Conservation and Restoration of Forested Wetlands: New Techniques and Perspectives

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Abstract.—A partnership of state and federal agencies and private organizations is developing advanced spatial analysis techniques applied for conservation and restoration of forested wetlands. The project goal is to develop an application to assist decisionmakers in defining the eligibility of land sites for entry in the Wetland Reserve Program (WRP) of the U.S. Department of Agriculture. The WRP is one of the most successful programs in restoring wetlands on marginal agriculture lands. For this effort, three 7.5-minute quadrangles in Louisiana (Indian Lake, Newlight, and Saranac) were used as a pilot area. A data set of thematic and remotely sensed data was collected and organized inside a geographic information system (GIS) ArcView project. By using the ArcView's internal scripting language (Avenue), the project has been customized for WRP needs. Procedures that make easier data display and analysis operations were then implemented.

The Lower Mississippi River Valley (LMRV) has experienced dramatic forested wetland losses (over 80 percent) in the last century as a result of clearing for agriculture and urban expansion. Federal and state efforts are oriented towards promoting wetland conservation and restoration programs that preserve these valuable resources for future generations. Advanced spatial analysis techniques, i.e., decision support geographic information systems (GIS), improve the resource manager's capability of defining potential sites for wetland restoration or conservation. This paper illustrates the results of a GIS demonstration project and advanced spatial analysis techniques applied to the WRP. Partners of this project are the U.S. Department of Agriculture (USDA)/Natural Resources Conservation Service (NRCS), Alexandria, LA; U.S. Fish and Wildlife Service (USFWS)/Ecological Services Office, Lafayette, LA; The Nature Conservancy (TNC), Baton Rouge, LA; and U.S. Geological Survey (USGS), National Wetlands Research Center (NWRC), Lafayette, LA.

WRP is a voluntary program to restore and protect wetlands on private property. It is administered by the USDA's NRCS, in consultation with the Farm Service Agency (FSA) and other federal agencies. Landowners who enter the program receive financial support to take their marginal agricultural land out of production for conversion to wetlands or for enhancement and/or protection of existing wetlands. The ultimate goal of WRP is to enroll under the program about 1 million acres nationwide. The states of Tennessee, Louisiana, Mississippi, and Alabama will benefit mostly from this program.

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GEOGRAPHIC INFORMATION SYSTEMS (GIS) SOLUTIONS AND DATA

Geographic information systems (GIS) is a technology that allows the assembly, storage, manipulation, display, and output of geographical and related tabular data. Investigations and analyses on different but geographically related data sets may be performed by using overlay or query techniques. Additionally, GIS can use different types of data and information from different sources and in different forms. The primary purpose of the GIS application is to present geographic and tabular data in one comprehensive, easy-to-use application. This WRP application incorporates those capabilities that enable the user to better utilize and analyze incoming environmental data with existing data sets.

Three 1:24,000-scale USGS quadrangles were selected: Indian Lake, Newlight, and Saranac, which are located in the northeast section of Louisiana (fig. 1).

The data sets that have been collected from existing sources or created for this project are:

1. WRP, Conservation Reserve Program (CRP), Farmers Home Administration (FmHA), Wildlife Management Area (WMA) Lands, and National Wildlife Refuges (NWR),
2. Soil Types, Hydric Soils, and Geology (1:24,000) (fig. 2),
3. Black Bear Habitat,
4. The Louisiana GAP Vegetation Data - Classified Landsat 5 Thematic Mapper imagery, along with other auxiliary data sets organized into 23 major vegetation groups and land-use categories,
5. SPOT Panchromatic (10 m resolution),
6. Landsat 5 Thematic Mapper, False Color Composite 4,5,3 (1993) (25 m resolution),

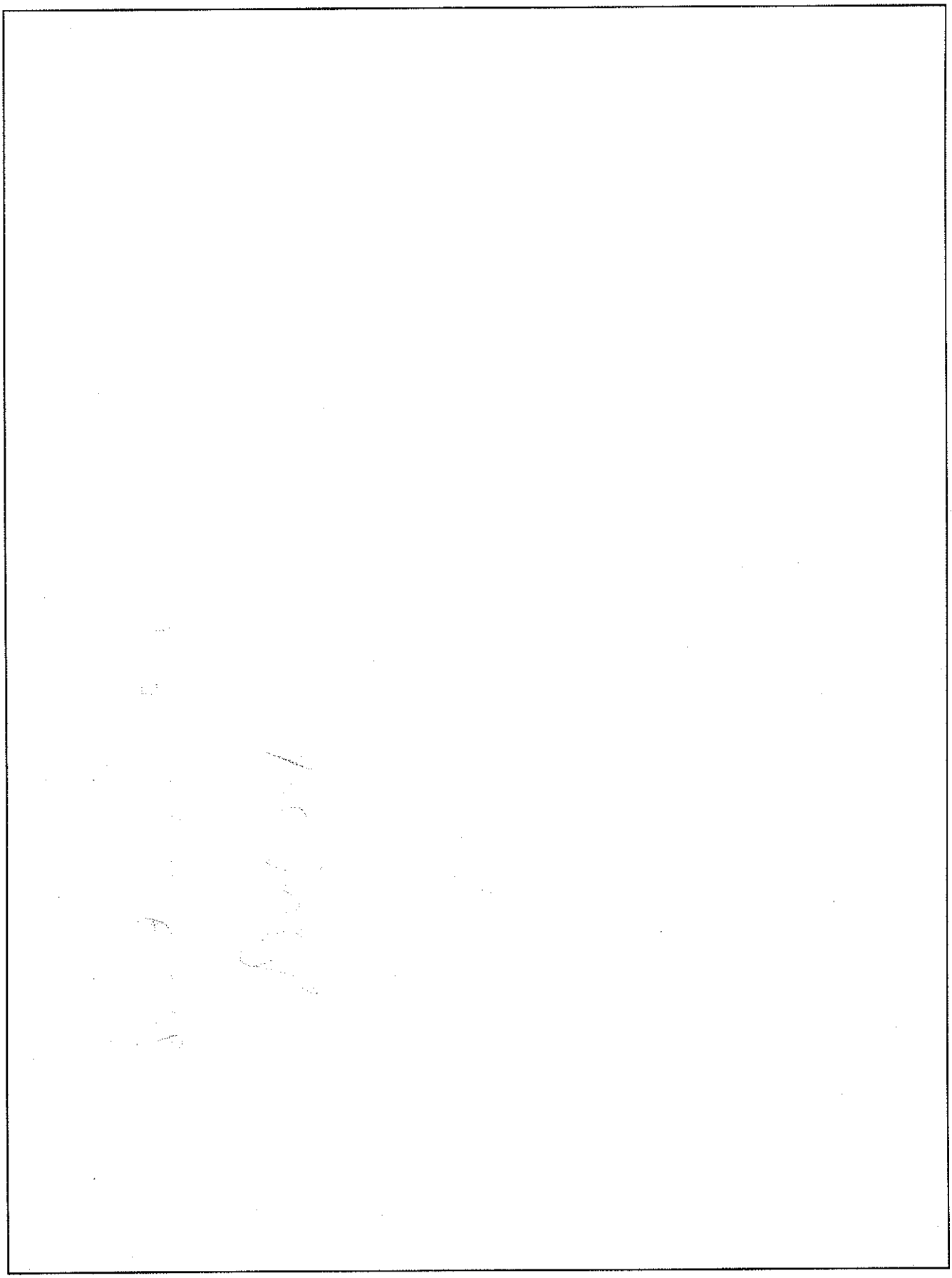

Figure 1.—*Study area and sample ArcView scripts for Wetland Reserve Program demonstration project.*

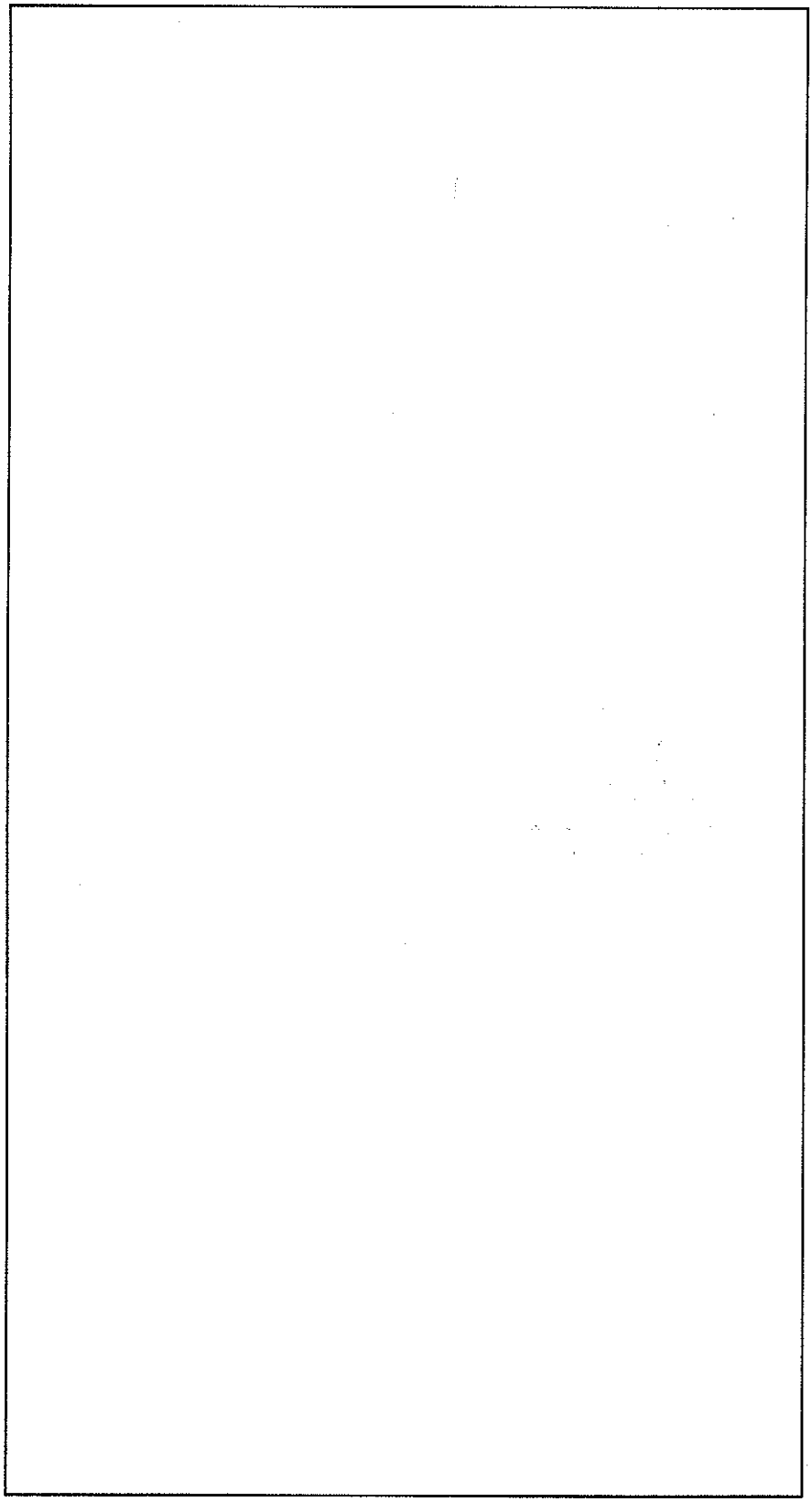

Figure 2.—*Example of detail soils data (1:24,000 scale) used for project.*

7. SPOT Panchromatic (1995)-Landsat Thematic Mapper (1993) merge (10 m resolution),
8. Mosaic of scanned 1995 color infrared photos,
9. Mosaic of scanned 1945-46 black and white historical photos,
10. Digital Orthophoto Quads (DOQ) (Newlight and Saranac) and mosaic of DOQ Quarters (Indian Lake),
11. Digital Raster Graphics (DRG) of 1:24,000 USGS quadrangles,
12. State and parish boundaries (digital),
13. USGS Hydrologic Unit boundaries,
14. Soil and Water Conservation District boundaries,
15. Oil and gas well locations, and
16. USGS Digital Line Graphs (DLG's) (1:100,000) for:
    * Transportation
    * Hydrology
    * Pipelines
    * Railroads
    * State and parish boundaries.

ARC VIEW PROJECT

Using Environmental Systems Research Institute (ESRI) ArcView 3.0a GIS software, an application was developed to organize the available data sets and allow land resource managers to access sophisticated display and analysis tools without being GIS experts. ArcView, combined with Avenue scripting language, offers the possibility of integrating and visualizing geographic and tabular data into a complete analysis system while creating a highly user-friendly windows environment. This was considered a primary goal because, unfortunately, GIS is rarely used due to its prohibitive cost (hardware and software) and learning curve.

ArcView Graphical User Interface (GUI) has been customized for this project using menus and menu items, as well as added buttons and tools. Land resource managers can access sophisticated display and analysis tools without being GIS experts. The GUI also allows the user to select information layers, open display windows, and perform some complex and multi-phase tasks in one or more steps. Input and selection message boxes guide the user to complete processes successfully.

DISPLAY AND ANALYSIS TOOLS

Several scripts have been developed to provide display and analysis tools. Thematic information and images can be displayed separately or overlaid over the same area. Additionally, a routine has been created to automatically open (and close) two views with user-selected themes to display. Zooming or panning in one view will display both views at the new extent. The purpose of this implementation is to provide users an easier way to display and compare two data sets over the same location. An interesting application is the comparison of aerial photography of two different dates (fig. 3). Using theme polygons on temporary boundary (graphic), a routine that clips layers and performs simple statistical analysis (acreage, perimeter, or length) has been developed. It is a multi-step procedure requiring users to input values or make selections from lists.

This project is also a test to explore possible integration between ArcView and an external relational database package like Microsoft (MS) Access 97. The purpose is to extend the capability of ArcView to display, input, and process tabular information by using MS Access interface, which is powerful and much easier to use. A simple MS Access application containing tables and input forms allows a person to display and update tabular information related to each enrolled WRP parcel. In particular, it stores functional assessments of assigned wetlands (according to several parameters of water quality, habitat, risk, and hydrology factors). Dynamic Data Exchange (DDE) technology, supported by ArcView, is the mechanism of communication between the two applications. Figure 4 is an example of interface designed to display and input land and landowner information, and point value of ranking factors.

Lastly, routines that allow a user to input or to update land parcels by using on-screen digitizing or GPS coordinates have been developed. With high-resolution aerial photography as a backdrop, the actual boundaries can be readily identified and drawn. Based on the Louisiana WRP ranking procedure, land parcels can be buffered to estimate the proximity to protected areas. We can also buffer lands already enrolled in conservation programs and create a map of distance.

CONCLUSION

The WRP, as well as the other wetland restoration and conservation programs, can greatly benefit from the use of GIS technology and spatial analysis techniques. The ESRI/ArcView GIS software has been successfully used for creating a user-friendly display and analysis tool of different types of geographical and tabular data. Avenue scripts allowed flexibility and simplification of repetitive and difficult tasks, making available to users and decisionmakers a tool that can help them analyze and evaluate sites for wetland restoration or conservation. The project is constantly being updated with new data sets and WRP-oriented spatial analysis routines. By increasing the cooperation among developers and final users, better solutions can be found.

In closing, there is an expectation of increasing the integration of typically GIS vector functions and raster functions made available by ArcView's Spatial Analyst and 3D Analyst extension; to "open" this ArcView-based project to other applications (basically relational databases) will improve the application capability.

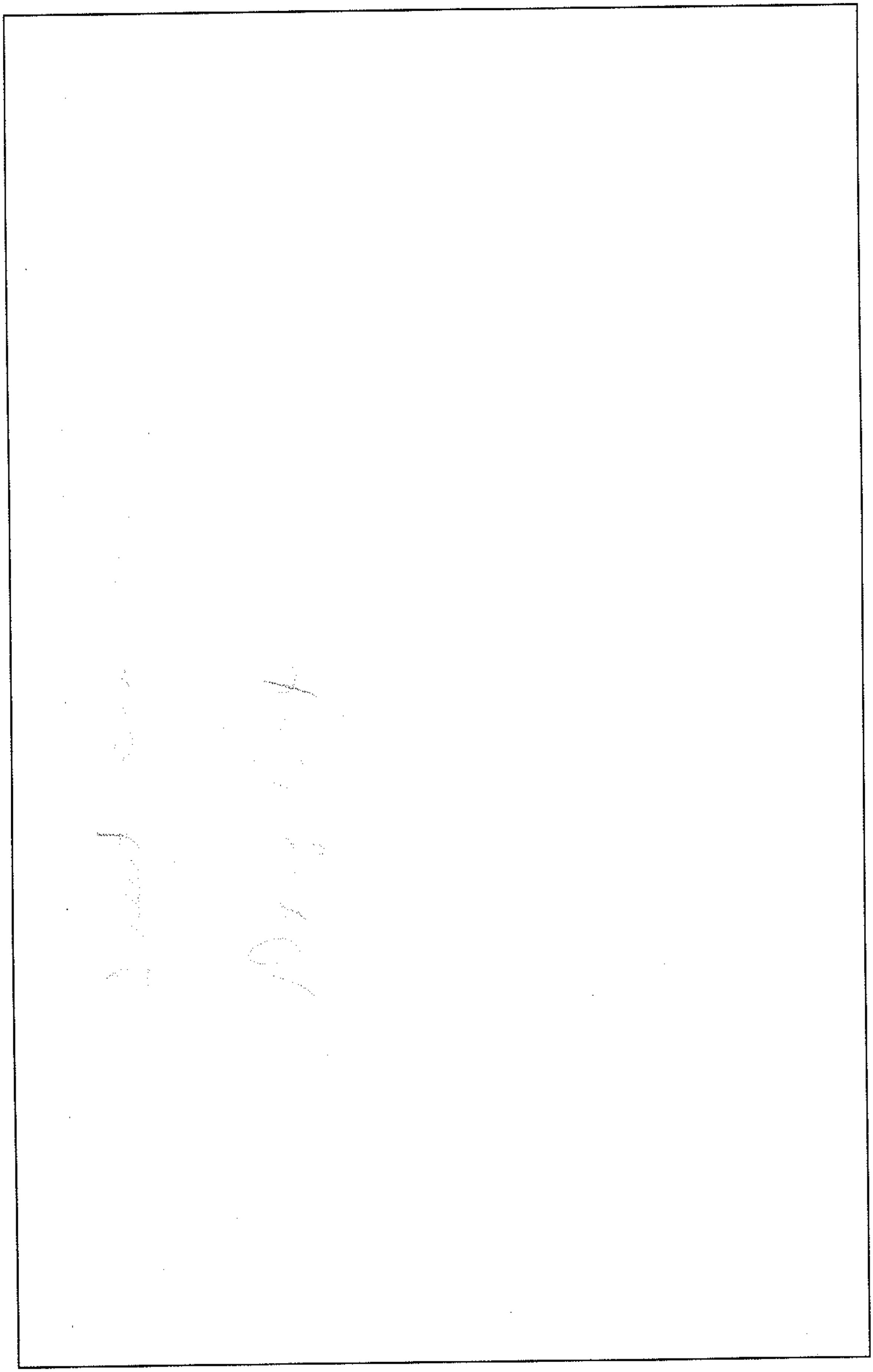

Figure 3.—*Side by side photographs displaying an area in 1995 (left) versus 1945 (right). Note clearing of forested wetlands for agriculture.*

Figure 4.—*Example of WRP Land Evaluation Form to rank parcels for the Program.*