Construction of a Geographic Information System for Wildlife Refuge Planning:

Crab Orchard National Wildlife Refuge[1]

by

Kali E. Sawaya, Thomas E. Burk, Paul V. Bolstad and John H. Schomaker[2]

January 2000

Staff Paper Series No. 142

Department of Forest Resources

College of Natural Resources
And
Minnesota Agricultural Experiment Station
University of Minnesota
St. Paul, Minnesota

**Construction of a Geographic Information System for Wildlife Refuge Planning:
Crab Orchard National Wildlife Refuge**

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.

It is important for each USFWS refuge to acquire, analyze, and present resource data in a geographic information system (GIS) if the refuge is to contribute to the conservation of biological diversity and to the structure and function of the ecosystem.

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 of the coverages. 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 Crab Orchard National Wildlife Refuge.

Crab Orchard NWR Dataset Name	Directory Name	Coverage & metadata text file names (all files in shapefile format except those noted)
Root Directory	**CRO/**	
Basemap Data	***/BASEMAP***	
Digital Elevation Models (DEMs)	**/DEMs**	dems (Arc/GRID)
Digital Orthophoto Quadrangles (DOQs)	**/DOQs**	doqs (Arc/BIL)
Digital Raster Graphics (DRGs)	**/DRGs**	drgs (TIF)
Floodplain Boundaries	**/floodpl**	Floodpl
Hydrography	**/hydro**	lakes, streams
Land Cover	**/landcvr**	Lndcvr
Land Use	**/landuse**	Landuse
Natural Heritage	**/NH**	Natareaply, natareapt
National Wetlands Inventory	**/NWI**	Nwi
Public Land Survey	**/PLS**	Pls
Political Boundaries	**/PolBnds**	
Counties	**/counties**	Cntyclp, counties
Municipal	**/municipal**	Munic
Political Townships	**/poltwp**	Poltwp
7.5 min quad boundaries	**/quads**	75quads
State	**/state**	Illinois
Transportation	**/Trans**	
Airports	**/airports**	airports
Railroads	**/railroad**	Rails
Roads	**/roads**	Roads
Utilities	**/utilities**	
Central Illinois Power	**/cips**	cipsmain, cipsgas
Egyptian Electric	**/egyptelec**	ee_distrib
Landfills	**/landfills**	Landfill
Mains	**/main**	Main
Watersheds	**/wsheds**	Ilwshed, wshed
Project Data (Specific to Refuge)	***/CROMAP***	
Cultural	**/cultural**	archeology, cemetery
Land ownership	**/landown**	Tracts
Management plans	**/MgmtPlns**	
Illinois Ordinance Plant	**/iop**	arealabels, indarea, iopbnd, iopfence
Refuge Land Plans	**/land**	agfields, grazing, pine, projreforest, reforest, wildrns
Project Boundary	**/Prjbnd**	Croleg
Public Recreation	**/Recreatn**	launch, obsdeck, pistol, trails
Real Property Inventory	**/RPIProp**	
Line data	**/lines**	Trail

Point data	**/points**	bldgs, bridges, docks, industry, misc, raw_rpi, misc, sewage, storage, toilets, wcs
Polygon data	**/polygons**	Impound
Wildlife	**/wildlife**	Eagles
Documents	**/Document**	
Directory Structure		dir_struct.doc
Summary Document		summary.doc
Graphics	**/Graphics**	fwslogo.tif,crobnd,cromap4, cromap5, inset

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.

Crab Orchard National Wildlife Refuge

Most of Crab Orchard National Wildlife Refuge is in Williamson County, Illinois with smaller portions in Jackson and Union counties (figure 2). The Refuge is located on State Highway 148, just west of Marion Illinois. Established in 1947, the refuge currently occupies 43,660 acres and is one of the largest refuges in the continental United States. Over 4,000 acres of the Refuge are designated as Wilderness. The Refuge landscape includes lakes, fields, low-lying wetlands, and rolling hills. The Refuge provides wildlife habitat for one of the main waterfowl stops along the Mississippi Flyway and is the Service's contact station for wetlands restoration on private lands in parts of Missouri, Kentucky, Indiana, and Southern Illinois.
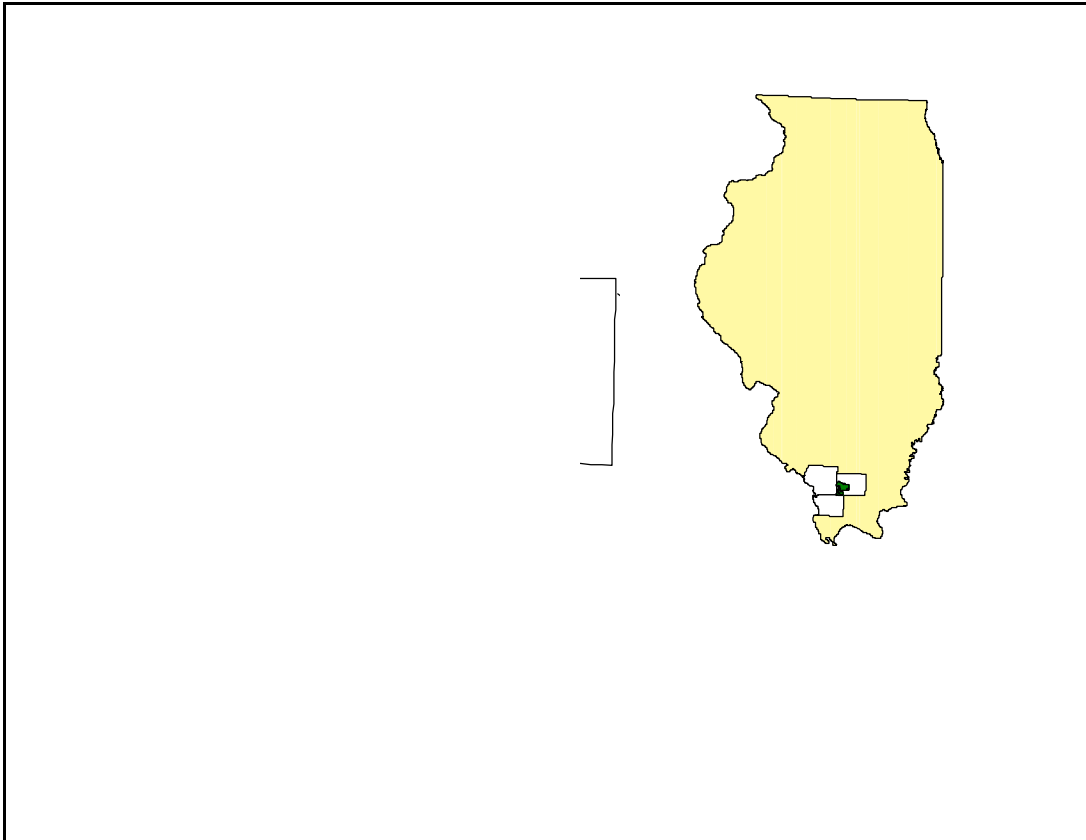
Figure 2. The Crab Orchard National Wildlife Refuge and its adjacent study area boundary, including portions of three counties.

The staff at Crab Orchard NWR face many challenges as they try to fulfill four purposes:

• Wildlife Conservation: The Refuge uses an ecosystem management approach to sustain optimum populations of native fish, wildlife, and migratory waterfowl species, as well as threatened and endangered wildlife.

• Agriculture: Crab Orchard encourages and facilitates agricultural practices that further wildlife conservation goals, benefit the local economy, and are attuned to other Refuge purposes.

• Industry: Management of an industrial complex operated by compatible businesses in compliance with safety, health, environmental, and maintenance standards.

• Recreation: The Refuge hosts about 1.2 million visitors each year. Refuge programs focus on wildlife-oriented activities and include automobile tours, hiking, camping,

boating, fishing, and hunting. Recreation environments range from primitive to full-service family camping areas and marinas (http://www.fws.gov/r3pao/cr_orch/).

Geo-referenced data will enhance the planning and coordination of the multiple purposes of the Refuge.

The GIS data collected for the Crab Orchard NWR spans two basic extents. Most basemap data was collected to include the entire refuge with a one-mile buffer around the perimeter. The project specific data layers (found under the CROMAP subdirectory) were collected to include everything inside the refuge boundary.

Table 2. Summary list of data layers and their respective extents.[a]

Data Set Name	Brief Description
These data layers were collected to include the Refuge with surrounding 1 mile buffer	
Floodplain Boundaries	1:6,000 - 1:24,000 flood plain zones from FEMA
Hydrography	Lakes and Streams derived from USGS 1:100,000 DLG
Natural Heritage	Natural areas digitized from 7.5-minute USGS Quadrangles and 1:8,000 aerial photos
National Wetlands Inventory (NWI)	National Wetlands Inventory from USFWS
Public Land Survey	From INRGDC (Illinois Natural Resource Geospatial Data Clearinghouse)
County Boundaries (countclp)	County Boundaries from INRGDC
Municipal Boundaries	Municipalities from INRGDC
Political Townships	Township Boundaries from the INRGDC
7.5 Minute Quad Boundaries	From INRGDC
Airports	Airport locations from INRGDC
Railroads	Railroads from the INRGDC
Landfills	From INRGDC
Archeology	Areas of high archaeological potential from Illinois State Museum
These data layers were collected to include only the Refuge boundary proper	
Land Use	Includes several categories of use within the Refuge
Land Ownership	Tract boundaries digitized from paper maps
Illinois Ordinance Plant	Boundaries of IOP areas within the Refuge derived from USGS 1:24,000 and 1:100,000 maps, IDOT records, CERCLA site maps, and field verification
Refuge Land Plans	Agricultural, grazing, and reforestation locations
Project Boundary	Legislative boundary for Crab Orchard NWR
Public Recreation	Sites of boat launches, observation decks, trails, and pistol range
Real Property Inventory:	
Lines	Trails within the Refuge
Points	Sites of buildings, bridges, docks, industries, sewage facilities, storage facilities, public restrooms, water

	control structures, and miscellaneous other property
Polygons	Impound areas in the Refuge
Wildlife	Eagle nest sites from summer 1997
These data layers were collected to other extents as indicated	
Digital Elevation Models (DEMs)	7 7.5-minute USGS DEMs
Digital Orthophoto Quadrangles (DOQs)	7 7.5-minute USGS DOQs
Digital Raster Graphics (DRGs)	7 7.5-minute USGS DRGs
Land Cover	INRGDC (square area)
County Boundaries (counties)	INRGDC (3 county area)
State Boundary	INRGDC (statewide)
Roads	INRGDC (Square area)
Central Illinois Power Supply	Digitized from paper maps (covers Refuge and adjacent areas)
Egyptian Electric	Digitized from paper maps (covers Refuge and adjacent areas)
Mains	Digitized from paper maps (covers Refuge and adjacent areas)

[a] All the data are geo-referenced to UTM Zone 16 with a datum of NAD83. The data consist of two CD-Roms: one contains basemap layers, and one contains refuge specific layers (cromap), documents and graphics.

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 Crab Orchard 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 information useful in planning could include a combination of current land uses and selected recreational features (figure 4). Figure 5 depicts the forest resources currently being managed at Crab Orchard NWR and their relation to tract boundaries. Other GIS analyses might include size and shape studies of management units, eagle nest distribution, or activity management on a per tract or section basis. 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 Crab Orchard National Wildlife Refuge.
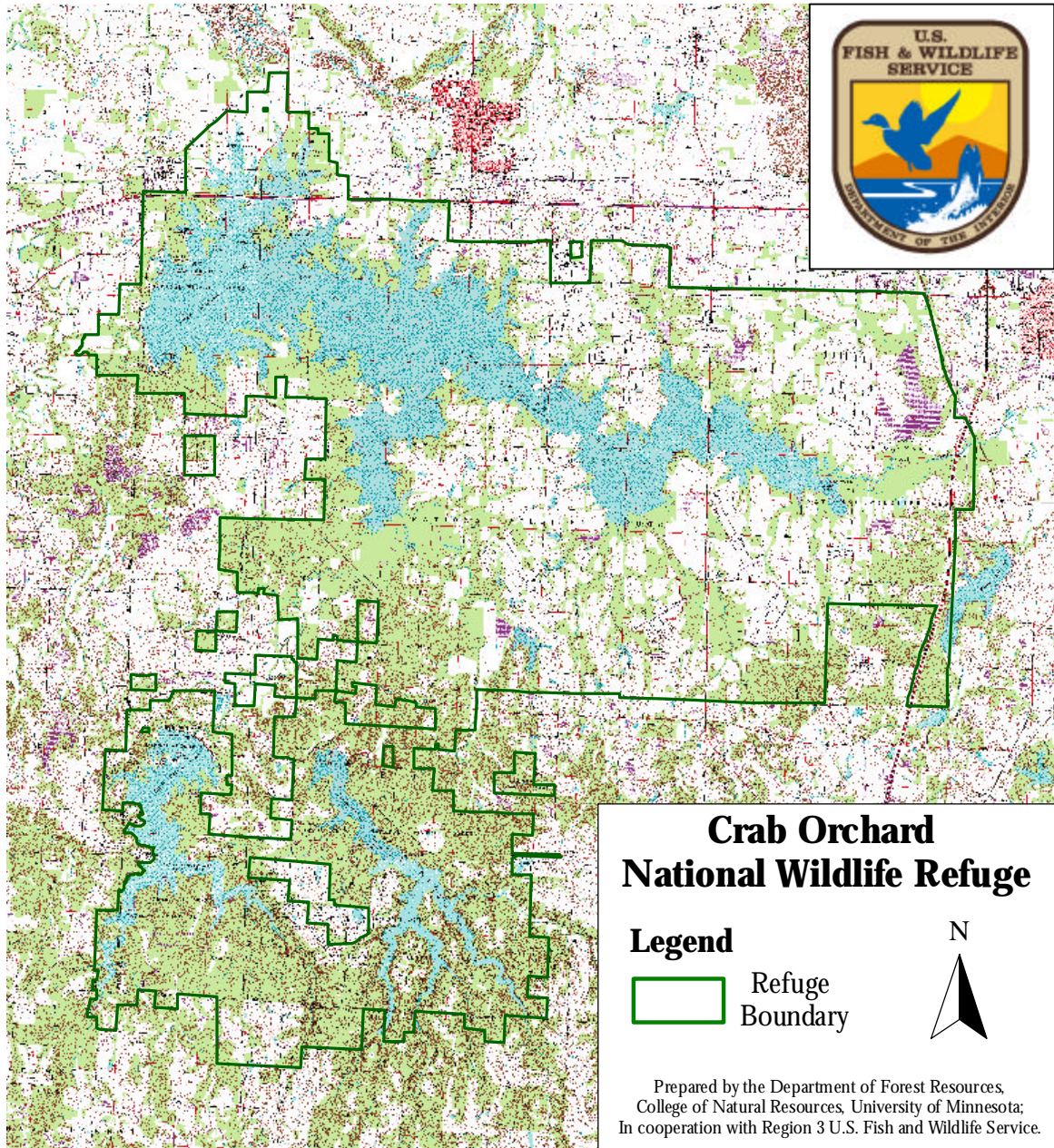
Crab Orchard National Wildlife Refuge

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

Crab Orchard National Wildlife Refuge
Land Uses And Public Recreation Facili

Map Legend

Land Uses

- agriculture
- grazing
- industry
- pine
- wilderness
- water
- unclassified

Õ Pistol Range

Ú Observation

T Boat Launch

≡ Trails

O Crab Orchard Boundary

N

Prepared by the Department of Natural Resources
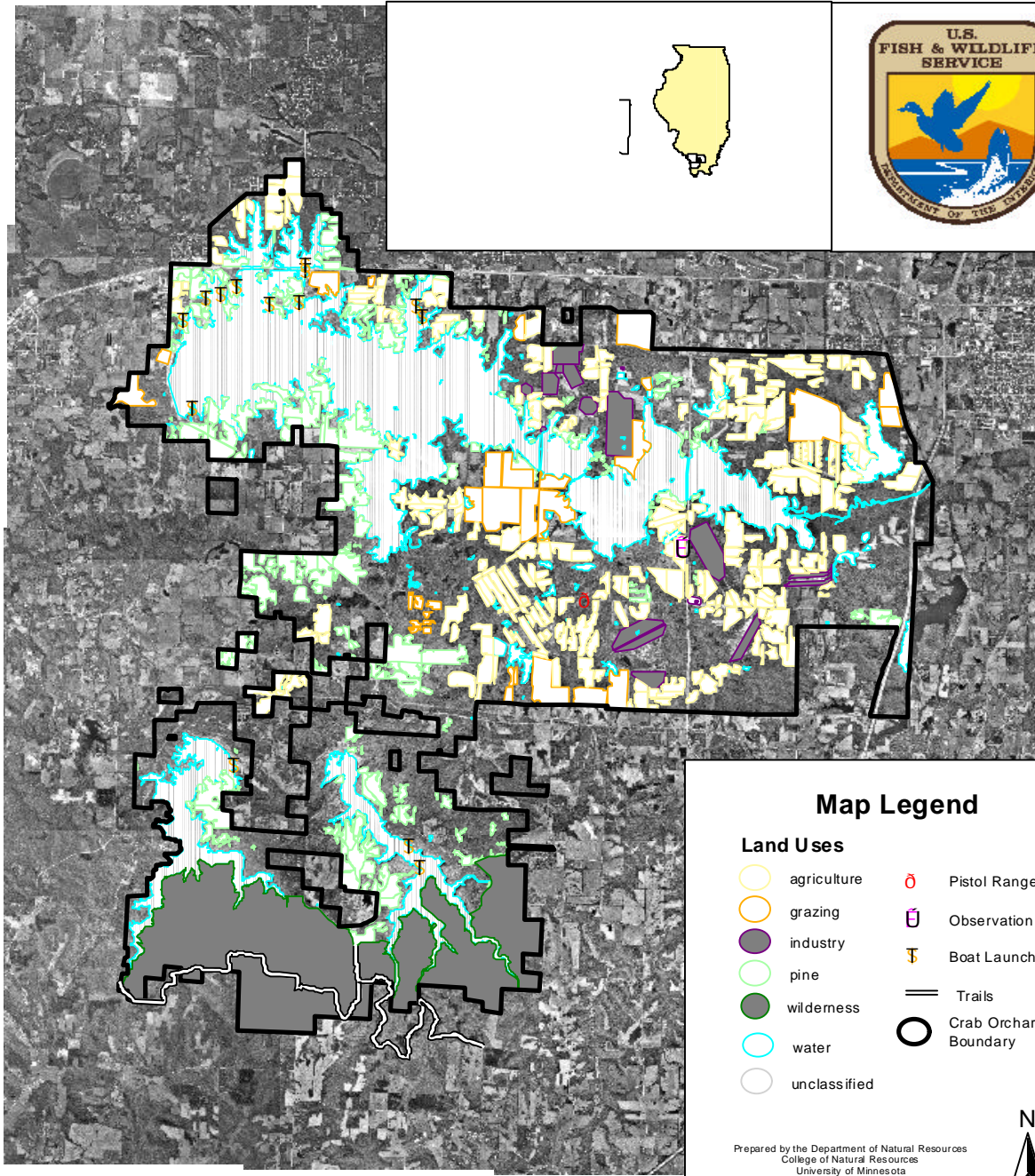College of Natural Resources
University of Minnesota

Figure 4. Map of Crab Orchard National Wildlife Refuge management plan land uses in relation to existing public recreational facilities over mosaiced digital orthophotos.

Crab Orchard National Wildlife Refuge
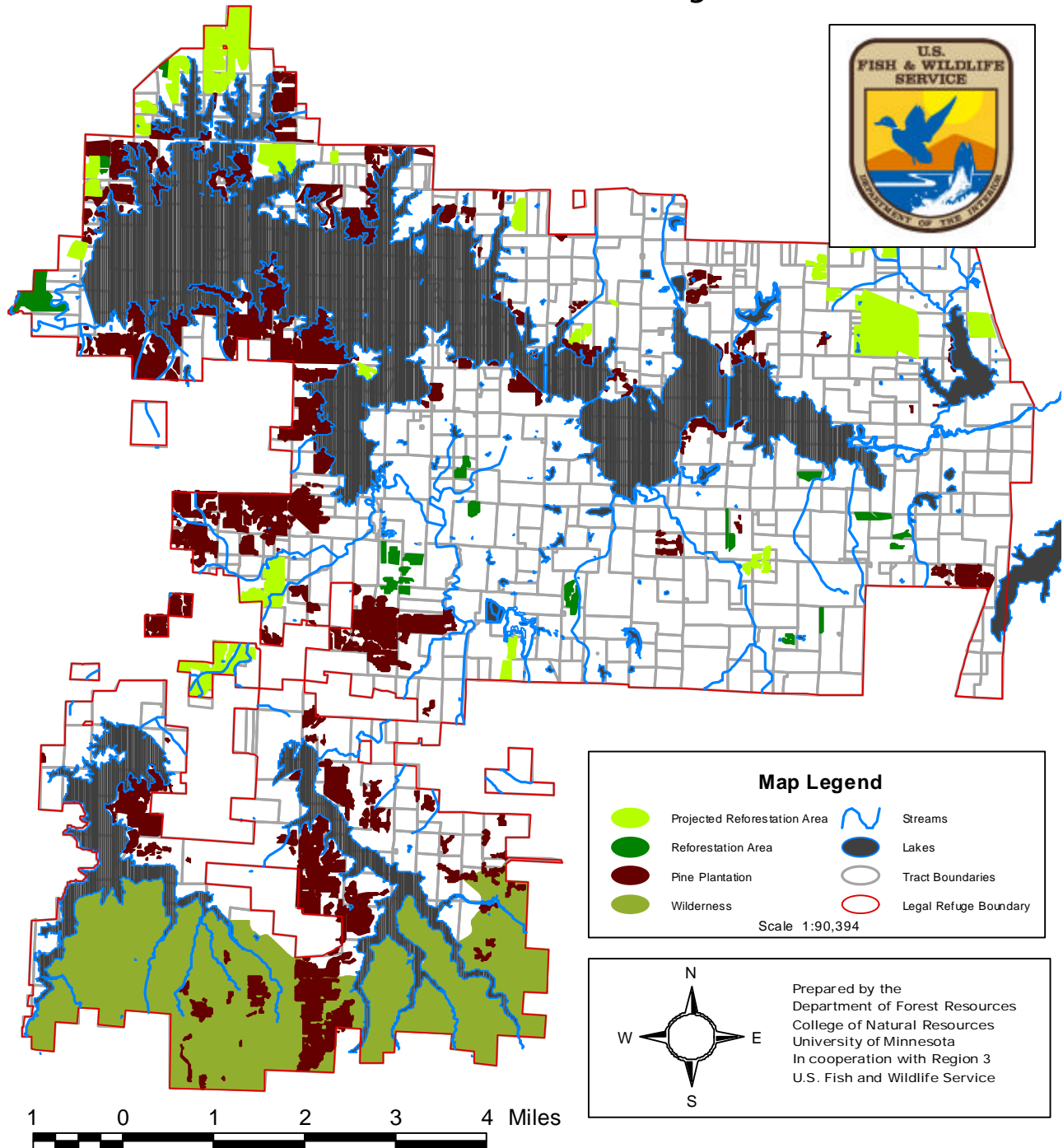## Forest Resources by Tract

Map Legend

Projected Reforestation Area	Streams
Reforestation Area	Lakes
Pine Plantation	Tract Boundaries
Wilderness	Legal Refuge Boundary

Scale 1:90,394

N
W   E
S

Prepared by the
Department of Forest Resources
College of Natural Resources
University of Minnesota
In cooperation with Region 3
U.S. Fish and Wildlife Service

1   0   1   2   3   4   Miles

Figure 5. Crab Orchard NWR tract divisions overlain with forest and aquatic features which have high potential as wildlife habitats.

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 …				
Note: Additional datasets may be requested				

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

Documentation:
This CD contains GIS data for the Crab Orchard National Wildlife Refuge, Missouri.

Overall Description:
This CD contains Basemap Layers, Refuge Specific Layers (CROMap) 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 16 with a DATUM of NAD83.

Basemap Data:

/cro/basemap/dems
This directory contains a mosaic of 7 quads of DEM data (Digital Elevation Model) in Arc GRID format and .img format.

/cro/basemap/doqs
This directory contains 13 separate DOQs (Digital Orthophoto Quadrangle) in ArcInfo BIL (.bil) format that cover the extent of the Crab Orchard National Wildlife Refuge.

/cro/basemap/drgs
This directory contains a mosaic of 7 quads of DRGs (USGS Digital Raster Graphics) in TIF (.tif) format.

/cro/basemap/floodpl
This directory contains an ArcView Shapefile depicting the 100 year and 500 year floodzones for the Crab Orchard NWR as indicated on the Federal Emergency Management Agency (FEMA) National Flood Insurance Program (NFIP) maps and Flood Hazard Boundary maps.

/cro/basemap/hydro
This directory contains ArcView Shapefiles for the hydrography data for the the Crab Orchard NWR study area. The file "lakes" represent lakes, and the file "streams" represent streams.

/cro/basemap/landcvr
This directory contains an Erdas Imagine (.img) file of Crab Orchard NWR with 19 land cover classes derived from Thematic Mapper (TM) satellite data from the Landsat 4 sensor and ancillary data

/cro/basemap/landuse
This directory contains an ArcView Shapefile for the land use/land cover data of the Crab Orchard NWR. The land cover types are listed in the attribute table.

/cro/basemap/nh
This directory contains ArcView Shapefiles depicting natural areas, digitized from USGS 7.5 minute quadrangles or from aerial photographs at a scale of 1:8,000. Boundaries are approximate and do not indicate ownership or property boundaries.

cro/basemap/nwi
This directory contains an ArcView Shapefile for the National Wetlands Inventory data for the Crab Orchard NWR study area.

/cro/basemap/pls
This directory contains the ArcView Shapefile for the Public Land Survey System data for the Crab Orchard NWR study area.

/cro/basemap/polbnds
This directory contains the ArcView Shapefiles for the Political Boundaries of the Crab Orchard NWR study area. The file "county" represents county names, "municipal" is incorporated areas in and around Crab Orchard NWR, "poltwp" is township boundaries, "quads" is 7.5' (1:24,000 nominal scale) quadrangles in and surrounding the Crab Orchard NWR, and "state" is the state boundary.

/cro/basemap/trans
This directory contains ArcView Shapefiles for the roads data for the Crab Orchard NWR study area. The file "airports" is airport locations, "railroad" is railroads, and "roads" is roads.

/cro/basemap/utils
This directory contains ArcView Shapefiles delineating a variety of utility lines running in and around the Crab Orchard NWR. "cips" contains an ArcView Shapefile depicting Central Illinois Power Supply Gas lines. "egyptelec" contains an ArcView Shapefile depicting Egypt Electric lines. "landfills" contains an ArcView Shapefile depicting the locations of landfills in the study area. "main" contains an ArcView Shapefile depicting a 10 inch gas main in the study area. "petroleum" contains an ArcView Shapefile depicting petroleum lines in and around Crab Orchard NWR.

/cro/basemap/wsheds
This directory contains the ArcView Shapefiles for the USGS 11-digit watershed delineation for the Crab Orchard NWR study area.

CROMap Data:

cro/cromap/cultural
This directory contains the ArcView Shapefile delineating points of archaeological studies and cemeteries in and around the Crab Orchard NWR.

cro/cromap/mgmtplns
This directory contains the ArcView Shapefiles for agricultural and forestry management plan data for the Crab Orchard NWR.

cro/cromap/prjbnd
This directory contains and ArcView Shapefile delineating the legislative boundary of Crab Orchard NWR.

/cro/cromap/rpiprop/points
This directory contains the ArcView Shapefiles for real property for the Crab Orchard NWR in the form of points. Included are files for buildings (bldgs.shp), bridges (bridges.shp), docks (docks.shp), industrial sites (industry.shp), boat launches (launch.shp), miscellaneous property (misc), unsorted real property (raw_rpi.shp), sewage facilities (sewage.shp), storage facilities (storage.shp), public restrooms (toilets.shp), and water control structures (wcs.shp)
.
/cro/cromap/rpiprop/polygons
This directory contains the ArcView Shapefiles for real property for the Crab Orchard NWR in the form of polygons. Included are impoundment areas (impound.shp) and lakes (lakespri.shp).

cro/cromap/tracts
This directory contains an ArcView Shapefile delineating the individual tract boundaries within the Crab Orchard NWR

cro/cromap/wildlife
This coverage contains the approximate locations of eagles' nests during the summer of 1999 as located by Crab Orchard Refuge biologists on digital orthophoto quads in the form of an ArcView Shapefile.