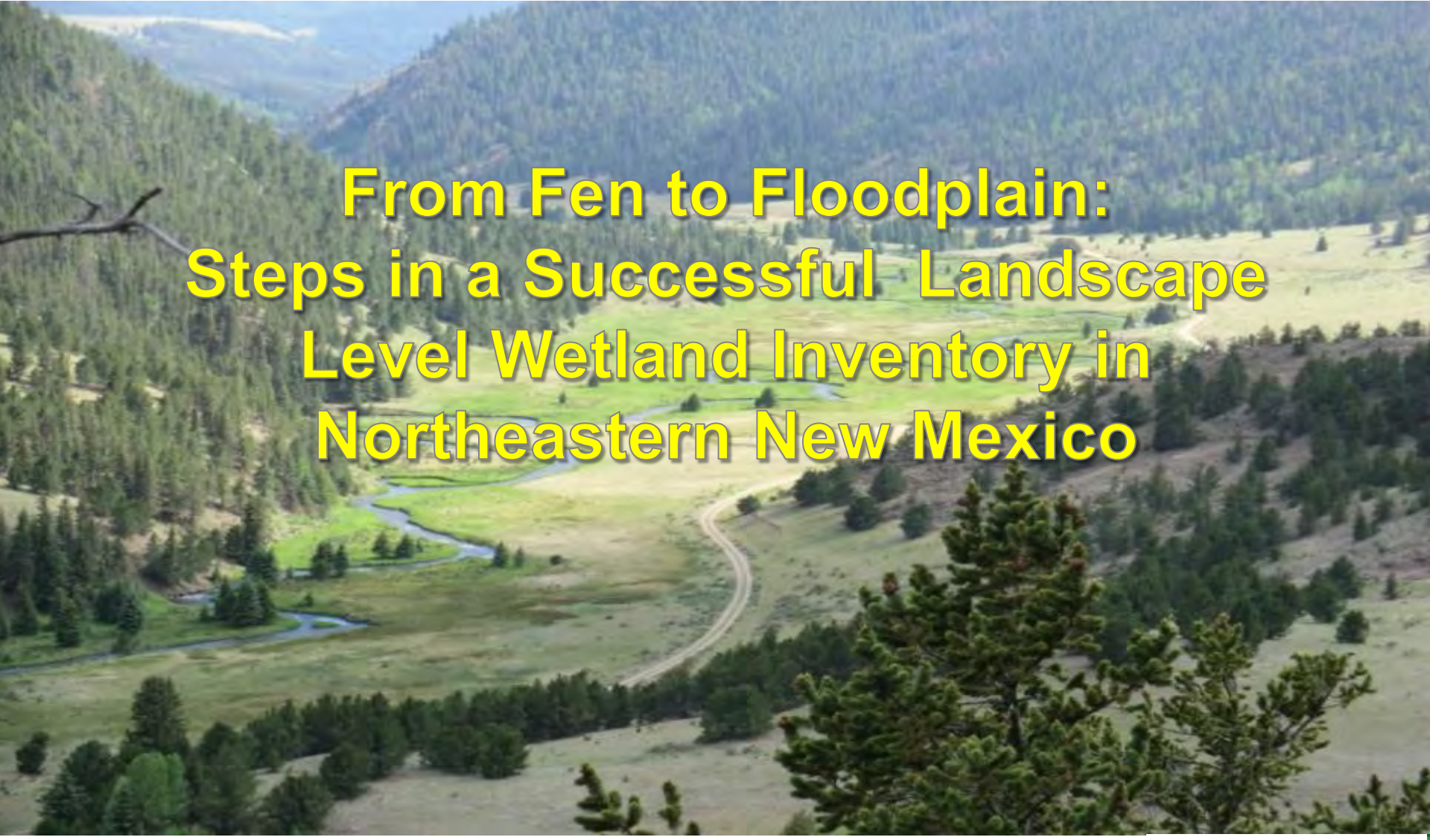


From Fen to Floodplain: Steps in a Successful Landscape Level Wetland Inventory in Northeastern New Mexico

GeoSpatialServices

Saint Mary's University of Minnesota

Association of State Wetland Managers

Wetland Mapping Consortium

October 21, 2015

New Mexico Environment Department

EPA 3 Level Technical Approach

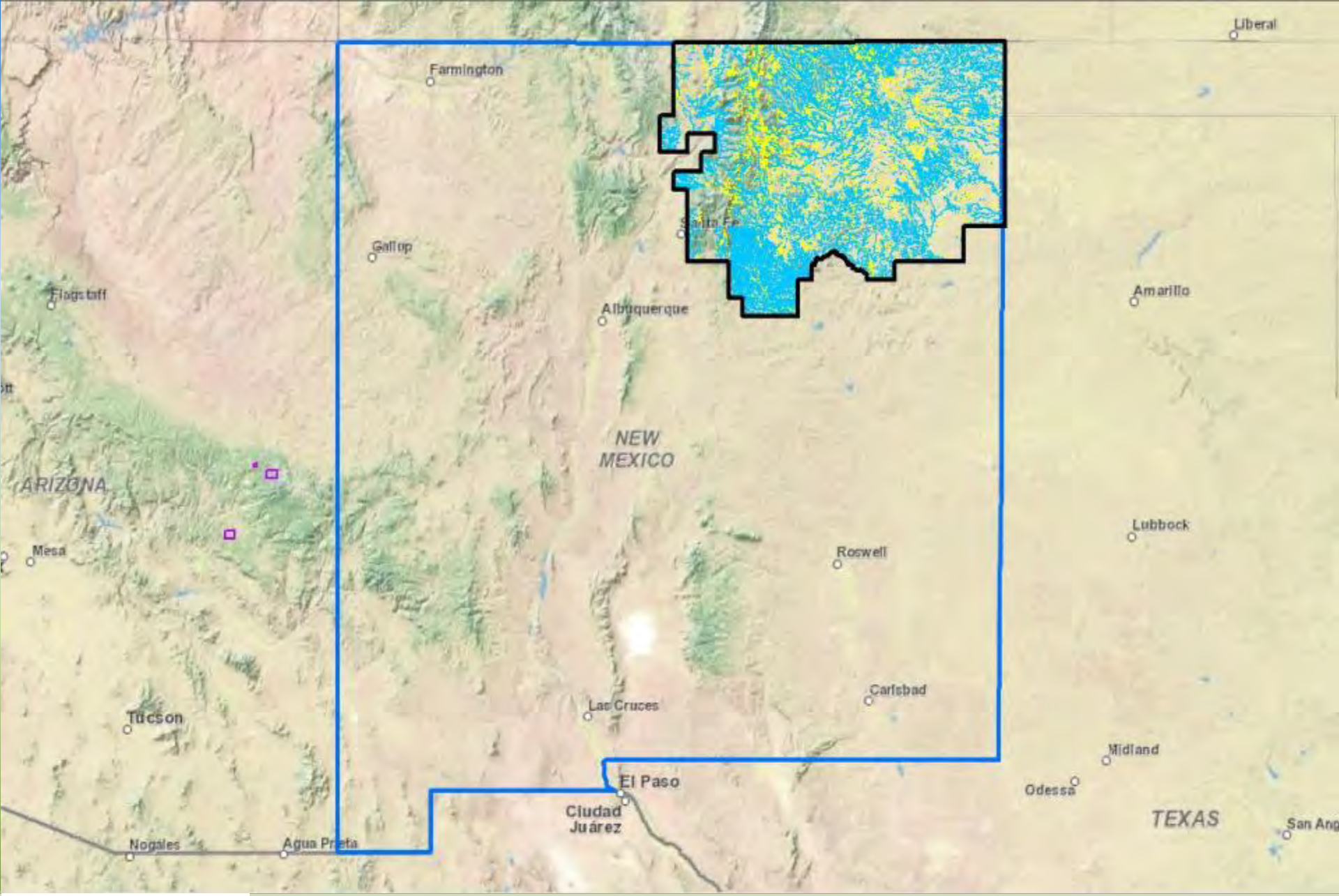
	Products/Applications
Level 1 - Landscape Assessment: Use GIS and remote sensing to gain a landscape view of watershed and wetland condition. Typical assessment indicators include wetland coverage (NWI), land use and land cover	•Targeting restoration and monitoring •Landscape condition assessment •Status and trends •Integrated reporting CWA 305(b)/303(d)
Level 2 – Rapid Wetland Assessment: Evaluate the general condition of individual wetlands using relatively simple field indicators. Assessment is often based on the characterization of stressors know to limit wetland functions e.g., road crossings, tile drainage, ditching.	•401/404 permit decisions •Integrated reporting •Watershed planning •Implementation monitoring of restoration projects, including nonpoint source BMPs, and Farm Bill programs
Level 3 – Intensive Site Assessment Produce quantitative data with known certainty of wetland condition within an assessment area, used to refine rapid wetland assessment methods and diagnose the causes of wetland degradation. Assessment is typically accomplished using indices of biological integrity or hydrogeomorphic function.	•WQS development, including use designation • Integrated reporting •Compensatory mitigation performance standards •Verify levels 1 and 2 methods

Level 1 - Landscape Level Wetland Mapping & Assessment

Project Objectives:

Use remote sensing, image interpretation techniques, collateral GIS data, and best professional judgment to:

- Map or update the wetland landscape
- Extend mapping to include “interpretable” hydrogeomorphic and other metrics
- Correlate wetland types and characteristics to wetland functions
- Map so as to provide continuity between Level 1, 2 and 3.



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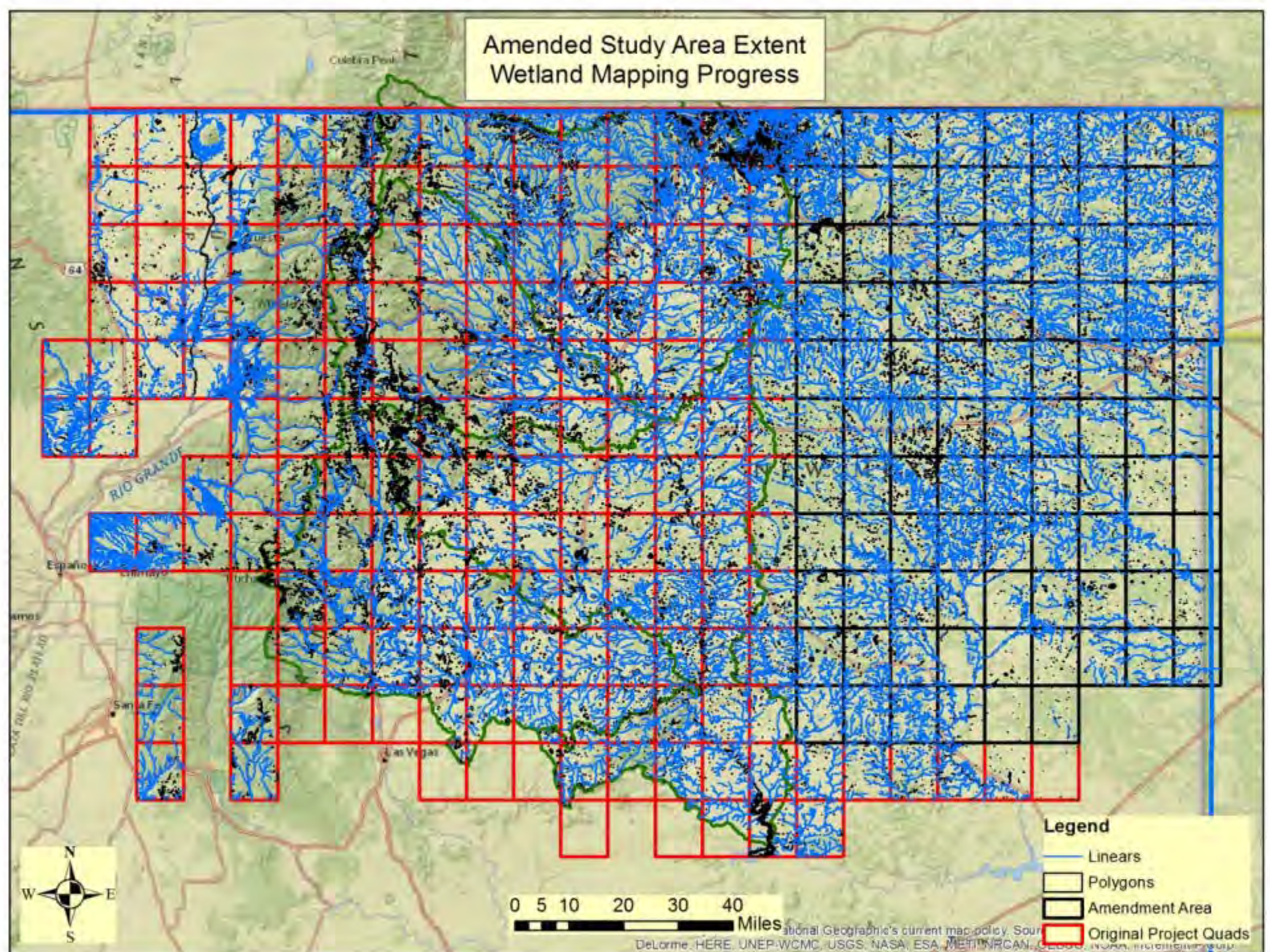

Amended Study Area Extent
Wetland Mapping Progress
Culebra Peak
64
RIO GRANDE
Española
Chimayo
Santa Fe
Las Vegas
N
W
E
S
0 5 10 20 30 40
Miles
Legend
Linears
Polygons
Amendment Area
Original Project Quads
DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp

Northeastern New Mexico Study Area Description

- Watersheds (HUC 8): Upper Canadian, Upper Rio Grande, Upper Pecos, Cimarron Rivers
- Total Area: 16,000 sq. miles or 10 million acres
- Counties: Colfax, Mora, San Miguel, Taos, Rio Arriba, Union, Harding and Santa Fe
- Previous Wetland Mapping: None, limited site specific NWI
- Major Ecoregions: Montane forests, foothill shrub lands, tableland shrub and grasslands, high plains

Primary Steps in a Wetland Inventory Project

1. Establish project scope – classification systems and study area boundaries
2. Investigate availability of imagery and collateral spatial data
3. Conduct pre-mapping field reconnaissance
4. Develop and document image interpretation conventions
5. Delineate and classify wetlands

Primary Steps in a Wetland Inventory Project

6. Perform quality assurance reviews and edge matching
7. Conduct draft map field review
8. Incorporate changes and finalize data
9. Develop wetland functional assessment
10. Create metadata documentation and write project report
11. Data delivery and distribution.

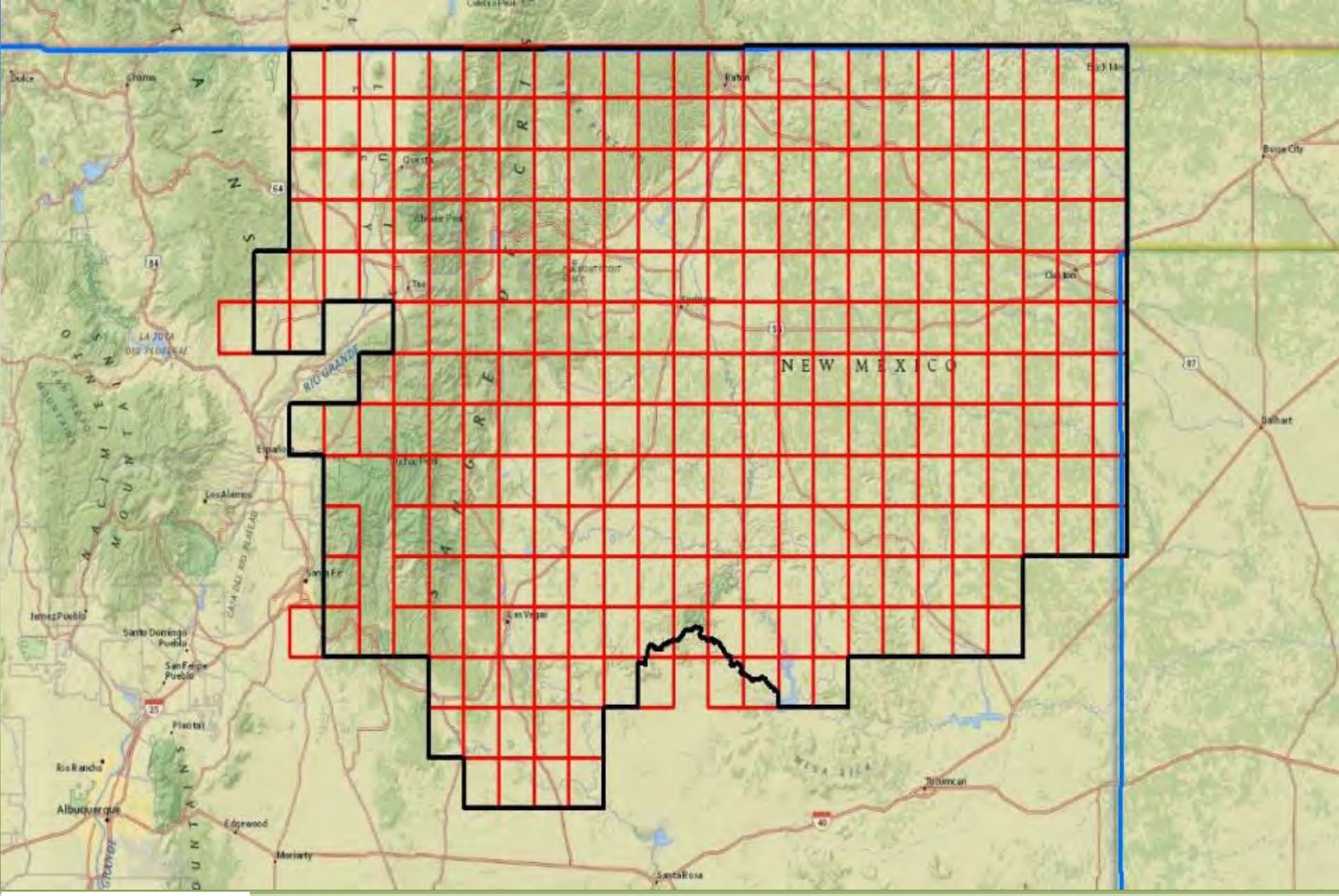
Step 1: Mapping and Classification Systems

- National Wetland Inventory (NWI) - Cowardin (1976)
- System for Mapping Western Riparian Areas - USFWS (2009)
- Landscape Position, Landform, Waterbody Type, Water Flow Path (LLWW) - Tiner (2013)
- Potentially Restorable Wetlands (PRW) Mapping - SMUMN (2012)
- Hydrogeomorphic Method (HGM) - Brinson (1993)

Step 1: Study Area Extents

Various Boundaries were Reviewed:

- Traditional Quadrangle Approach
- Watersheds (NHD HUC Boundaries)
- EPA Level 3 Ecoregions
- Exclusions
- Private and Public Land Extents



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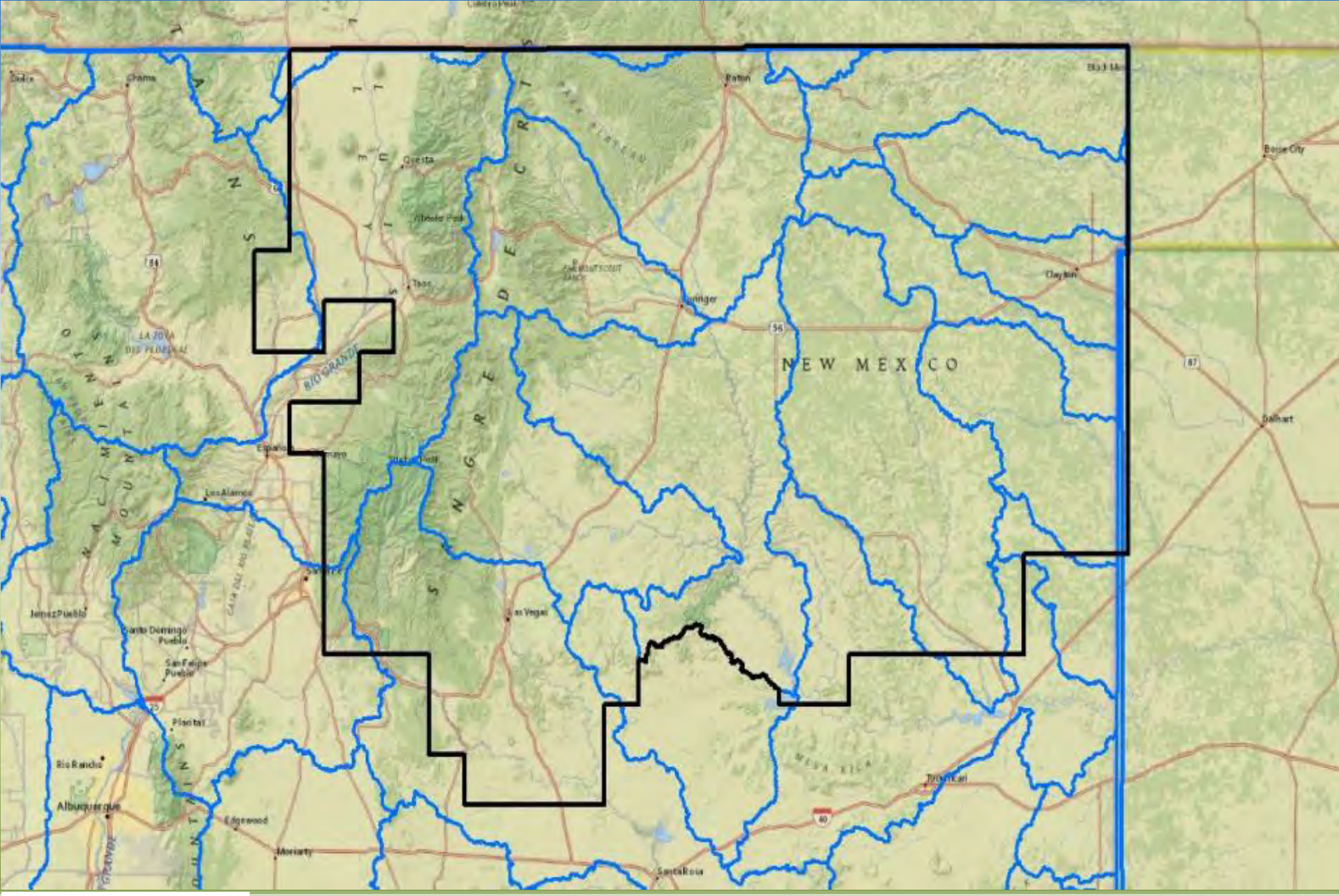
Quadrangles



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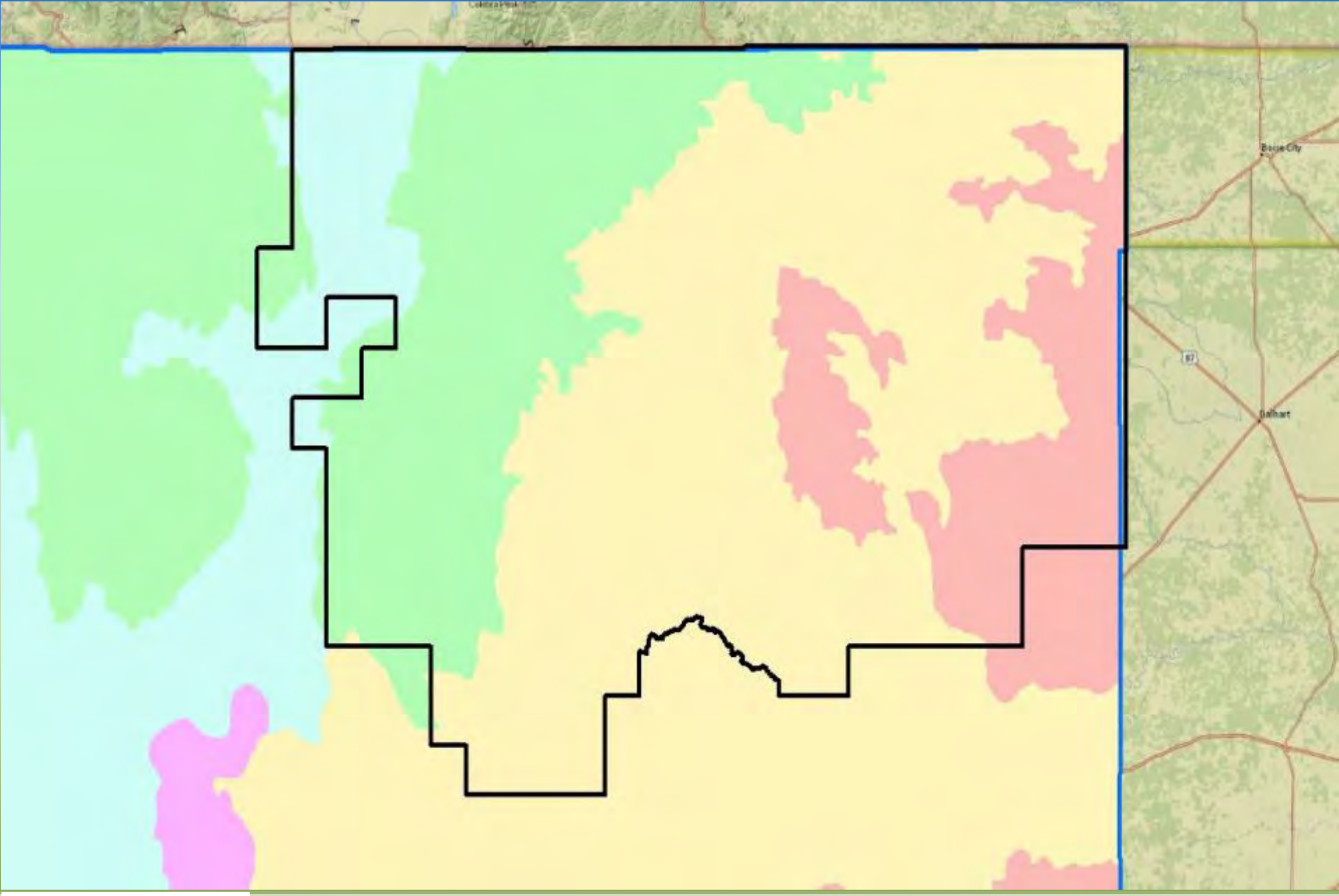
Watersheds

NEW MEXICO ENVIRONMENT DEPARTMENT



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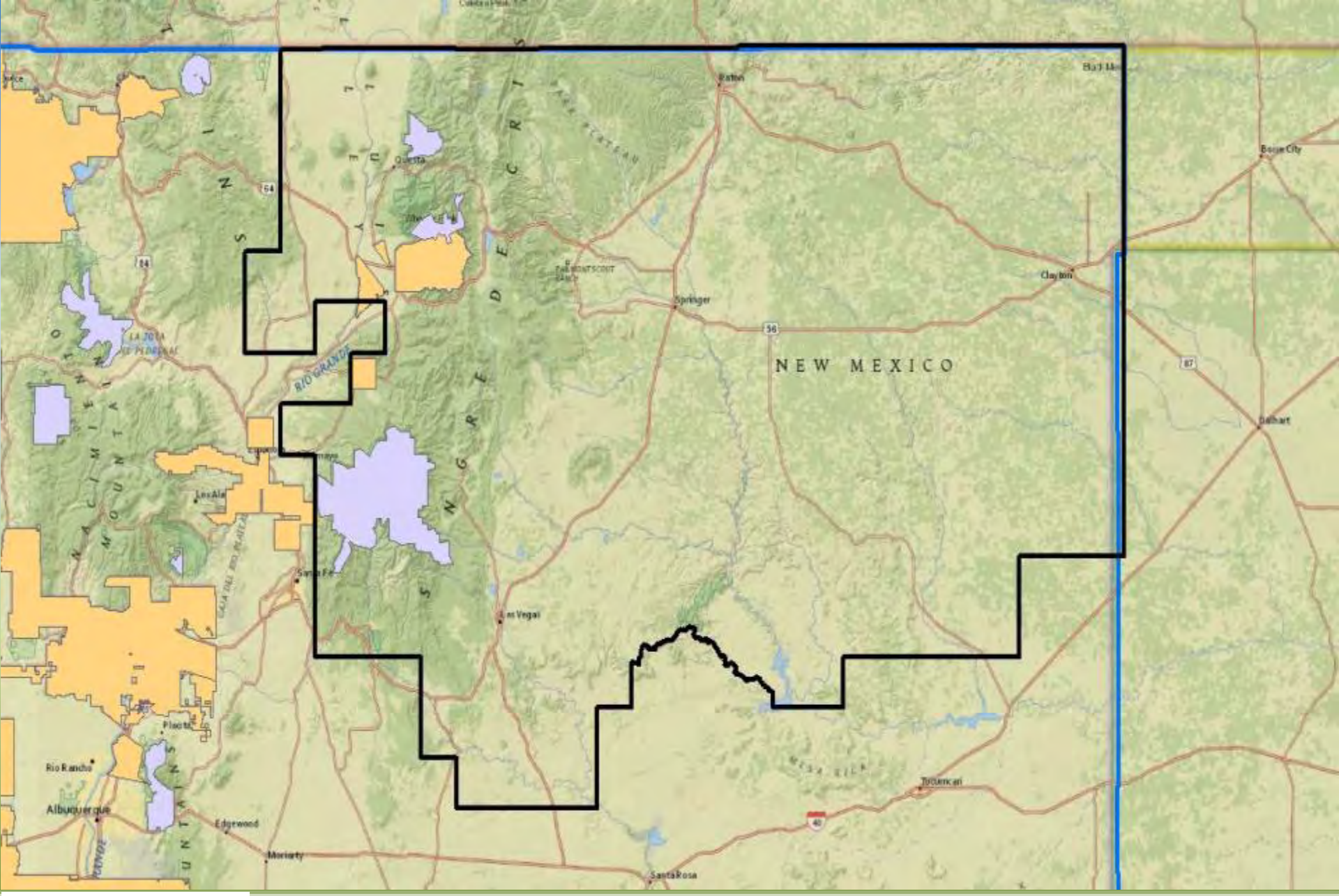
EcoRegions



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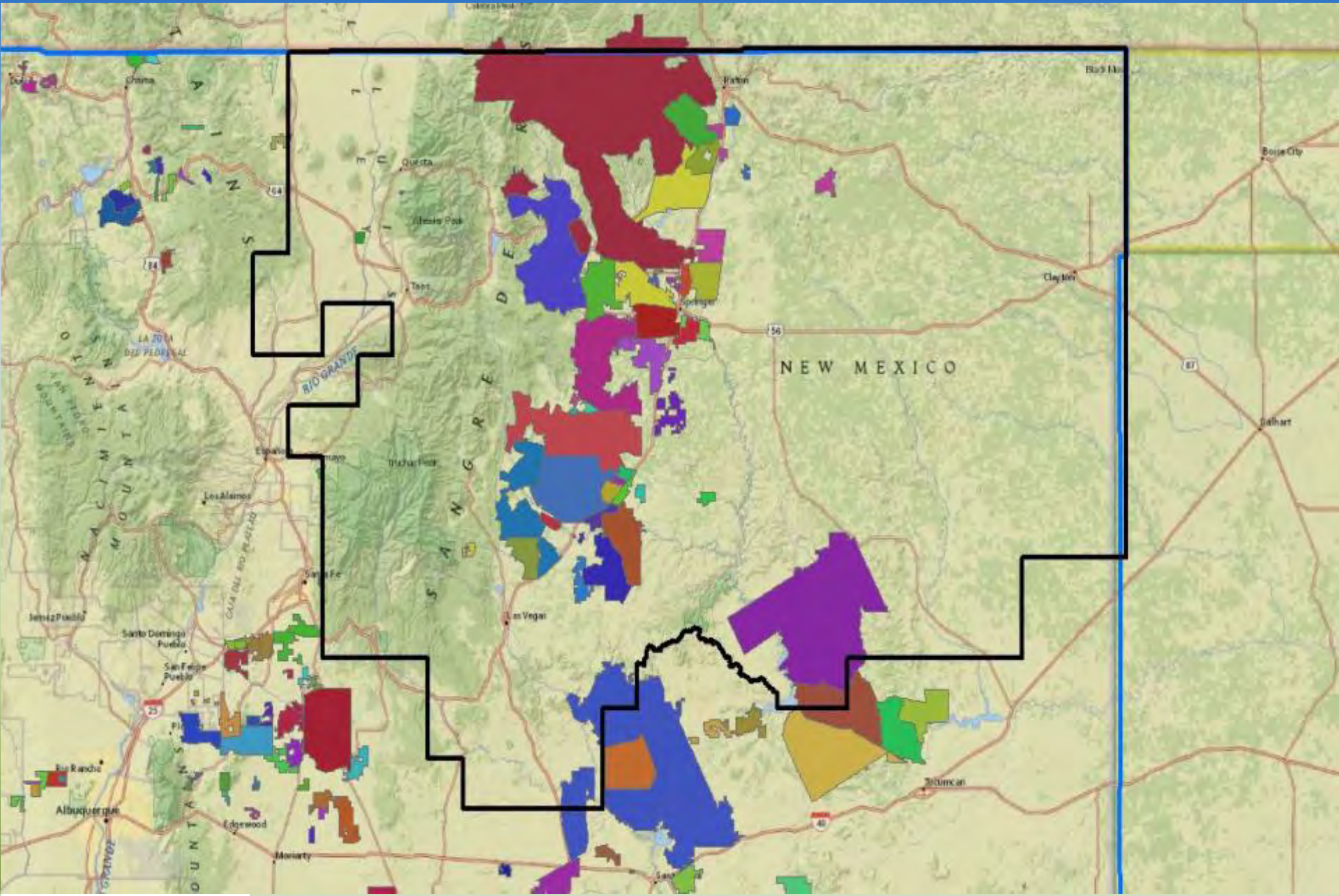
Exclusions



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Private Lands

Step 2: Investigate Project Imagery and Collateral Data

Imagery Considerations:

- Resolution (Pixel Size) and Accuracy (NMAS)
- Season of Acquisition (Spring Preference)
- Image Type and Emulsion (TC, CIR, Hyper)
- Platform (Aerial, Satellite)
- Antecedent Moisture Conditions
- Climate Normal Years

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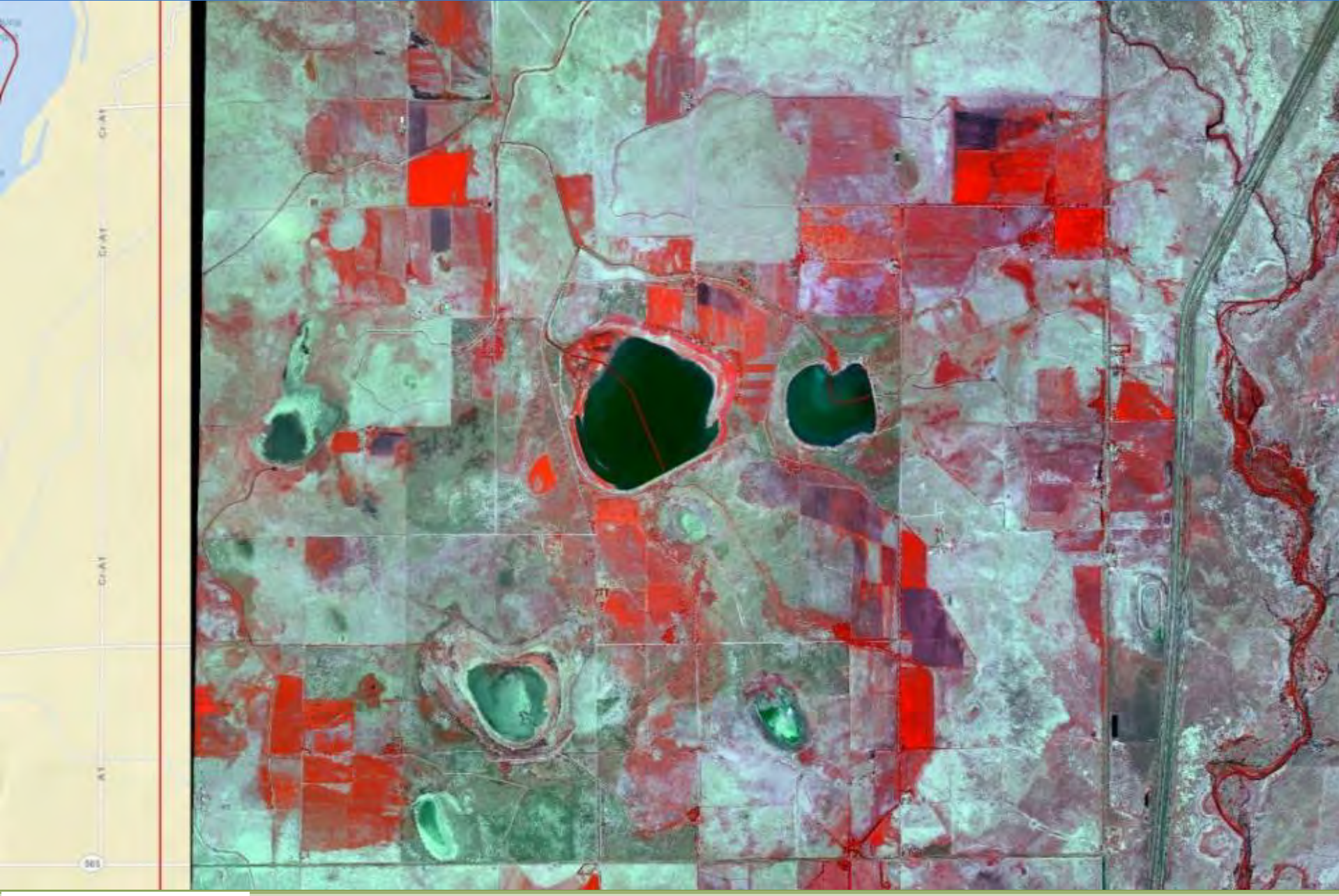
Maxwell Wildlife Refuge
2009 NAIP



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Maxwell Wildlife Refuge
2009 NAIP CIR

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Maxwell Wildlife Refuge
2005 NAIP

Maxwell Wildlife Refuge
2005 – 2009 Imagery

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Step 2: Investigate Project Imagery and Collateral Data

Collateral Data Sources:

- USGS 1:24,000 DRG
- USGS NHD streams and waterbodies
- NRCS SURRGO Soils Data
- NAIP Imagery 2001, 2005, 2009 CIR
- Google Earth imagery time slider tool
- SWQB Stream Data (cold water, warm water, fish species)
- USGS 30m and 10m National Elevation Dataset
- USFS Springs and Seeps database

Step 3: Conduct Pre-Mapping Field Reconnaissance

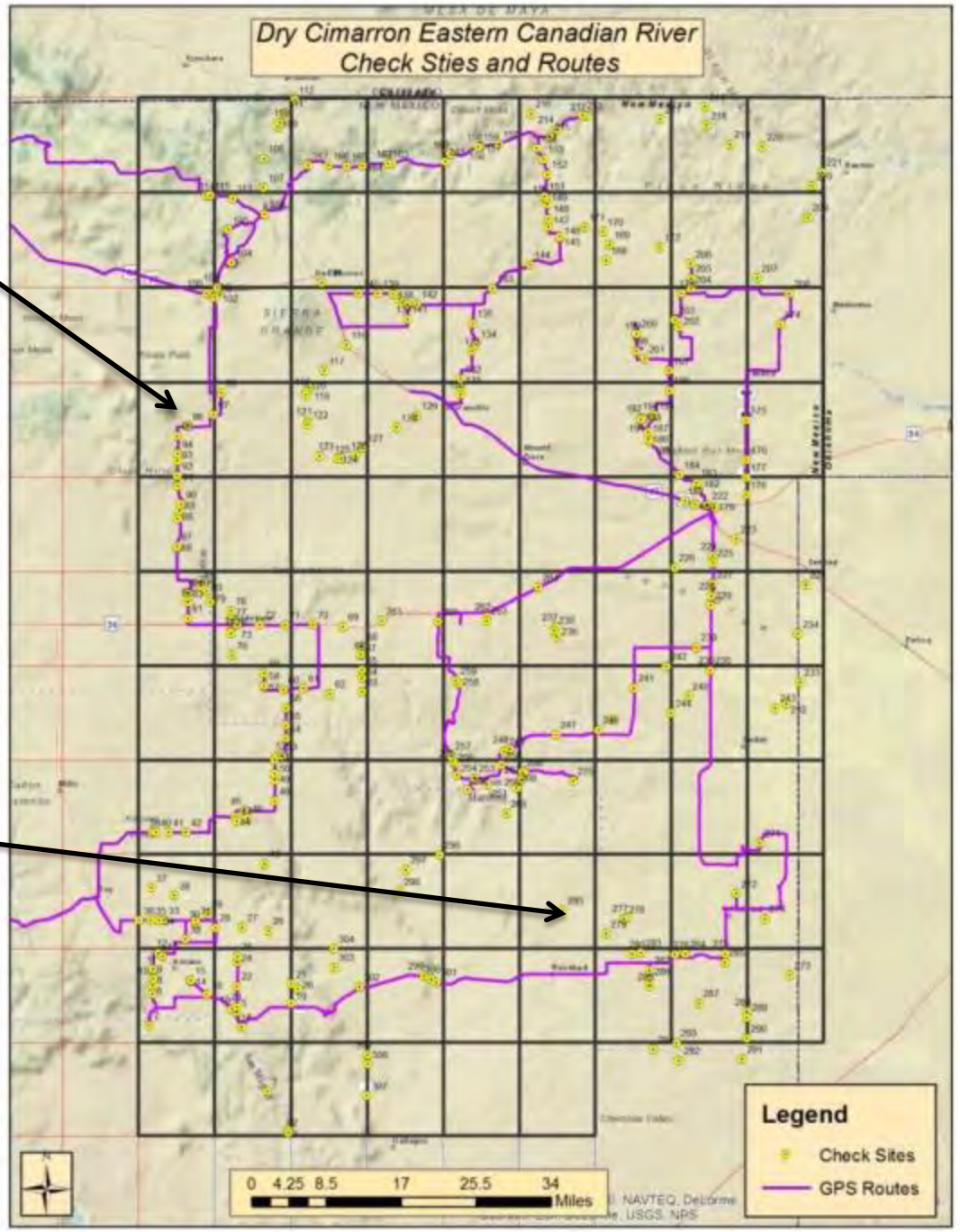
Field Considerations:

- Preselect Check Sites Using Project Imagery
- Typical and Atypical Wetland Signatures
- Accessible/Viewable from Road or Public Land
- Mix of Windshield Survey and Field Data Sheets
- GPS – Routes, Sites and GeoTagged Photos
- Field Maps for Each Site – Notes, Classification, Delineation Refinements

Step 3: Conduct Pre-Mapping Field Reconnaissance

Field Equipment:

- Laptop Computer and GPS Camera
- GPS Units – Navigation and Plot Locations
- Soil Probe, Spade and Munsell Color Chart
- Field Data Sheets, Site Maps with Imagery
- Road Map and Study Area Overview Plots
- Field Guides (Vegetation, Surficial Geology etc.), Loupe, Compass, Knife, Sample Bags
- COE Wetland Plant List



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Validation of image signatures

Confirmation of landscape position and other hydrogeomorphic metrics

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Step 4: Develop Image Interpretation Conventions

Considerations:

- Detailed Notes Regarding Classification Signatures
- Document with Photos, Maps and Image Examples
- Include Typical and Atypical Wetland Signatures
- Document Image Anomalies and Conditions
- Consider Project Goals and Objectives – NWI, LLWW, Riparian, WFA, HGM

Figure 2. Field visit site 193, Clayton Lake State Park, Union County, NM.

Documentation:

Baseline imagery and collateral data were reviewed and documented upon return from the field visit. A list of common wetland classifications and their associated photosignatures were compiled. Considerations as to applicability of collateral data to wetland / upland calls and wetland classification were documented. Outstanding signature questions were labeled on-screen and will be forwarded to local experts for discussion and assessment.

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Field Trip Summary Report for Verification of Aerial Imagery
National Wetland Inventory
Dry Cimarron and Eastern Canadian River Watersheds
October 20th to 24th, 2013

Purpose

This field trip was conducted for the purpose of verification of wetland features and non-wetland features so that a "selective key' of photosignatures could be created. This baseline information will serve as a guide for identifying and classifying features (as interpreted from the project imagery) within the National Wetland Inventory (NWI), the Riparian Classification System, and the NWI Plus (LLWW - Landscape Position, Landform, Water Flow Path, and Waterbody) Classification Systems.

Field Verification Team

Michelle Barnes – Environmental Scientist, New Mexico Environment Department (NMED), Surface Water Quality Bureau
Andy Robertson– Project Manager, GeoSpatial Services, SMUMN
John Anderson – Image Analyst, GeoSpatial Services, SMUMN

Methods

The field-verification process involved three stages; check-site selection, in-field verification, and post-trip documentation.

Check-site Selection:

Leaf-on, 2009 and 2011 imagery was reviewed for check site selection. Points representing sites to be visited were created heads-up using ArcGIS 10.1.

Check sites were selected in advance for areas that could not be clearly identified as upland or wetland or classified accurately on the imagery with the aid of the available NWI database coverage, Digital Raster Graph (DRG) topographic maps, the Natural Resources Conservation Service's (NRCS) Soil Survey Geographic Database (SSURGO), and collateral imagery (e.g. Google Earth).

Field verification points were located at those locations where imagery signatures indicated that a wetland might exist, but was not obvious as wetland. Other checksite points were included where the NWI or Riparian classifications needed clarification. For example, areas shaded as open water or contour intervals indicating topographic depressions were referenced to select possible locations of playa lakes and ponds. Areas mapped as hydric soil in the SSURGO database provided check site locations for other wetland types including floodplain and saturated wetlands.

Additionally, sites were selected that exhibited signatures caused by drawn down water levels due to prolonged drought. Site selection also focused on identifying signatures of plant communities of interest such as sedge meadows (*Carex sp.*). Dominant riparian species such as: cottonwood (*Populus*

PEM1Ch (Palustrine, Emergent, Persistent, Seasonally Flooded, Impounded) – Representative signatures are dark green in color, have smooth photographic textures, are in defined wetland drainage patterns adjacent to open water reservoirs and stock ponds. (check site #59, 83, 172)

PEM1Ci (Palustrine, Emergent, Persistent, Seasonally Flooded, Alkaline) – These are playa areas dominated by saltgrass (*Distichlis stricta*). Signatures are located in basins with a predominantly emergent signature that has a smooth to somewhat rough photographic texture and is interspersed with a smooth stippled light gray to bright white tone. (check site #53, 117, 118, 119, 120, 128, 133, 156, 158, 172)

PFO1A (Palustrine, Forested, Broad-leaved Deciduous, Temporarily Flooded) – Forested floodplains that are dominated by cottonwood trees Representative signatures are darker green in color, have rough photographic textures, and are in defined wetland drainage patterns. Few of these signature types were observed in the field. (check site #130)

Step 5: Delineate and Classify Images

Considerations:

- Traditional Image Interpretation
- Automated Delineation and Classification
- Consultation with Collateral Data
- Order of Operations – NWI, LLWW, HGM
- Generate Datasets that Support Wetland Mapping – DEM Hillshades, Hydrography Flow Lines, Valley Confinement, PRW

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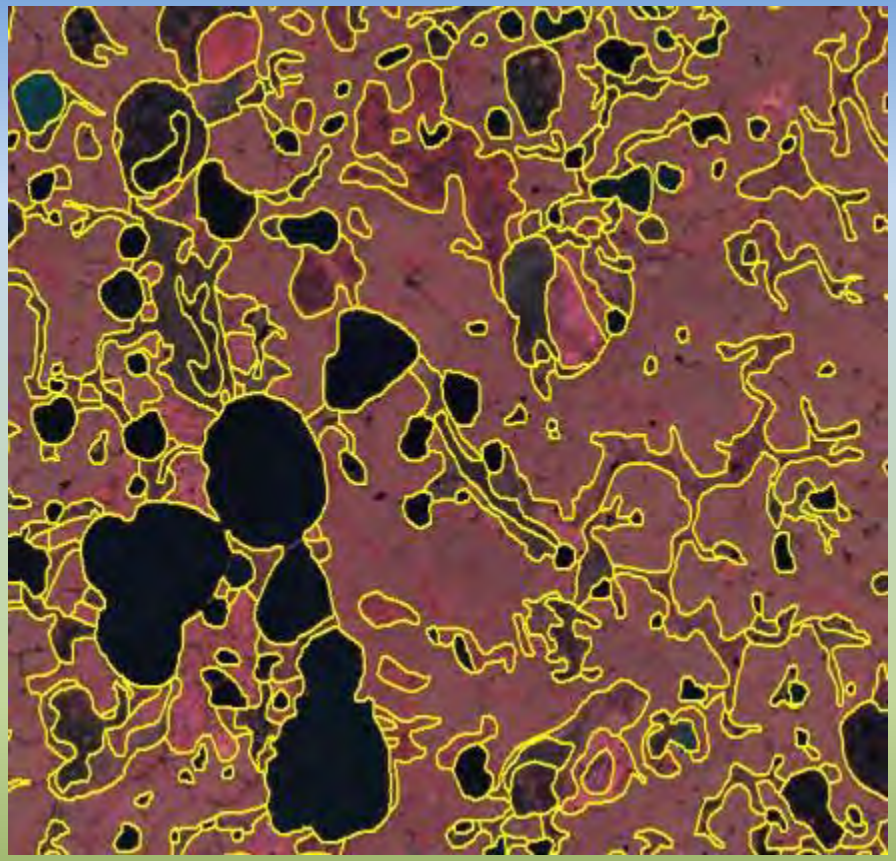
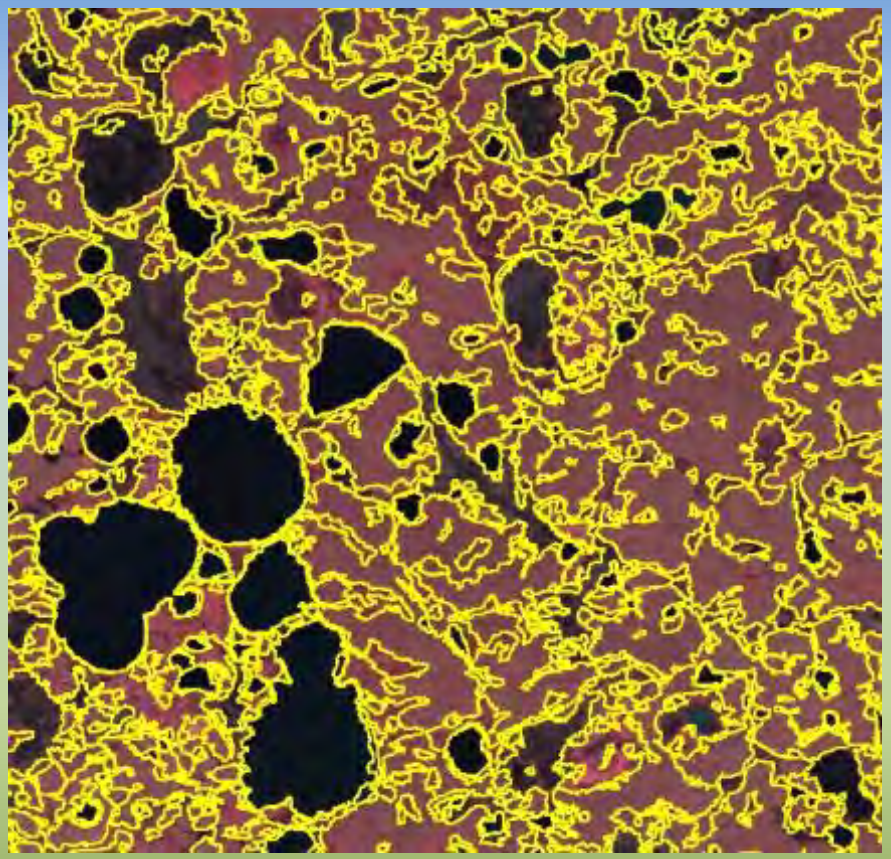
Traditional Image Interpretation





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Automated Wetland Classification

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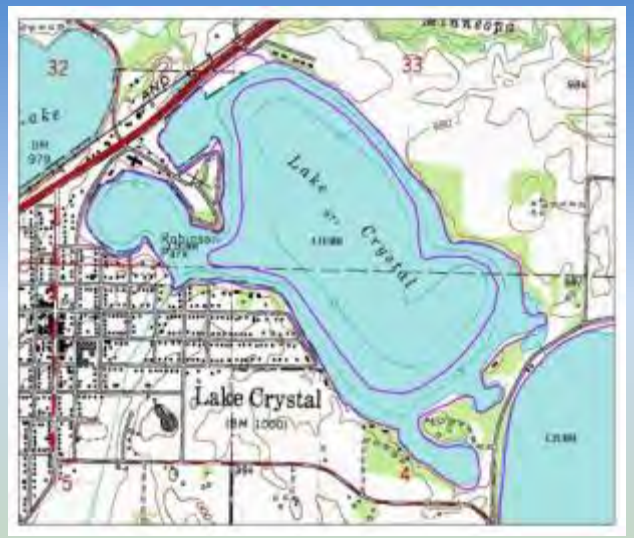
LiDAR Hillshade



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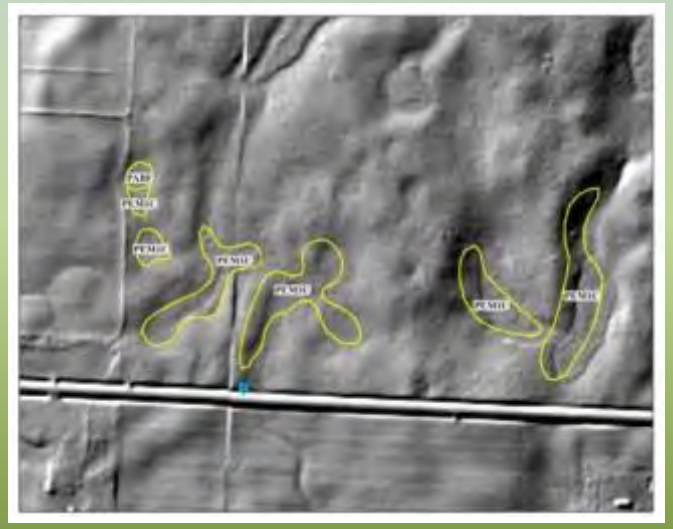
DRG Support



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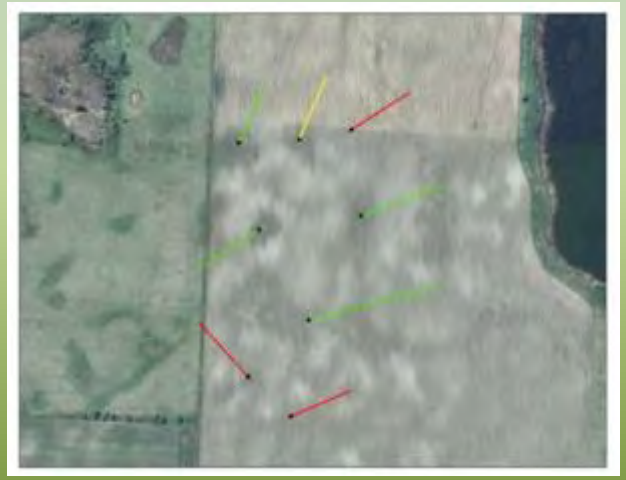
Imagery, DEM and Field Observations

2011 CIR

2010 NAIP

2009 NAIP



2008 NAIP

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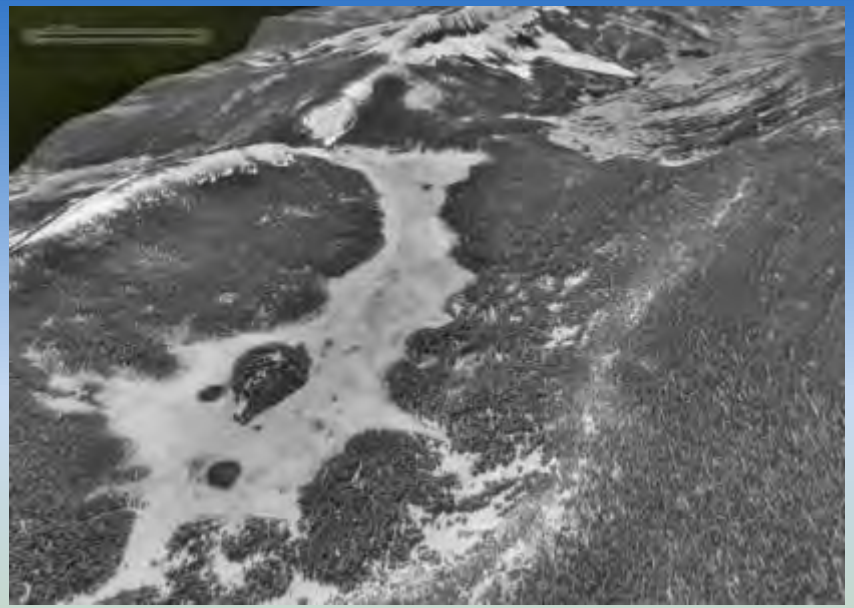
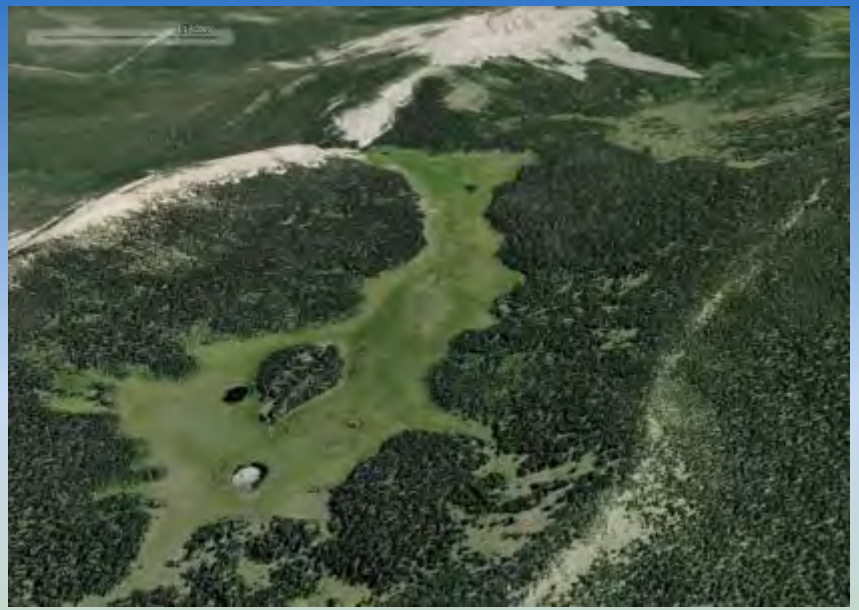
Multiple Image Dates





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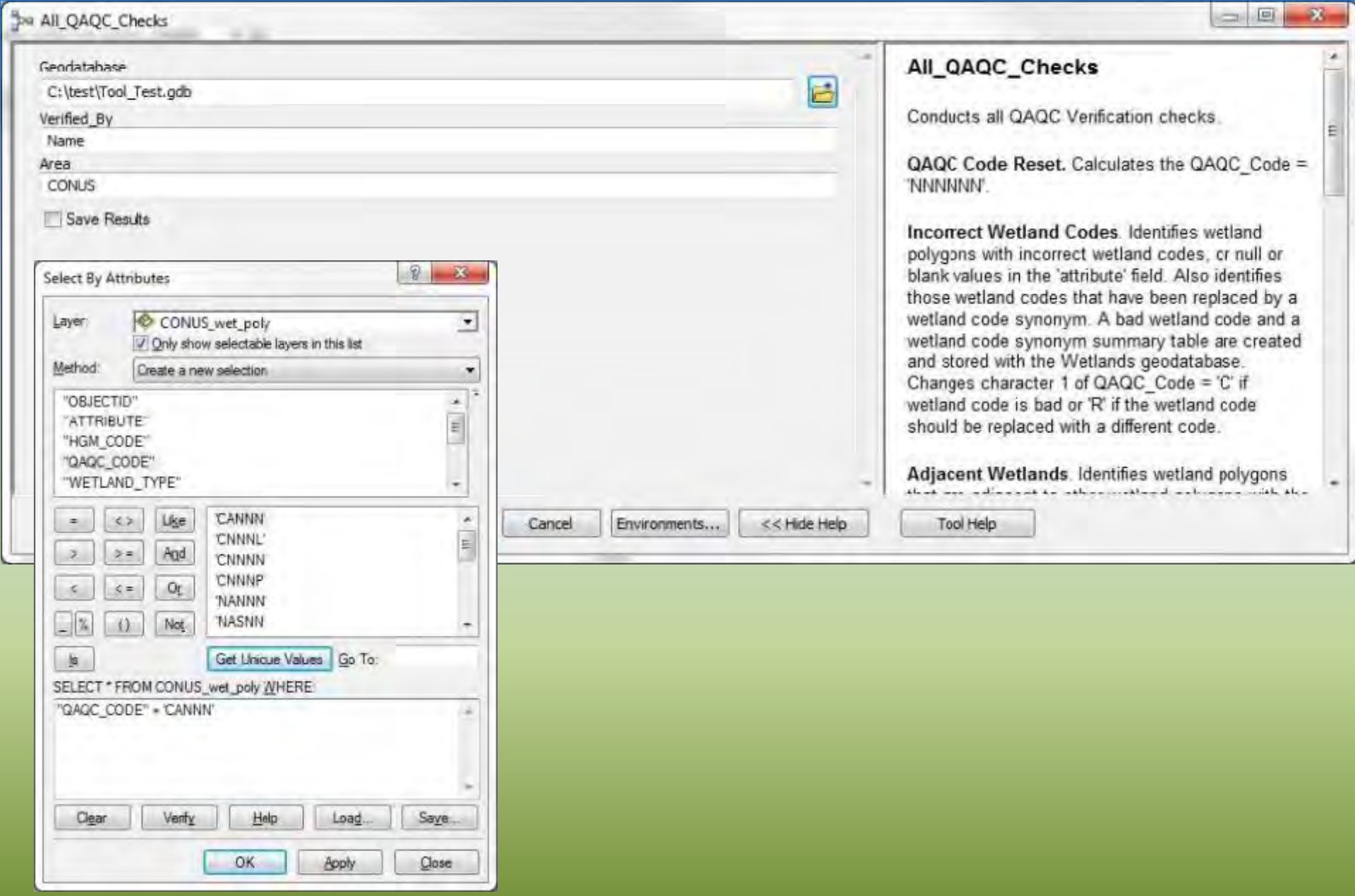
Google Earth

Step 6: QA/QC Review and Edits

Considerations:

- Study Area Logical Work Units (e.g. quads)
- Perform 100% Visual QA/QC
- Use Automated GIS Tools and Scripts for Errors
- Run USFWS NWI Verification Tool
- Attribute Checks for LLWW, Database Domains and Table Parsing
- Initial Delivery to Customer



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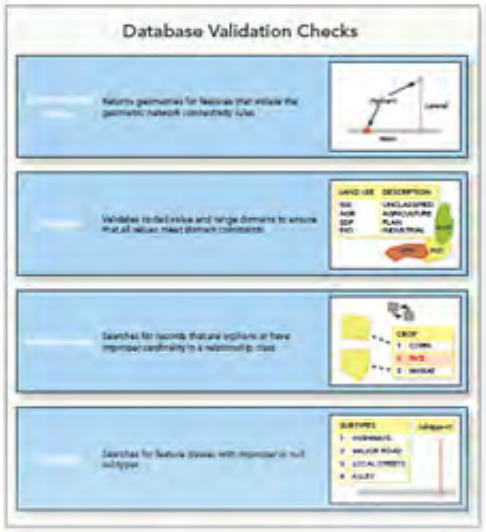
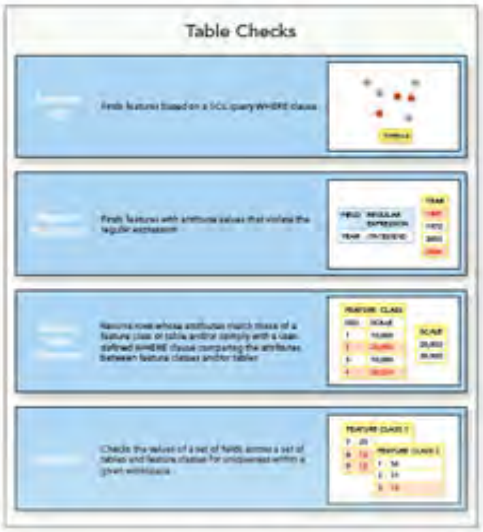
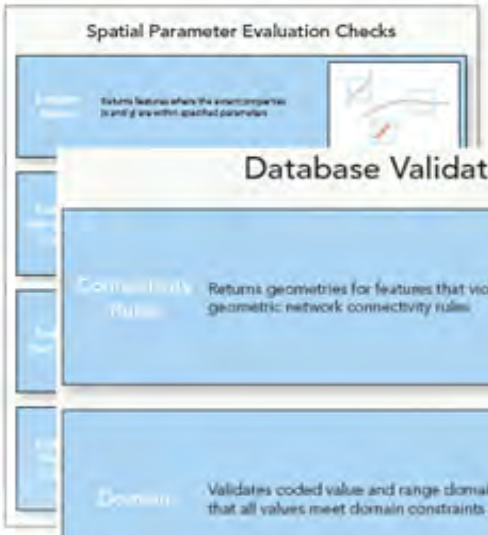
USFWS NWI Verification Tool

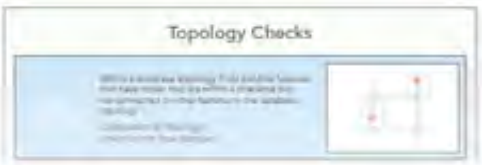
esri

ArcGIS® Data Reviewer Checks









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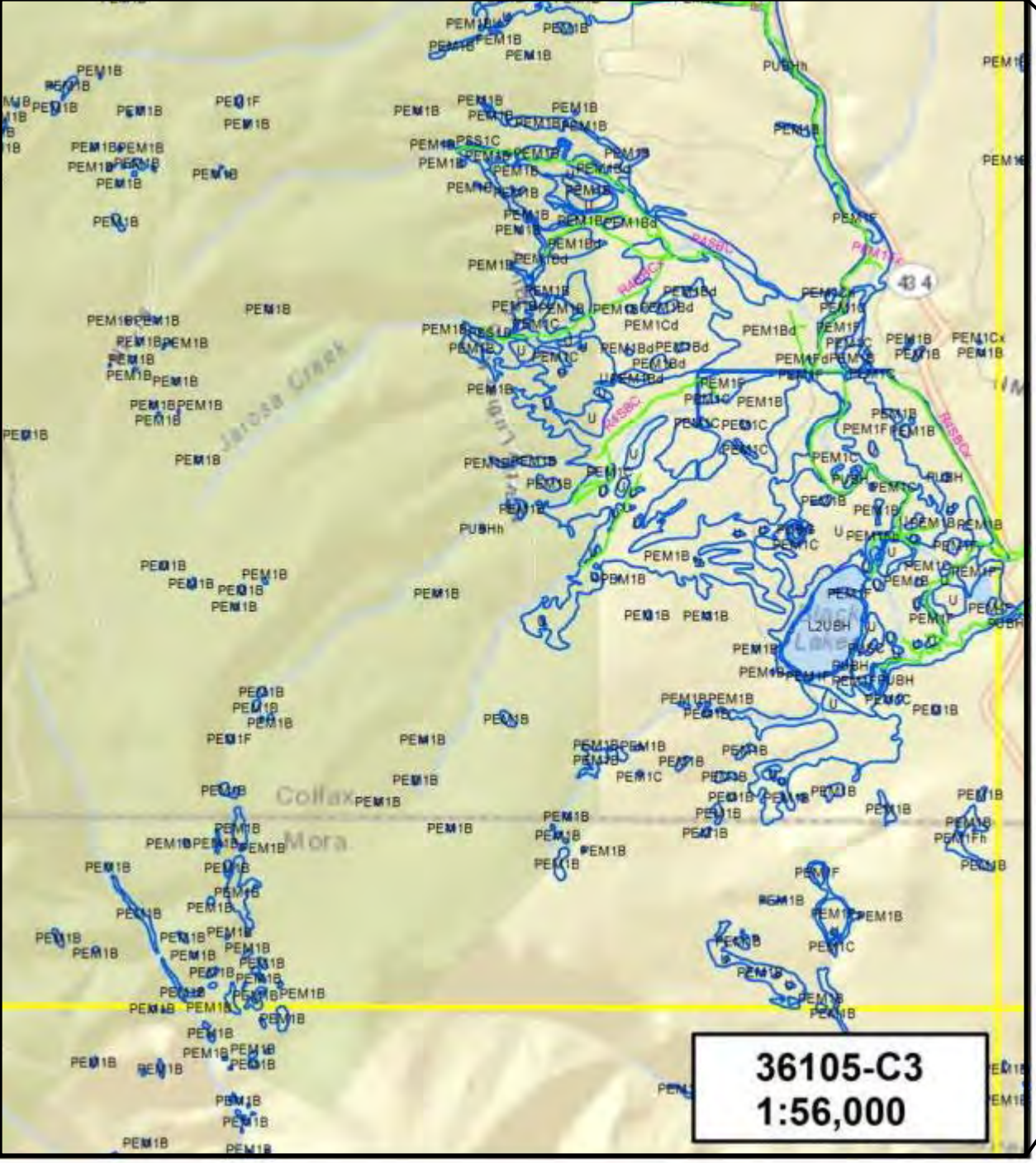
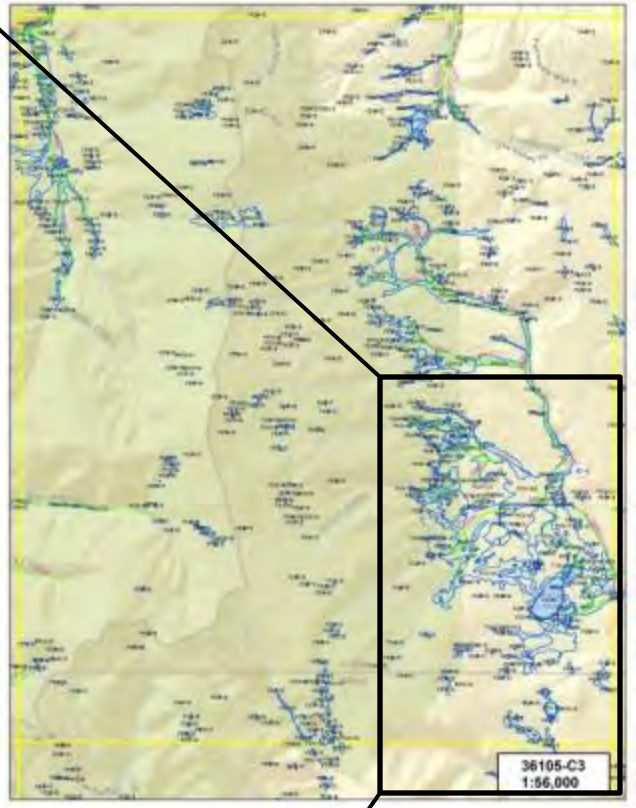
ESRI Data Reviewer

Step 7: Draft Map Review Field Trip

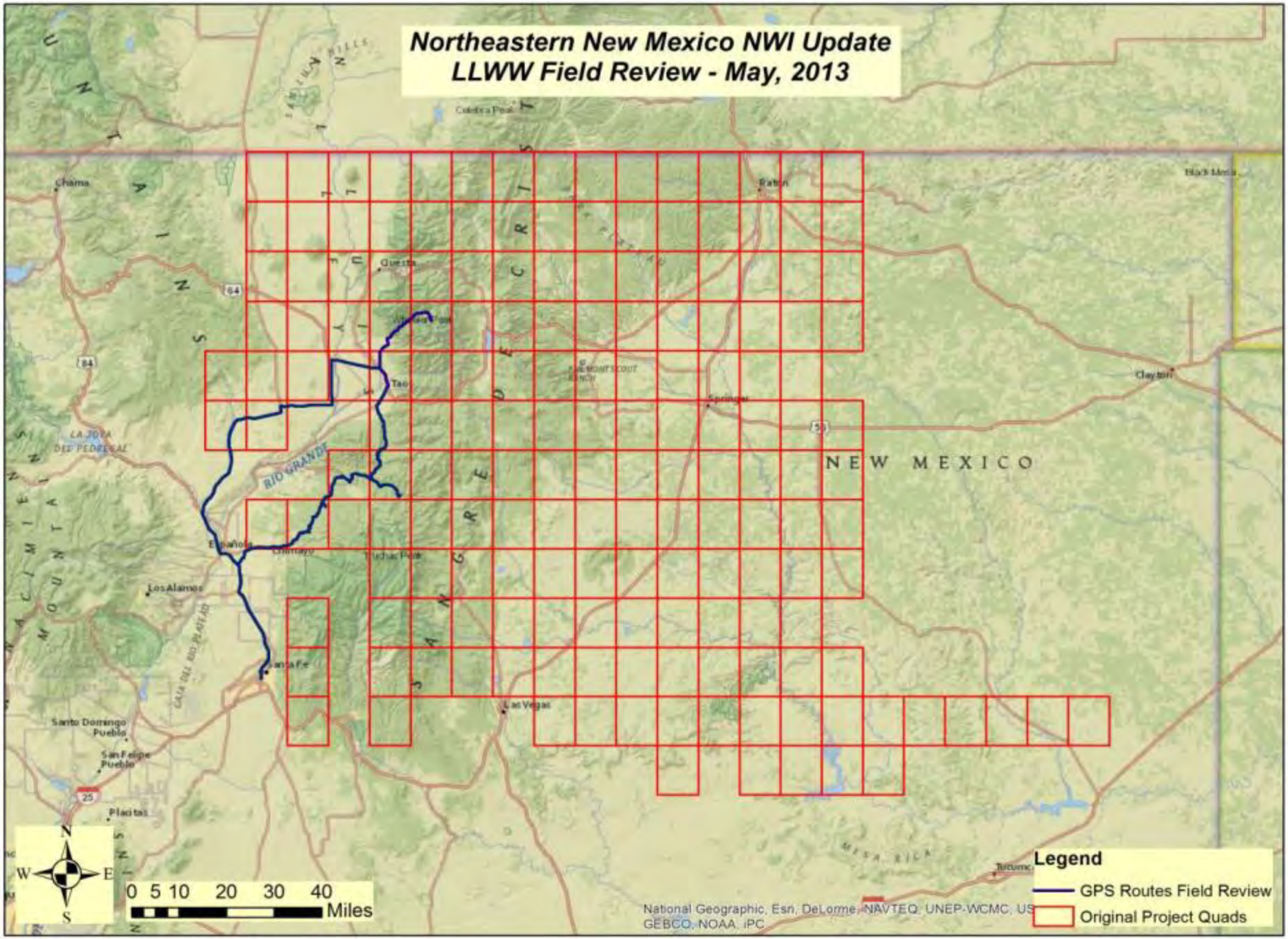
Considerations:

- Focused on Customer Review
- Partners Review All Aspects of Mapping
- Sites Selected for Field Validation
- Reconnaissance Level Field Visits to Confirm
- Searching for Errors of Omission and Commission
- Confirm Wetland Boundaries and Water Regimes





Field Map


Northeastern New Mexico NWI Update
LLWW Field Review - May, 2013
NEW MEXICO
RIO GRANDE
Chama
Questa
Taos
Raton
Clayton
Springer
Los Alamos
Santa Fe
Las Vegas
Santo Domingo Pueblo
San Felipe Pueblo
Placitas
Tucumcari
0 5 10 20 30 40
Miles
N
W
E
S
Legend
GPS Routes Field Review
Original Project Quads
National Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, US
GEBCO, NOAA, iPC

Step 8: Incorporate Edits and Changes

Considerations:

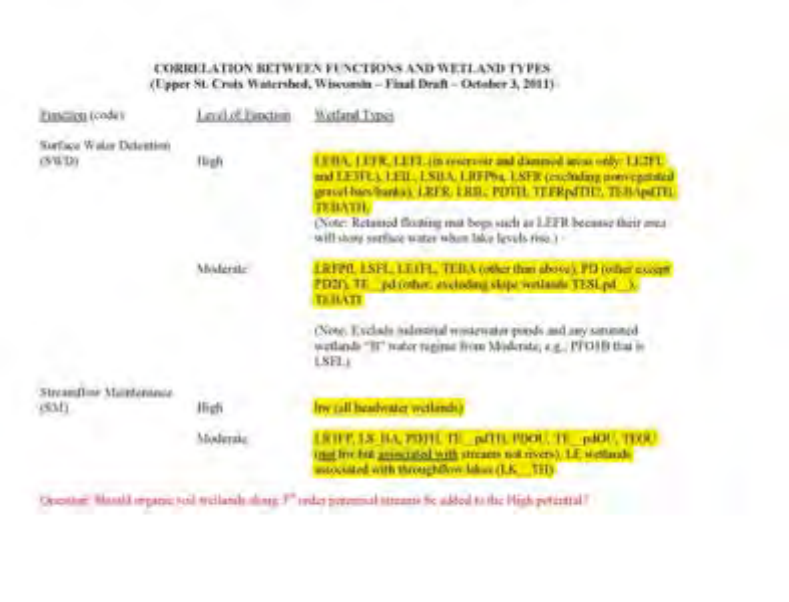
- Guided by Field and Office Reviews
- Apply Consistent Corrections Across the Dataset
- Consult with Customer as Necessary
- Validate with US FWS Regional Coordinators
- Coordinate with NSST Staff

Step 9: Conduct Wetland Functional Assessment

Considerations:

- Traditional Image Interpretation
- Automated Delineation and Classification
- Consultation with Collateral Data
- Order of Operations – NWI, LLWW, HGM
- Generate Datasets that Support Wetland Mapping – DEM Hillshades, Hydrography Flow Lines, Valley Confinement, PRW

Wetland Functional Correlation



CORRELATION BETWEEN FUNCTIONS AND WETLAND TYPES
(Upper St. Croix Watershed, Wisconsin – Final Draft – October 3, 2011)

Function (code)	Level of Function	Wetland Types
Surface Water Detention (SWD)	High	LFBA, LFFR, LEFL (in reservoir and diammed areas only; L12FL and LE3FL), LEIL, LSBA, LRFPra, LSFR (excluding non-vegetated gravel bars/banks), LEFR, LRB, PDTH, TEFR/pdTH, TEBA/pdTH, TEBATH. (Note: Retained floating mat bogs such as LEFR because their area will store surface water when lake levels rise.)
	Moderate	LRFPH, LSFL, LE1FL, TEBA (other than above), PD (other except PD2f), TE__pd (other, excluding skipc/wetlands TESLpd__), TEBATH
		(Note: Excludes industrial wastewater ponds and any saturated wetlands "H" water regime from Moderate, e.g., PFO1B that is LSFL.)
Streamflow Maintenance (SM)	High	frw (all headwater wetlands)
	Moderate	LRFPF, LS: BA, PEMH, TE__pfTH, PEOU, TE__pdOU, TEOU (and frw but associated with streams not rivers), LE wetlands associated with throughflow lakes (LK__TH)

Question: Should organic soil wetlands along 3rd order perennial streams be added to the High potential?

- Identify functions each wetland provides based on classifications
- Best professional judgment exercise
- Starting points are correlation tables from other projects (region, nation)
- Wetlands identified as providing functions at a high or moderate level (relative to other wetlands in watershed)

Streamflow Maintenance (SM) - High

Exclusions

None

Wetland Types

"hw" and "sf" wetlands (unaltered - excluding "d", "h", and "x" types and "J" types), or LR_FPhs, or LRBA, or LSBA, or TEBAOUds, or TESLOUds (excluding impounded wetlands from TEBAOUds and TESLOUds only).

Selection Statement

```
(( "LLWW" LIKE ('%hw%') OR ( "LLWW" LIKE ('%sf%') AND NOT "LLWW" LIKE ('%sfg%')))
AND NOT ( "NWI_Modifier" = 'd' OR "NWI_Modifier" = 'x' OR "NWI_Modifier" = 'h' OR "NWI_Regime" = 'J' ))
OR
(( "LLWW" LIKE ('%hw%') OR ( "LLWW" LIKE ('%sf%') AND NOT "LLWW" LIKE ('%sfg%')))
AND ( "NWI_Modifier" IS NULL AND NOT "NWI_Regime" = 'J' ))
OR
( "LLWW" LIKE (LR%FPhs%) OR "LLWW" LIKE (LS%BA%) OR "LLWW" LIKE (LR%BA%) OR ( "LLWW"
LIKE 'TE%BA%OU%ds%' AND NOT "NWI_Modifier" = 'h' ) OR ( "LLWW" LIKE 'TE%BA%OU%ds%' AND
"NWI_Modifier" IS NULL ) OR ("LLWW" LIKE 'TE%SL%OU%ds%' AND NOT "NWI_Modifier" = 'h' ) OR (
"LLWW" LIKE 'TE%SL%OU%ds%' AND "NWI_Modifier" IS NULL )) AND NOT "NWI_Regime" = 'J'
```

Wetland Functional Correlation

Wetland Functions for Assessment

Water Quality Functions

- Surface Water Detention
- Streamflow Maintenance
- Groundwater Recharge
- Shoreline Stabilization
- Nutrient Transformation
- Carbon Sequestration
- Sediment or Particulate Retention

Habitat Functions

- Fish Habitat
- Aquatic Invertebrate Habitat
- Waterfowl Habitat
- Water Bird Habitat
- Other Wildlife Habitat
- Unique and Uncommon Wetlands

Step 10: Finalize Data, Metadata and Project Report

Considerations:

- Traditional Image Interpretation
- Automated Delineation and Classification
- Consultation with Collateral Data
- Order of Operations – NWI, LLWW, HGM
- Generate Datasets that Support Wetland Mapping – DEM Hillshades, Hydrography Flow Lines, Valley Confinement, PRW

Supplemental Map Information (User Report)

Outline

Project ID/Agreement No.: 12-667-5000-0005 A2

Project Title/Area: Mapping and Classification for Wetland Protection, Northeastern New Mexico Highlands and Plains

Source Imagery (type, scale and date): 2009 true-color NAIP, USDA, one-meter

Collateral Data (include any digital data used as collateral):

- DRGs
- NWI historical data
- National Hydrography Dataset (NHD): USGS (used for open water delineation: ponds, rivers/streams, swamps, etc.)
- Soils: NRCS
- Various collateral layers (e.g. air quality, ground water, and transportation): New Mexico Environment Department Surface Water Quality Bureau (SWQB)

Inventory Method (original mapping, map update, techniques used):

- Original on-screen mapping was done at a scale of 1:6,000 using 1999 DOQQs CIR along with collateral data.
- QAQC of the photo interpretation and wetland delineation was completed at a scale of 1:3,000.
- Wetlands represented are wetlands with areas (acres) greater than .5 acres which were delineated and attributed according to wetland type.
- Open water features, regardless of area (acres) were delineated and attributed according to wetland feature type.
- Original mapping was completed by 24K quad areas, with QAQC being completed for each of the 24K areas.
- The data was then edgematched to form the seamless 1999 dataset.

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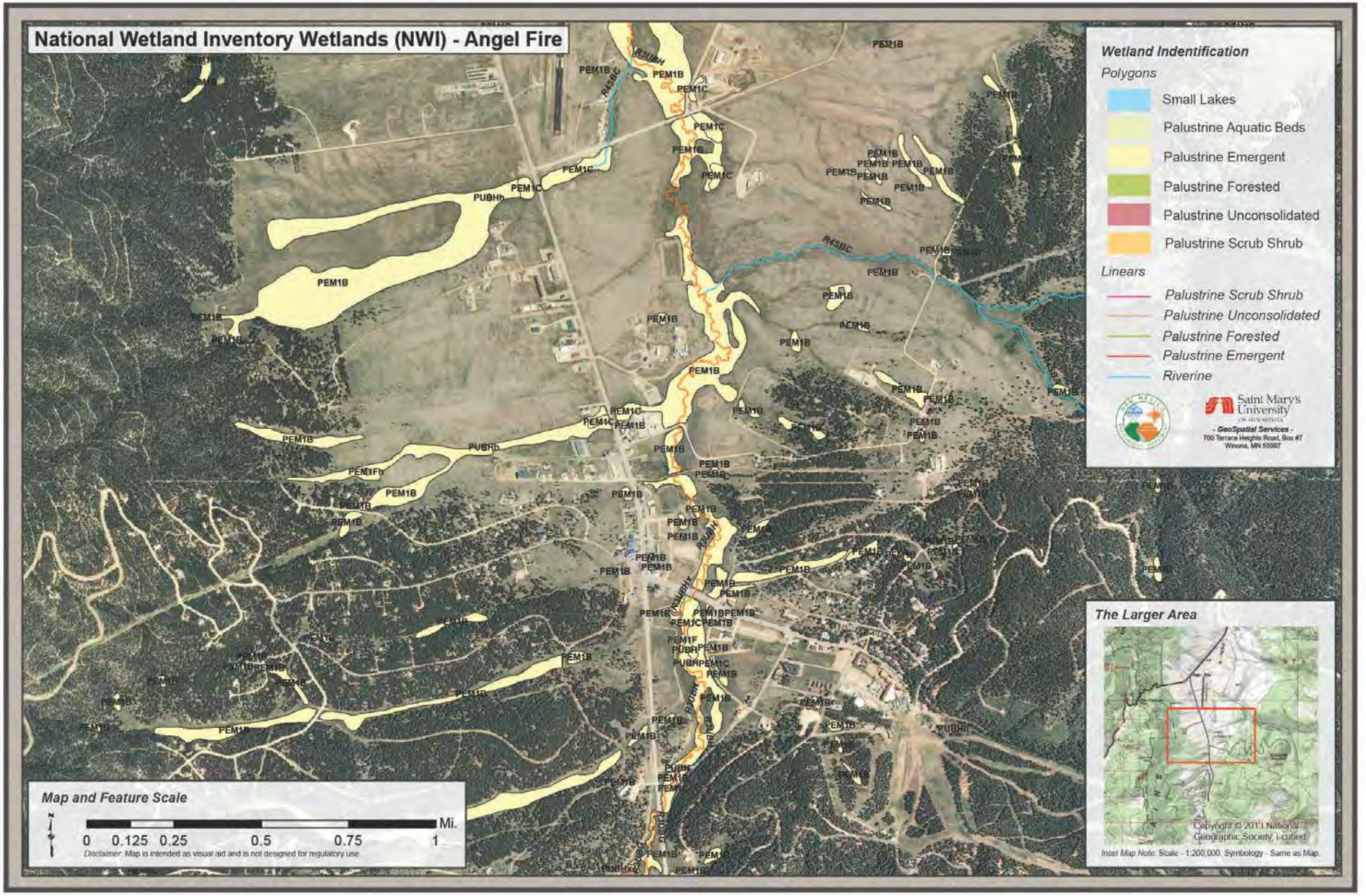
Mapping and Classification of Wetlands for Protection:
Northeastern New Mexico Highlands and Plains

Step 11: Produce and Distribute Data and Cartographic Products

Considerations:

- National Mapper
- Plots
- Map Books
- Story Maps
- Custom Web Delivery and Query Tools



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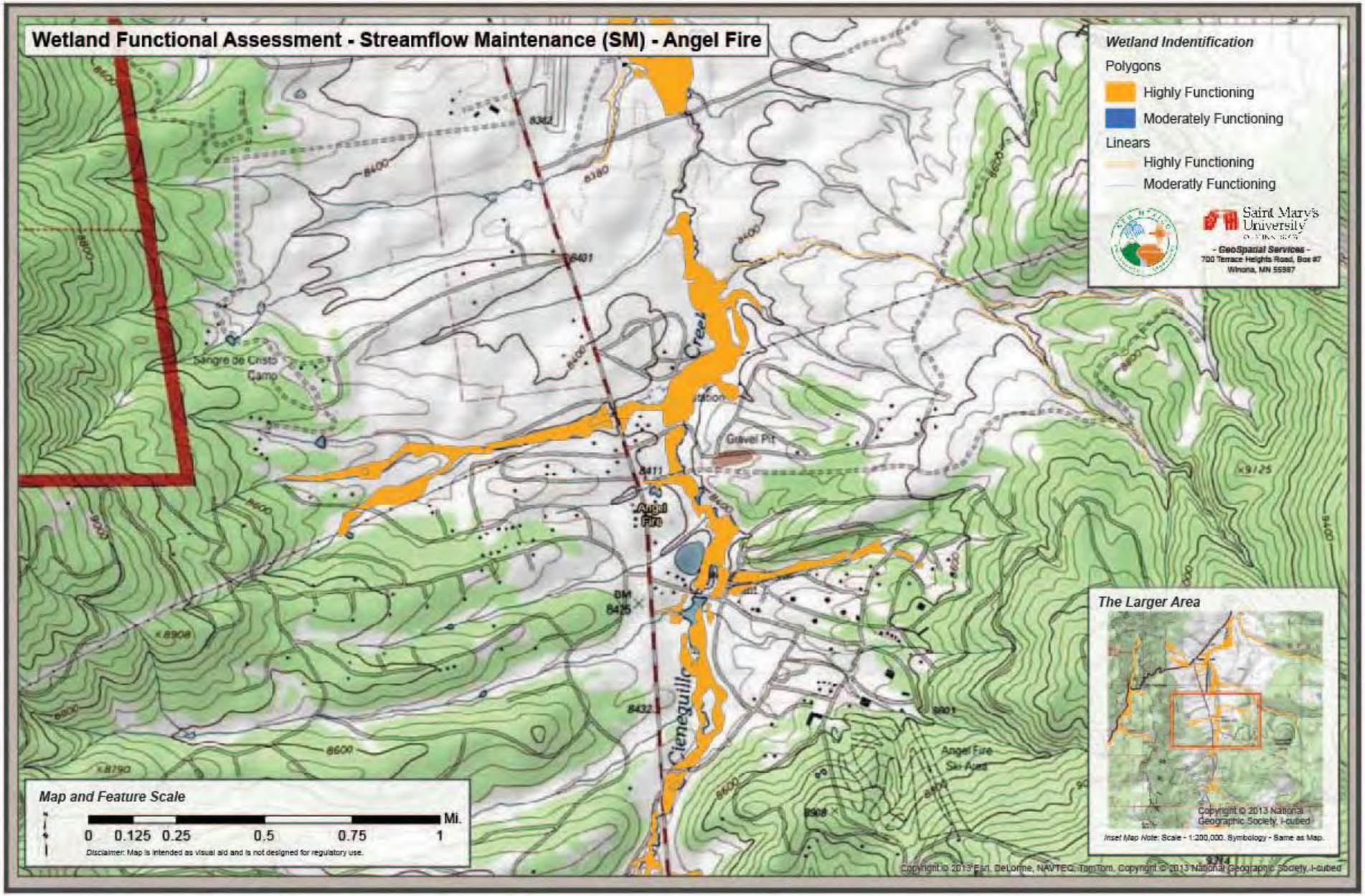
Hardcopy Plots



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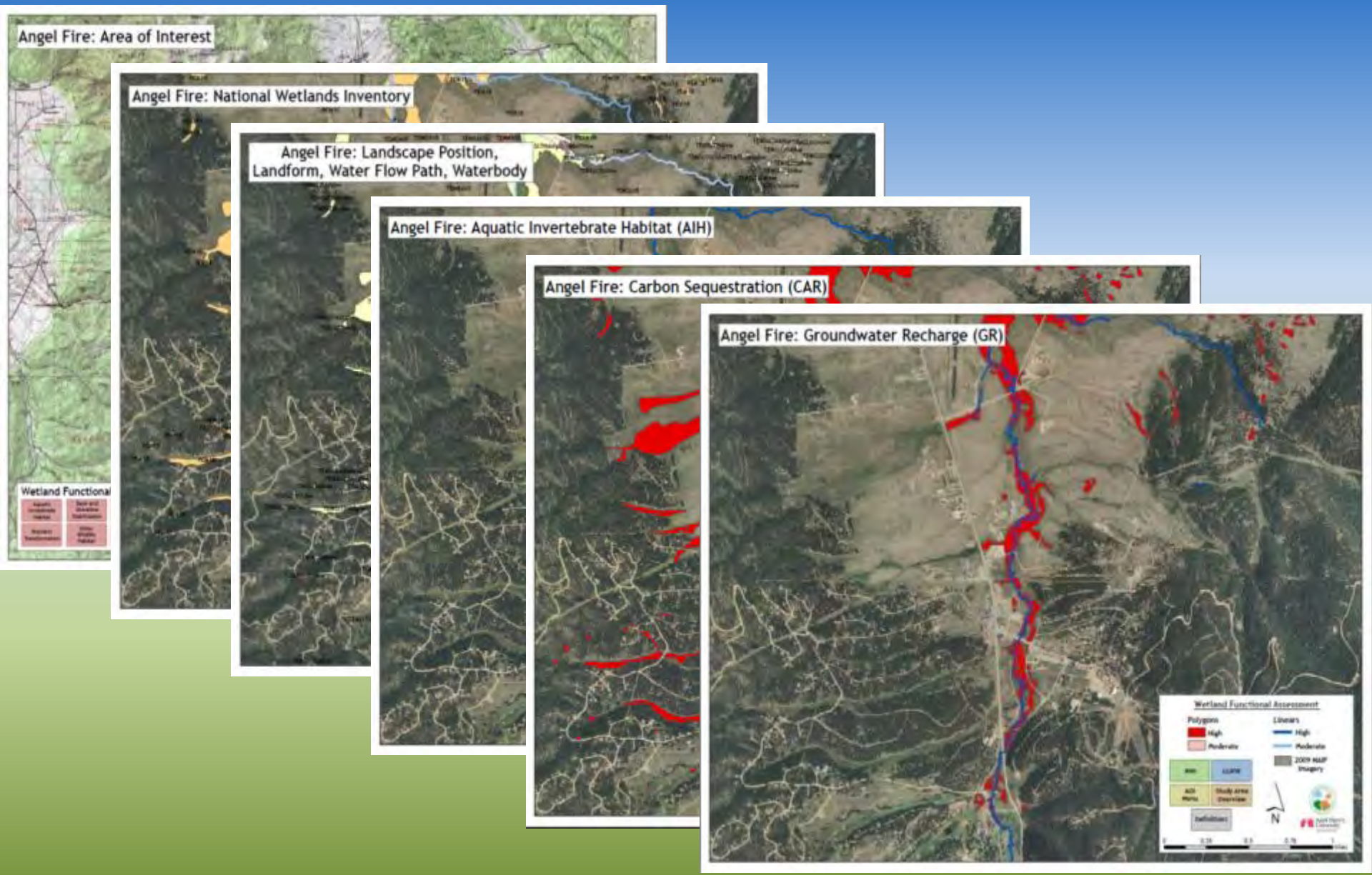

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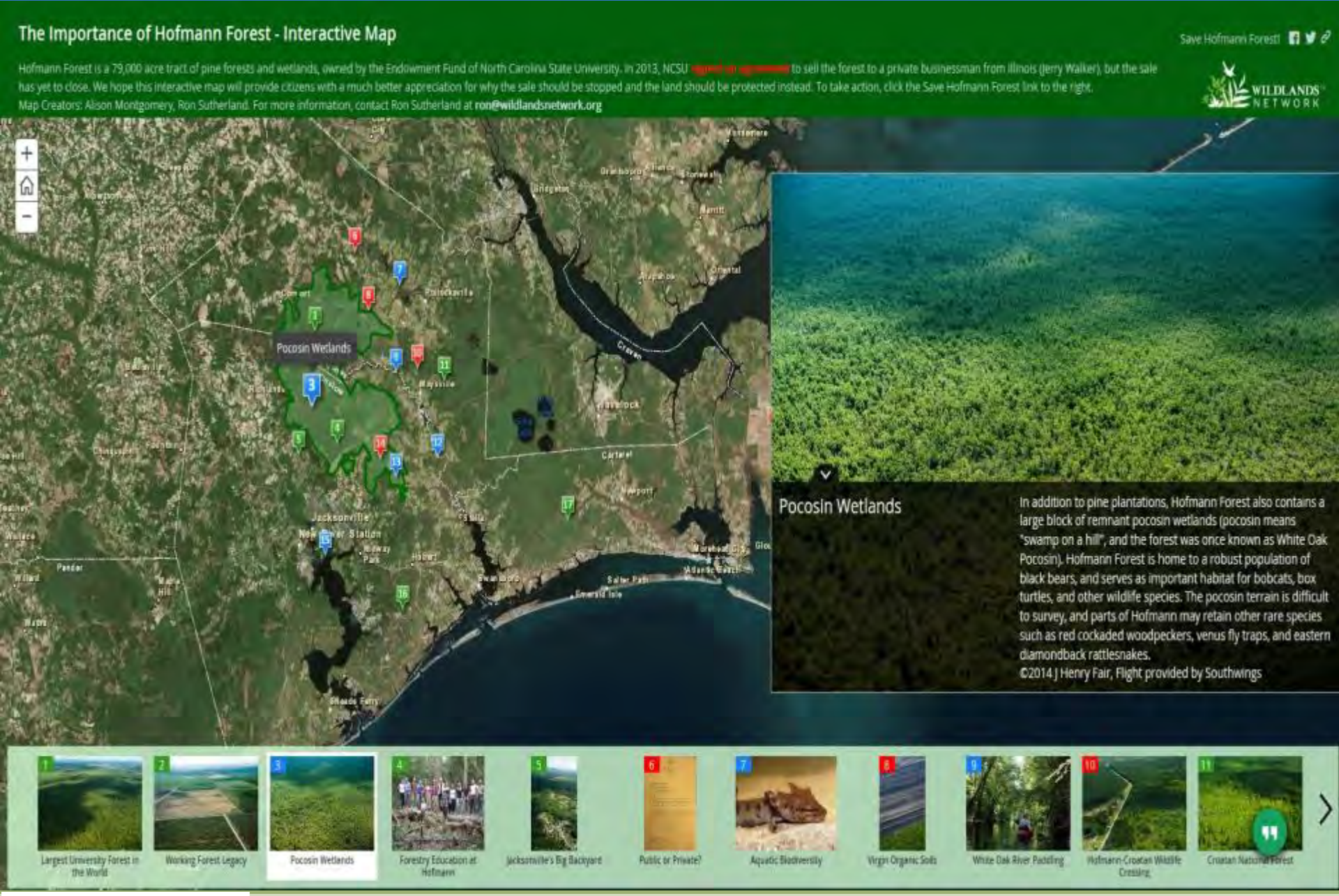
PDF Mapbooks



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Story Maps

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