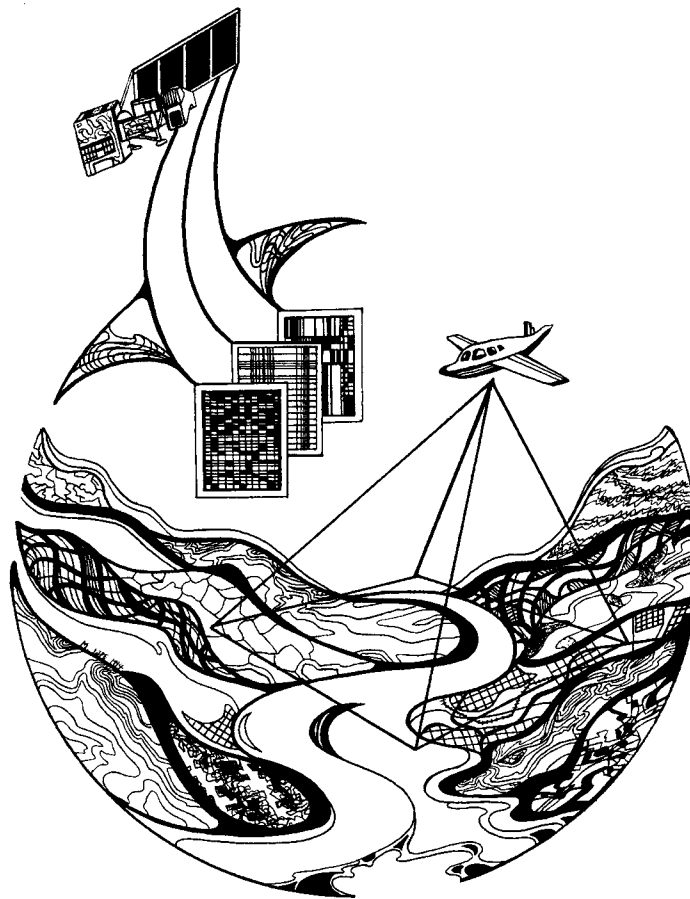


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**Geospatial Application:**

**A Geographic Information  
System Interface Designed for  
Use in River Management**



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**July 1996**

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# **Geospatial Application: A Geographic Information System Interface Designed for Use in River Management**

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July 1996

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## **Preface**

The Long Term Resource Monitoring Program (LTRMP) was authorized under the Water Resources Development Act of 1986 (Public Law 99-662) as an element of the U.S. Army Corps of Engineers' Environmental Management Program. The LTRMP is being implemented by the Environmental Management Technical Center, a National Biological Service Science Center, in cooperation with the five Upper Mississippi River System (UMRS) States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The U.S. Army Corps of Engineers provides guidance and has overall Program responsibility. The mode of operation and respective roles of the agencies are outlined in a 1988 Memorandum of Agreement.

The UMRS encompasses the commercially navigable reaches of the Upper Mississippi River, as well as the Illinois River and navigable portions of the Kaskaskia, Black, St. Croix, and Minnesota Rivers. Congress has declared the UMRS to be both a nationally significant ecosystem and a nationally significant commercial navigation system. The mission of the LTRMP is to provide decision makers with information for maintaining the UMRS as a sustainable large river ecosystem given its multiple-use character. The long-term goals of the Program are to understand the system, determine resource trends and effects, develop management alternatives, manage information, and develop useful products.

The strategy to conduct spatial analyses to provide support to LTRMP partner activities is included in the LTRMP Operating Plan (USFWS 1993) as Strategy 4.3.1, *Develop Data Management and Analysis Capabilities*. This report was developed with funding provided by the Long Term Resource Monitoring Program.

Additional copies of this report may be obtained from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161 (1-800-553-6847 or 703-487-4650).

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# **Geospatial Application: A Geographic Information System Interface Designed for Use in River Management**

By David R. McConville, Thomas W. Owens, and Anjela S. Redmond

## **Abstract**

A pilot geographic information system (GIS) graphical user interface (GUI) was designed to facilitate habitat rehabilitation and enhancement planning by the U.S. Army Corps of Engineers, St. Louis District. Undertaken in summer 1993, the project was developed to provide sample analyses for the Calhoun Point Habitat Rehabilitation and Enhancement Project on Pool 26 of the Upper Mississippi River System. The main objective of the project was to show how a GIS can assist in the design and evaluation of a project. The interface allows users to become familiar with the features of the area from a contemporary as well as a historical perspective, conduct statistical summaries, and develop and test varying modeling scenarios involving dike placement and water level elevations. The interface was written in Arc Macro Language and executed in the ARC/INFO version 6.1 (Environmental Systems Research Institute, Redlands, CA) vector and raster environment on a UNIX workstation platform. The GUI is menu-driven and designed around an expandable hierarchical data structure. In operation, the user sets the analysis environment by selecting, through a series of menus, the elements needed for analysis, including the land cover layer, management plan, and elevations. Graphic and numeric results are displayed on the screen.

## **Introduction**

Geographic information systems (GIS) are powerful processing tools for spatial analysis. To demonstrate the capabilities of this tool in facilitating river management and habitat analysis, an interface program was created by using an ARC/INFO (Environmental Systems Research Institute, Redlands, CA) GIS.

We describe a specific interface program example in detail, guiding the user step-by-step through the interface menus. The U.S. Army Corps of Engineers (Corps), St. Louis District, expressed an interest in using a GIS for project design and planning on a Habitat Rehabilitation and Enhancement Project (HREP). At the National Biological Service, Environmental Management Technical Center (EMTC), at Onalaska, Wisconsin, the interface program was developed around the requirements for a specific HREP, with the coverages and analysis modules designed to produce the output that the planners for the project desired. However, the main objective in developing the program for this project was to show the planners how a GIS can assist in the design and evaluation of an HREP. Among other aids, the interface affords planners an opportunity to experiment with levee placement and provides them with the ability to interactively design and analyze the results of various design scenarios. In this instance, the program served only as an example of how a GIS can be used in project planning and design.

The interface program can be modified for use with other projects that have the needed spatial data layers. In addition, the menus and analysis modules in the program could be structured to meet the objectives of a project with different design and management plans than those of the example presented in this manual.

## Program Structure

Based on a hierarchical data structure, the interface main menu is the trunk of the program and secondary menus branch from it (Appendix A). As a generic structure, the series of menus provides access to displays of coverages, management area plans, and elevations that will be used for analysis. The different management area plans and elevation coverages can be overlaid onto the other available coverages. The analysis section of the program is a series of modules written in Arc Macro Language, a programming language in ARC/INFO that processes the data and produces the results. The user sets the analysis environment by selecting, through a series of menus, the land cover, management plan, and elevations for analysis. Graphic and numeric results are displayed on the screen.

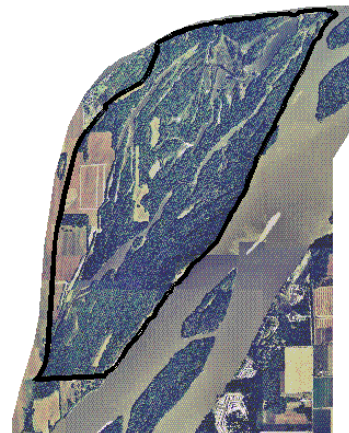
Some menu options displayed in the program are not available. If one of these options is chosen, a message stating the unavailability of this selection will appear. The purpose of providing these options in the program is to show the user the further capabilities of the program. For example, in the modeling section of the interface, the user can choose from one or multiple dikes to model. The user can now exercise the full suite of options for a single-dike design but only a subset of options for multiple-dike design. The multiple-dike design option was added later to demonstrate the expandability of the interface.

## Calhoun Point Habitat Rehabilitation and Enhancement Project

### *Area Description*

Calhoun Point is a floodplain management complex on Pool 26 at the confluence of the Illinois and Mississippi Rivers in Calhoun County, Illinois. The area is owned by the Corps and is managed by the U.S. Fish and Wildlife Service, Mark Twain National Wildlife Refuge, and the Illinois Department of Conservation.

The 890.3-ha (2,200-acre) area consists of lowland hardwood forests and small areas of open water, backwater sloughs, and farmland (Fig. 1). Construction of Lock and Dam 26 at Alton, Illinois, about 32 km (20 mi) downstream of Calhoun Point, affected the character of the Calhoun Point area by altering the open-flow regime of the Mississippi and Illinois Rivers. In 1938, when the dam was completed and the gates closed, water levels in Calhoun Point rose 2.6 m (8.5 ft) (Nelson et al. 1994). About 242.8 ha (600 acres) of emergent land in Calhoun Point were permanently inundated by the increase in river stage. Water levels in Calhoun Point are now controlled by operations at Lock and Dam 26. The average water level on Pool 26 is 127.9 m (419.5 ft).



**Figure 1.** Aerial photocomposite created from 1:15,000-scale color photographs.



The Calhoun Point area is characterized by low topography, with a high elevation of 131 m (430 ft) above mean sea level (msl). Most of the area is 129.2 m (424 ft) above msl or lower (Roelle and Hamilton 1991). Natural and constructed low-head levees are present in parts of Calhoun Point but do not prevent the flooding by the Illinois and Mississippi Rivers that occurs because of the low relief of the area. Between 1972 and 1991, the river stage exceeded 129.2 m (424 ft) above msl on 25 occasions; in some years, floods occurred as many as five times during the growing season. Silt deposition also occurred during these floods. In 1990, when Calhoun Point flooded five times, several inches of silt were deposited. According to the Corps (1994), the average sedimentation rate after impoundment on Pool 26 is 1.3 cm (0.5 inches)/yr.

Frequent flooding and the resulting sedimentation can have negative effects on the biota in Calhoun Point. Flooding can kill tree seedlings if they are overtopped by floodwaters and can destroy moist-soil vegetation and agricultural crops used by wildlife. Sedimentation can also prevent the growth of aquatic vegetation and inhibit movement of and suitable spawning habitat for several species of fish inhabiting backwaters of Calhoun Point (Corps 1994).

### *Calhoun Point Proposed Habitat Rehabilitation and Enhancement Project*

The area is recognized as a valuable, multiple-use resource by resource managers in the States of Illinois and Missouri who have lost substantial portions of their wetlands and want to preserve remaining areas. The Corps is also interested in preserving and enhancing riverine wetlands. The area is a candidate for environmental improvement under the Upper Mississippi Environmental Management Program (Public Law 99-662, Upper Mississippi River Management Act of 1986).

In February 1991, a 4-day workshop was held under the sponsorship of the Riverlands Area Office of the Corps of Engineers, Region 3 of the Fish and Wildlife Service, and the Illinois Department of Conservation. This workshop produced the framework for future management of Calhoun Point (Roelle and Hamilton 1991). The goal of the proposed habitat rehabilitation project is to improve and prolong the longevity of the area as a multiple-use resource for fish, wildlife, and recreation. The most important element of the management plan was determined to be the re-creation of the low-head levee system around the area. This would simplify water level management in the area, reduce the frequency of flooding, and reduce sediment inflow. Other proposed actions included installing water control structures, removing selected woody vegetation around the fringes of lakes, installing short dikes between lakes to facilitate independent management, and revegetating certain areas with plants high in waterfowl value. Suggestions for primary fish habitat improvements included reconnecting selected lakes with the mainstem river in a way that minimizes silt inflow and dredging selected lakes to re-create deeper water habitat.

## **Data Used in the Calhoun Point Interface**

The availability and suitability of data is an important aspect of any analysis. The National Biological Service, EMTC, at Onalaska, Wisconsin, maintains an extensive database on the Upper Mississippi River System. Most of the data used in the program are present in this database. Descriptions for each spatial coverage used in the interface program for Calhoun Point follow.

### *Land Cover/Use, 1989*

The 1989 land cover/use coverage was created from 1:15,000-scale color-infrared aerial photography using a genus-level classification scheme and a minimum mapping unit of less than 0.4 ha (1 acre), 10% vegetation cover. The data were interpreted by the Midcontinent Ecological Science Center (D'Erchia 1993).

### *Land Cover/Use, 1975*

The 1975 land cover/use coverage was created as part of the Great River Environmental Action Team (GREAT) project. The data were interpreted from 1:24,000-scale color-infrared aerial photography. The minimum mapping unit was about 0.4 ha (1 acre). Copies of the photographic mylars were rectified and computerized in the early 1990s by the Midcontinent Ecological Science Center (D'Erchia 1993).

### *Land Cover/Use, 1930*

The 1930 land cover/use coverage was created from a composite of aerial photographs collected between 1927 and 1936. The photographs were interpreted by the U.S. Geological Survey (Rolla, Missouri) for inclusion in the Corps St. Louis District's report titled "Terrestrial and aquatic land use and habitat change as a result of the nine-foot channel project," released March 1980. These data were then computerized by the Long Term Resource Monitoring Program (LTRMP) from project mylars. Original data interpretation was performed at a 1:24,000-scale and 50% vegetation cover. The original minimum mapping unit is unknown (D'Erchia 1993).

### *Land Cover/Use, 1903*

The 1903 land cover/use data were created for the U.S. Army Corps of Engineers (Chicago) from J. W. Woermann's 1902–04 map of the secondary triangulation system of the Illinois and Des Plaines Rivers from Chicago, Illinois, to the mouth of the Illinois River. Copies of the maps were computerized by the Pool 26 Field Station, LTRMP. The minimum mapping unit, minimum vegetative mapping cover, method of data acquisition, original mapping scale, and the scale of the map computerized are unknown.

### *Land Cover/Use, 1890s*

The 1890s land cover/use data were collected by the Mississippi River Commission Survey. The data were collected through a series of ground surveys and tower observations, then drafted using a plane table. The data were computerized in the 1990s by the LTRMP. The original map scale was 1:20,000 (D'Erchia 1993).

## *Land Cover/Use, 1817*

The 1817 land cover/use data were created from a 1817 Federal land surveyors' plat map. Copies of the maps were provided by the Illinois State archives and the data computerized by the Pool 26 Field Station, LTRMP. The minimum mapping unit, minimum vegetative mapping cover, method of data acquisition, original mapping scale, and the scale of the map computerized are unknown.

## *Wetlands Coverages*

Four National Wetlands Inventory (NWI) wetlands coverages are included. These are NWI System and Subsystem, System and Class, Class and Subclass, and Water Regime. All were derived from the NWI wetlands' codes contained in the 1989 land cover/use coverage previously listed. The NWI classification codes were determined at the time of photointerpretation by personnel at the Midcontinent Ecological Science Center (D'Erchia 1993).

## *Soils*

The soils coverage was created from paper maps contained within the publication *Soil Survey of Calhoun County, Illinois* (Lilly 1989). The scale of the coverage is 1:15,850; the minimum mapping unit is unknown. The original survey was made by the U.S. Department of Agriculture, Soil Conservation Service, and by the Illinois Agricultural Experiment Station (Lilly 1989). The data were computerized in 1994 by the LTRMP.

## *Elevations*

The elevation contour coverage was created from a 1990 partial 2-ft line contour coverage of the Calhoun Point Environmental Demonstration Area provided by the U.S. Army Corps of Engineers, St. Louis District, and supplemented with additional field data obtained in spring 1994 (vertical datum unknown). The field map is unverified, and the original mapping scale and the scale of the map computerized are unknown. The line coverage was created with the Universal Transverse Mercator (UTM) coordinate system, Zone 15, North American Datum of 1927. For modeling, 1-ft raster cell coverages from 420 to 432 ft above msl were interpolated from this line coverage with the ARC/INFO Triangulated Irregular Network (TIN) module. All automation and elevation coverage derivations occurred at the LTRMP in summer 1993. No quality control of the interpolated coverage was performed since the interface served only as an example of GIS capabilities and was not used in the actual Calhoun Point HREP planning and design.

## *Photocomposites*

Georeferenced true-color and color-infrared aerial photocomposites were created. These were created from the EMTC's 1:15,000-scale photography of Pool 26 from September 1989, using GRID image analysis tools.

## *Calhoun Point Management Areas*

The management areas coverage was created from sketches provided by the Corps, St. Louis District, Missouri (Gates and Nico 1993). The data were interpreted and computerized by the LTRMP. The management areas coverage was registered to the 1989 land cover/use coverage listed previously.

### *Roads*

The road coverage was created from the U.S. Geological Survey's 1:24,000-scale, 7.5-ft quadrangle tiles (trngrafton & trnbrussels). It was computerized by the LTRMP (D'Erchia 1993).

### *Endangered Species, Historical or Archeological Sites, and Fisheries Research Sites*

Coverages for endangered species, historical or archeological sites, and fisheries research sites were created at the Pool 26 Field Station, LTRMP. The endangered species coverage and the historical or archeological coverages simply provide warnings that sites of significance exist. Location information is not specific because of the desire to protect the areas. Further information on endangered species can be obtained from the Program Manager, Endangered Species Protection, Illinois Department of Conservation, Springfield, Illinois. Information on historical or archeological sites is available from the Chair, Illinois Archeological Survey Site File Access Committee, Illinois State Museum, Springfield, Illinois.

The fisheries site coverage was created as a point coverage of active LTRMP fish collection locations. Specific site information is listed on the fisheries site coverage.

## **Using the Interface**

This program was created in ARC/INFO version 6.1 and run on a Sun workstation platform. The interface is designed to be run from within the directory that contains the necessary databases listed in the preceding section. After you have initiated an ARC session, start the interface by typing "**&run calstart**" at the ARC prompt.

Upon first entering the program, a menu appears and you are asked to choose the screen display size. The small screen option is designed for a 14- to 15-inch monitor (if you are using an X-window emulator program on your personal computer) and the large screen choice is designed for a 17-inch monitor or larger. Choose the option that applies to your monitor size.

### *Main Menu*

After the screen size has been set, an aerial photocomposite of Calhoun Point is drawn on the screen, and the Calhoun Point Main Menu appears at the top (Fig. 2). The Main Menu bar contains

buttons that represent the eight major components of the program. Information about each component and the choices available under each button follows.

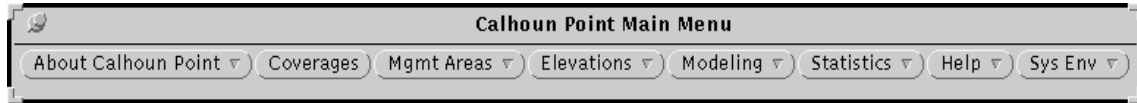


Figure 2. Calhoun Point Interface Main Menu.

## Main Menu Button: About Calhoun Point

This button provides several views of Calhoun Point to show the location of the project area from several perspectives. The menu that appears after you select the About Calhoun Point button contains three choices (Fig. 3). "In the UMRS" presents the area in the perspective of the Upper Mississippi River System. "On Pool 26" shows the location of Calhoun Point on Pool 26 of the Mississippi River. "Local Reference" provides a close-up view of the project area in detail, as well as a brief overview of the area's history.

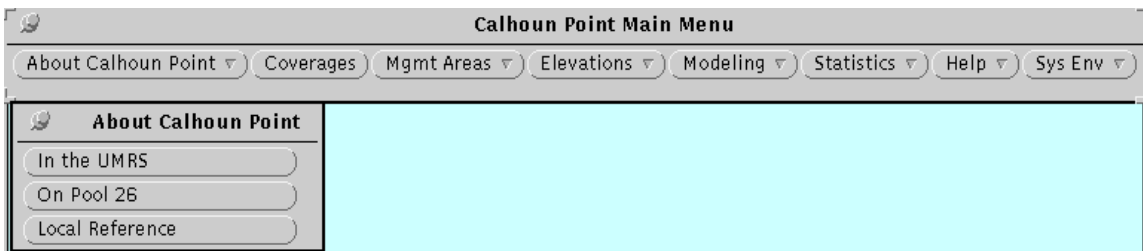


Figure 3. About Calhoun Point Menu.

## Main Menu Button: Coverages

Selecting the Coverages button on the Main Menu bar activates the Coverages Menu (Fig. 4). Menu selections available for viewing different coverages of the Calhoun Point area are land cover coverages, imagery, wetland types, soil types, endangered species, forest survey, important sites, roads, and system environment. Each Coverage Menu selection is explained in the following sections.

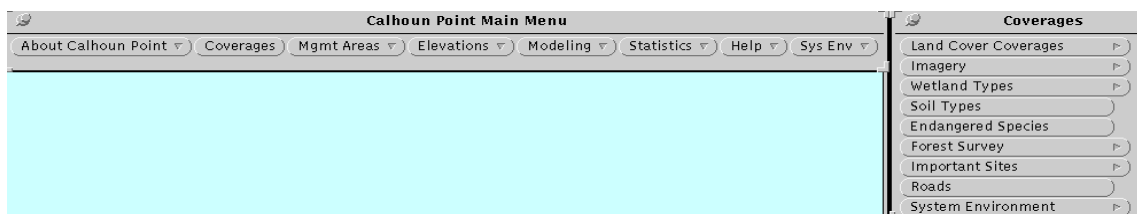
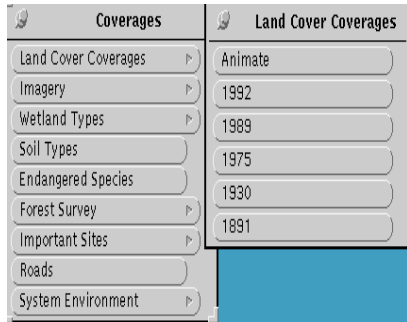


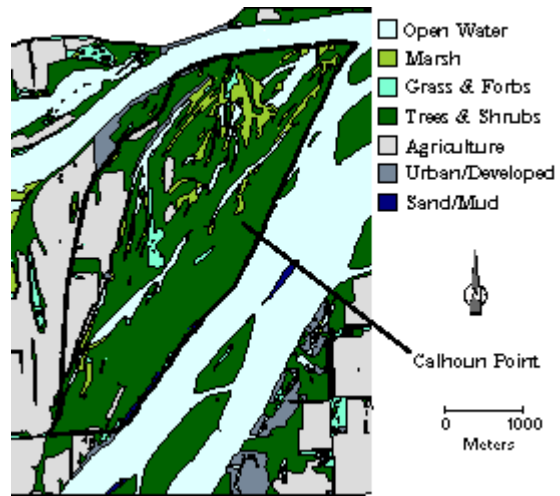
Figure 4. Main Menu with Coverages Menu.

**Coverages Menu Button: Land Cover Coverages.** Coverages displaying land cover from several years are available under this button selection. From the land cover menu that appears, you may choose to display land cover for the area from the years 1891, 1930, 1975, and 1989 (Fig. 5). The 1989 land cover display is shown in Figure 6. The year 1992 is also listed on the menu; however, the coverage is not yet available. Menu selections can be modified to include or exclude any coverage. The animate option available on the menu will draw each coverage in quick succession, providing a view of the change in land cover from 1891 to the present.

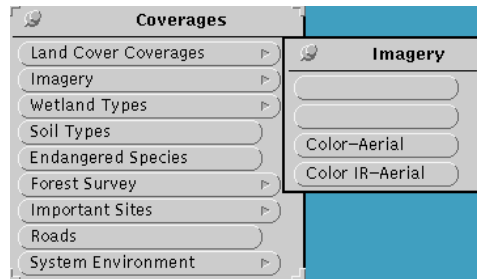


**Figure 5.** Coverages Menu with Land Cover Menu.

The 1891 cover was derived from Mississippi River Commission Survey materials. The 1930 cover was derived from Corps St. Louis District materials. The 1975 cover was derived from GREAT I overlays. The 1989 layer was derived from the EMTC Pool 26 coverage. In each instance, land cover is represented by a seven-class system consisting of open water, marsh, grass and forbs, trees and shrubs, agriculture, urban/developed, and sand/mud.



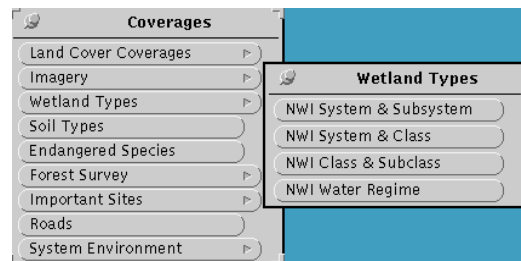
**Figure 6.** Display of the 1989 Land Cover Coverage.



**Figure 7.** Coverages Menu with Imagery Menu.

**Coverages Menu Button: Imagery.** An Imagery Menu appears next to the Coverages Menu when you choose this button. You may choose to view either true-color or color-infrared views of Calhoun Point (Fig. 7). Both choices are photocomposites created from 1989 photography and georeferenced against the EMTC 1989 land cover layer for Pool 26.

**Coverages Menu Button: Wetland Types.** When you select this button, the Wetland Types Menu appears next to the Coverages Menu (Fig. 8). Coverages available in this menu group feature classifications according to NWI criteria (USFWS 1986). The Wetland Types menu choices are NWI System and Subsystem, NWI System and Class, NWI Class and Subclass, and NWI Water Regime.

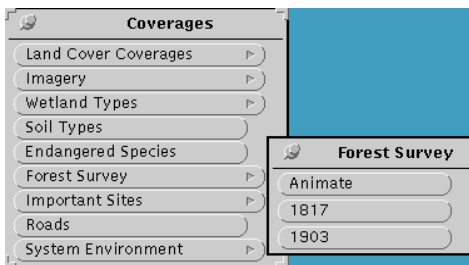


**Figure 8.** Coverages Menu with Wetland Types Menu.

These coverages were derived from the NWI classification codes present in the EMTC's 1989 land cover layer for Pool 26 (Appendix B).

**Coverages Menu Button: Soil Types.** A soils map of the area is displayed on the screen after you select the Soils Types button. The map was automated from a set of soils maps for Calhoun County, which were created in 1984 by the U.S. Department of Agriculture, Soil Conservation Service, in conjunction with the Illinois Agricultural Experimental Station.

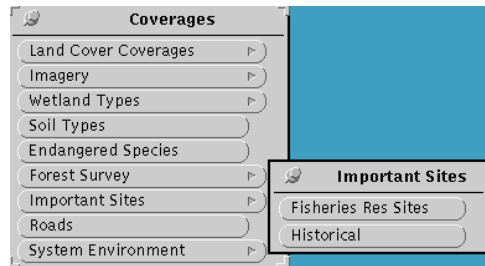
**Coverages Menu Button: Endangered Species.** When you choose this button, the seven-class land cover coverage of Calhoun Point is displayed on the screen along with a statement that threatened and endangered species are present in Calhoun Point. The agency to contact for more information is also listed.



**Figure 9.** Coverages Menu with Forest Survey Menu.

**Coverages Menu Button: Forest Survey.** A menu that appears when the Forest Survey button is selected provides you with three options (Fig. 9). The "1817" and "1903" choices allow you to see the area as it appeared in these years. The "animate" option draws the two coverages in quick succession so you can view the land cover changes. For each coverage, land cover information is presented according to a four-class scheme—water, prairie (wet/dry), forest, and agriculture.

**Coverages Menu Button: Important Sites.** Two choices are available on the menu that appears when you select the Important Sites button (Fig. 10). "Fisheries Res Sites" draws the locations of the LTRMP fisheries sites that are sampled by biologists at the Illinois Natural History Survey's Pool 26 field station. The "Historical" selection displays the seven-class land cover coverage of Calhoun Point along with a statement that historically and archaeologically significant sites exist in the area. The agency to contact for further information is also listed.



**Figure 10.** Coverages Menu with Important Sites Menu.

**Coverages Menu Button: Roads.** When you choose the Roads button on the Coverages Menu, roads in the immediate vicinity of Calhoun Point are drawn. Roads shown are either primary or secondary improved roads. Trails are omitted. The roads presented were selected from the Digital Line Graph coverage and then updated to include missing roads. Roads may be drawn as a base layer or as a reference overlay to another layer. They may be drawn as an overlay on any of the other Coverages Menu coverages, the Mgmt Areas Menu management areas or the Elevations Menu elevations coverages.

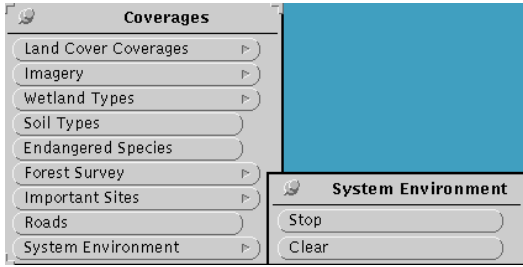


Figure 11. Coverages Menu with Sys Env (System Environment) Menu.

**Coverages Menu Button: Sys Env (System Environment).** This button is the last menu selection in the Coverages Menu and is designed to allow you to return to the Main Menu or to clear the screen and allow you to choose another item from the Coverages Menu. Two choices are presented on the menu that appears (Fig. 11). "Stop" signals the end of selections from the Coverages Menu and returns you to the Main Menu. "Clear" is used to clear the display screen between selections in the Coverages Menu.

### Main Menu Button: Mgmt Areas (Management Areas)

Selection of this Main Menu button allows you to view one or all of the seven management areas present under the proposed management plan for Calhoun Point. The management areas are designated A through G (Gates and Nico 1993). The Mgmt Areas Menu that appears gives you a choice of viewing all of the areas, or you may select a management area of interest (Fig. 12). A management area can be drawn as a base layer on an empty graphics screen or as an overlay on other coverages. Coverages on which management areas may be drawn as an overlay include all of those presented by the Coverages Menu or the Elevations Menu.

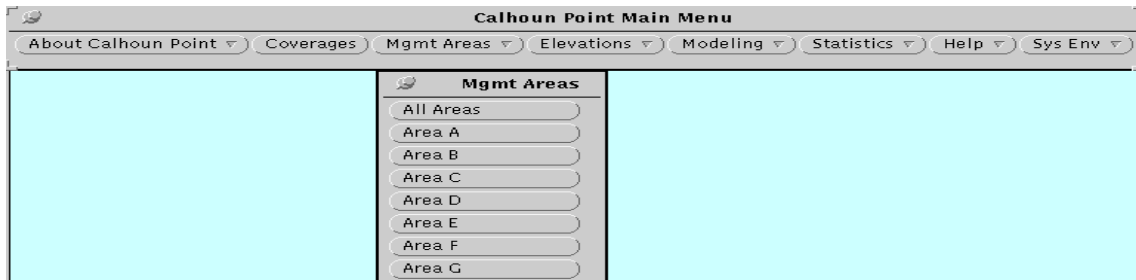


Figure 12. Main Menu with Mgmt Areas Menu.

### Main Menu Button: Elevations

Elevation information is present in two forms. When the Elevations button is selected, a menu appears below the button (Fig. 13).

You may choose the "Contours" option, which is a line contour coverage of the elevation in the area. The contour coverage can be drawn as a base layer on the screen, and roads and management areas can be added. The contours can also be drawn as an overlay on top of the coverages presented under the Coverages Menu options. They may also be overlaid on the TIN-interpolated grids that are available on the Elevations Menu. The contour coverage was created by automating a partial 1990 elevation map of the area supplemented with additional data collected in 1993. Both were obtained from the Corps St. Louis District. Automation occurred at the EMTC.



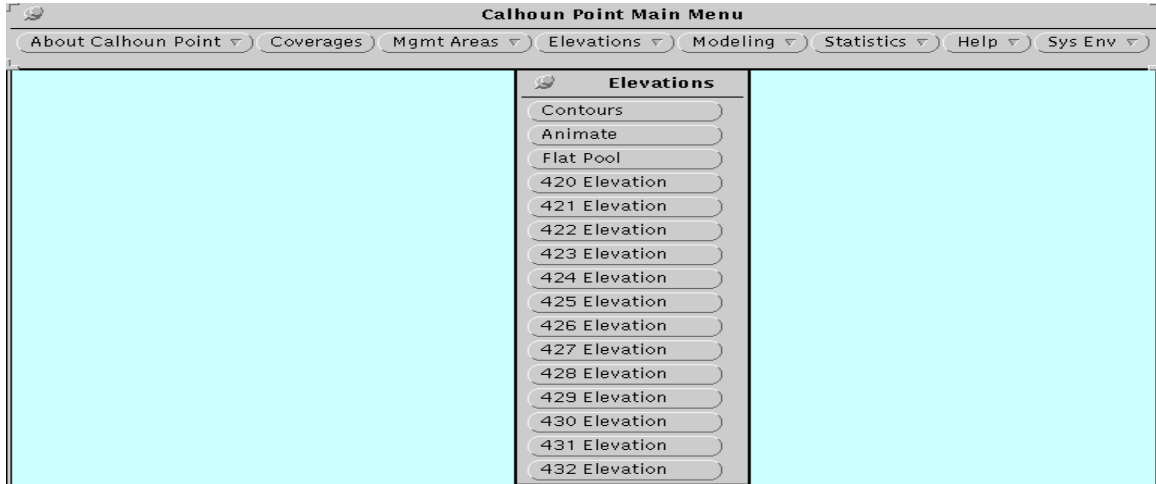


Figure 13. Main Menu with Elevations Menu.

The remaining menu choices consist of a series of TIN-interpolated grids of the line contour coverage. These coverages draw each 0.3-m (1-ft) interpolated elevation contour as a different color. The TIN-interpolated grids can be drawn, one at a time, from a base elevation of flat pool to a high elevation at 132 m (432 ft) above msl. The base TIN grid presents an approximation of how the area might appear at a river stage of 128–132 m (419–420 ft) above msl because water levels at Lock and Dam 26 are maintained at an average of 128 m (419.5 ft) above msl (Corps 1994). The TIN grid at 132 m (432 ft) above msl shows the entire area inundated. Intermediate elevation coverages present a projection of how the area might appear with successive 0.3-m (1-ft) increases in river stage. These coverages may also be seen with the animation option as they are drawn in quick succession.

As the primary purpose of this program was to provide an example of GIS capabilities, no verification of the interpolated grids occurred. However, if the program was to be funded for the purpose of providing actual input into the design and planning phase of a project, then verification would be necessary.

### Main Menu Button: Modeling

The Modeling option is the backbone of the interface program and consists of five interactive modeling options. When you select the Modeling button, a menu appears listing the five modeling choices (Fig. 14). They are "Elevation Change Impact," "Dike Design," "Dike Development," "Dike Effectiveness Test," and "Flood Animation." The Elevation Change Impact module is an

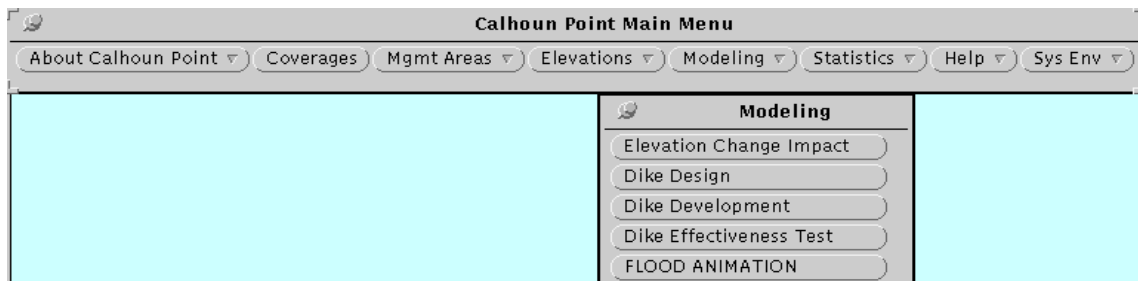
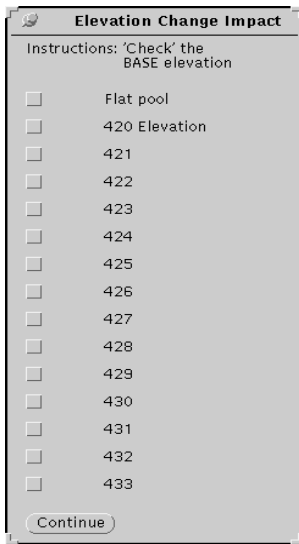


Figure 14. Main Menu with Modeling Menu.

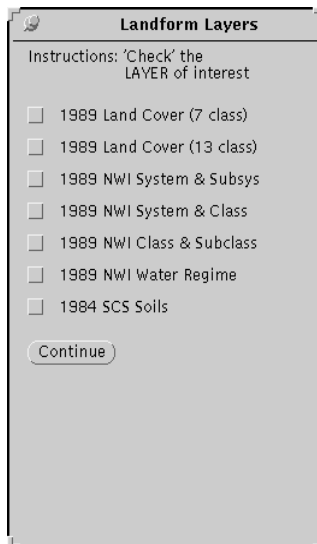
independent module that can be run anytime. The remaining modules must be completed sequentially because each module, except the first, provides input to the next module. Each available modeling option is explained below. Again, it is emphasized that the project demonstrated in this user's manual is an example and not used in actual project design.

**Modeling Menu Button: Elevation Change Impact.** When this module is executed, you can visualize the area as it appears at a river stage you select, and see how it changes as the river increases to a selected higher stage. As the user, you control the environment for analysis and set the modeling environment through menu selections. First, a sidebar menu appears and you are prompted to choose the base elevation (Fig. 15). At the next menu, you are prompted to choose the new, higher elevation. A third menu appears and you must choose the landform layer to view in relation to the change in stage (Fig. 16). The landform choices are "1989 Land Cover (7-Class)," "1989 Land Cover (13-Class)," "1989 NWI System & Subsys," "1989 NWI System & Class," "1989 NWI Class & Subclass," "1989 NWI Water Regime," and "1984 SCS Soils."

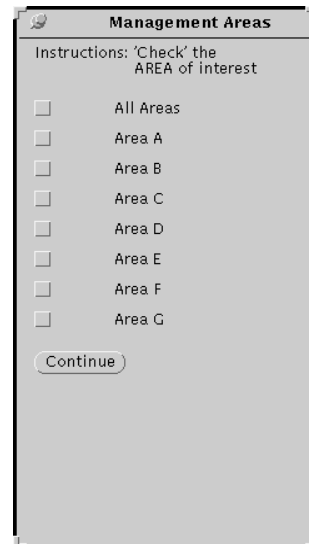
The last input menu seeks information about the proposed management areas you would like to include in the analysis. You may select all areas or any one of the individual management areas (Fig. 17).



**Figure 15.** Elevation Change Impact Module with Base Elevation Menu.



**Figure 16.** Elevation Change Impact Module with Landform Layers Menu.



**Figure 17.** Elevation Change Impact Module with Management Areas Menu.

When analysis is complete, the results appear in the four quadrants of the display screen (Fig. 18). The base elevation coverage is displayed in the upper left quadrant. The upper right quadrant displays the portion of the management area of interest that remains dry after the increase in river stage and shows where inundation occurred. The lower left quadrant displays what landform features in the management area of interest are lost by the increase in river stage. The lower right quadrant presents a numeric summary (in hectares) of the features inundated.

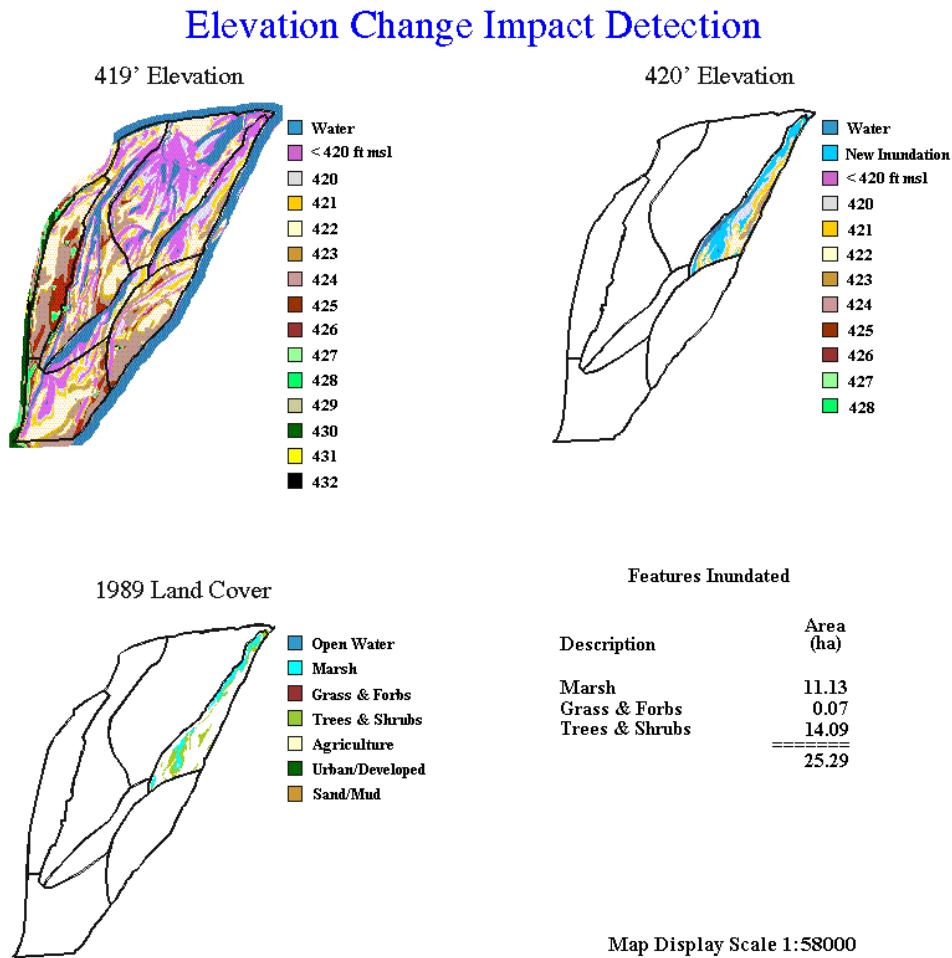


Figure 18. Display of the Elevation Change Impact analysis results.

**Modeling Menu Button: Dike Design.** This interface option allows you to lay out a dike design. The procedure begins by offering you a choice of creating one or multiple dikes in the project area (Fig. 19). Next, you are presented with a sidebar menu asking for a dike's design elevation (Fig. 20).

An ARCEDIT session is activated for on-screen dike digitizing. In the window, a 1989 true-color photocomposite is drawn. Overlaid on this is a

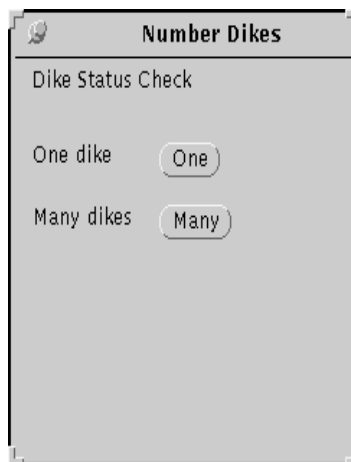


Figure 19. Number of Dikes Menu.

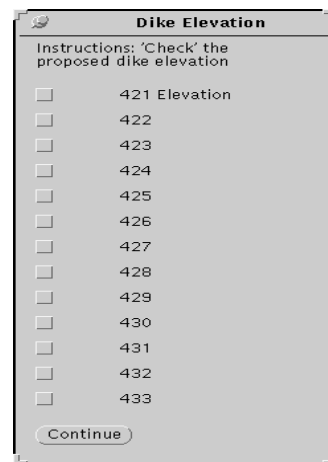
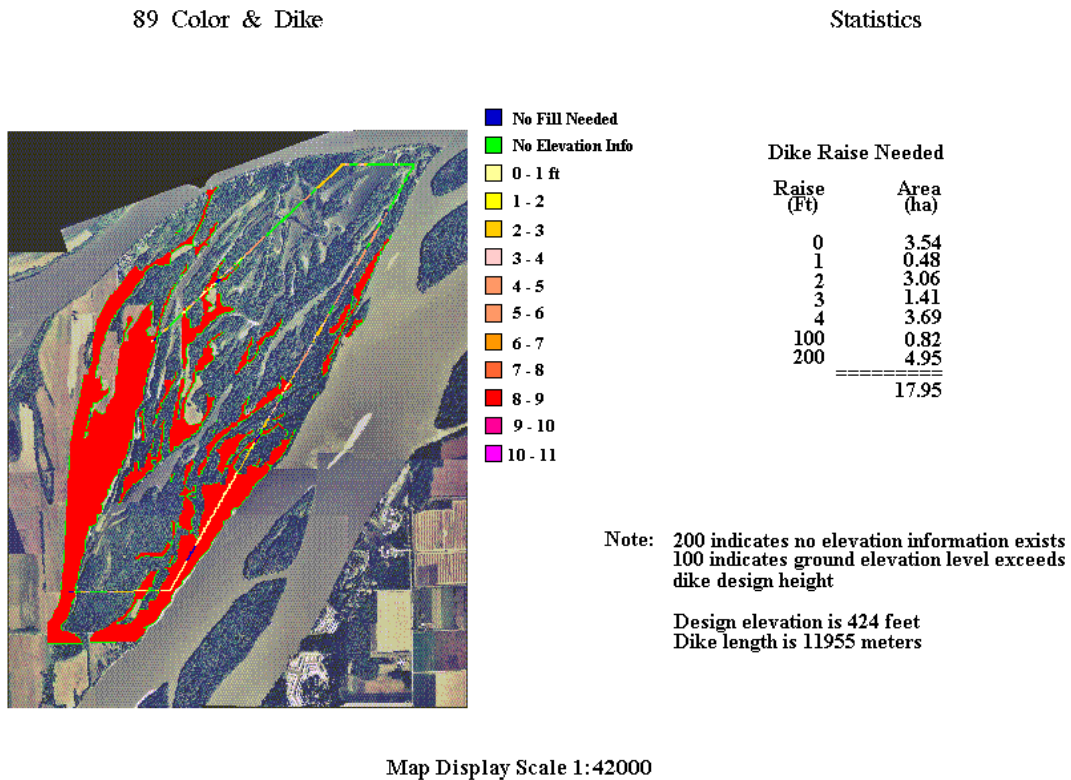


Figure 20. Dike Elevation Menu.

coverage, drawn in red, showing the areas that are at or above the dike's design elevation. Instructions for digitizing are presented in the main graphics window. To ensure integrity of the proposed dike, you are encouraged to tie all dike ends into the red areas (areas with elevations at or above the dike's design elevation). The columnar dike created by the model has a top design width of 15 m. This dike structure can be modified to meet the requirement of a specific project.

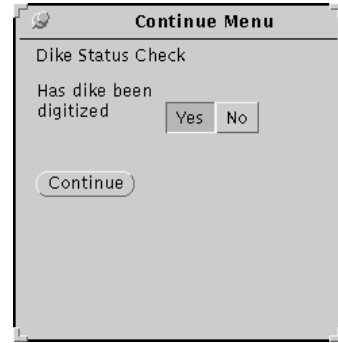
When analysis is completed, the graphics window is divided into two parts (Fig. 21). The left half displays the proposed dike or dikes overlaid on the 1989 true-color photocomposite of the area. The dike is presented according to a color code scheme that signals how much fill is needed to raise the various dike areas to the dike design height. The right half presents a numeric summary that includes the dike design elevation, total dike length (in feet) and a summary of fill required to achieve design elevations. Areas where no elevation information exists or areas within the dike's route that already equal or exceed the dike's design height are also presented and numerically summarized.

## Dike Layout Model Display



**Figure 21.** Display of the Dike Design analysis results.

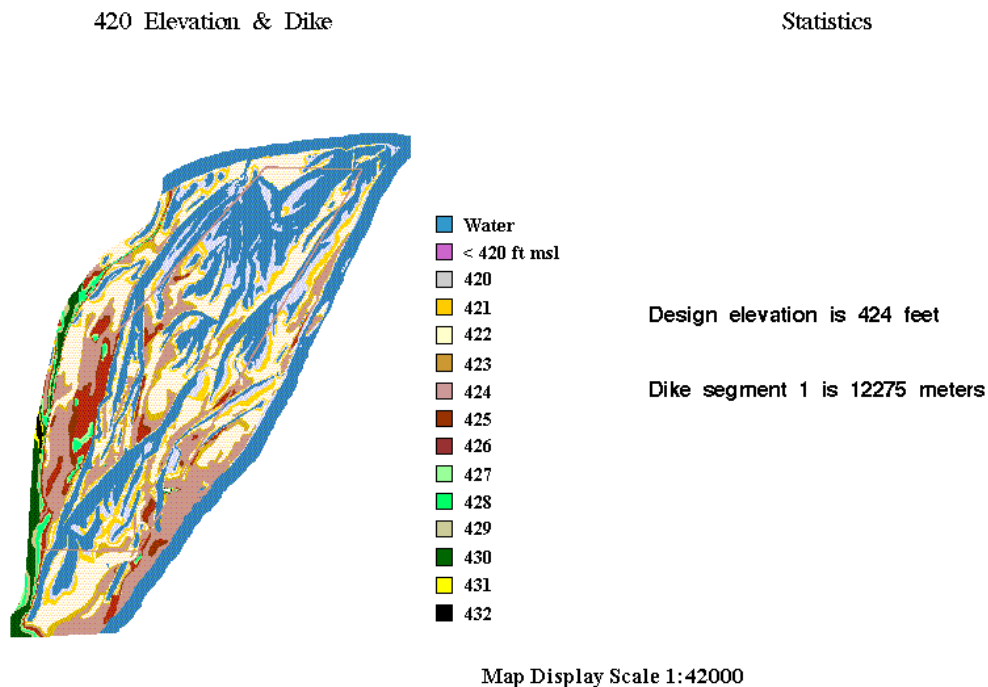
**Modeling Menu Button: Dike Development.** Before the module begins, a menu appears and you are asked if a dike has been designed (Fig. 22). If you have completed this step, choose "Continue" from the menu. If you have not created a dike yet, choose "No" from the menu and return to the Dike Design module. This option works for both a single dike design as well as a multiple-segment dike design.



**Figure 22.** Continue Menu from the Dike Development Module.

Execution of the Dike Development module begins by testing to verify that the Dike Design module has been exercised and that a dike was successfully created. If anything erroneous is detected, you are returned to the Dike Design module. If a dike is determined to exist, it is then merged with the Calhoun 419 msl base elevation coverage (normal pool level). Results are presented on a split screen (Fig. 23). The left half shows the base elevation coverage integrated the dike. The right half presents a numeric summary that includes the dike's design elevation (in feet), the number of dike segments created, and the linear length of each segment (in meters).

## Dike/Elevations Model Display



**Figure 23.** Display of the Dike Development results.

**Modeling Menu Button: Dike Effectiveness Test.** This module tests the integrity of a simulated dike. It can be executed only after the Dike Design and Dike Development modules have been completed. This module tests dike integrity by checking to see if polygon topology is present for the area inside the dike. You must have connected the dike you create to itself or to the higher elevation areas shown in red on coverage over which you digitized the dike. If a problem is detected, you are returned to the Main Menu. In the initial version of the interface, if you choose to design multiple dikes, you will not be able to continue any further in the modeling process. A message will appear on the screen indicating that this option is not available yet. The multiple-segment dike option provides an example of how the program can be modified. If you have chosen to design only one dike, the Dike Effectiveness Test will continue.

This module is computationally intensive. It tests to determine whether the simulated dike maintains its integrity and isolates the area landward at a river stage greater than the design height of the dike. If the dike fails, you are notified that the dike was not effective. A display of the ineffective dike appears on the left half of the graphics screen, showing what features would be inundated. On the right half of the graphics screen, you receive a summary message suggesting that you return to the Dike Design module and start over.

If it is determined that the simulated dike has protected the area behind it, then several additional steps are undertaken. First, the area (in hectares) protected by the dike is determined. Second, a view of the protected area as it would look when the river stage is less than or equal to the design height of the dike is created. Last, the area (in hectares) of each land cover type that would be lost should the dike fail at the design height is determined.

The graphics screen is divided into four quadrants to display the results (Fig. 24). The base elevation with the dike overlaid on it is presented in the upper left quadrant. The protected area behind the simulated dike is presented in the upper right quadrant. The area that would be inundated should the dike fail at a river stage equal to the dike design height is presented in the lower left quadrant. Numeric results are presented in the lower right quadrant, listing the land cover types that would be inundated should the dike fail.

**Modeling Menu Button: Flood Animation.** Flood animation is the last of the dynamic modeling options. Like the others, it can be executed only if the previous steps have been completed, namely the Dike Design, Dike Development, and Dike Effectiveness Test modules. It begins by testing to verify that the previous modules have been run. If an error is detected, you are returned to the Main Menu.

If the dike passes all tests, a menu appears and prompts you to enter a river stage crest height. This height is then used to model the effect of high water on the area.

Results presented on the graphics screen are a simulation of the river stage rising, reaching a crest, and then receding to the base elevation. As the crest rises, the diked area maintains its integrity until the river stage reaches one stage greater than the dike design height. The river stage continues to increase and the area is submersed. Initially, if overtopped, an outline of the dike is visible, but it disappears if the river stage continues to rise.

## Dike Effectiveness Test Module

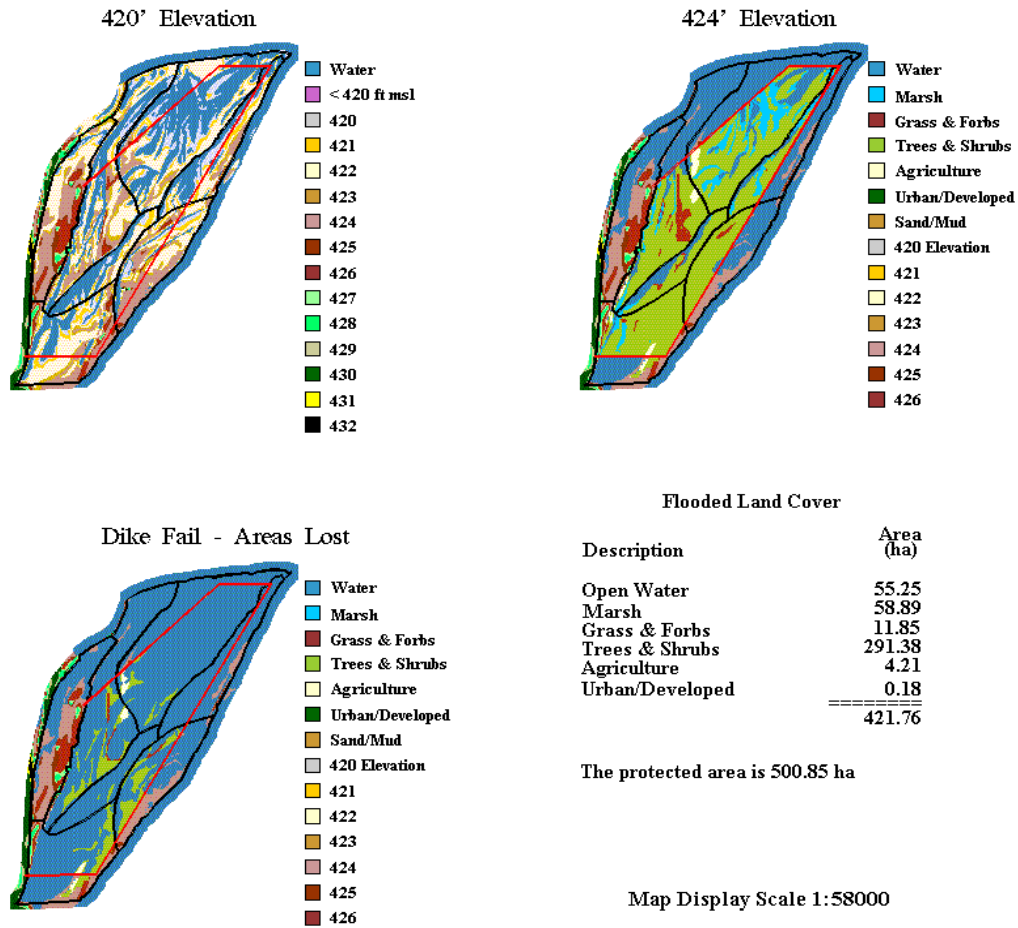


Figure 24. Display of the Dike Effectiveness Test results.

### Main Menu Button: Statistics

The Statistics option determines the area (in hectares) by class for the land cover layer or by elevation for the flat pool elevation coverage. Statistics may be performed on any of the seven management areas. You set the analysis by choosing the management area of interest, the coverage, and the statistics option from menus that appear on the screen. The only statistics option now available is an area summary. Summary statistics options can be added (Figs. 25, 26, 27).

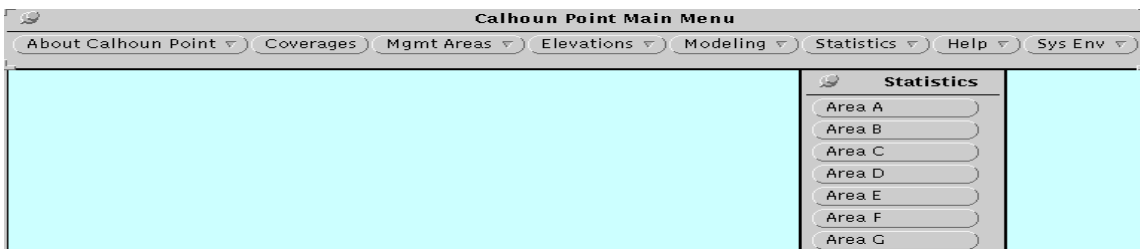
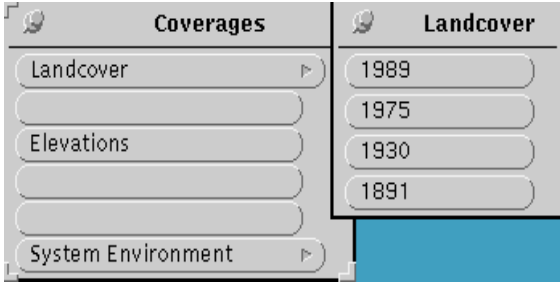
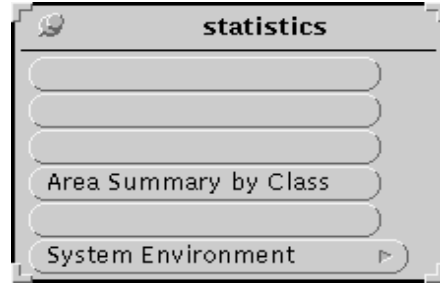


Figure 25. Statistics Menu for selecting a Management Area for analysis.



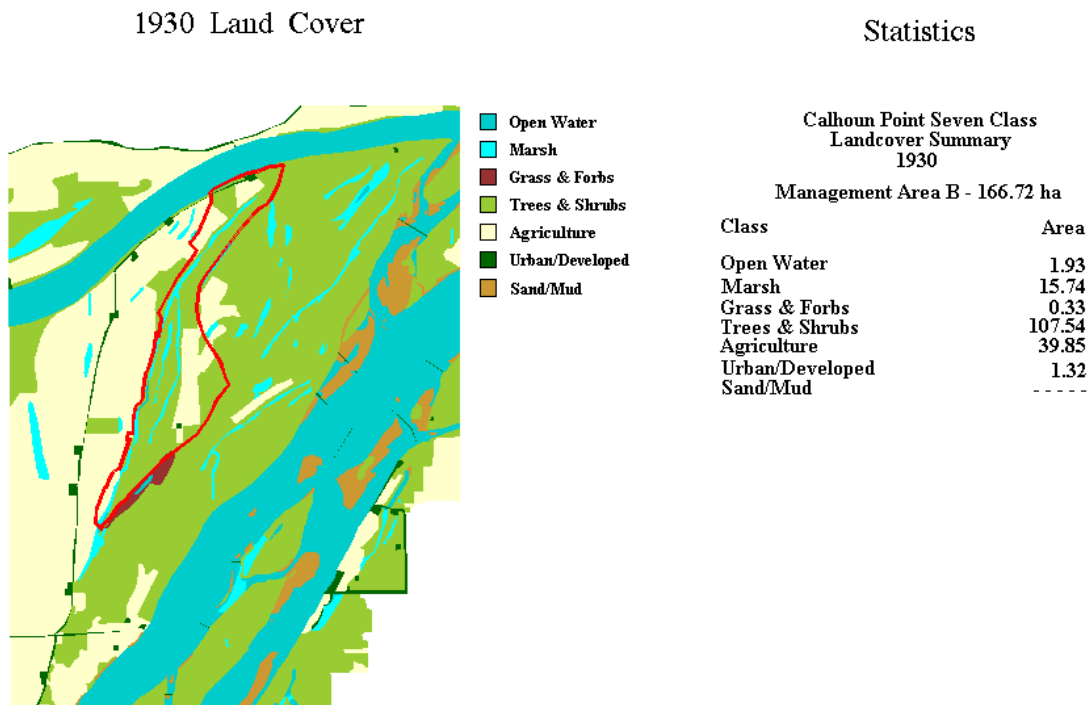
**Figure 26.** Coverages Menu with Landcover Menu in the Statistics Module for selecting a land cover layer for analysis.



**Figure 27.** Statistics Menu for selecting an option for analysis.

Results are presented on a split graphics screen (Fig. 28). The left half of the screen presents the land cover layer overlaid with the management area of interest. The right half contains the numeric summaries.

## Calhoun Statistics Report Management Area - B



Map Display Scale 1:42000

**Figure 28.** Display of Statistics results for Management Area B.

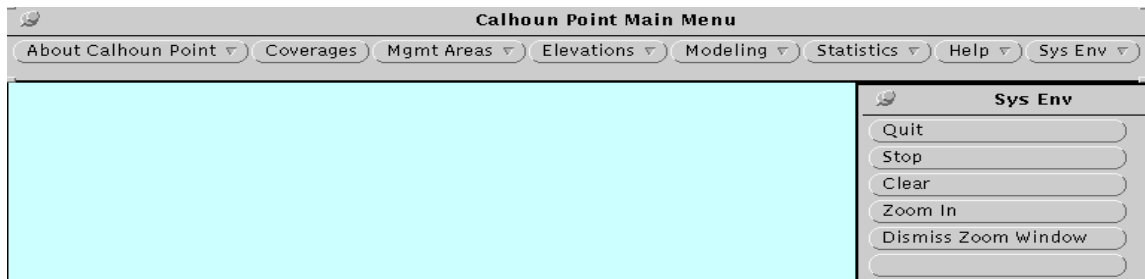


## Main Menu Button: Help

The Help button is designed to provide you with on-screen help for any interface component and is set up to follow the interface menu format. Navigate the menus that appear until help is obtained on the interface component of interest.

## Main Menu Button: Sys Env (System Environment)

The System Environment button provides you with several options for systems maintenance. In the Sys Env menu, the Main Menu button offers you several choices (Fig. 29). These choices are "Quit," "Stop," "Clear," "Zoom In," and "Dismiss Zoom Window." Each selection is explained in further detail.



**Figure 29.** Main Menu with Sys Env (System Environment) Menu.

*Sys Env Menu: Quit.* The "Quit" choice ends the operation of the interface. When "Quit" is chosen, an orderly shutdown of the interface occurs and unneeded coverages are deleted. System messages are presented on the graphics window as shutdown progresses.

*Sys Env Menu: Stop.* "Stop" exits the menu you are presently in and takes you back to the Main Menu.

*Sys Env Menu: Clear.* "Clear" is available to clear the graphics screen. If you are uncertain as to what can be overlaid on what, you can use the "Clear" option to ensure that an interface analysis venture will begin with a clear screen.

*Sys Env Menu: Zoom In and Dismiss Zoom Window.* Zoom In and Dismiss Zoom Window are features that work as a pair. The Zoom In button can be selected anytime when active processing is not occurring. It creates a zoom window in the lower left corner and presents crosshairs in the graphics window. You should use the crosshairs to select the area to be enlarged. The entire graphics screen will be redrawn. The selected area will be drawn in enlarged form in the zoom window. When you are finished viewing the zoomed area, the zoom window should be dismissed by selecting the Dismiss Zoom Window.

## Summary

The Calhoun Point graphical user interface was developed in response to a request by the St. Louis District of the U.S. Army Corps of Engineers to create a geographic information systems tool that would facilitate Habitat Rehabilitation and Enhancement Project planning in Pool 26. Our objective was to create a "user-friendly" interface that planners could use to analyze habitat characteristics of the area, experiment with management scenarios, create statistical summaries, and generate graphical visualizations.

In accomplishing this objective, the interface was designed with a modular structure. The modular design of the interface facilitates modification of the program and, as such, the interface could be readily adapted for use with another HREP in another area of the Mississippi River. Additionally, because of its structured design, the opportunities for expansion of the interface to offer new analyses are limitless. This document is a user's manual that describes how to use the interface. It also provides a brief description of the data layers utilized by the interface and a summary of the history behind the Calhoun Point project.

## References

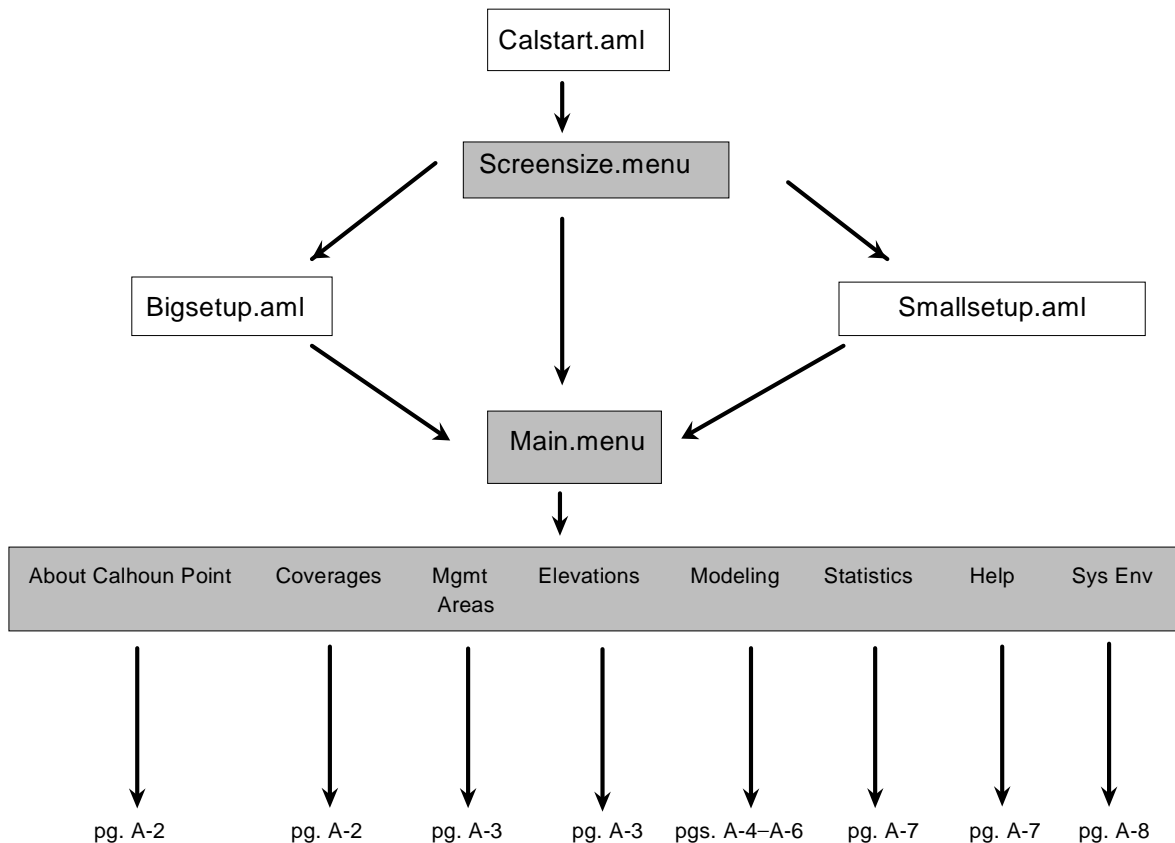
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- U.S. Army Corps of Engineers. 1994. Pages 1–20 *in* Upper Mississippi River System Environmental Management Program-Definite Project Report (SL-7) with Integrated Environmental Assessment, Calhoun Point Habitat Rehabilitation and Enhancement Project, Pool 26, Illinois and Mississippi Rivers, Calhoun County, Illinois. U.S. Army Corps of Engineers, St. Louis District.
- U.S. Fish and Wildlife Service (USFWFS). 1993. Operating Plan for the Upper Mississippi River System Long Term Resource Monitoring Program. Environmental Management Technical

Center, Onalaska, Wisconsin, Revised September 1993. EMTC 91-P002R. 179 pp. (NTIS #PB94-160199)

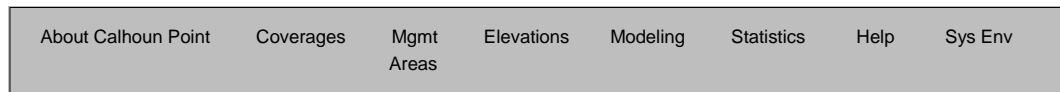
USFWS. 1986. Photointerpretation conventions for the National Wetlands Inventory. 29 pp. + Appendixes.

## Appendix A. Flow Charts Documenting the Interface Structure and Program Flow.

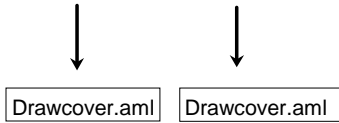
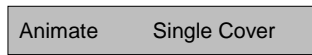
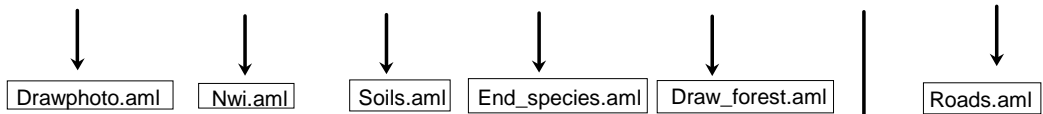
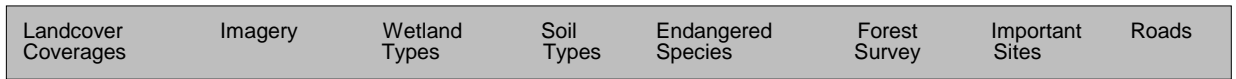
Calhoun Point Project Flow Chart



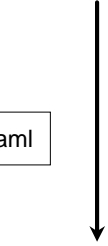
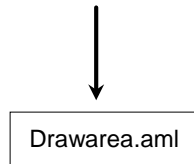
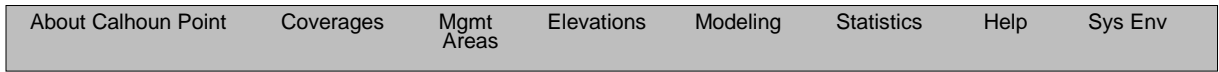
### Calhoun Point Main Menu



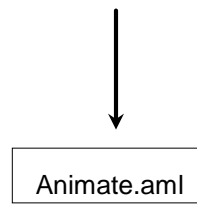
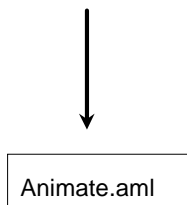
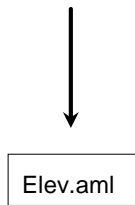
### Coverages Main Menu



### Calhoun Point Main Menu



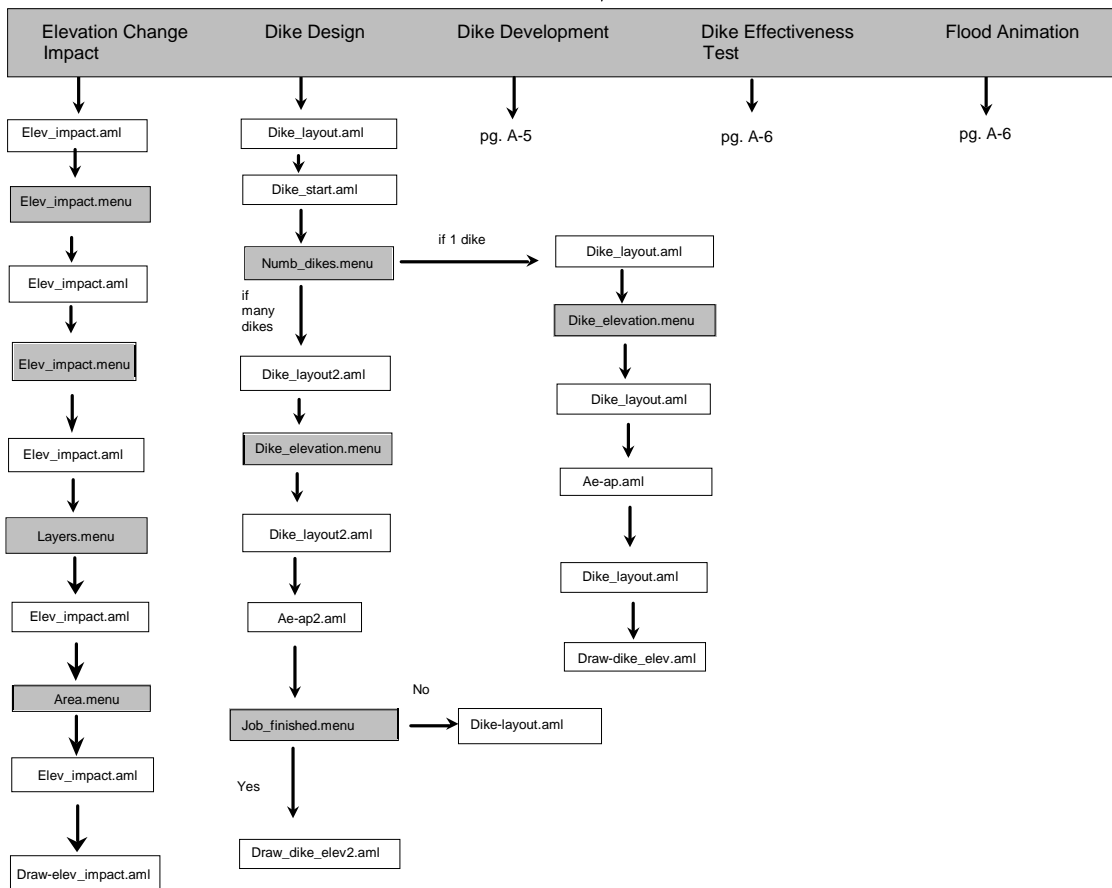
### Elevations Menu



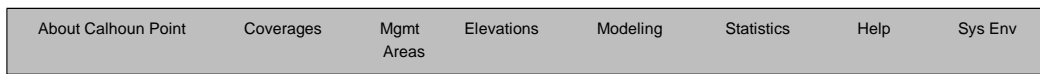
## Calhoun Point Main Menu



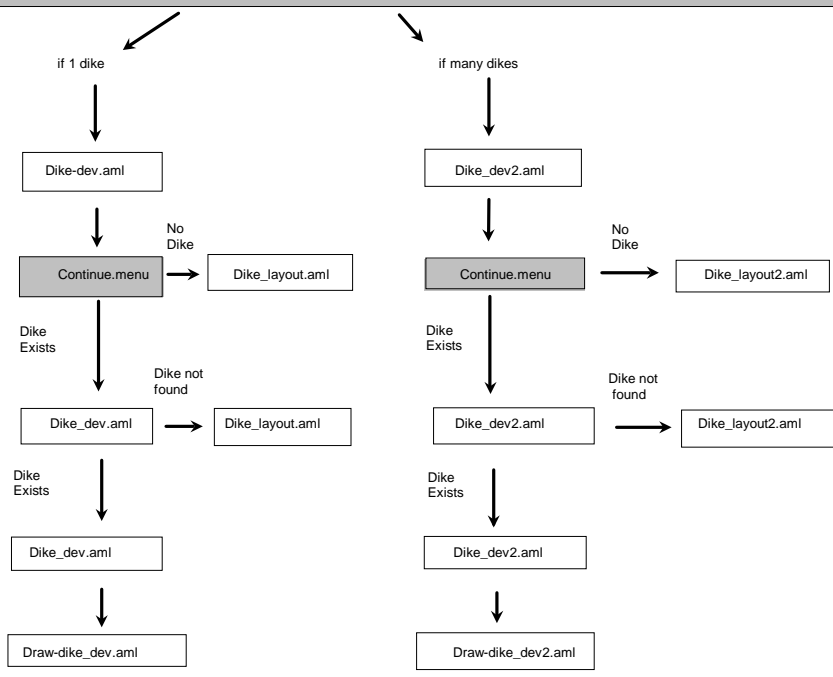
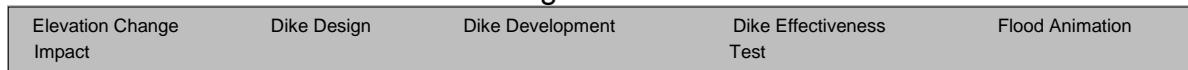
### Modeling Menu



### Calhoun Point Main Menu



### Modeling Menu

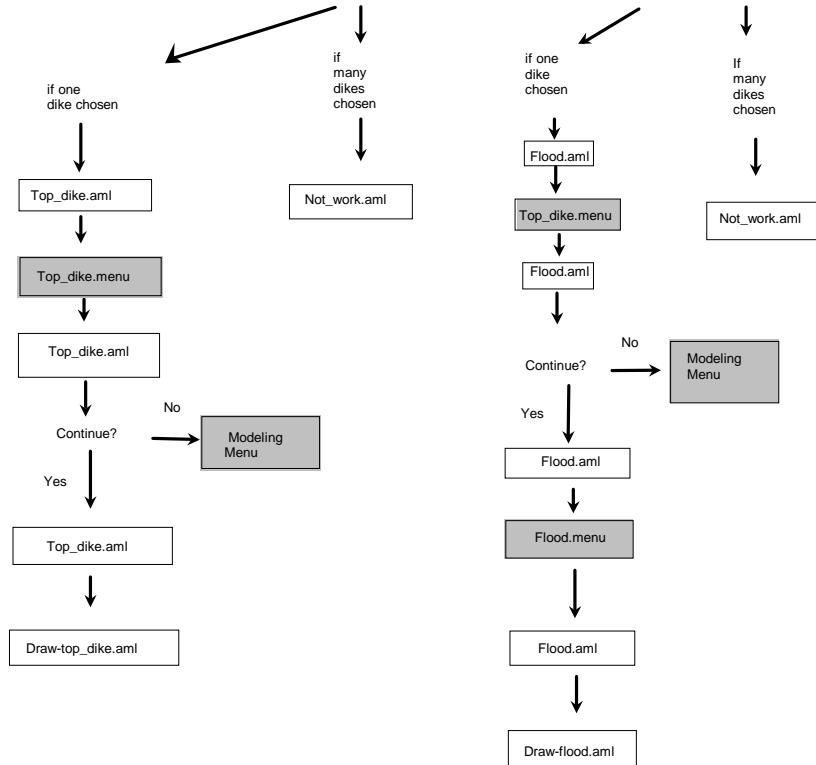
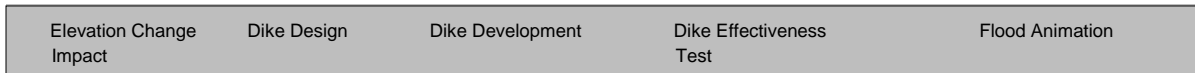




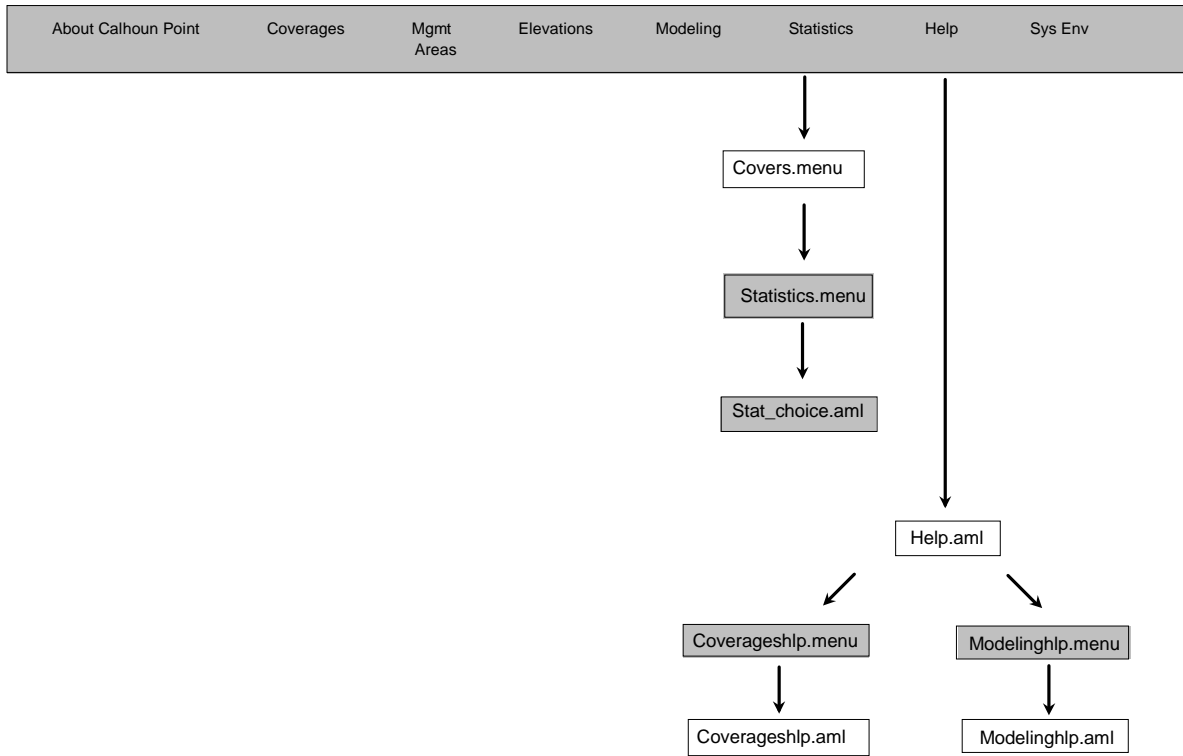
### Calhoun Point Main Menu



### Modeling Menu



## Calhoun Point Main Menu



## Calhoun Point Main Menu

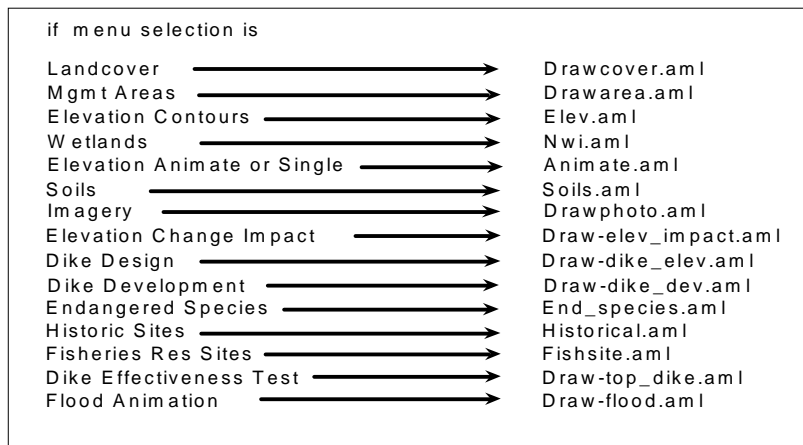


### Sys Env Menu



Zoom .aml

Dismiss\_zoom .aml



## **Appendix B. National Wetlands Inventory Classification for the Calhoun Point Area.**

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<b>NWI Code</b>	<b>Classification</b>
PFO1Ah	Palustrine, forested; broadleaf deciduous, temporary, impounded
PSS1Ah	Palustrine, scrub/shrub; broadleaf deciduous, temporary, impounded
EM1Ch	Palustrine, emergent; persistent, seasonal, impounded
U	Unknown
PEM1Fh	Palustrine, emergent; persistent, semipermanent, impounded
L2AB3Hh	Lacustrine, littoral, aquatic bed, rooted vascular, permanent, impounded
L2UB3Hh	Lacustrine, littoral, unconsolidated bottom, mud, permanent, impounded
PFO1Ch	Palustrine, forested, broadleaf deciduous, seasonal, impounded
PEM1Ah	Palustrine, emergent, persistent, temporary, impounded
L1UB3Hh	Lacustrine, limnetic, unconsolidated bottom, mud, permanent, impounded
L2AB4Hh	Lacustrine, littoral, aquatic bed, floating vascular, permanent, impounded
L2EM2Hh	Lacustrine, littoral, emergent, nonpersistent, permanent, impounded
PSS1Ch	Palustrine, scrub/shrub, broadleaf deciduous, seasonal, impounded
L2EM2Gh	Lacustrine, littoral, emergent, nonpersistent, intermittently exposed, impounded
L2AB4Gh	Lacustrine, littoral, aquatic bed, floating vascular, intermittently exposed, impounded
PAB4Hh	Palustrine, aquatic bed, floating vascular, intermittently exposed, impounded
PEM2Gh	Palustrine, emergent, nonpersistent, intermittently exposed, impounded
PAB4Gh	Palustrine, aquatic bed, floating vascular, permanent, impounded
PUB3Gh	Palustrine, unconsolidated bottom, mud, intermittently exposed, impounded
PAB3Hh	Palustrine, aquatic bed, rooted vascular, permanent, impounded

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PAB3Gh	Palustrine, aquatic bed, rooted vascular, intermittently exposed, impounded
L2US2Ch	Lacustrine, littoral, unconsolidated shore, sand, intermittently exposed, impounded
PEM2Hh	Palustrine, emergent, nonpersistent, permanent, impounded
L2US2Chs	Lacustrine, littoral, unconsolidated shore, sand, seasonal, impounded, spoil
PUS3Ch	Palustrine, unconsolidated shore, mud, seasonal, impounded
L2RS2Ch	Lacustrine, littoral, rocky shore, rubble, seasonal, impounded
PEM1Chs	Palustrine, emergent, persistent, seasonal, impounded, spoil
PUB3Ghx	Palustrine, unconsolidated bottom, mud, intermittently exposed, impounded, excavated

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6. AUTHOR(S) David R. McConville, <sup>1</sup> Thomas W. Owens, <sup>2</sup> and Anjela S. Redmond <sup>3</sup>			
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13. ABSTRACT (Maximum 200 words) A pilot geographic information system (GIS) graphical user interface (GUI) was designed to facilitate habitat rehabilitation and enhancement planning by the U.S. Army Corps of Engineers, St. Louis District. Undertaken in summer 1993, the project was developed to provide sample analyses for the Calhoun Point Habitat Rehabilitation and Enhancement Project on Pool 26 of the Upper Mississippi River System. The main objective of the project was to show how a GIS can assist in the design and evaluation of a project. The interface allows users to become familiar with the features of the area from a contemporary as well as a historical perspective, conduct statistical summaries, and develop and test varying modeling scenarios involving dike placement and water level elevations. The interface was written in Arc Macro Language and executed in the ARC/INFO version 6.1 (Environmental Systems Research Institute, Redlands, CA) vector and raster environment on a UNIX workstation platform. The GUI is menu-driven and designed around an expandable hierarchical data structure. In operation, the user sets the analysis environment by selecting, through a series of menus, the elements needed for analysis, including the land cover layer, management plan, and elevations. Graphic and numeric results are displayed on the screen.			
14. SUBJECT TERMS Geographic information system, GIS modeling, habitat improvement, spatial modeling, wetlands enhancement		15. NUMBER OF PAGES 21 pp. + Appendixes A-B	
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The Long Term Resource Monitoring Program (LTRMP) for the Upper Mississippi River System was authorized under the Water Resources Development Act of 1986 as an element of the Environmental Management Program. The mission of the LTRMP is to provide river managers with information for maintaining the Upper Mississippi River System as a sustainable large river ecosystem given its multiple-use character. The LTRMP is a cooperative effort by the National Biological Service, the U.S. Army Corps of Engineers, and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin.

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