

**Construction of a Geographic Information System
for Wildlife Refuge Planning:
Rice Lake National Wildlife Refuge¹**

by

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Background

The National Wildlife Refuge System Improvement Act of 1997³ requires the U.S. Fish and Wildlife Service (USFWS) to develop Comprehensive Conservation Plans (CCP) for the management of lands under its jurisdiction. Section 7 of the Committee Report from the Act⁴ describes five areas that must be addressed in each national wildlife refuge CCP, including:

- 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; and
- opportunities for fish- and wildlife-dependent recreation.

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, which administers 46 National Wildlife Refuges over an eight state region (Figure 1) works cooperatively with the University of Minnesota to acquire and create Geographic Information System (GIS) data for each refuge. These data sets are invaluable for analyzing refuge resources and visualizing alternative management scenarios.

Standard Procedures

Since 1997, the University of Minnesota Department of Forest Resources has worked cooperatively with the USFWS to compile geo-referenced data for each National Wildlife Refuge in USFWS Region 3. Data collection



Figure 1. The Great Lakes-Big Rivers Region of the U.S. Fish and Wildlife Service administers 46 refuges and 11 Wetland Management Districts over an eight-state area.

³ <http://refuges.fws.gov/policymakers/mandates/HR1420/index.html>

⁴ <http://refuges.fws.gov/policymakers/mandates/HR1420/Part4.html>

and development efforts are guided by a standardized list of pre-determined data sets at three different spatial extents: regional, watershed and refuge specific (See Appendix A). The regional extent attempts to place the refuge within broad human and ecological contexts. Regional extent data includes generalized, small-scale data layers covering several countries, such as vegetation, highways and county boundaries. The watershed level extent is typically derived from the major watershed boundary in which the refuge lies, and includes more detailed data layers, such as streams, wetlands, and roads. Watershed level data is appropriate for map production, spatial reference, and analysis. Refuge-specific layers, such as management plans, wildlife habitat, and real property inventory, are collected only within the refuge boundaries. Data acquisition differs between individual refuges depending on availability and specific refuge needs. Student research assistants attempt to collect spatial data at no-cost from various local, state and federal agencies, academic, professional and government Internet sites, and some private companies. In some instances, students and/or refuge staff have gathered data using a global positioning system (GPS) and other data have been purchased by the USFWS. Students process all data using GIS software including ESRI's Arc/Info, ArcView, and ArcGIS, and image processing software (ERDAS Imagine) on both Microsoft Windows and Unix workstations.

In addition to the spatial data layers, students also create metadata files, which provide lineage information for each data set, including data source and geoprocessing procedures. Metadata files are created using simple text editors or specialized metadata tools like ESRI's ArcCatalog. The final text file is checked for compliance with FGDC standards using the U.S. Geological Survey's MetaParser program.⁵

Final data and corresponding metadata are delivered to the USFWS on CD-ROM using a standardized directory structure. A text file with brief descriptions of the data contained on the CD-ROM is also included. (See Appendices B and C for text descriptions of Rice Lake National Wildlife Refuge data.)

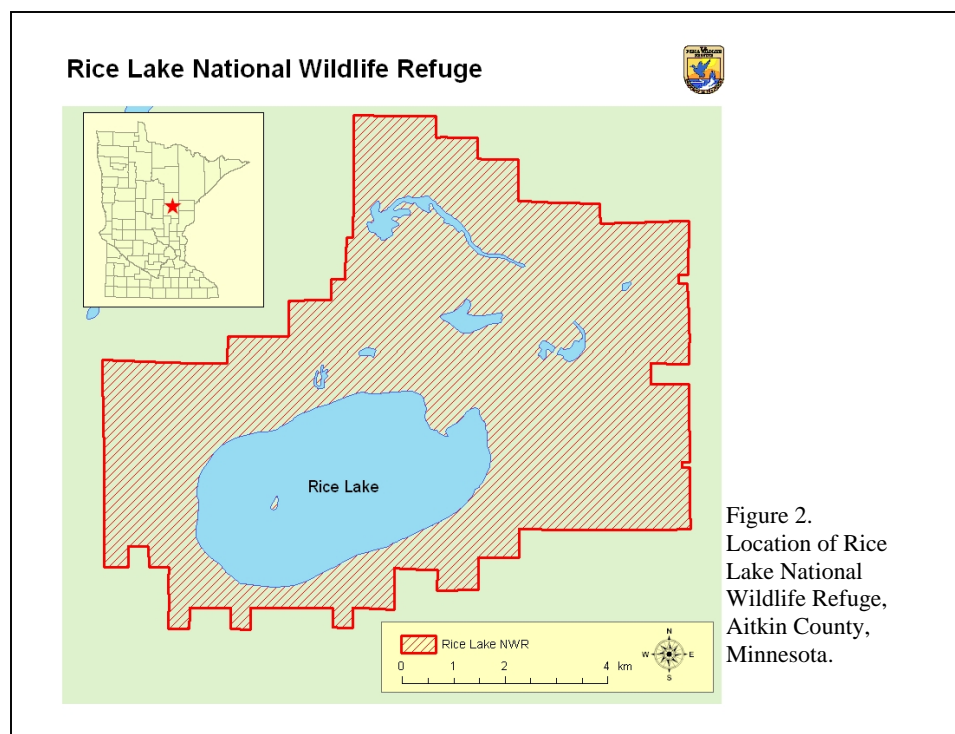
All of the GIS data layers and metadata files created for the USFWS Region 3 are intended to be useful operationally. Data sets specific to the refuge require field verification by refuge staff familiar with the refuge lands. Additionally, refuge boundaries adhere to specifications of the U.S. Fish and Wildlife Service Lands Boundary Data Standard Operating Procedures (SOP Number 97-01). As noted in the corresponding metadata files, 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

⁵ <http://geology.usgs.gov/tools/metadata/tools/doc/mp.html>

such. It is the responsibility of the user to use the data appropriately and consistently, recognizing its limitations.

Rice Lake National Wildlife Refuge

Rice Lake National Wildlife Refuge is located in Aitkin County, in east-central Minnesota, about five miles south of McGregor (pop. 404, Census 2000) (Figure 2). The refuge was established in 1935 to preserve important migratory bird and waterfowl habitat. The most important resource of this 18,300 acre refuge is Rice Lake itself, a shallow, 4,500 acre wild rice-producing lake (Figure 3). The Rice River drains the refuge, flowing from the southeast corner to the northwest, ultimately emptying into the Mississippi River 20 miles west of the refuge.



Rice Lake National Wildlife Refuge is located in the glaciated transition zone between hardwood and coniferous forest types and contains a wide range of habitats from bog to upland hardwoods. A system of horseshoe-shaped moraines, or glacial ridges, surrounds the area on three sides, opening to the northeast. The moraines block natural water drainage to the south, allowing the area to gradually become a floating or muskeg-like bog, a natural haven for waterfowl. The encroaching bog is slowly transforming marshy, shallow lakes into bog lands, which contain



Figure 3. Rice Lake is a 4,500 acre shallow basin lake. Active water level management optimizes wild rice production, providing important migratory bird and waterfowl habitat.

poorly-drained organic soils known as peat. Peat supports a spongy mixture of flowering plants, grasses, low shrubs and small islands of black spruce, balsam fir and tamarack.

Wild rice and wild celery beds in Rice Lake are especially attractive to migrating ducks and geese (Figure 4). Wild rice produced by Rice Lake attracts thousands of migrating waterfowl who feed and rest on the lake and the surrounding marshes and bogs. Rice Lake water levels are manipulated to benefit wild rice production. Additionally, Rice Lake National Wildlife Refuge plays an important role in the management of the ring-necked duck. About one-quarter of the continental harvest of this duck occurs in Minnesota. Rice Lake supports one of the largest concentrations of ring-necks in the state. Up to 70,000 ring-necked ducks can be found on Rice

Lake during fall migration.



Pickerelweed
(*Pontederia cordata*)

Wild rice provided food for early Woodland Indians who lived in the area from 1000 B.C. to 1700 A.D. Indian village sites and seasonal encampments were situated on the shores of Rice Lake, as evidenced through discovery of various artifacts. Earthen burial mounds also occur on the refuge. Currently, Local Ojibwe Indians use traditional methods to

harvest wild rice each September.



Figure 4. Emergent vegetation at Rice Lake includes large wild rice beds which provide an important food resource for migrating waterfowl. Humans have harvested the wild rice in this area for over 3,000 years.

Diverse habitats found across the refuge attract migratory and resident avian species. Several species of hawks and owls frequent the refuge, as well as large numbers of bald eagles during spring and fall migrations. Both sharp-tailed and ruffed grouse are present, as well as Canada geese, snow geese and sandhill cranes. Primary nesting duck species include mallard, blue-winged teal, wigeon and wood duck. Mammalian species present on the refuge include white-tailed deer, black bear, mink, beaver, otter, and porcupine. Gray wolves occasionally frequent the refuge.

Rice Lake contains natural spawning areas for northern pike, suckers and buffalofish. Yellow perch, walleye, crappie, black bullhead, bowfin and eel pout are found on the refuge. Rice Lake NWR also provides habitat for reptiles and amphibian species, including several frog species, common toads, painted and snapping turtles, garter and green snakes and salamanders.

Refuge visitors can participate in a wide variety of recreational activities. Seven miles of hiking trails traverse many habitat types, including deciduous and coniferous forests, grasslands

and wetlands. Fishing for northern pike along the Rice River is also a popular activity. The refuge allows boat access (non-motorized, electric) to two refuge lakes, Mandy Lake and Twin Lakes. Deer and small game hunting is allowed in specially designated areas during regulated seasons. A 9.5 mile self-guided auto-tour is open from May through October. All trails are open to snowshoeing and cross-country skiing during the winter.

GIS Data: Spatial Extents and Data Layers

The GIS data collected for Rice Lake National Wildlife Refuge span three spatial extents. The regional extent covers 7 counties (Aitkin, Carlton, Crow Wing, Kanabec, Mille Lacs, Morrison and Pine) capturing the diverse ecological regional context of the refuge, ranging from upland deciduous and coniferous to black spruce bogs (Figure 5). The watershed extent includes a group of contiguous 7.5-minute quadrangle boundaries covering a portion of the major watershed in

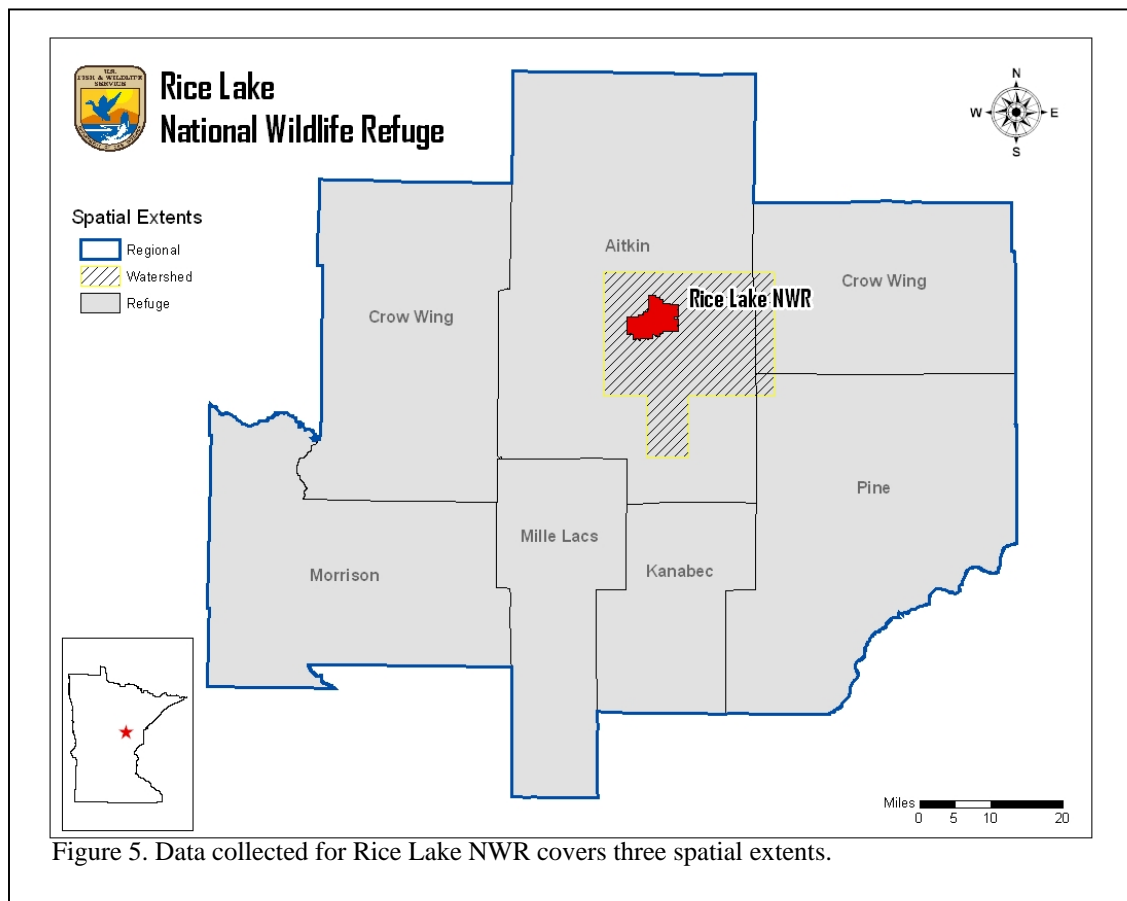


Figure 5. Data collected for Rice Lake NWR covers three spatial extents.

which Rice Lake lies⁶. Refuge specific layers lie mainly within the refuge boundaries. Appendix D contains a list of data collected for Rice Lake NWR along with brief descriptions of each data layer. The data file structure and file names, based on a naming standard developed for the current project, are also listed

Sandstone Unit of Rice Lake NWR

The Sandstone Unit of Rice Lake NWR is located in Pine County in east-central Minnesota, about 2 miles southeast of Sandstone. The Sandstone Unit was initially acquired to serve as a location for a federal prison, but in 1969, a federal judge declared that a portion of the original acquisition was unnecessary to support the Sandstone Correctional Institution. On February 18, 1970, the surplus land was transferred to the U.S. Fish & Wildlife Service.

The unit contains 2,045 acres composed of diverse plant communities, including upland forest, grassland, forested wetland, shallow marshes, bogs and riverine wetlands. Most of the Sandstone Unit is forested upland, predominated by sugar maple, basswood, aspen, paper birch, red and white pine, and several oak species. The remaining area is mostly grassland, with the exception of 160 acres of wetlands in small 1-12 acre basins. The unit encompasses 2,045 acres and includes portions of the State of Minnesota designated Wild and Scenic Kettle River.

Visitors to the Sandstone Unit Refuge can participate in a wide variety of recreational activities, including hiking, cross-country skiing and snow-shoeing on old logging trails. Visitors can also view wildlife in designated areas. Diverse habitats found across the unit attract several migratory and resident songbird species, including ruffed grouse, woodcock, wood ducks and mallards. Visitors may also see white-tailed deer and beaver. The Unit is open to small game, woodcock, snipe and archery deer hunting in accordance with state seasons and dates in designated hunting areas. The Sandstone Unit is closed to migratory waterfowl hunting. Visitors may also fish on the west side of the unit in the Kettle River. Camping is not permitted in the Sandstone Unit.

⁶ Rice Lake NWR is located in the extreme northeast portion of a large watershed, which would include 50 USGS 7.5 minute quads. Collecting data for the entire watershed was deemed unnecessary since data would be collected that would not be proximate to the refuge itself. A subset of 7.5 minute quads was selected instead.

GIS Data: Spatial Extents and Data Layers

The GIS data collected for the Sandstone Unit of Rice Lake National Wildlife Refuge span three spatial extents (Figure 8). The regional extent covers includes 7 Minnesota counties (Aitkin, Carlton, Crow Wing, Kanabec, Mille Lacs, Morrison and Pine) and Burnett County, Wisconsin. The watershed extent includes 38 contiguous 7.5-minute quadrangle boundaries covering a portion of the major watershed in which Rice Lake lies. Refuge specific layers lie mainly within the refuge boundaries. Appendix E contains a list of data collected for the Sandstone Unit along with brief descriptions of each data layer. The data file structure and file names, based on a naming standard developed for the current project, are also listed.

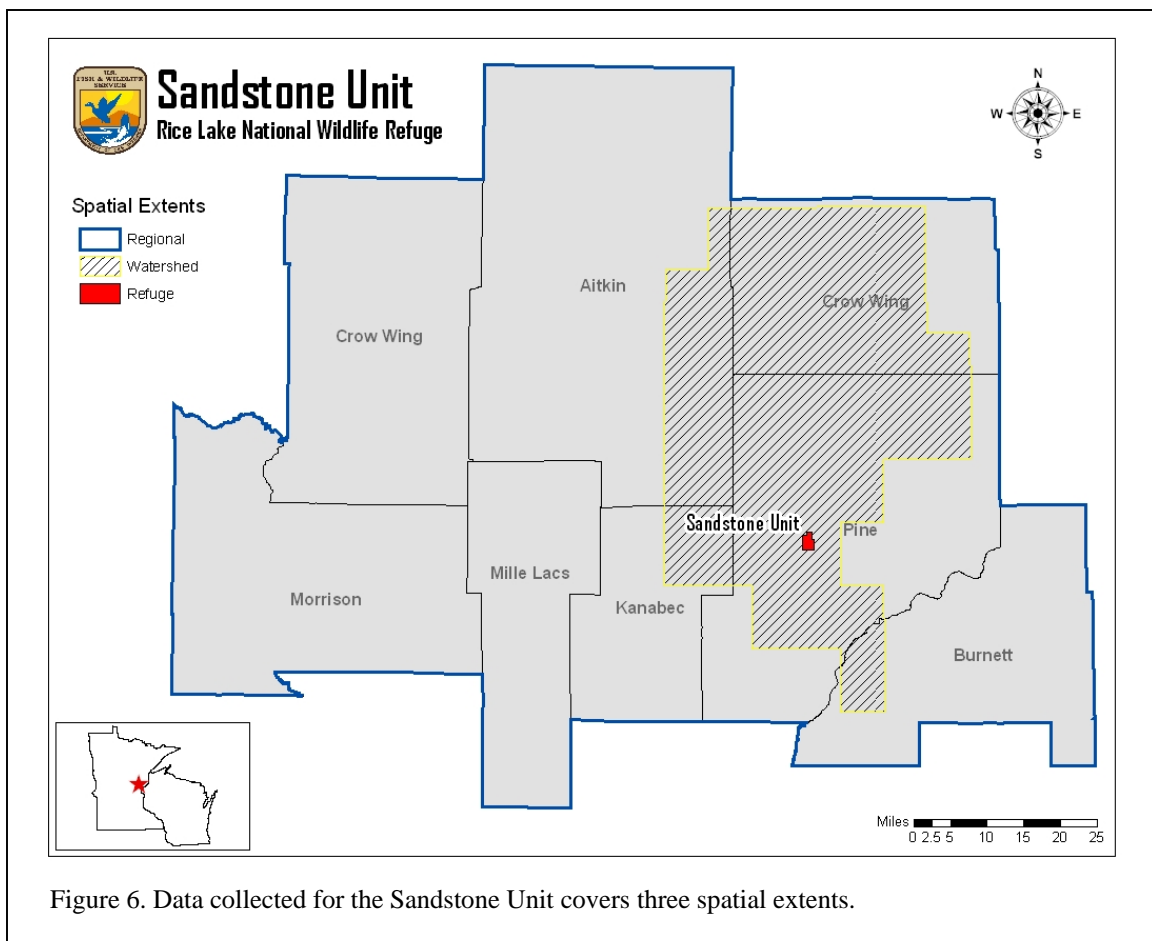


Figure 6. Data collected for the Sandstone Unit covers three spatial extents.

Spatial Analysis

Overlaying data layers in a GIS greatly enhances the conservation planning process. Resource managers can use the data to visualize the spatial relationships between refuge resources and the potential effects of different management activities. For example, overlaying burn unit boundaries on a fuel load model can help biologists better understand how a prescribed burn may behave,

helping staff to safely execute burn plans (Figure 7). Refuge managers may use presettlement vegetation data to determine natural community potential in habitat restoration efforts (Figure 8). Such data may also provide useful productivity indexes and natural disturbance patterns. Resource managers may potentially use water quality data collected in the field along with watershed and stream spatial data to perform analysis regarding impacts of land use on water quality (Figure 9). This analysis could be used in conjunction with a trout stream habitat assessment to improve trout populations in adjacent streams. Other GIS analyses could include studies of various wetland types, sizes, and shapes in and around the refuge. As refuge staff becomes more proficient with using GIS as a powerful management tool, spatial analysis many maps and analyses can be produced to enhance natural resource management activities at lands administered by Rice Lake National Wildlife Refuge.



Rice Lake National Wildlife Refuge

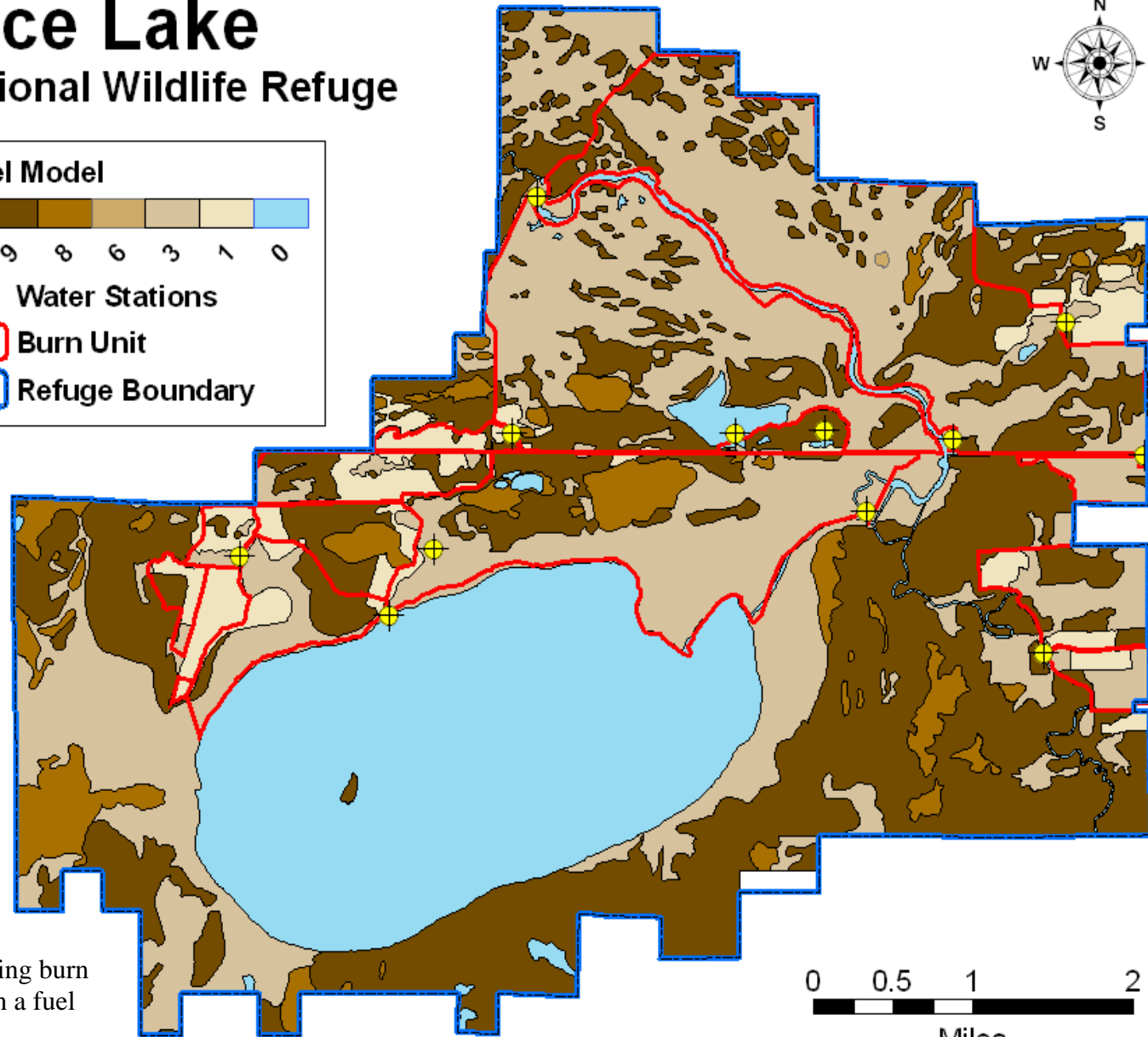
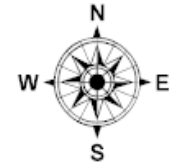
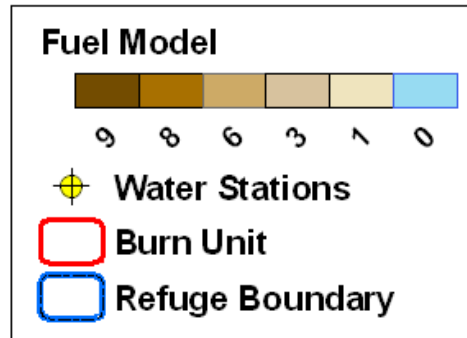
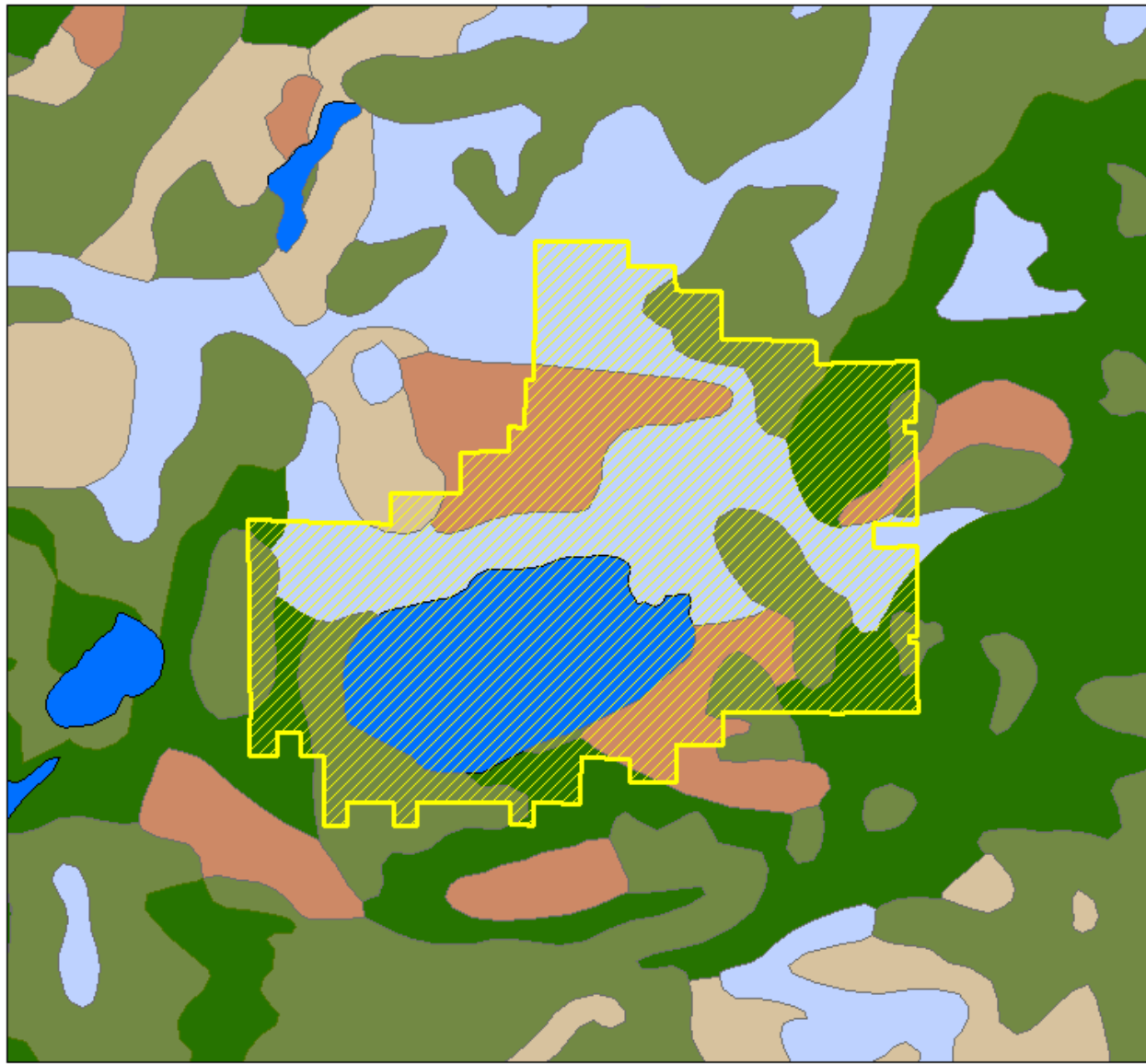
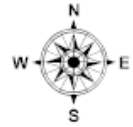


Figure 7. Overlaying burn unit boundaries on a fuel load model.



Rice Lake

National Wildlife Refuge



Marschner's Pre-settlement Vegetation

 Refuge Boundary

Type

-  Aspen
-  Coniferous Bogs
-  Hardwoods
-  Jack Pine Barrens
-  Muskeg
-  Oak
-  Pine
-  Prairie
-  River Bottom Forest
-  Undefined
-  Water
-  Wet Prairie

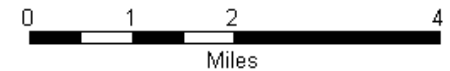


Figure 8. Marschner's pre-settlement vegetation derived from public land survey notes.

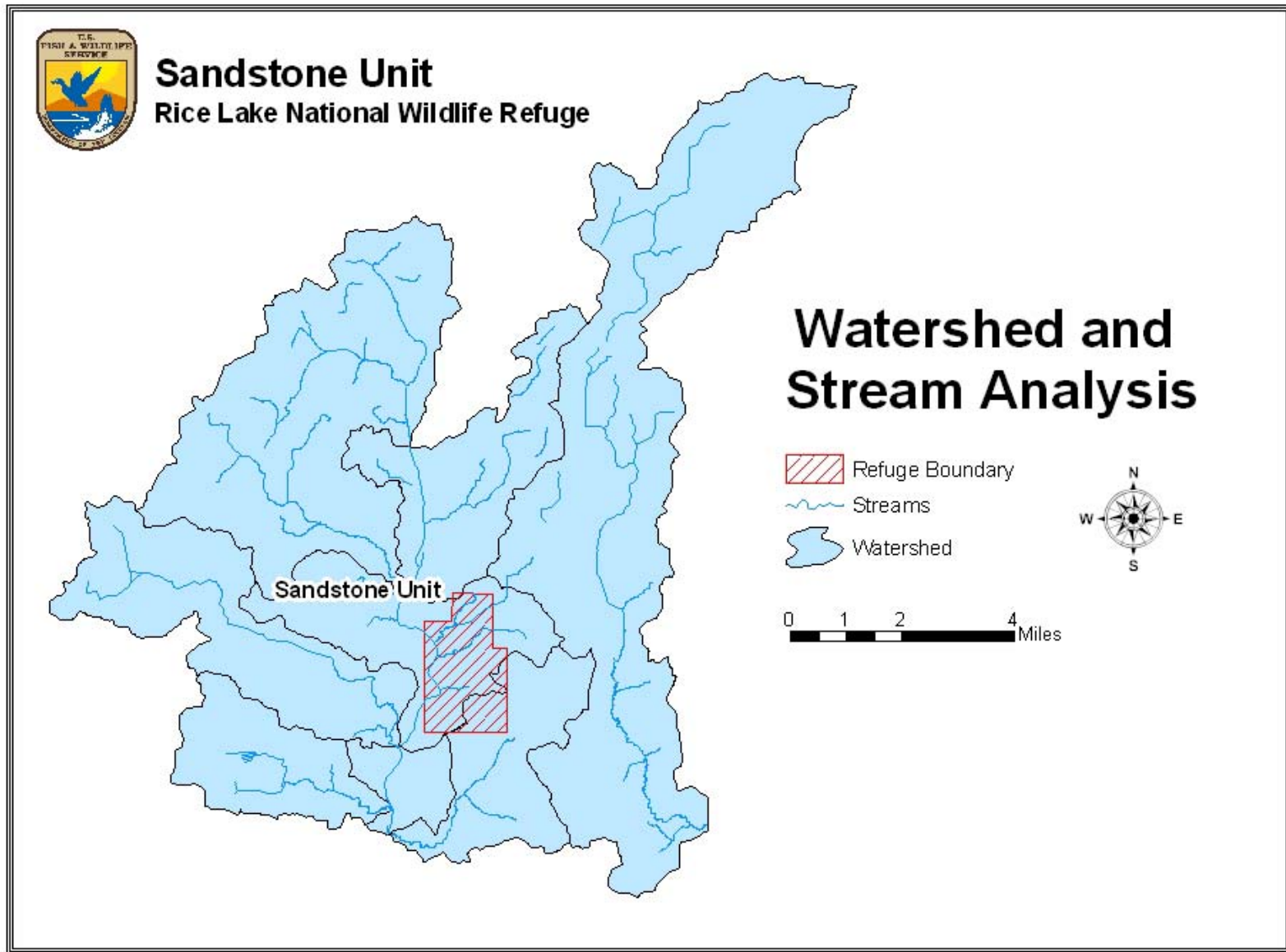


Figure 9. Analysis of watersheds and upstream impacts on water quality can be performed using field data and spatial data.

Appendix A: A National Wildlife Refuge GIS Data Inventory (last revision Nov. 2003)

Data Set Name	Status / Notes	Source	Resolution	Extent	MetaData
<i>Regional Data</i>					
DRG's 1:250,000					
<i>Hydrography</i>					
Major Lakes					
Major Rivers					
<i>Land Ownership</i>					
Other Public Lands					
Land Use/Land Cover					
<i>Political Boundaries</i>					
Congressional Districts					
Counties					
State					
<i>Transportation</i>					
Roads - major					
<i>Vegetation</i>					
Historical					
Potential (Kuchler)					
<i>Watersheds</i>					
Watersheds - major					
<i>Watershed Data</i>					
Digital Elevation Models (DEMs)					
DRG's 1:24,000					
<i>Floodplains (FEMA)</i>					
100 year boundaries					
500 year boundaries					
<i>Hydrography</i>					
Lakes					
Rivers					
Streams					
Natural Heritage Data					
National Wetlands Inventory (NWI)					
<i>Political Boundaries</i>					
Cities / Municipal Boundaries					
Civil Townships					
Zoning					
<i>Public Land Survey</i>					

Data Set Name	Status / Notes	Source	Resolution	Extent	MetaData
Township/Range					
PLS Sections					
PLS 40's					
<i>Soils</i>					
STATSGO					
<i>Transportation</i>					
Airports					
Railroads					
Roads - minor					
<i>Watersheds</i>					
Watersheds - minor					
<i>Refuge Data</i>					
Digital Orthophoto Quadrangles					
<i>Boundaries</i>					
Easements					
Refuge Legislative Boundary					
Refuge Ownership Boundary					
Tracts (Internal tracts)					
WPAs					
<i>Cultural</i>					
Archeological Sites					
Land Cover					
<i>Management plans</i>					
Burn Units					
Cropland Management Plan					
Future Planning					
<i>Public Recreation</i>					
Boat Access					
Fishing Access					
Hiking Trails					
Parks					
Picnic Areas					
<i>Real Property Inventory</i>					
Dikes					
Ditches					
Drainage Network					
Signs					
Storm water Sewers					

Data Set Name	Status / Notes	Source	Resolution	Extent	MetaData
Structures					
Water Control Structures					
<i>Soils</i>					
SSURGO					
<i>Transportation</i>					
Refuge Roads					
Parking Areas					
<i>Wildlife Habitats</i>					
Critical Habitat					
Eagles, Herons, etc					
Fish Habitat					

Appendix B: Text file description for Rice Lake National Wildlife Refuge GIS data

Documentation:

This CD contains GIS data for the Rice Lake National Wildlife Refuge in Aitkin County, Minnesota.

Overall Description:

This CD contains basemap layers at regional and watershed extents, and refuge specific layers. The data exist either as ArcView shapefiles, or any of a variety of image files (TIFF, JPG, IMG, or other file types). All spatial data are geo-referenced to UTM Zone 15, using the North American Datum of 1983. There are also metadata .MET files with a detailed description of each data layer. These metadata files are found in the same directory and with the same name as the spatial data files.

Rice Lake National Wildlife Refuge Data

/rcl/document/

This directory contains the summary document and the filenames document for Rice Lake National Wildlife Refuge.

/rcl/graphics/

This directory contains the Adobe Illustrator files for the CD labels and case inserts for Rice Lake National Wildlife Refuge.

/rcl/regional/drgs/

This directory contains the compressed TIFF file format file **drg250k**, a mosaic of the 1:250,000 scale USGS Digital Raster Graphics (DRGs) for the region surrounding Rice Lake National Wildlife Refuge.

/rcl/regional/eco_reg/

This directory contains the ArcView shapefile **eco_reg**, representing Bailey's ecological units for the region surrounding Rice Lake National Wildlife Refuge.

/rcl/regional/hydro/

This directory contains the ArcView shapefiles **lakes**, **streams**, and **wtrshed**. These shapefiles cover the major hydrographic features for the region surrounding Rice Lake National Wildlife Refuge.

/rcl/regional/landown/

This directory contains the ArcView shapefile **publand**, which shows the public land ownership, and **dnrland**, which provides information about Minnesota DNR owned land (including Scientific & Natural Areas and state parks) for the region surrounding Rice Lake National Wildlife Refuge.

/rcl/regional/lulc/

This directory contains a variety of land use and land cover files for the region surrounding Rice Lake National Wildlife Refuge. The ArcView shapefile **histveg** is a digital version of Marshner's historical vegetation map, derived from original Public Land Survey notes. The ArcView shapefile **potveg** shows Kuchler's map of potential natural vegetation of the conterminous United States. This map represents natural vegetation that would occur today if urban, agricultural, and other human influences were removed. Also contained in this directory is

nlcd83, which is an ArcInfo grid file depicting the National Land Cover Data (NLCD). The NLCD was compiled from Landsat satellite TM imagery (circa 1992) with a spatial resolution of 30 meters.

/rcl/regional/polbnds/

This directory contains political boundary data. The state (ArcView shapefile **state**) and county (ArcView shapefile **county**) boundaries are given for the state of Minnesota, while the congressional district boundaries (ArcView shapefile **congdist**) are given for the region surrounding Rice Lake National Wildlife Refuge. Also included is the ArcView shapefile **regbnd**, which represents the regional area of interest boundaries.

/rcl/regional/statsgo/

This directory contains the ArcView shapefile **soils**, which contains STATSGO data for the region surrounding Rice Lake National Wildlife Refuge.

/rcl/regional/trans/

This directory contains the ArcView shapefile **hwys**, representing the major highways for the region surrounding Rice Lake National Wildlife Refuge.

/rcl/wtrshed/dems/

This directory contains the GRID dataset **dems**, representing a 30-meter Digital Elevation Model (DEM) for the watershed in which Rice Lake National Wildlife Refuge lies. A TIFF image, **relief**, is also included and depicts a hillshade for Rice Lake NWR derived from the DEM.

/rcl/wtrshed/drgs/

This directory contains the compressed TIFF file format files **drg24k**, a mosaic of the 1:24,000 scale USGS Digital Raster Graphics (DRGs).

/rcl/wtrshed/floodpl/

This directory contains the ArcView shapefile **floodbnd**, representing the Federal Emergency Management Agency (FEMA) 100-year and 500-year floodplain boundaries for the watershed in which Rice Lake National Wildlife Refuge lies.

/rcl/wtrshed/hydro/

This directory contains the ArcView shapefiles **lakes**, **streams**, and **wtrshed**, representing 1:24000 hydrographic data for the watershed in which Rice Lake National Wildlife Refuge lies.

/rcl/wtrshed/nwi/

This directory contains the ArcView shapfile **nwi**, representing the National Wetland Inventory (NWI) polygon data for the watershed in which Rice Lake National Wildlife Refuge lies.

/rcl/wtrshed/pls/

This directory contains the ArcView shapefiles **twprge** and **plssec**, and **pls40**, showing Public Land Survey (PLS) township and range, section and 40-acre boundaries for the watershed in which Rice Lake National Wildlife Refuge lies.

/rcl/wtrshed/polbnds/

This directory contains political boundaries. The ArcView shapefiles **civtp** and **munbnd** show civil townships and municipal boundaries for the watershed in which Rice Lake National Wildlife Refuge lies. The ArcView shapefile depicts the watershed area of interest boundary.

/rcl/wtrshed/trans/

This directory contains transportation information for the watershed in which Rice Lake National Wildlife Refuge lies. The ArcView shapefiles **roads**, **railroad**, and **runway** show roadways, railroad tracks, and airport runways.

/rcl/rclmap/buildings/

This directory contains ArcView shapefile **bldg**, which shows refuge building locations for a variety of project boundary data types.

/rcl/rclmap/cultural/

This directory contains the ArcView shapefiles **archeoln**, **archeopt**, **archeopy**, and **potential**, representing archeological features as points, lines and polygons, and polygonal zones of archaeological probability, respectively, for Rice Lake National Wildlife Refuge.

/rcl/rclmap/doqs/

This directory contains the compressed Mr. Sid file **doqs**, which is a mosaic of 1992 USGS digital orthophoto quadrangles of Rice Lake National Wildlife Refuge.

/rcl/rclmap/lulc/

This directory contains the ESRI shapefiles **ecosub** and **vegcov**, which describe land cover at varying scales for Rice Lake National Wildlife Refuge.

/rcl/rclmap/mgmtplns/burnunits

This directory contains the ArcView shapefiles related to prescribed burns, including **helibase** and **helispot**, which show helicopter landing locations, **rxburn**, which contains prescribed burn units, and **wtrfill**, which shows water fill station locations.

/rcl/rclmap/mgmtplns/wildfiremgmt

This directory contains ArcView shapefiles related to fire activities on the refuge, including **firehist**, which depicts locations of recent wild fires, **fuelload**, which is a fuel load model used for developing burn plans, and **monitor**, which shows fire monitoring stations.

/rcl/rclmap/photos/

This directory contains an infrared color aerial photograph mosaic for Rice Lake NWR. The 1998 photos were obtained from Minnesota DNR - Resource Assessment.

/rcl/rclmap/prjbnd/

This directory contains the ArcView shapefiles **rclbnd**, showing refuge land ownership status boundaries and **rclleg** depicting refuge legislative boundaries.

/rcl/rclmap/pubrec

This directory contains the ArcView shapefiles **obdeck** and **parking**, which show observation decks and parking areas open to public use.

/rcl/rclmap/realprop/points

This directory contains the ArcView shapefile **pwrpole**, which shows the locations of power poles located on the refuge.

/rcl/rclmap/trans

This directory contains the ArcView shapefile **roads**, showing roads within Rice Lake National Wildlife Refuge.

/rcl/rclmap/wildlife

This directory contains the ArcView shapefiles **eagle** and **heron**, which show the locations of eagle nests and heron rookeries on the refuge.

Appendix C: Text file description for the Sandstone Unit of Rice Lake NWR GIS data

Documentation:

This CD contains GIS data for the Sandstone Unit of Rice Lake National Wildlife Refuge located in Pine County, Minnesota.

Overall Description:

This CD contains basemap layers at regional and watershed extents, and refuge specific layers. The data exist either as ESRI Shapefiles, or any variety of image files (TIFF, JPG, IMG, or other file types). All spatial data are geo-referenced to UTM Zone 15 using the North American Datum of 1983. Metadata (.MET) files containing a detailed description of each data layer are included in the same directory as the spatial datasets themselves.

Sandstone Unit of Rice Lake NWR Data

/rcl s/documents/

This directory contains the summary and filenames documents for the Sandstone Unit.

/rcl s/graphics/

This directory contains Adobe Illustrator files used to create CD labels and case inserts for the Sandstone Unit.

/rcl s/regional/cities/

This directory contains a ESRI shapefile **cities** (point) representing populated places for the region surrounding the Sandstone Unit.

/rcl s/regional/drgs/

This directory contains the compressed TIFF file format file **drg250k**, a mosaic of the 1:250,000 scale USGS Digital Raster Graphics (DRGs) for the region surrounding the Sandstone Unit.

/rcl s/regional/eco_reg/

This directory contains the ESRI shapefile **eco_reg** (polygon) representing Bailey's ecological units for the region surrounding The Sandstone Unit.

/rcl s/regional/hydro/

This directory contains the ESRI shapefiles **lakes** (polygon), **streams** (arcs), and **wtrshed** (polygon). These shapefiles cover the major hydrographic features for the region surrounding the Sandstone Unit.

/rcl s/regional/landown/

This directory contains the ESRI shapefile **publand** (polygon) that shows public land ownership for the region surrounding The Sandstone Unit.

/rcl s/regional/lulc/

This directory contains three datasets related to land use and land cover for the region surrounding the Sandstone Unit. The ESRI shapefile **histveg** (polygon) is a digital version of Marshner's historical vegetation map, originally derived from original Public Land Survey notes. The ESRI shapefile **potveg** (polygon) contains a potential natural vegetation dataset derived from Kuchler (MN) and Finley (WI), representing natural vegetation that would occur today if urban, agricultural, and other human influences were removed. Also contained in this directory is **nlcd** (ArcInfo Grid) that depicts the National Land Cover Data (NLCD). The NLCD was compiled from Landsat satellite TM imagery (circa 1992) with a spatial resolution of 30 meters.

/rcl s/regional/nhd/

This directory contains the ESRI shapefile **nhd** (polygon) that depicts the National Hydrography Data (NHD) for the region surrounding the Sandstone Unit.

/rcl s/regional/polbnds/

This directory contains political boundary data as ESRI shapefiles for the region surrounding the Sandstone Unit, including: **state** (polygon) boundaries for Minnesota and Wisconsin and **county** (county) boundaries for the 8-county regional extent. Congressional district boundaries (**congdist**) (polygon) are given for the region surrounding the Sandstone Unit. The 8-county regional area of interest boundary, **regbnd** (polygon) was used as a clipping boundary for the regional extent.

/rcl s/regional/trans/

This directory contains the ESRI shapefile **hwys** (arcs) that represents the major highways for the region surrounding the Sandstone Unit.

/rcl s/wtrshed/dems/

This directory contains **dems**, an ArcInfo Grid representing a 30-meter Digital Elevation Model (DEM) for the watershed encompassing the Sandstone Unit. A TIFF image, **relief**, is also included and depicts a hillshade for the Sandstone Unit derived from the DEM.

/rcl s/wtrshed/drgrs/

This directory contains the compressed TIFF file format files **drgr100k**, a mosaic of 1:100,000 scale USGS Digital Raster Graphics (DRGs) for the watershed encompassing the Sandstone Unit.

/rcl s/wtrshed/hydro/

This directory contains the ESRI shapefiles **lakes** (polygon) and **streams** (arcs) representing 1:24,000 hydrographic data for the watershed encompassing the Sandstone Unit.

/rcl s/wtrshed/nwi/

This directory contains the ESRI shapefile **nwi** (polygon) representing Minnesota National Wetland Inventory (NWI) data for the watershed encompassing the Sandstone Unit.

/rcl s/wtrshed/pls/

This directory contains the ESRI shapefiles **twprng** (polygon) and **plssec** (polygon) showing Public Land Survey (PLS) township and range, and section boundaries for the watershed encompassing the Sandstone Unit.

/rcl s/wtrshed/polbnds/

This directory contains the ESRI shapefiles **munbnd** (polygon) that shows municipal boundaries, and **wtrbnd** (polygon) for the watershed encompassing the Sandstone Unit. **Wtrbnd** depicts the watershed boundary of interest and serves as a clipping boundary for the other datasets.

/rcl s/wtrshed/soils/

This directory contains the ESRI shapefile **statsgo**, which contains STATSGO data for the watershed encompassing the Sandstone Unit. Also included are the soil data tables that contain information about each soil polygon.

/rcl s/wtrshed/trans/

This directory contains four ESRI shapefiles representing transportation data including **airport** (point), **railroad** (arcs), **roads** (arcs) and **runway** (arcs) that respectively show airport locations, railroad tracks, roadways and airport runways.

/rcl s/rclmap/doqq/

This directory contains the ERDAS Imagine file **doqq**, the 1992 USGS digital orthophoto quadrangle for the Sandstone Unit

/rcl s/rclmap/drqs/

This directory contains the compressed TIFF file format files **drq24k**, the 1:24,000 scale USGS Digital Raster Graphics (DRGs) for the Sandstone Unit.

/rcl s/rclmap/photos/

This directory contains an infrared color aerial photograph mosaic for the Sandstone Unit. The 1998 photos were obtained from Minnesota Department of Natural Resources Resource Assessment office in Grand Rapids, MN.

/rcl s/rclmap/prjbnd/

This directory contains the ESRI shapefile **rcl_s_bnd** (polygon), which shows the refuge legislative boundary.

/rcl s/rclmap/pubrec

This directory contains the ESRI shapefile **prkng** (point) that shows the parking area open to public use on the Sandstone Unit.

/rcl s/rclmap/trans

This directory contains the ESRI shapefile **roads** (line) and represents refuge roads for the Sandstone Unit.

Appendix D: Summary list of data layers for Rice Lake National Wildlife Refuge, with data file structure and names

Dataset Name	Directory Name	Datafile Name	Description
<i>Basemap Data, Regional Level</i>	<i>/regional</i>		
Digital Raster Graphics	/drgs	drg250k	Image - mosaic of 1:250,000 scale USGS topographic maps
Ecological Regions	/eco_reg	eco_reg	Polygons - ecological characterization boundaries
Hydrography	/hydro		
Lakes - major		lakes	Polygons - major lake boundaries
Streams - major		streams	Lines - major stream features
Watersheds - major		wtrshed	Polygons - major watershed boundaries
Land Ownership	/landown	publand	Polygons - land ownership info for other public lands
		dnrland	Polygons - MN DNR land ownership, including S&A's
Land Use/Land Cover	/lulc		
Historical Vegetation		histveg	Polygons - Marshner's map of historical vegetation
National Land Cover Data		nlcd	
Potential Vegetation		potveg	Polygons - Kuchler's map of potential natural vegetation
Political Boundaries	/polbnds		
Congressional Districts		congdist	Polygons - congressional districts for the region
County		county	Polygons - county boundaries for the state of Minnesota
Regional Extent		region	Polygons - county boundaries for the regional extent
State		state	Polygons - Minnesota state boundary
Transportation - major roads	/trans	hwys	Lines - major roads of the region
<i>Basemap Data, Watershed Level</i>	<i>/wtrshed</i>		
Digital Elevation Models	/dems	dems	Raster - 30 meter DEM mosaic

Dataset Name	Directory Name	Datafile Name	Description
Digital Raster Graphics	/hydro	drg24k	Image - mosaic of 1:24,000 scale USGS topographic maps
Hydrography	/hydro		
Lakes		lakes	Polygons - 1:24,000 scale lake data
Streams		streams	Lines - 1:24,000 scale stream data
Watersheds - minor		wtrshed	Polygons - minor watershed boundaries
National Wetlands Inventory	/nwi	nwi	Polygons - NWI data obtained from the Minnesota DNR
Political Boundaries	/polbnds		
Municipal Boundaries		munbnd	Polygons - municipal boundaries
Civil Townships		civtwp	Polygons - civil township boundaries
Public Land Survey	/pls		
Township/Range		twprng	Polygons - public land survey township/range boundaries
PLS Sections		plssec	Polygons - public land survey section boundaries
PLS 40 Acre		pls40	Polygons - public land survey forty acre boundaries
Transportation	/trans		
Airports		runway	Polygons - airports mapped at 1:24,000
Railroads		railroad	Lines - 1:24,000 scale railroad lines
Roads - minor		roads	Lines - 1:24,000 scale obtained from the Minnesota DNR
<i>Basemap Data, Refuge Specific</i>	<i>/rclmap</i>		
Buildings	/buildings	bldgs	Points - refuge building locations
Cultural Resources	/cultural		
Archaeological Points		archopt	Points - Locations of archeological point features
Archaeological Lines		archofn	Lines - Locations of archeological line features
Archaeological Polygons		archofy	Polygons - Locations of archeological polygon features

Dataset Name	Directory Name	Datafile Name	Description
Potential Archeological Sites		potential	Polygons - Locations of potential archeological sites
Digital Orthophotos	/doqs	doqs	Image - mosaic of black and white aerial photos
Land cover	/lulc		
Ecological Subsections		ecosub	Polygons - 1:100,000 scale Ecological Subsections from the MN DNR.
Forest Ecological System		fes	Polygons - Forest ecological system from Aitkin County, MN.
Vegetation Cover		vegcov	Polygons - Vegetation cover from an unknown source.
Management Plans	/mgmtplans/burnunits		
		helibase	Point - helicopter base location
		helispot	Point - helicopter landing locations
		rxburn	Polygon - prescribed burn units
		wtrfill	Point - water fill stations
	/mgmtplans/wildfiregmt		
		firehist	Polygon - locations of recent fires.
		fuelload	Polygon - fuel load model
		monitor	Points - fire monitoring stations.
Aerial Photographs	photos		
Refuge Boundary	prjbnd		
		rclbnd	Polygons - boundary of USFWS ownership
		rcleg	Polygons - boundary of USFWS ownership
Public Recreation	/pubrec		
		obdeck	Points - observation deck locations
		parking	Points - public parking areas
Real Property	/realprop/point	pwrpole	Points - power pole locations
Transportation	/trans	roads	Lines - refuge roads

Dataset Name	Directory Name	Datafile Name	Description
Wildlife	/wildlife		
		eagle	Points - eagle nest locations
		heron	Points - heron rookery locations.

Appendix E: Summary list of data layers for the Sandstone Unit of Rice Lake National Wildlife Refuge with file structure and names.

Dataset Name	Directory Name	Datafile Name	Description
<i>Basemap Data, Regional Level</i>	<i>/regional</i>		
Populated Places	/cities	Cities	Points – Locations of populated places
Digital Raster Graphics	/drgs	drg250k	Image - mosaic of 1:250,000 scale USGS topographic maps
Ecological Regions	/eco_reg	eco_reg	Polygons - ecological characterization boundaries
Hydrography	/hydro		
Lakes - major		lakes	Polygons - major lake boundaries
Streams - major		streams	Lines - major stream features
Watersheds - major		wtrshed	Polygons - major watershed boundaries
Land Ownership	/landown	publand	Polygons - land ownership info for other public lands
Land Use/Land Cover	/lulc		
Historical Vegetation		histveg	Polygons - Marshner's map of historical vegetation
National Land Cover Data		nlcd	Grid – National Land Cover Data
Potential Vegetation		potveg	Polygons - Kuchler's map of potential natural vegetation
Hydrology	/nhd	nhd	Polygons - National Hydrology Data
Political Boundaries	/polbnds		
Congressional Districts		congdist	Polygons - congressional districts for the region
County		county	Polygons - county boundaries for the state of Minnesota
Regional Extent		regbnd	Polygons - county boundaries for the regional extent
State		state	Polygons - Minnesota state boundary
Transportation - major roads	/trans	hwys	Lines - major roads of the region
<i>Basemap Data, Watershed Level</i>	<i>/wtrshed</i>		
Digital Elevation Models	/dems		

Dataset Name	Directory Name	Datafile Name	Description
		dems	Raster - 30 meter DEM mosaic
		relief	Image – Hillshade relief derived from DEM
Digital Raster Graphics	drgs	drg100k	Image - mosaic of 1:100,000 scale USGS topographic maps
Hydrography	/hydro		
Lakes		lakes	Polygons - 1:24,000 scale lake data
Streams		streams	Lines - 1:24,000 scale stream data
National Wetlands Inventory	/nwi	nwi	Polygons - NWI data obtained from the Minnesota DNR
Political Boundaries	/polbnds		
Municipal Boundaries		munbnd	Polygons - municipal boundaries
Public Land Survey	/pls		
Township/Range		twprng	Polygons - public land survey township/range boundaries
PLS Sections		plssec	Polygons - public land survey section boundaries
Transportation	/trans		
Airports		airprt	Points - airports mapped at 1:24,000
Railroads		railroad	Lines - 1:24,000 scale railroad lines
Roads - minor		roads	Lines – minor roads
Runways		runway	Lines – runways
<i>Basemap Data, Refuge Specific</i>	<i>/rcl_s_map</i>		
Digital Orthophotos	/doqs	doqs	Image – 1992 USGS black and white aerial photo
Digital Raster Graphics	/drgs	drg24k	Image – 1:24,000 scale USGS topographic maps
Photos	/photos		Image - Mosaic of 1998 CIR aerial photos

Dataset Name	Directory Name	Datafile Name	Description
Project Boundary	/prjbnd	rcl_s_bnd	Polygon – Approved legislative boundary.
Public Recreation	/pubrec	prkng	Point – Parking area available for public use.
Refuge Roads	/trans	Roads	Lines – refuge roads