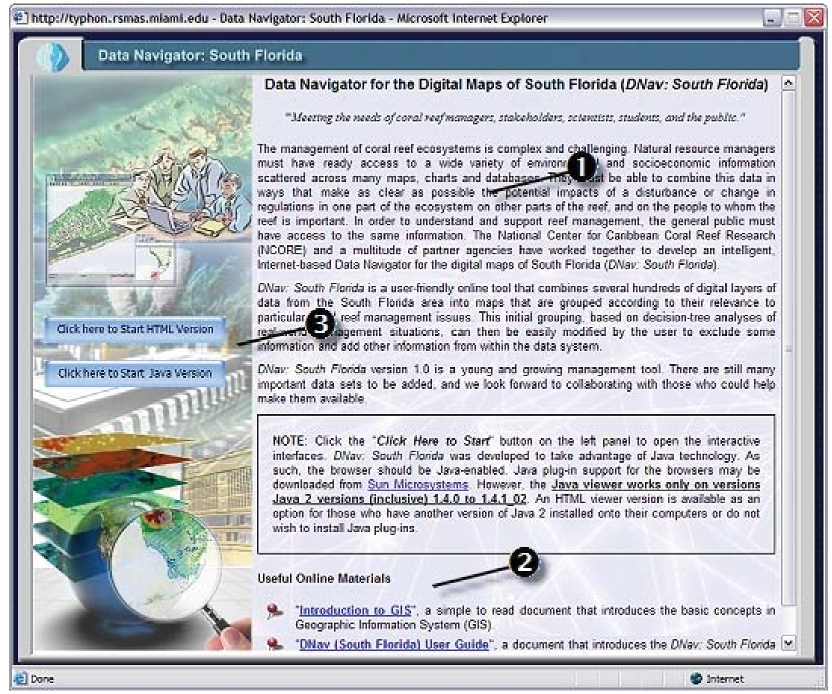

Figure 6. Introductory page of *DNAV*: ❶ Introductory notes; ❷ link to other online documents; and ❸ command button to load the *Overview Frames*.

The initial page of the *Overview Frames* (Figure 7) has three essential features: ❶ option to select an issue; ❷ immediate access to the compiled maps and links to animation files; and ❸ links to other pages. Users have the option to immediately access the compiled maps (Figure 7-❷) by expanding the list in the "GENERAL LIST" folder and clicking on the map. However, as the list of maps in this tool grows in time, scanning through the list to search the appropriate map may prove difficult and time consuming. It is advisable for users to first select an issue (Figure 7-❶) to filter a list of maps that are commonly used from field experiences and recommendations made by a team of experts in addressing an issue.

The initial page (and preceding pages) also have links to: (1) *DNav* User Guide; (2) FAQ or frequently asked questions; (3) the *DNav* startup page (Figure 6); (4) contact information; and link to NCORE website.

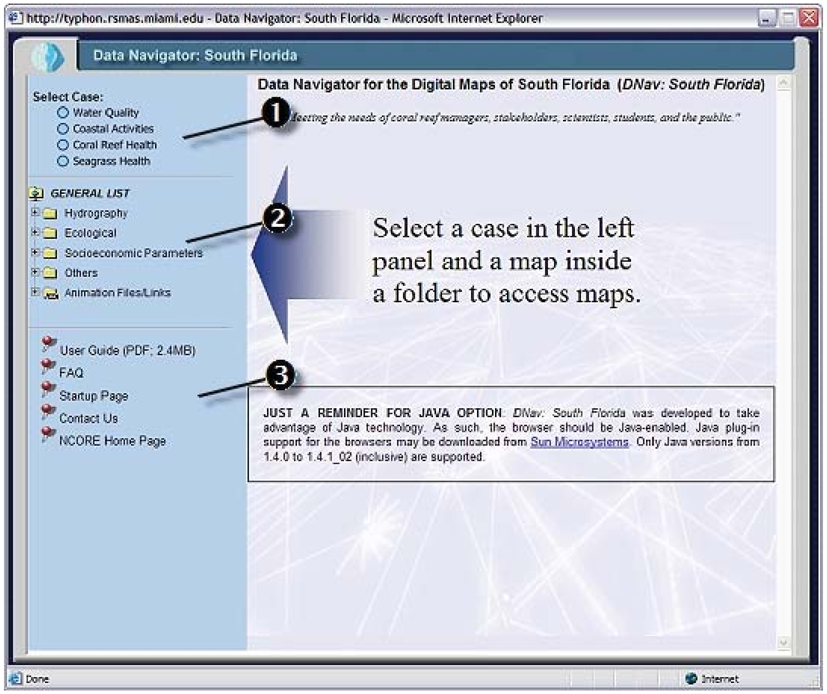

Figure 7. The initial screen of the *Overview Frames* interface with three essential features: ❶ option to select a case; ❷ immediate access to the compiled maps; and ❸ links to other pages.

Once a case has been selected (Figure 7-❶ and Figure 8-❷), the folder structure in the left panel will change (Figure 8-❸). Three more items are listed:

(1) <u>General Notes</u>: A page that introduces the issue and the rationale for the list in the "Commonly Used Maps";
(2) <u>Decision Diagram</u>: The resulting diagram that eventually leads to the listing within "Commonly Used Maps" that filters the database of maps; and
(3) "<u>Commonly Used Maps</u>" folder: A list of maps that are normally used in addressing an issue.

The upper portion of the right panel contains a command button (Figure 8-❺) to load the *Interactive Frames* interface (Figure 9) and two tabs (Figures 8-❻ and 8-❼): *Overview* and *Metadata*. The *Overview* tab (as shown in Figure 8) contains introductory notes to the map and data layers used in constructing the map. The Metadata tab, as the name implies is a page that provides a link to the metadata files (in HTML format) for all the data layers used.

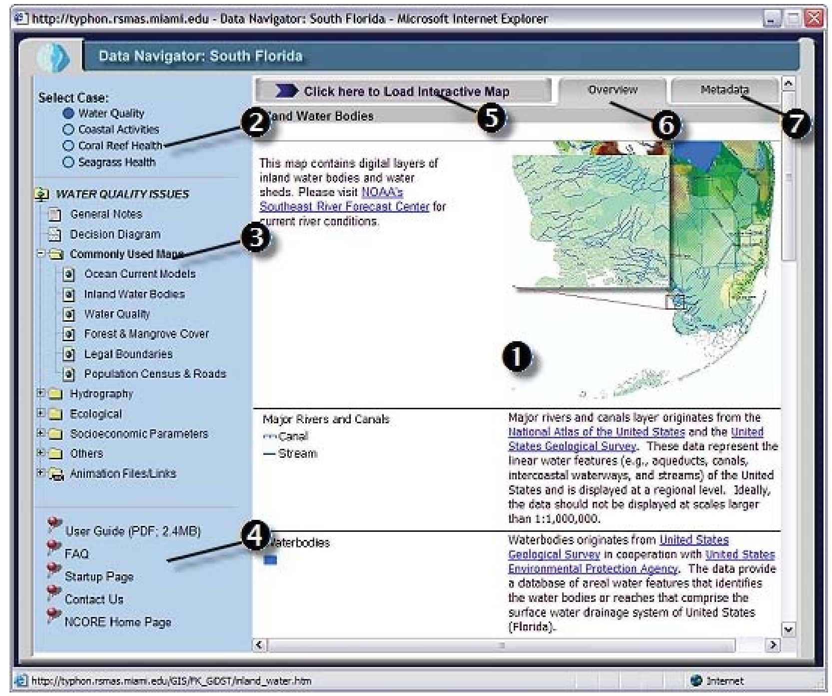

Figure 8. The *Overview Frames* interface: ❶ snapshot of the map and list of data layers used; ❷ list of cases; ❸ map list and a folder filtering the most commonly used maps for the select case and links to the decision diagram and expert notes; ❹ links to other important pages in the system; ❺ link to open the *Interactive Frames* interface; ❻ 'Overview' tab (as shown here); and ❼ 'Metadata' tab to open the metadata files.

Clicking the "**Click here to Load Interactive Map**" button will open the *Interactive Frames* interface in a new window (Figures 9 and 10). This interface has six essential features:

❶ **Title bar**: Contains the title of the software and on the right corner of the bar is a label of the active function.

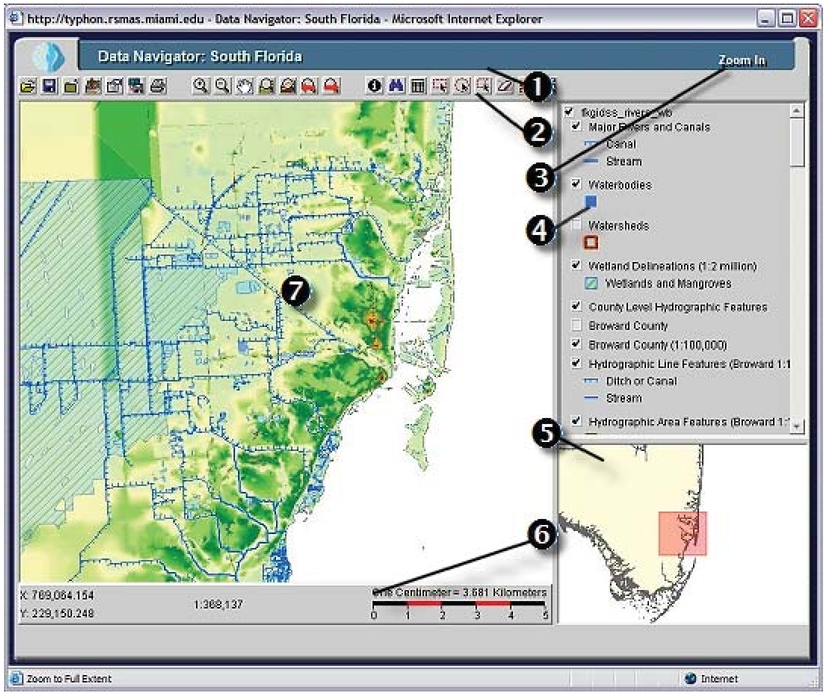

Figure 9. The Data Frame user interface for Java Viewer: ❶ title bar; ❷ toolbar; ❸ active function; ❹ map layer list or sometimes referred to as "Table of Contents"; ❺ map overview; ❻ status bar; and ❼ work space.

❷ **Toolbar**: Contains command buttons for file manipulation, navigation, and other map manipulation functions.

❸ **Active Function**: Displays the label of the function that is active (default is Zoom In function).

❹ **Table of Contents**: A list of data layers used in the creation of the map. This table can be used to turn layers on or off by checking the box next to the layer description.

❺ **Overview**: Displays the full-map extent (complete view of the maps) and draws the relative position of the locator map.

❻ **Status bar**: Displays the current position of the mouse cursor (in decimal degrees), the scale, and also used for text inputs (e.g. when saving an image).

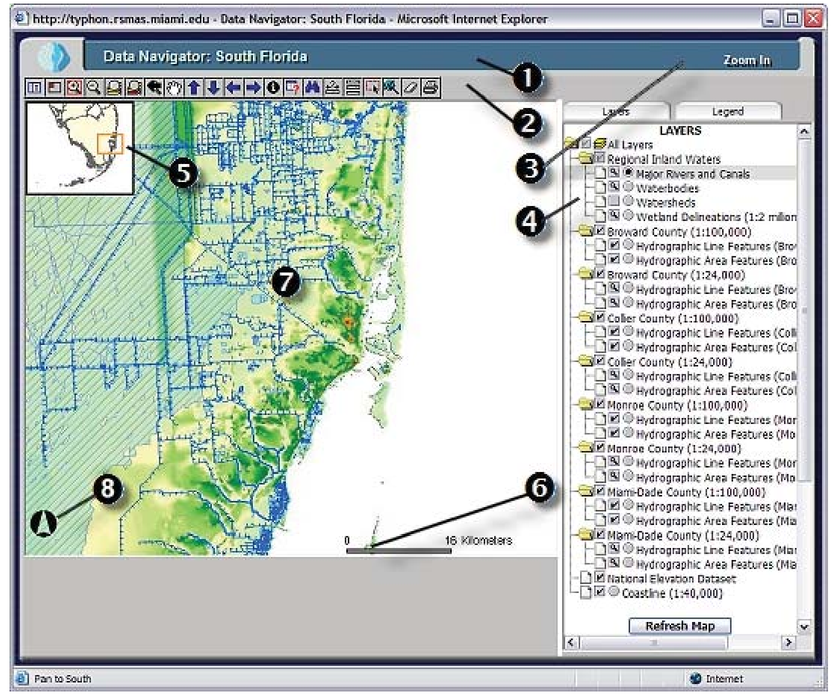

Figure 10. The Data Frame user interface for HTML Viewer: ❶ title bar; ❷ toolbar; ❸ active function; ❹ map layer list or sometimes referred to as "Table of Contents" with a tab to access the legend of displayed layers; ❺ map overview; ❻ status bar; ❼ work space and ❽ magnetic north.

❼ **Work space**: Displays the digital map and may also be referred to as the map display frame.

❽ **Magnetic north** Arrow symbol showing the direction of the magnetic north (available only for HTML Viewers).

The Java Viewer Toolbar and Functions

This section is applicable to the Java Viewer.

The Toolbar contains standard tools needed by users to examine the digital maps. Table 2 summarizes these functions.

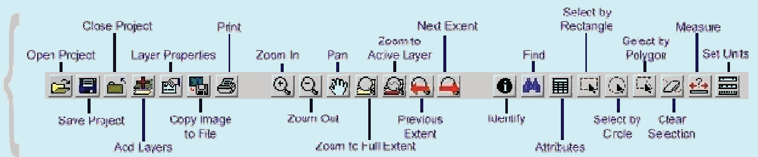

Figure 11. The toolbar for the Java version containing online functions (see Table 2 for details).

Table 2. Toolbar functions for the Java Viewer.

Function	Remarks
Open Project	Allows the user to load a locally saved ESRI project configuration file (*.axl).
Save Project	Saves the maps as an ESRI configuration file (*.axl).
Close Project	Closes the loaded project and all the maps
Add Layers	Opens a Catalog to allow users to add layers to the map.
Layer Properties	Tabulates the attributes of the identified layer.
Copy Image to File	Allows the user to save the image to a file for other applications.
Print	Allows the user to print the image to a printer.
Zoom In	Zooms to a user-defined area in the map.
Zoom Out	Zooms out from an area of the map to a larger scale.
Pan	Pans the map in the direction of the mouse.
Zoom to Full Extent	Displays the full extent of the map.
Zoom to Active Layer	Zooms in (or out) to the active layer.
Previous Extent	Zooms to the last user-defined extent.
Next Extent	Zooms to the next user-defined extent.
Identify	Displays a table of the attributes of the user-identified feature.
Find	Finds a feature in the map.
Attributes	Displays information about the identified feature.
Select by Rectangle	Selects features contained in a user-defined rectangle in the map.
Select by Circle	Selects features contained in a user-defined circle in the map.
Select by Polygon	Selects features contained in a user-defined polygon in the map.
Clear Selection	Clears all selection in the map.
Measure	Measures distances in the map.
Set Units	Redefines the unit of measurement (default is kilometers).

TIP: A mouse right-click also opens a pop-up menu when applicable.

Opening, Saving, and Closing Projects

The *Data Frame* interface automatically loads the selected thematic map. However, this interface also allows users to create their own compilation of layers and saved projects in local directories. The project configuration files are stored in *Extensible Markup Language* (XML) format with file extension AXL (i.e. .axl) to differentiate it from XML files. These AXL files may be located in the local or networked directories. Clicking the **Open Project** button will open a Windows Open File dialog box (Figure 12) to allow users to select AXL files in the local directory.

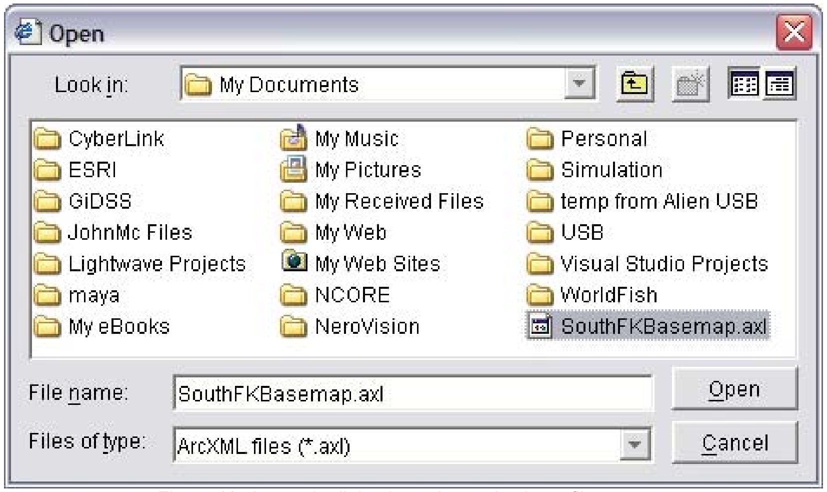

Figure 12. A sample dialog box when selecting a file to open.

The configuration file contains, among other things, details as to what data are needed, where to retrieve that data from, what layer is made visible and the initial extent of the map. New layers added to a project or other modifications made will not change the original content on the server when saving (i.e. when clicking the **Save Project** button) the new project file to a local directory (Figure 13).

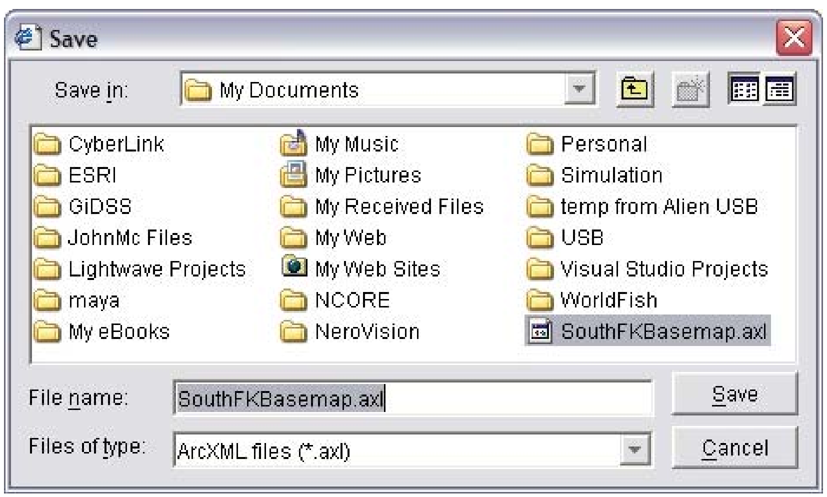

Figure 13. A sample dialog box when saving a project file.

These simple routines allowing the user to open and save configuration files locally will be useful when the pre-generated thematic maps are insufficient for a particular need (see *Adding layers and layer properties* section below for more on creating custom project files).

Clicking the **Close Project** button will clear the *Work Space*, *Layer* and *Overview* panes. Please note that this function is automatically called when opening a new *Project File*.

Adding Layers and Layer Properties

As previously stated, the interface will load the predefined project files in the server but will allow users to interactively modify the layers and/or create a new project file. Clicking the **Add Layers** button will open a dialog box (Figure 14) that will give users the option to load additional layers. The data (ESRI Shapefiles or Image files) may be loaded from a local directory, an IMS server (Internet Map Server), or ArcSDE (Advanced Spatial Data Server) sites. The NCORE IMS site is *http://typhon.rsmas.miami.edu* and it contains a collection of project files that may be used. Users of this system may also use the other files available on the server (Please visit the University of Miami Disclaimer (http://www.miami.edu/legal/) and privacy (http://www.miami.edu/privacy/) statements when using data from the NCORE server).

Some ArcIMS servers available on the Internet that may be of interest to resource managers are:

- NEP-WCMC (http://nene.unep-wcmc.org)
- ESRI (http://www.geographynetwork.com)
- NOAA/NGDC (http://map.ngdc.noaa.gov/)
- The Nature Conservancy (http://gis.tnc.org/)
- USGS EROS Data Center (http://gisdata.usgs.net)
- Worldbank (http://nebula.worldbank.org)
- Commonwealth of Kentucky (http://kygeonet.ky.gov)
- Earth Satellite Corporation (http://www.earthsat.com)
- Geography Network Canada (http://dev.geographynetwork.ca)
- Minnesota MetroGIS DataFinder (http://www.datafinder.org)
- Pennsylvania Spatial Data Access (http://cegis2.cas.psu.edu)
- TNRIS - Texas Natural Resources (http://www.tnris.org)

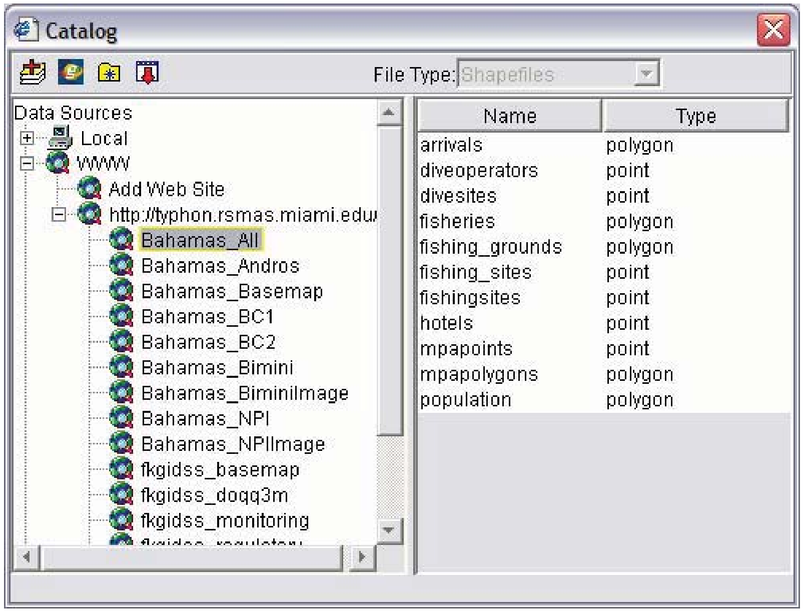

Figure 14. Dialog box when accessing layers from remote sites.

The digital map layers available to users are either images or vector files in ESRI Shapefile data format (.shp). The main advantage of using Shapefiles over images is that, the layers can be overlaid directly to previously loaded vector files or images. The system will download the Shapefile and render the image on the client's machine. Since shapefiles are normally bigger than compressed images, it will take longer to download the required files. However, once the Shapefiles are loaded, navigating through the map will be faster because rendering will no longer require the remote machine. All rendering activities will be done locally.

A main disadvantage in using an image for map overlays is that if new images are loaded, the previous image will no longer be visible. To make the previous image visible or to be able to manipulate the image when a layer is made visible, users may modify layer properties by clicking the **Layer Properties** button (Figure 15).

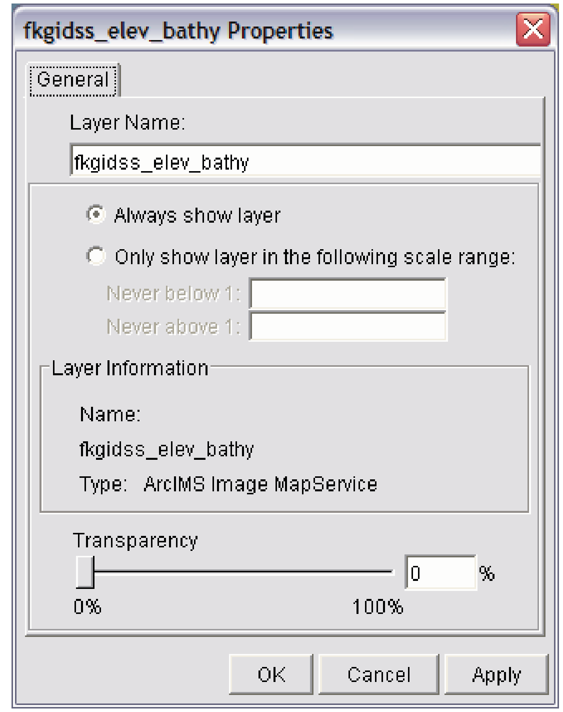

Figure 15. A sample dialog box for layer properties.

TIP: Another option available to users to make a layer visible when an image file is loaded is to change the layer's hierarchy. A user can modify the hierarchy of the layer in the *Layer* pane by clicking on and dragging the layer.

Saving Map Image and Print Function

The **Copy Image to File** button may be used to save the image on the *Work Space* to a file. The image displayed in the *Work Space* (and not the full extent) will be saved in JPEG file interchange format. This image format has become universally accepted and can be imported into almost any other Microsoft Windows program. When the **Copy Image to File** button is clicked, the user will be prompted (just below the Status Bar; Figure 16) to enter a title for the display (default is 'Map') and the filename. The default filename is '*C:/Temp/FK_GiDST/ mapImage_xxxx.jpg*' where '*xxxx*' is a four digit number randomly selected by the system.

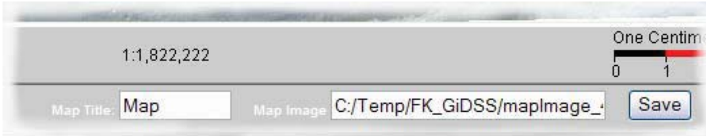

Figure 16. Part of the interface showing the prompt for title and filename to save the image.

Please be reminded that when the image is used in publications or reports, the data source should be acknowledged (e.g. Source: *DNav*, NCORE, University of Miami - RSMAS, FL, USA).

As with any other Windows-based software, the **Print** button opens a standard printer dialog box to allow users to configure the printer before finally printing the image. Like the **Copy Image to File** function, only the image as displayed in the *Work Space* will be printed.

Zooming Functions

Navigating through the various maps almost always involves zooming on the displayed image (map) workspace. The **Zoom In** button will allow the user to have a closer view and examination of a region in the map. Depending on how the thematic maps were developed (largely influenced by experts), some layers may become visible (see also Figure 14 above) at various scales. This technique is usually used by professionals to avoid cluttered displays of maps and symbols. The **Zoom Out** button is used to zoom out of the user-defined region to have a much wider view of the map.

If the full extent (i.e. full view of the map) is not in effect, the **Pan** button can be used to drag to other regions of the map. To drag or pan the image, left-click the mouse and without releasing the mouse button, move the mouse to the direction you want to pan the image. Two other zoom buttons that are useful when examining a map are the **Zoom to Full Extent** and **Zoom to Active Layer**. The former displays the whole image and the latter only displays the full extent of the active layer.

TIP: It is also possible to pan through the map by dragging the red box in the *Overview* pane.

Zooming to a region of the map is a commonly used function. However, users may want to navigate through the previously viewed extents (similar in function to Back and Forward functions in an Internet browser). The **Previous Extent** and **Next Extent** buttons may be used for such a purpose.

Querying the Layer and Attributes

Efforts were made by the authors to change the color of the attributes (attributes are information about a geographic location typically stored in a table and linked to the feature of a layer), hierarchy of the overlays, symbols to mark points, legends of the various attributes in the *Layer* pane, and a few other features to make the maps easy to read and interpret. However, there are cases where numeric or textual values become necessary when analyzing the data. There are several ways to query the spatial data in the *Work Space*.

When you want information about a layer displayed in the workspace, you can use the **Identify** tool (Figure 17). Clicking the **Identify** button will change the mouse cursor (arrow with the 'i' floating with the cursor) to signify the activation of the function. The **Identify** tool allows the user to see the attributes of the active data layer. Clicking the Identify tool on a location inside the workspace will present the attributes of the data at that location. The Identify tool is the easiest way to learn something about a location in a map.

When identifying layers with the **Identify** tool, the attributes are presented in a feature-by-feature manner in the Identify Results dialog box. If more than one feature was identified, you can click any of the features in the left panel of the Identify Results window to see the attributes of that feature.

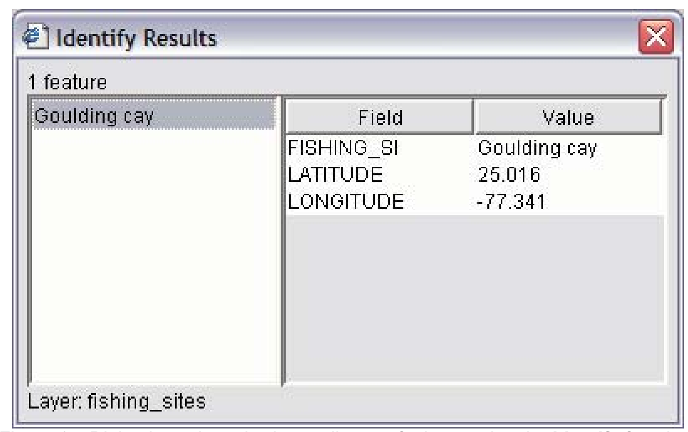

Figure 17. Dialog box when viewing attributes of a layer using the **Identify** function.

The **Find** button can also be used to query the spatial data. This function can be applied in conjunction with the selection tools to view attributes of multiple features in a region of the map if applicable (Figure 18). To select multiple features of a layer, click on the **Select by Rectangle**, **Select by Circle** or **Select by Polygon** buttons to select a region to query. The **Clear Selection** button is used to deselect all selected objects.

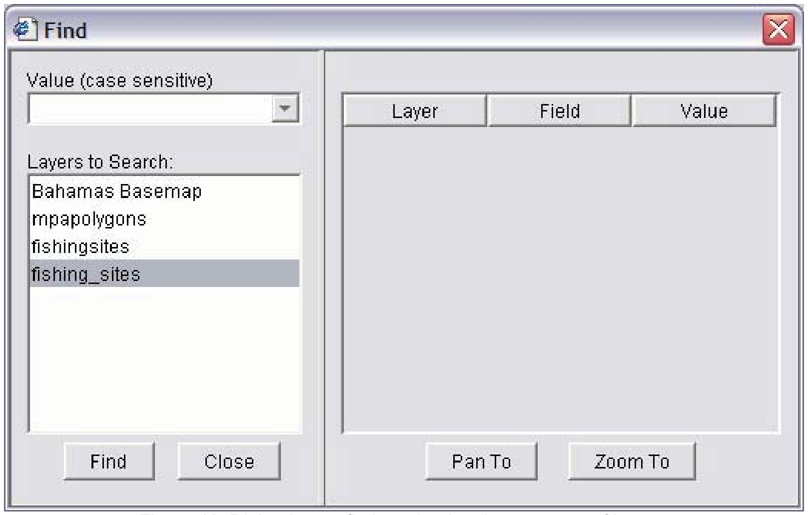

Figure 18. Dialog box to find a value in a layer or sets of layers.

Measuring Distances

Another useful function in the toolbar is the **Measure** command button. As the label implies, this tool will allow users to measure a distance from one point to another (here referred to as a segment) or total distances from various segments. The results are displayed in the upper left corner of the map (Figure 19).

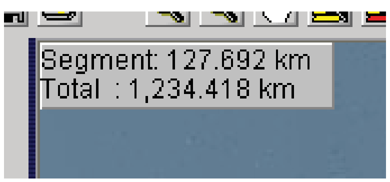

Figure 19. Part of the display showing the measurement of the last segment and cumulative distances of all segments.

To create a segment, click on the starting point of the segment to measure and drag the line (i.e. without releasing the left mouse button) to the end point of the segment. In cases where a curve line is necessary to measure a distance between two points, create multiple segments.

As a default, the unit of measure is in kilometers (i.e. metric). This unit of measurement can be changed by the user by clicking on the **Measure Unit** command button (Figure 20).

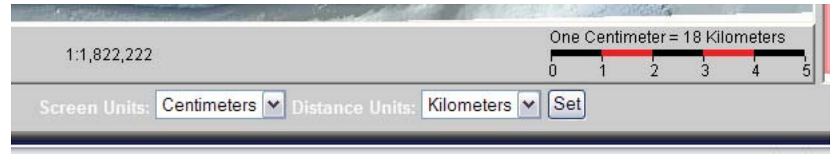

Figure 20. Part of the interface showing the prompts to change the units of measurement.

Changing of the units does not imply that the next time the map is loaded, the altered unit of measure made will be used. The default units will always be applied for all the maps.

The HTML Viewer Toolbar and Functions

<HTML> This section is applicable to the HTML Viewer.

The Toolbar (Figure 21) contains standard tools needed by users to examine the digital maps. Table 3 summarizes these functions.

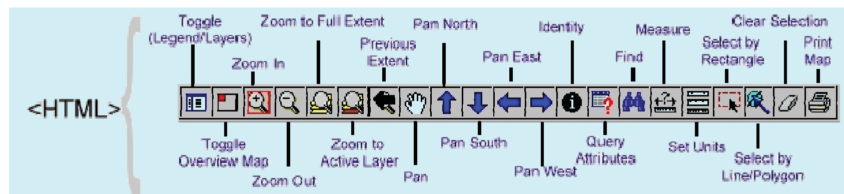

Figure 21. The toolbar for the HTML version containing online functions (see Table 3 for details).

Table 3. Toolbar functions for the HTML Viewer (see Figure 21).

	Function	Remarks
<HTML>	**Toggle (Legend/Layers)**	Allows the user to switch between a folder list of layers in the map frame and a graphical legend showing the active layer symbols in the map frame.
	Toggle Overview Map	Allows the user to turn the overview map in the upper left corner of the map frame on/off.
	Zoom In	Zooms to a user-defined area in the map.

Zoom Out	Zooms out from an area of the map to a larger scale.
Zoom to Full Extent	Displays the full extent of the map.
Zoom to Active Layer	Zooms in (or out) to the active layer.
Previous Extent	Zooms to the last user-defined extent.
Pan	Pans the map in the direction of the mouse.
Pan North	Pans the map in the north direction.
Pan South	Pans the map in the south direction.
Pan West	Pans the map in the west direction.
Pan East	Pans the map in the east direction.
Identify	Opens a window below the map and displays a table of the attributes of the user-identified feature.
Query Attributes	Opens a window below the map frame for the user to enter a SQL query of the active layer in the map
Find	Opens a window below the map frame for the user to enter a text string that will be used to search among the active layer in the map.
Measure	Measures distances in the map.
Set Units	Redefines the unit of measurement (default is kilometers).
Select by Rectangle	Selects features contained in a user-defined rectangle in the map.
Select by line/polygon	Selects features contained in a user-defined line/polygon in the map.
Clear Selection	Clears all selection in the map.
Print	Opens a window below the map to format the map for printing through a new browser window.

Toggle (Legend/Layers) Function

The **Toggle (Legend/Layers)** button allows the user to toggle between displays of the *Layers* and *Legend* in the far right frame (Table of Contents; TOC) within the viewer. The *Layer* and *Legend* information can also be access by clicking the tabs in the TOC.

Layers Frame:

The Layers frame (Figure 22) displays a "tree" structure which groups layers into folders. There are several important symbols to be aware of in order to understand how to manipulate the Layers Menu:

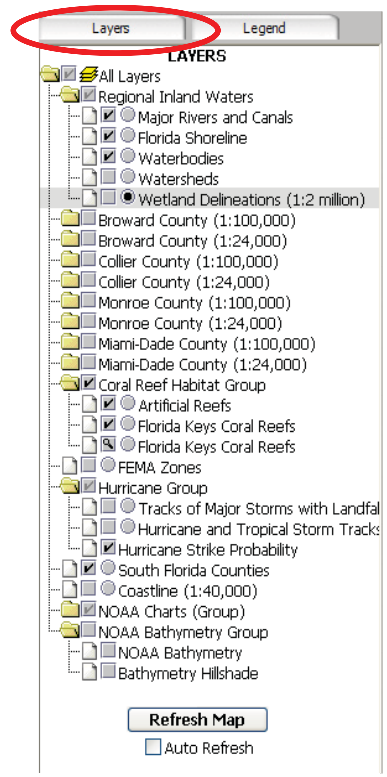

Figure 22. Sample content when the Layers tab (or toggled) is displayed.

A closed group, click to open. A group of layers that has been closed. If you click on the folder icon it will maximize/open.

An open group, click to close. A group of layers that has been maximized/opened. If you click on the folder icon it will be closed.

A map layer. A map layer can be either an image or feature class such as a shapefile. Clicking this icon will make the layer active and the user will be able to select, query, search and identify features within the layer.

A hidden group/layer, click to make visible. If a group or layer is not visible the user can check this box to make the group/layer visible.

A visible group/layer, click to hide. If a group or layer is visible the user can un-check this box to make the group/layer hidden.

A visible layer, but not at this scale. If a layer is visible only at certain scales this icon will be shown. In order to make the layer visible the user must zoom in until the layer becomes visible.

A partially visible group, click to make visible. If a group has multiple layers, some layers can be visible while others are hidden. If the user clicks on this icon all layers in the group will become visible unless they are only visible at certain scales in which the user would need to zoom in.

An inactive layer, click to make active. If a layer is inactive, the user does not have the ability to select, query, search and identify features of this layer. Click this icon to make the layer active.

Figure 23. Sample content of the Legend frame showing symbols used in the map display.

The active layer. If a layer is active, the user has the ability to select, query, search and identify features of this layer. Click this icon to make the layer active. Only one layer can be active at any one time and only vector features such as shapefiles can be made active layers. Click this icon to make the layer inactive.

The "**Refresh Map**" button is used to show changes if you select or unselect the Visible option. The default setting is "Auto Refresh" which means that every time the user makes a change to the Layers Menu the map frame will automatically refresh. Uncheck the box to turn off this function.

Legend Frame:

The Legend frame displays all the active layers in the map frame as well as the graphical symbols used to represent the layer (Figure 23).

TIP: If you do not see a particular layer in the legend menu it is most likely not visible or only visible at certain scales. Make sure the layer you want to see is visible and then zoom in until you see the symbols.

Toggle Overview Map Function

The **Toggle Overview Map** button allows the user to turn the overview map in the upper left corner of the map frame on/off. The overview map indicates the current map display frame view. If the user clicks on a point in the overview map the map display frame will re-center itself to that selected point.

Zooming Functions

Navigating through the various maps almost always involves zooming on the displayed image (map) workspace. The **Zoom In** button will allow the user to have a closer view and examination of a region in the map. As described in the previous function, some layers may become visible at various scales. This technique is usually used by professionals to avoid cluttered displays of maps and symbols. The **Zoom Out** button is used to zoom out of the user-defined region to have a much wider view of the map.

If the full extent (i.e. full view of the map) is not in effect, the **Pan** button can be used to drag to other regions of the map. To drag or pan the image, left-click the mouse and without releasing the mouse button, move the mouse to the direction you want to pan the image. Directional panning such as **Pan North, Pan South, Pan East,** and **Pan West** automatically move the map in the direction specified. Map scale is preserved when panning. Two other zoom buttons that are useful when examining a map are the **Zoom to Full Extent** and **Zoom to Active Layer**. The former displays the whole image and the latter only displays the full extent of the active layer.

Zooming to a region of the map is a commonly used function. However, users may want to navigate through the previously viewed extents (similar in function to Back and Forward functions in an Internet browser). The **Previous Extent** and **Next Extent** buttons may be used for such a purpose.

Identifying Feature Attribute Function

The **Identify** button allows the user to view the attributes of a particular feature. In the Layer view in the far right frame simply select the layer desired to be active before using the Identify tool. Clicking the **Identify** button will change the mouse cursor (arrow with the 'i' floating with the cursor) to signify the activation of the function. **Identify** will only return attributes for the active layer (Figure 24) and only one layer can be active at any one time. The attributes will be displayed on the bottom of the view area. If the desired layer/feature for which attributes are desired isn't listed in the Layer view, zoom in until it is displayed, then identify it.

Major Rivers and Canals

Rec	FID	#SHAPE#	ObjectID	FEATURE	NAME	STATE
1	44	[line]	2818836	Canal		FL
2	45	[line]	2818838	Canal		FL
3	62	[line]	2818835	Canal		FL

Figure 24. Table display of the attributes associated to an item in the active layer.

Query Attributes Function

The **Query** button allows the user to select features based on a filter of selected fields of that feature. Hit the **Query** button to call up the query frame (Figure 25) near the bottom of the viewer. In the field area, there is a pull down menu that can be used to select the field of interest. Then choose an operator such as =, >, or LIKE to define a specific value of the field. In the value box, type the value of what you're searching for based on the field. Then hit the "Get Samples" button to see a sampling of what can be typed in this field. If the desired value is listed, simply click on that value. Once all 3 fields are complete, hit the "**Add to Query String**" button and hit the "**Execute**" button. This will perform the query and return the results as well as zoom into the area of interest which highlights the query results.

Please refer to standard SQL (Microsoft Structure Query Language) references for details on how to create query statements.

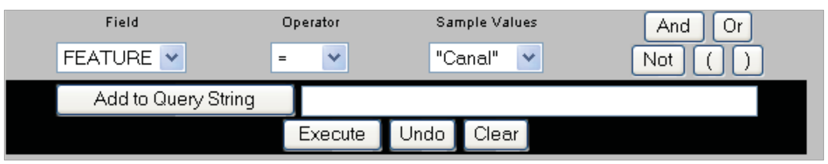

Figure 25. The “Query” frame to select/identify map features.

Find Text String Function

The **Find** button allows the user to search for a text string in the active layer (Figure 26). This search is case sensitive so to search for a particular reef name (for example) the user will need to capitalize the first letter.

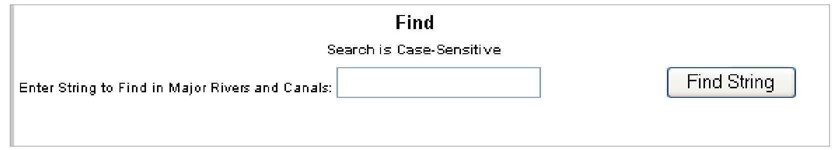

Figure 26. Frame to search a string value in the active layer.

Measure Function

The **Measure** button allows the user to click on two or more points and return the distance in the current units (see **Set Units Function** below; Figure 27).

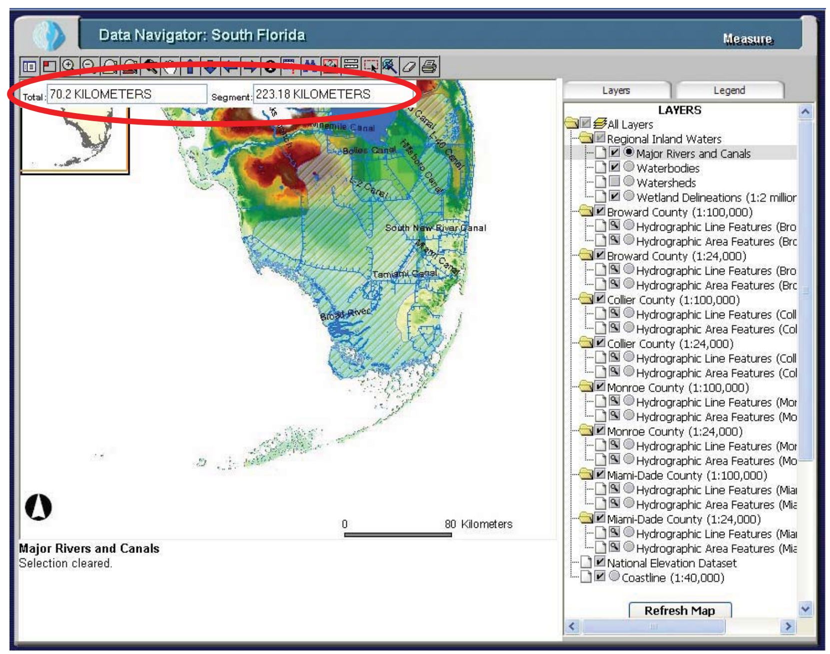

Figure 27. Note measure made for the segment and running total in the upper left corner of the display.

It keeps track of the length of the segment as well as a running total in case there is a need to obtain the length of a route between multiple points. The readout is at the top of the map display frame.

Set Units Function

The **Set Units** button allows the user to set the map units in Degrees, Feet, or Meters, and display units in Feet, Miles, Meters, or Kilometers (Figure 28). Use the pull-down menu to select a unit of measurement and then click Set Units. Changing of the units does not imply that the next time the map is loaded, the altered unit of measure made will be used. The default units will always be applied for all the maps.

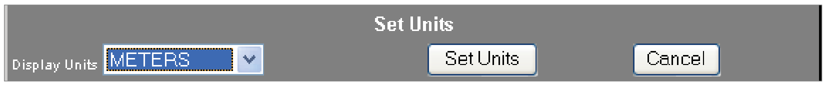

Figure 28. Frame displayed to change unit of measure.

Select by Rectangle Function

The **Select by Rectangle** button allows the user to drag a box with the cursor to define an area of selection. Any active feature that touches or falls within the box will be selected. The selected set will be highlighted. Once features are selected, other functions can be performed on this selected set.

Select by Line/Polygon Function

This button allows the user to create a line route upon which all active features the line crosses will be selected or to create a polygon upon which all features touching or contained within that polygon area will be selected. To create a line, click on one or more points in the view and then hit the *Complete Line & Select* button and the selected set will be highlighted and it's attributes will be displayed in the lower window. To create a polygon, click on the view in selected points until the desired area is defined then hit the *Complete Polygon & Select* button to highlight the selected set as well as display the attributes. If a point is hit mistakenly, just hit the *Delete Last Point* button to take it off.

Clear Selection Function

This button will clear any selected features or remove any added graphics such as lines or polygons used with the Line/ Polygon tool.

Print Map Layout Function

This button creates a printable, simple map layout of the current view area along with a legend. After clicking the **Print** button, fill in the *Title to Display on Map* and hit *Create Print Page*. Use your Internet Browser's printing function to finish printing the document.

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The **National Center for Caribbean Coral Reef Research (NCORE)** is focused on the analysis and forecasting of coral reef resilience in order to improve the scientific basis of coral reef management issues. The goal is to advance coral reef science to the degree that we can determine the range of potential consequences of a given disturbance or change in management strategy on both the ecology of the reef and the socioeconomics of the reef-dependent people. In short, we aim to move coral reef science away from post-mortem analysis toward useful scenario testing.

NCORE's initiative to develop the **Data Navigator: South Florida** is a step forward in an attempt to bridge gaps among science, resource management and public knowledge. The digital layers presented here have been selected and grouped together via a decision tree based on potential field scenarios. Wherever applicable, animated time series of layers are presented to provide a better understanding of the dynamics of the data and comments from experts in their respective fields have been inserted to help guide the user.