

**Construction of a Geographic Information
System for Wildlife Refuge Planning:
Squaw Creek National Wildlife Refuge¹**

by

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Background

The U.S. Fish and Wildlife Service (USFWS) is required to develop Comprehensive Conservation Plans (CCP) for the management of lands within its jurisdiction under the National Wildlife Refuge System Improvement Act of 1997 (<http://refuges.fws.gov/NWRSFiles/Legislation/HR1420/TOC.html>). This legislation has introduced the need for more complete, geo-referenced digital data coverage for each of the USFWS national wildlife refuges. Region 3 of the USFWS comprises an eight-state area (figure 1) and includes approximately fifty refuges. Section 7 of the Committee Report from the National Wildlife Refuge System Improvement Act of 1997 (<http://refuges.fws.gov/NWRSFiles/Legislation/HR1420/Part4.html>) describes the following five areas which must be included in each national wildlife refuge CCP:

- The purposes of the refuge
- The fish, wildlife and plant populations, their habitats, and the archaeological and cultural values found on the refuge
- Significant problems that may adversely affect wildlife populations and habitats and ways to correct or mitigate those problems
- Areas suitable for administrative sites or visitor facilities
- Opportunities for fish- and wildlife-dependent recreation



Figure 1. Region 3 of the U.S. Fish and Wildlife Service.

Each USFWS refuge must acquire, analyze and present resource management planning data in a geographic information system (GIS) to assist in planning for the conservation of biological diversity and to the structure and function of the ecosystem in which they are located.

Common Procedures

The University of Minnesota Department of Forest Resources has been compiling geo-referenced data for each national wildlife refuge in cooperation with USFWS Region 3 since the fall of 1997. A standardized list of data sets has been developed (Appendix A). Actual data layers acquired differ among refuges depending on availability and USFWS instruction. Data have been collected from various local, state and federal agencies, academic, professional and government Internet sites and some private companies. In some instances, students have gathered refuge data using Global Positioning System (GPS) technology. Much of the data have been available at no cost, and other data have been purchased by the USFWS. Research Assistants have been working with GIS and imaging software programs from ESRI (Arc/Info, Arcview) and ERDAS (Imagine) on both NT and Unix workstations.

In addition to the spatial data layers, students are also creating metadata text files which describe each data set, its sources, and processing procedures. One metadata text file is created for each coverage. This has been done using a combination of software tools available from the Internet. First, the spatial extent (or bounding coordinates) of a coverage is found using an Arcview Extension (<http://www.fws.gov/data/avmeta.html>). Second, a metadata entry program called Corpsmet95 from the U.S. Corps of Engineers (<http://corpsgeo1.usace.army.mil/welcome.html>) is used for the majority of file creation; Corpsmet95 is FGDC compatible. Finally, the program MetaParser from the U.S. Geological Survey (USGS) (<http://geology.usgs.gov/tools/metadata/tools/doc/mp.html>) is used to check the metadata text file for errors and/or reformat the file. When a refuge's data are delivered to the USFWS, each metadata file is located with its corresponding data file. Final data collections and corresponding metadata files are delivered to the USFWS on CD-ROM with brief text description files included on each CD (Table 1 and Appendix B provide examples).

Table 1. Data set naming standards for the Squaw Creek National Wildlife Refuge.

Squaw Creek NWR Dataset Name	Directory Name	Shape file names, Arc/Info Coverage name & metadata text file
Root Directory	SQC/	
Graphics	/Graphics	fwslogo.tif
Documents	/Document	
Directory Structure		dir_struct.doc
Summary Document		Summary.doc
<i>Basemap Data</i>	<i>/BASEMAP</i>	
Digital Elevation Models (DEMs)	/DEMs	dems (16 bit), dems2 (8 bit)
Digital Orthophoto Quadrangles (DOQs)	/DOQs	Doqs
Digital Raster Graphics (DRGs)	/DRGs	Drgs
Floodplain Boundaries	/Floodpl	Floodpl
Historical Vegetation	/histveg	mo1879, pprairie, forest
Hydrography	/Hydro	
Lakes		Lakes
Streams		streams
Land Cover	/Landcvr	Geology
Land Ownership	/Landown	Dnrpark
Land Use	/Landuse	Lulc
National Wetlands Inventory	/NWI	Nwi
Public Land Survey	/PLS	Pls
Political Boundaries	/PolBnds	
Congressional Districts		Congdist
County		county
Municipal		Muncpl
State		state, mocounties
Township		Township
Soils	/Soils	Soils
Transportation	/Trans	
Airports		airports
Railroads		rroads
Roads		Roads
Utilities	/utilities	gas, electric
Wildlife	/wildlife	Vertebrates
Watersheds	/Wsheds	
Watersheds		Wsheds
<i>Project Data (Specific to Refuge)</i>	<i>/SQCMAP</i>	
Cultural	/cultural	Archeo
Hydrology	/hydro	Levees
Land ownership	/landown	Tracts
Management plans	/MgmtPlns	

Burn Units, Cropland Management		burnpln, croppln
Photos (15 NAPP photos from 1996-97)	/Photos	Doqs
Project Boundary	/Prjbnd	
Authorized Boundary		Sqcleq
Study Boundary		Sdybnd
Easements	/easements	Easement, floodpl, fmha
Public Recreation	/Recreatn	Observ, picnic
Real Property Inventory	/RPIProp	
Lines	/Lines	
Hiking Trails		Hiking
Points	/Points	
Buildings, WCS		Bldgs, bridges, parking, utils, wcs, other

All of the GIS data layers and metadata files created for the USFWS Region 3 are intended to be operationally useful; in addition, the refuge boundaries adhere to specifications of the U.S. Fish and Wildlife Service Lands Boundary Data Standard Operating Procedures (SOP Number 97-01). Most data sets will require field verification by refuge staff familiar with the refuge lands. As noted in each metadata file, the intended application of the boundary data is to serve as a spatial reference for other data layers in GIS and mapping applications. It is not intended to be used as a land survey or representation of land for conveyance or tax purposes. The data are not legal documents and are not intended to be used as such. It is the responsibility of the user to use the data appropriately and consistently, recognizing its limitations.

Squaw Creek National Wildlife Refuge

The Squaw Creek National Wildlife Refuge is located in the Missouri River floodplain in Holt County, Missouri (figure 2). Established in 1935, the refuge currently occupies 7,350 acres of land. The area was once a large marsh with meandering creeks that were straightened for agricultural drainage. The refuge property also includes loess bluff hills, an unusual geologic formation caused by wind deposited soil. These bluffs hold some of the last remnants of native prairie. In addition to hosting 301 bird species, 33 mammal species and 35 reptile and amphibian species, the refuge is a large wintering area for bald eagles and snow geese. There are several public use opportunities at Squaw Creek NWR including; environmental education, wildlife observation, and auto tour route, hiking, picnicking, hunting, and mushroom picking. Current management practices include

wetland restoration, cooperative farming, grassland management and water management (<http://www.fws.gov/r3pao/squaw%5Fck/index.html>). Planning for the coordination of these activities will be enhanced through the acquisition and use of geo-referenced data.

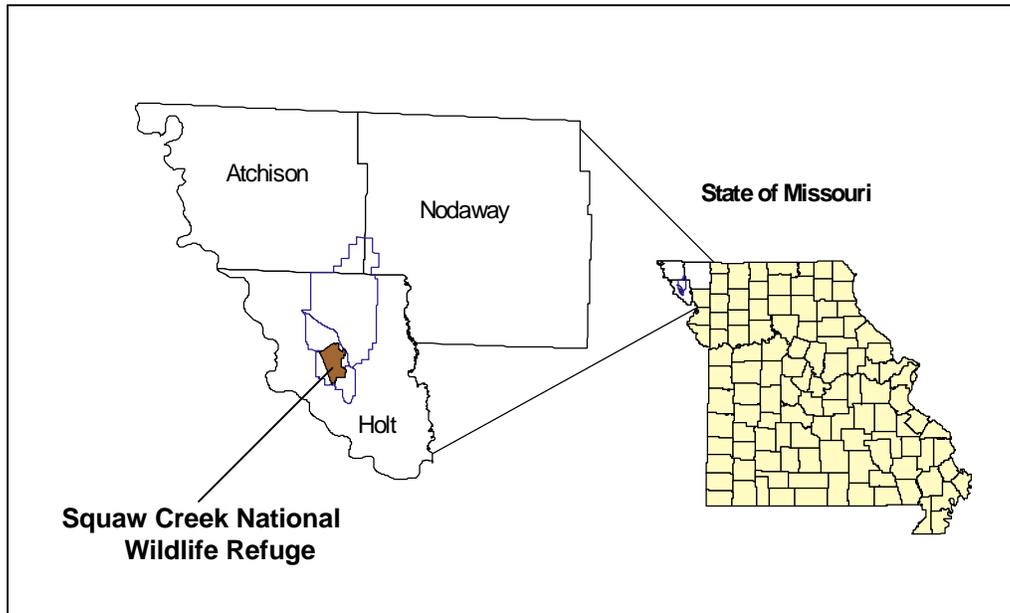


Figure 2. The Squaw Creek National Wildlife Refuge (brown) and its adjacent study area boundary (blue), including portions of three counties.

The GIS data collected for the Squaw Creek NWR spans two extents. The first extent is the study area boundary delineated in blue in figure 2. The study area has been formed to investigate potentially valuable land adjacent to the refuge boundary, which includes additional wetlands and forested loess bluffs. Each layer listed in Table 2 has been collected to cover the study area or the refuge property, if appropriate. This extent includes the current refuge boundary as well as 6, 7.5-minute USGS quadrangles (Big Lake, Craig, Dotham, Kimsey Creek, Mound City and Tarkio SE) that include portions of three counties; Holt, Atchison and Nodaway.

Table 2. Summary list of data layers for the Squaw Creek National Wildlife Refuge.^a

Data Set Name	Brief Description
<i>All of these layers were collected to include the Refuge and Study area extent (6 quadrangles)</i>	
Digital Elevation Models (DEMs)	7.5-minute DEMs from USGS
Digital Orthophoto Quadrangles (DOQs)	1:12,000 DOQs obtained from USFWS, Region 3
Digital Raster Graphics (DRGs)	7.5-minute DRGs obtained from USFWS, Region 3
Floodplain Boundaries	Landsat interpreted flood plain zones from SAST
Historical Vegetation	Presettlement Prairie and Forest cover
Lakes	1:100,000 lakes from the MSDIS
Streams	1:100,000 streams from the MSDIS
Land Cover	Digitized version of the DGLS Geologic map
Land Ownership	DNR parks from MSDIS
Land Use	MO Land Use/Landcover data from EPA/BASINS
National Wetlands Inventory (NWI)	National Wetlands Inventory from FWS (LMIC edited)
Townships	Township Boundaries from the MSDIS
County Boundaries	County Boundaries from MSDIS
Municipal Boundaries	Municipalities from EPA/BASINS
State	Missouri State Boundary from MSDIS
Congressional Districts	Congressional Districts from MSDIS
Soils	SSURGO soils data from MSDIS
Airports	Airport locations from MSDIS
Railroads	1:2,000,000 Railroads from the MSDIS
Roads	Transportation infrastructure from the MSDIS
Watersheds	11 digit hydrologic units from the MSDIS
<i>Other Extents (as noted)</i>	
Historical Vegetation	Missouri 1879 Vegetation (extent: MO River floodplain)
Utilities	St. Joseph's Light and Power lines surrounding Refuge
Wildlife	Statewide range and distribution of vertebrates
Archaeology	Results of study conducted on one tract of SQC Refuge
Levees	Levees found in the MO River floodplain
Refuge Boundary (legislative and study area)	Both legislative and study area refuge boundaries
Easements (Floodplain, FmHA, fee title)	Easements and corresponding DRGs for 20 county Fish and Wildlife Management District
Tract ownership	SQC Refuge tracts of ownership
Cropland management plans	SQC Refuge cropland units from paper maps
Burn Units	SQC Refuge burn units from paper maps
Hiking Trails (RPI Property)	SQC Refuge hiking trails gathered using GPS
Buildings (RPI Property)	SQC Refuge building locations gathered using GPS
Bridges (RPI Property)	SQC Refuge bridge locations gathered using GPS
Other (RPI Property)	SQC Refuge RPI locations gathered using GPS
Parking (RPI Property)	SQC Refuge parking lot locations gathered using GPS
Utilities (RPI Property)	SQC Refuge utility locations gathered using GPS
Water Control Structures (WCS)	SQC Refuge water control structure locations

^a All the data are geo-referenced to UTM Zone 15 with a datum of NAD83. The data consist of two CD-Roms: one contains basemap layers, and one contains refuge specific layers (sqcmap), documents and graphics.

The second extent covers the twenty county Fish and Wildlife management district.

These outer counties contain Farmers Home Administration Easements (FmHAs) and

Conservation Easements managed by the Squaw Creek Refuge. FmHA easements are loan leveraged federally reclaimed lands that have been deeded to the USFWS. Often these easements contain riparian or wetland areas that serve to preserve habitat critical to waterfowl and other wildlife. Conservation Easements are perpetual contracts with willing private landowners that protect wetlands and grasslands. One or two 7.5 minute DRGs (scanned USGS topographic maps) serve as the basemap for the easement parcels. The DRGs can be used for map production, spatial reference, and resource management. See the project boundary easement directory (e:\sqc\sqcmap\prjbnd\esmts) for a listing of the DRGs and more information.

Each GIS data layer can be combined and analyzed in different ways to reveal spatial relationships between different themes. The following figures contain a few examples of potential GIS applications for Squaw Creek NWR. By combining the mosaiced DRGs (scanned USGS topographic maps) and a digital, geo-referenced boundary file we can produce the map used for refuge boundary review by USFWS Region 3, Division of Realty and Refuge staff (figure 3). Other useful information in planning for ongoing management activity could include burn unit delineations and adjacent public recreational areas shown over the DOQ (USGS Digital Orthophoto Quadrangles) basemap (figure 4). An imminent issue at Squaw Creek involves sedimentation filling in the wetlands. Figure 5 depicts the hydrologic layers and refuge property and study boundaries over a Digital Elevation Model (DEM) and potential sources of erosion. Other GIS analyses might include size and shape studies of burn units, vertebrate distribution, or cropland management units. As refuge staff become more familiar with GIS, many maps and analyses can be produced to assist in enhancing natural resource management activities at the Squaw Creek National Wildlife Refuge.

Squaw Boundary c

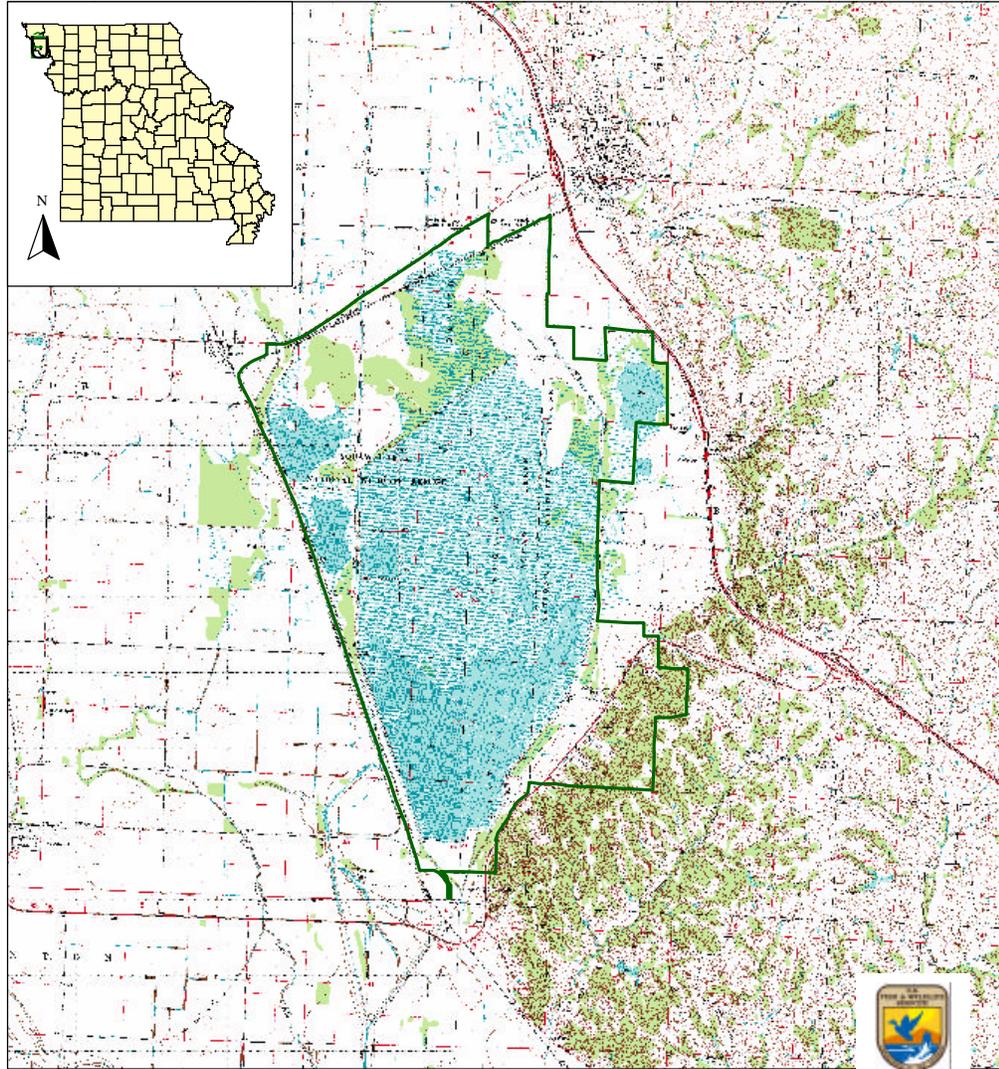


Figure 3. Squaw Creek National Wildlife Refuge, overlaid on mosaiced USGS 7.5-minute topographic map data.

Squaw Creek National Wildlife Refuge Burn units over Digital Orthophotos

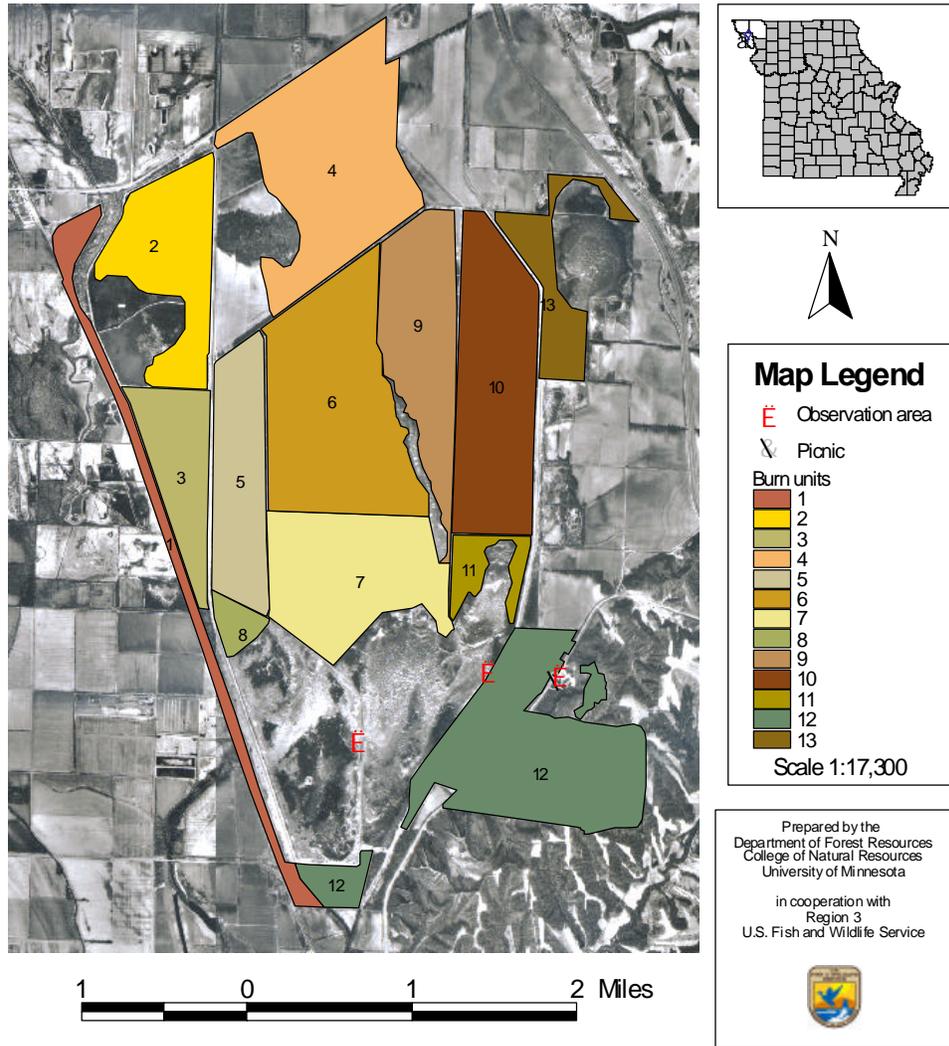


Figure 4. Map of burn units and recreational areas over digital orthophotos developed at the University of Minnesota for the Squaw Creek National Wildlife Refuge.

Squaw Creek National Wildlife Refuge Hydrology over Digital Elevation Model

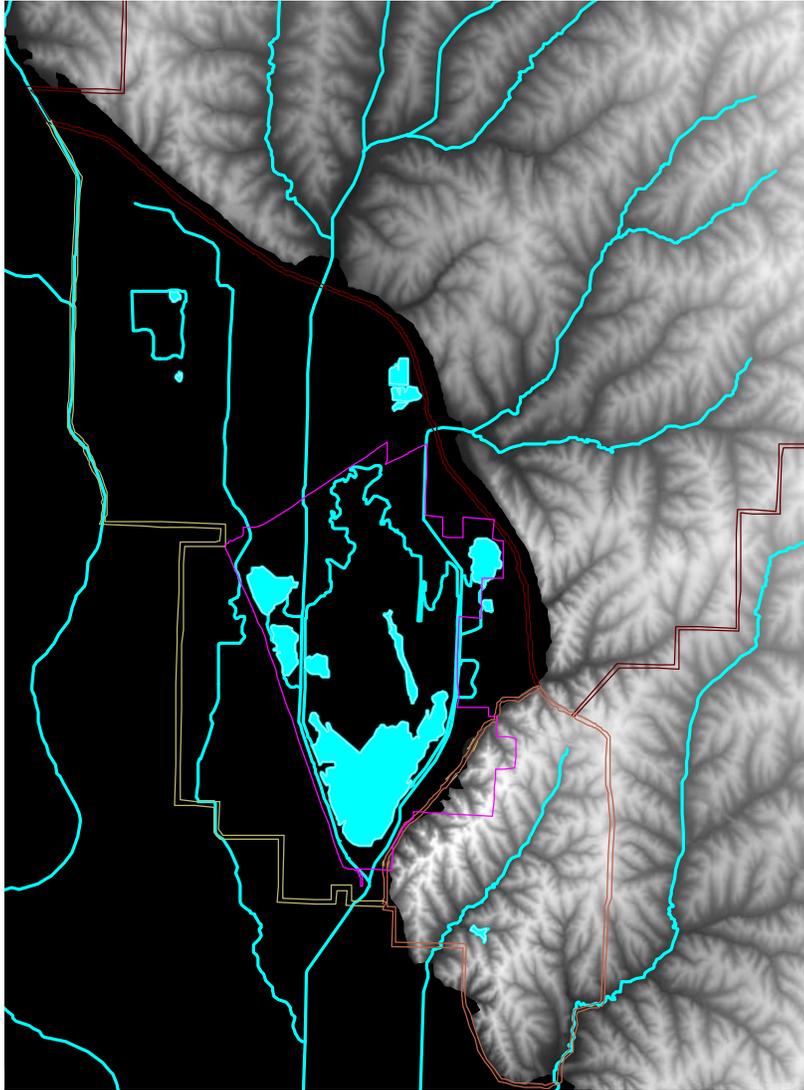


Figure 5. Lakes and stream flow overlaid over a Digital Elevation Model (DEM) of Squaw Creek NWR and portions of the surrounding study area.

Appendix A: National wildlife refuge GIS inventory (April 1999 draft).

Data Types from USFWS	Status / Notes	Source	Resolution	MetaData
Basemap Data				
Digital Elevation Models (DEMs)				
Digital Orthophoto Quadrangles (DOQs)				
Digital Raster Graphics (DRGs)				
Floodplain Boundaries (100yr and 500yr - FEMA)				
Historical Vegetation				
Hydrography				
Lakes				
Streams				
Land Cover				
Land Ownership (Other Public Lands)				
Land Use				
Natural Heritage Data				
National Wetlands Inventory (NWI)				
Political Boundaries				
Cities / Municipal Boundaries				
Civil Townships				
Congressional Districts				
County				
State				
Zoning				
Public Land Survey				
PLS Sections				
Soils				
Transportation				
Airports				
Railroads				
Roads (may have different types)				
Watersheds				
Watersheds Watershed Basins				
Project Data (Specific to Refuge)				
Cultural				
Archeological Sites				
Fish Habitat				
Critical Habitat				
Stormwater Sewers				
Land cover (more detailed than above)				
Tracts (Internal tract boundaries)				
Management plans				
Burn Units				
Cropland Management Plan				
Future Planning				
Photos				
Project Boundary				
Refuge Boundary (Authorized Expansion)				
WPAs Easements ...				
Public Recreation				
Fish Access Boat Access Parks ...				
Real Property Inventory				
Signs Structures Water Control Structures...				
Hiking Trails Dikes Drainage Ditches ...				
Parking Areas ...				
Wildlife Habitats				
Eagle Herons ...				
<i>Note: Additional datasets may be requested</i>				

Appendix B. Text file description on CD-Rom for Squaw Creek National Wildlife Refuge data (October 1999).

Documentation:

This CD contains GIS data for the Squaw Creek National Wildlife Refuge, Missouri.

Overall Description:

This CD contains Basemap Layers, Refuge Specific Layers (SCQMap) and Fish and Wildlife Management District Layers. The various geo-referenced data exists as either ArcView shape files, tiff files, Arc Export format or .img (Erdas Imagine) files. There are also metadata files (a detailed description) of each data layer. These metadata files can be found in the same directory as the geo-referenced data sets. All layers are geo-referenced to UTM Zone 15 with a DATUM of Nad83.

Basemap Data:

/sqc/basemap/dems

This directory contains two versions of the 6 quad mosaic coverage of DEM data (Digital Elevation Model) in ERDAS Imagine (.img) format. The first version (DEM) is the 16-bit encoded data that is not viewable in ArcView. The second version (DEM2) has been recoded using 8-bit encoding so it can be viewed in ArcView. See metadata file for statistical reformulation.

/sqc/basemap/doqs

This directory contains a mosaic of DOQs (Digital Orthophoto Quadrangle) in ERDAS Imagine (.img) format that was created by orthorectifying NAPP photos from 1996 and 1997.

/sqc/basemap/drgs

This directory contains the 6 quad mosaic of DRGs (USGS Digital Raster Graphics) in ERDAS Imagine (.img) format.

/sqc/basemap/floodpl

This directory contains an ArcView Shapefile for the visually interpreted floodplain data from Landsat for the Missouri River Valley.

/sqc/basemap/histveg

This directory contains an ArcView Shapefile of the Missouri 1879 Historical Vegetation, an ArcView Shapefile of Pre-settlement Prairie, and an ArcView Shapefile of the Forested areas of the Squaw Creek NWR. The 1879 vegetation history covers the extent of the Missouri River floodplain, the other two layers include the entire study area boundary.

/sqc/basemap/hydro

This directory contains ArcView Shapefiles for the hydrography data for the the Squaw Creek NWR study area. The file "lakes" represent lakes, and the file "streams" represent streams.

/sqc/basemap/landcvr

This directory contains an ArcView Shapefile for the geologic land cover data of the Squaw Creek NWR study area. The geologic types are listed in the attribute table.

/sqc/basemap/landown

This directory contains an ArcView Shapefile which delineates all the DNR park land found within the Squaw Creek NWR study area.

/sqc/basemap/landuse

This directory contains an ArcView Shapefile for the land use/land cover data of the Squaw Creek NWR study area. The land cover types are listed in the attribute table.

/sqc/basemap/nwi

This directory contains an ArcView Shapefile for the National Wetlands Inventory data for the Squaw Creek NWR study area.

/sqc/basemap/pls

This directory contains the ArcView Shapefile for the Public Land Survey System data for the Squaw Creek NWR study area.

/sqc/basemap/polbnds

This directory contains the ArcView Shapefiles for the Political Boundaries of the Squaw Creek NWR study area. The file "muni" represents city names, "congdist" is congressional districts, "county" is county boundaries, and "state" is the state boundary.

/sqc/basemap/soils

This directory contains the ArcView Shapefiles for the soils data for the Squaw Creek NWR study area. Also contained in the directory are a series of tabular data that allows the user to assess the suitability of each given soil type for different uses, such as Prime Farmland, Wildlife Habitat, etc. The file also contains a read-me file to help the user merge appropriate tabular data into the ArcView files.

/sqc/basemap/trans

This directory contains ArcView Shapefiles for the roads data for the Squaw Creek NWR study area. The file "airports" is airport locations, "rroad" is railroads, and "roads" is roads.

/sqc/basemap/utilities

This directory contains the ArcView Shapefile delineating the St. Joseph Light and Power lines which run adjacent to the Squaw Creek NWR. The file "gas" shows gas lines and "electric" shows electricity lines.

/sqc/basemap/wildlife

This directory contains a series of range and distribution coverages for vertebrates around the state of Missouri. The files are stored in Arc Export format (.e00) to save space. Files can be converted into ArcView Shapefiles using the import tool found in ArcView software.

/sqc/basemap/wsheds

This directory contains the ArcView Shapefiles for the USGS 11-digit watershed delineation for the Squaw Creek NWR study area.

SQCMap Data:

sqc/sqcmap/cultural

This directory contains the ArcView Shapefile delineating points where archaeological studies were conducted on the Derr tract of the Squaw Creek NWR.

Sqc/sqcmap/hydro

This directory contains the ArcView Shapefile of the levees found within the Missouri River Floodplain. This coverage envelops the entirety of the Squaw Creek NWR boundary and a portion of the study area.

/sqc/sqcmap/landown

This directory contains the ArcView Shapefiles of the tract ownership data for Squaw Creek NWR. It is based on paper maps of tract boundaries and acquisition information from the Realty division of USFWS.

sqc/sqcmap/mgmtplns

This directory contains the ArcView Shapefiles for management plan data for the Squaw Creek NWR. The files "burnpln" are the Burn Units for the refuge and the file "cropln" is the cropland management units.

/sqc/sqcmap/photos

This directory contains a mosaic of DOQs (Digital Orthophoto Quadrangle) in ERDAS Imagine (.img) format that was created by orthorectifying NAPP photos from 1996 and 1997.

/sqc/sqcmap/prjbnd

This directory contains the ArcView Shapefile for the legislative boundary of the Squaw Creek NWR. It also contains the Study boundary encompassing three study areas; watershed, wetland and loess bluff. This directory also contains a separate subdirectory named esmts (described below).

/sqc/sqcmap/prjbnd/esmts

This directory contains three sets of easement ArcView Shapefiles: "conserv", "floodplain", and "fmha". Each dataset is accompanied by a directory that contains the DRGs associated with the parcels. Each directory also contains a "readme" file that lists the DRG that goes with each parcel.

/sqc/sqcmap/recreatn

This directory contains ArcView Shapefiles for recreation related data. "Observ" are public observation areas, and "picnic" are public picnic grounds.

/sqc/sqcmap/rpiprop/lines

This directory contains the ArcView Shapefiles for real property for the Squaw Creek NWR in the form of lines. The file "hiking" delineates public hiking trails.

/sqc/sqcmap/rpiprop/points

This directory contains the ArcView Shapefiles for real property for the Squaw Creek NWR in the form of points. "Bldgs" are buildings, "bridges" are bridges (wooden and otherwise), "parking" are parking areas (public and employee), "utils" are utilities, "wcs" delineate water control structures. The "other" file delineates curb and gutter, retaining walls, loading docks and a fence.