DEVELOPMENT OF A GEOGRAPHIC INFORMATION SYSTEM AS AN ANALYSIS TOOL FOR MANAGEMENT OF BLACK-CAPPED VIREO ON THE KERR WILDLIFE MANAGEMENT AREA, KERR COUNTY, TEXAS

THESIS

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By

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ABSTRACT

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The Black-capped Vireo GIS Database for the Kerr Wildlife Management Area, Kerr County, Texas, was developed as an analysis tool for assisting the wildlife manager in making sound management decisions for the management of the endangered Black-capped Vireo (*Vireo atricapillus*). The Black-capped Vireo GIS incorporates Black-capped Vireo surveys, breeding bird surveys, black and white aerial photographs, digital orthophoto color infrared aerial photography, vegetation, topography, soils, incidence of parasitism, prescribed burning and wildfire, water sources, roads, and pastures on the Kerr Wildlife Management Area. The Black-capped Vireo GIS will enable analysts to answer management questions about the Black-capped Vireo and monitor change over time in population, distribution, and vegetational structure. The development of a data dictionary, metadata standards, and the relational database provides a model for the use of GIS in wildlife management and provides standardization and coding specific to the study of the Black-capped Vireo.

INTRODUCTION

GIS in Wildlife Biology

A set of computer-based analysis tools exists for wildlife and natural resource managers called the Geographic Information System (GIS). The purpose of the GIS is to enable the user to query graphic (spatial) data and non-graphic (tabular) data that are linked through common geographic reference points. In the GIS, multiple sources are used to build a digital model referenced to real-world coordinates. Spatial analysis can be performed, using computer software, as maps are overlayed and data tables are related, discovering new information. Some applications of GIS in wildlife management include land use inventory, vegetative mapping, species distribution estimates, preferred habitat definition, and land developmental planning (Koeln *et al.* 1994).

In the GIS system, preexisting data are digitized from maps, aerial photographs, or satellite data. Many of the tasks that a wildlife manager performs with conventional paper maps, such as calculate areas, measure distances, and calculate the amount of edge (Koeln *et al.* 1994), can now be automated with GIS technology. The concept of using GISs for resource management can be credited to Ian McHarg (1969) who manually overlaid a series of maps on land characteristics, such as physiography, soils, forest types, and wildlife distributions, for land use planning. Using GIS, wildlife managers can integrate locational information (spatial data) and descriptive information (attribute data) to perform analyses on a specific location on the surface of the Earth, combining the data to create new information.

Support for GIS applications in the biological sciences on a national level provides a framework and leadership needed to assist scientists. Efforts at scientific assessment to preserve biological diversity have been hampered in the past by the lack of cohesive sets of data. A comprehensive national diversity information system using GIS techniques to organize existing data and improve spatial aspects of the assessment has been suggested by Davis *et al.* (1990), following the guidelines set forth by the National Center for Geographic Information and Analysis (NCGIA) (Abler 1987). Alarm over the accelerating rate of extinctions of plant and animal species and the destruction of ecosystems has prompted a call in the scientific community to make a comprehensive assessment of the status and trend of biological diversity and recommend strategies for conservation.

Corbley (1996a), discussed another approach, the Gap Analysis Program (GAP). The GAP program uses a centralized GIS that provides an overview of the distribution of plant and animal species across the United States. The intent of the U.S. National Biological Survey (NBS) is to identify the extent of representation of all native plant and animal species existing on private and public conservation lands in the United States. The GAP analysis will identify species and habitats that are not found on protected lands in the current network of conservation land holding, considered “gaps”. Each state will contribute individually to the program, eventually the national GAP system will “assemble and edge-match” state information to form a nationwide GIS that will demonstrate biodiversity patterns, show gaps in species protection, and model future environmental changes that will impact biodiversity. Corbley (1996b) discussed a practical application of GAP, in protecting species while still common, rather than beginning conservation efforts after a species has been listed as endangered.

Cristofani (1996) used a GPS-based data collection tool to document the biodiversity of terrestrial ecosystems in Caribbean islands and Latin America developed by the Nature Conservancy. The focus of the program was to achieve comprehensive data about the flora, fauna, and their habitats, to facilitate the proper management of natural areas, and to prioritize conservation efforts. Cristofani emphasized the importance of tools such as GIS, remote sensing, and GPS receivers to greatly improve the collection of information necessary to make accurate conservation decisions.

The application of GIS technology to habitat analysis and ecological landscape classification has been widely discussed in the literature. GIS has been applied to the description and characterization of potential habitat for the Black-capped Vireo (*Vireo atricapillus*) (BCV) and Golden-cheeked Warbler (*Dendroica chrysoparia*). GIS has been used to monitor, classify, and assess habitat quality and the effects of habitat modification on local wildlife populations (Duncan *et al.* 1994, Foresman 1993, Narumalani *et al.* 1993), to monitor and predict changes resulting from forest practices (Green and Consentino 1996, Wettstein and Cohen 1995, Dyer 1994, Green *et al.* 1993), and to manage extensive environmental resources (McGarigle 1994). GIS has provided tools for environmental characterization, modeling, decision support, quantitative analysis, and landscape classification of ecotones (Baker and Weisberg 1995, Carver *et al.* 1995, Davis 1990, Johnston and Bonde 1989).

One example of GIS in habitat assessment that encompasses most of the aforementioned characteristics is the Master Habitat Data Bank of New York. This GIS-based data bank was the answer to the need for rapid, automated access to information relating to wildlife land management issues. The project is an ongoing effort to integrate and automate natural resource data for planning, protecting, and managing fish, wildlife, and their habitats (McGarigle 1994). McGarigle (1994) stated that the GIS has the largest organizational role in the data bank, providing analysis and display of land management areas, and habitat locations for rare and endangered species. To maintain accuracy, the GIS and other data bases must be updated regularly to reflect fluctuations in wildlife populations, and the constantly changing nature of environmental conditions and habitats. Also, new data are constantly needed to status projects.

GIS technology in the field of wildlife biology can be applied to the study of wildlife populations. At the U.S. Army Base, Fort Benning, Georgia, the Natural Resources Management Branch (NRMB) adopted the Geographic Resource Analysis Support System (GRASS). GRASS is a "public domain system", providing low-cost alternatives to assess environmental impacts, evaluate site suitability, detect change, and manage the wildlife resources (Ertep 1996). GIS has been used in many projects involving forestry, fish and wildlife, threatened and endangered species, cultural resources, and soil at Fort Benning.

Wildlife managers have used GIS for mapping Florida Scrub Jay (*Aphelocoma coerulescens*) habitat (Breininger *et al.* 1991), modeling habitat of the endangered Mt. Graham Red Squirrel (*Tamiasciurus hudsonicus grahamensis*) (Pereira and Itami 1991), predicting beaver (*Castor canadensis*) colony density and aquatic patch creation (Johnston and Naiman 1990, Broschart *et al.* 1989), monitoring elk (*Cervus elaphus*) habitat (Leckenby *et al.* 1985), mapping patterns in species richness (Stoms 1994), and characterizing habitats and monitoring population productivity of the Kirtland's Warbler (*Dendroica kirtlandii*) (Miller and Conroy 1990) and Mallard Duck (*Anas platyrhynchos*) (Johnson *et al.* 1987).

As a tool for wildlife biologists, the GIS has become one of the most critical assets for land and natural resources management. The Black-capped Vireo GIS project for the Kerr Wildlife Management Area (KWMA) presents a model of how GIS can be incorporated into wildlife management as an important tool for developing sound wildlife management practices and monitoring existing management practices. The project for the federally-listed endangered BCV at the KWMA is part of an effort to provide a complete geo-referenced inventory of the KWMA which can be used for long-term management and spatial analysis.

Background

The BCV was listed as an endangered species in 1987 by the U.S. Fish and Wildlife Service (Ratzlaff 1987) due to population decline, low reproductive success, low recruitment, and nest parasitism by cowbirds (*Molothrus spp.*) (Grzybowski 1991). Nesting habitat loss through habitat destruction, modification and deterioration by fire suppression, and indirect effects on habitat by poor range management practices have impacted the BCV population. The historic breeding range of the BCV extended north from Coahuila, Mexico through Texas and Oklahoma into south-central Kansas (Graber 1957). The current breeding range has been reduced to a few localities in Oklahoma (Grzybowski *et al.* 1986, Grzybowski 1989) and numerous locations across Texas, particularly in the Edwards Plateau ecoregion (Grzybowski 1991). No recent breeding records exist for Kansas.

STUDY AREA

The KWMA was purchased by the Texas Parks and Wildlife Department (TPWD) in 1950 under the Pittman-Robertson Act using Federal Aid in Wildlife Restoration Program funds. The KWMA serves as a wildlife research station focusing on the interactions between wildlife, domestic livestock, and rangeland vegetation. The KWMA is seasonal habitat for many breeding birds including two endangered species, the BCV and the Golden-cheeked Warbler. Habitat on the KWMA is representative of Edwards Plateau Ecoregion of Texas with live oak (*Quercus fusiformis*) and white shin oak (*Quersus sinuata*) thickets and dense stands of Ashe Juniper (*Juniperus ashei*), known as cedar brakes, dominating the landscape. The Edwards Plateau receives 15-33 inches of precipitation annually with peaks in May and September. The KWMA is located 12 miles northwest of Hunt, Texas in Kerr County on the North Fork of the Guadalupe River. The KWMA encompasses 6,493 acres enclosed by a 7-foot fence and is divided into pastures where rotational grazing, brush control and prescribed burning are practiced. White-tailed deer (*Odocoileus virginianus*) and Rio Grande turkey (*Meleagris gallopavo*) are hunted on the KWMA as part of the wildlife research program. Habitat for another endangered species, the Tobusch fishhook cactus (*Ancistrocactus tobuschii*) (TPWD 1996), occurs on the KWMA.

The GIS project for BCV on the KWMA was developed at the Texas Parks and Wildlife Department GIS Laboratory in Austin, Texas. No funding was provided for the project. All data in electronic form is archived at the Texas Parks and Wildlife Department GIS Laboratory and will eventually be incorporated into the Terrestrial Wildlife Database for Texas, currently under construction.

Description of Project

The advantage of the GIS lies in its analysis function and the ability to query the database for various management actions (Akcakaya 1994; Shaw and Atkinson 1990). In addition to the spatial component of the GIS, the critical focus of the project was the development and organization of a relational database for the BCV on the KWMA. The development of a data dictionary, metadata standards, and the relational database provides a model for the use of GIS in wildlife management and provides standardization and coding specific to the study of BCV.

The Black-capped Vireo GIS Database for the management of the BCV on the KWMA incorporates surveys from 1985 through 1996, breeding bird surveys from 1996, aerial photographs shot between 1951 and 1995, vegetational change from 1951 through 1995, topography, soils, incidence of parasitism recorded from 1985 through 1996, prescribed burning and wildfire records from 1954 through 1997, water sources, roads, and pastures.

The Black-capped Vireo GIS will enable analysts to answer management questions and monitor changes in population, distribution, and vegetational structure. The objectives of the Black-capped Vireo GIS were to address recovery actions and objectives set forth in the BCV Recovery Plan (USFWS 1991) and the BCV Population and Habitat Viability Assessment Report (PHVA) (USFWS 1996), establish and demonstrate spatial and tabular query as a basis for further analysis, develop and implement data standards specific to the study of the BCV, and propose guidelines for database expansion. Spatial query will be used to answer management questions such as: Has prescribed burning had an immediate influence on BCV territory establishment? The effects of prescribed burning on BCV territory establishment is part of an on-going research project with Southwest Texas State University and the KWMA (O'Neal *et al.* 1996). The indirect effects of land uses, livestock grazing, cowbird presence associated with livestock, predators, and edge effect, that may impact BCVs can be monitored.

METHODS AND MATERIALS

Definition of Terms

A GIS and analog cartography (conventional mapping) share the components of data indexing, symbols, and the display of spatial information. The GIS differs from analog cartography because it has spatial and non-spatial attributes, while conventional mapping shows only spatial relationships (Goodchild 1990). The GIS can display information in a spatial (map) format or in a tabular format and this information may be updated, manipulated and analyzed. The GIS has topology which identifies the relationship between spatial attributes (ESRI 1990). The spatial information can be layered in a computer and new information can be discovered through overlay and analysis.

Spatial data can be represented in two formats: raster and vector. The raster mode (cells or pixels) is grid based. Remotely sensed image data, including aerial photography, satellite imagery, and radar, are digital representations of the earth stored as data files (images) of numerical values (pixels or picture elements). An image is a digital picture or representation of an object (ERDAS 1994). A pixel is the smallest part of an image with a single value which represents attribute information (Burrough 1986). The numerical value is the measured brightness of the pixel at a particular wavelength. Each pixel represents reflected or emitted heat from the earth's surface at a particular location. Each location (pixel) is arranged in a grid and represented by a x- and y- coordinate system (ERDAS 1994). The vector mode is represented by points, lines, and polygons (areas). The space in vector mode is viewed as continuous, not discrete as in raster mode. A non-spatial attribute table provides information about the point, line, or polygon in vector data or the cell in raster data (Burrough 1986).

In ARC/INFO 7.0.4 (Environmental Systems Research Institute [ESRI], 1982-1996, Redlands, California), the basic unit for storing data is the coverage. The coverage (ESRI 1990) is a set of thematically associated data stored as primary features (arcs, nodes, polygons and label points) and secondary features such as tics (geographic control point representing a location on the earth's surface), extent, and annotation (descriptive text used to label map features, not topologically linked). Map feature attributes are described and stored separately in an attribute table.

A map projection converts the surface of the spherical earth to a flat two dimensional map, using a mathematical conversion. A projection is used to ensure a known relationship between a location on a map and its true location on earth. A coordinate is an x,y location in a Cartesian coordinate system, representing locations on the earth's surface. A plane coordinate system describes a two dimensional x,y location in terms of distance from a fixed reference (ESRI 1990). The coordinate system used for all coverages in the KWMA project is the State Plane Coordinate System, Zone 5401. The North American Datum 1927 was used to perform the State Plane calculations and is based on the Clarke 1866 spheroid. All units are in feet. The State Plane is a coordinate system (not a map projection) whose zones divide the United States into over 130 sections, each with its own projection and grid network (ERDAS 1991). The Lambert Conformal projection is used for Texas due to east-west direction of the zones designated for the state. Each state plane zone has a centrally located origin and a central meridian which passes through its origin (ERDAS 1994).

Overview of Software Functionality

Two platforms were used to run the computer software programs used in the KWMA project: workstations using UNIX and PC under Windows NT. All PC based software ran on Microsoft Windows NT Workstation 4.0 1985 -1996, Microsoft

Corporation with a Pentium 120 processor. The UNIX ran on a Sun SparcStation 5 running Solaris 2.5 UNIX operating system.

Magic Scan 3.0 (UMAX Data Systems, 1995, Freemont, California), and CADImage Scan for DOS, Windows, and UNIX Version 3.4 (Contex A/S, 1995, Denmark), are PC based image scanning programs used for capturing raster data from individual aerial photographs, aerial photograph mosaics, slide images, figures, topographic maps, and soil maps to be geo-referenced for ARC/INFO coverages. Both scanning software programs were used in conjunction with Adobe Photoshop 3.5 PC (Adobe Systems Incorporated, 1989-1996, San Jose, California) to capture raster data from a flatbed scanner, UMAX Mirage D-16L, and a full scale scanner, FSS 8200DSP. Adobe Photoshop was used to adjust image quality and save images to a TIF (tagged image format) file which could be read by ERDAS IMAGINE 8.2, ARC/INFO 7.0.4, and ArcView GIS 3.0.

PixelTrak 3.5 (Cadix Research and Development Group, 1994, Mississauga, Ontario, Canada), operates on any IBM PC/AT compatible computer system and requires MS DOS 6.0. Pixel Tract creates a DXF file (drawing interchange file) from raster data. PixelTrak is designed to convert a file from raster format, such as the images produced by the scanner, to a vector format for GIS (Cadix 1994). The user defines the vector using the TIF file, created by scanning the image as a backdrop or guide on the display monitor from which to draw the line segment or vector. PixelTrak allows various attributes to be attached to the vector in the process. The TICPTS layer contains the geographic coordinates from which the new vector layer will be geo-referenced. When working with topographic maps, elevation values can be added at the time of vectorization (Cadix 1994).

ARC/INFO 7.0.4 is a vector-based computer software program for managing geographic information requiring a UNIX operating system. It is a GIS program for handling, managing, and analyzing geographic information. ARC/INFO possesses modeling and geographic analysis capabilities. Data can be entered, stored, edited, and updated using the relational database management system (RDBMS) incorporated into the software. ARC/INFO consists of a cartographic system built around a RDBMS. ARC/INFO handles spatial (cartographic) data which describe the location and topology of a point, line, and polygon feature and tabular (attribute) data which describe each feature. The spatial data are linked to the non-spatial or tabular data through common feature numbers found in the attribute table (ESRI 1997).

ARC/INFO is composed of parts for handling the many aspects of managing geographic information. ARC allows the user to run all ARC/INFO commands. TABLES is the relational database for attribute table management to create, manipulate, list and manage attribute data. ARCEDIT is an interactive graphics editor which allows for coverage creation and updating. In ARC/INFO, all data sets are organized into workspaces and coverages. A workspace differs from a UNIX system directory through the presence of INFO. INFO in the workspace holds all information about the coverages. It contains all tabular information about attribute files, coding and attributes, tic (coordinate location) files, and all other tables associated with a coverage (ESRI 1997). A coverage without the INFO is not a coverage and can not be displayed or edited. The primary coverage features in ARC/INFO are nodes, representing arc endpoints, arcs representing lines and/or polygon borders, label points representing point features, and polygons representing an area defined by a series of arcs (ESRI 1990).

ERDAS IMAGINE 8.2 (Earth Resources Data Analysis Systems [ERDAS] Incorporated, 1991-1995, Atlanta, Georgia), is an image processing system for raster-based images requiring a UNIX operating system. IMAGINE can be used to rectify and register aerial photographs which can then be used in conjunction with ARC/INFO. Images can provide additional attribute information about coverage features and, when registered to a real world coordinate system, can serve as a backdrop to coverage data. IMAGINE can also be used with vector coverages and in spatial analysis (Smith and Pouncey 1996).

With ArcView GIS 3.0 (Environmental Systems Research Institute 1992-1997, Redlands, California), data stored as ARC/INFO coverages, images from ERDAS IMAGINE, TIF files, and tabular data, such as dBASE files, can be integrated into a project. The data can be displayed, queried, summarized, and organized geographically (ESRI 1996). ArcView has an advantage over ARC/INFO in that it can run on more than one platform: UNIX and PCs under Windows or Windows NT. ArcView can be used to create and view maps and modify the map with legends, symbols, color palette choices, fonts, and labeling (Dichter 1995). ArcView GIS 3.0 can be used as a management decision support tool. It can summarize, manipulate, and perform statistical analysis on non-spatial tabular data and can create charts and maps (ESRI 1996).

Data Acquisition

Vegetation and Brush Cleared Areas

Black and white aerial photographs from 1951 (1:660), 1955 (scale unknown), and 1968 (1:1,320) were obtained form the KWMA. The photographs represented composite images from several photographs mosaiced into one image. The original source of the photographs was the Soil Conservation Service (Natural Resources Conservation Service). Eight aerial photographs of the KWMA locality for 1981 (1:24,000) were purchased from Texas Natural Resource Information System, and six digital orthophoto color-infrared photographs from 1995 (1:40,000) were acquired from the National Aerial Photography Program.

Black-capped Vireo Surveys

Black-capped Vireo locations and field data for the KWMA for 1985, 1986 and 1987 (Grzybowski 1988), 1988 and 1989 (Grzybowski 1990a), 1990 (Grzybowski 1990b), and 1991 (Grzybowski 1991) were obtained from Fish and Wildlife Service (USFWS) reports. No data were available for 1992. Attribute tables for ARC/INFO coverages from 1985-1991 were built from KWMA dBASE files containing BCV observation summary data from the study period. Black-capped Vireo data on surveys from KWMA 1993-1996 were obtained directly from field personnel. Observation maps were approximated on the top of existing United States Geologic Survey (USGS) 7.5 minute Quads and attribute tables were created from field notes (K.G. O'Neal unpublished, J. Nelka unpublished). Points on the map correspond with the field observation number, representing sight, sound, or evidence of BCV presence. For the earlier studies, 1985-1991, where BCV territories were determined, the centroid of the existing territory was used to maintain a coherent data set. Four dBASE files were created from several sources using the UNIX platform with ArcView GIS 3.0: FLDNOTES.DBF (K. G. O'Neal unpublished, J. Nelka unpublished), BCVTLPAS.DBF, TTLBCV.DBF, and BANDTTL.DBF (Grzybowski 1991).

Breeding Bird Survey Points

The Breeding Bird Survey is a two-day survey conducted across North America during the peak of the nesting season. From fixed observation points, a three-minute and five-minute point count of all birds seen or heard is recorded for a 0.25 mile diameter at the stop. The breeding bird survey points are 65 points established on the KWMA in 1996. The points indicate permanent observation points for an annual area wide bird survey to be conducted by TPWD biologists and field staff. Since the points had not been geo-referenced, points were approximated on top of an existing KWMA pasture map. Attribute table information is related to point data through four dBASE files (BBS96.DBF, BBSCON.DBF, BBSLOCAT.DBF, and BBSNAME.DBF), obtained from the KWMA and linked by the common field.

Parasitism/Cowbird Control

Permanent cowbird trap locations at the KWMA for 1985 through 1991 were obtained from a USFWS report (Grzybowski 1991). The attribute file contains the items created by ARC/INFO and an item TRAP_ID which links the table to related dBASE files. All tables can be linked together through the common field. CB8591.DBF was created on UNIX ArcView GIS 3.0 from the following USFWS reports: 1985 (Grzybowski 1985), 1986 and 1987 (Grzybowski 1988), 1988 and 1989 (Grzybowski 1990a), 1990 (Grzybowski 1990b), and 1991 (Grzybowski 1991). Attribute file information for 1992-1996 was built from KWMA dBASE files, CB9296.DBF and CBDETAIL.DBF. An additional dBASE file, COWBDSUM.DBF, was built to add and summarize data. Cowbird trap locations for 1992-1996 were obtained by KWMA field staff on a Global Positioning Satellite (GPS) receiver (Motorola LGT 1000). The GPS records the x - and y- coordinate for the location in WGS84 coordinate system.

Prescribed Burns and Wildfire

The history of prescribed burning and the history of wildfire on the KWMA for each pasture from 1954-1997 was obtained from KWMA records. An existing pasture map was used as the background for each map and each year's burning activity was recorded on a separate map. The attribute table was built using a unique number for each burn and linked with the dBASE file, BURN.DBF.

Pasture, Water Sources, and Roads

The locations of water sources (stock tanks) and road lines on a map of pastures at the KWMA were obtained as GPS coordinates generated by a Motorola LGT 1000 with 2-5m accuracy. The coordinates were collected in WGS84 coordinate system.

Topography

The Bee Cave Creek and Boneyard Draw USGS 7.5 minute Quads 1983 (1:24,000) with 20 foot contour intervals were used to create digital topography layers. All USGS 7.5 quadrangle maps for the United States use State Plane coordinates. The two topographic quads were used to create the digital elevation model (DEM).

Soils

Soil associations were obtained from the Soil Survey for Kerr County, Texas (Soil Conservation Service 1986, pages 10-11 and 17-18). Field work for soil associations was conducted in 1982. The book contained black and white aerial photographs of Kerr County at a scale of 1:24,000 in State Plane coordinates. Vectors were overlaid on aerial photographs showing soil associations and attribute data. Attribute tables were built from these models.

Photographs

Slides of KWMA acquired from staff of the TPWD Non-game and Urban Program consisted of color slides of representative vegetation, a BCV in its nest, a parasitized nest with a BCV and a cowbird egg, BCV in habitat, and a cowbird trap.

Automation of Spatial Data

Vegetation and Brush Cleared Areas

Six images and six coverages were created from black and white aerial photographs from 1951, 1955, 1968, and 1981, and digital orthophoto color-infrared photographs from 1995 using ERDAS IMAGINE 8.2 and ARC/INFO 7.0.4. The 1951, 1955, and 1968 aerial photographs were scanned into raster images using a full scale scanner with CADImage/Scan 3.4 and Adobe Photoshop 3.5 on a PC. The 1981 photographs consisted of eight photographs that were scanned separately on a flatbed scanner using Magic Scan 3.0 to create individual raster based TIF files for each photo. The digital orthophotos consisted of 6 photographs that were individually scanned on the flatbed scanner to raster based TIF files. The TIF files, using a file transfer protocol (FTP), were transferred to the UNIX platform and brought into ERDAS IMAGINE. IMAGINE supports the TIF format. The TIF was converted to an image file (IMG) which is supported by ARC/INFO. Images can be viewed on the screen or output to a hardcopy device.

Once an image has been converted from a TIF to an IMG, it must be geo-referenced in order to be displayed with other geo-referenced data. When the image is scanned, x,y coordinates are held in scanner units. To make this information meaningful by imposing a scale factor, the measurements were converted to a real-world coordinate system in the same projection as the original photograph. This process is called transformation (ERDAS 1991). To bring the image into a real world coordinate system, each image must be registered and then rectified. An ARC/INFO coverage exists in a real-world or map coordinate measured in feet. The x,y coordinates of the vector coverage differ from the raster image which is organized and measured by rows and columns. For coverages and images to be displayed simultaneously, the rows and columns of the image must be mapped onto the x,y plane of a map coordinate system (ESRI 1992a).

Each image from 1981 (8 images) and 1995 (6 images) had to be registered and rectified separately. The registration process established the relationship between the image coordinate system (rows and columns) and the map coordinate system (x,y coordinate) (ESRI 1992b). Through an interactive program in IMAGINE, the image (the source) was geo-referenced to an image for which map coordinates were known (the destination) by establishing ground control points (GCPs) (Smith and Pouncey 1996). A GCP in the destination was selected, and then the same location on the source image was selected. Both the source and destination coordinate were entered into the GCP editor. Eight to 10 GCPs were established for each image.

After the GCPs were established, a transformation matrix was calculated from the GCPs. A transformation matrix is a set of numbers computed from the GCPs which, when entered into a polynomial equation, are used to transform the coordinates from one system to the other (Smith and Pouncey 1996). The GCP editor displays the results of the transformation. The corresponding GCPs are re-transformed to the source coordinate system using the destination-to-source transformation matrix. The distance between the source GCP coordinates and these re-transformed coordinates is the RMS (root means squared) error. RMS error is expressed as distance in the source coordinate system, a measure of accuracy (Smith *et al* 1996).

Rectification is accomplished by saving the transformation to a file, selecting the order of transformation, and resampling the image to fit the new coordinate system. In this project, a second order transformation (polynomial warp) was performed on each image. Second order transformations are non-linear transformations which are used with distorted data (to correct for camera lens distortion) (ERDAS 1991). The rectification creates a new image by permanently transforming image data to real world coordinates. The rectification process removes any rotational or scaling problems from the image and aligns the image to the destination coordinate system (ESRI 1992a). All images aligned to the same coordinate system can be displayed with coverage data. The image must be resampled during the transformation process to determine the new pixel values in the transformed image from the source image. All images were resampled using the nearest neighbor method of interpolation. This method calculates the value for an output pixel by assigning it the value of the nearest pixel in the input image (ERDAS 1994).

Once transformed, the 1981 and 1995 individual photographs were used to create a mosaic of the study area for each year. The process for creating the mosaic images from individual photographs followed Smith and Pouncey (1996). Photographs for 1951, 1955, 1968, 1981, and 1995 were then used in ARC/INFO, ARC/EDIT module, as background coverages for creating vector coverages of brush cleared and uncleared areas on the KWMA. Vector coverages were created by heads-up digitizing. In heads-up digitizing, the raster TIF or IMG (in this case the aerial photograph) is displayed on the monitor. Using interactive graphics, vectors, brush cleared and uncleared areas, were digitized directly from the raster file (Stevenson 1995). The CLIP command in ARC was used to designate the study area. The CLIP command extracted a portion of each layer from the database (ESRI 1990) and clipped it to the pasture coverage which served as the base map for the study area.

Black-capped Vireo Surveys

The BCV territory maps from 1985-1991, (USFWS reports) were of two types. The 1989 and 1990 territory maps had territories estimated on top of USGS 7.5 minute Quads, while the others (1985, 1986, 1987, 1988, and 1991) were drawings estimated on top of an outline of the existing pastures map. The territories approximated on the top of the pasture outline were scanned using a flatbed scanner and Magic Scan 3.0, and then brought into Adobe Photoshop 3.5, creating a TIF file. The TIF file was then transferred via FTP across platform to the UNIX system. Using ERDAS IMAGINE 8.2, the TIF was converted into an image. The image was registered and rectified using the same procedure described previously. The destination was the vector polygon coverage PASTURPY created in ARC/INFO. GCPs were matched to the pasture outline to transform the image into real world coordinates. Once this was completed the image was used as a background coverage in ARC/EDIT. A new coverage was created for each year. Labels were added, representing the centroid of each territory. Each coverage was built as a point coverage, using the BUILD command in ARC (ESRI 1990), establishing topology.

The 1989 and 1990 territory maps were handled in the same manner as the 1993, 1994, 1995, and 1996 maps. The topographic coverage with the pasture map overlayed served as the background coverage in ARC/EDIT. A new coverage for each year was created. The labels added represented the territory centroid, 1989 and 1990, or observation points, for 1993-1996. Each coverage was built in ARC as a point coverage, establishing topology.

Breeding Bird Survey Points

The breeding bird survey point map displayed survey points on the KWMA, with the pasture map outline as a background. The same procedure was used, as described above, for scanning, importing, and converting the image to serve as a background coverage in ARC/EDIT. A new coverage was created and labels added. The coverage was built in ARC as a point coverage, establishing topology.

Parasitism/Cowbird Control

The cowbird coverages were built differently due to the nature of the source. The permanent cowbird trap locations for 1985-1991 were automated by scanning the trap locations from a map with the pasture outline obtained from a USFWS report. The same procedure described above was used for scanning, importing, and converting the image to serve as a background coverage in ARC/EDIT. A new coverage was created and labels added. The coverage was built in ARC, as a point coverage, establishing topology.

The permanent cowbird trap locations for 1992-1996 were located using a Motorola LGT 1000 (2-5m accuracy) GPS unit by KWMA field staff. The coordinates were collected in a WGS84 coordinate system. The WSG84 GPS coordinates had to be transformed in ARC to the State Plane Coordinate System using the PROJECT command. The PROJECT command asks for a set of parameters from the input coordinate system (the GPS) and the output coordinate system (State Plane) (ESRI 1990). The transformed coordinates were entered into a text file and a coverage was automatically created in ARC using the GENERATE command. The GENERATE command creates an ARC/INFO coverage from raw coordinates, adding features to a coverage (ESRI 1997). The coverage was built as a point coverage, establishing topology.

Prescribed Burns and Wildfires

Prescribed burn and wildfire information from 1954-1997 were obtained from maps drawn on the pasture outline of the KWMA for each year. In ARC/EDIT, the pasture map was used as the background coverage. An ARC/INFO coverage was created for each year and type of burn: PBUR##PY coverages represent prescribed burn polygon coverages with the last two digits of the year indicated. The WFIR##PY coverages indicate wildfire polygon coverages with the last two digits of the year in which each occurred. Each year may have one or more polygons in the same coverage representing different burns within that year. Each burn was assigned a unique pasture number. The polygons were added in ARC/EDIT. The coverage was built as a polygon coverage in ARC, establishing topology.

Topography

Bee Cave Creek and Boneyard Draw USGS 7.5 minute Quads were scanned by the full scale scanner into a TIF file using CADImage Scan 3.4 and Adobe Photoshop 3.5.

The TIF file was imported into PixelTrak 3.5 where the topographic lines were drawn, one by one, by heads-up digitizing and line following, into a vector layer. Line following involves placing the cursor on a line to be digitized in the raster TIF. The software program automatically digitizes the line until a problem is reached. This requires constant correction, due to intersections between lines and the end of a line (Stevenson 1995).

A second layer was added to the vector layer called TICPTS. A tic is the registration or geographic control point for the layer representing known locations on the earth's surface (ESRI 1990). Tics allow all coverage features to be recorded in a common coordinate system. All newly created vectors were saved as a DXF file (drawing exchange format). This file was transferred to the UNIX system using FTP and then converted into a vector coverage in ARC/INFO by the DXFCON command (ESRI 1997). When converted from a DXF file to an ARC/INFO coverage, ARC recognizes the TICPTS layer and automatically geo-references the new coverage. The new coverage must be built as a line coverage to establish topology.

Once converted, the new coverage must be edited and cleaned in ARC/EDIT to repair any nodes not connected or disjunct lines. This was done for each quad separately. The two coverages were edge matched to create a new coverage called TOPO20LN, indicating a topographic coverage with contour intervals of 20 feet. Edge matching is an editing procedure for adjusting the locations of connecting arcs and polygons that cross coverage boundaries (ESRI 1990). Each individual contour line from each coverage must be matched to the adjacent coverage to create a continuous topographic map coverage. The actual hard copy map was used as a reference to ensure arcs and nodes matched properly and lines were digitized properly. Any overshoot (portion of an arc digitized past its intersection with another arc) or undershoot (arc not extending far enough to intersect with another arc) (ESRI 1990) must be corrected to build a new line coverage with topology. The APPEND command was used to join the coverages into a new coverage.

The APPEND command allows the combining of up to 500 coverages into a new single coverage. The new coverage contains all features and attributes of both input coverages (ESRI 1990).

Once built, the new coverage was used to create the digital elevation model (DEM) for the KWMA. In ARC/INFO, the TOPOGRID command creates a DEM from topographic line coverages. The TOPOGRID command is an interpolation method designed for the creation of hydrologically correct digital elevation models from elevation coverages (ESRI 1997). Water is the primary erosive force determining the general shape of most landscapes, resulting in a drainage pattern of local maximums (hill tops) and local minimums (sinks). The TOPOGRID command uses this knowledge and an interpolation process, ANUDEM (ESRI 1997), to create a DEM using contours and elevations from the topographic coverage. The new topographic coverage and the DEM were clipped (process of extracting data from a coverage that reside entirely within the boundary features in another coverage) (ESRI 1990) with a boundary coverage for the KWMA. When overlayed, the topographic map and the DEM could be used as background coverages, lining up exactly with the pasture map.

Soils

The soil maps, aerial photographs with vector overlay of soil associations, were bound in a soils book and could not lay flat on the flat bed scanner. A mylar overlay was used for each of the four soil maps that included the KWMA. A mylar overlay is a clear sheet on which soil lines were traced using a fine point permanent marking pen. TICPTS were established for each soil map to geo-reference the map to the existing coverages. Four mylar sheets were scanned by the full scale scanner, CADImage/Scan 3.4, and Adobe Photoshop 3.5, into four separate TIF files. The lines from each mylar sheet were then traced in PixelTrak 3.5. Three vector layers were created for each TIF: a soil polygon layer, a boundary layer, and TICPTS. When completed, the four DXF files were imported into ARC/INFO via FTP to the UNIX platform and converted to ARC/INFO coverages. The four coverages were built as line coverages. In ARC/EDIT, the four coverages were edge matched to create a continuous coverage of soil lines. Once edge matched, a new coverage was built using APPEND. The line coverage was clipped with the pasture outline coverage, creating a new coverage SOILPY. The new coverage was built as a polygon coverage. The boundary of the polygon coverage coincided with the shape of the KWMA, and each soil association was represented by a separate polygon. The attribute table was built using soil attribute information for each soil association from the SCS book.

Background Coverages: Pasture, Water Sources, and Roads

The water, road, and pasture coverages were built from WGS84 GPS coordinates projected in ARC/INFO into the State Plane Coordinate System. The GENERATE command in ARC/INFO created coverages from the new coordinates. The BUILD command processed the points, constructed topology, and created feature attribute tables for each new coverage (ESRI 1990). In ARC/EDIT, the GPS points in the pasture coverage were connected by adding arcs and nodes between points to create the polygon coverage PASTURPY. Water sources (stock tanks), WATERPY, are represented by GPS points created in the coverage. The road lines were created by connecting points along a road obtained from GPS coordinates, creating a line coverage, ROADLN. All coverages were built to establish topology.

Photographs

Slides acquired from the staff of the TPWD Non-game and Urban Program were scanned into a TIF file format using a flatbed scanner with Magic Scan 3.0 and Adobe Photoshop 3.5. The TIF file format is compatible with ArcView GIS 3.0 and can be added to a view as a theme, and therefore incorporated into a project.

Development of Data/dBASE Dictionary

Data Dictionary

The Data Dictionary created for this project defines each coverage name and contents. The attribute tables, either PAT for point and polygon attribute table or AAT for line attribute table, are defined by establishing set parameters for each item (the field of information displayed as a column) in the attribute table (ESRI 1990). The row displays attributes for a record which holds information (descriptors) about one coverage feature in each field. In the Data Dictionary, the input width, output width, and data type are defined for each item. Each item was defined and the attributes allowed are listed under each item. The Data Dictionary lists guidelines for creating a coverage, so there will be continuity and standardization on all coverages created by TPWD. In Appendix A, the complete Data Dictionary for this project is presented. The Data Dictionary refers the user to all related dBASE files for a particular coverage. The last two letters in any coverage name define the feature type, i.e., LN, line coverage; PT, point coverage; and PY, polygon coverage.

dBASE Dictionary

Like the Data Dictionary, the dBASE Dictionary describes and defines the contents of the field and field attributes of each dBASE file. The dBASE Dictionary refers the user to all coverages that can be linked or joined to the dBASE file through the coverage point, polygon, or line attribute table. The complete dBASE Dictionary is available in Appendix B.

The Relational Database

Attribute Tables

The database concept is central to a GIS. In ARC/INFO, ARC stores information on the location features, while INFO handles the attributes that describe features and how they are related to each other. The Database Management System (DBMS) is a collection of software required for using and manipulating a tabular database, and displays many different views of the data (ESRI 1990). The attribute table is the DBMS table directly associated to the spatial data. It contains both the spatial data characteristics and attributes. The attribute is a characteristic of a map feature described by numbers or characters, stored in tabular format, and linked by the user assigned identifier. The first several items of each attribute table are automatically written by ARC/INFO; others are defined by the user and added to the table. The user may add as many items as necessary to fully describe the data. For the KWMA project, 44 coverages and 44 attribute tables were built, each with unique identifiers linking the spatial and non-spatial data.

dBASE Files

A tabular DBMS that can be used with ARC/INFO to store and manipulate map feature attributes is a dBASE file. A Relational Database Management System (RDBMS) is a database management system with the ability to access data organized in tabular files that may be related by a common field. Each record is a "row" and each field in a record is a "column". A set of rows stored under columns comprise a table (Dichter 1995).

In ArcView, dBASE files can be linked via a common field name to a common item name in an attribute table using a join or link operation. The join and link operations establish a connection between corresponding records in two tables using an item common to both (ESRI 1996). Each record in one table is connected to one or more records in the other table that share the same value for a common item. Once tables are related to one another, the dBASE file is linked to the spatial data in the map. By relating tables, the user has access to additional feature attributes that are not stored in a single table. The connection can be temporary or permanent. In the KWMA project, 44 coverages, 44 attribute tables, 13 dBASE files, and 13 images comprise the relational database.

Metadata

The Metadata describe the content, quality, condition, and other characteristics of data. Metadata are "data about data" (FGDC 1995). Metadata were created for each coverage using DOCUMENT AML, the metadata software from ESRI. Metadata describe different aspects of data, helping locate and understand data. The DOCUMENT AML format for metadata can be found in Appendix C. DOCUMENT AML stores important information about the contents and lineage of a coverage and was used after the production of coverages was complete. Metadata for each coverage define each item and attribute in the attribute files, give source information, projection, and other descriptive information. The Methods and Materials section of this paper cites specific sources for data acquisition, therefore, due to the size of metadata files, they have not been included in this paper. Metadata files are separate digital files which accompany a coverage and are available from:

GIS Laboratory
Texas Parks and Wildlife Department
GIS Laboratory Librarian
4200 Smith School Road
Austin , Texas 78744
Phone (512) 389 - 8070
Fax (512) 389 -8300

Data Integration in ArcView GIS

Because all images and coverages were created on the UNIX platform with ARC/INFO or ERDAS IMAGINE , the coverages, arranged into workspaces to retain the INFO files, were transferred from the UNIX platform to the PC in order to create the project in ArcView GIS 3.0. In ARC/INFO, a workspace must be created to transfer coverages to the PC. ARC/INFO coverages have INFO files associated with them that contain the PAT, AAT, and TIC information for each coverage. Without these files the coverage cannot be opened by ArcView. In ArcView, each coverage was checked and the attribute files were edited. Using the parameters defined in the data dictionary, new items were added to the attribute tables and data were entered in ArcView. dBASE files were also created in ArcView. Existing dBASE files were modified to relate to other attribute files and dBASE files based on a common field. Legends were added to all coverages for display purposes.

When opened, 15 available views appear in the project window of the ArcView GIS project KWMA.APR. A project contains all views, tables, charts, layouts and scripts used for a particular ArcView application, stored in one place. A view is an interactive map that allows the user to display, explore, query, and analyze geographic data in ArcView (ESRI 1990). The views were created to show the available themes in the database. The project window allows access to all data and coverages. The available views in the project window are: Aerial Photography, Black-capped Vireo Observations, Breeding Bird Survey Points, Brush Cleared vs. Uncleared Areas, Digital Elevation Model, History of Cowbird Trapping, History of Prescribed Burning, History of Wildfire, Soils, Topographic Map with Roads and Water sources, and seven photographs. All views, except photographs, have the pasture map available as a base map. By double-clicking with the mouse on any view, a window will open displaying all available themes for that category. Each theme has associated attribute tables and/or dBASE files which can be accessed by using the Tables window.

The final product, the Black-capped Vireo GIS Database for the KWMA, was developed in PC ArcView GIS 3.0, and data were burned onto a Verbatim Multi-speed 74/63 minute recordable CD-ROM. The file KERRWMA is 275MB (288,711,318 bytes) and contains 1,066 files in 68 folders. The CD is organized into the project file, KWMA.APR, a back-up project, and individual data files and coverages arranged into workspaces based on category. The user can access the project, where all data are organized into views by category, or choose to work only with selected data sets from individual folders. Field access will require a minimum of ArcView GIS Version 3.0 and a CD-ROM Drive. The program can run directly off the CD-ROM, therefore field stations do not need added storage space to accommodate the data files. Files can be copied to a hard drive from the CD-ROM and then updated or edited. Data can be added to the CD-ROM in subsequent years.

RESULTS

The results illustrate the Black-Capped Vireo GIS Database produced for the management of the BCV at the KWMA. Figures 1-12 illustrate screen captures of the Black-Capped Vireo GIS Database from ArcView GIS 3.0. Each view, with all available themes, from the project file, KWMA.APR is represented. Figures 13-14 present sample pages from the Data Dictionary and dBASE Dictionary.

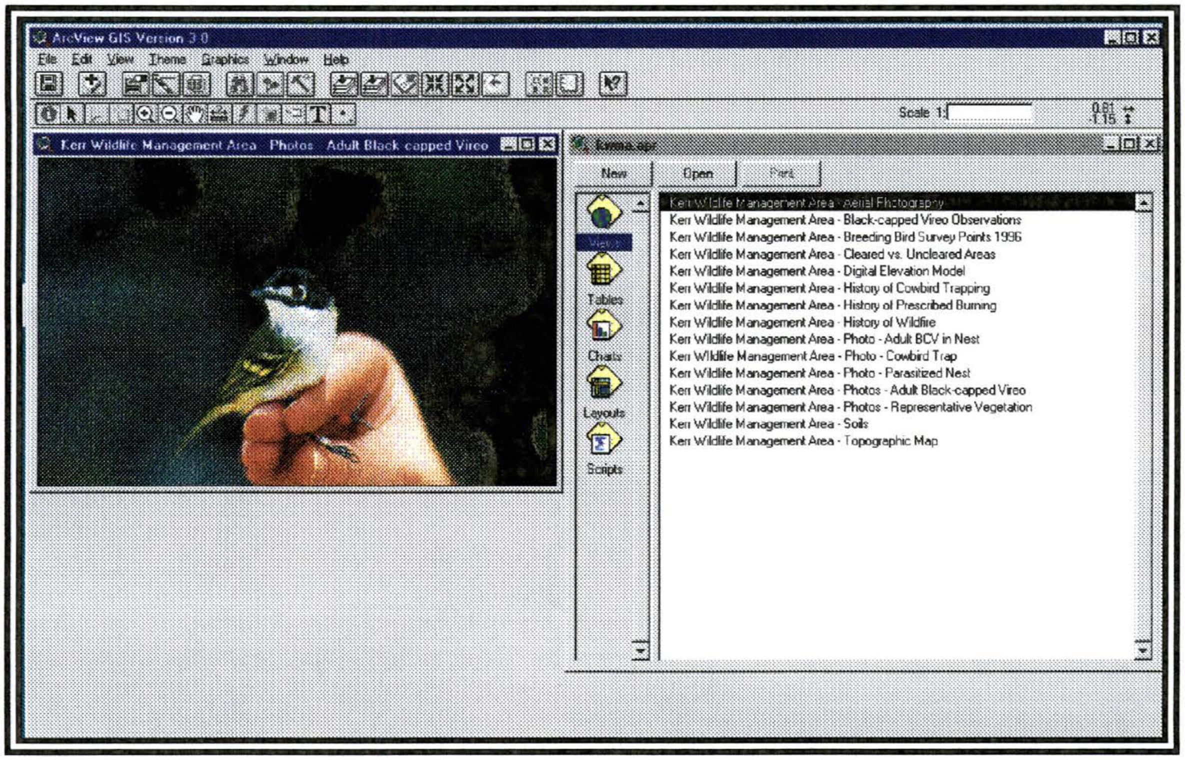

Figure 1. Black-capped Vireo GIS Database for the Kerr Wildlife Management Area. The figure illustrates the project window in ArcView GIS 3.0 from which a view can be selected by double-clicking on the area of interest. In this example, the Black-capped Vireo photograph was selected from the menu. When the Black-capped Vireo GIS project is activated from the CD-ROM, this is the first window that appears, providing access to all areas of interest: aerial photography, Black-capped Vireo observations, breeding bird survey points, brush cleared vs. uncleared areas, digital elevation model, histories of prescribed burning, wildfire and cowbird trapping, soils, topographic map with water and roads, and color photographs.

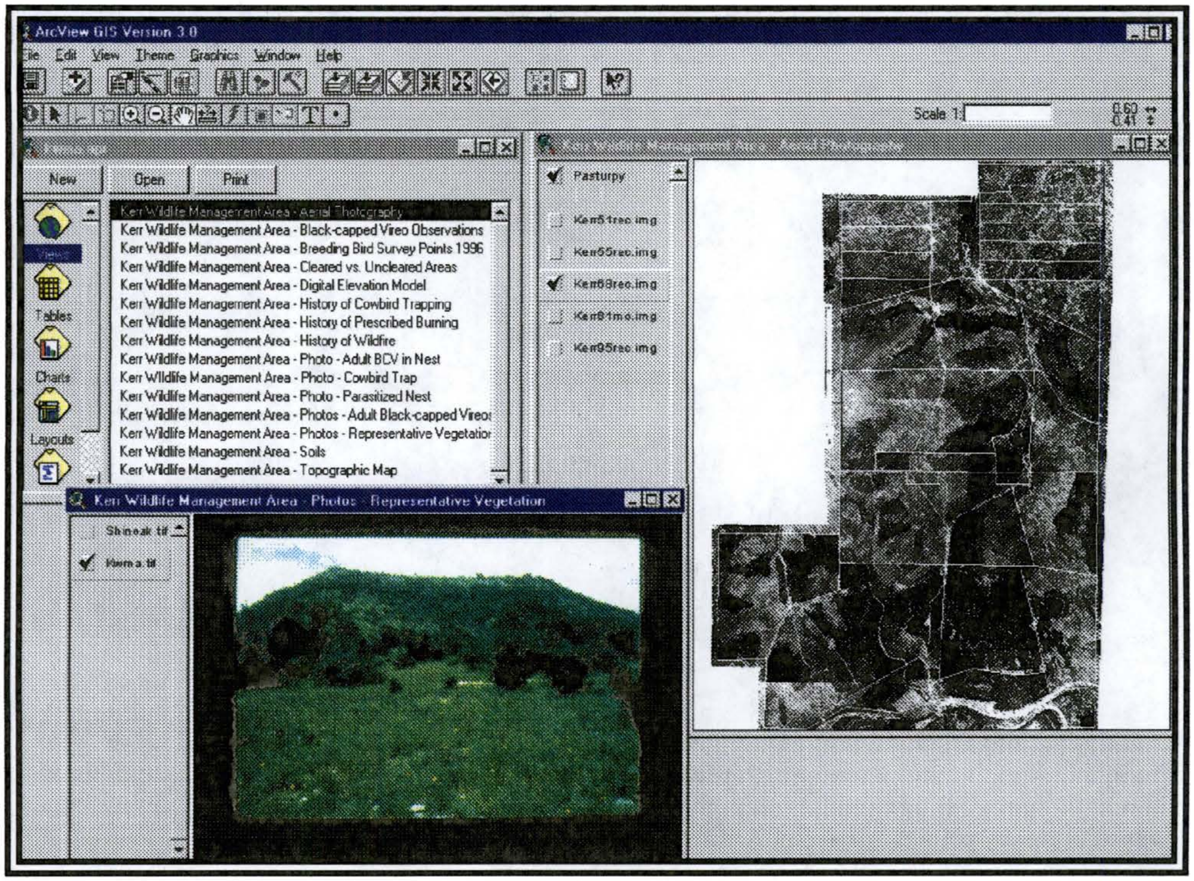

Figure 2. Kerr Wildlife Management Area - Aerial Photography. View shows five aerial photographs from 1951-1995 available as themes. The active themes, illustrated by a check-mark by the name, are the 1968 aerial photograph of the Kerr Wildlife Management Area with the pasture map overlayed in white. The photograph is used to show representative vegetation on the Kerr Wildlife Management Area.

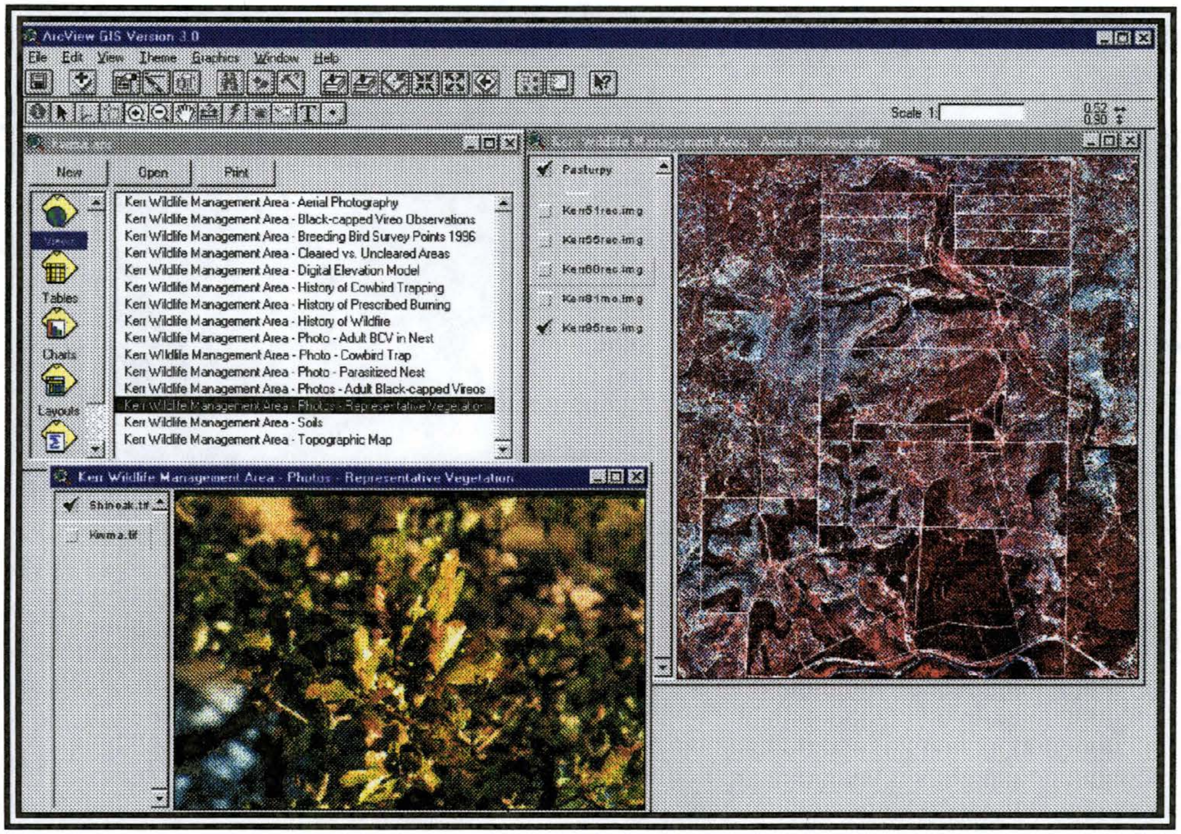

Figure 3. Kerr Wildlife Management Area - Aerial Photography. In this view, the digital orthophoto color infrared aerial photograph from 1995 is the active theme with the pasture coverage overlayed in white. The photograph displays a white shin oak (*Quercus sinuata*) as a representative vegetational type on the Kerr Wildlife Management Area.

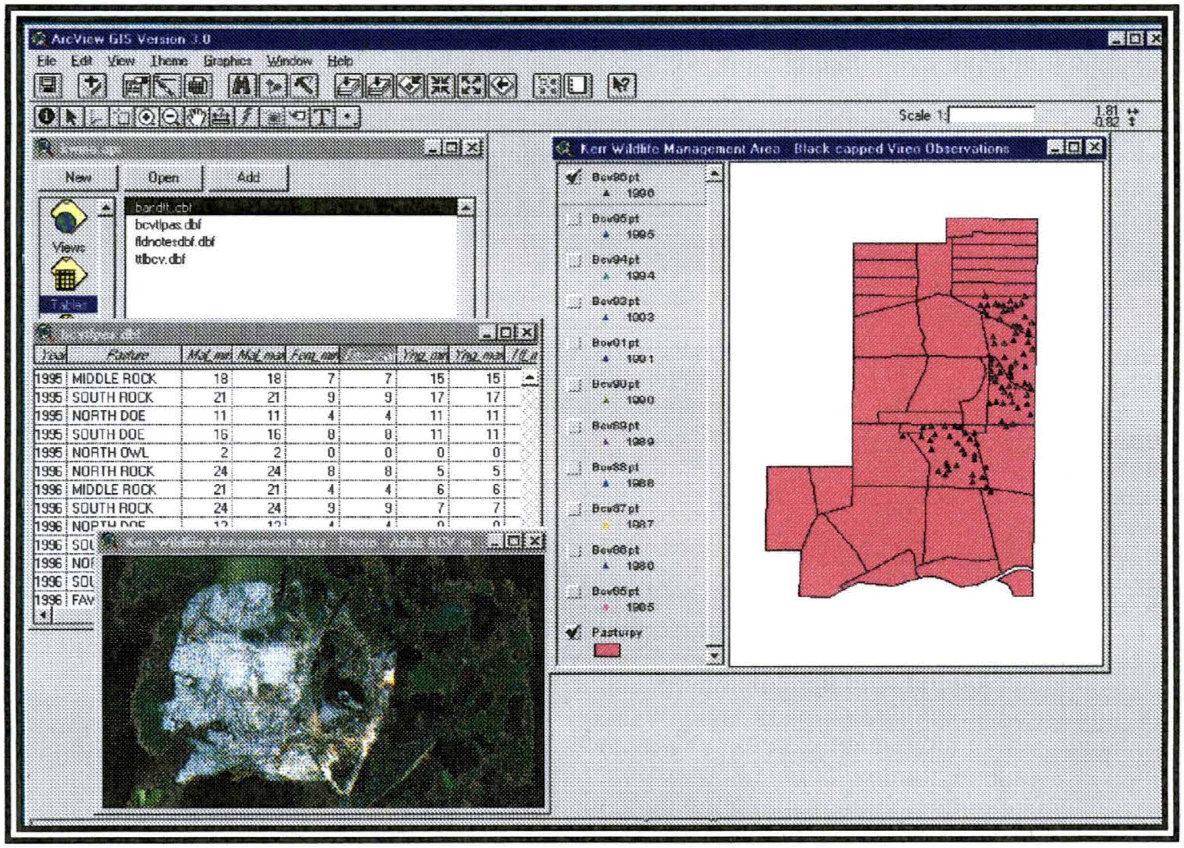

Figure 4. Kerr Wildlife Management Area - Black-capped Vireo Observations. The view displays the active theme for Black-capped Vireo observations for 1996 with the background polygon coverage displaying the pasture map. Other themes, Black-capped Vireo observations for 1985-1995, can be activated by pointing and clicking on the box next to the theme. Multiple themes can be displayed at one time. The Table Window displays four dBASE files related to the active theme. The photograph shows a male Black-capped Vireo in its nest.

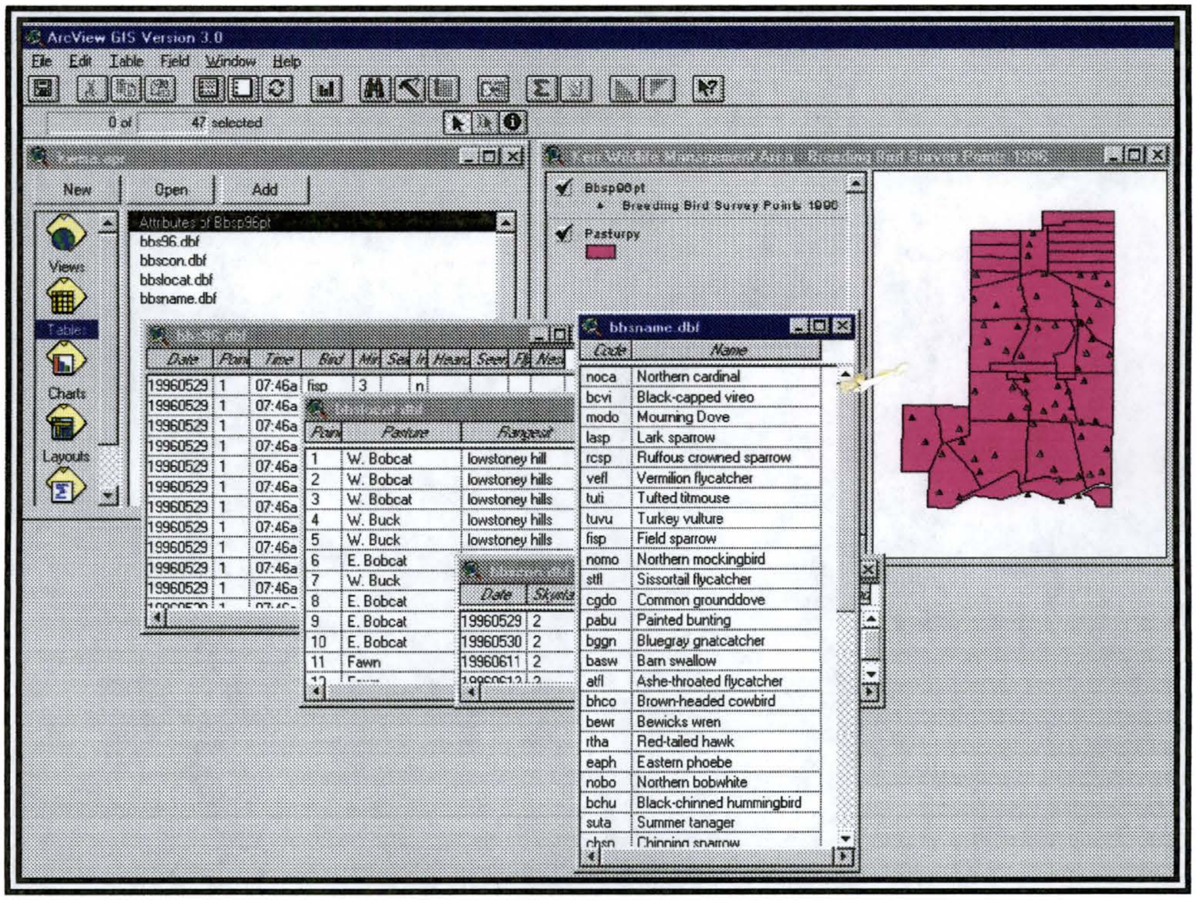

Figure 5. Kerr Wildlife Management Area - Breeding Bird Survey Points. The active theme displays the breeding bird survey points established in 1996 with the polygon pasture coverage. Each point represents multiple observations of avian species with descriptive information recorded in the dBASE files.

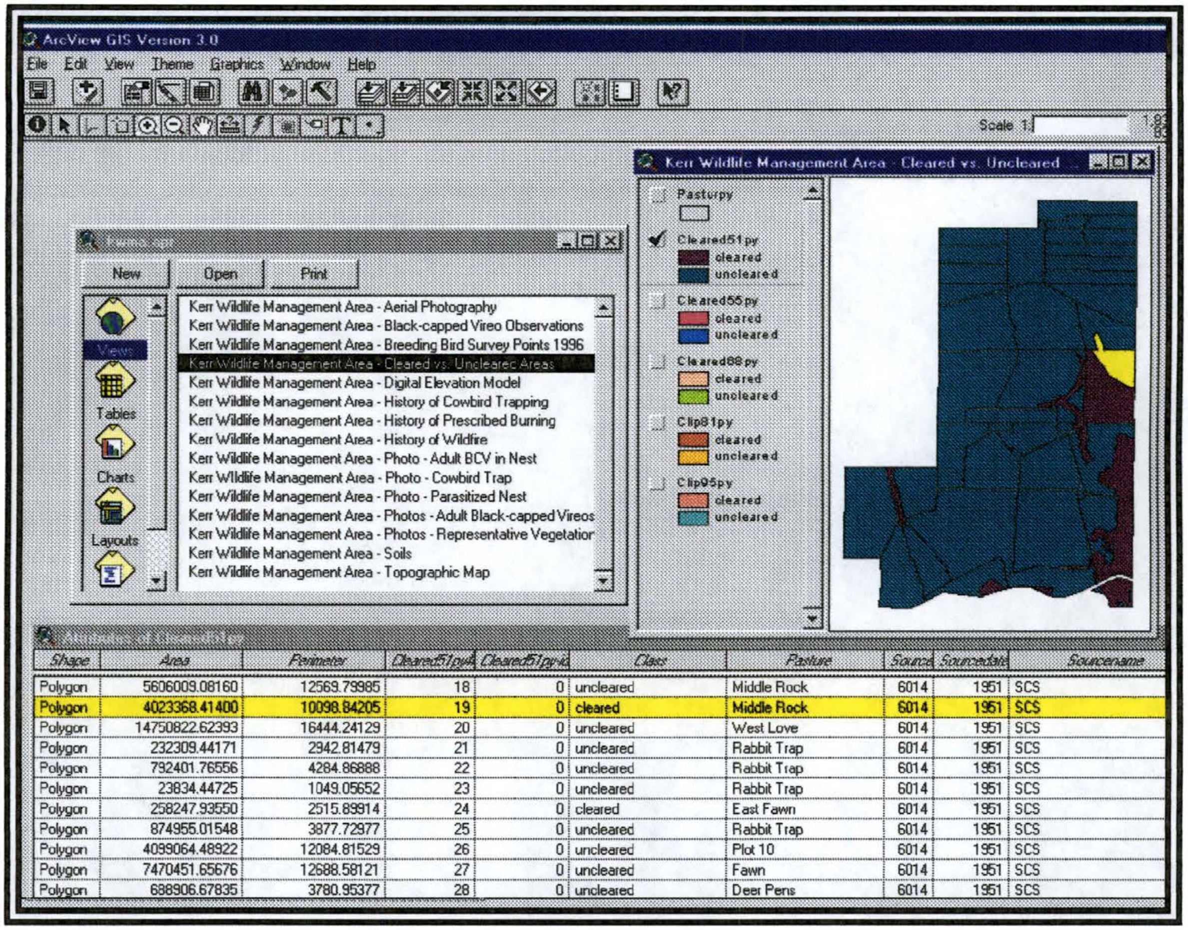

Figure 6. Kerr Wildlife Management Area - Brush Cleared and Uncleared Areas. The active theme displays brush cleared and uncleared areas on the Kerr Wildlife Management Area in 1951. Other themes available are 1955, 1968, 1981, and 1995. The attribute table is linked with the spatial data. By selecting a record, the corresponding polygon is highlighted in the view.

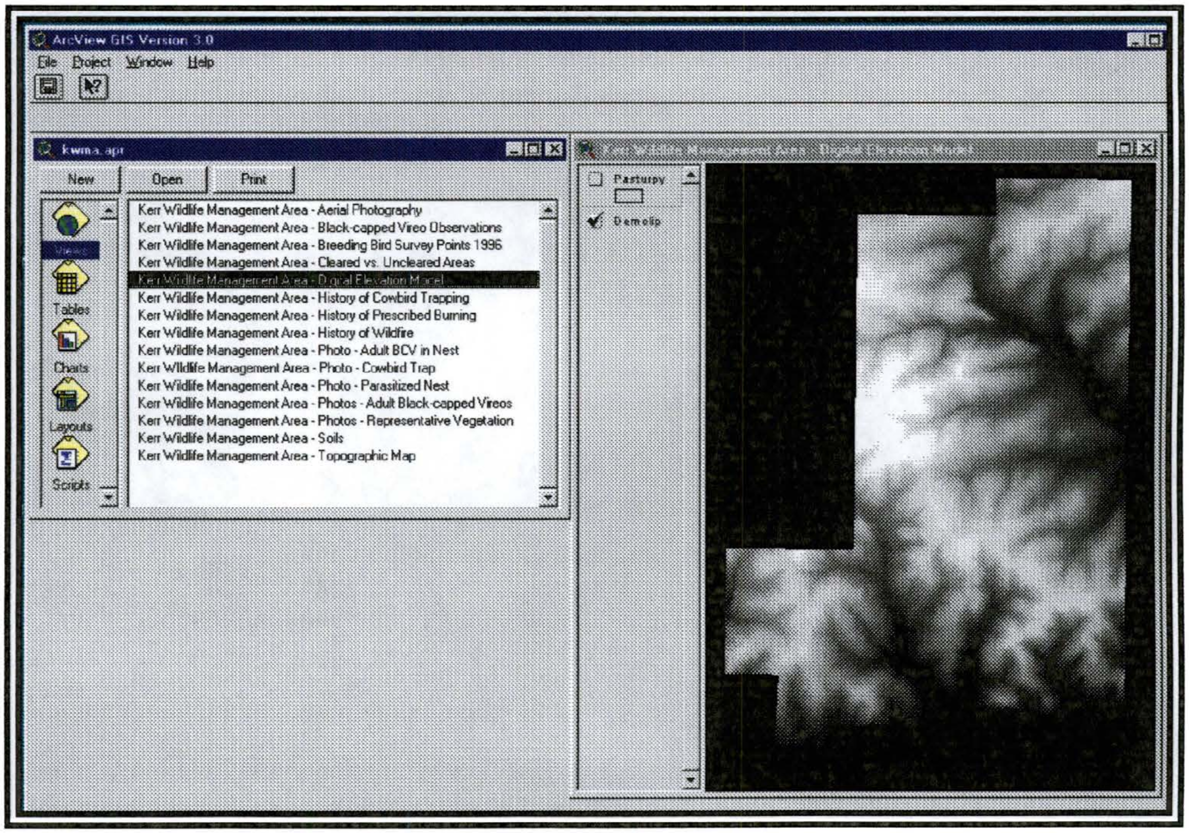

Figure 7. Kerr Wildlife Management Area - Digital Elevation Model. The digital elevation model is the active theme. Using a Digital Elevation Model, elevation, slope, and aspect can be determined. The Digital Elevation Model shows the water drainage patterns for the Kerr Wildlife Management Area based on contour lines.

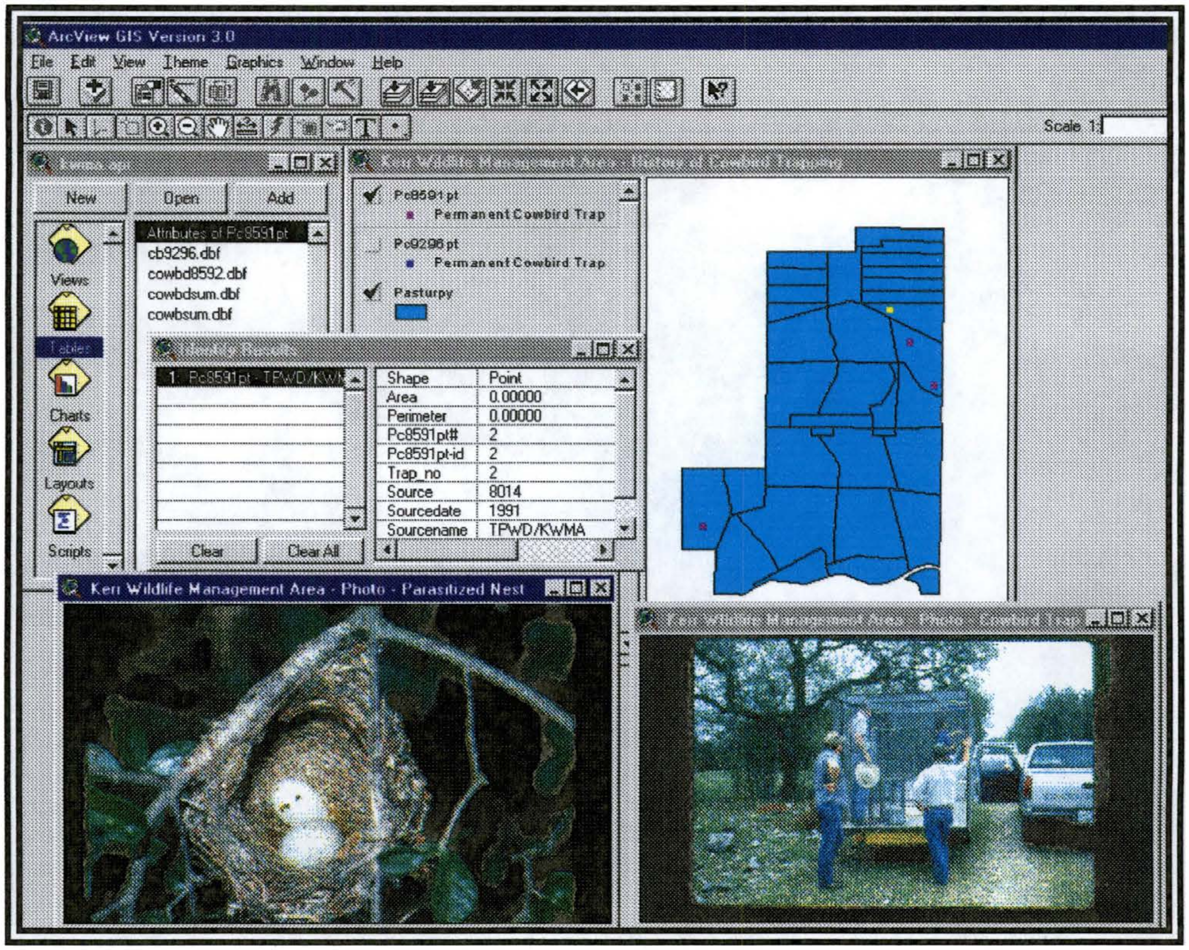

Figure 8. Kerr Wildlife Management Area - History of Cowbird Trapping. The active theme displays permanent cowbird trap placement on the Kerr Wildlife Management Area from 1985-1991. In the theme, trap one was selected with the identify tool and the Identify Results Window displays information for the selected trap. Four dBASE files and the point attribute file are displayed in the table menu and can be related in a query. The photographs show a Black-capped Vireo nest with a cowbird egg present (note the holes in the Black-capped Vireo egg) and an example of a cowbird trap used at the Kerr Wildife Management Area.

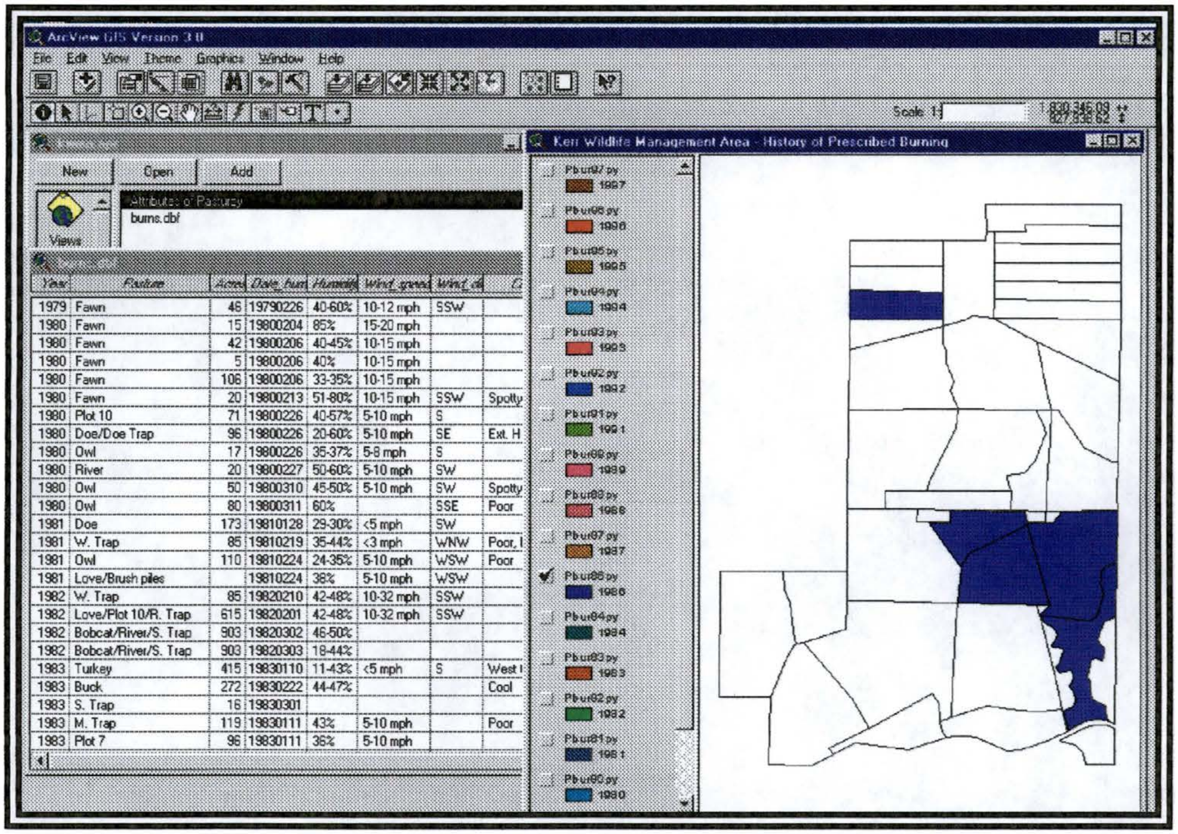

Figure 9. Kerr Wildlife Management Area - History of Prescribed Burning. The active theme displays areas where prescribed burning was conducted during 1986. Prescribed burn themes for 1979-1997 are available. The polygon attribute file and the dBASE file in the tables menu can be related in a query.

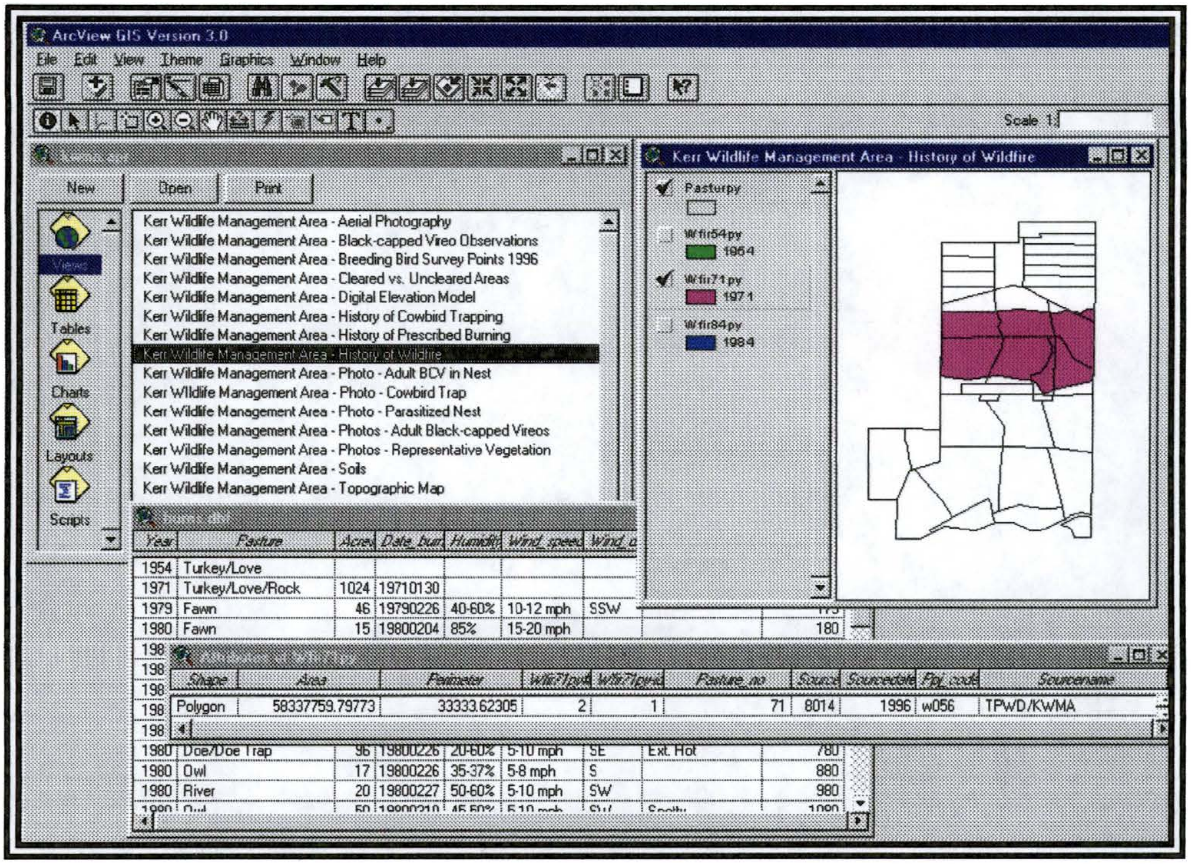

Figure 10. Kerr Wildlife Management Area - History of Wildfire. The active theme displays a wildfire that occurred in 1971. Other themes available are wildfire activity from 1954 and 1979. The polygon attribute file and the dBASE file can be related in a query based on a common field.

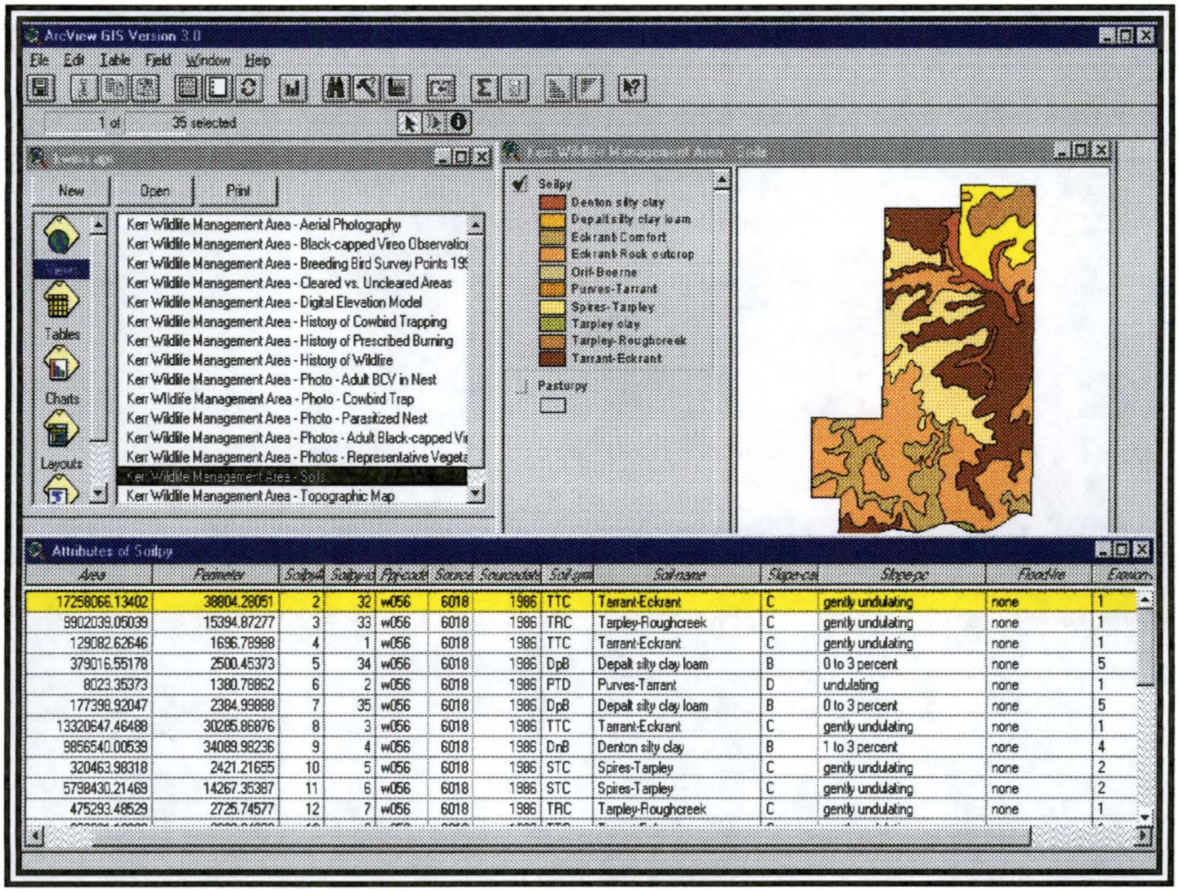

Figure 11. Kerr Wildlife Management Area - Soils. The active theme displays the soil type coverage and the legend for interpreting soil associations. The pasture polygon coverage is available for overlay. The soil polygon attribute table is displayed. The selected record in the table and the related polygon in the coverage are displayed.

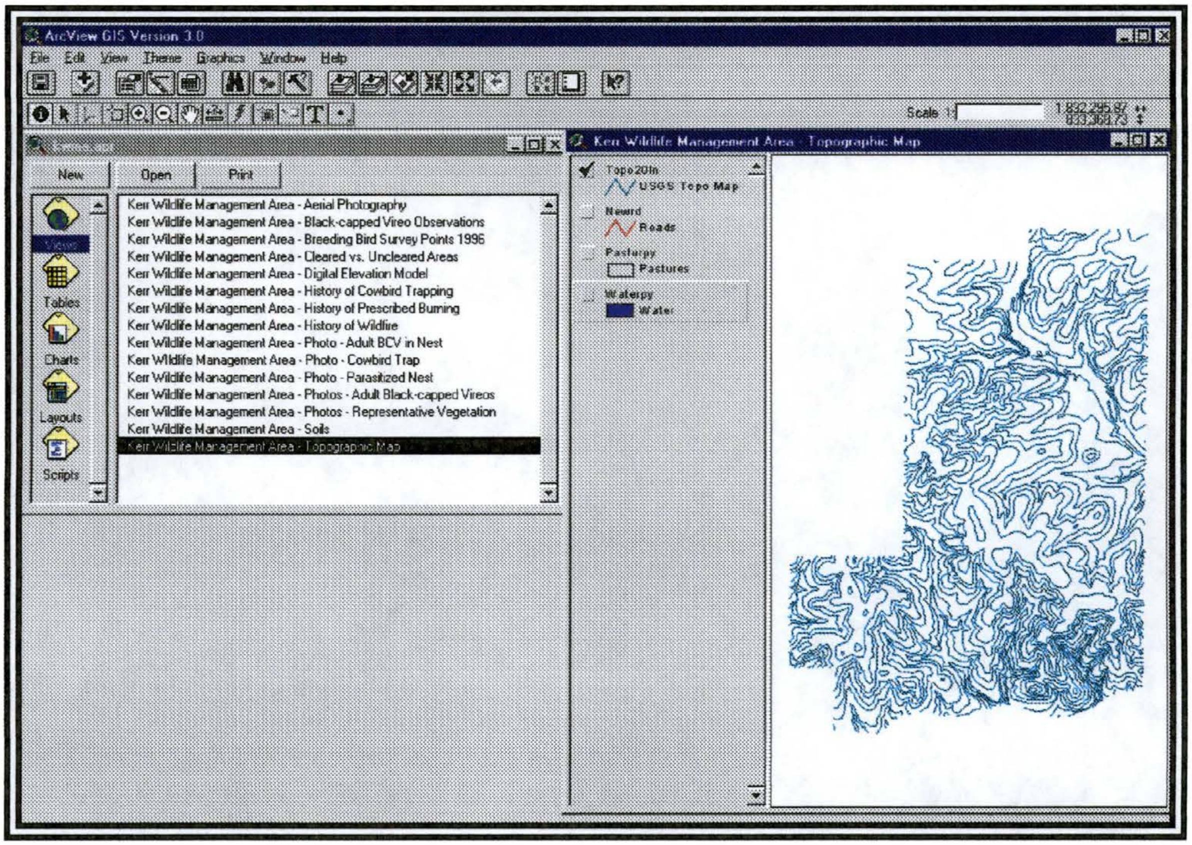

Figure 12. Kerr Wildlife Management Area - Topographic Map. The active theme displays the topographic map created from USGS 7.5 minute QUADS. Other themes, roads, water, and pasture coverages, are available for overlay.

PBUR##PY

Park Name Kerr Wildlife Management Area **Coverage Name** PBUR##PY

Coverage Contents PRESCRIBED BURNING BY YEAR

Coverage Type polygon

Mapscale

inch to inch	1 12,000	1 24,000	1 100,000	1 250,000	
inch to feet 1 50	1 100	1 200	1 250	1 500	1 1000

Coverage History and Mapping Procedure

(To be completed by field staff when updating coverage information, current coverage history available in metadata file)

DATABASE ATTRIBUTE FORMAT - POLYGON FEATURES (PAT FILE)

PPJ_CODE	4	4	C	ppj code of facility using capital letter (P151)
SOURCE	5	5	I	graphic data source
SOURCENAME	50	50	C	name of source collector's name or map source name
SOURCEDATE	8	8	I	yyyymmdd, date of source listed above
PASTURE_NO	10	10	I	xx-yyyy xx = pasture number, yyyy = year

Attribute Choices - Polygon Features

PASTURE_NO: unique number assigned to burn and the year

Related or Associated Tables (see dBASE dictionary for file and field descriptions)

BURN DBF

Bibliography

last modified 5/25/97

Figure 13. Sample of a Data Dictionary entry developed for prescribed burning activity coverages on the Kerr Wildlife Management Area.

BURN DBF

Park Name Kerr Wildlife Management Area **File Name** BURN.DBF

File Contents PRESCRIBED BURNING AND WILDFIRE DATA

File Type dBASE

FIELD ATTRIBUTES

YEAR
PPJ_CODE
PASTURE
ACRES
DATE_BURN
HUMIDITY
WIND_SPEED
WIND_DIR
COMMENTS
PASTURE_NO

FIELD ATTRIBUTE DESCRIPTION

YEAR: year; xxxx

PPJ_CODE: ppj code of facility using capital letter (P151)

PASTURE: name of pasture

ACRES: acreage burned

DATE_BURN: date of burn

HUMIDITY: humidity recorded at time of burn

WIND_SPEED: wind speed recorded at time of burn

WIND_DIR: wind direction recorded at time of burn

COMMENTS: comments on intensity of fire and conditions not otherwise noted

PASTURE_NO: unique number assigned to burn and the year

Related or Associated Coverages

PRESCRIBED BURNING COVERAGES:

PBUR79PY
PBUR80PY
PBUR81PY
PBUR82PY
PBUR83PY
PBUR84PY
PBUR86PY
PBUR87PY
PBUR88PY
PBUR89PY
PBUR91PY
PBUR92PY
PBUR93PY
PBUR94PY
PBUR95PY
PBUR96PY
PBUR97PY

WILDFIRE COVERAGES·

WFIR54PY
WFIR71PY
WFIR84PY

Bibliography

last modified 5/25/97

Figure 14. Sample of dBASE Dictionary entry for related dBASE files for the prescribed burning activity on the Kerr Wildlife Management Area.

DISCUSSION

The Black-capped Vireo GIS Database for the KWMA is an analysis tool for assisting the wildlife manager in making sound management decisions. The Black-capped Vireo GIS can be utilized to address the recovery actions and objectives set forth in the BCV Recovery Plan (USFWS 1991) and the BCV Population and Habitat Viability Assessment Report (PHVA) (USFWS 1996). The Black-capped Vireo GIS can assist in the development and implementation of the conservation strategies discussed in both reports. The BCV Recovery Plan discusses strategies to preserve, protect, and enhance BCV populations to meet the initial objective of downlisting the species to threatened and meeting the ultimate goal of full recovery (USFWS 1991). The PHVA report assessed the current state of knowledge on the biology of the BCV, predicted the probability of extinction or survival under various management scenarios, and sought to determine viable population size (USFWS 1996). The PHVA was the result of a workshop between federal, state, county, local, academic, and private sector participants who examined and synthesized information on BCV life history, ecology, and management techniques to build a framework for conservation action (USFWS 1996).

Addressing Recovery Actions with GIS

By defining specific tasks needed to accomplish recovery objectives, the BCV Recovery Plan outlines actions for specific research and information needs, habitat management, monitoring, and research on winter range. The Black-capped Vireo GIS can be used to model the use of GIS in endangered species management by addressing specific recovery actions through spatial and tabular analysis. The Black-capped Vireo GIS research, data collection, and construction focused on data required to address specific Recovery Plan actions and PHVA needs.

The spatial database layers and tabular attribute tables with direct application to the recovery actions and PHVA assessment are topography, soils, BCV observations, aerial photography, digital elevation model, prescribed burning and wildfire, and the history of cowbird trapping. The future plans to integrate all white-tailed deer survey data including spotlight surveys, browse lines, livestock rotational grazing, and other range management techniques for the KWMA will enhance the analysis capabilities of the database for meeting recovery task objectives.

Grzybowski (1991) discussed possible links between geology, soils, and topography investigated by Sexton et. al. (unpublished MS) and Graber (1957) and suggested further research was needed. Sexton et al. (unpublished MS) found some relationship between the Fredericksburg limestone and occupied BCV habitat. The Black-capped Vireo GIS can be used to address Recovery Plan Task 1.441, identifying habitat substrates. In this database, the relationship between BCV to habitat substrate can be explored. Substrates that maintain BCV populations overtime can be identified, and this knowledge will help in the selection of sites for possible BCV development. The DEM can be used to find slope, aspect, and topographic position which can be correlated with BCV distribution. The DEM is the closest the GIS comes to true surface representation (Koeln *et al* 1994).

The BCV coverages can be used within the relational database to address Recovery Plan Tasks 1.1, 1.2, 1.21, 1.22, and 1.7. The Recovery Tasks share the same objectives set forth in the PHVA Population Biology and Modeling assessment. Recovery Tasks 1.1 and 1.2 address the need for surveys, additional data, and analysis to refine population sizes, amount of area, configurations between species habitat patches, and levels of reproductive success. Recovery Task 1.21 addresses the need for surviorship and dispersal data for female and juveniles, and Task 1.7 addresses the need for a continuation of banding studies to collect age structure data as an indicator of population health.

The Black-capped Vireo GIS integrates dBASE files containing field notes, banding data, survey totals for male, female, and young by year, and survey totals for the same year by pasture. The dBASE files can be related to attribute tables of the coverage through the relational database. A description of the contents of all attribute and dBASE files can be found in the Data Dictionary (Appendix A) and the dBASE Dictionary (Appendix B). Recovery Task 1.22 addresses the need to record areas where viable populations exist and find potential areas for development. The Black-capped Vireo GIS, through spatial overlay, can show trends and patterns of association. For example, the DEM, contour map, soil maps, and brush cleared vs. uncleared areas (for the closest year to the observation) can be overlayed in ArcView GIS. The wildlife manager can access potential sites for BCV habitat that meet all criteria of the exisiting site. Through examination of soil, topographic, and DEM parameters that meet the criteria, habitat manipulation could create a juniper cleared area that provides appropriate habitat. Prescribed burning is another method that could be used to manage rangeland for BCV habitat.

Fire suppression in the Edwards Plateau Ecoregion of Texas has led to the development of dense stands of Ashe juniper, known locally as cedar. Early studies (Graber 1957), showed that BCVs were found on burned areas. The BCV occupies a successional habitat of shrubland which passes through serial stages of suitable and unsuitable habitat (USFWS 1991). Prescribed burning has been used as a method of creating and maintaining BCV habitat on the KWMA. In O'Neal *et al.* (1996), prescribed burning was studied at the KWMA to determine the effects on BCV habitat. The PHVA Habitat Management Strategies and Recovery Plan Task 1.43, determining habitat management for the BCV, and Task 1.442, successional changes, apply to the value of prescribed burning and wildlife data to the GIS. The objective of this recovery task is to create and maintain existing BCV habitat. Predicting and controlling prescribed burning for wildlife and habitat management with the use of computer technologies signals the changing scene in wildlife management and the advancement of better understanding of our environment.

The cowbird is a brood parasite (Grzybowski 1995). Data are needed on nest predation by cowbirds and other predators (USFWS 1991). The Black-capped Vireo GIS can be used to address Recovery Task 1.3, cowbird threat and the role of cattle. Removing cowbirds from BCV territories is labor intensive (Grzybowski 1991). The KWMA has an extensive monitoring program and maintains detailed dBASE files on cowbird trap activity. The cowbird activity is recorded in relation to rotational livestock grazing programs and white-tailed deer management. The cowbird dBASE tables, coverages (Appendix D), and attribute tables can be used in overlay operations to research these management issues. Plans to add white-tailed deer data and rotational grazing coverages to the database will further enhance the functionality of the Black-capped Vireo GIS.

Overgrazing and extensive browsing remove vegetation at the exact height suitable for BCV nesting (Grzybowski 1995). The Black-capped Vireo GIS can be used to address Recovery Plan Task 1.45 and the PHVA Habitat Management strategies. The recovery plan suggested more research was needed to identify the possible impacts of cattle on BCVs at the beginning of the nesting season (USFWS 1991). Further investigations were suggested on the impact of white-tailed deer and other browsers on BCV habitat. White-tailed deer and BCV use the same resources because BCVs nest in habitat that is good browse habitat for white-tailed deer. Browsers can change the density or vegetational structure of the vegetation BCVs use for nesting.

BCV habitat can be described as a complex mosaic of shrubby vegetation. At the KWMA, BCVs occupy patchy habitat of open grassland with oak mottes dominating nesting choices (Grzybowski 1991, K. G. O'Neal unpublished, J. Nelka unpublished). Breeding BCVs use low, shrubby cover extending to ground level for nesting sites

(Graber 1957). Habitat fragmentation can be monitored with aerial photography and supplemented with ground level assessment of vegetational structure and density. This application of the Black-capped Vireo GIS addresses Recovery Plan Task 1.442, successional change, and the PHVA Habitat Management research needs. One objective was to assemble and evaluate information on histories of occupied sites, assemble and collect data on vegetational changes, and apply remote sensing techniques. The Black-capped Vireo GIS explores all three objectives of this task. Aerial photographs allow subjective assessment of habitat. Aerial photography can show differences between dense juniper stands on the KWMA versus open shrubland habitat interspersed with oak mottes. Aerial photographs can be used to identify areas with dense juniper stands that could be manipulated to create BCV habitat, to monitor successional stage, and to select sites for prescribed burning.

By studying aerial photographs, the wildlife manager can identify areas of relative stability and areas that require monitoring and modification. The delineation of brush cleared and uncleared vegetation polygons as separate coverage in the database allow for overlay with other spatial data such as BCV and cowbird data to discern relationships. Further vegetational analysis is needed to identify components of structural complexity. The integration of aerial photography, remote sensing, and GIS to construct computer models for ecosystem management has far reaching applications for all natural resources.

The Recovery Plan and the PHVA outline the specific needs or criteria to ensure recovery. The Black-capped Vireo GIS Database can be used for exploration of these needs on a small scale with development to encompass a larger area. The database addresses the need to clarify habitat components and develop information directly available to the wildlife manager through its Desktop GIS application. ArcView GIS is increasing in its use in TPWD field offices and research stations.

The Query

A GIS system has the capability to receive input, store and retrieve data, manipulate and analyze the data, and produce output (Aronoff 1989) in the form of tabular reports, maps, and charts. Selective searches, defined by the user, that retrieve data from the database are called queries. Data are extracted from the relational database by a query in which the user defines the relationship between data. The power of the GIS is more than data inventory and monitoring. Its power resides in how we combine, recombine, and evaluate the data to discover new information. The spatial analysis component realizes the potential and capability of the GIS over conventional data collection, storage, retrieval, and analysis techniques.

The five basic questions that a GIS answers were described by Walker and Miller (1990) as: <u>(1) What exists at a particular site or location?</u> The Black-capped Vireo GIS addresses this question by allowing spatial queries to view multiple layers in a given geographic area. Figure 15 displays a View from ArcView GIS with four active themes: the soil coverage, contour lines, and BCV 1985 and 1986 coverages. By zooming in on the view, a particular BCV observation point can be found, and the soil and elevation type identified for the observation site. Information about any of the four themes can be obtained using the Identify Tool. The Identify Results window will show all attributes for the selected feature. By using this spatial query one can identify habitat substrate for the BCV. The wildlife manager can use this capability to describe the habitat and obtain habitat parameters through visual interpretation of the map and tabular display of data tables for verification.

<u>(2) Where are certain conditions met?</u> A tabular query can utilize tabular data sets from dBASE and attribute files to perform a query, and display the results of the query in a tabular and/or spatial form. Figure 16 illustrates the use of a tabular query to identify spatial features in the view. In the relational database, unique identifiers identify records

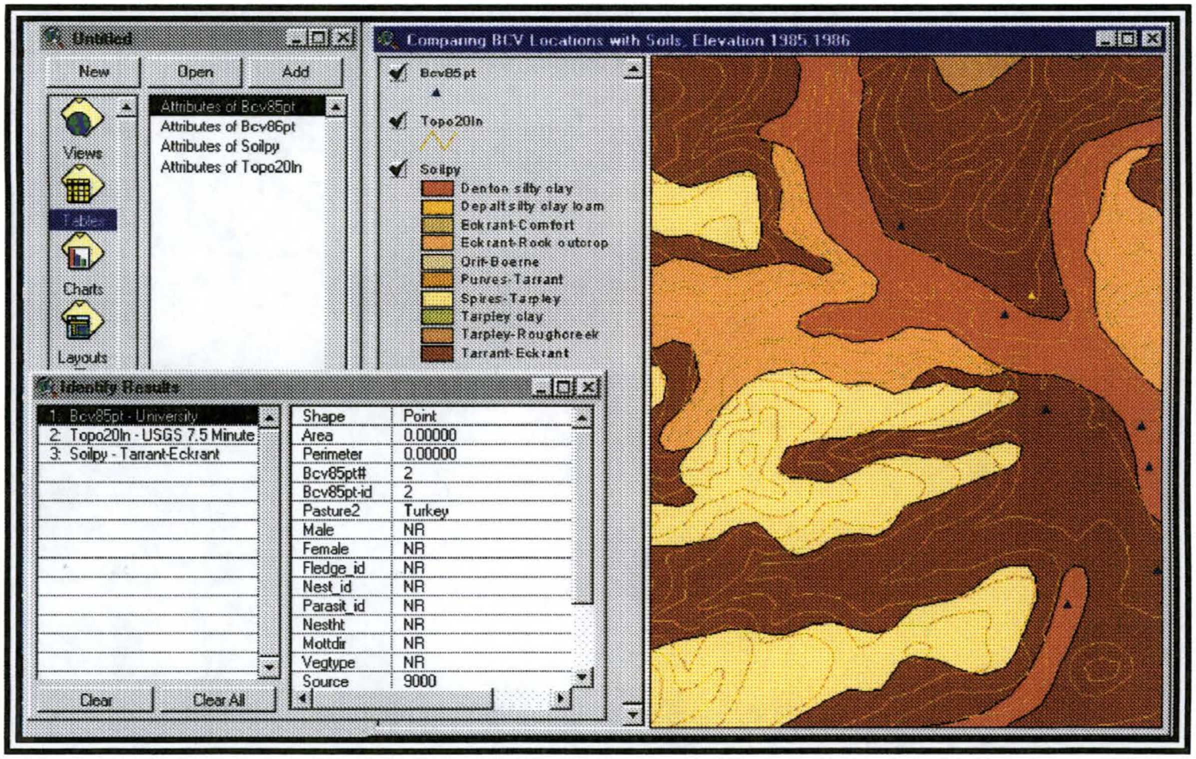

Figure 15. Screen capture displays a view from ArcView GIS with four active themes: the soil, topography, and Black-capped Vireo survey information from 1985 and 1986 at the Kerr Wildlife Management Area. By zooming in on the view, a particular Black-capped Vireo observation point, represented by a triangle, can be found and the soil and elevation types identified for the observation site. The Identify Results Window displays information about the selected point (field data), shown as a yellow triangle in the upper right quadrant of the view. The Identify Results Window can display elevation and soil type information by double-clicking in the window.

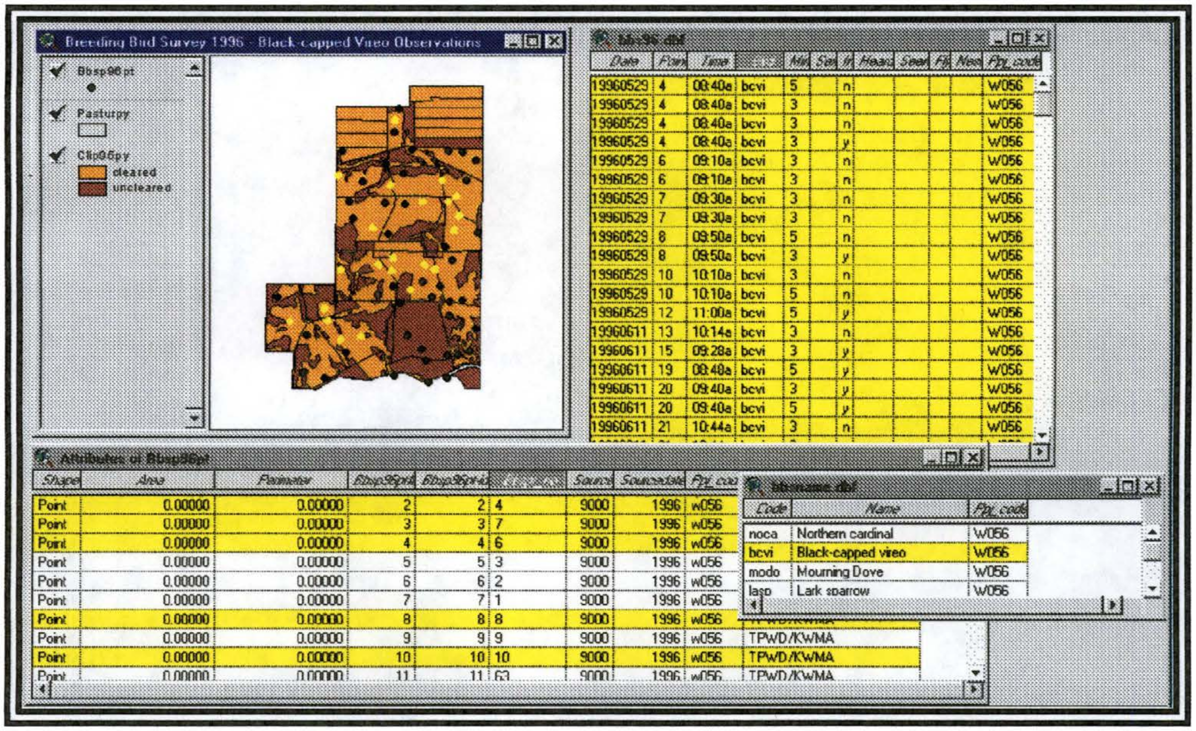

Figure 16. Screen capture illustrates the use of a tabular data linkage based on a common field. Using the dBASE to attribute file link, the Black-capped Vireo observations are selected out of both tables and are displayed spatially on the map. The DEM, soils, topographic map, and vegetational data of brush cleared vs uncleared areas can be displayed as background coverage.

in each file (Burrough 1986), allowing linkage between data tables. This query asks where particular situations and conditions occur on a given site. Figure 16 illustrates the use of a tabular data linkage based on a common field. The Breeding Bird Survey coverage has information for all bird species identified on the KWMA during a survey in 1996.

First, the BCV observations were extracted from the dBASE file by identifying the code name used in survey data, contained in BBSNAME.DBF. Using the common field of observation point, the attribute table and dBASE file BBS96. DBF were linked in a many to one relationship. Once the tables are linked, selecting a record in one table will highlight all similiar records in the other table. The query "BIRD = BCVI" was formulated in the query window. This operation selected only BCV observations for the survey. The brush cleared vs. uncleared coverage for 1996 served as the background cover for the pasture map and BCV observation data. Over time, observations can be monitored for the BCV and all bird species on the KWMA. The survey data can be overlayed with the soils, topographic map, DEM, and vegetational data for comparison with comprehensive yearly surveys for examining trends.

<u>(3) What changes have occurred over time and where have these changes occurred?</u> Aerial photography and the vector coverages of brush cleared and uncleared areas can be used to answer this question. For example, the wildlife manager can monitor fire scars and changing successional stages. Figure 17 illustrates the use of the digital orthophoto color infrared aerial photography in a spatial query. The View has been zoomed in to identify a particular pasture area. The BCV observations for 1996 are overlayed, showing the relationship between vegetation and BCV habitat use. The Identify Results window was used to select a single observation point and to display information about the point. In this example, the window shows that at this observation point, 83-96, an unbanded BCV male, cap class 5, was identified. Two nesting attempts were found, one producing a BCV egg, and the other producing four BCV fledglings. The

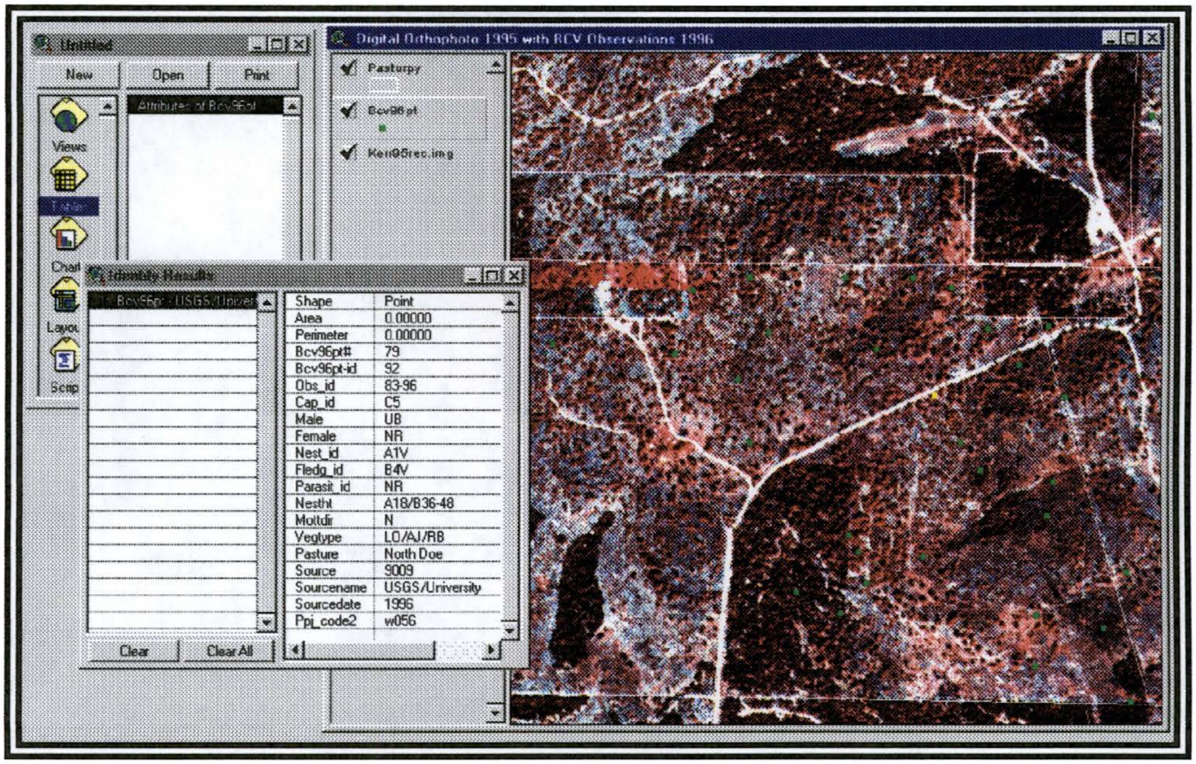

Figure 17. Screen capture illustrates the use of the digital orthophoto color infrared aerial photograph in a spatial query. The view has been zoomed in to identify a specific pasture at the Kerr Wildlife Management Area. The Black-capped Vireo observations for 1996 are overlayed, represented by green points, showing the relationship between vegetation and habitat use. The Identify Results Window displays information about the point highlighted in yellow.

nest heights and vegetation types are also identified. Interpretation of the tabular data and codes can be found in the Data Dictionary (Appendix A).

(4)What are the social, economic, or environmental impacts on a particular change in the use of the land? The Black-capped Vireo GIS can be used to ascertain the benefits of land use management techniques to wildlife populations. The database can be used to monitor existing management practices, such as prescribed burning, livestock rotational grazing systems, deer browsing, and cowbird trapping. Figure 18 compares BCV locations for 1985 and 1986 with prescribed burn activity for 1983, and prescribed burn and wildfire activity for 1984. A join was used to merge the BURN.DBF file with the attribute table for each coverage based on a unique pasture number for each burn. The dBASE file contains information about size, intensity, and other burn parameters. The effects of prescribed burns on population size can be monitored through spatial overlay and tabular analysis.

(5) What will happen if the existing land use for a particular site is altered to another type of use? This GIS capability allows for the long term analysis of management practices by determining the impact of management decisions on particular areas of the KWMA. Overtime, land-use practices can be monitored in relation to the BCV population. The Black-capped Vireo GIS can be used to create charts and graphs from tabular data. Figure 19 illustrates how charts can be created from tabular data tables. BCV population totals for the KWMA, contained in the dBASE file TTLBCV.DBF, were used to create a chart for total young produced per year and a chart for total BCV production on the KWMA per year.

The value of any query is only as good as the value of initial input data. The coverages (Appendix D) and attribute table definitions (Appendix A), images (Appendix D), and dBASE file contents (Appendix B) have been attached as appendices to enable the reader to examine the database on paper and formulate their own queries that could

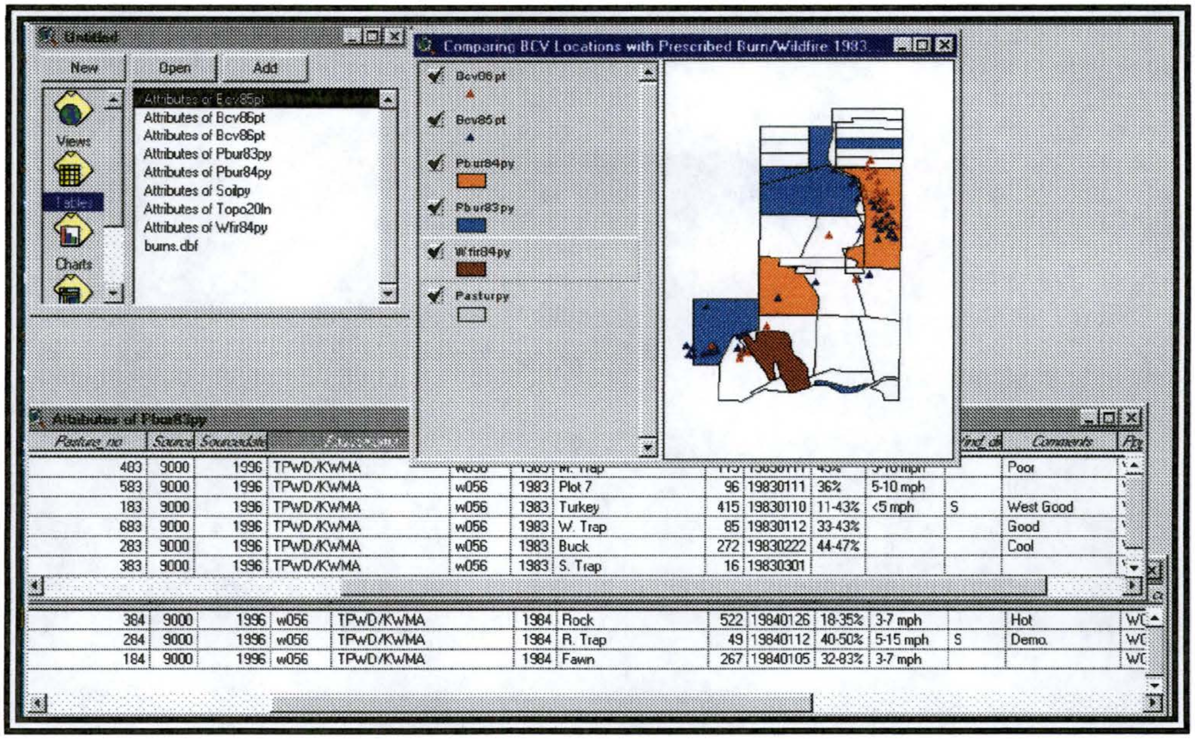

Figure 18. Screen capture shows a comparison of Black-capped Vireo locations for 1985 and 1986 with prescribed burning activity for 1983, and prescribed burning and wildfire activity for 1984. A join was used to merge the dBASE and attribute file for each coverage based on a unique pasture number assigned to each burn.

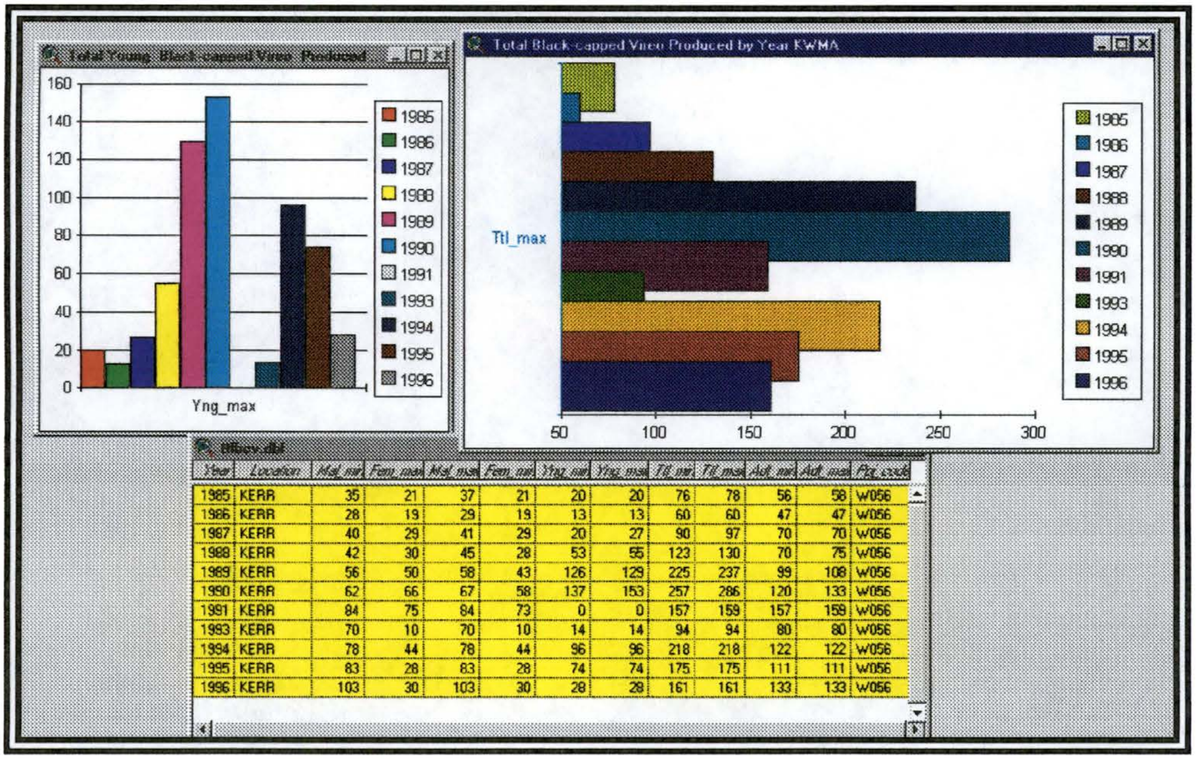

Figure 19. Screen capture illustrates the creation of charts and graphs from tabular data tables. Black-capped Vireo population totals for the Kerr Wildlife Management Area, contained in the dBASE file TTLBCV.DBF were used to create a chart for total young produced per year and a chart for total Black-capped Vireo production on the Kerr Wildlife Management Area per year.

be applied to the spatial database. There is a need for more detailed data collection for the attribute tables, allowing for further tabular queries to be performed. The Black-capped Vireo GIS serves initially as an inventory tool, but must evolve to an spatial and tabular query tool and ultimately to a wildlife management tool, forming a toolbox of quantitative knowledge.

Database Expansion - A Framework for Conservation

The GIS can act as a catalyst by putting complex information into simpler form for interpretation and integration of multiple sources. The GIS makes connections by relating spatial information to reveal new information not previously apparent or realized. Therefore, the more BCV data that can be integrated into the database, the more complete and refined queries can be conducted on the spatial and tabular database. While data may have existed on paper, the value of the GIS data exists in the centralized organization and access of data integrated together. Data can be readily analyzed or accessed for presenting status reports, preparing maps, and charts. The collection of information and the assemblage into common access complete with sources and descriptive information about the data avoid redundancy. The Black-capped Vireo GIS data can be updated, queried, manipulated, and extracted from the database for report generation. GIS has the ability to produce new information and insights from existing data.

Because the BCV breeding range is limited to northern Mexico to Oklahoma (USFWS 1996), the potential exists for including all BCV data from its distribution in a GIS for the breeding range of the BCV that enables monitoring of all areas. Between 1970-1989, BCVs were recorded in 40 counties across Texas (USFWS 1991). Between 1985-1990 BCVs were recorded in 3 regions of Oklahoma and six regions in Texas (USFWS 1991). There is great potential for synthesis of all existing data into a comprehensive database for the species. On a smaller scale, TPWD has the potential to be a leader in developing such a database as a model for endangered species management. The lack of detailed data emphasizes the importance of monitoring all habitat factors because, if a sudden decline should occur, the wildlife manager will need a multiplicity of data to access the specific cause. The Black-capped Vireo GIS database presents one small step towards better management and conservation of the BCV.

Guidelines set forth in the Data Dictionary (Appendix A) and dBASE Dictionary (Appendix B) provide the basis to get started, with a great potential for adding more and more specific data to refine the analysis. For example, Grzybowski (1991) stressed the importance of low deciduous cover to BCV habitat and listed three additional characteristic of importance: density of vegetation; presence of cedar; openness (35-55% woody cover allowing deciduous cover to be maximized in lower height zones). Other characteristics are important for the comprehensive management of BCVs. Nest sites are placed in the forks of bushes. It is important to note what bush is selected, its health, and vegetative structure. The characteristics listed above could be incorporated into the spatial database if linked with a specific spatial entity, such as a BCV observation point, and could be added to the attribute table.

The GIS capabilities would provide further analysis and query ability to the wildlife manager if more detailed habitat records and biology of the BCV were available and related spatially by GPS to a particular location. The emphasis has been on population monitoring and detailed notes are not available for specific locations (territory centroids or observations) over time. Further banding studies are needed so dispersal and survival can be monitored spatially in the GIS. There is a need for better compilation of final field results and consistency in data collection by field personnel from year to year. Even when the same person collects data, different methods are used from month to month, or year to year (day to day?). Room for improvement exists in methods of data collection, data standardization, metadata, access, and data sharing. Field staff training is needed to teach GPS receiver use and GIS concepts for use in Desktop GIS applications such as ArcView GIS 3.0.

The Recovery Plan calls for monitoring across the range of the species to determine success of conservation actions or status of BCV populations. Techniques for standardization of data collected at all BCV monitoring sites need to be developed and implemented so results can be compared. Better descriptive data is needed to build attribute tables. Field notes for BCV studies at the KWMA studies 1985-1991, were not available to build descriptive attribute tables of territories. Though dBASE files exist at the KWMA, the field identification number assigned in the study and all of the associated data, such as banding information, could not be built into an attribute table and linked with spatial data because the map territories were not recorded. The original author was contacted to provide the field identification numbers, but chose to retain numbers and data due to unpublished nature. The contribution to the database of this field data is welcomed at anytime.

Data Standardization

Metadata

Metadata can address issues in secondary data acquisition. For example, metadata can answer questions about age, accuracy, scale, resolution, pedigree, and definition and categorization of data (FGDC 1995). Metadata can evaluate the quality of data and reduce redundancy and duplication. Metadata are data layer documentation which can assist users of multiple data sets in determining the quality and limitations of the data (Morain 1996). The major uses of metadata are organization and maintenance of investment in data, facilitation of data sharing with other organizations, data layer documentation through the production of digital files that aid in data transfer by accompanying and interpreting the data (FGDC 1995). The best time to collect metadata is when data are being collected and developed to avoid loss of/or incomplete information in the future

(FGDC 1995). Metadata records the lineage of data. The history of modification and use that defines the data or jeopardizes its uses is recorded in the metadata. The metadata format used for the Black-capped Vireo GIS was the DOCUMENT AML software from ESRI (available through ARC/INFO). A sample of the data recorded in the metadata file is presented in Appendix C.

Developing and Maintaining Data Standards

Developing standards for sharing information, maintaining standards developed in entities such as the Data Dictionary and dBASE Dictionary, and identifying accuracy through recording source data error and data capture errors allows the database user to determine whether the data meets an acceptable level of accuracy for the geographic project. The goal of data standardization is better and more accurate data. For example, GPS of BCV observations as opposed to territories approximated on the top of existing maps provide better and more accurate data. The paper maps are practical for field identification, but for the creation of a digital layer, a GPS provides accuracy (within limits and subject to the object being recorded).

The Data Dictionary ensures that data are interpreted properly by all users. The Data Dictionary defines essential database architecture and focuses early on data standards, for example, defining links and joins between tabular data attributes early (How will files relate in the RDMS?). The GIS is driven by data, therefore it is only as good as the input data. Eichelberger (1993) discussed the pursuit of data independence. Data independence means that data are not "owned" by a particular application, providing files can be related to other files for analysis but retain their integrity, and can therefore, be used by many databases for different purposes and analyses.

A concern to consider in developing a GIS database is positional accuracy. Positional accuracy describes how well a coordinate in the coverage corresponds to actual units on the ground. In this study, digitization from wrinkled maps produced errors in positional accuracy. In addition, the "eyeballing" of territory centroid locations or observations on a topographic map increases the error. The potential for perpetuated errors from observation to database to final analysis to management decision show the importance of accurate data input. Inherent in all databases is the cumulative nature of errors (Koeln *et al.* 1994). Data quality impacts decisions, therefore a lack of data quality decreases the analysis benefits.

On a national level, the National Spatial Data Infrastructure (NSDI) provides a standard for collection, management, distribution, and use of spatial data. The NSDI was developed by the Federal Geographic Data Committee (FGDC) as a digital spatial information resource responsible for facilitating exchange of information and data transfer, establishing an implementing standards for quality content and transferability, and coordinating the collection of spatial data to minimize duplication of effort (Hogan and Perreca 1996). FGDC involves academic, private, and governmental bodies in standards development. Data sharing facilitation can be used to create a statewide/rangewide database for the BCV provided standardization, codes, and definitions are in place. The Black-capped Vireo GIS provides an initial framework for such an application.

Integration of GIS in Wildlife Management

The wildlife manager can use GIS technology for improving decision-making capabilities that directly affect wildlife management decisions and can use GIS to participate in land-use planning (Koeln *et al.* 1994). A misplaced or poorly researched land-use decision could reverse all the efforts (wildlife habitat enhancements) of the wildlife manager. Therefore, it is critical that biologists learn to use this technology and participate in land-use planning actions, that may effect wildlife habitat, at the city, state, and federal level. For example, a wildlife manager could participate in reviewing an action that would result in habitat destruction of an endangered or threatened species by a commercial development.

The KWMA is a model of endangered species and range management practices working together. In preparing to manage land and wildlife resources for the approaching 21st Century, the wildlife manager must use the advanced technology available. Working together to communicate goals and monitor decision-making at all levels will aid in the conservation of natural resources. The GIS is a way to bridge the gap between disciplines and enhance analysis and decision-making capabilities.

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APPENDIX A

DATA DICTIONARY
KERR WILDLIFE MANAGEMENT AREA
BLACK-CAPPED VIREO (*Vireo atricapillus*) PROJECT

DATA DICTIONARY
KERR WILDLIFE MANAGEMENT AREA
BLACK-CAPPED VIREO (*Vireo atricapillus*) PROJECT

Item Definitions

Each line and polygon attribute file has a specified format for each item in the data file. ARC/INFO defines the following items automatically (ESRI 1990):

COLUMN 1

Item Name - any name with up to 16 alphanumeric characters

COLUMN 2

Item Width - number of spaces (or bytes) used to store item values

COLUMN 3

Output Width - number of spaces used to display the item values

COLUMN 4

Item Type - the data type of the item

Data Types Defined: (REFERENCE)

B - whole numbers stored as binary integers (width of 2 or 4 bytes only). The maximum value for width of 2 is 32,767; for width of 4 is 2,147,483,647.

C - character (width up to 320 alphanumeric characters)

F - decimal numbers stored in internal floating-point representation (width of 4 or 8 bytes only). A 4-byte width is single precision real (7 digits of precision), and 8 bytes is double precision (14 digits of precision).

I - integer stored as 1 byte per digit (width from 1 to 16, maximum value possible is 2,147,483,647).

N - decimal numbers stored as 1 byte per digit (width from 1 to 16).

COLUMN 5

Number of Decimals - the number of digits to the right of the decimal place for item types which hold decimal numbers

Attributes Common to all ARC/INFO Coverages

The following attributes are assigned by ARC/INFO and are common to all coverages of the specified feature type in the Data Dictionary, therefore they are assumed to be present on each coverage. To avoid repetition, the following items do not appear for each coverage.

DATABASE ATTRIBUTE FORMAT - LINE FEATURES (AAT FILE)

FNODE#		4	5	B	created by ARC/INFO
TNODE#	4	5	B		created by ARC/INFO
LPOLY#	4	5	B		created by ARC/INFO
RPOLY#	4	5	B		created by ARC/INFO
LENGTH	4	12	F	3	created by ARC/INFO
COVER_NAME#	4	5	B		created by ARC/INFO
COVER_NAME_ID	4	5	B		created by ARC/INFO

DATABASE ATTRIBUTE FORMAT - POLYGON FEATURES (PAT FILE)

AREA	4	12	F	3	created by ARC/INFO
PERIMETER	4	12	F	3	created by ARC/INFO
COVER_NAME#	4	5	B		created by ARC/INFO
COVER_NAME_ID	4	5	B		created by ARC/INFO

BBSP##PT

Park Name Kerr Wildlife Management Area **Coverage Name** **BBSP##PT**

Coverage Contents **BREEDING BIRD SURVEY POINTS BY YEAR**

Coverage point

Mapscale

inch to inch:	1:12,000	1:24,000	1:100,000	1:250,000	
inch to feet:	1:50	1:100	1:200	1:250	1:500
	1:1000				

Coverage History and Mapping Procedure

(To be completed by field staff when updating coverage; current history available in metadata file)

DATABASE ATTRIBUTE FORMAT - POINT FEATURES (PAT FILE)

PPJ_CODE	4	4	C	ppj code of facility using capital letter (P151)
SOURCE	5	5	I	graphic data source
SOURCENAME	50	50	C	name of source: collector's name or map source name
SOURCEDATE	8	8	I	yyyymmdd; date of source as listed above
BBSPT_NO	10	10	C	xx-yyy xx = field point number, yyy= year

Attribute Choices - Point Features

BBSPT_NO · identifies a unique field point number - point number-year

Related or Associated Tables (see dBASE dictionary for file and field descriptions)

BBS96.DBF
BBSNAME.DBF
BBSLOCAT.DBF
BBSCON.DBF

Bibliography

last modified: 5/25/97

Park Name Kerr Wildlife Management Area **Coverage Name** **BCV##PT**

Coverage Contents **BLACK-CAPPED VIREO OBSERVATION POINTS BY YEAR**

Coverage Type point

Mapscale

inch to inch:	1:12,000	1:24,000	1:100,000	1:250,000		
inch to feet:	1:50	1:100	1:200	1:250	1:500	1:1000

Coverage History and Mapping Procedure

(To be completed by field staff when updating coverage; current history available in metadata file)

DATABASE ATTRIBUTE FORMAT - POINT FEATURES (PAT FILE)

PPJ_CODE	4	4	C	ppj code of facility using capital letter (P151)
SOURCE	5	5	I	graphic data source
SOURCENAME	50	50	C	name of source: collector's name or map source name
SOURCEDATE	8	8	I	yyyymmdd
PASTURE	16	16	C	
OBS_ID	10	10	C	
CAP_ID	8	8	C	
MALE	10	10	C	
FEMALE	10	10	C	
FLEDGE_ID	10	10	C	
NEST_ID	10	10	C	
PARASIT_ID	10	10	C	
NESTHT	10	10	C	
MOTTDIR	3	3	C	
VEGTYPE	16	16	C	

Attribute Choices - Point Features

PPJ-CODE: ppj code of park using a capital letter

SOURCE: source of the line or point, use number from source list

SOURCENAME: name of source

SOURCEDATE: date of source

PASTURE: name of pasture
NR = NO RECORD (no information recorded by field worker)

OBS_ID: a unique character string assigned to identify observation
NR = NO RECORD (no information recorded by field worker)
C_YR = unique string - year of observation

CAP_ID: identifies cap class used in determing age of bird
NR = NO RECORD (no information recorded by field worker)
C1

C2
C3
C4
C5
C1_or_C2
C2_or_C3
C3_or_C4
C4_or_C5

MALE: identifies sex of bird and notes banding information

NR = NO RECORD (no information recorded by field worker)
UB = UNBANDED MALE
-/- = LEFT LEG/RIGHT LEG; WHERE NO CODE IS REPRESENTED ON ONE SIDE OF THE SLASH THEN A BAND IS NOT PRESENT ON INDICATED LEG

S = SILVER
B = BLUE
Bk = BLACK
Y = YELLOW
R = RED
G = GREEN
O = ORANGE
W = WHITE

FEMALE: identifies sex of bird and notes banding information

NR = NO RECORD (no information recorded by field worker)
UB = UNBANDED FEMALE
-/- = LEFT LEG/RIGHT LEG; WHERE NO CODE IS REPRESENTED ON ONE SIDE OF THE SLASH THEN A BAND IS NOT PRESENT ON INDICATED LEG

S = SILVER
B = BLUE
Bk = BLACK
Y = YELLOW
R = RED
G = GREEN
O = ORANGE
W = WHITE

FLEDGE_ID: identifies sex of bird and notes banding information (A,B,C....after entry for more than one nest)

NR = NO RECORD (no information recorded by field worker)
UB = UNBANDED FLEDGE
-/- = LEFT LEG/RIGHT LEG; WHERE NO CODE IS REPRESENTED ON ONE SIDE OF THE SLASH THEN A BAND IS NOT PRESENT ON INDICATED LEG

S = SILVER
B = BLUE
Bk = BLACK
Y = YELLOW
R = RED
G = GREEN
O = ORANGE
W = WHITE

NEST_ID: identifies number of Black-capped Vireo (*Vireo atricapillus*) eggs present in nest (A,B,C....after entry for more than one nest)

NR = NO RECORD (no information recorded by field worker)

COMPLETED (NO EGGS RECORDED)
ABANDONED
#V = # OF BLACK-CAPPED VIREO EGGS
1V
2V
3V
4V
5V

PARASIT_ID: identifies number of cowbird (*Molothrus aster)* eggs present in nest (A,B,C….after entry for more than one nest)

NR = NO RECORD (no information recorded by field worker)
NEST DESTROYED (NO EGGS RECORDED)
#C = # OF COWBIRD EGGS
1C
2C
3C
4C
5C

NESTHT: height of nest off the ground in inches

NR = NO RECORD (no information recorded by field worker)

MOTTDIR: direction which nest was built in motte

NR = NO RECORD (no information recorded by field worker)
N = NORTH
NE = NORTHEAST
NW = NORTHWEST
S = SOUTH
SE = SOUTHEAST
SW = SOUTHWEST
E = EAST
W = WEST

VEGTYPE: vegetation recorded (common name) from field notes

NR = NO RECORD (no information recorded by field worker)
LO = Live Oak
SO = Shin Oak
NH = Netleaf Hackberry
RO = Red Oak
RB = Redbud
AG = Agarita
BW = Black Walnut
AJ = Ashe Juniper
FS = Flameleaf Sumac
TO = Texas Oak
MP = Mexican Persimmon
MT = Mountain Laurel

Related or Associated Tables (see dBASE dictionary for file and field descriptions)

BANDTTL.DBF
TTLBCV.DBF
FLDNOTES.DBF
BCVTLPAS.DBF

Bibliography

last modified: 5/25/97

Park Name Kerr Wildlife Management Area **Coverage Name** CLRD##PY

Contents Name CLEARED VS. UNCLEARED AREAS BY YEAR

Coverage Type polygon

Mapscale

inch to inch:	1:12,000	1:24,000	1:100,000	1:250,000	
inch to feet:	1:50	1:100	1:200	1:250	1:500
	1:1000				

Coverage History and Mapping Procedure

(To be completed by field staff when updating coverage; current history available in metadata file)

DATABASE ATTRIBUTE FORMAT - POLYGON FEATURES (PAT FILE)

PPJ_CODE	4	4	C	ppj code of facility using capital letter (P151)
SOURCE	5	5	I	graphic data source
SOURCENAME	50	50	C	name of source: collector's name or map source name
SOURCEDATE	8	8	I	yyyymmdd
CATEGORY	16	16	C	
METHOD	16	16	C	

Attribute Choices - Polygon Features

CATEGORY:
CLEARED
UNCLEARED

METHOD:
(METHOD OF LAND CLEARING)
UNKNOWN
WILDFIRE
PRESCRIBED BURNING
BULLDOZING
SHREDDING
ROLLER-CHOPPING
ROOT PLOWING
CHAINING
MOWING
HERBICIDE
GRAZING
HAND CUTTING

Related or Associated Tables (see dBASE dictionary for file and field descriptions)

Bibliography
last modified: 5/25/97

PASTURPY

Park Name Kerr Wildlife Management Area　　　**Coverage Name** **PASTURPY**

Coverage Contents **PASTURES**

Coverage Type polygon

Mapscale

inch to inch:	1:12,000	1:24,000	1:100,000	1:250,000	
inch to feet:	1:50	1:100	1:200	1:250	1:500
	1:1000				

Coverage History and Mapping Procedure

(To be completed by field staff when updating coverage; current history available in metadata file)

DATABASE ATTRIBUTE FORMAT - LINE FEATURES (AAT FILE)

PPJ_CODE	4	4	C	ppj code of facility using capital letter (P151)
SOURCE	5	5	I	graphic data source
SOURCENAME	50	50	C	name of source: collector's name or map source name
SOURCEDATE	8	8	I	yyyymmdd
CATEGORY	16	16	C	

DATABASE ATTRIBUTE FORMAT - POLYGON FEATURES (PAT FILE)

PPJ_CODE	4	4	C	ppj code of facility using capital letter (P151)
SOURCE	5	5	I	graphic data source
SOURCENAME	50	50	C	name of source: collector's name or map source name
SOURCEDATE	8	8	I	yyyymmdd; date of source listed above
CATEGORY	16	16	C	
ACRES	5	5	I	
NAME_LOCAL 30	30	C		
ACRES_OF_VIS 10	10	I		
ABBREV_NAME	16	16	C	
ACRES/DEER	10	10	C	
ALT_NAME	16	16	C	

Attribute Choices - Line Features
(none)

Attribute Choices - Polygon Features

ACRES: acreage of individual pasture

NAME_LOCAL: pasture name used locally

ACRES_OF_VIS: acres of visibility (used in deer survey)

ABBREV_NAME: abbreviated pasture name

ACRES/DEER: acres in pasture available per deer

ALT_NAME: alternative pasture name (used to reflect changes in pasture name past to present)

Related or Associated Tables (see dBASE dictionary for file and field descriptions)

Bibliography

last modified: 4/22/97

Park Name Kerr Wildlife Management Area **Coverage Name** **PBUR##PY**

Coverage Contents **PRESCRIBED BURNING BY YEAR**

Coverage Type polygon

Mapscale

inch to inch:	1:12,000	1:24,000	1:100,000	1:250,000	
inch to feet:	1:50	1:100	1:200	1:250	1:500
	1:1000				

Coverage History and Mapping Procedure

(To be completed by field staff when updating coverage; current history available in metadata file)

DATABASE ATTRIBUTE FORMAT - POLYGON FEATURES (PAT FILE)

PPJ_CODE	4	4	C	ppj code of facility using capital letter (P151)
SOURCE	5	5	I	graphic data source
SOURCENAME	50	50	C	name of source· collector's name or map source name
SOURCEDATE	8	8	I	yyyymmdd; date of source listed above
PASTURE_NO	10	10	I	xx-yyyy xx = pasture number, yyyy = year

Attribute Choices - Polygon Features

PASTURE_NO: unique number assigned to burn and the year

Related or Associated Tables (see dBASE dictionary for file and field descriptions)

BURN.DBF

Bibliography

last modified: 5/25/97

PC####PT

Park Name Kerr Wildlife Management Area **Coverage Name** **PC####PT**

Coverage Contents **PERMANENT COWBIRD TRAPPING LOCATION START YEAR TO END YEAR**

Coverage Type point

Mapscale

inch to inch:	1:12,000	1:24,000	1:100,000	1:250,000	
inch to feet:	1:50	1:100	1:200	1:250	1:500
	1:1000				

Coverage History and Mapping Procedure

(To be completed by field staff when updating coverage; current history available in metadata file)

DATABASE ATTRIBUTE FORMAT - POINT FEATURES (PAT FILE)

PPJ_CODE	4	4	C	ppj code of facility using capital letter (P151)
SOURCE	5	5	I	graphic data source
SOURCENAME	50	50	C	name of source: collector's name or map source name
SOURCEDATE	8	8	I	yyyymmdd; date of source listed above
TRAP_NO	5	5	I	

Attribute Choices - Point Features

TRAP_NO: identifies permanent cowbird trap

Related or Associated Tables (see dBASE dictionary for file and field descriptions)

CB8591.DBF
CB9296.DBF
COWBDSUM.DBF
CBDETAIL.DBF

Bibliography

last modified: 5/25/97

ROADLN

Park Name Kerr Wildlife Management Area **Coverage Name** ROADLN

Coverage Contents **ROADS USED BY CARS AND TRUCKS; ALSO INCLUDES A CENTER LINE FOR SOME ROADS CONTAINED IN THE ROADPY COVERAGE**

Coverage Type polygon

Mapscale

inch to inch:	1:12,000	1:24,000	1:100,000	1:250,000	
inch to feet:	1:50	1:100	1:200	1:250	1:500
	1:1000				

Coverage History and Mapping Procedure

(To be completed by field staff when updating coverage; current history available in metadata file)

DATABASE ATTRIBUTE FORMAT - LINE FEATURES (AAT FILE)

PPJ_CODE	4	4	C	ppj code of facility using capital letter (P151)
SOURCE	5	5	I	graphic data source
SOURCENAME	50	50	C	name of source: collector's name or map source name
SOURCEDATE	8	8	I	yyyymmdd; date of source listed above
CATEGORY	30	30	C	
PROPERTY#	10	10	I	
NAME_LOCAL 50	50	C		
WIDTH_CLASS 10	10	C		
MATERIAL	30	30	C	
SURFACE	8	8	C	
OWN_MAINT	10	10	C	
CON_NAME	25	25	C	
CON_PHONE#	12	12	C	

Attribute Choices - Line Features

CATEGORY:
PAVED ROAD
UNPAVED ROAD
PARKING LOT
NOT ROAD - i.e. land within polygons
BRIDGE
CATTLE GUARD

PROPERTY#: property number assigned by TPWD property division

NAME_LOCAL: road name

WIDTH_CLASS:
20 FEET
18 FEET
12 FEET
OTHER

MATERIAL:
CALICHE
HMAC
2 COURSE SURFACE TREATMENT

OIL SAND
GRAVEL
DIRT
CONCRETE

SURFACE: SURFACED
IMPROVED
UNIMPROVED

OWN_MAINT: owner responsible for maintenance
FEDERAL
STATE
COUNTY
CITY
TPWD
PRIVATE

CON_NAME: contact name for maintenance

CON_PHONE#: contact phone number in format xxx-xxx-xxxx

Related or Associated Tables (see dBASE dictionary for file and field descriptions)

Bibliography

last modified: 5/25/97

Park Name Kerr Wildlife Management Area **Coverage Name** SOILPY

Coverage Contents SOIL POLYGONS FROM SCS COUNTY SOIL MAP

Coverage Type polygon

Mapscale

inch to inch:	1:12,000	1:24,000	1:100,000	1:250,000	
inch to feet:	1:50	1:100	1:200	1:250	1:500
	1:1000				

Coverage History and Mapping Procedure

(To be completed by field staff when updating coverage; current history available in metadata file)

DATABASE ATTRIBUTE FORMAT - POLYGON FEATURES (PAT FILE)

PPJ_CODE	4	4	C	ppj code of facility using capital letter (P151)
SOURCE	5	5	I	graphic data source
SOURCENAME	50	50	C	name of source: collector's name or map source name
SOURCEDATE	8	8	I	yyyymmdd; date of source listed above
SOIL_SYM	5	5	C	from SCS book
SOIL_NAME	80	80	C	from SCS book
SLOPE_CAT	2	2	C	from SOIL_SYMBOL
SLOPE_PC	30	30	C	
FLOOD_FRE	15	15	C	
EROSION_T	10	10	C	

Attribute Choices - Polygon Features

SOIL_SYM: soil symbol as listed on soil polygon in SCS county book

SOIL_NAME: soil name (to match soil symbol) as listed in SCS county book

SLOPE_CAT: slope category from the SOIL SYMBOL (A, B, C, D, E, etc.)

SLOPE_PC: slope percent - words explaining the slope category, i. e. if slope - category is B, then put '0-4 percent slopes'

FLOOD_FRE: flood frequency (from SCS book)
- frequent
- occasional
- none
- unknown

EROSION_T: (from SCS book) for every soil type

Related or Associated Tables (see dBASE dictionary for file and field descriptions)

Bibliography

last modified: 5/25/97

Park Name Kerr Wildlife Management Area **Coverage Name** TOPO##LN

Coverage Contents CONTOUR LINES

Coverage Type line

Mapscale

inch to inch:	1:12,000	1:24,000	1:100,000	1:250,000	
inch to feet:	1:50	1:100	1:200	1:250	1:500
	1:1000				

Coverage History and Mapping Procedure

(To be completed by field staff when updating coverage; current history available in metadata file)

DATA BASE ATTRIBUTE FORMAT - LINE FEATURES (AAT FILE)

PPJ_CODE	4	4	C		ppj code of facility using a capital letter (P151)
SOURCE	5	5	I		source of the line or point; see vector source list
SOURCENAME	50	50	C		name of source: collector's name or map source name
SOURCEDATE	8	8	I		yyyymmdd; date of source listed above
CATEGORY	30	30	C		
ELEV_FEET	9	9	N	3	elevation in feet

Attribute Choices - Line Features

CATEGORY: index

Related or Associated Tables (see dBASE dictionary for file and field descriptions)

Bibliography

last modified: 5/25/97

WATERPY

Park Name Kerr Wildlife Management **Coverage Name** WATERPY

Coverage Contents **LAKES, PONDS, TANKS, WIDE RIVERS; ALL HYDROLOGY FEATURES THAT ARE POLYGONS**

Coverage Type polygon

Mapscale

inch to inch:	1:12,000	1:24,000	1:100,000	1:250,000	
inch to feet:	1:50	1:100	1:200	1:250	1:500
	1:1000				

Coverage History and Mapping Procedure

(To be completed by field staff when updating coverage; current history available in metadata file)

DATABASE ATTRIBUTE FORMAT - LINE FEATURES (AAT FILE)

PPJ_CODE	4	4	C	ppj code of facility using capital letter (P151)
SOURCE	5	5	I	graphic data source
SOURCENAME	50	50	C	name of source: collector's name or map source name
SOURCEDATE	8	8	I	yyyymmdd

DATABASE ATTRIBUTE FORMAT - POLYGON FEATURES (PAT FILE)

PPJ_CODE		4	4	C		ppj code of facility using capital letter (P151)
SOURCE		5	5	I		graphic data source
SOURCENAME		50	50	C		name of source: collector's name or map source name
SOURCEDATE	8	8	I			yyyymmdd; date of source listed above
CATEGORY		16	16	C		
NAME_LOCAL	50	50	C			
ELEV_LOW		10	10	N	1	
ELEV_HIGH		10	10	N	1	
DEPTH_AVE		10	10	N	1	
DEPTH_MAX		10	10	N	1	
USES		65	65	C		
RESTRICT		65	65	C		
HAZARDS		30	30	C		
DATE_BUILT		8	8	I		
MATERIAL		30	30	C		
CONDITION		30	30	C		
HEIGHT		10	10	N	2	
WIDTH	10	10	N	2		
LENGTH		10	10	N	2	
CIRCUM		10	10	N	2	
COST		10	10	N	2	
TEXT1		80	80	C		

Attribute Choices - Polygon Features

CATEGORY: RESERVOIR - DAMNED RESERVOIR, FROM STOCK POND TO LAKE
TANK - WATER STORAGE CONTAINER HAVING A HARD SURFACE AROUND IT - STOCK TANK, METAL WATER TANK, ETC.
RIVER - BORDERS OF WIDE RIVER

NOT WATER - ISLANDS, LAND POLYGONS WITHIN WATER

NAME_LOCAL: capitalize first letter in all words; local name

ELEV_LOW: low elevation

ELEV_HIGH: high elevation

DEPTH_AVE: average depth

DEPTH_MAX: maximum depth

USES: SWIMMING BEACH
WATER SKIING
FISHING

RESTRICT: NO SWIMMING
NO WATER SKIING
NO FISHING
NO DRINKING
NO BODY CONTACT
XX HORSEPOWER

HAZARDS:

DATE_BUILT: yyyymmdd

MATERIAL: EARTH
CONCRETE
STONE
METAL
WOOD

CONDITION: ADEQUATE
NEEDS REPAIR
SILTED IN
NEW

HEIGHT: in feet

WIDTH: in feet

LENGTH: in feet

CIRCUM: circumference (if circular) in feet

COST: in dollars

TEXT1: text on structure (year, name, etc.)

Related or Associated Tables (see dBASE dictionary for file and field descriptions)

Bibliography

last modified: 5/25/97

WFIR##PY

Park Name Kerr Wildlife Management Area **Coverage Name** WFIR##PY

Coverage Contents WILDFIRES BY YEAR

Coverage Type polygon

Mapscale

inch to inch:	1:12,000	1:24,000	1:100,000	1:250,000	
inch to feet:	1:50	1:100	1:200	1:250	1:500
	1:1000				

Coverage History and Mapping Procedure

(To be completed by field staff when updating coverage; current history available in metadata file)

DATABASE ATTRIBUTE FORMAT - POLYGON FEATURES (PAT FILE)

PPJ_CODE	4	4	C	ppj code of facility using capital letter (P151)
SOURCE	5	5	I	graphic data source
SOURCENAME	50	50	C	name of source: collector's name or map source name
SOURCEDATE	8	8	I	yyyymmdd; date of source listed above
PASTURE_NO	10	10	I	xx-yyyy xx = pasture number, yyyy = year

Attribute Choices - Polygon Features

PASTURE_NO: unique number assigned to burn and the year

Related or Associated Tables (see dBASE dictionary for file and field descriptions)

BURN.DBF

Bibliography

last modified: 5/25/97

APPENDIX B

DBASE DICTIONARY
DEFINITION OF FIELD ATTRIBUTES
KERR WILDLIFE MANAGEMENT AREA
BLACK-CAPPED VIREO (*Vireo atricapillus*) PROJECT

Park Name Kerr Wildlife Management Area **File Name** **BBS96.DBF**

File Contents **BREEDING BIRD SURVEY POINT OBSERVATION TABLE**

File Type dBASE

FIELD ATTRIBUTES

DATE
PPJ_CODE
POINT
TIME
BIRD
MIN
SEX
IN
HEARD
SEEN
FLY
NEST

FIELD ATTRIBUTE DESCRIPTION

DATE: yyyymmdd

PPJ_CODE: ppj code of facility using capital letter (P151)

POINT: identifies unique field point number; point number - year; relate to PAT file in ARC/INFO coverage

TIME: 24-hour time system; numbering the hours of the day consectutively starting at midnight (0000 hours)

BIRD: identifies bird by species using a unique code number

MIN: minutes in observation interval
3 = first 3 minute interval
5 = 3 - 5 minute interval

SEX: identifies male or female bird

IN: observation made inside a circle with a 50 m radius from the survey point
Y = Yes
N = No

HEARD: # of birds heard (but not seen) of a particular species

SEEN: # of birds seen of a particular species

FLY: observation type; bird in flight
Y = Yes
N = No

NEST: observation type; nest found
Y = Yes
N = No

Related or Associated Coverages

BBSP96PT

Bibliography

last modified: 5/25/97

BBSCON.DBF

Park Name Kerr Wildlife Management Area **File Name** **BBSCON.DBF**

File Contents **BREEDING BIRD SURVEY POINT: FIELD CONDITIONS**

File Type dBASE

FIELD ATTRIBUTES

FIELD_DATE
PPJ_CODE
SKYSTART
SKYEND
WINDST
WINDEND
TEMPSTART
TEMPEND

FIELD ATTRIBUTE DESCRIPTION

FIELD_DATE: date of survey

PPJ_CODE: ppj code of facility using capital letter (P151)

SKYSTART: description of sky at start of survey period (using Buford Index)

SKYEND: description of sky at end of survey period (using Buford Index)

WINDST: wind speed and direction at start of survey period (using Buford Index)

WINDEND: wind speed and direction at end of survey period (using Buford Index)

TEMPSTART: temperature at start of survey period

TEMPEND: temperature at end of survey period

Related or Associated Coverages

BBSP96PT

Bibliography

last modified: 5/25/97

BBSLOCAT.DBF

Park Name Kerr Wildlife Management Area **File Name** **BBSLOCAT.DBF**

File Contents **BREEDING BIRD SURVEY POINT LOCATION INFORMATION TABLE**

File Type dBASE

FIELD ATTRIBUTES

POINT
PPJ_CODE
PASTURE
RANGESIT
STAGE
LOCATION

FIELD ATTRIBUTE DESCRIPTION

POINT: identifies unique field point number; point number - year; relate to PAT file in ARC/INFO coverage

PPJ_CODE: ppj code of facility using capital letter (P151)

PASTURE: name of pasture

RANGESIT: description of range

STAGE: stage of succession
1 = LOW BRUSH; LITTLE OVERSTORY
2 = LOW BRUSH; MODERATE OVERSTORY
3 = LOW BRUSH; MATURE OVERSTORY
4 = OPEN GRASSLAND; SOME BRUSH
5 = MATURE; LITTLE UNDERSTORY
6 = MATURE JUNIPER
7 = 5 - 10 FT RE-GROWTH JUNIPER

LOCATION: specific locality information to locate the established observation point each year
VLT = Vegetation Line Transect

Related or Associated Coverages

BBSP96PT

Bibliography

last modified: 5/25/97

BBSNAME.DBF

Park Name Kerr Wildlife Management Area **File Name** **BBSNAME.DBF**

File Contents **BREEDING BIRD SURVEY POINT NAME AND CODE TABLE**

File Type dBASE

FIELD ATTRIBUTES

NAME
CODE
PPJ_CODE

FIELD ATTRIBUTE DESCRIPTION

NAME: full name of species

CODE: code name for species

PPJ_CODE: ppj code of facility using capital letter (P151)

Related or Associated Coverages

BBSP96PT

Bibliography

last modified: 5/25/97

Park Name Kerr Wildlife Management Area **File Name** BCVTLPAS.DBF

File Contents BLACK-CAPPED VIREO TOTALS (1985-1996) BY PASTURE FOR KWMA (MALE, FEMALE AND YOUNG)

File Type dBASE

FIELD ATTRIBUTES

YEAR
PPJ_CODE
PASTURE
MAL_MIN
MAL_MAX
FEM_MIN
FEM_MAX
YNG_MIN
YNG_MAX
ADT_MIN
ADT_MAX
TTL_MIN
TTL_MAX

FIELD ATTRIBUTE DESCRIPTION

YEAR: year; xxxx

PPJ_CODE: ppj code of facility using capital letter (P151)

PASTURE: name of pasture

MAL_MIN: total male Black-capped Vireos by pasture; minimum recorded

MAL_MAX: total male Black-capped Vireos by pasture; maximum recorded

FEM_MIN: total female Black-capped Vireos by pasture; minimum recorded

FEM_MAX: total female Black-capped Vireos by pasture; maximum recorded

YNG_MIN: total young Black-capped Vireos by pasture; minimum recorded

YNG_MAX: total young Black-capped Vireos by pasture; maximum recorded

ADT_MIN: sum total male and female adult Black-capped Vireos by pasture; minimum recorded

ADT_MAX: sum total male and female adult Black-capped Vireos by pasture; maximum recorded

TTL_MIN: sum total male, female, and young Black-capped Vireos by pasture; minimum recorded

TTL_MAX: sum total male, female, and young Black-capped Vireos by pasture; maximum recorded

Related or Associated Coverages

BCV85PT
BCV86PT
BCV87PT
BCV88PT
BCV89PT
BCV90PT
BCV91PT
BCV93PT
BCV94PT
BCV95PT
BCV96PT

Bibliography

last modified: 5/25/97

FLDNOTES.DBF

Park Name Kerr Wildlife Management Area **File Name** **FLDNOTES.DBF**

File Contents **FIELD NOTES ON BLACK-CAPPED VIREO AT KWMA 1994 - 1996**

File Type dBASE

FIELD ATTRIBUTES

OBS_ID
DATE
TIME
FLD_NOTES
PPJ_CODE

FIELD ATTRIBUTE DESCRIPTION

OBS_ID: a unique character string assigned to identify observation; relates to PAT file in ARC/INFO coverage
C-YR = unique character string - year of observation

DATE: yyyymmdd

TIME: 24 - hour time system; numbering the hours of the day consectutively starting at midnight (0000 hours)

FLD_NOTES: field notes recorded at time of observation

PPJ_CODE: ppj code of facility using capital letter (P151)

Related or Associated Coverages

BCV85PT
BCV86PT
BCV87PT
BCV88PT
BCV89PT
BCV90PT
BCV91PT
BCV93PT
BCV94PT
BCV95PT
BCV96PT

Bibliography

last modified: 5/25/97

Park Name Kerr Wildlife Management Area **File Name** TTLBCV.DBF

File Contents **BLACK-CAPPED VIREO TOTALS FROM 1985 - 1996 FOR KWMA**

File Type dBASE

FIELD ATTRIBUTES

YEAR
PPJ_CODE
LOCATION
MAL_MIN
MAL_MAX
FEM_MIN
FEM_MAX
YNG_MIN
YNG_MAX
ADT_MIN
ADT_MAX
TTL_MIN
TTL_MAX

FIELD ATTRIBUTE DESCRIPTION

YEAR: year; xxxx

PPJ_CODE: ppj code of facility using capital letter (P151)

LOCATION: name of wildlife management area

MAL_MIN: total male Black-capped Vireos by year; minimum recorded

MAL_MAX: total male Black-capped Vireos by year; maximum recorded

FEM_MIN: total female Black-capped Vireos by year; minimum recorded

FEM_MAX: total female Black-capped Vireos by year; maximum recorded

YNG_MIN: total young Black-capped Vireos by year; minimum recorded

YNG_MAX: total young Black-capped Vireos by year; maximum recorded

ADT_MIN: sum total male and female adult Black-capped Vireos by year; minimum recorded

ADT_MAX: sum total male and female adult Black-capped Vireos by year; maximum recorded

TTL_MIN: sum total male, female, and young Black-capped Vireos by year; minimum recorded

TTL_MAX: sum total male, female, and young Black-capped Vireos by year; maximum recorded

Related or Associated Coverages

BCV85PT
BCV86PT
BCV87PT
BCV88PT
BCV89PT
BCV90PT
BCV91PT
BCV93PT
BCV94PT
BCV95PT
BCV96PT

Bibliography

last modified: 5/25/97

Park Name Kerr Wildlife Management Area **File Name** **BANDTTL.DBF**

File Contents **BLACK-CAPPED VIREO BANDING TOTALS FROM 1985 - 1990 FOR KWMA**

File Type dBASE

FIELD ATTRIBUTES

YEAR
PPJ_CODE
LOCATION
MALBND_NO
FEMBND_NO
YNGBND_NO
TTLBND_NO

FIELD ATTRIBUTE DESCRIPTION

YEAR: year; xxxx

PPJ_CODE: ppj code of facility using capital letter (P151)

LOCATION: name of wildlife management area

MALBND_NO: total male Black-capped Vireos banded by year

FEMBND_NO: total female Black-capped Vireos banded by year

YNGBND_NO: total young Black-capped Vireos banded by year

TTLBND_NO: sum total male, female, and young Black-capped Vireos banded by year

Related or Associated Coverages

BCV85PT
BCV86PT
BCV87PT
BCV88PT
BCV89PT
BCV90PT
BCV91PT
BCV93PT
BCV94PT
BCV95PT
BCV96PT

Bibliography

last modified: 5/25/97

BURN.DBF

Park Name Kerr Wildlife Management Area **File Name** **BURN.DBF**

File Contents **PRESCRIBED BURNING AND WILDFIRE DATA**

File Type dBASE

FIELD ATTRIBUTES

YEAR
PPJ_CODE
PASTURE
ACRES
DATE_BURN
HUMIDITY
WIND_SPEED
WIND_DIR
COMMENTS
PASTURE_NO

FIELD ATTRIBUTE DESCRIPTION

YEAR: year; xxxx

PPJ_CODE: ppj code of facility using capital letter (P151)

PASTURE: name of pasture

ACRES: acreage burned

DATE_BURN: date of burn

HUMIDITY: humidity recorded at time of burn

WIND_SPEED: wind speed recorded at time of burn

WIND_DIR: wind direction recorded at time of burn

COMMENTS: comments on intensity of fire and conditions not otherwise noted

PASTURE_NO: unique number assigned to burn and the year

Related or Associated Coverages

PRESCRIBED BURNING COVERAGES:

PBUR79PY
PBUR80PY
PBUR81PY
PBUR82PY
PBUR83PY
PBUR84PY
PBUR86PY
PBUR87PY

PBUR88PY
PBUR89PY
PBUR91PY
PBUR92PY
PBUR93PY
PBUR94PY
PBUR95PY
PBUR96PY
PBUR97PY

WILDFIRE COVERAGES:

WFIR54PY
WFIR71PY
WFIR84PY

Bibliography

last modified: 5/25/97

Park Name Kerr Wildlife Management Area **File Name** CB8591.DBF

File Contents **TRAPPED COWBIRDS 1985 -1991 ON KWMA; BY PASTURE TOTALS**

File Type dBASE

FIELD ATTRIBUTES

YEAR
PASTURE
TRAP_NO
TTL_COWBD
PPJ_CODE

FIELD ATTRIBUTE DESCRIPTION

YEAR: year; xxxx

PASTURE: name of pasture where trap was located

TRAP_NO: trap number; relates with PAT file in ARC/INFO coverage

TTL_COWBD: sum total male, female, and young cowbirds trapped

PPJ_CODE: ppj code of facility using capital letter (P151)

Related or Associated Coverages

PC8591PT

Bibliography

last modified: 5/25/97

Park Name Kerr Wildlife Management Area **File Name** CB9296.DBF

File Contents **TRAPPED COWBIRDS 1992-1996 ON KWMA; INCLUDES PERMANENT AND MOBILE TRAP DATA**

File Type dBASE

FIELD ATTRIBUTES

DATE
TIME
LOCATION
TRAP_NO
TRAP_ID
PPJ_CODE
M_REMOVED
F_REMOVED
I_REMOVED
M_REMAIN
F_REMAIN
M_PRESENT
F_PRESENT
I_PRESENT
M_ADDED
F_ADDED
OTHER_SPEC
REMARKS

FIELD ATTRIBUTE DESCRIPTION

DATE: yyyymmdd

TIME: 24-hour time system; numbering the hours of the day consectutively starting at midnight (0000 hours)

LOCATION: name of pasture where trap was located

TRAP_NO: trap number; a character field indicating mobile and permanent trap number
M# = MOBILE TRAP
= PERMANENT TRAP

TRAP_ID: trap number for permanent traps only; relates with PAT file in ARC/INFO coverage
0 = MOBILE TRAP
1 - 5 = PERMANENT TRAPS

PPJ_CODE: ppj code of facility using capital letter (P151)

M_REMOVED: number of male cowbirds removed; negative number = # escaped or found dead

F_REMOVED: number of female cowbirds removed; negative number = # escaped or found dead

I_REMOVED: number of immature cowbirds removed; negative number = # escaped or found dead

M_REMAIN: # of males left in trap

F_REMAIN: # of females left ın trap

M_PRESENT: # of males in trap when checked

F_PRESENT: # of females in trap when checked

I_PRESENT: # of immature in trap when checked

M_ADDED: # of males added to trap

F_ADDED: # of females added to trap

OTHER_SPEC: other species found in trap

REMARKS: comments

Related or Associated Coverages

PC9296PT

Bibliography

last modified: 5/25/97

CBDETAIL.DBF

Park Name Kerr Wildlife Management Area **File Name** **CBDETAIL.DBF**

File Contents **TRAPPED COWBIRDS 1985 - 1993 ON KWMA ; INCLUDES PERMANENT AND MOBILE TRAP DATA WITH ASSOCIATED LIVESTOCK AND DEER DATA**

File Type dBASE

FIELD ATTRIBUTES

YEAR
DATE
LOCATION
TRAP_NO
TRAP_ID
PPJ_CODE
TRAP_PERIOD
M_REMOVED
F_REMOVED
I_REMOVED
COWS_PASTU
COWS_ADJPA
PASTURE
COWS_DPENS
COW_PASTUR
COW_ADJ
NO_COWS
DEERPEN_W
DEERPEN_WO

FIELD ATTRIBUTE DESCRIPTION

YEAR: year; xxxx

DATE: mmdd_to_mmdd

LOCATION: name of pasture where trap was located

TRAP_NO: trap number; a character field indicating mobile and permanent trap number

TRAP_ID: trap number for permanent traps only; relates with PAT file in ARC/INFO coverage

PPJ_CODE: ppj code of facility using capital letter (P151)

TRAP_PERIOD: number of days in trap period for a particular location

M_REMOVED: number of male cowbirds removed; negative numbers indicate dead or escaped

F_REMOVED: number of female cowbirds removed; negative numbers indicate dead or escaped

I_REMOVED: number of immature cowbirds removed; negative numbers indicate dead or escaped

COWS_PASTU: dates that cows were present in pasture; mmdd_to_mmdd

COWS_ADJPA: dates that cows were present in adjacent pasture; mmdd_to_mmdd

PASTURE: name of adjacent pasture where cows were located

COWS_DPENS: date cows in pasture near dear pens; mmdd_to_mmdd

COW_PASTUR: # of cowbirds caught in in the pasture that has trap

COW_ADJ: # of cowbirds caught when cows were in the adjacent pasture

NO_COWS: # of cowbirds caught with no cows in pasture or in adjacent pasture

DEERPEN_W: # of cowbirds caught with cows present near deer pens

DEERPEN_WO: # of cowbirds caught without cows present near deer pens

Related or Associated Coverages

PC8591PT
PC9296PT

Bibliography

last modified: 5/25/97

COWBDSUM.DBF

<u>**Park Name**</u> Kerr Wildlife Management Area <u>**File Name**</u> **COWBDSUM.DBF**

<u>**File Contents**</u> **TOTAL TRAPPED COWBIRDS 1985 -1996 ON KWMA; SUMMARY TABLE FOR MALE, FEMALE, AND YOUNG BY YEAR**

<u>**File Type**</u> dBASE

<u>**FIELD ATTRIBUTES**</u>

YEAR
MALE
FEMALE
YOUNG
TOTAL
PPJ_CODE

<u>**FIELD ATTRIBUTE DESCRIPTION**</u>

YEAR: year; xxxx

MALE: total male cowbirds trapped by year

FEMALE: total female cowbirds trapped by year

YOUNG: total young cowbirds trapped by year

TOTAL: sum total of male, female, and young cowbirds trapped by year

PPJ_CODE: ppj code of facility using capital letter (P151)

<u>**Related or Associated Coverages**</u>

PC8591PT
PC9296PT

<u>**Bibliography**</u>

last modified. 5/25/97

APPENDIX C

DOCUMENT AML METADATA FORMAT FOR ON-LINE ENTRY

DOCUMENT AML

Fill in all areas that are in bold type

1. Basic Documentation Menu

Geo Dataset Name:
Theme:
Keywords:
Contact Person:
Organization:
Geo Dataset Revision:
Description of location or extent:
Resolution and units: +/-
Scale: 1:
Storage location, if archived:
Progress or status: (complete, in progress, planned)

Dates and times of Data Coverage:
Beginning (or only) Date(yyyymmdd):
Beginning Time (hhmm):
Ending Date (Unknown, Present) (yyyymmdd):
Ending Time (hhmm):

Citation Information (on this dataset):
Author(s):
Title:
Pub. Date (yyyymmdd):
Pub. Time (hhmm):
Edition/Version:
Map Type: (atlas, diagram, globe, map, model, profile, remote-sensing image, section, veiw)
Series Name:
Issue/Number:
Publisher:
Pub. Place:
Other Info.:
Larger Work Citation Key:
On-line Link (URL):

2. Document Reference Menu

Exact citation of a source to this data set (may be multiple):
Author(s):
Title:
Pub. Date (yyyymmdd):
Pub. Time (hhmm):
Edition/Version:
Map Type:
Series Name:
Issue/Number:
Publisher:
Pub. Place:
Larger Work Citation Key:
Other Info:

On-line Link (URL):

3. Document Attribute Table Menu (This section will repeat for .AAT and .PAT)

Complete the following for each attribute table (.AAT)
Short description of attribute table:
Data source for the items in this table:

Complete the following for each attribute you created in .AAT:
Item Name:
Short Description of this item:
Domain (valid codes) for this item:
Data source of this item:
Accuracy of this item:

Complete the following for each attribute table (.PAT)
Short description of attribute table:
Data source for the items in this table:

Complete the following for each attribute you created in .PAT:
Item Name:
Short Description of this item:
Domain (valid codes) for this item:
Data source of this item:
Accuracy of this item:

4. Narrative Description

(Note: Please remove all sections contained in parentheses – they are included to assist the user in filling out the narrative section. The indentation and headings are those required by the FGDC Metadata Content Standard. There is a 100 line limit under each heading. The line width in DOCUMENT AML is 80 characters).

Abstract:

(A concise description of the dataset)

Purpose:

(Types of applications for which the dataset were designed and types of projects that do use the dataset. BE SPECIFIC if the dataset is geared towards a narrow set of applications.)

Limitations of Data:

(Examples are for use at certain scales with certain date ranges and for use with other datasets.)

Entity and Attribute Overview:

(Describe each table that has attributes in it. Use the contents of the .AAT table for reference. For each column and each item give a brief description and a list of valid attribute values that are associated with it. Input from this field is displayed in the Entity and Attribute Information: Overview Description section of the FGDC Standard.)

Procedures Used:

(Describe from beginning to end procedures/steps used to process the dataset from the initial collection format all the way through to the documentation you are working on just now. Particularly, include all changes such as tape type and format, tape to disk conversion, processing tolerances, etc. List each step performed and the commands and arguments used. Also, include if other on-line datasets were added and name and reference them; and use DOCUMENT information. NOTE: The information in this section is intended to let anyone yield the same results you acquired if the steps described are repeated.)

Revisions:

(Number each revision and describe the changes resulting from the revision. This is important user information since different versions of a spatial dataset potentially produce different results in analysis.)

Reviews Applied to Data:

(Spatial data ready to be documented and placed in a library must go through some in-house review. A review includes inspection of the LOG file for completeness and conformance to the steps described in this narrative, verification of table and column/item identities and definitions, validity of the reference datasets and citations, and review of any additional quality assurance measures performed on the dataset.)

Related Spatial and Tabular Data Sets:

(The identity and location of datasets or tables that may be related to the basic feature attribute tables. These include symbol lookup tables and additional tables that contain extended definitions, like county names to match codes or county numbers. Be sure to identify which items or columns can be used to establish relates.)

References Cited:

(Given in bibliographic reference form, for example, Author/creator, publication year, title/name of dataset, publisher/publishing organization, publication place.)

Notes:

(Any additional comments, caveats, etc.)

Currentness Reference:

(This information relates to the time period of content (.DOC file) of the dataset and describes how it was determined. You can include information on updates.)

Maintenance and Update Frequency:

(Describe how often changes or additions are made to the dataset. Possible values include: continually, daily, weekly, monthly, annually, biannually, unknown, as needed, irregular, none planned.)

Access Constraints:

(Describe any restrictions or legal pre-requisites for accessing the dataset. Enter n/a if no restrictions apply.)

Data Set Credit:

(Acknowledge individuals and organizations that assisted in the creation of the dataset and its documentation.)

Completeness Report:

(Information on selection criteria, generalization, deliberate omissions, definitions, and other rules applied to create the dataset.)

Horizontal Positional Accuracy Report:

(An explanation of the accuracy of the horizontal coordinate measurements and a description of tests used to determine the horizontal positional accuracy. Positional accuracy defines how correctly the digital features match real-world features. It s related to the concept of the National Map Accuracy Standard and states xx% of well-defined point features fall within xx units of their true position. NOTE: This is different from the horizontal resolution as reported in the .DOC file. Resolution is the size of the smallest feature that can be represented in the plane or on a surface. It is a term used primarily with the digital representation of geographic data.)

Vertical Positional Accuracy Report:

(An explanation of the accuracy of the vertical coordinate measurements; these may be encoded with a two-dimensional feature; for example, cell estimates. A description of the contour interval of the input data and its basis can be described here.)

Cloud Cover:

(The area of a dataset obtained from aerial photographs and remotely sensed images, which is obstructed by clouds. Cloud cover is typically expressed as a percentage of the spatial extent of the dataset.)

Contact Information: This section only needs to be complete once for each contact person.
Contact Person:
Contact Organization:
Contact Position/Title:

Contact Address:
Type: (Mailing, Physical, Mailing and Physical)
Street Address:
City:
State:
Zip code:

Contact Telephone # and Electronic Mail Address(es):
Voice #:
Fax #:
E-mail:

Contact instructions (Supplemental):

APPENDIX D

KERR WILDLIFE MANAGEMENT AREA
BLACK-CAPPED VIREO PROJECT

ARC/INFO COVERAGES
AERIAL PHOTOGRAPHY

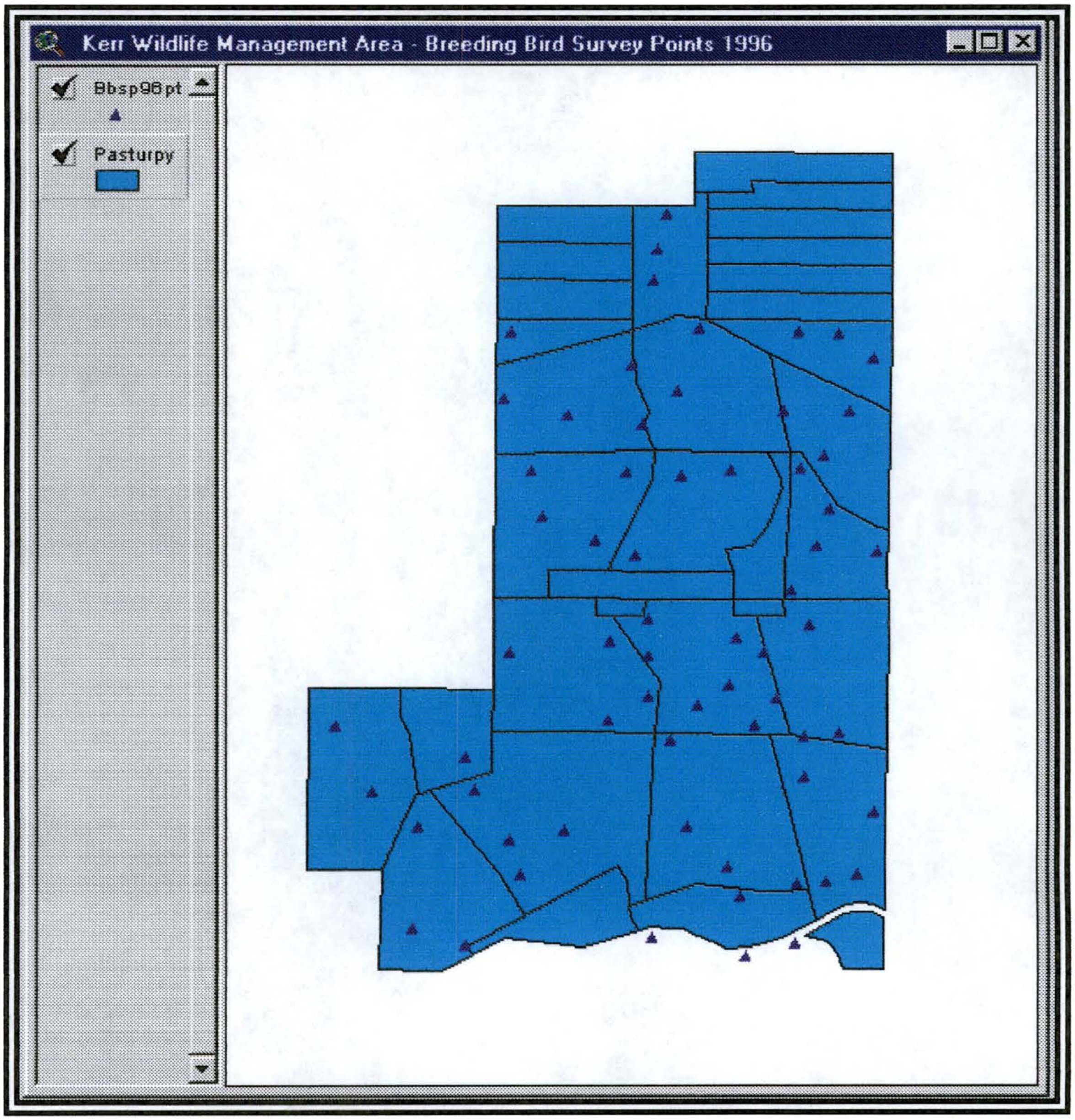

Figure 20. Breeding Bird Survey Points for 1996, BBSP96PT.

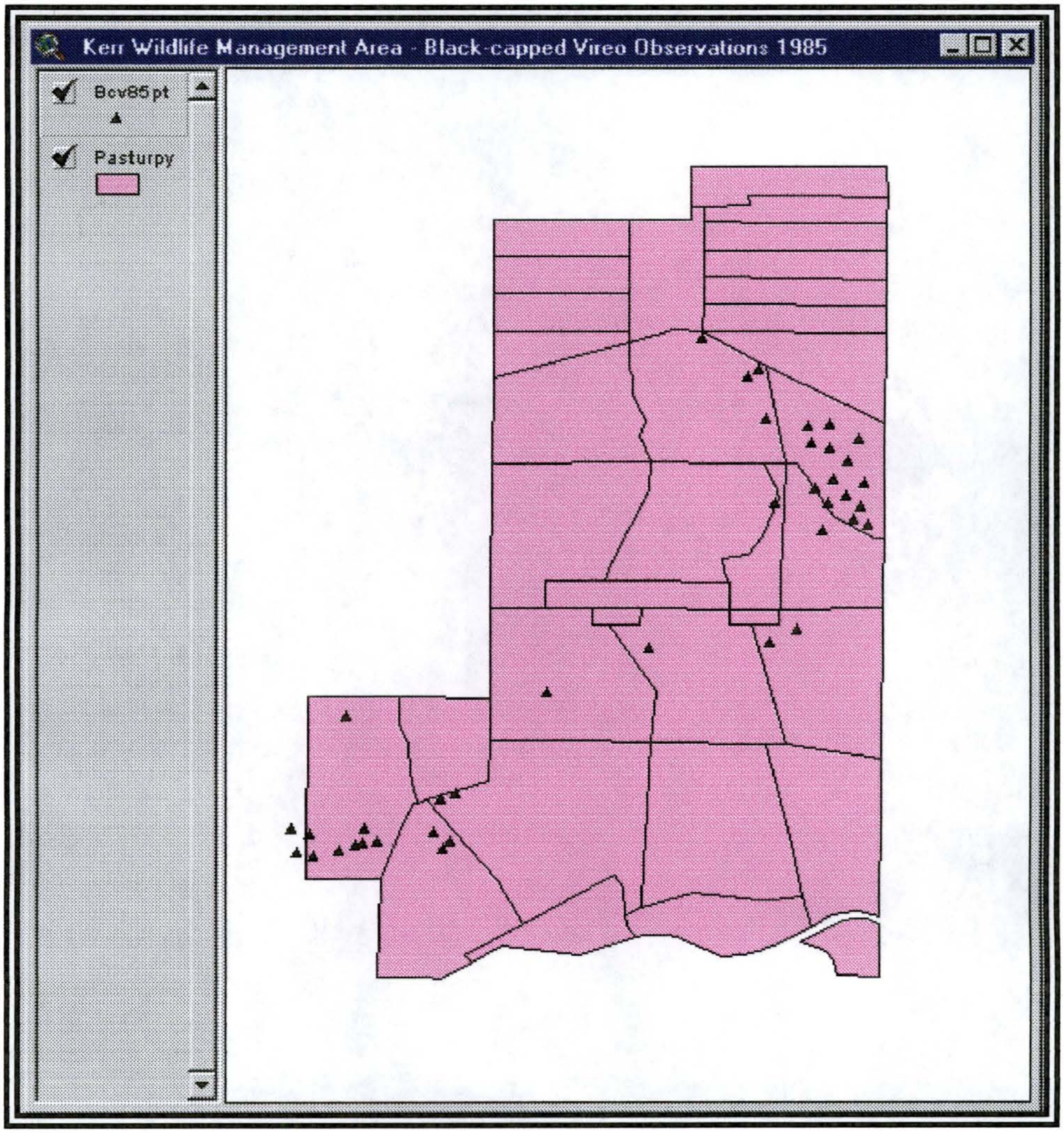

Figure 21. Black-capped Vireo Observation Points for 1985, BCV85PT.

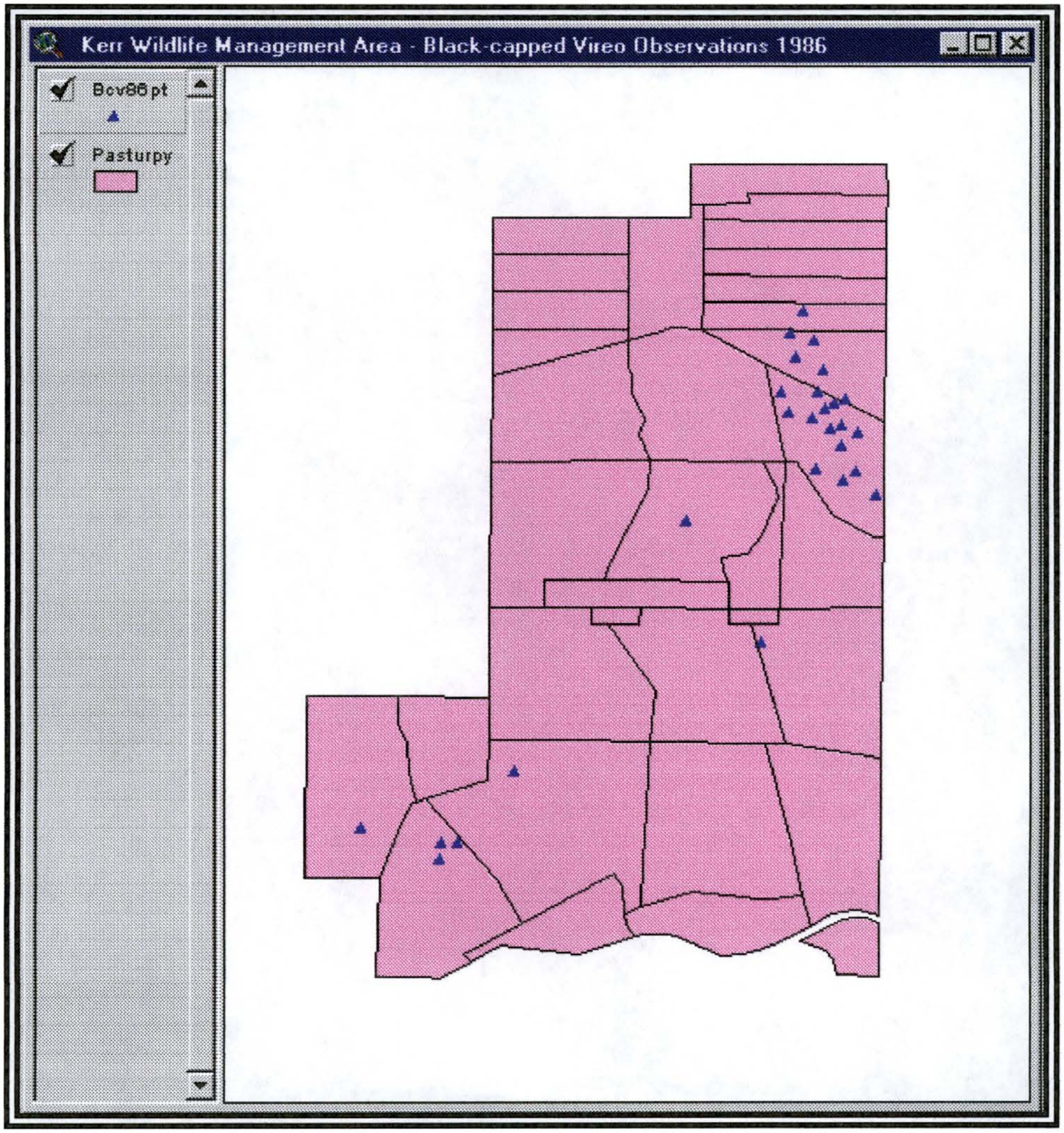

Figure 22. Black-capped Vireo Observation Points for 1986, BCV86PT.

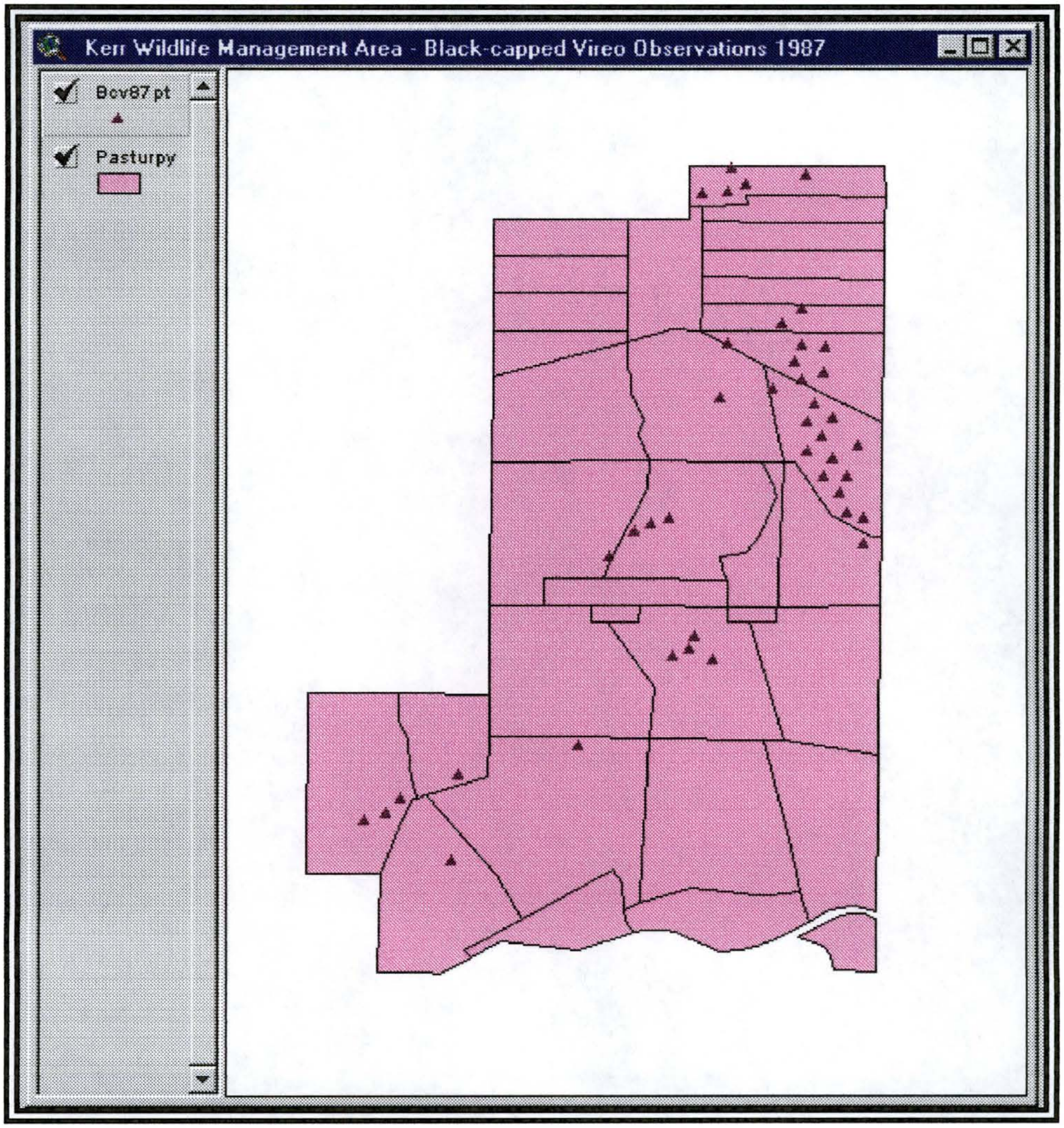

Figure 23. Black-capped Vireo Observation Points for 1987, BCV87PT.

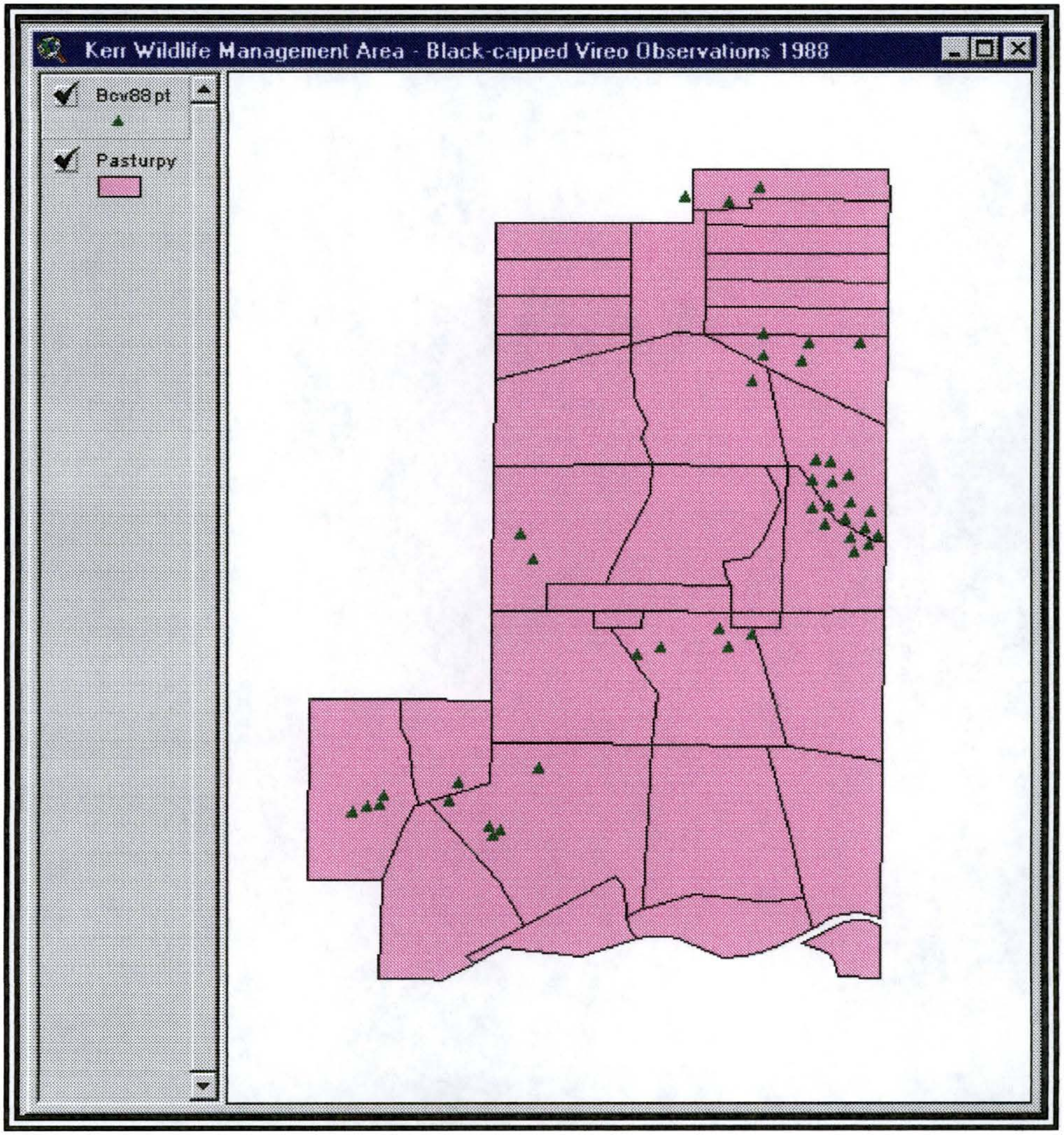

Figure 24. Black-capped Vireo Observation Points for 1988, BCV88PT.

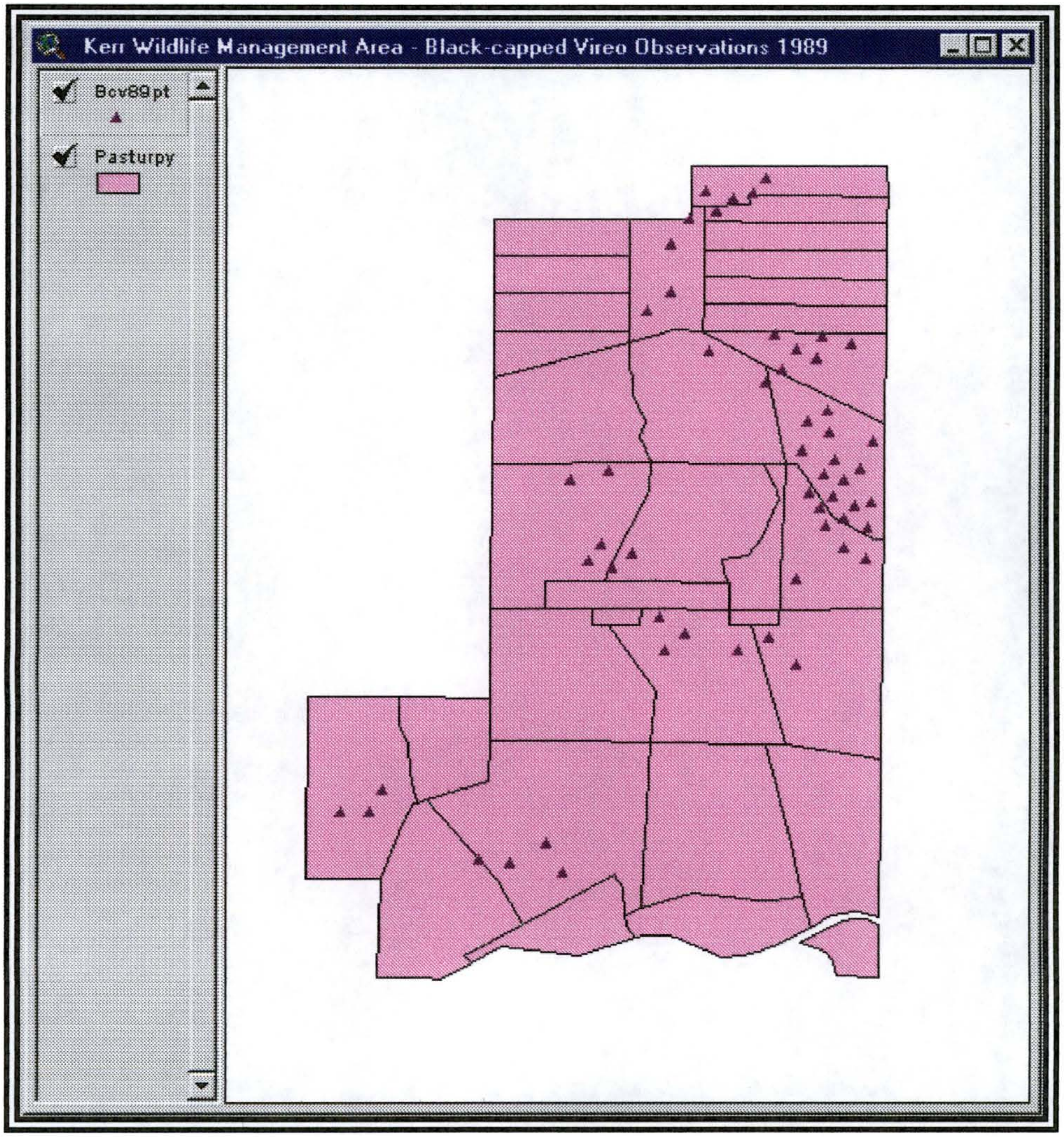

Figure 25. Black-capped Vireo Observation Points for 1989, BCV89PT.

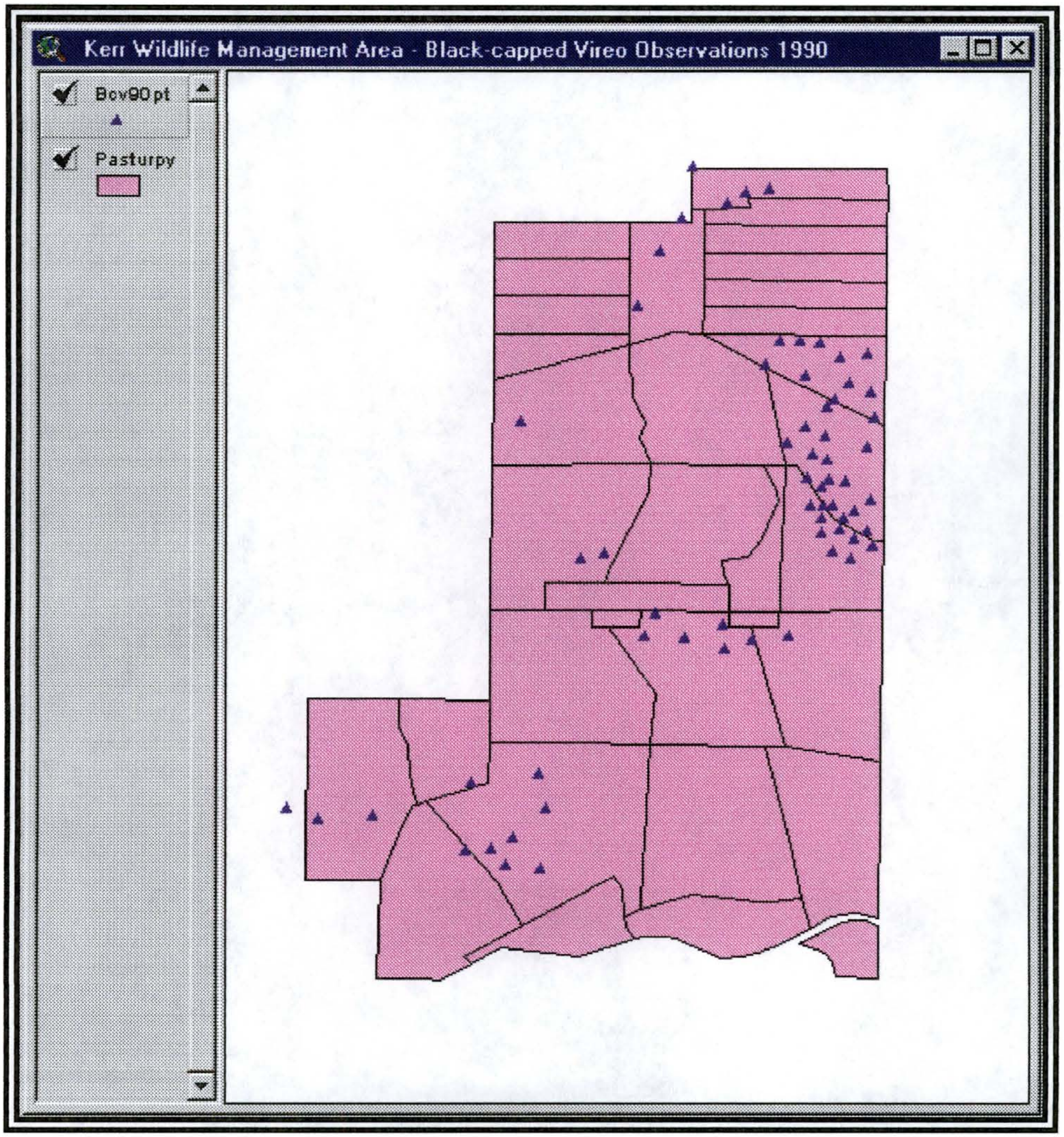

Figure 26. Black-capped Vireo Observation Points for 1990, BCV90PT.

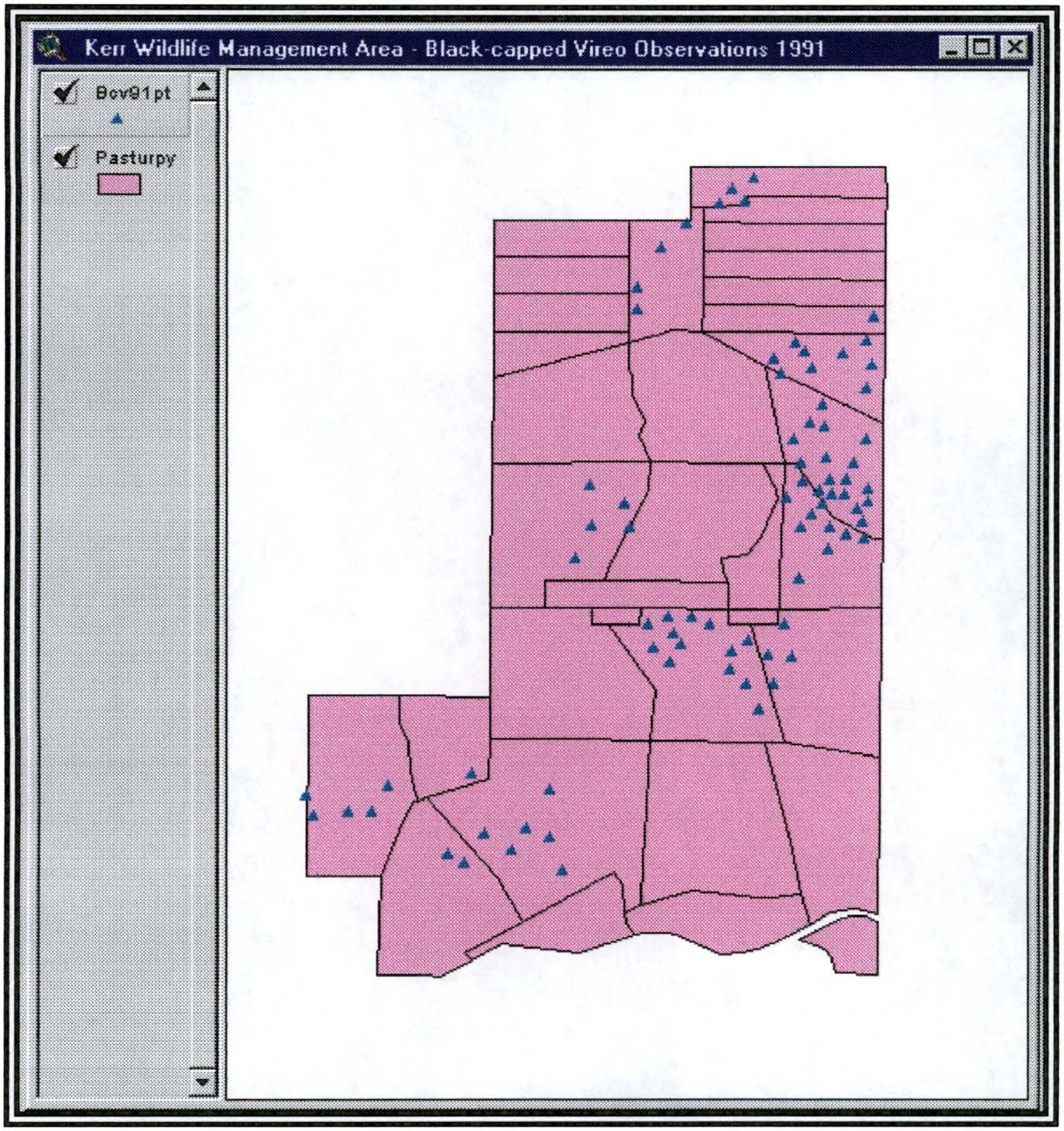

Figure 27. Black-capped Vireo Observation Points for 1991, BCV91PT.

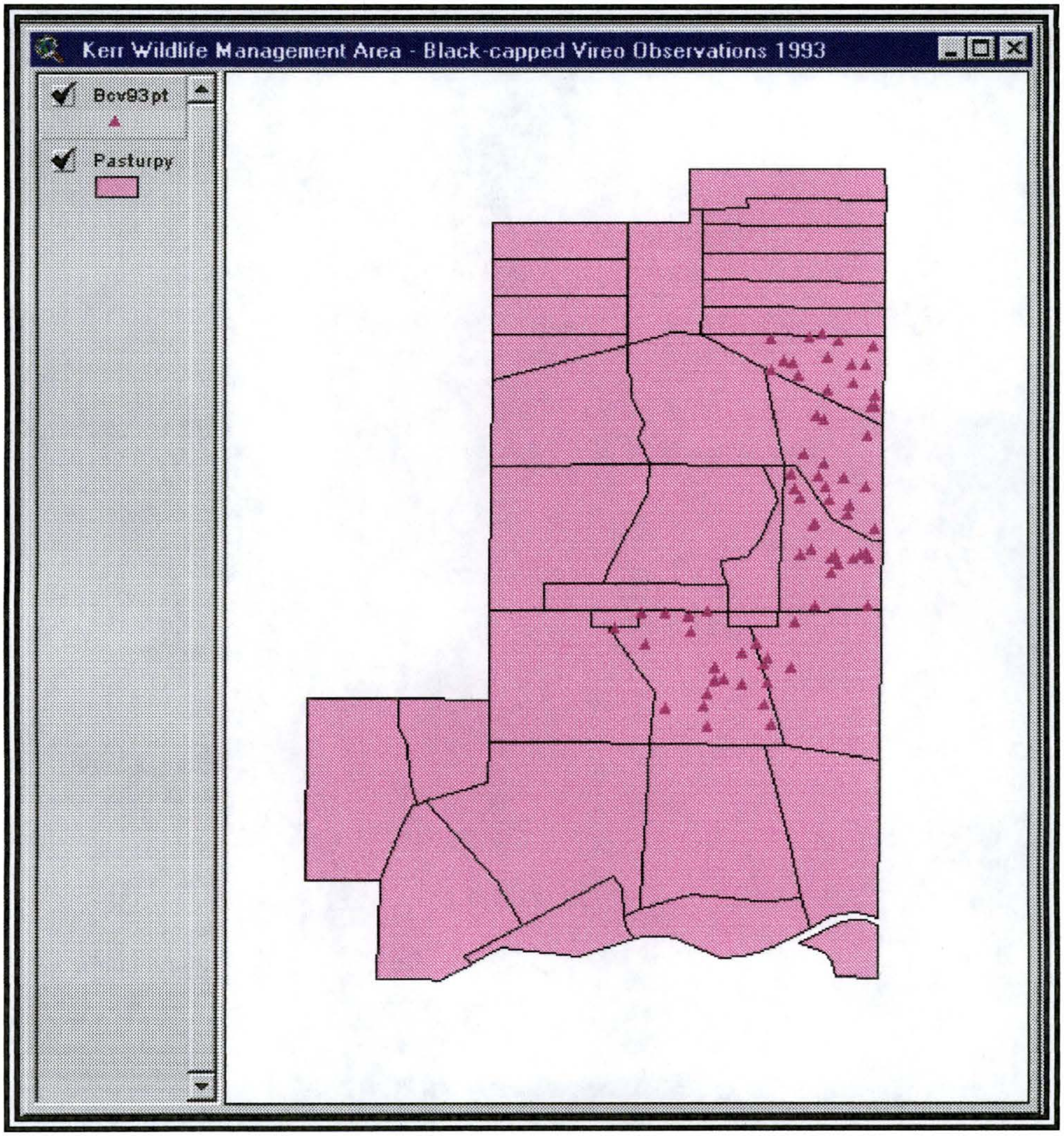

Figure 28. Black-capped Vireo Observation Points for 1993, BCV93PT.

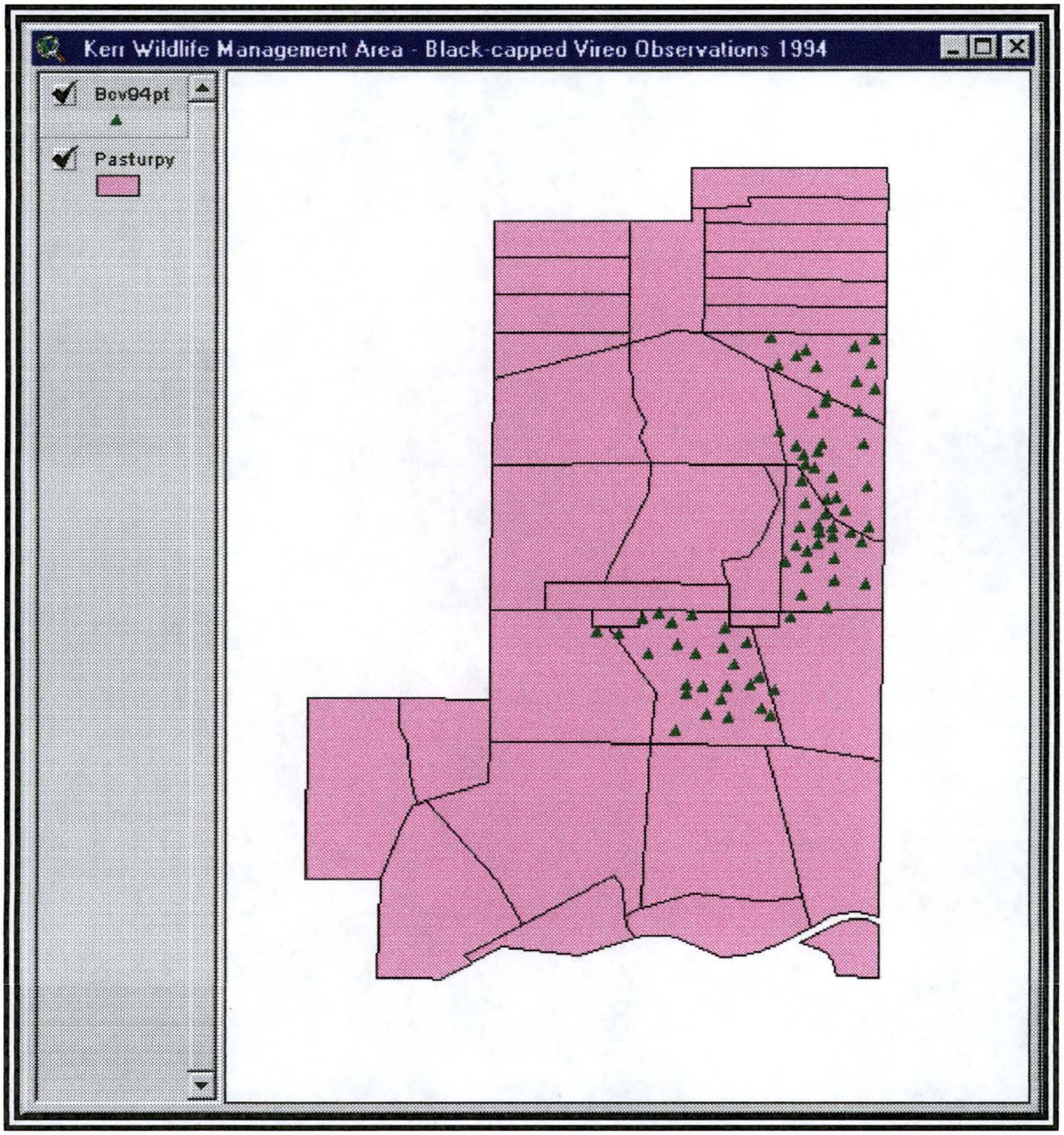

Figure 29. Black-capped Vireo Observation Points for 1994, BCV94PT.

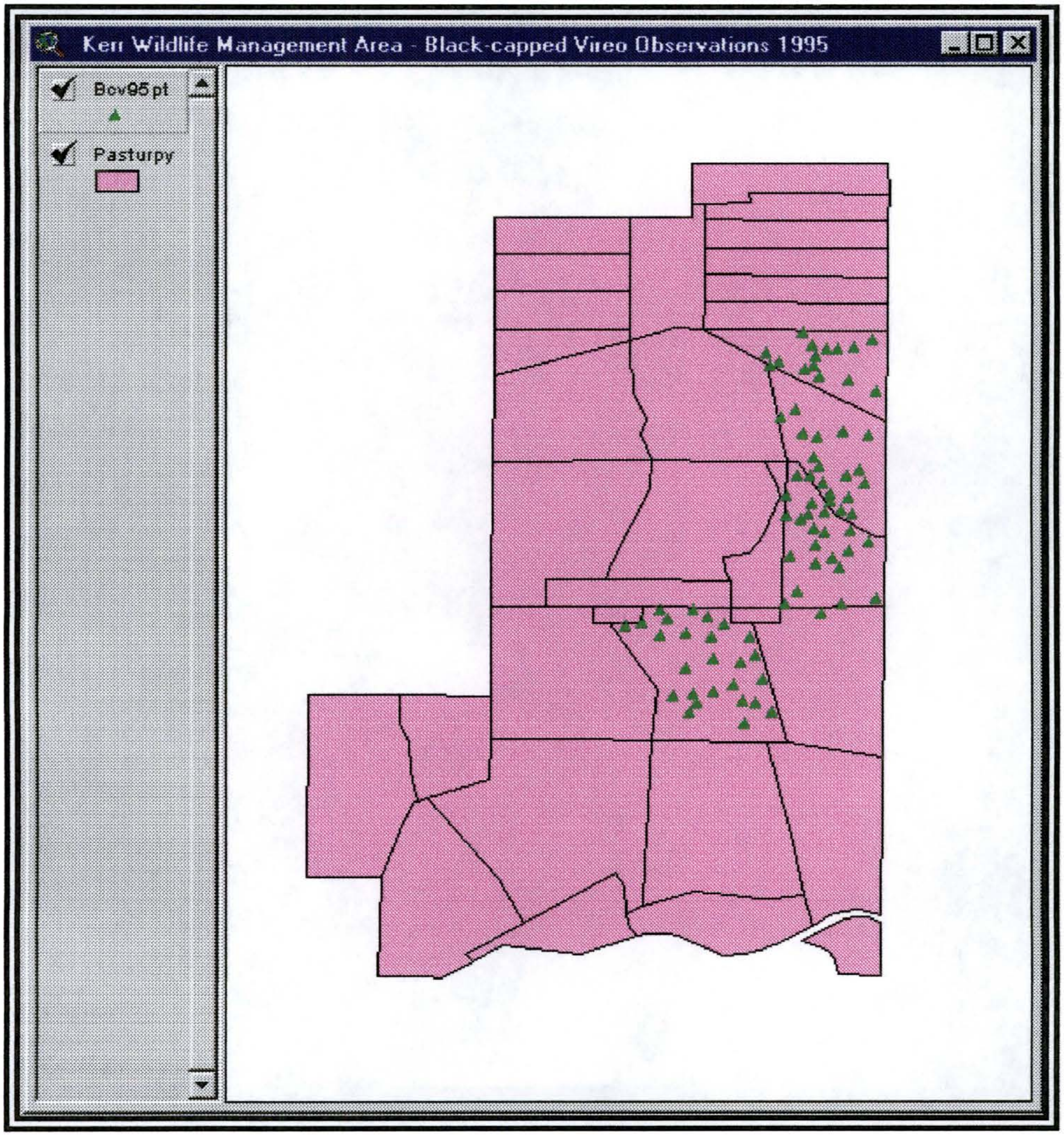

Figure 30. Black-capped Vireo Observation Points for 1995, BCV95PT.

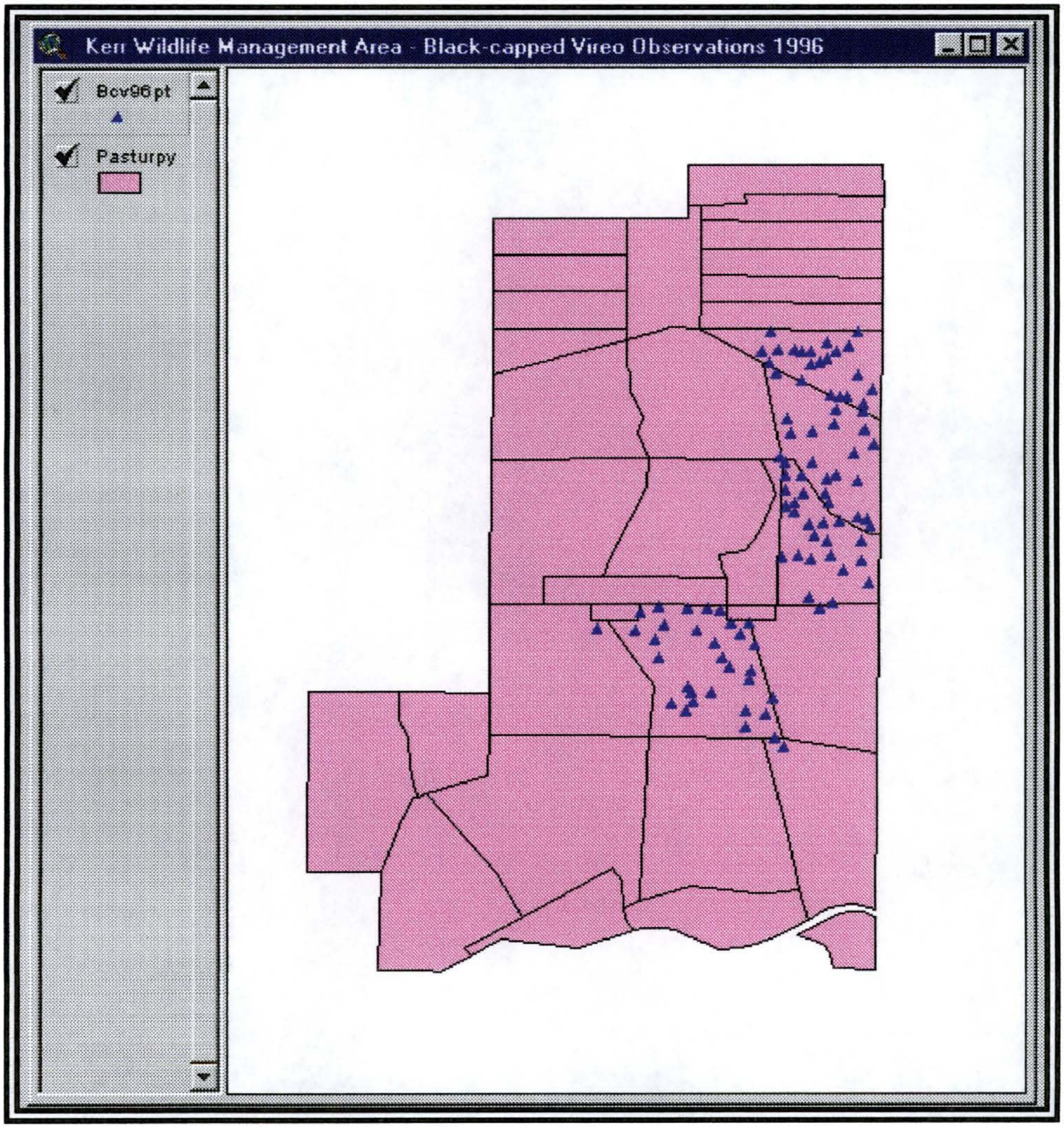

Figure 31. Black-capped Vireo Observation Points for 1996, BCV96PT.

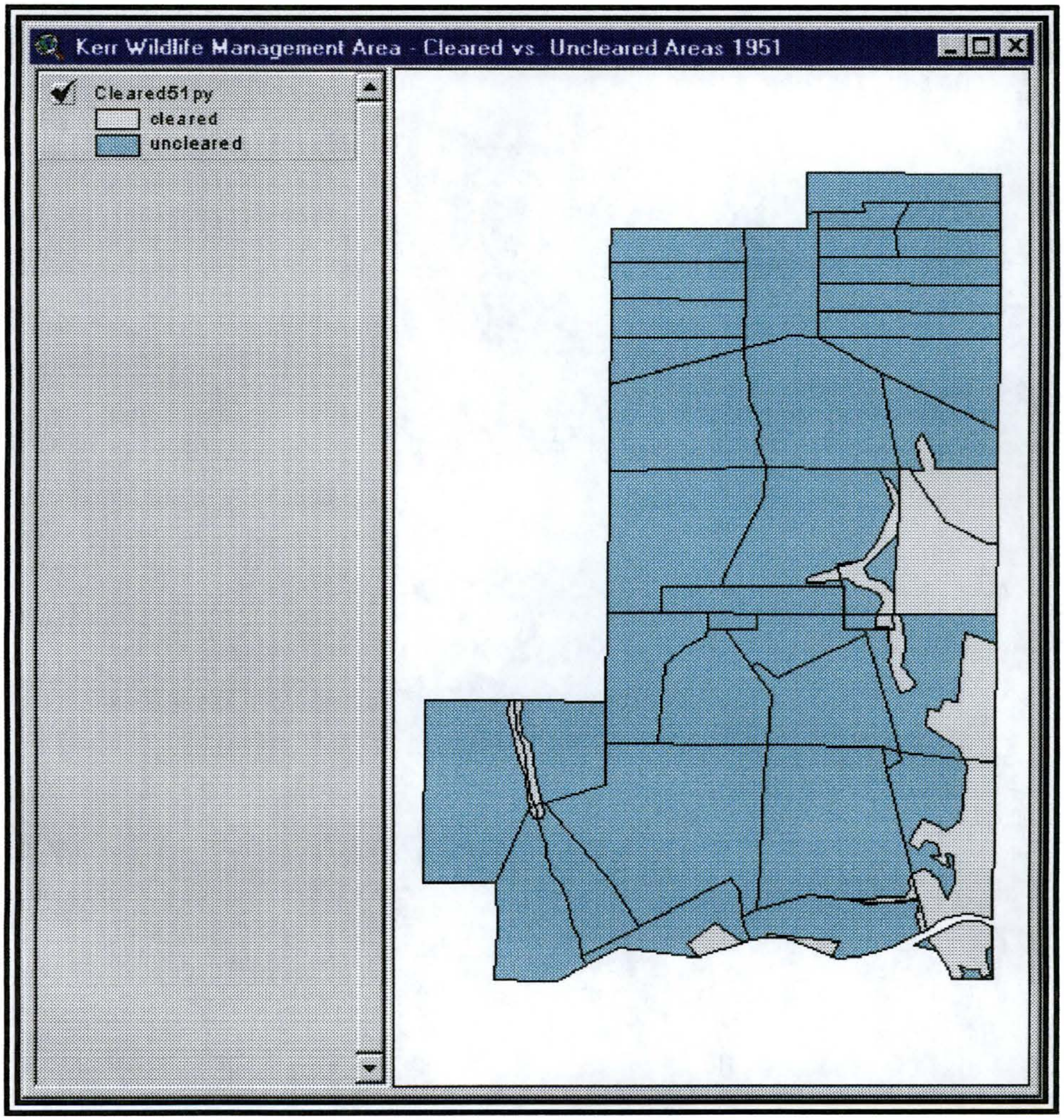

Figure 32. Brush Cleared and Uncleared Areas 1951, CLRD51PY.

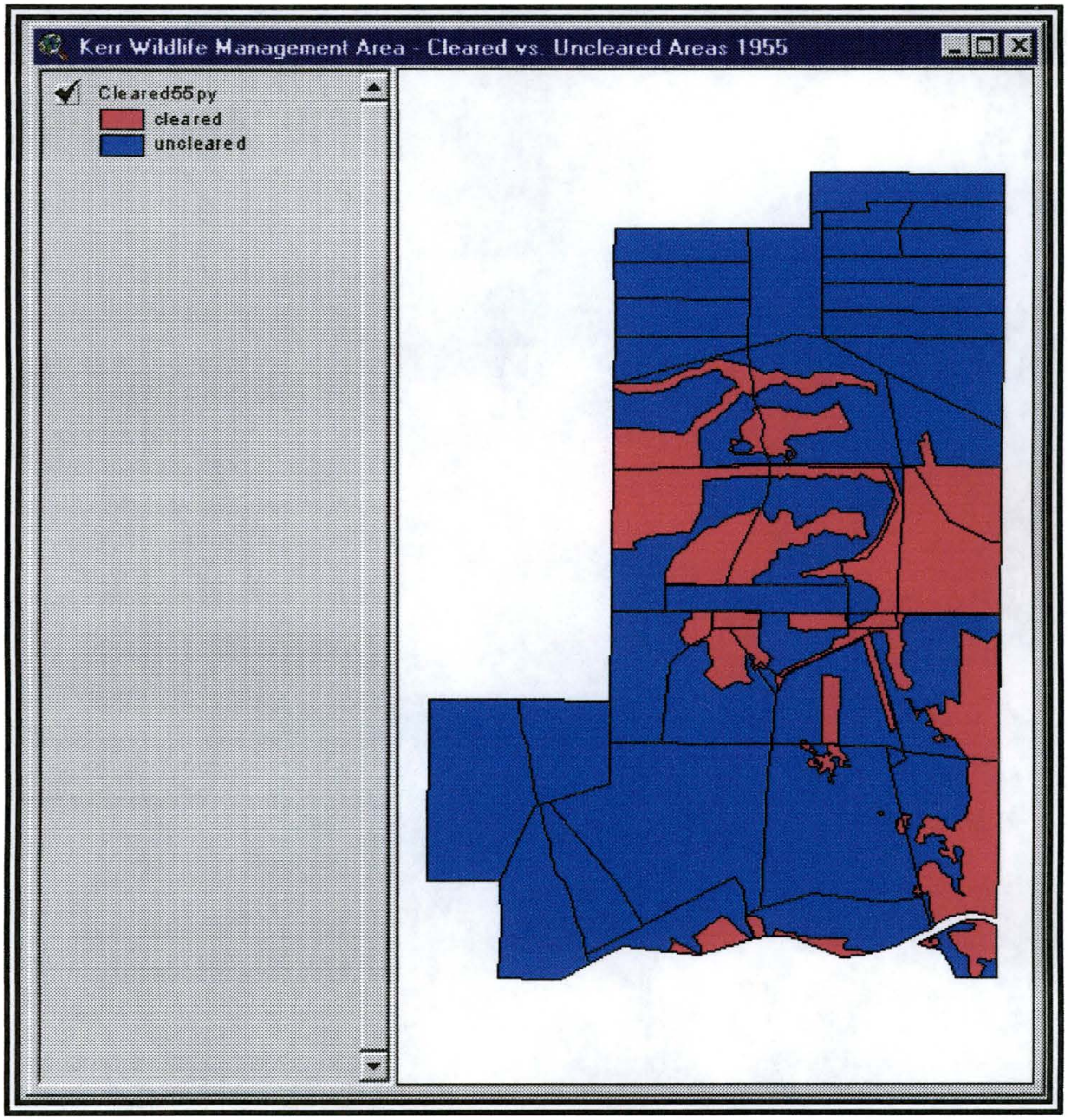

Figure 33. Brush Cleared and Uncleared Areas 1955, CLRD55PY.

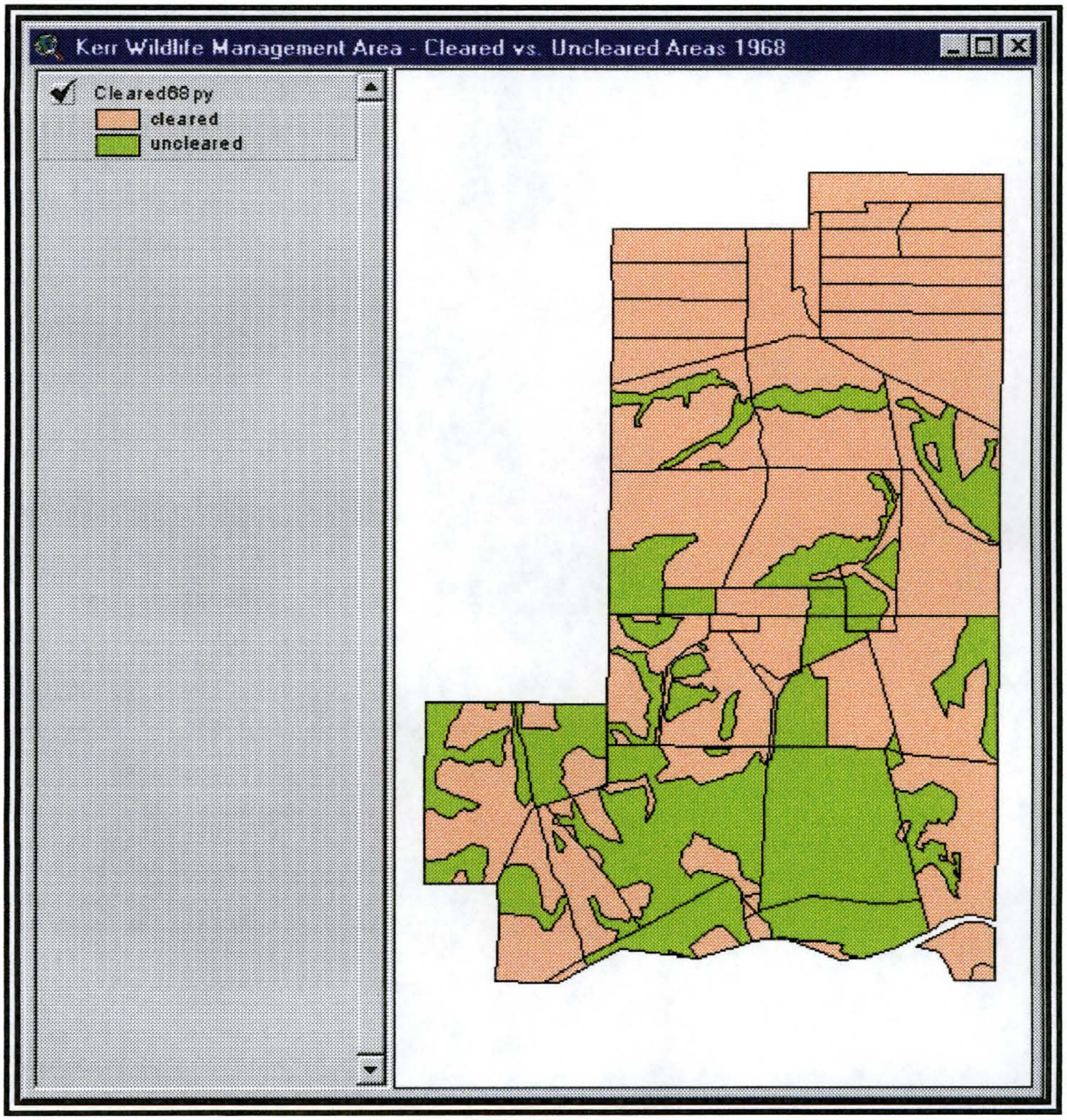

Figure 34. Brush Cleared and Uncleared Areas 1968, CLRD68PY.

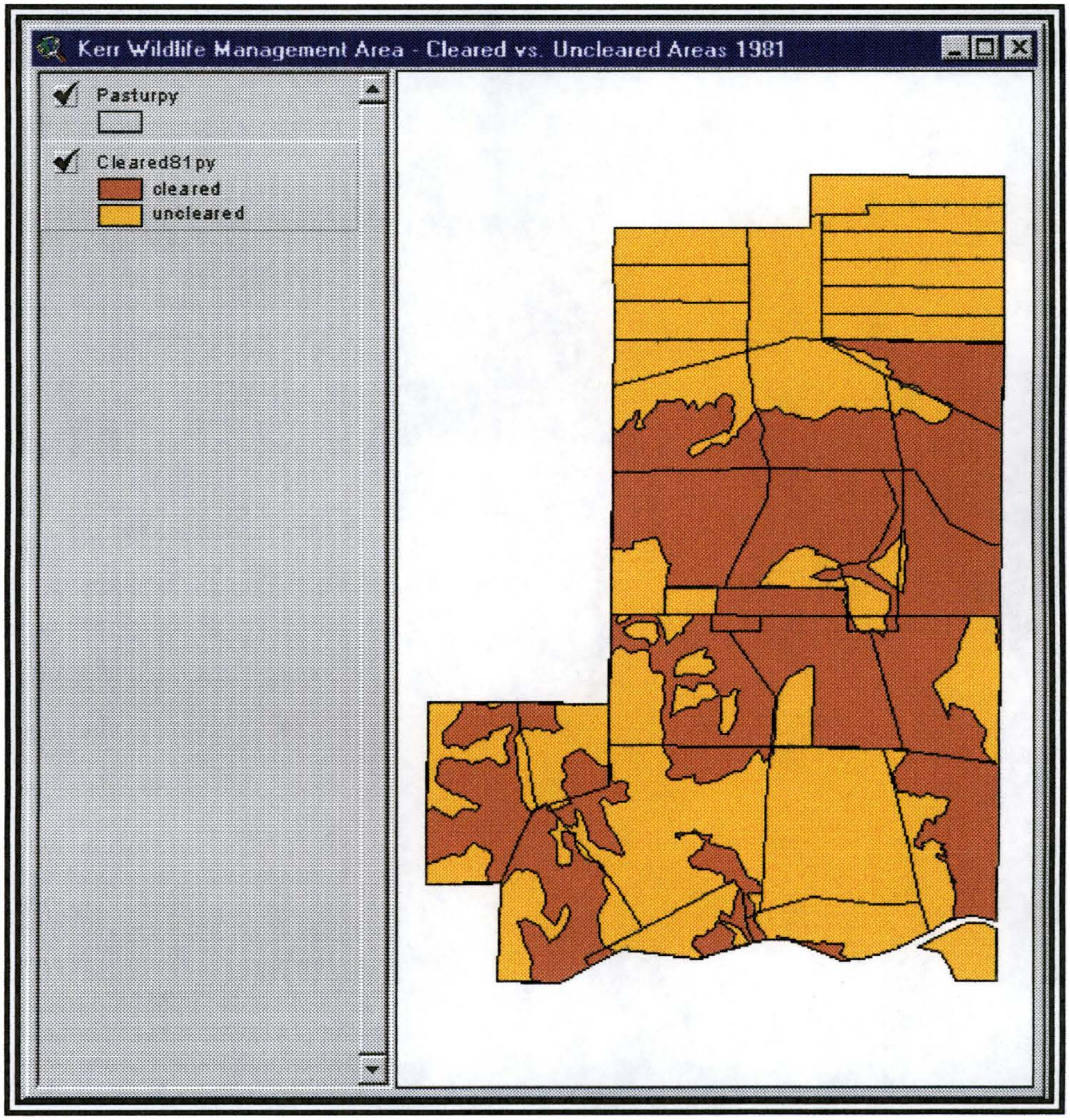

Figure 35. Brush Cleared and Uncleared Areas 1981, CLRD81PY.

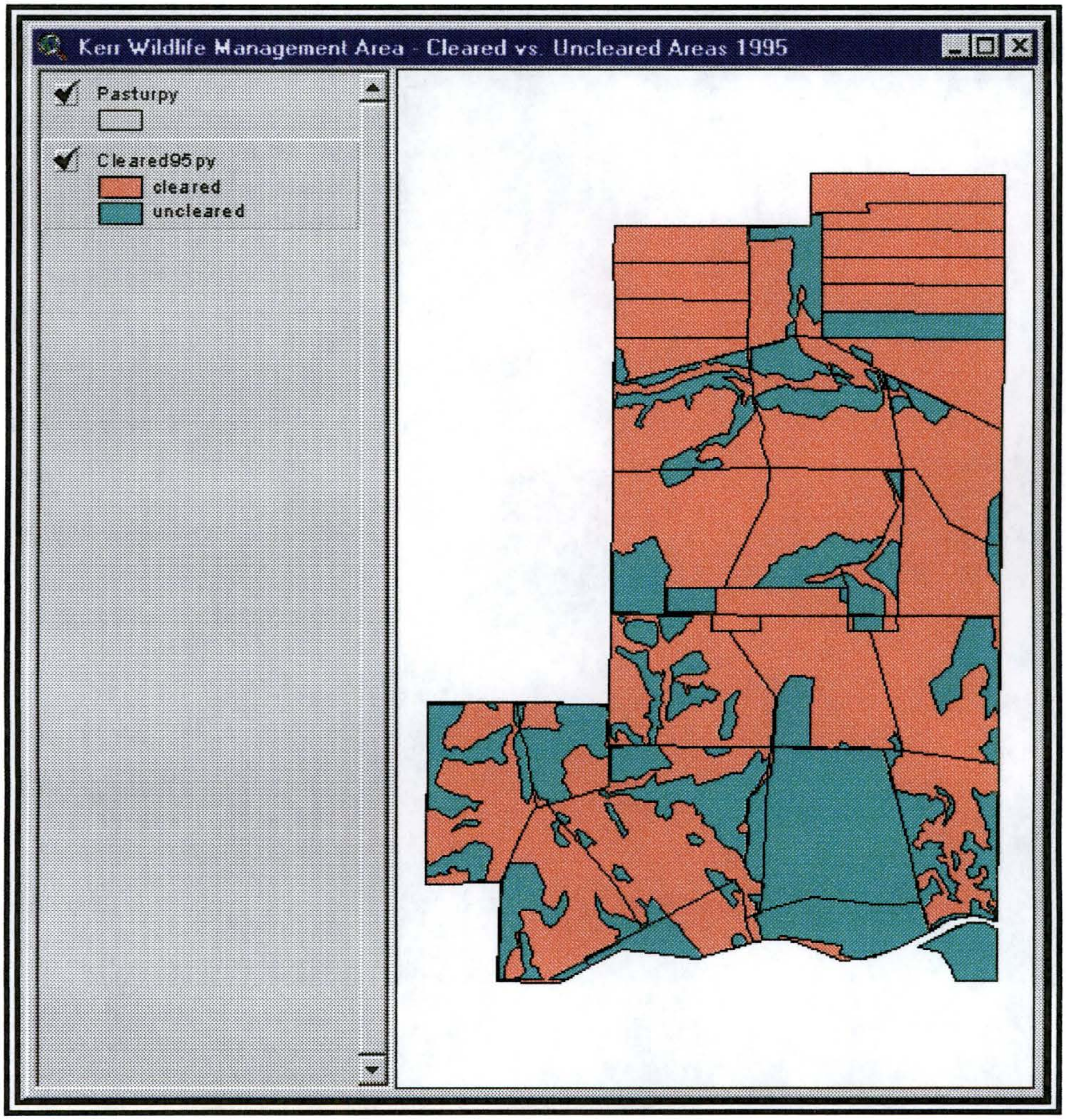

Figure 36. Brush Cleared and Uncleared Areas 1995, CLRD95PY

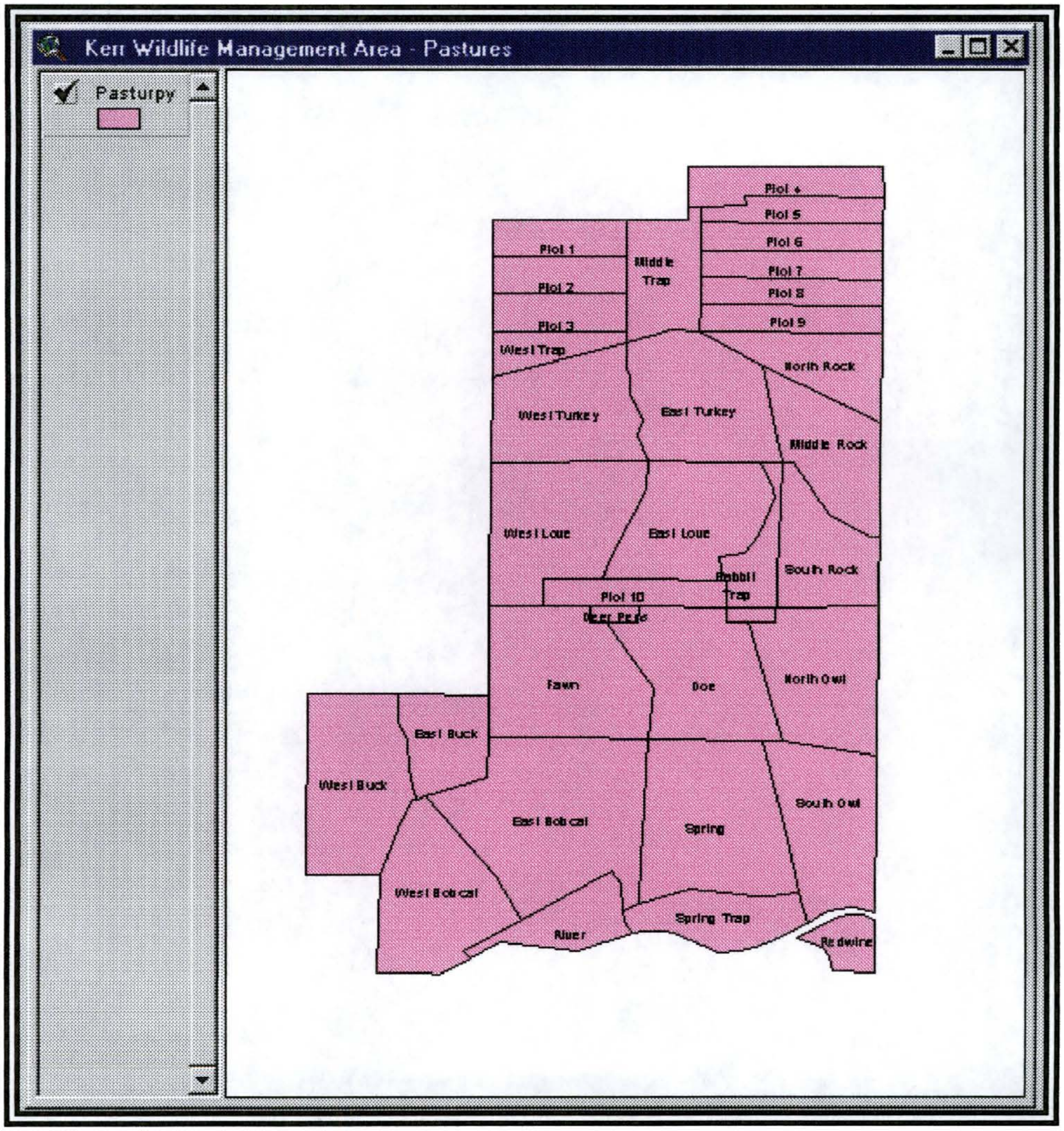

Figure 37. Pasture areas, PASTURPY, which serves as a base map.

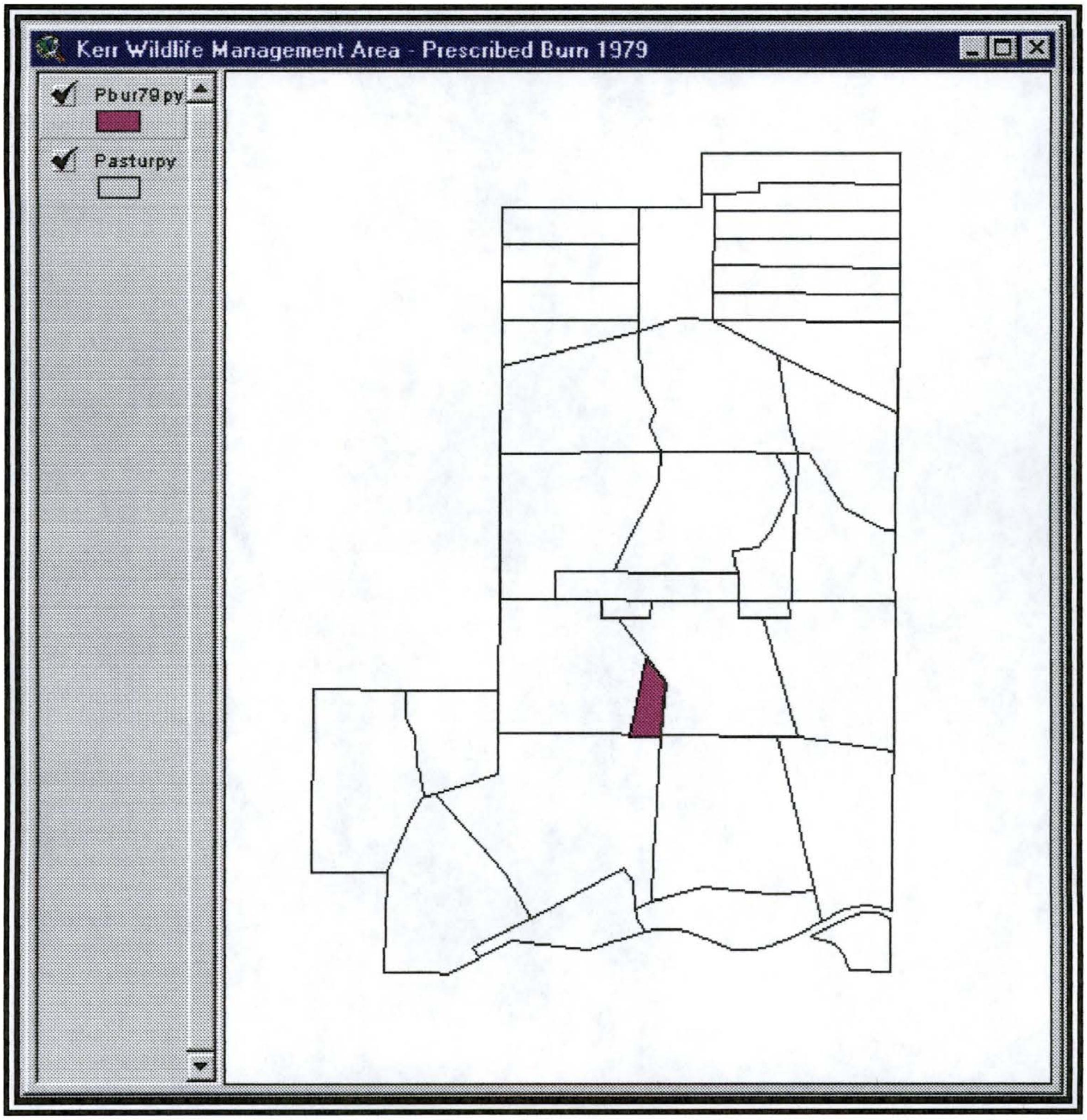

Figure 38. Prescribed burn areas for 1979, PBUR79PY.

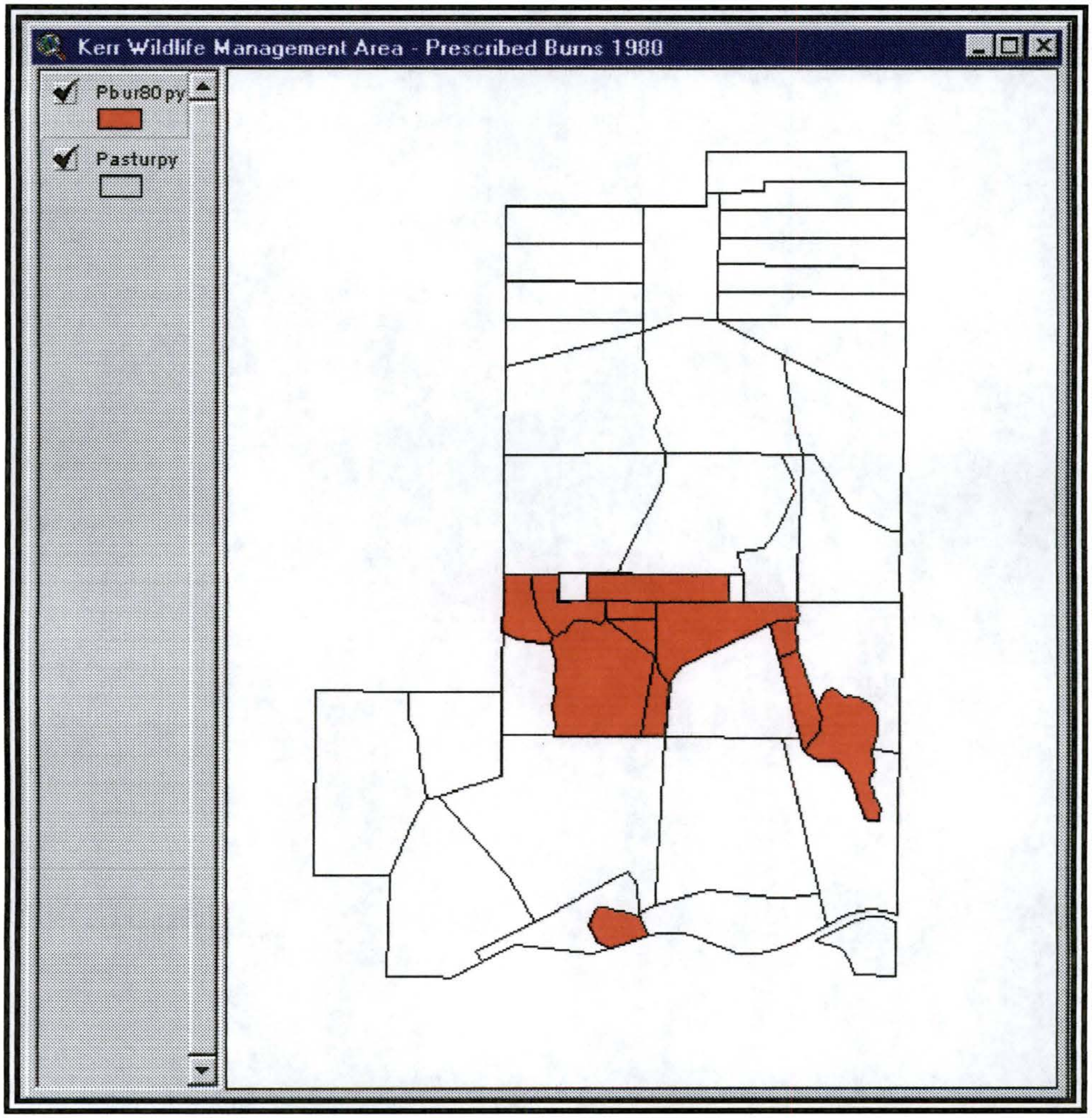

Figure 39. Prescribed burn areas for 1980, PBUR80PY.

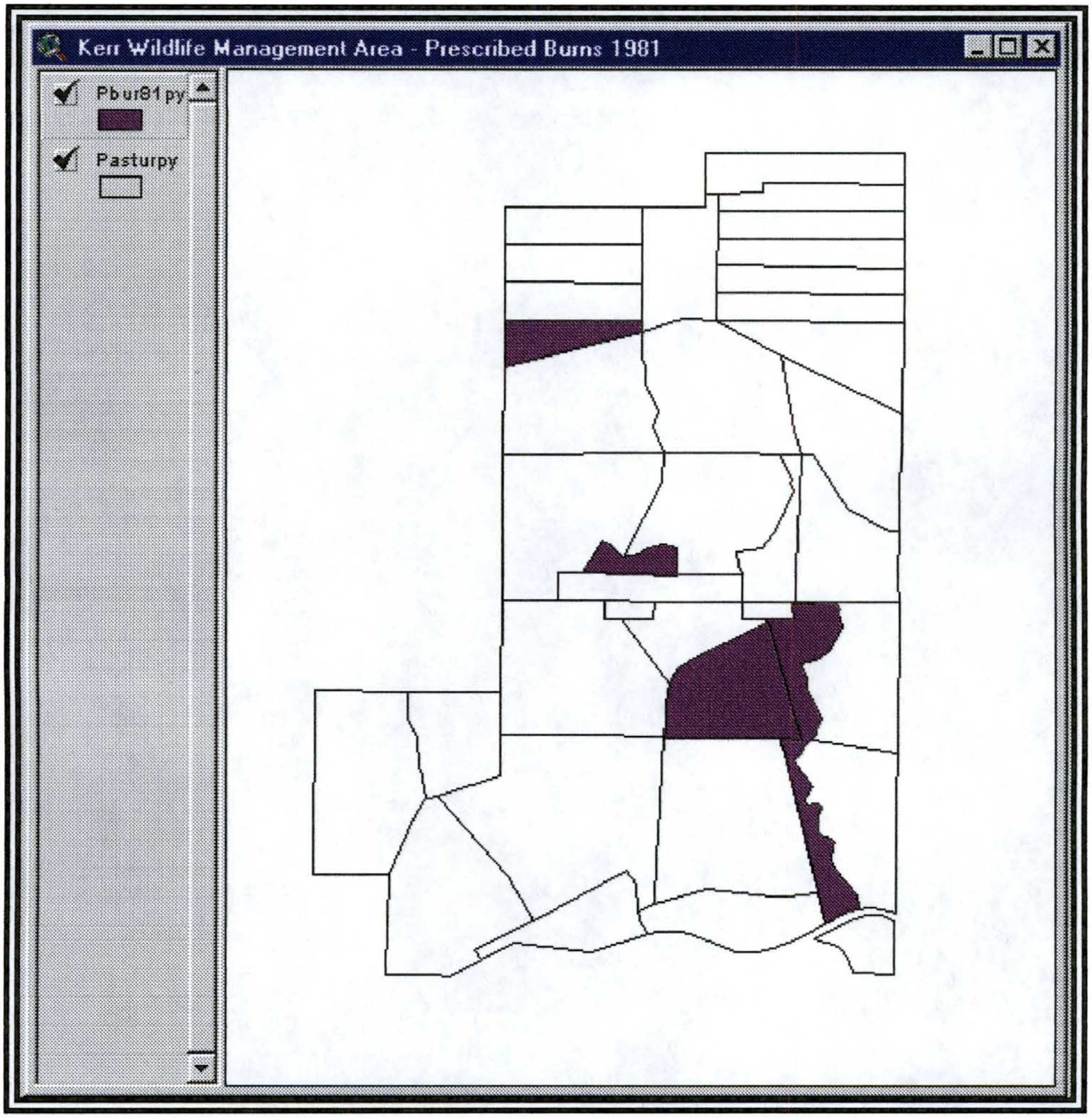

Figure 40. Prescribed burn areas for 1981, PBUR81PY.

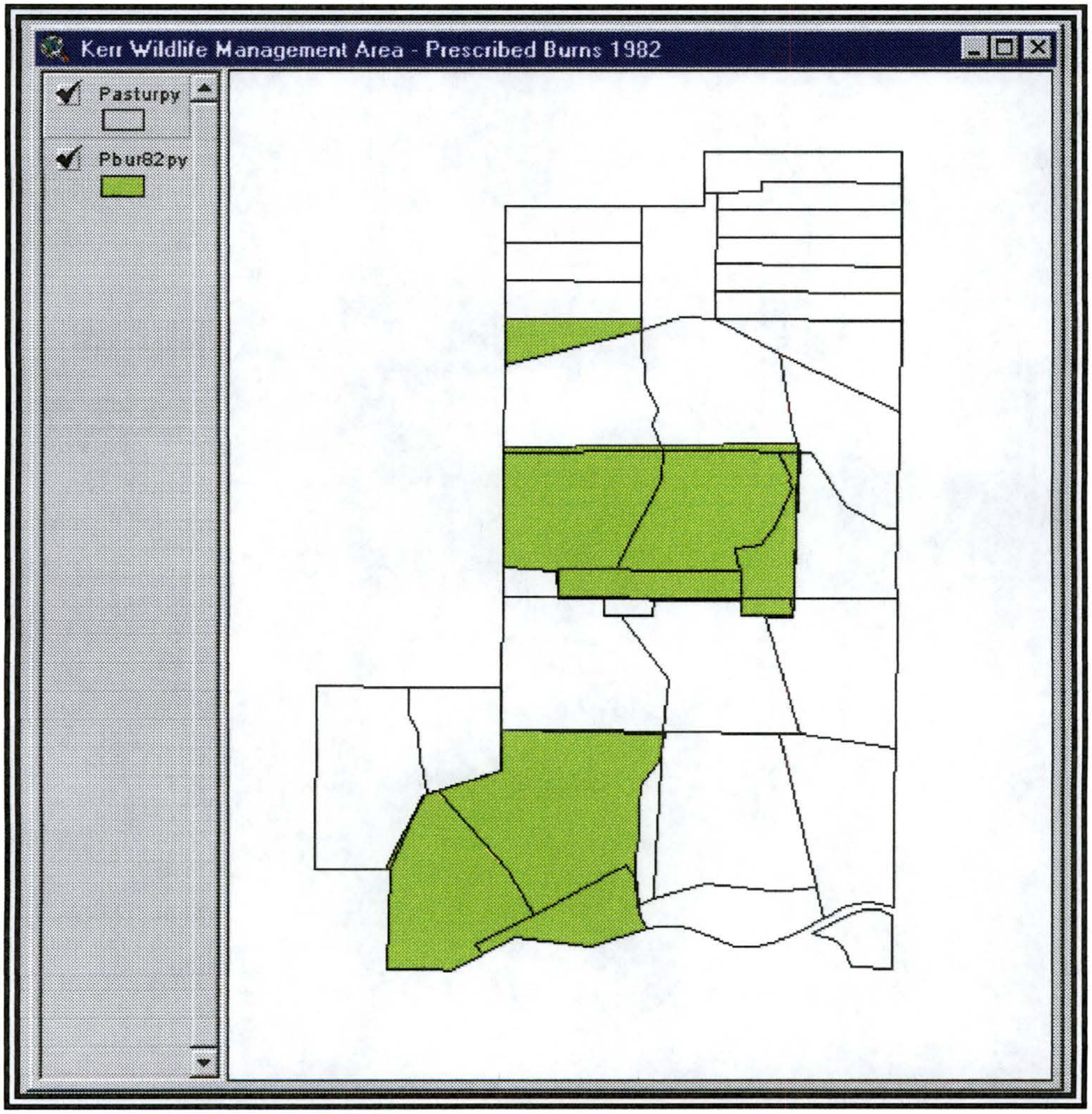

Figure 41. Prescribed burn areas for 1982, PBUR82PY.

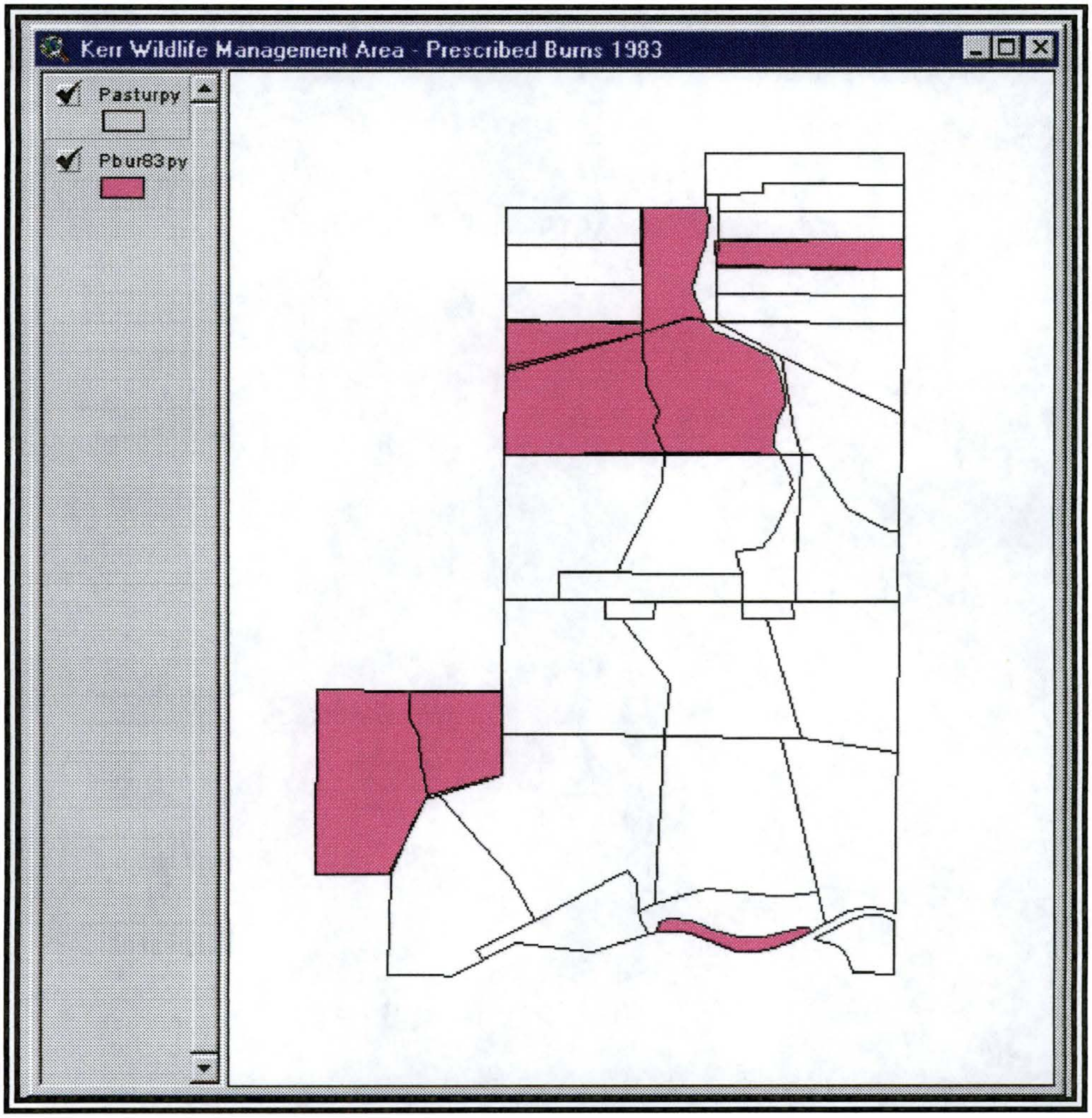

Figure 42. Prescribed burn areas for 1983, PBUR83PY.

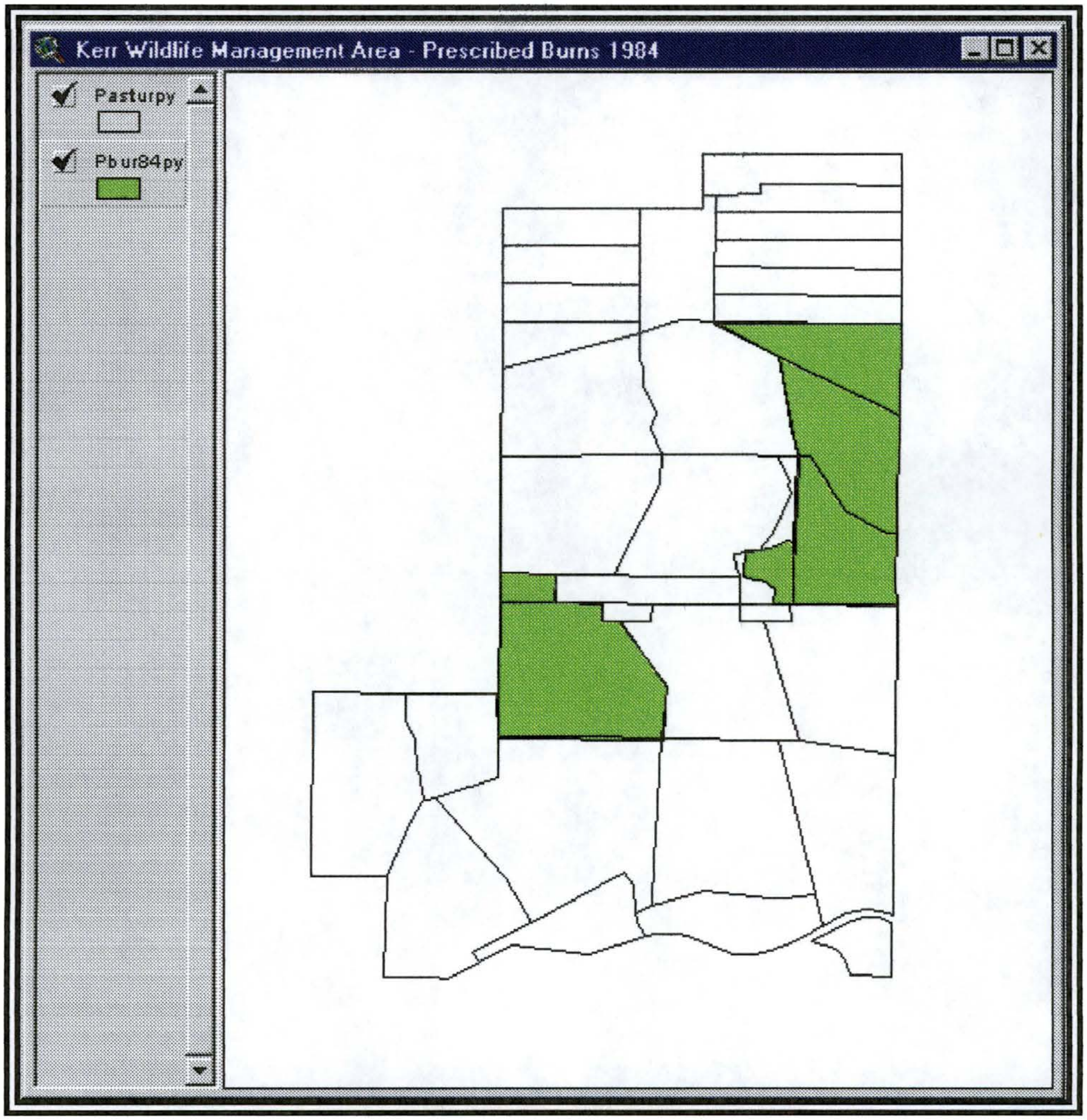

Figure 43. Prescribed burn areas for 1984, PBUR84PY.

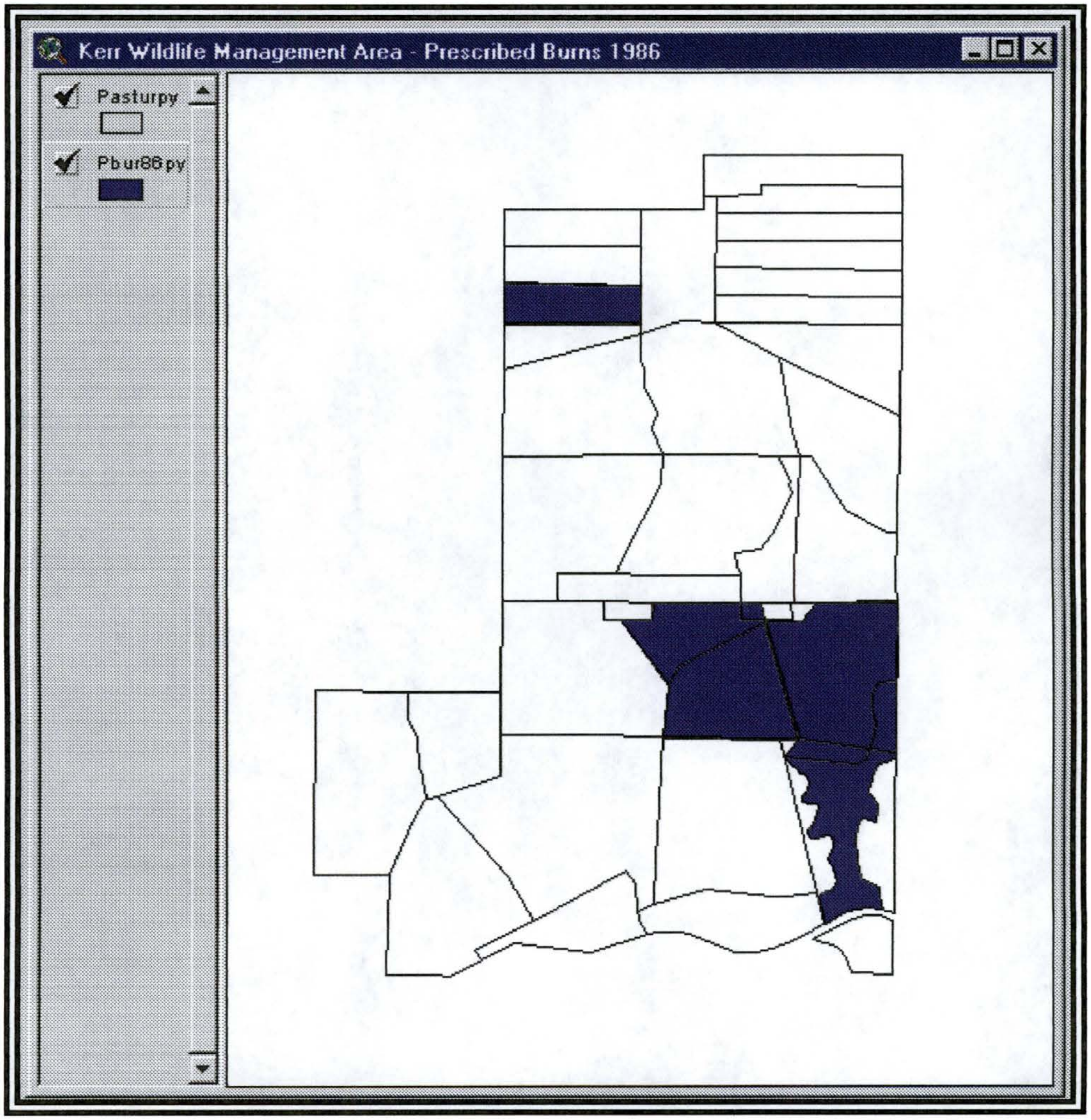

Figure 44. Prescribed burn areas for 1986, PBUR86PY.

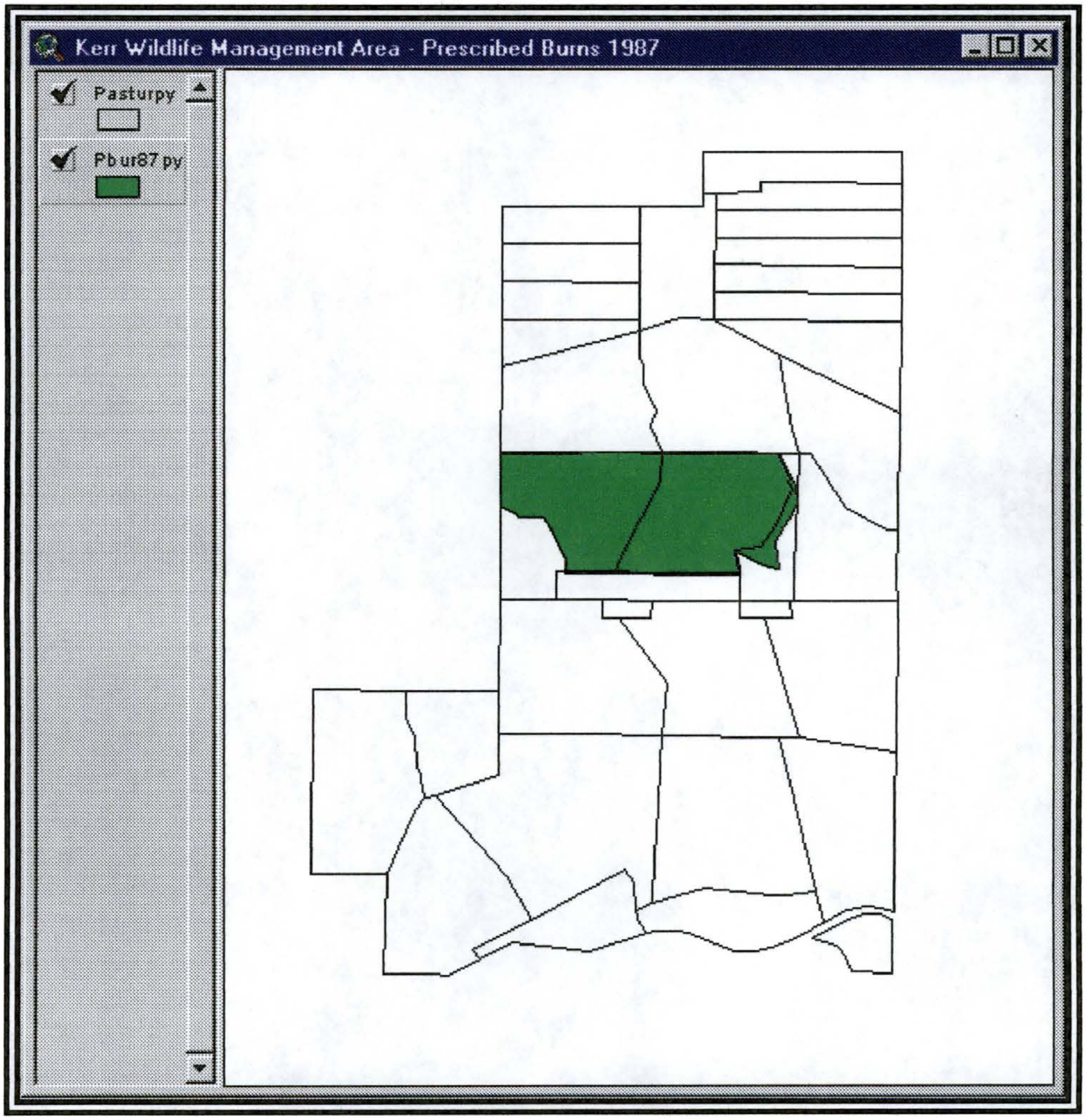

Figure 45. Prescribed burn areas for 1987, PBUR87PY.

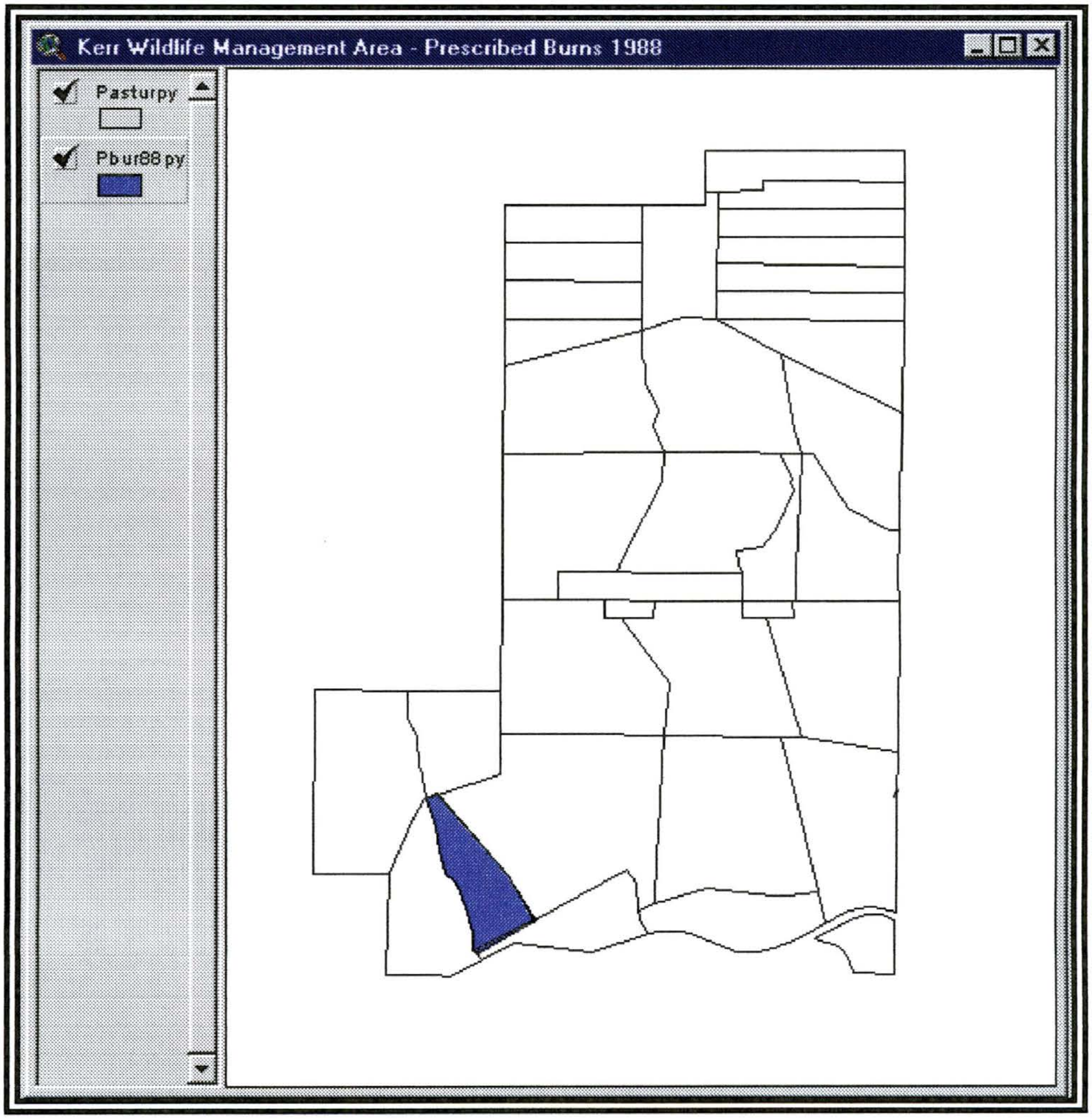

Figure 46. Prescribed burn areas for 1988, PBUR88PY.

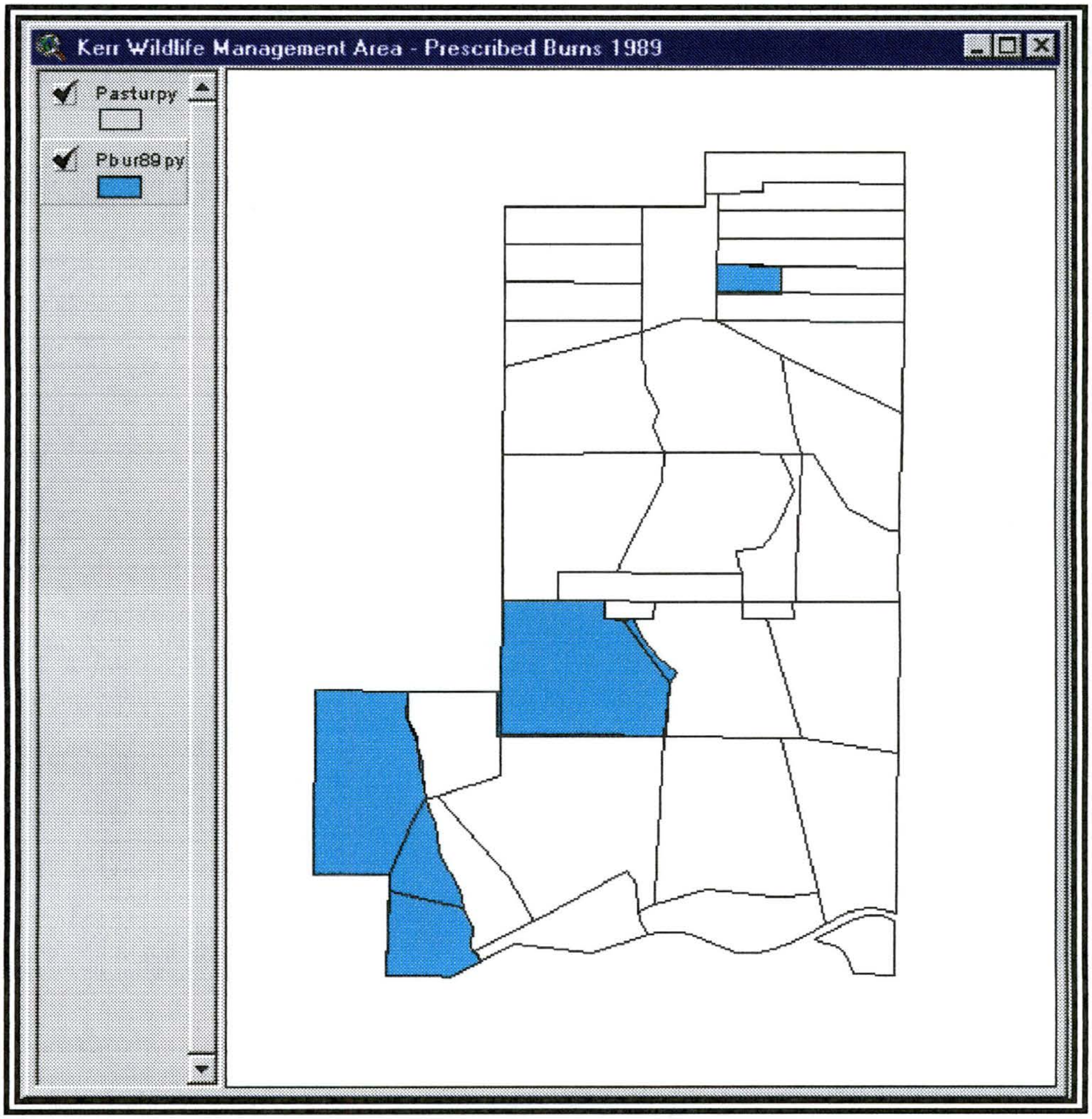

Figure 47. Prescribed burn areas for 1989, PBUR89PY.

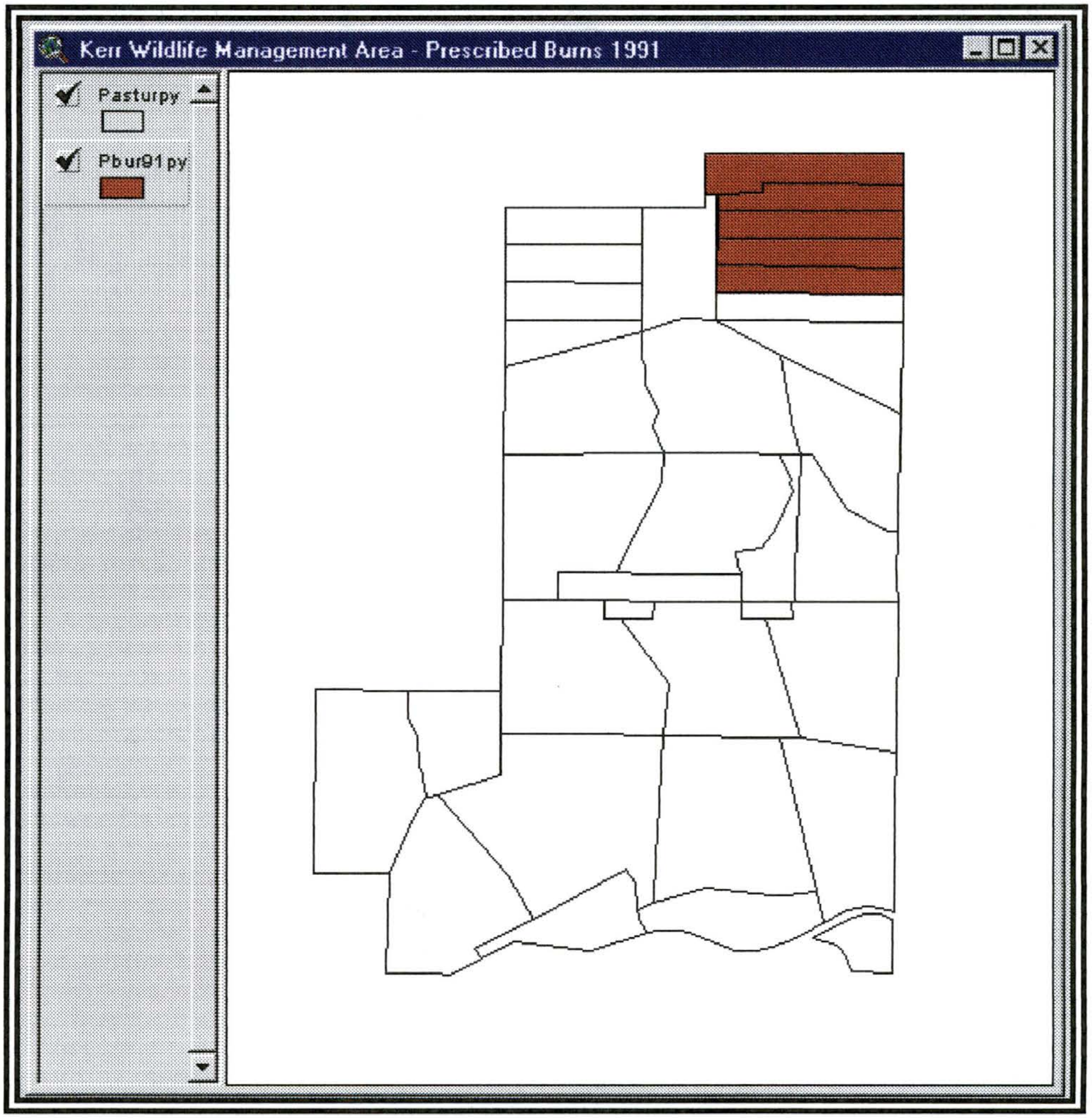

Figure 48. Prescribed burn areas for 1991, PBUR91PY.

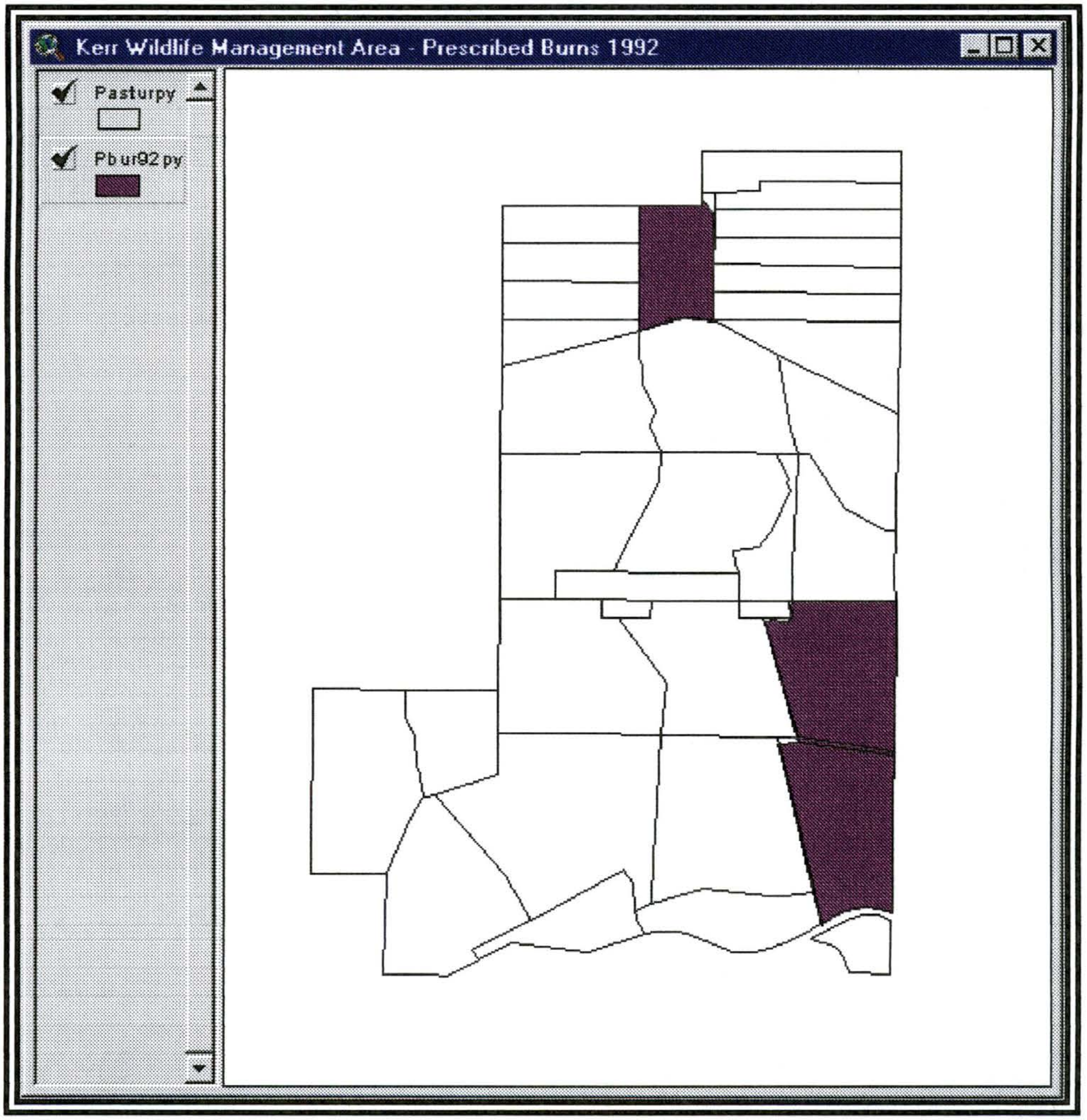

Figure 49. Prescribed burn areas for 1992, PBUR92PY.

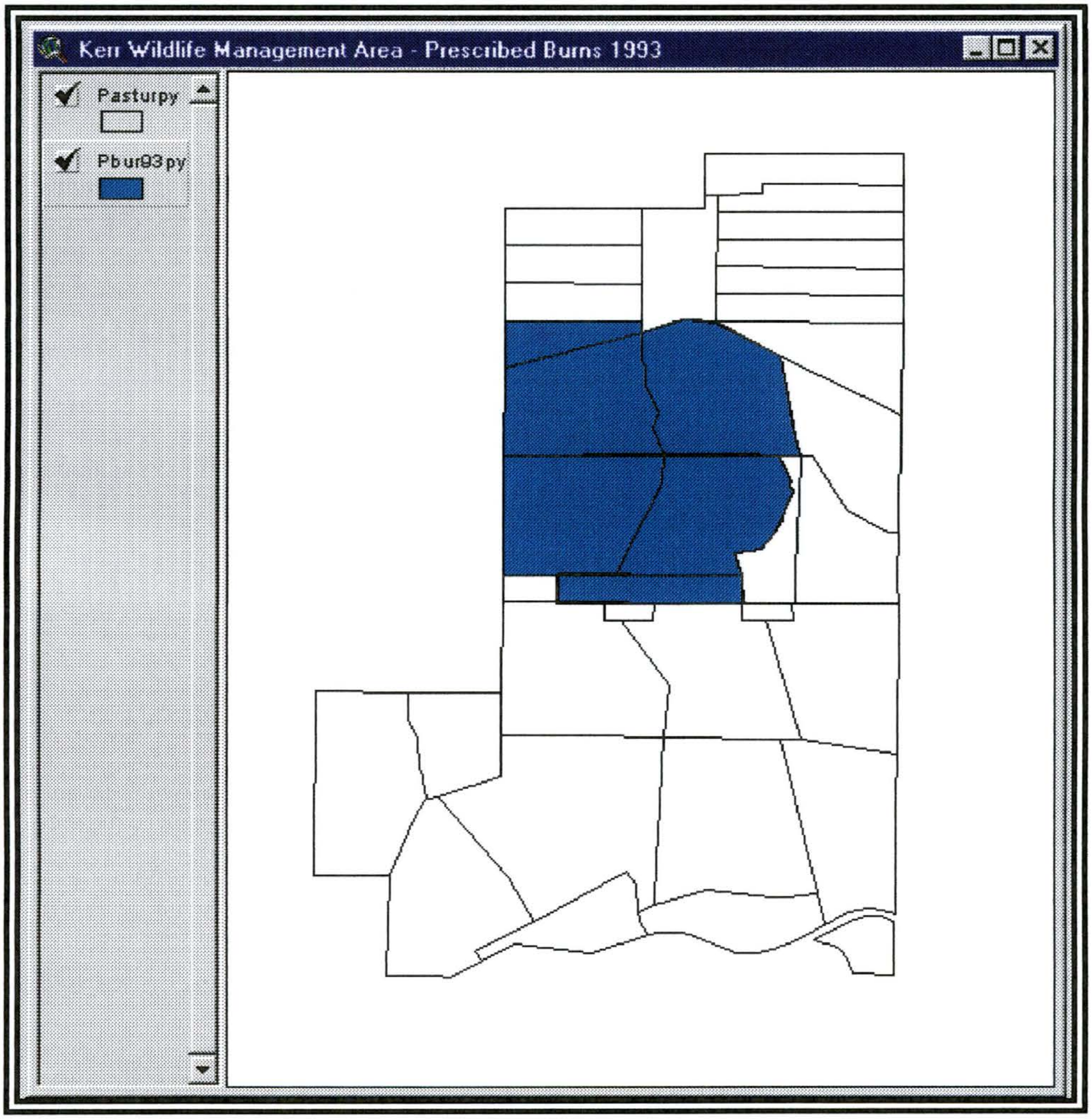

Figure 50. Prescribed burn areas for 1993, PBUR93PY.

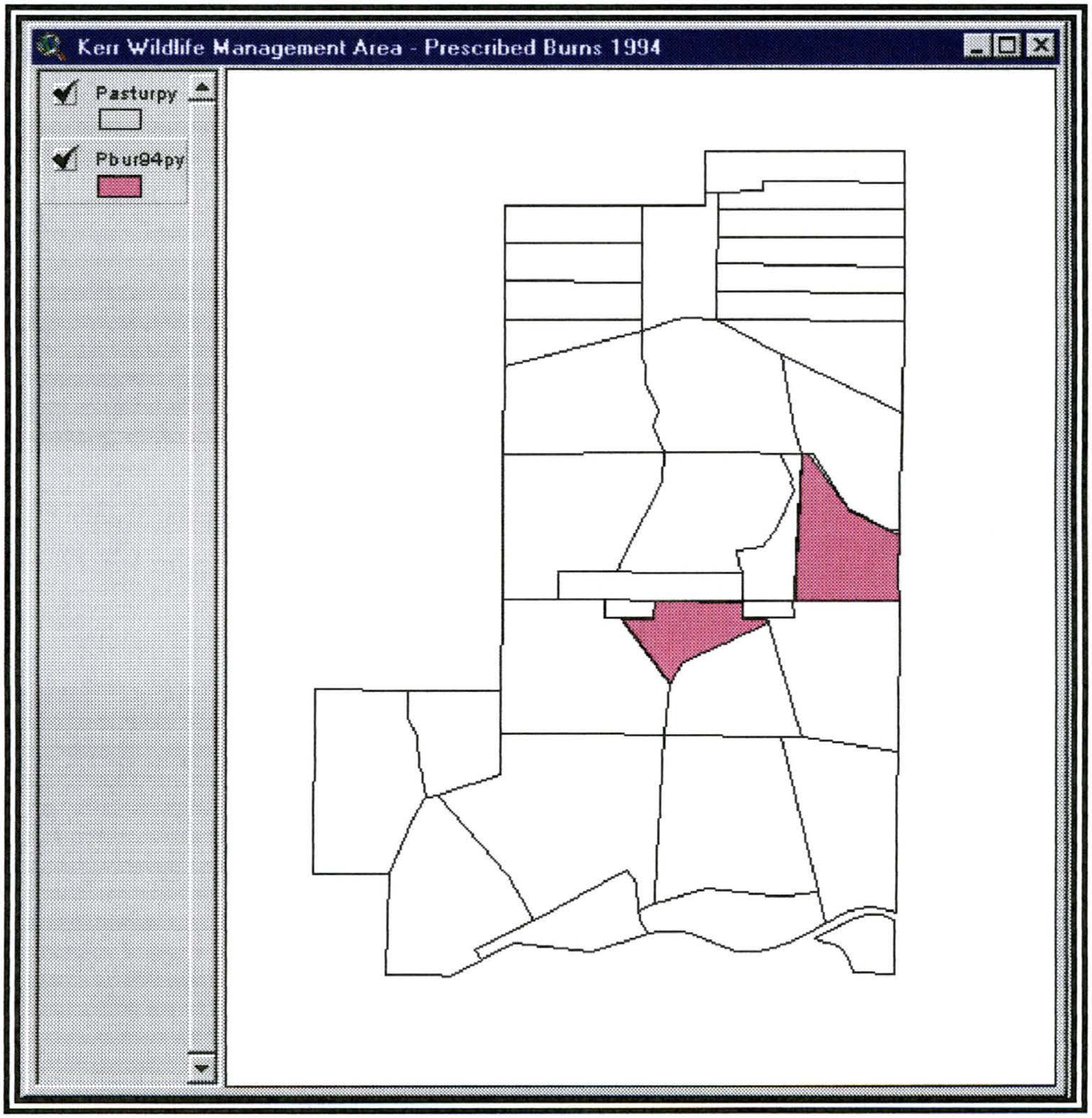

Figure 51. Prescribed burn areas for 1994, PBUR94PY.

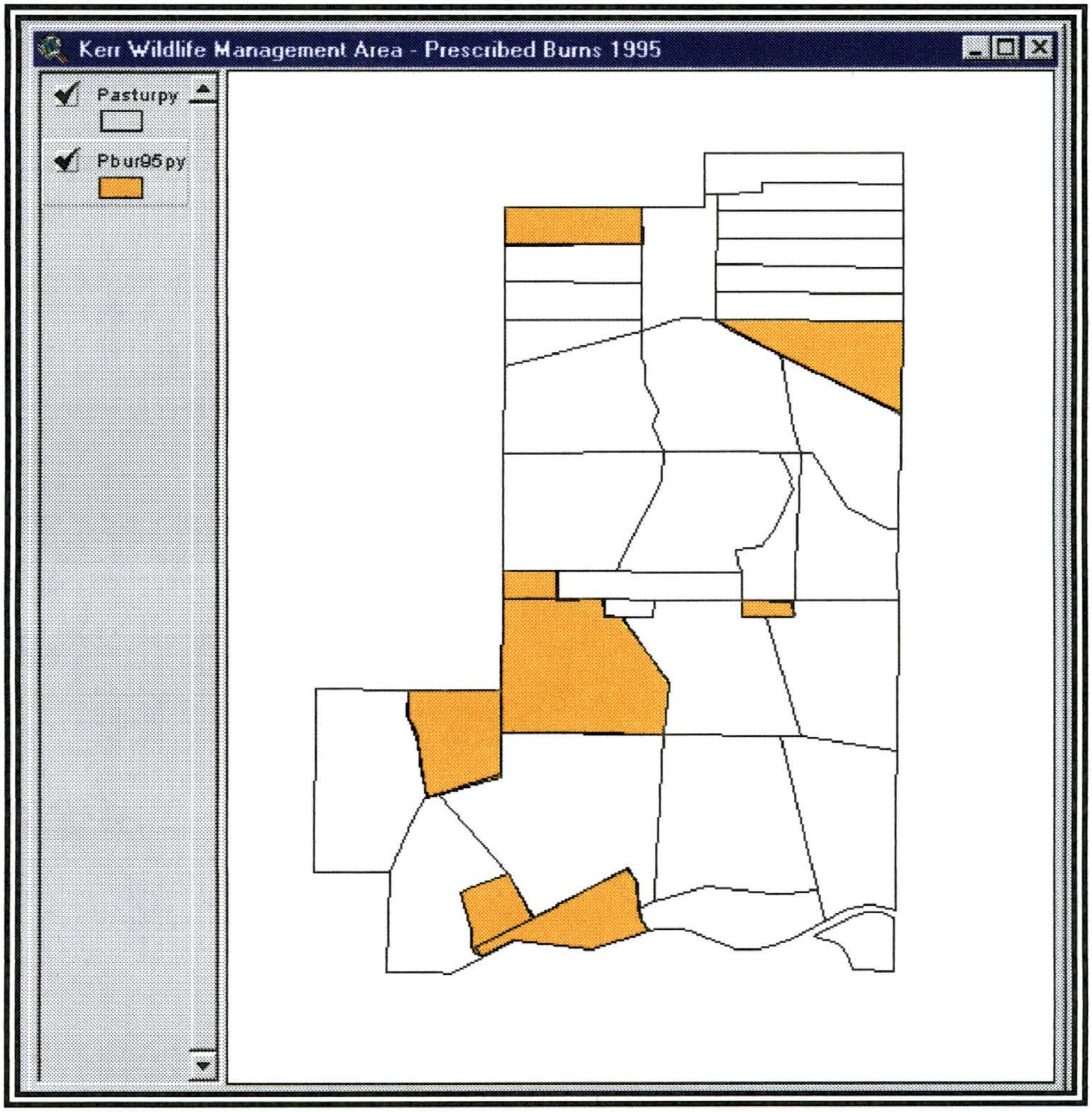

Figure 52. Prescribed burn areas for 1995, PBUR95PY.

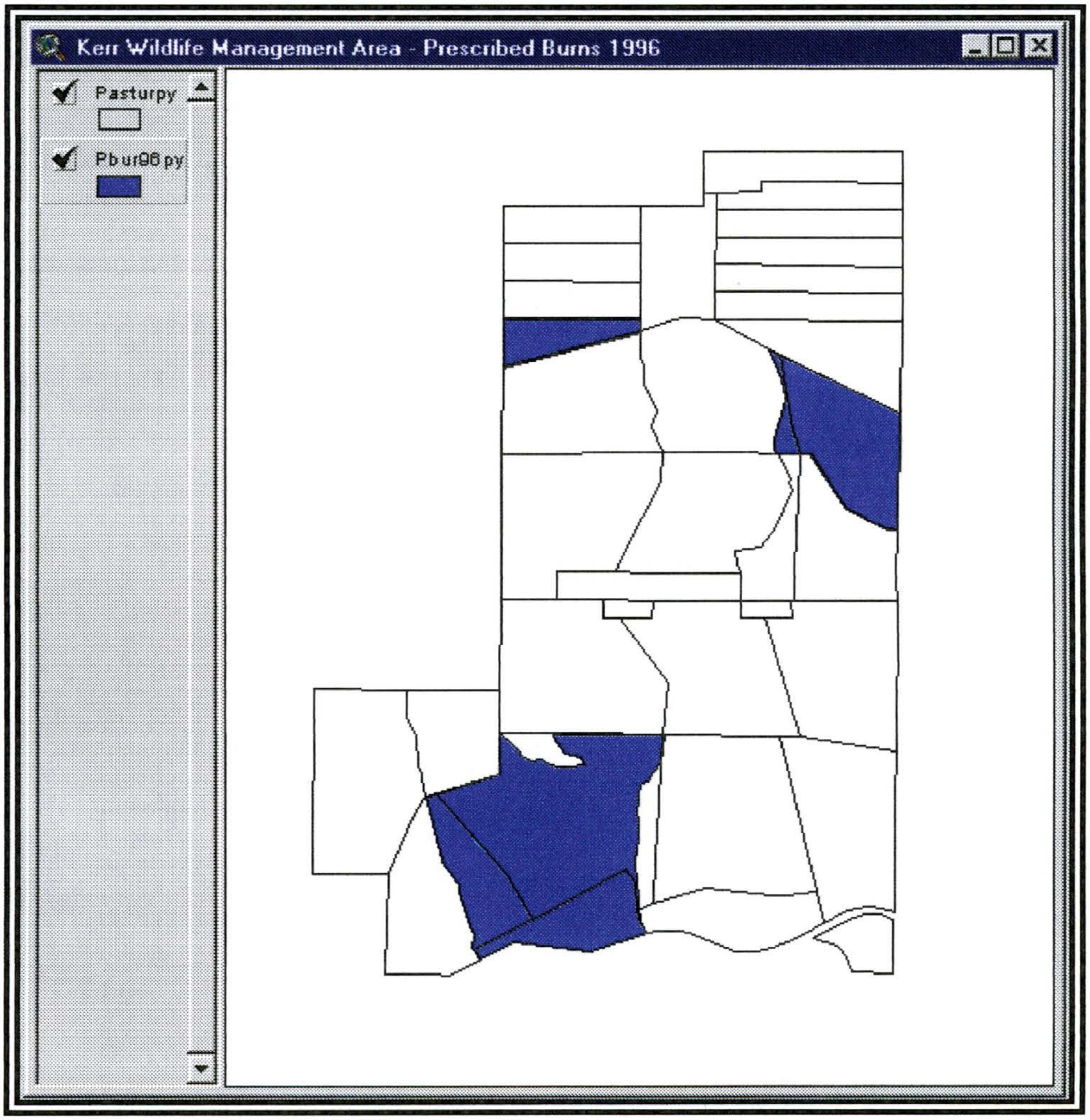

Figure 53. Prescribed burn areas for 1996, PBUR96PY.

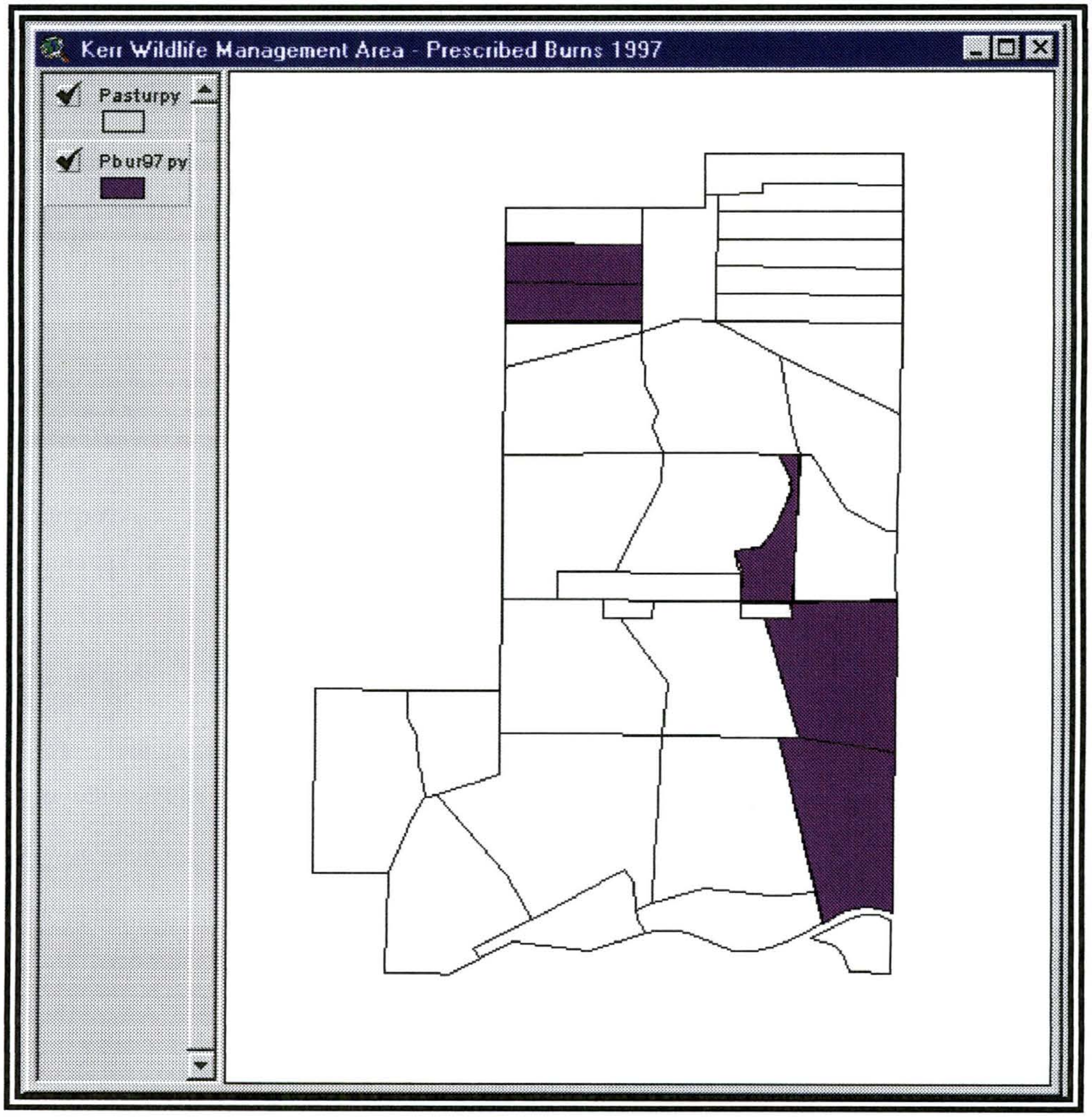

Figure 54. Prescribed burn areas for 1997, PBUR97PY.

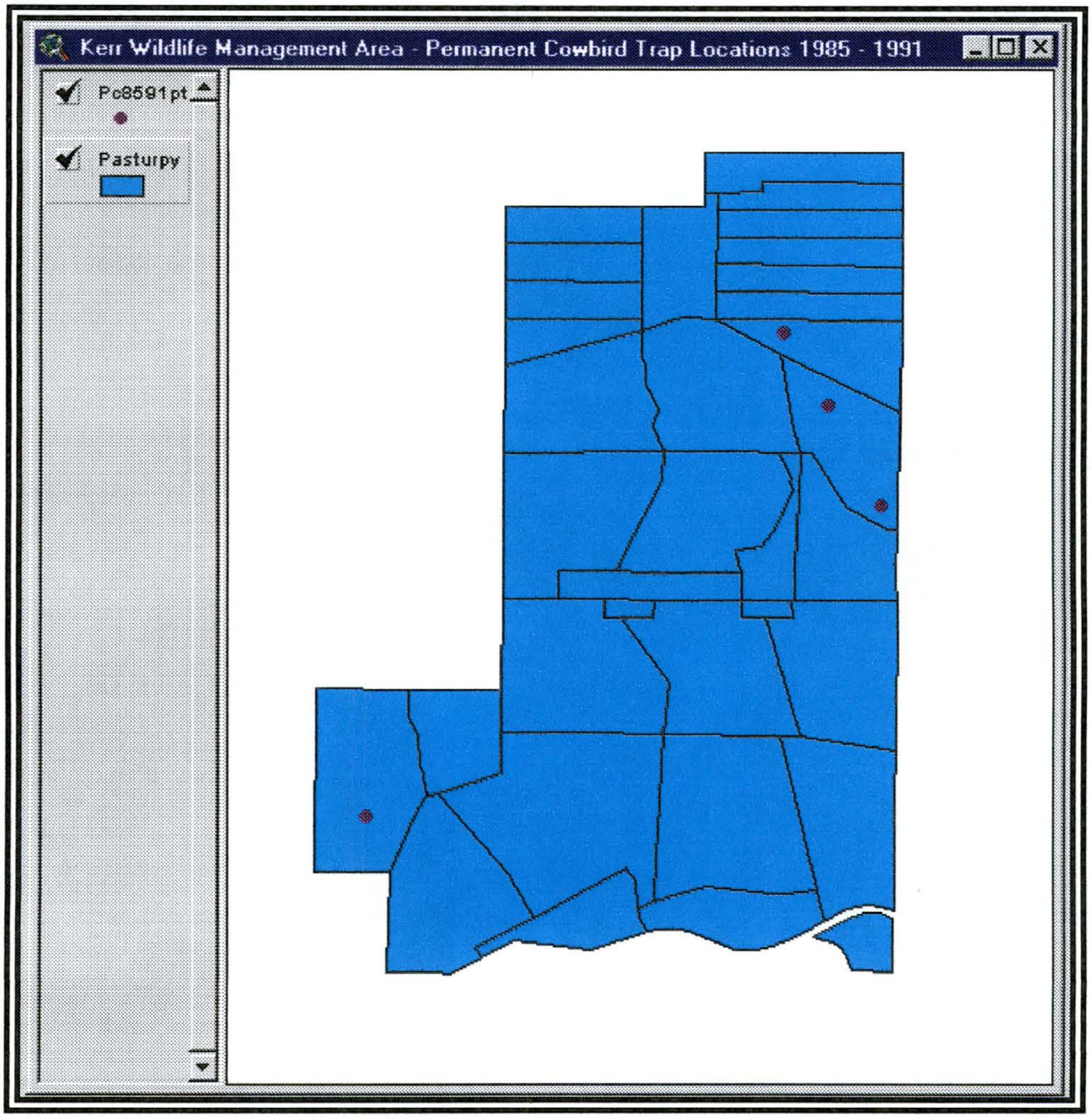

Figure 55. Cowbird trap locations 1985-1991, PC8591PT.

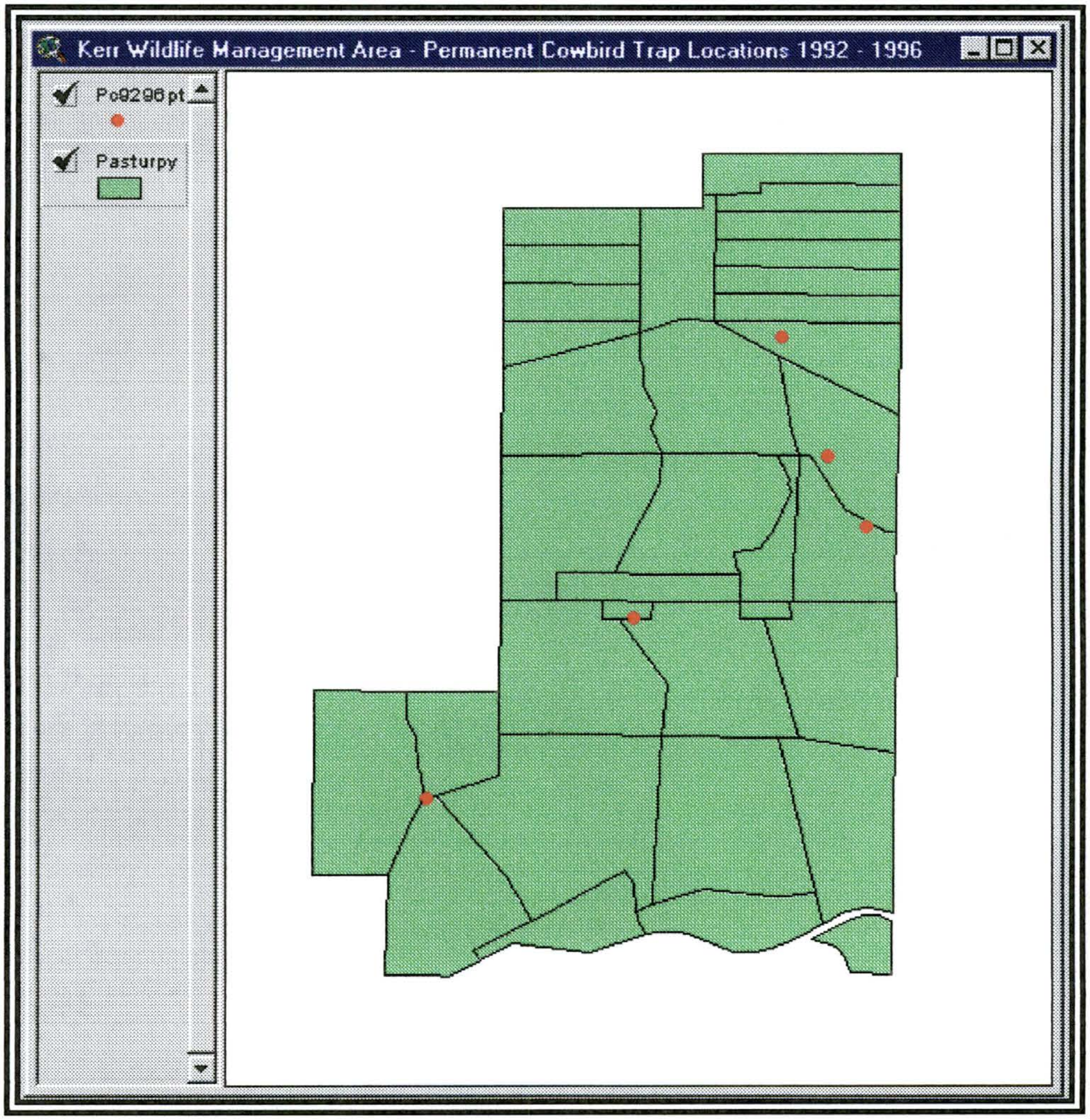

Figure 56. Cowbird trap locations 1992-1996, PC9296PT.

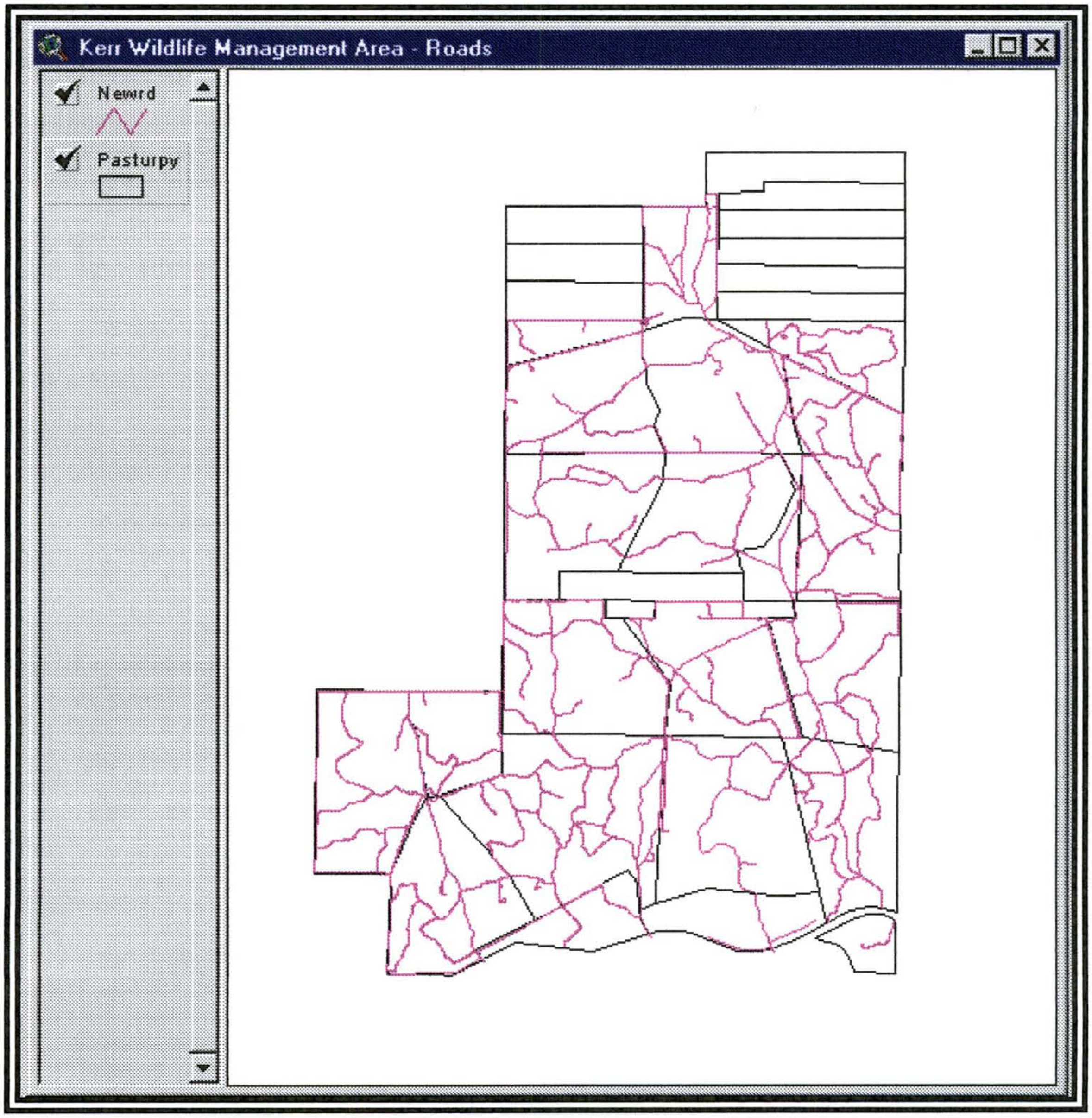

Figure 57. Road Map, ROADLN.

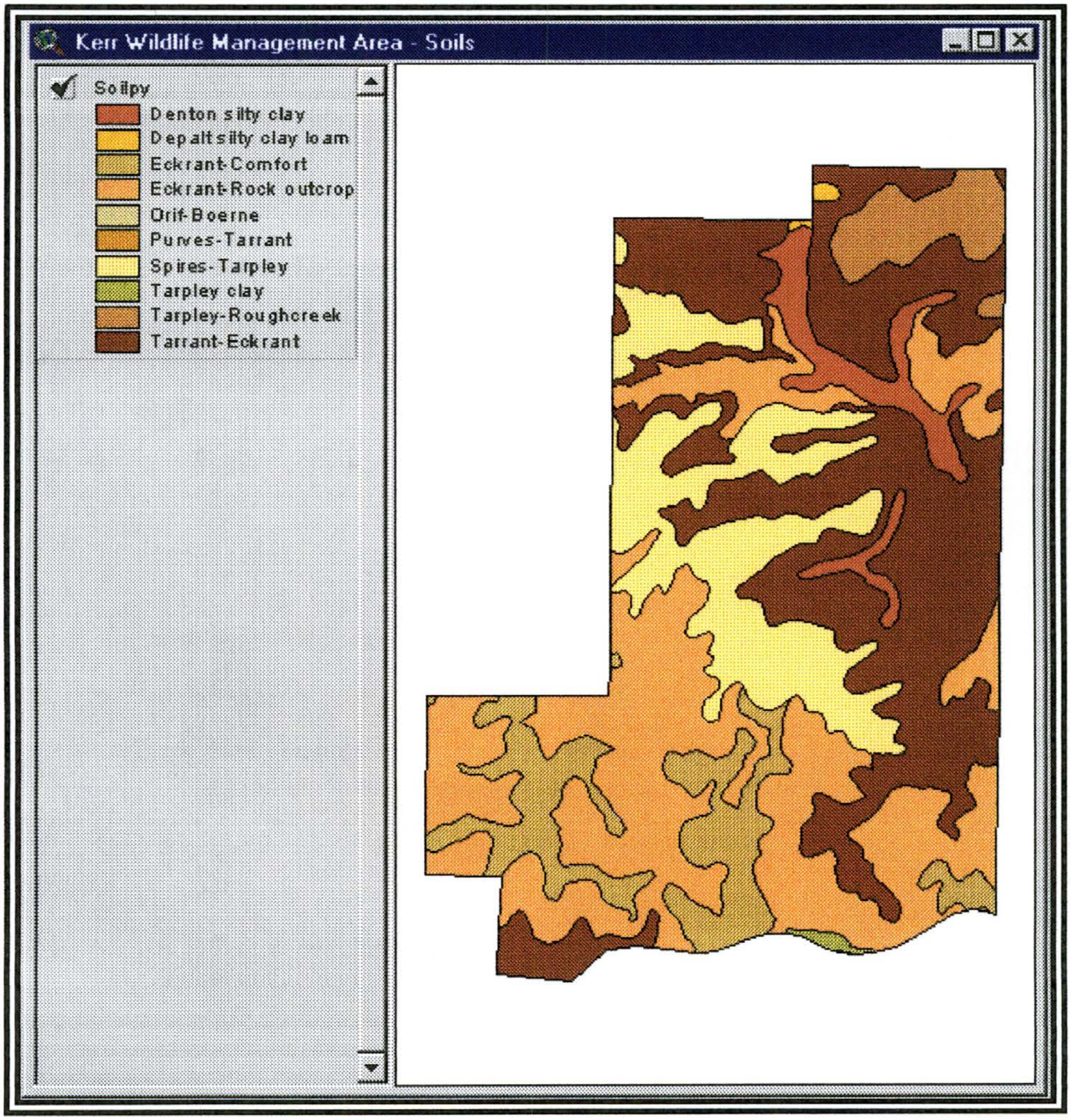

Figure 58. Soil Map, SOILPY.

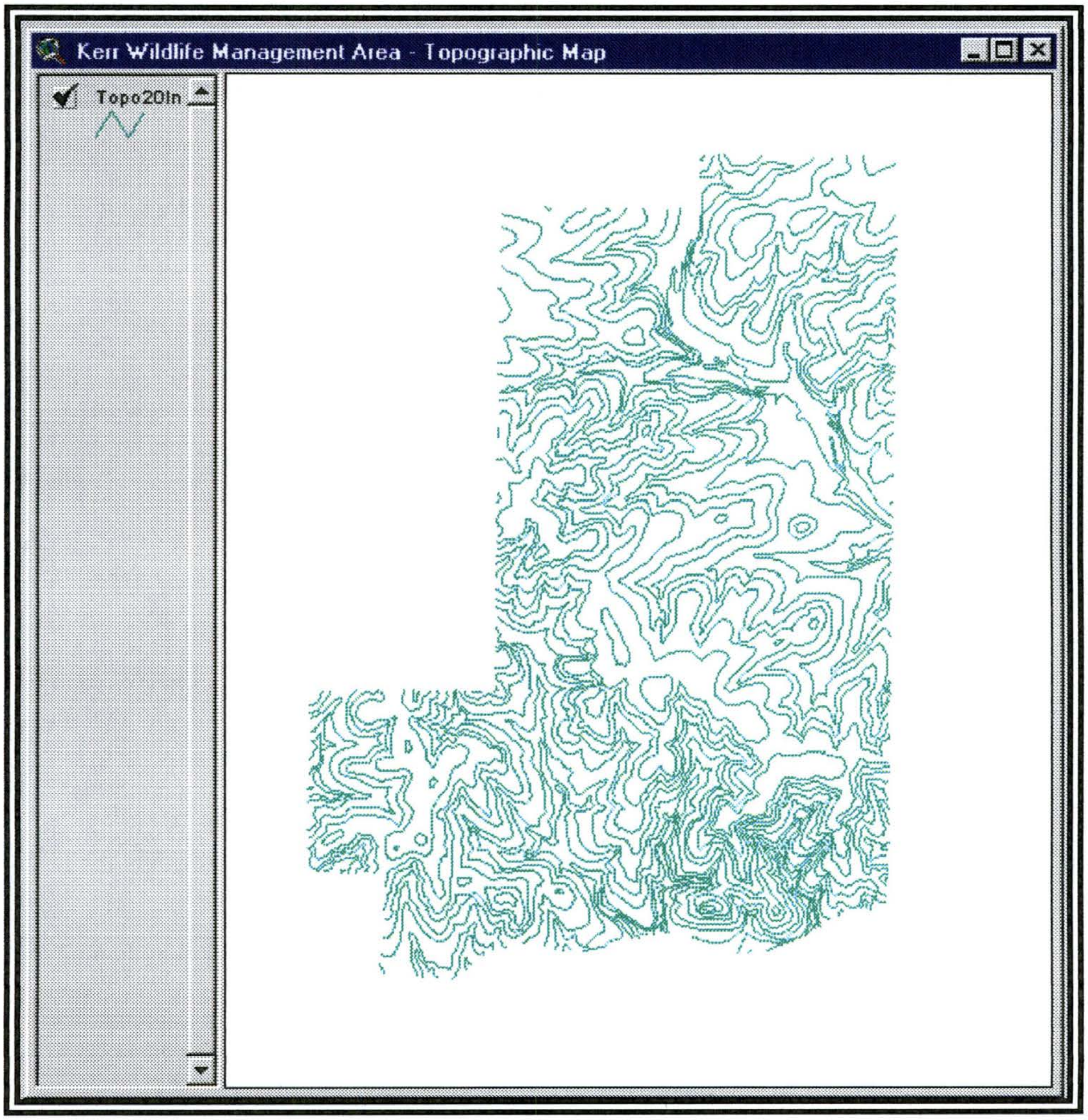

Figure 59. Contour map with 20ft intervals, TOPO20LN.

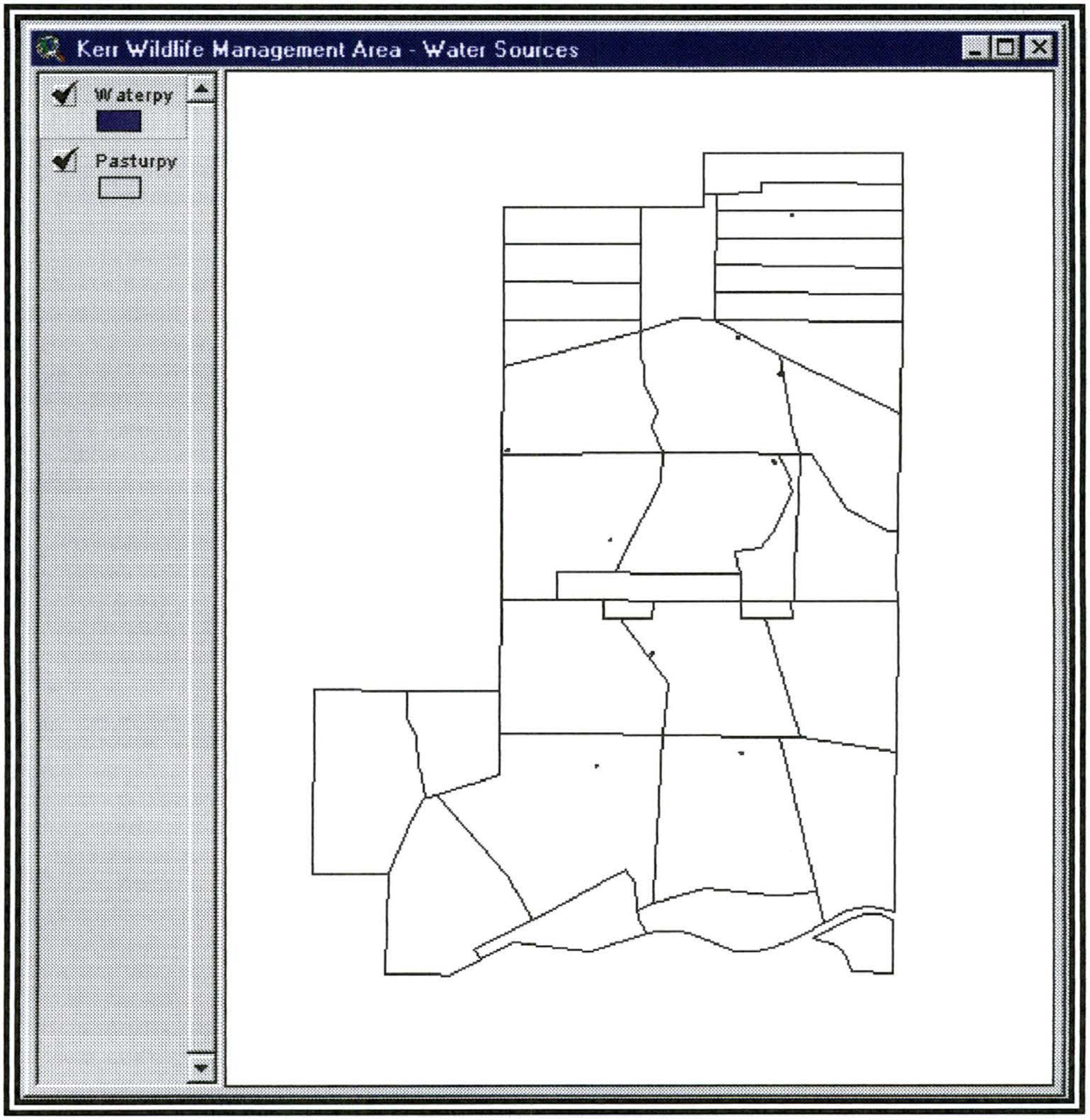

Figure 60. Water Sources indicating stock tank locations, WATERPY.

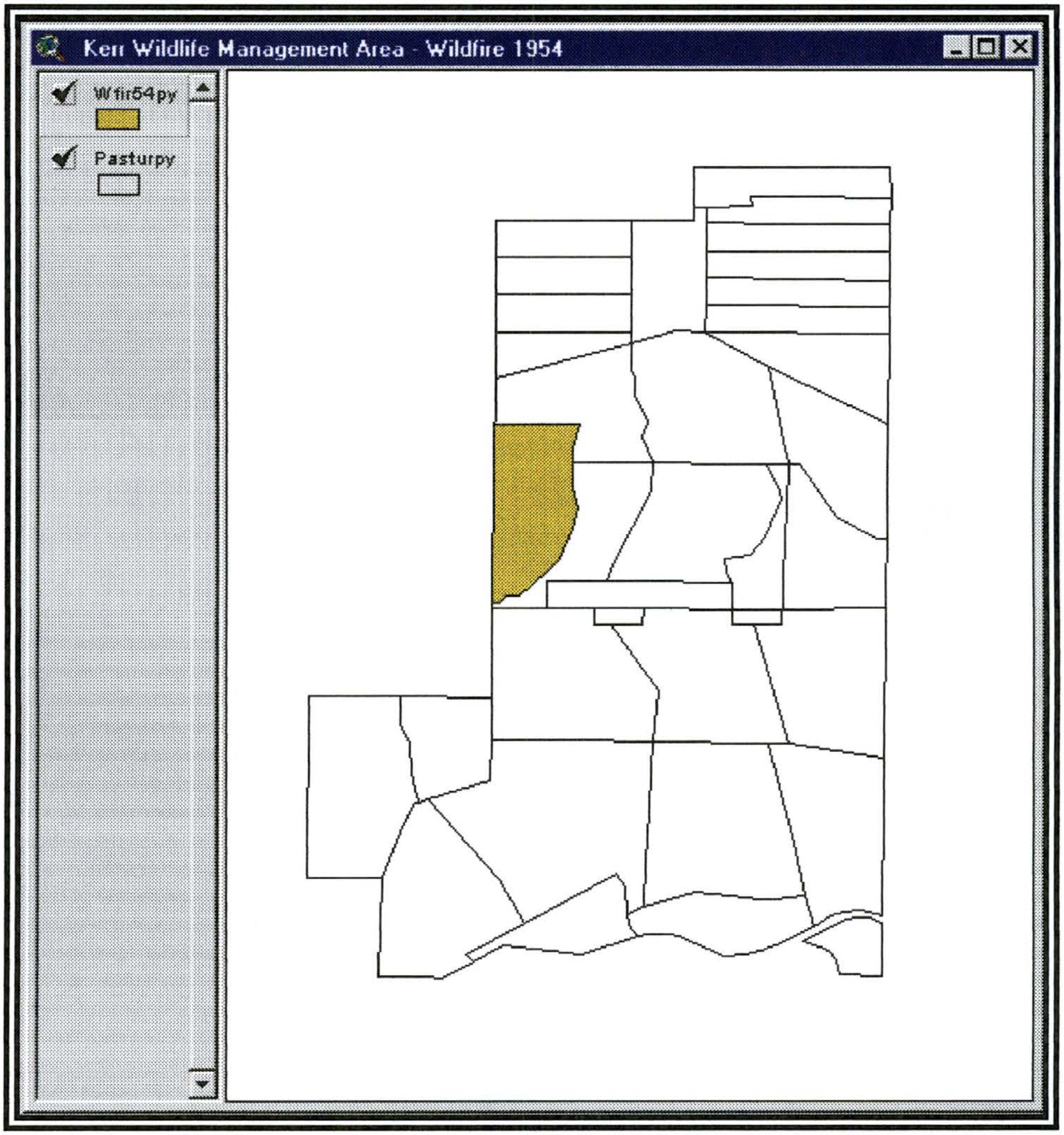

Figure 61. Wildfire 1954, WFIR54PY.

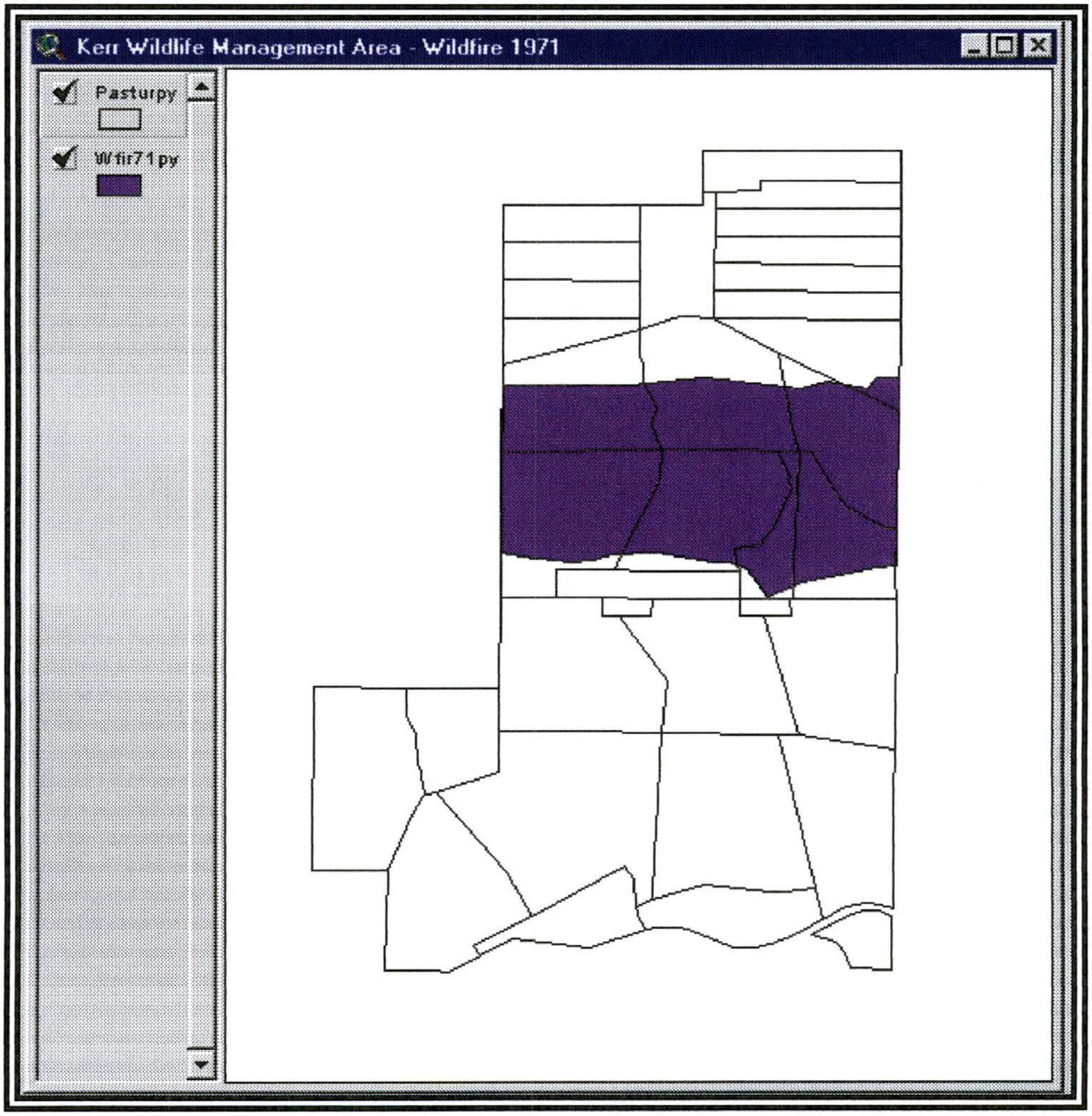

Figure 62. Wildfire 1971, WFIR71PY.

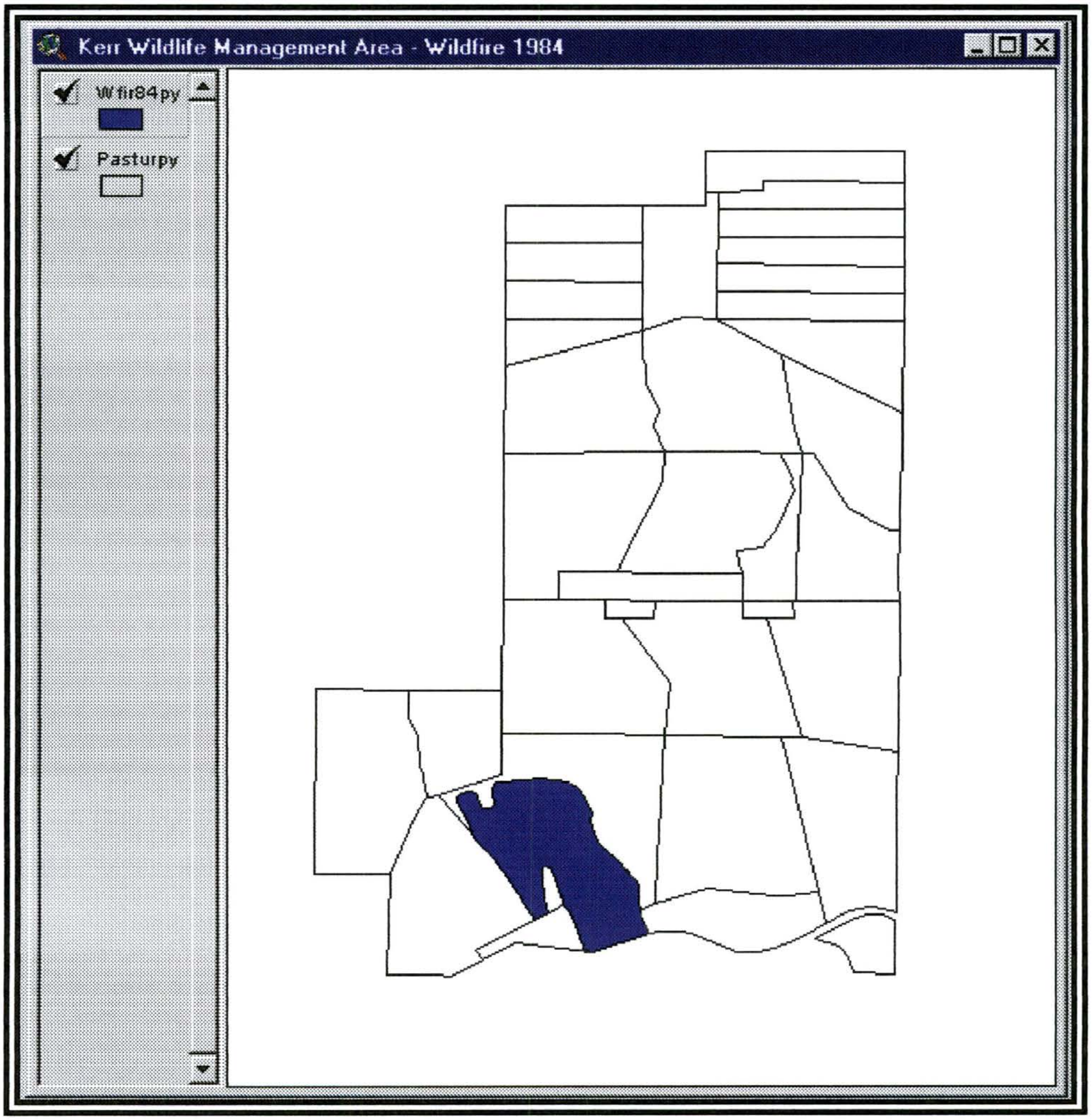

Figure 63. Wildfire 1984, WFIR84PY.

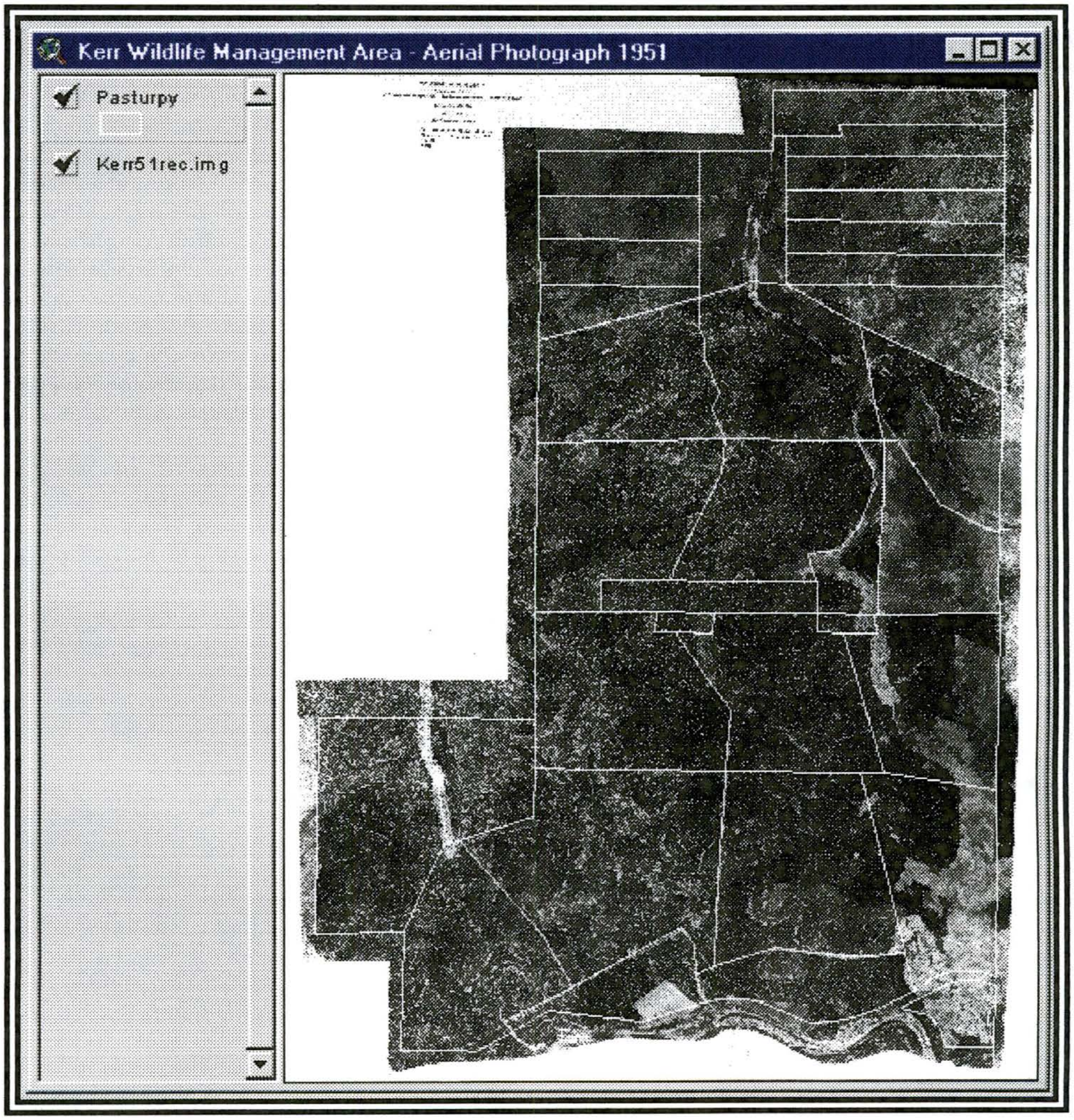

Figure 64. Rectified Aerial Photograph 1951, KERR51REC.IMG.

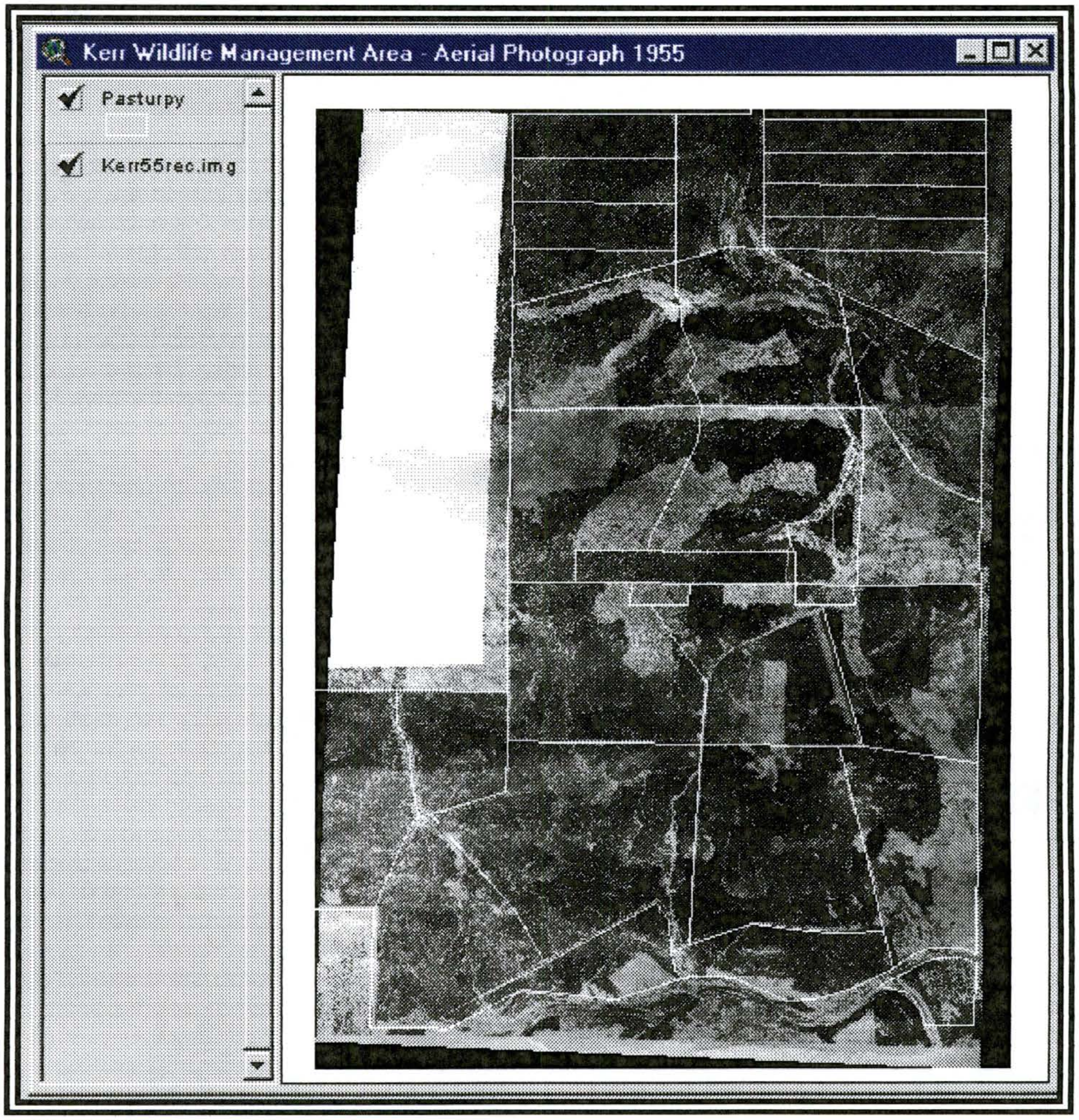

Figure 65. Rectified Aerial Photograph 1955, KERR55REC.IMG.

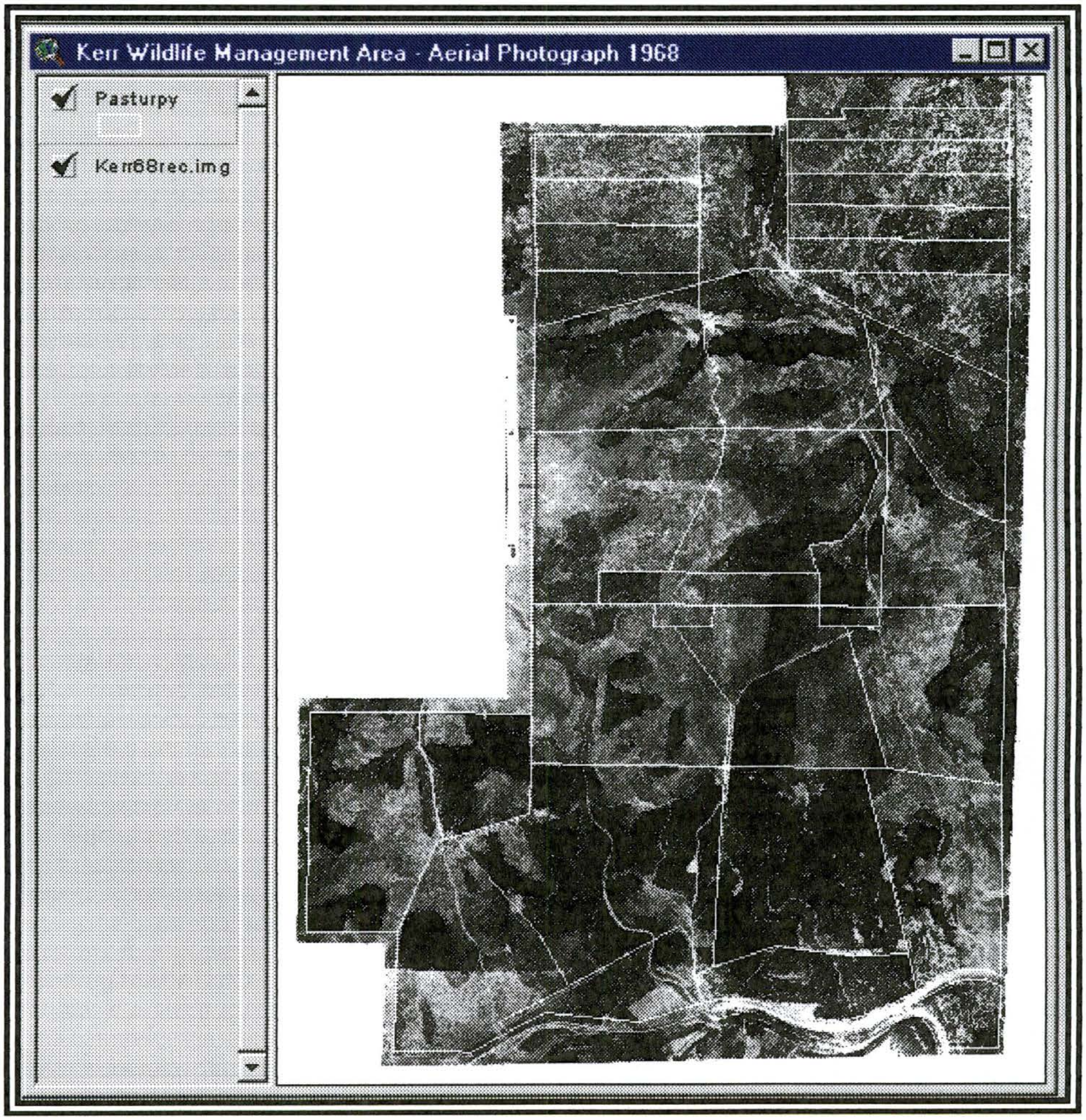

Figure 66. Rectified Aerial Photograph 1968, KERR68REC.IMG.

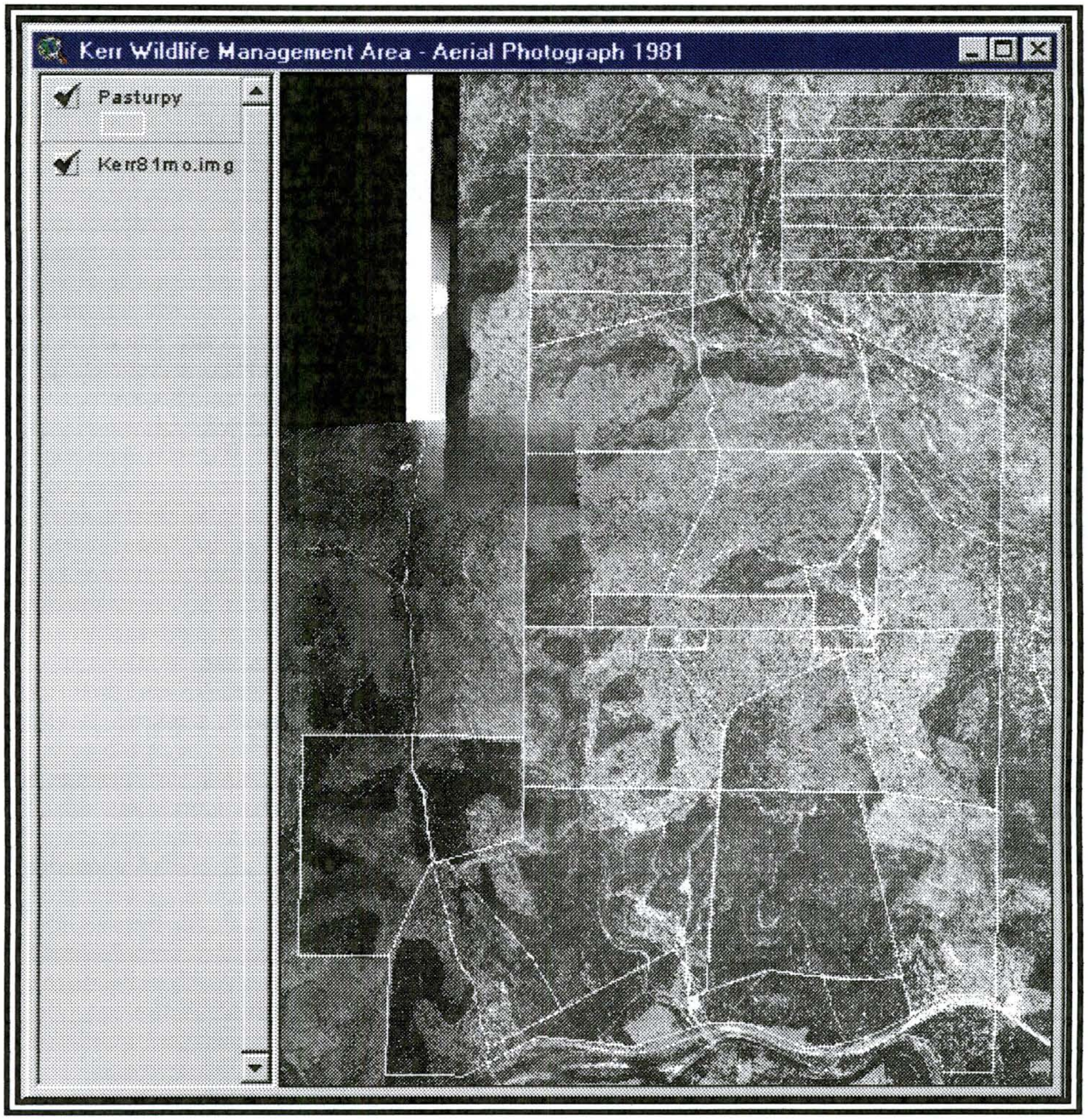

Figure 67. Rectified Aerial Photograph 1981, KERR81REC.IMG.

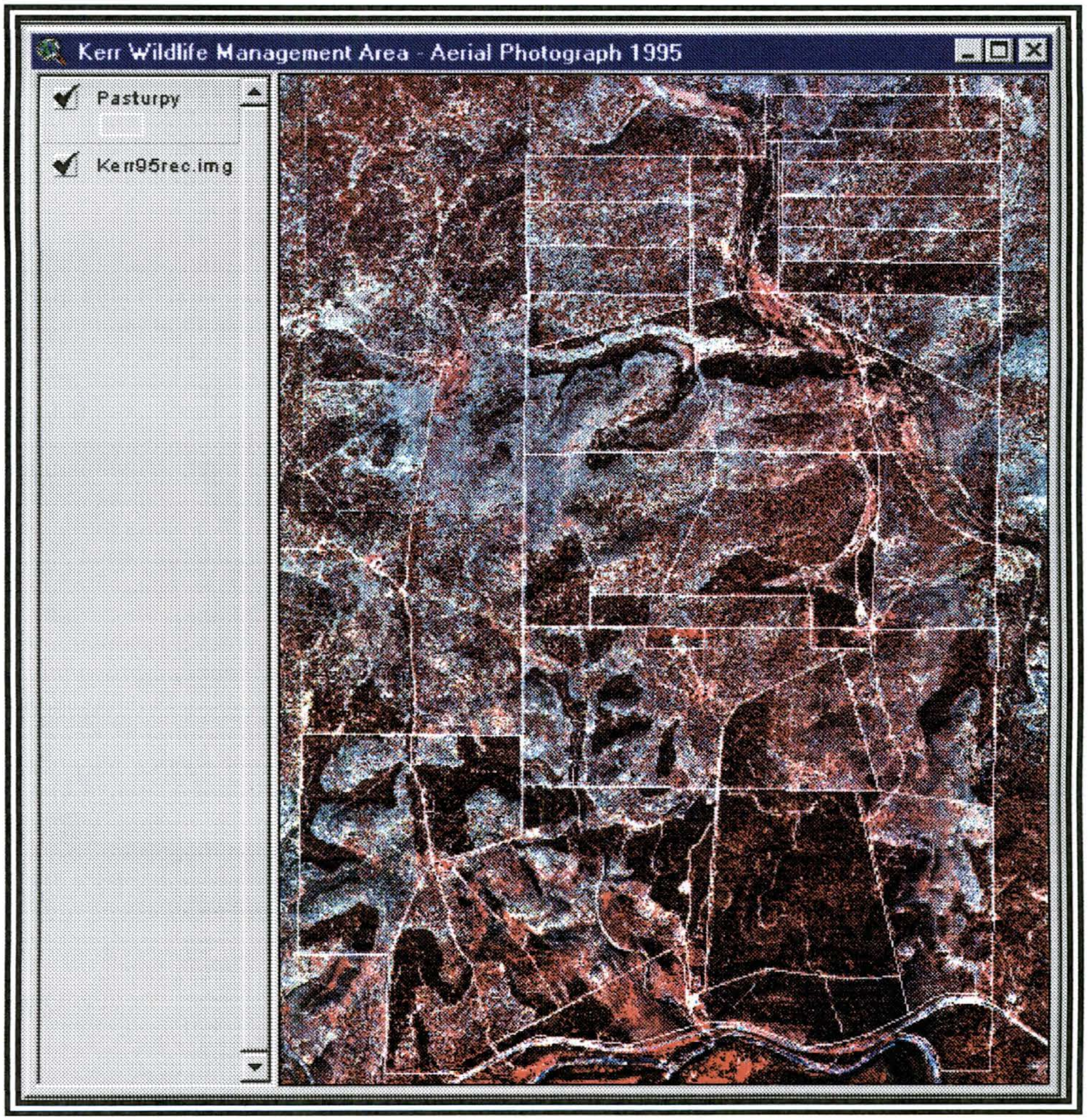

Figure 68. Rectified Aerial Photograph 1995, KERR95REC.IMG

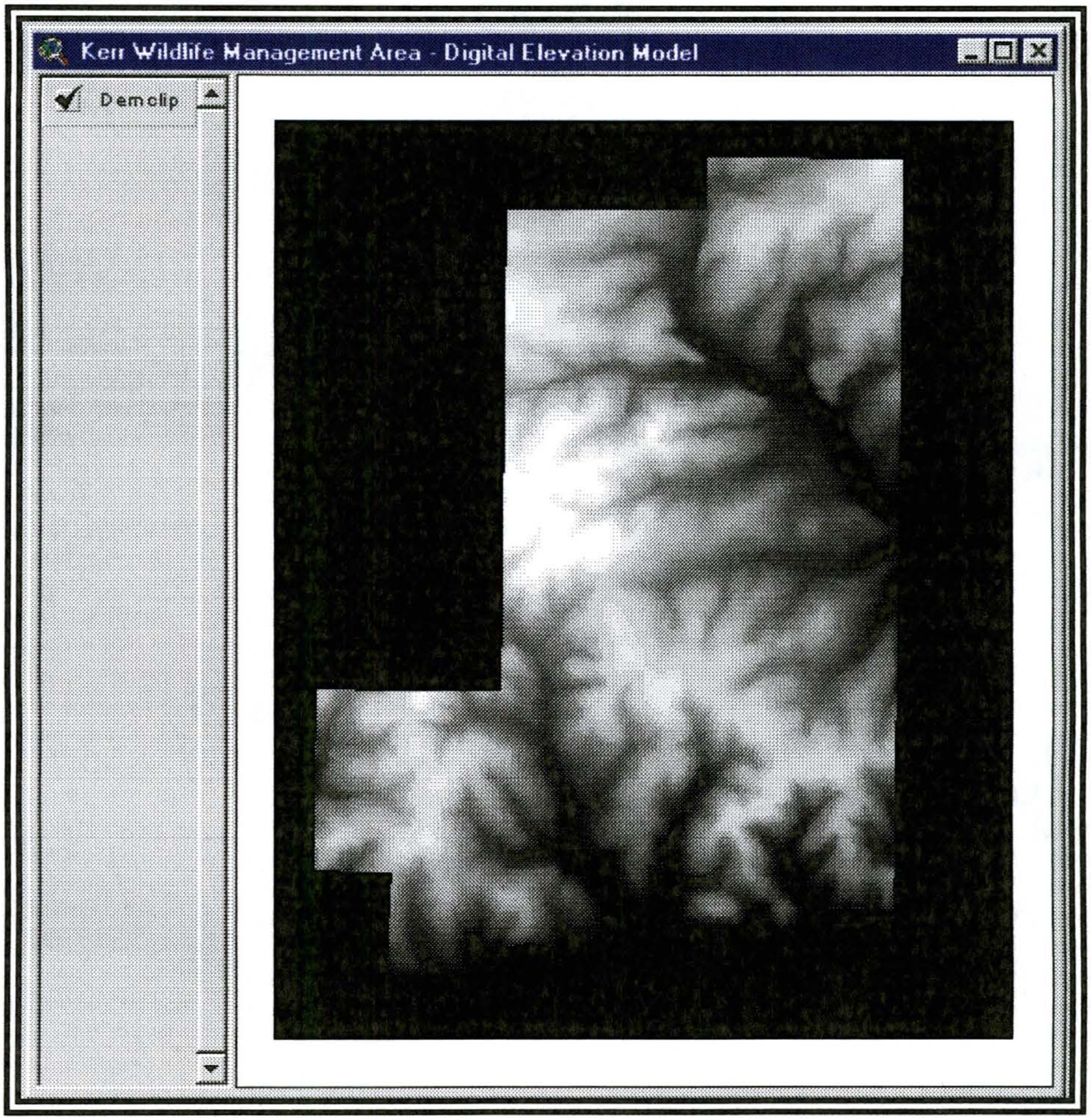

Figure 69. Digital Elevation Model, DEMCLIP.