Land Use/Cover Change Projects

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USDA

FSA
FARM SERVICE AGENCY

Overview

- Over the last few years APFO has been asked to do several land use change, remote sensing type projects in support of FSA business.
  - Chicago, Sacramento, Dallas, Raleigh, Chesapeake Bay, Salt Lake City, and Devil's Lake Basin in ND
- APFO has also been asked to provide historical ortho or georeferenced products to several entities as well
  - MIT, NRCS, FSA, Public
- I was asked to speak about these and decided to focus on the Devil's Lake Project.

USDA-FSA-APFO
July 2010

Devil's Lake ND Digitizing on Imagery and Basic Analysis

USDA

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Outline

- Project Request and Scope
- Products Overview
- Area of Interest (AOI)
- Task Levels of Accuracy
- Products (Detail)
- Recommendations
- Resources
- Deliverable Data

Project Request and Scope

Project Request

- Requestor
  - FSA Administrator
  - FSA Deputy Administrator for Farm Programs
  - FSA-APFO Director
- Customer
  - FSA Administrator
  - FSA Deputy Administrator for Farm Programs
  - FSA-APFO Director
  - FSA ND State GIS Specialist

Project Scope

- **Task**
  - Digitize all water extents within the Area of Interest (AOI) for 1959 (photo index), 1978 (photo index), 1997 (MDOQ), 2003 (NAIP), 2006 (NAIP), and 2009 (NAIP)
  - Produce Products and Perform Analysis

- **Digitizing Rules**
  - Digitize at 1:12000 in NAD83 UTM14
  - Snap to edge of AOI as needed
  - No overlapping polygons
  - Digitize all water within AOI
  - Populate year and season attributes
  - Cut out holes in large islands
  - Digitize water level itself as represented on the imagery

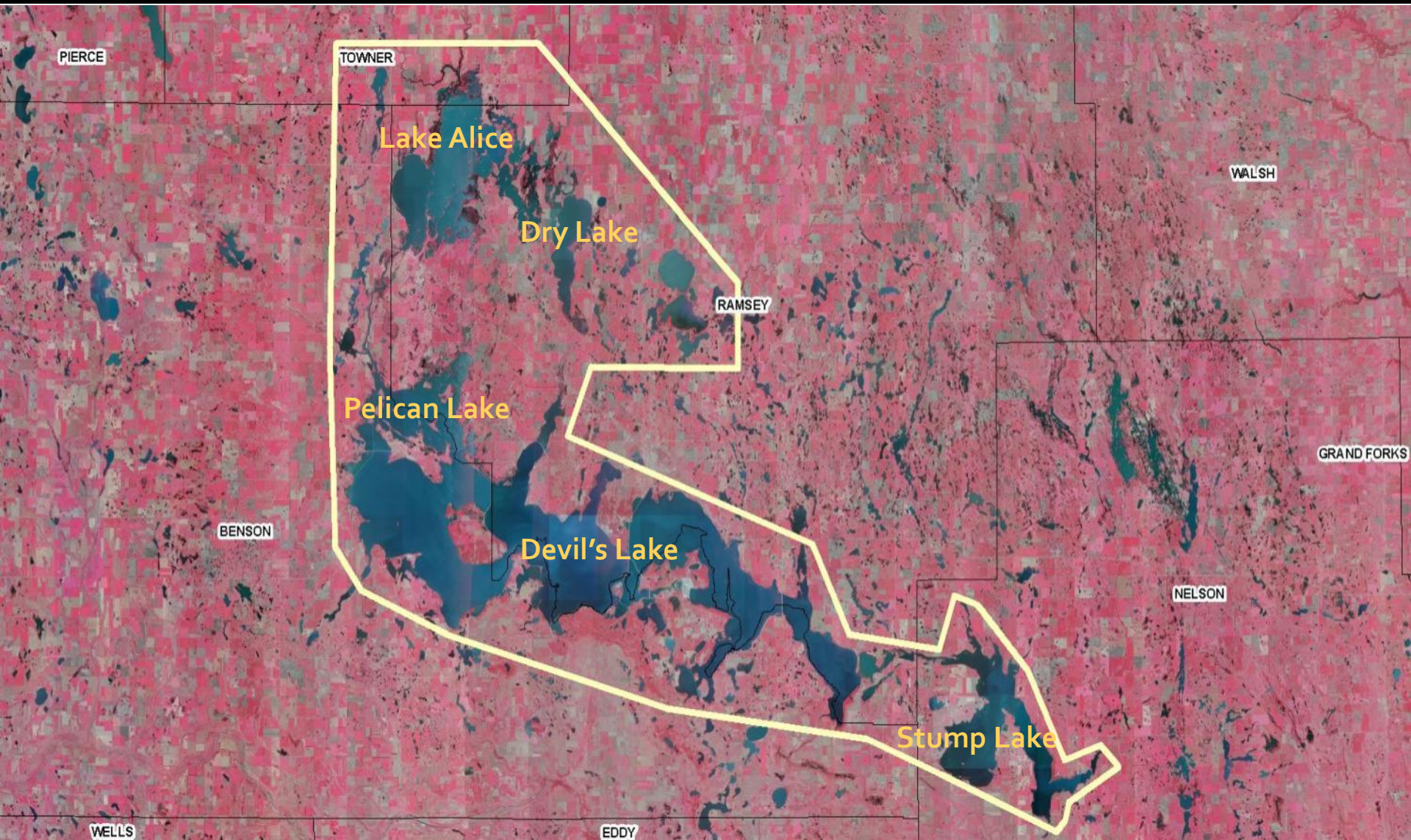
Products Overview

Products

- **Products**
  - Visual Change Depictions from Imagery
  - Digitized Water Surface within AOI for Each Year
  - Total Water Surface Area within AOI in Acres by Year
  - Surface Area Graphics and Total Acreage Trend Charts
  - Short Report (This PowerPoint)
  - Additional Analysis
    - Level 1 – "From to" clipping and change analysis. Clip out areas that were not water in one year of imagery and are water in the next, then analyze change underneath these polygons…ID land classes in major change areas (e.g. from farming to water). Create land class feature classes for these areas, graphics and acreage charts
    - Level 2 – Clipping CLU – ID CLU that are now under water for various years, show acreages of loss, use codes, etc.
  - Hard Copy Products – TBD
  - Web Services – TBD
  - Follow-on Recommendations
- Note***All Data/Info Generated for this project will be forwarded to FSA ND State GIS Specialist for further use

Area of Interest (AOI)

Area of Interest (AOI) Over 2009 NAIP

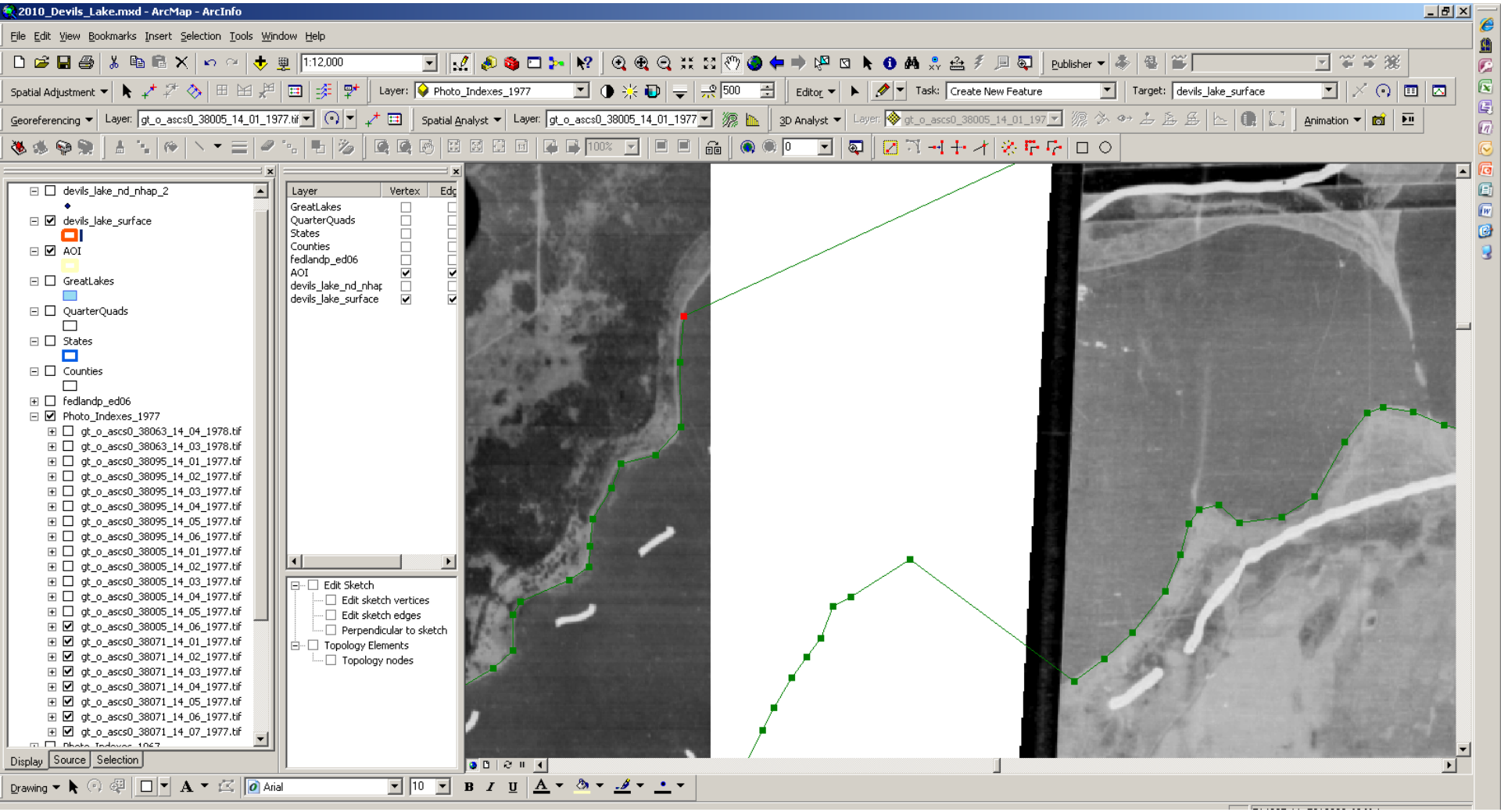


Task Levels of Accuracy

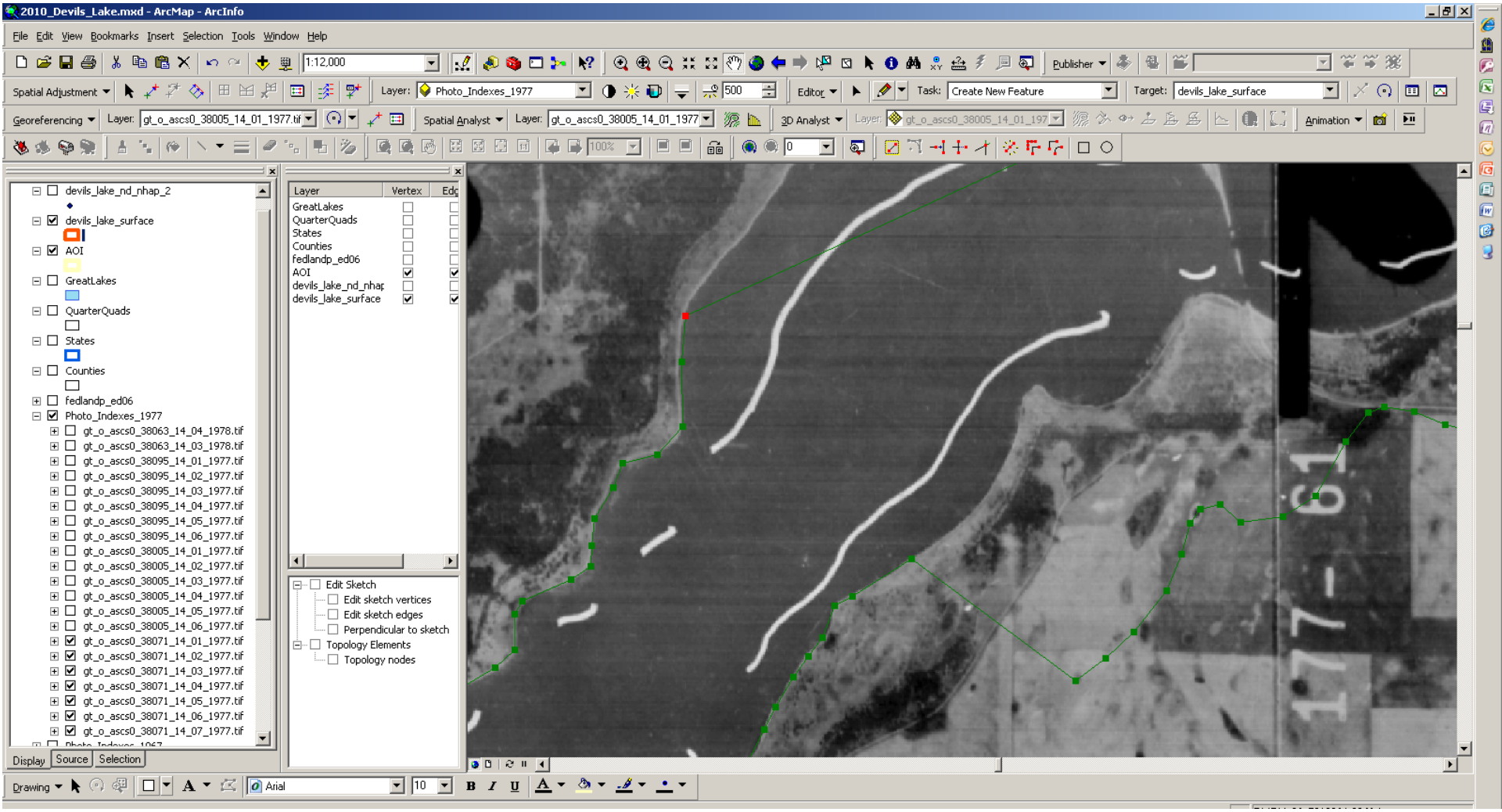
Task Levels of Accuracy

- Digitizing and analysis accuracy should be high for 1997-2009 imagery
- Digitizing and analysis accuracy is suspect for the 1959 and 1978 Indexes…but is still good for average total acreages and trends
  - Increase accuracy would result given resources to georeference scans rather than use indexes
- Analysis is only as good as the digitizing
- Factors
  - Variability in digitizing – 6 digitizers
    - Assumptions were made within the AOI and best judgment used while digitizing
  - Water, grass, or mud?
    - Difficult to determine, especially on BW and NC imagery
  - For 1978 data, used 1959 index for extreme SE corner of AOI, no 1978 indexes available
  - Some lake level shifts in shapes can be caused by misalignment of older imagery datasets, but should not account for overall acreage differences from year to year
  - In some cases the rule of snapping to the AOI extent was not honored, but the results in the overall trends and analysis are negligible

Index Digitizing Issues (1959 and 1978 Only)



Index Digitizing Issues (1959 and 1978 Only)



Products (Detail)

Visual Change Depictions

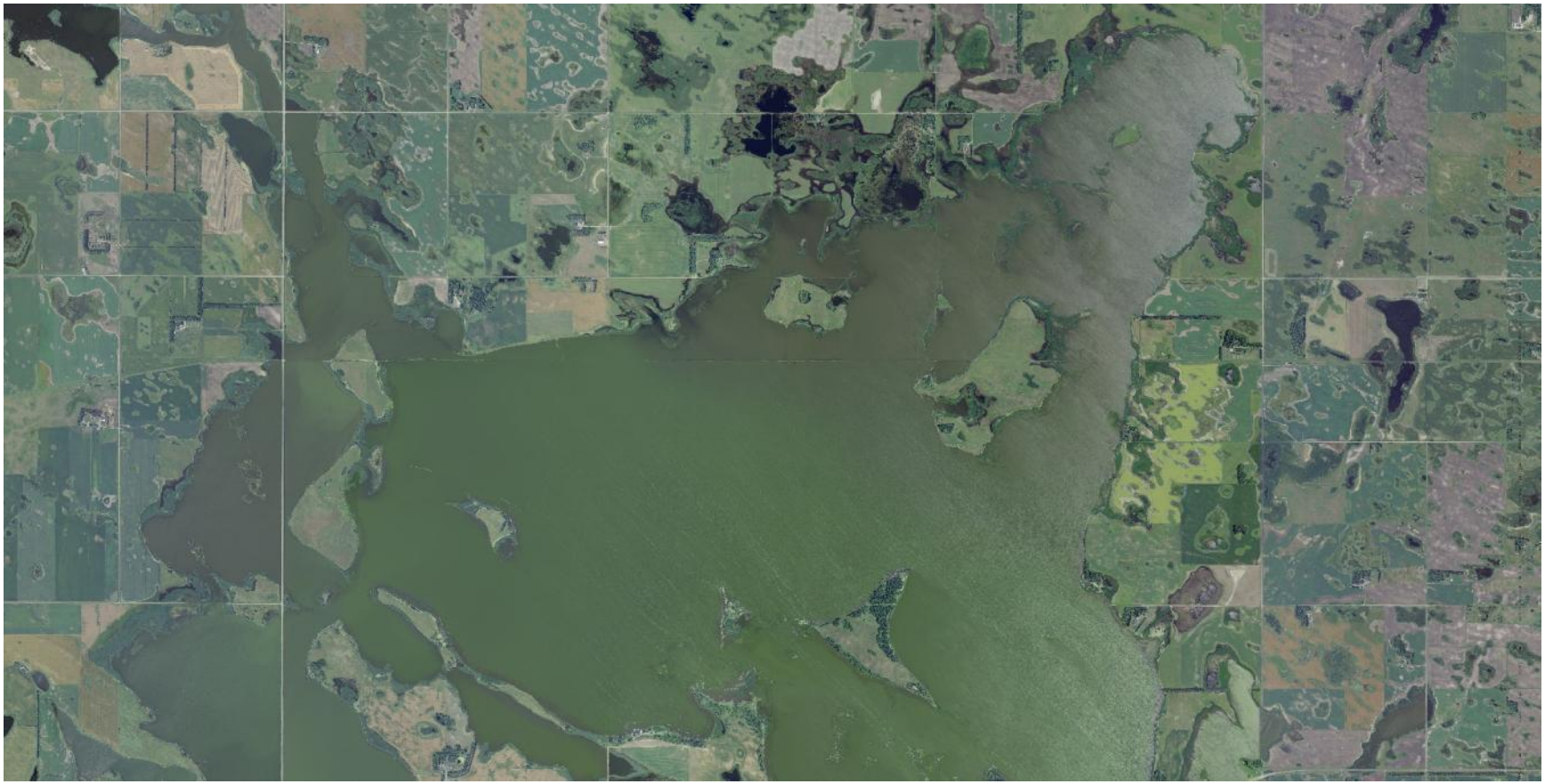
1978 vs. 2009

1978 (Minnewaukan, ND) - There is a USDA Service Center located here and FSA has already moved some files from the office to a different location "just in case" – Janes (FSA)

2009 (Minnewaukan, ND) - There is a USDA Service Center located here and FSA has already moved some files from the office to a different location "just in case" – Janes (FSA)

Close-Up North (1997)

Close-Up North (2009)



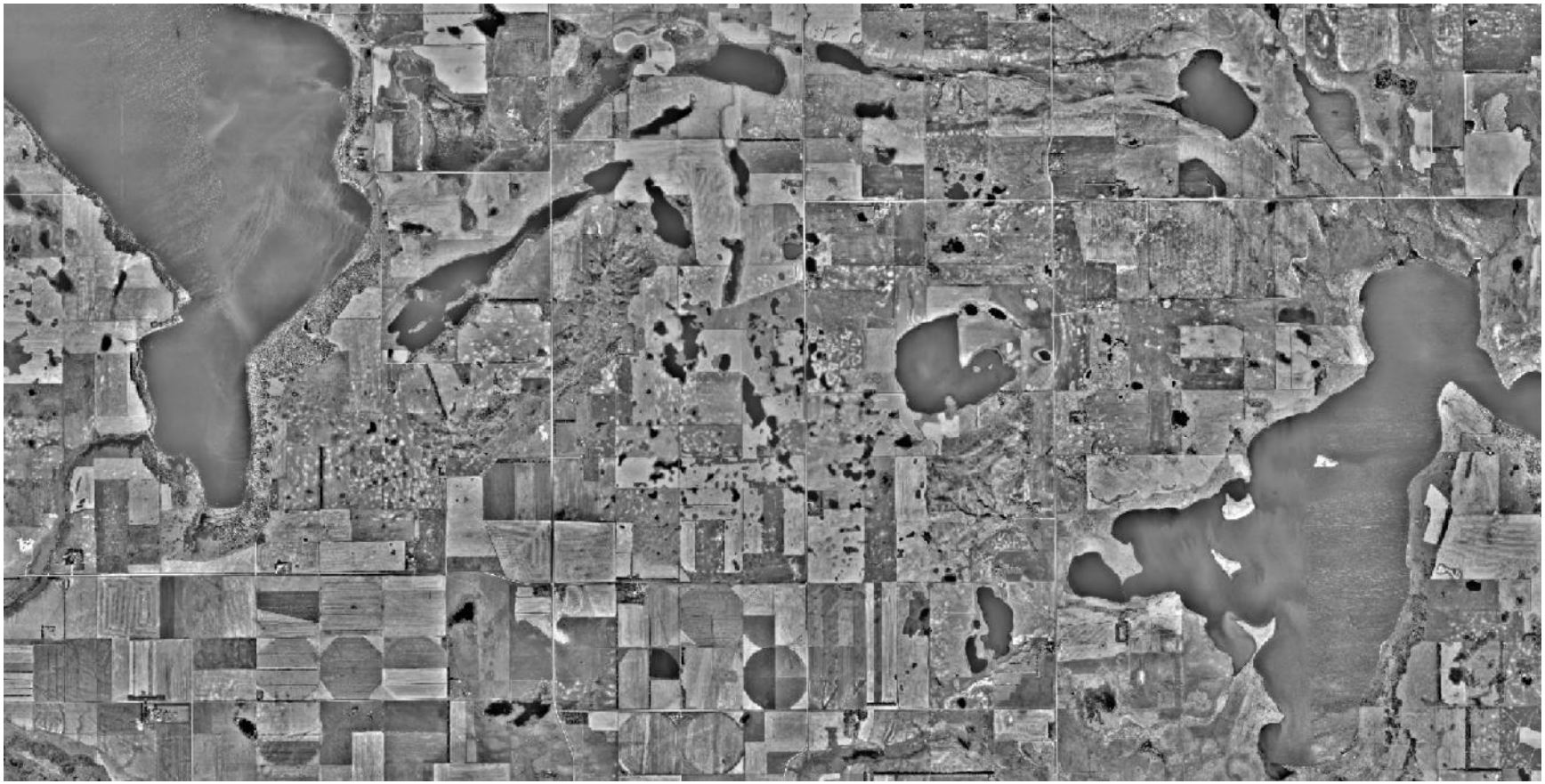
Close-Up South – Camp Grafton is in the NE Corner of the Image (1978)

Close-Up South – Camp Grafton is in the NE Corner of the Image (1997)

Close-Up South – Camp Grafton is in the NE Corner of the Image (2009)

Close-Up East - Jerusalem Outlet (1978)

Close-Up East - Jerusalem Outlet (1997)

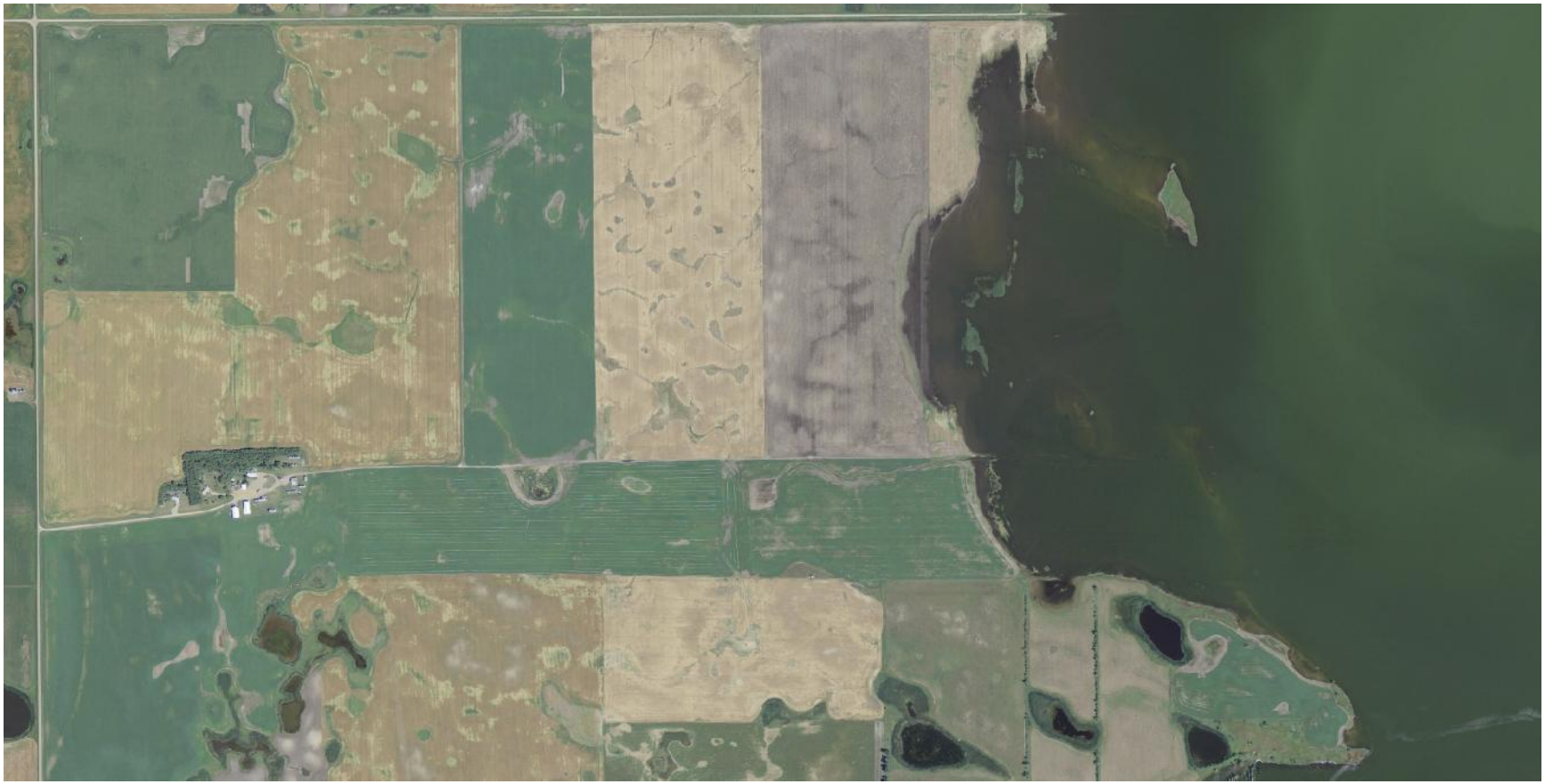


Close-Up East - Jerusalem Outlet (2009)

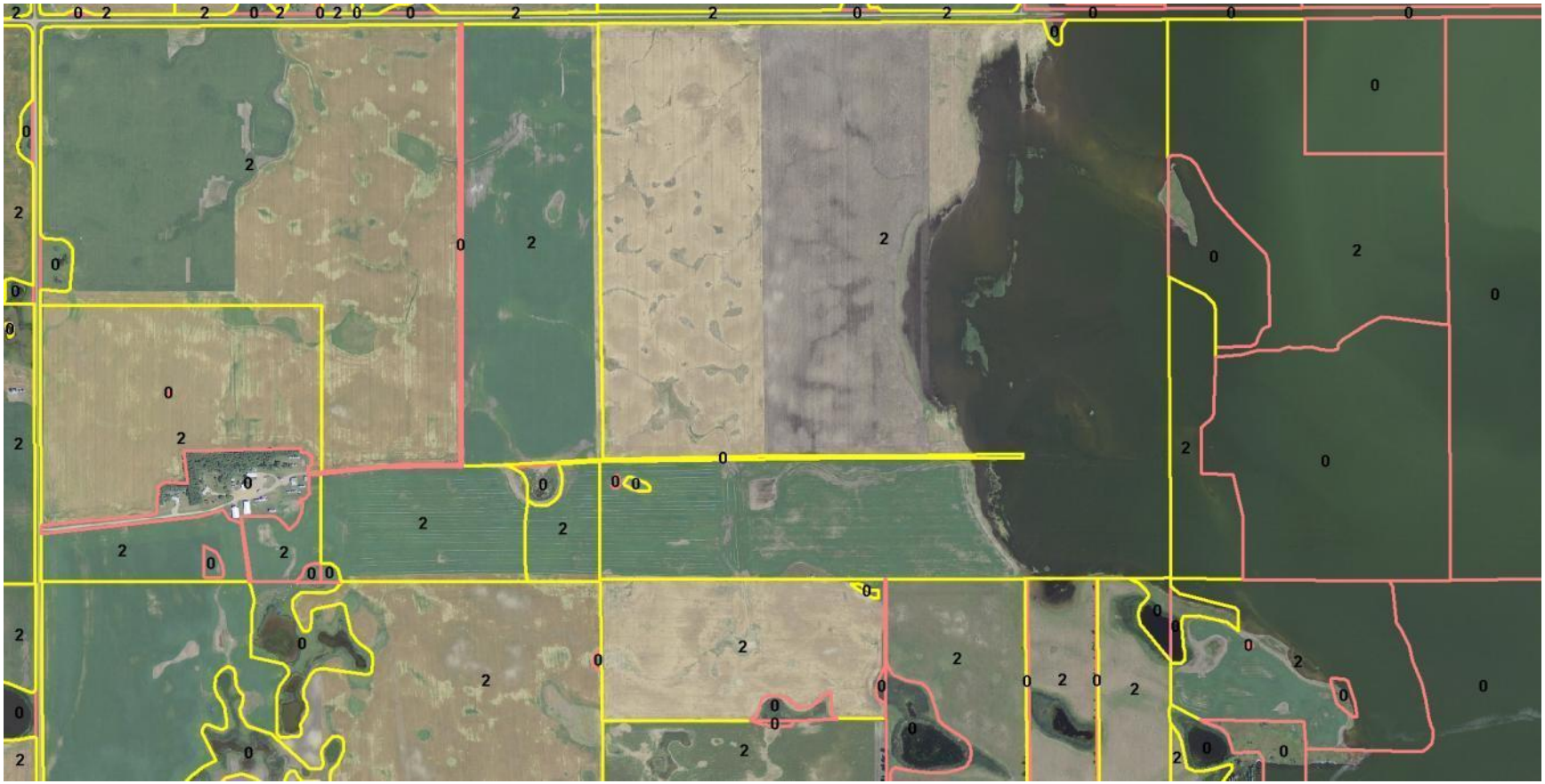
Close-Up East Ag (1997)

Close-Up East Ag (2005)

Close-Up East Ag (2009)



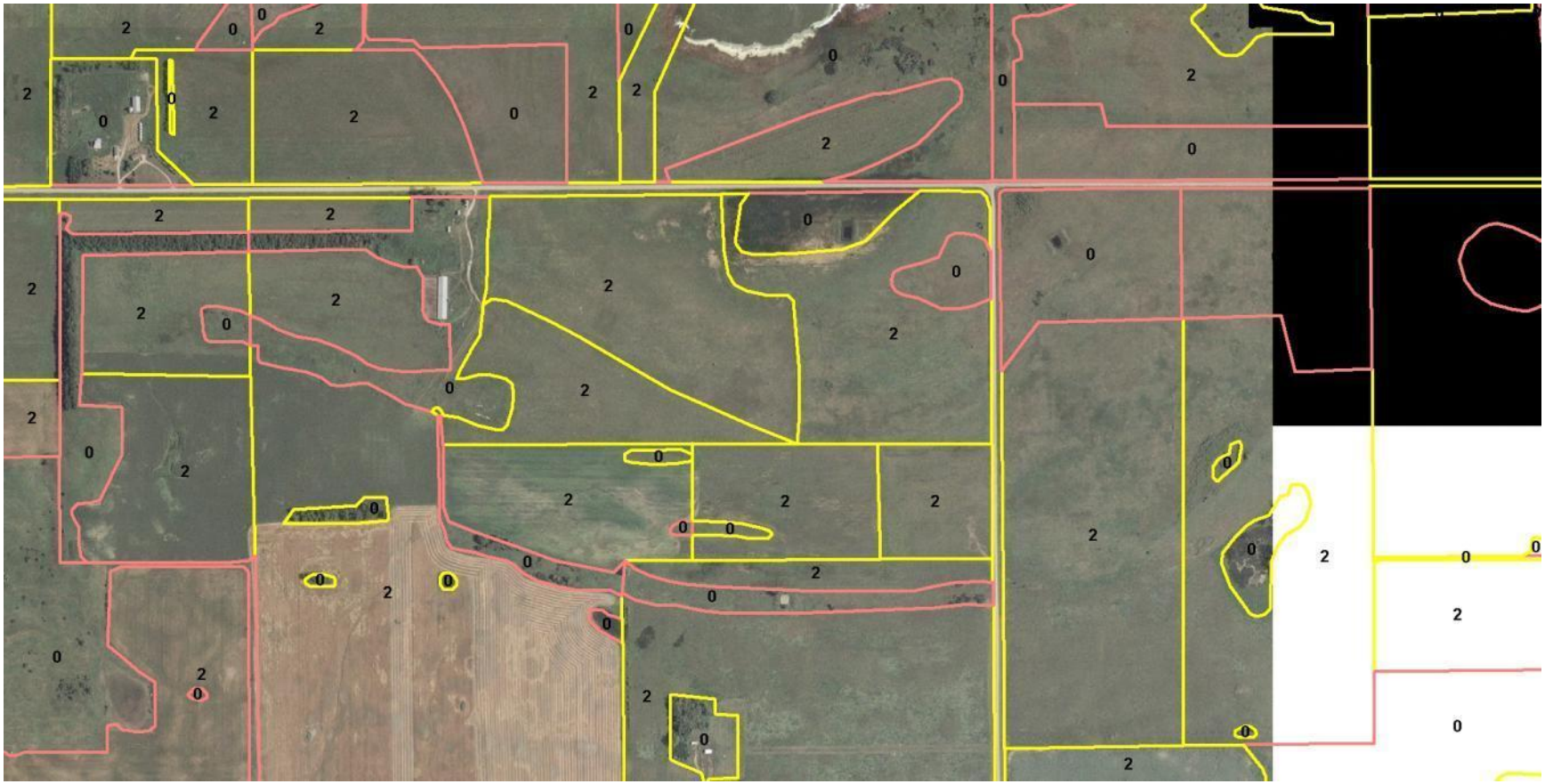
Close-Up East Ag+CLU (2009)



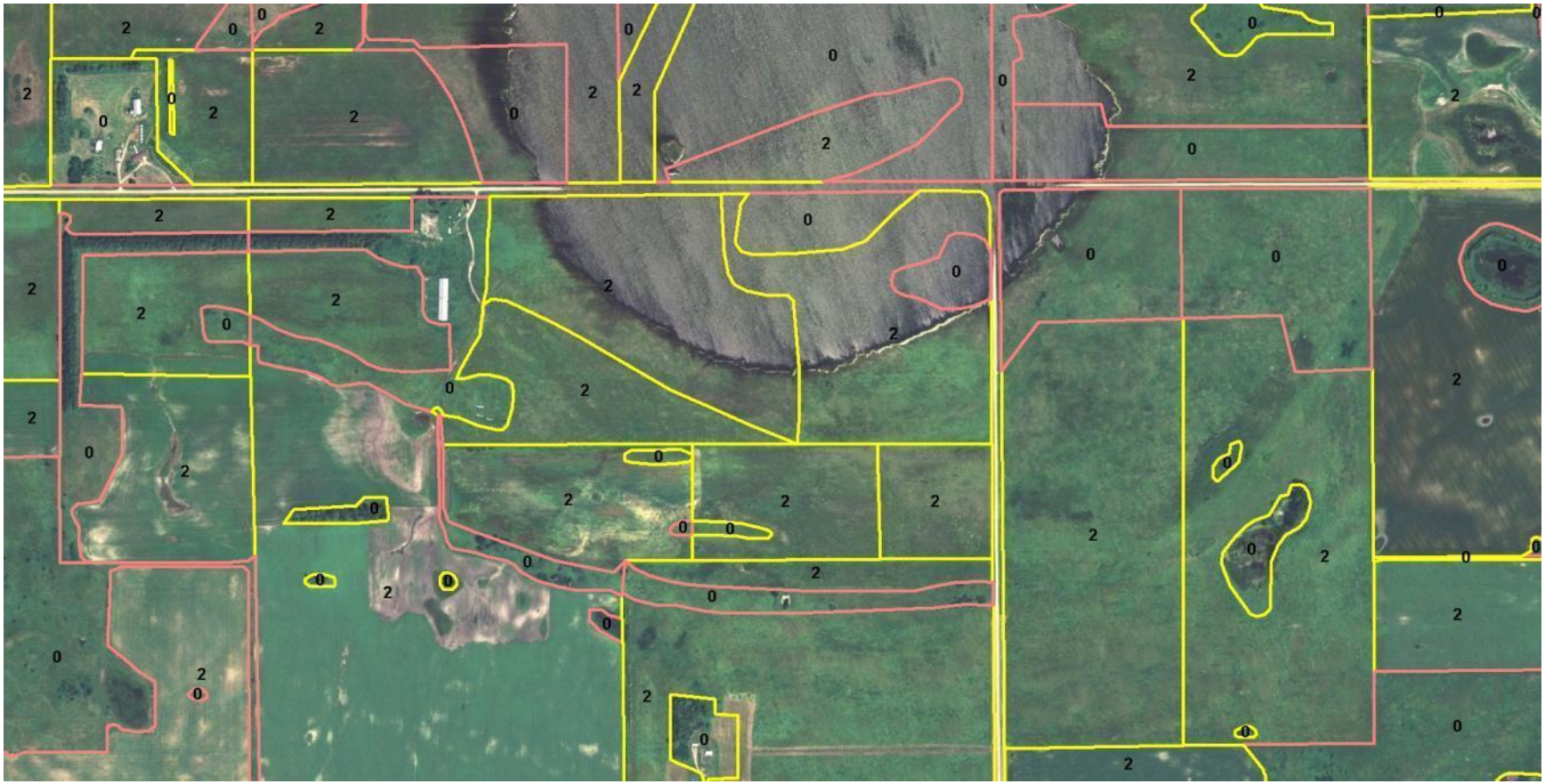
CLU Use Code 2 = Crop Land

Close-Up South Ag+CLU (1997)

Close-Up South Ag+CLU (2003)



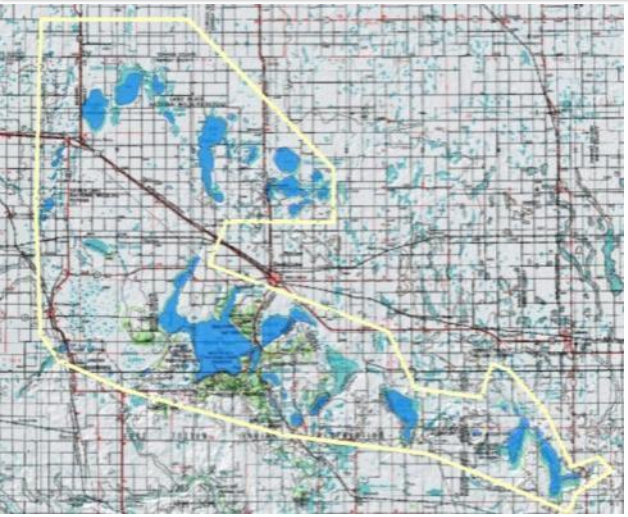
Close-Up South Ag+CLU (2005)



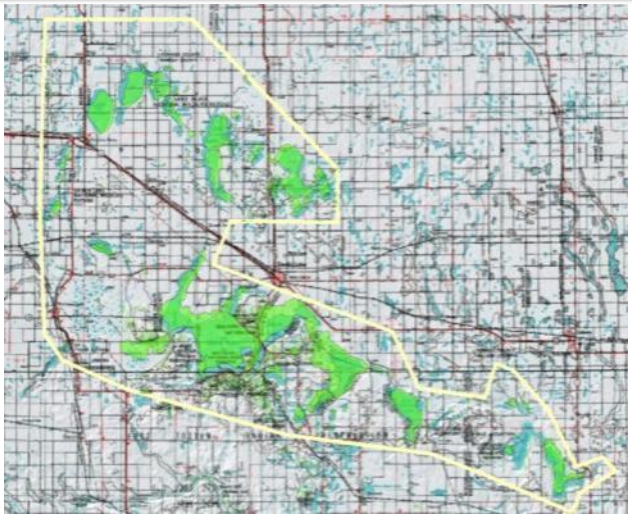
Close-Up South Ag+CLU (2009)

Notice the dead trees in the wind break and the structures that required moving

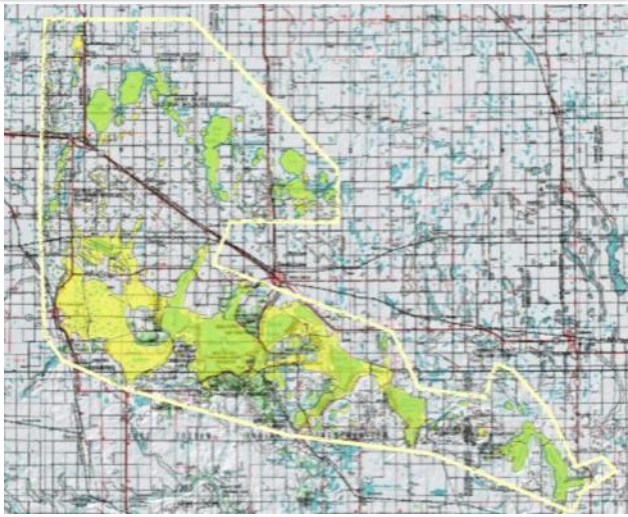
Digitized Water Surface Graphic within AOI for 1959-2009



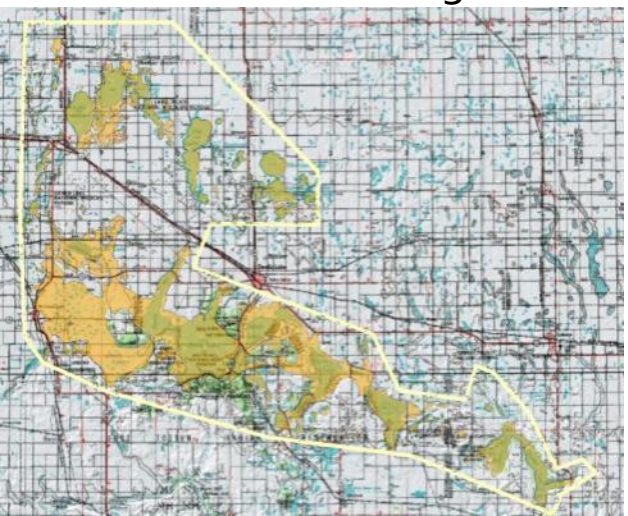
1959



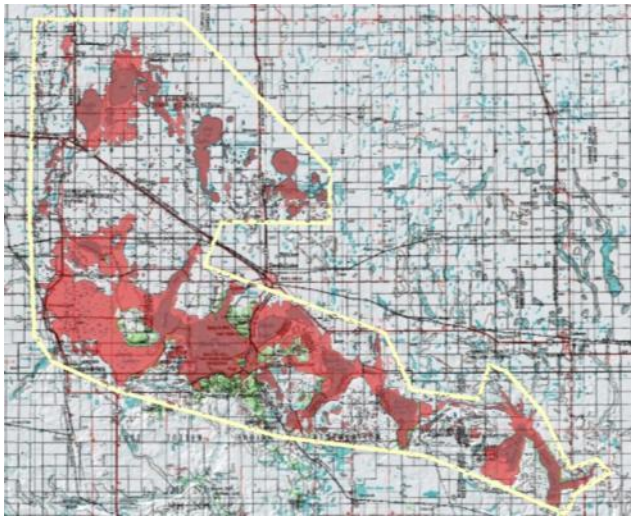
1978



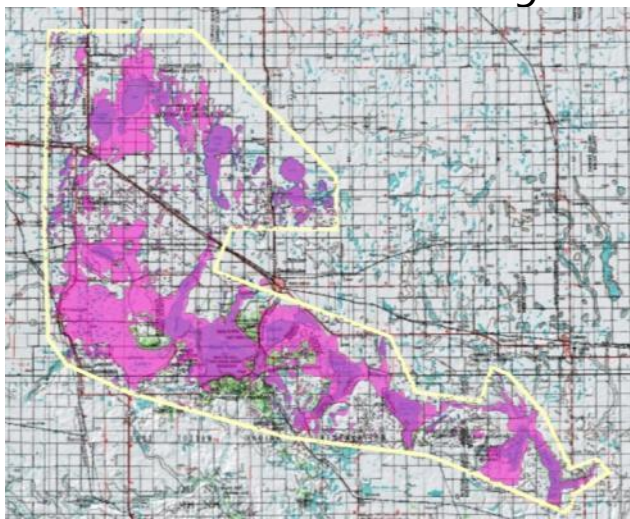
1997



2003



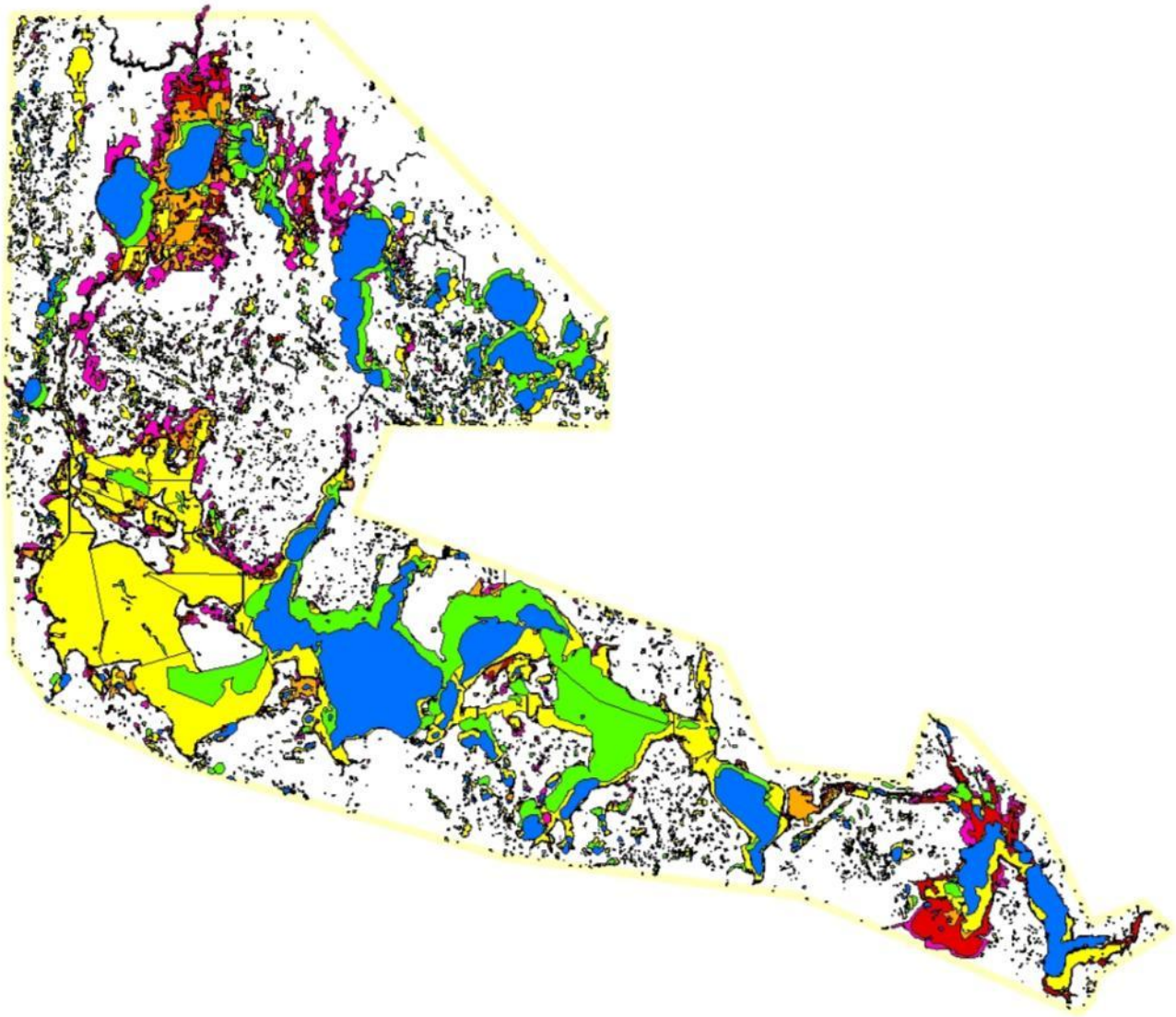
2006



2009

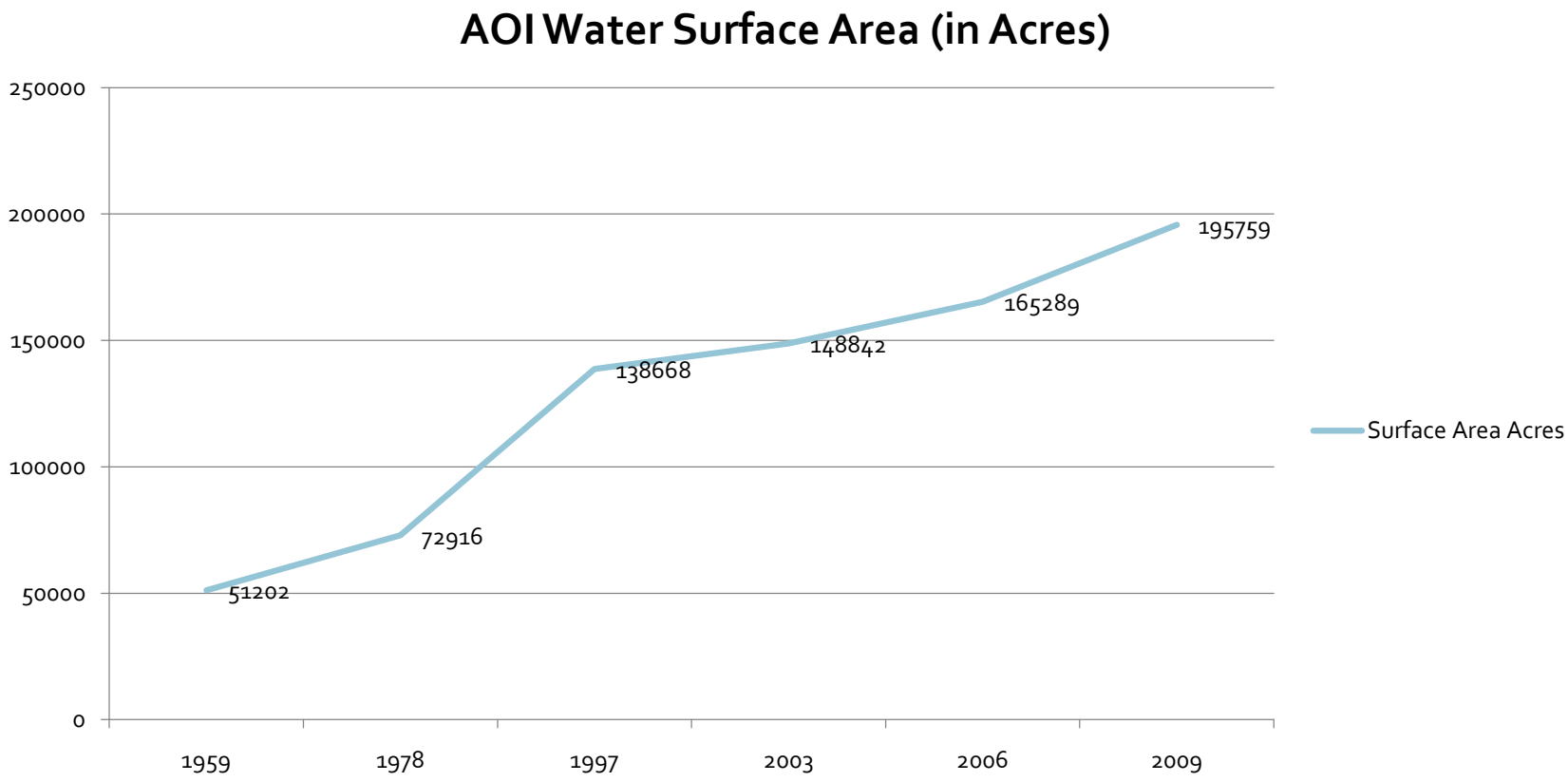
Overlay of all Water Surface Digitizing

Pink, red, and orange colors indicate most recent expansion, while blue indicates lake levels in 1959. Notice the greatest areas of most recent expansion are to the east and to the north within the AOI, mostly affecting the Lake Alice National Wildlife Refuge and the Stump Lake Wildlife Refuge

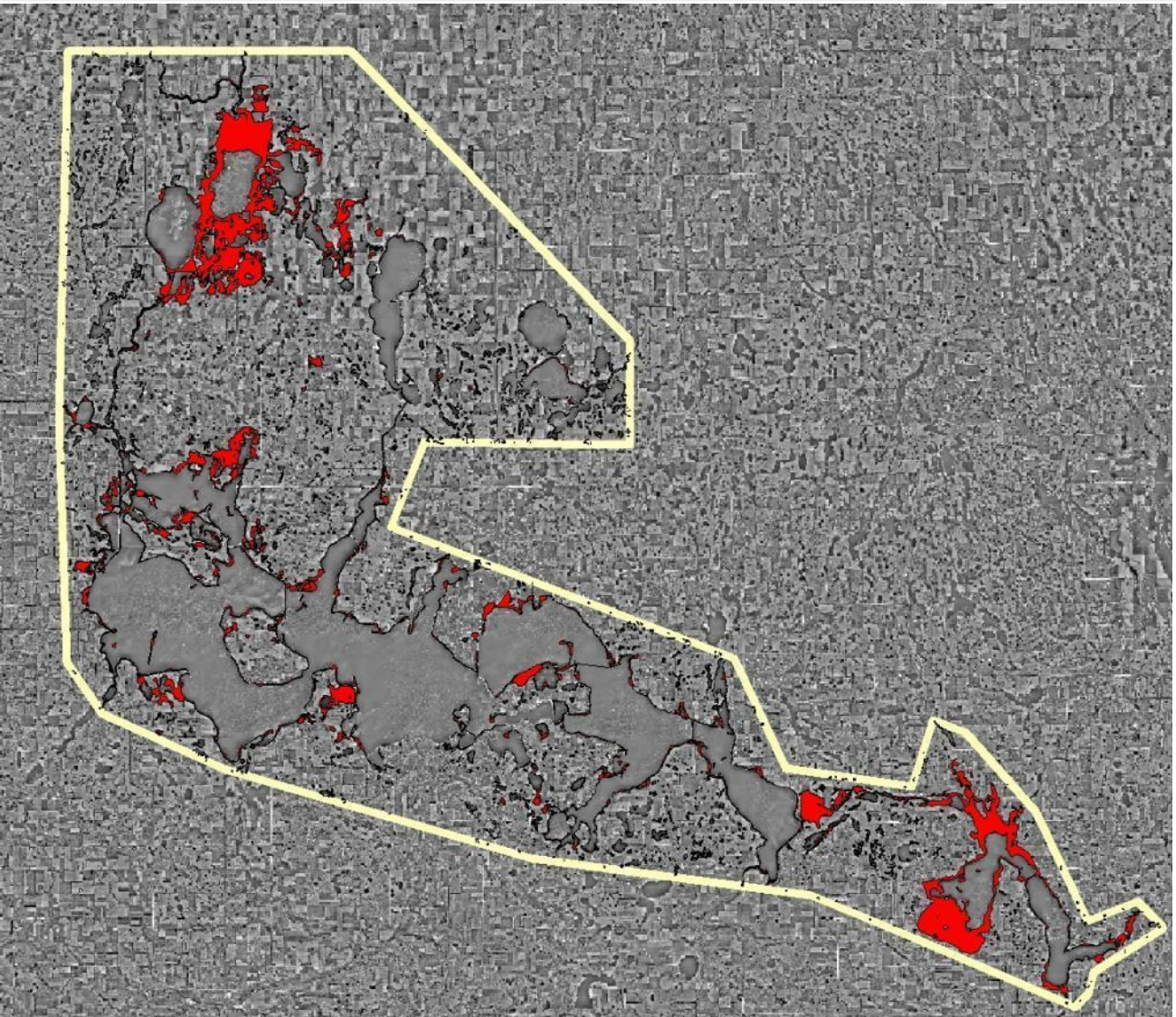


Total Water Surface Area within AOI in Acres by Year

- This chart shows total water surface area acreages within the AOI for all years of imagery represented.

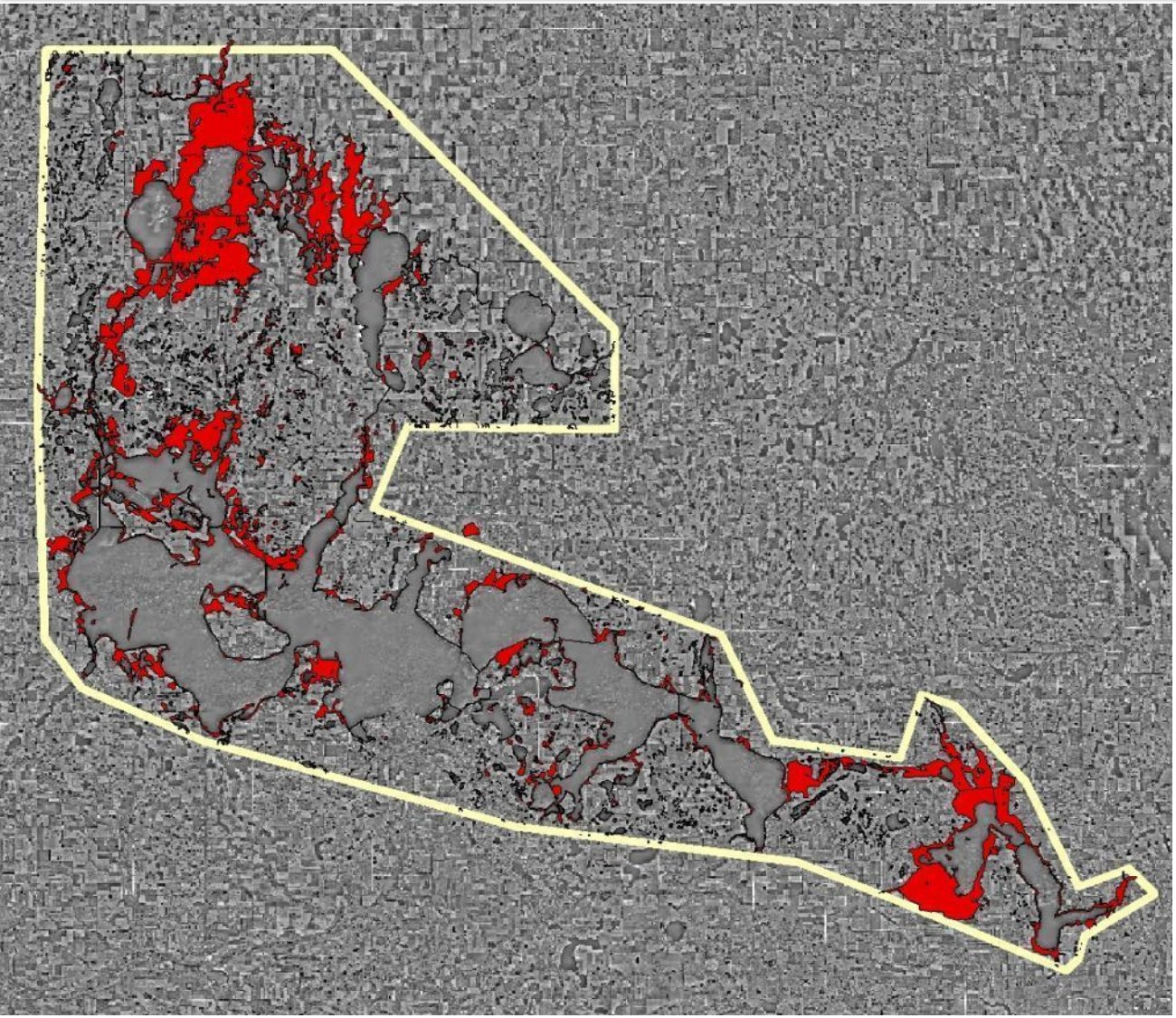


1997 to 2006 Water Surface Area Growth



The red depicts areas of lake growth from 1997 to 2006. Red indicates where in 1997 there was no water, but in 2006 there is. This is an increase of 26,621 acres of water in just under 10 years.

1997 to 2009 Water Surface Area Growth



The red depicts areas of lake growth from 1997 to 2009. Red indicates where in 1997 there was no water, but in 2009 there is. This is an increase of 57,091 acres of water in about 12 years.

Additional Analysis – Level 1 – Land Classes

- To show land cover classes that were once something other than water, but are now water
  - Take 2 digitized water surface years, use the 'erase' tool in ArcGIS to output a vector dataset that only shows where water is in the latter year, where it was not in the former year. Then manually analyze land classes underneath the polygons based on the older year imagery (prior to the land being under water)
  - ***This analysis was not completed due to lack of time. This analysis would likely take 1-2 weeks to complete if requested

Additional Analysis – Level 2 – CLU

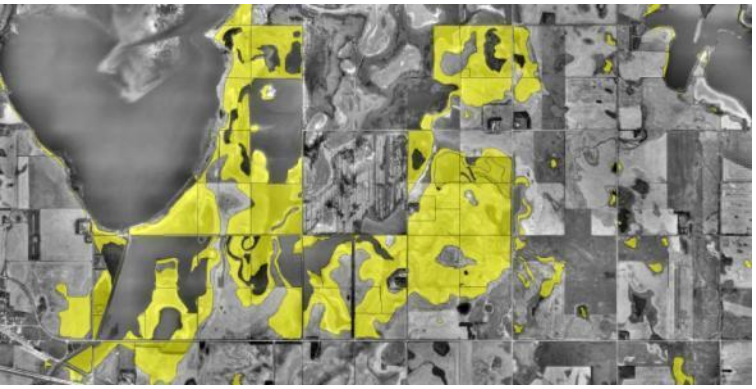
- To show CLU that once was above water and is now under water
  - Take 2 digitized water surface years, use the 'erase' tool in ArcGIS to output a vector dataset that only shows where water is in the latter year, where it was not before. Then use 'intersect' tool on each county CLU shapefile (one at a time) with the output of the 'erase' tool. Then merge the outputs of the intersect process. The resulting file will be CLU that is now under water (for whatever year one used) that was not under water in the previous year imagery
  - Classify data by CLUCLSCD code and acreage if so desired

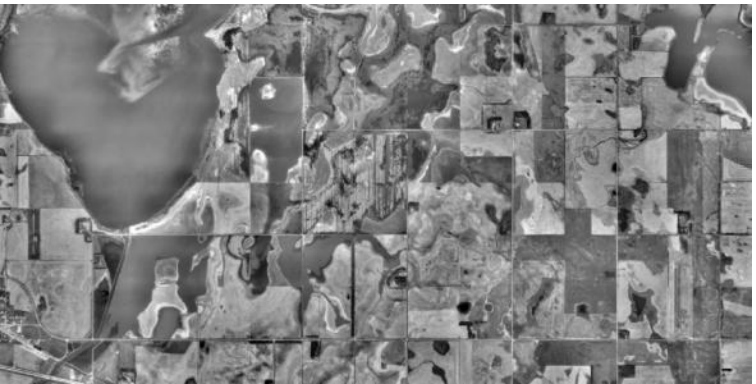
Additional Analysis – Level 2 – CLU - Steps

- Step 1 – Added all CLU for AOI
- Step 2 – Ran 'erase' on 2 years (1997 and 2006) of digitized lake levels
- Step 3 – Took 'erase' result and ran 'intersect' on all CLU (4 counties) producing 4 files
- Step 4 – Ran 'merge' on the 4 files – the resulting file was delineation of all CLU that was not under water in 1997, but was under water in 2006
- Step 5 – Selected by attributes CLUCLSCD 2 and exported to new feature class – this feature class shows all cropland CLU that were under water in 2006, but were not under water in 1997.
- Step 6 – Calculated the acreages

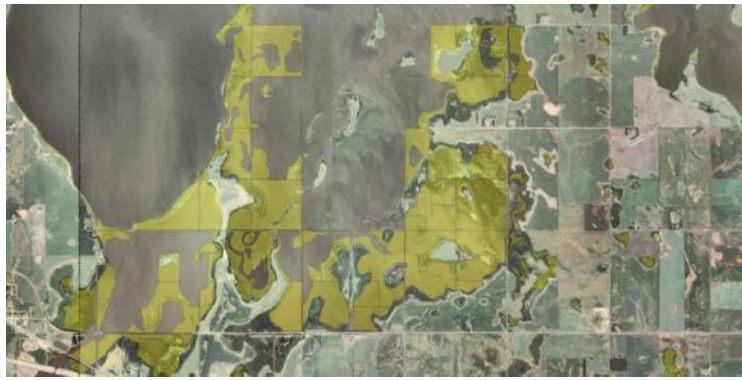
Additional Analysis – Level 2 – CLU - Results

- Results
  - Within the AOI, there are **~14,500 acres** of CLU currently identified as "cropland", under water in 2006 that were not under water in 1997.



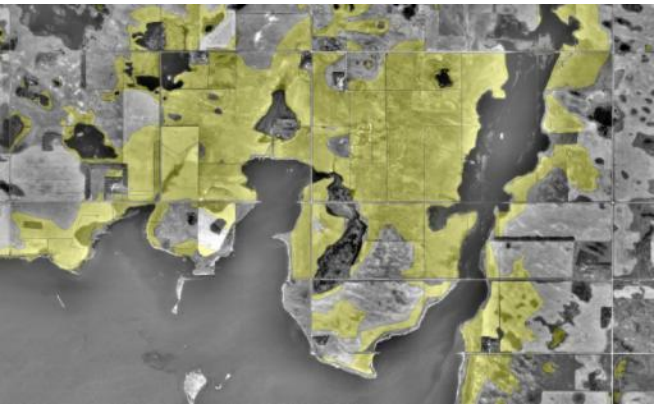


Close-up near Lake Alice of 1997 (left) imagery with current cropland CLU that is under water in 2006 (right)



Additional Analysis – Level 2 – CLU - Results

- Results – The same analysis was done for 1997 to 2009…
  - Within the AOI, there are **~35,000 acres** of CLU currently identified as "cropland", under water in 2009 that were not under water in 1997.



Close-up near Pelican Lake of 1997 (left) imagery with current cropland CLU that is under water in 2009 (right)

Recommendations

Recommendations

- Scan and Georeference 1980's CIR NHAP and compare to 2009 and 2010 NAIP CIR. A very high level of change detection accuracy could be obtained (manual or index)
- Additional Analysis
  - Level 1 – Mentioned in a previous slide; not completed here
  - Level 3 – Predictive analysis of where the lake is expanding
    - Some of this work has been completed by the FSA ND State GIS Specialist
- All analysis represented within this document should be verified independently (as needed)

Resources

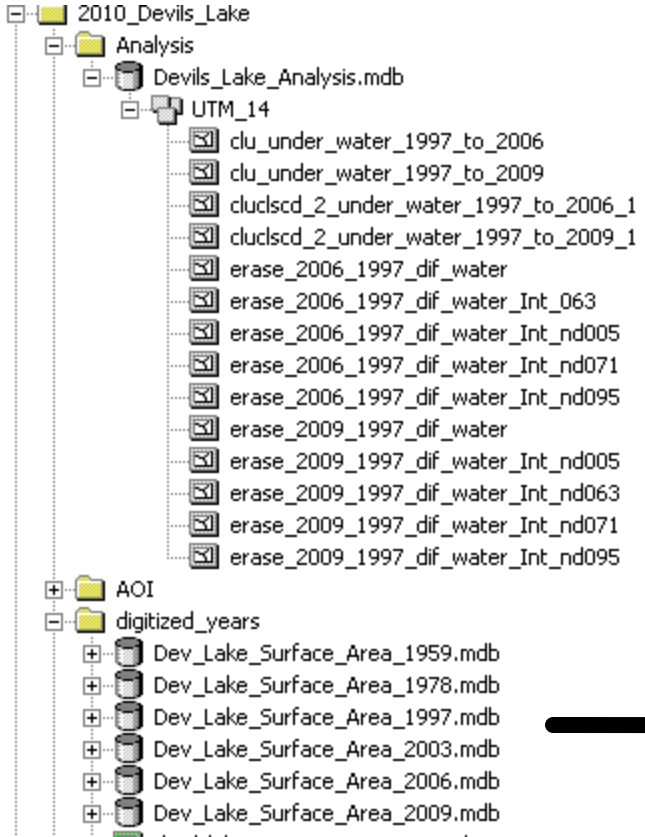
Resources

- http://nd.water.usgs.gov/devilslake/index.html - USGS
- http://www.swc.state.nd.us/4DLink9/4dcgi/GetContentPDF/PB-206/DL_Quick_Facts.pdf - ND State Water Commission
- http://www.swc.state.nd.us/4dlink9/4dcgi/GetSubContentPDF/PB-1945/JerusalemTolnaOutlets.pdf - ND Geological Survey
- USDA-FSA NAIP
- APFO Image Services
- USDA-FSA-APFO Historical Aerial Imagery Archive
- ESRI NGS Topo World 2d Services
- Dan Janes – FSA ND State GIS Specialist

Deliverable Data

Deliverable Data

- The following datasets will go to Dan Janes, FSA ND State GIS Specialist, for further use



Analysis of various digitized surface datasets utilizing 'erase', 'intersect', and 'merge' tools in ArcGIS

Digitized lake surface datasets as represented on various years of imagery

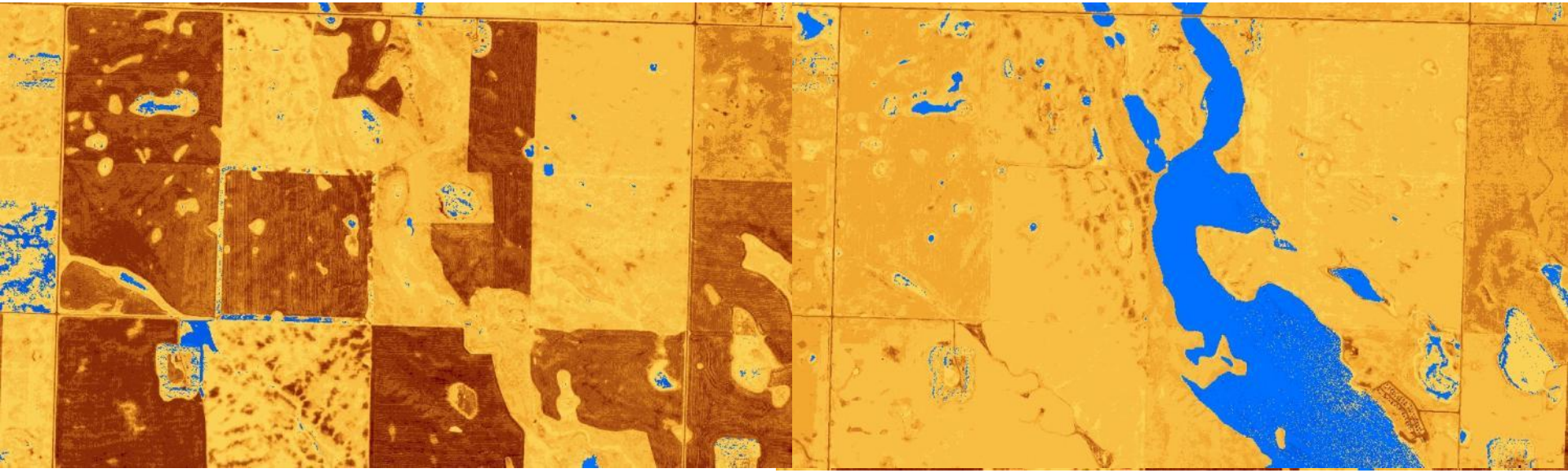
End July Briefing

Continued Work

- Since then, FSA ND has asked for the early 1980's NHAP data for the area to be scanned and georeferenced. We will also build a mosaic for Nelson County

1981 NHAP vs. 2010 NAIP

Water Analysis – 1981 vs. 2010



So What's the Point

- Historical imagery has tremendous value to the geospatial community, and FSA is beginning to see these benefits. We *should* archive all imagery indefinitely, however there is a cost
- APFO has been doing this kind of work for FSA , other agencies and educational institutions, although our capacity to do so is fairly low right now
- We have the historical data. Let us know what you need. We do it for the cost of labor and reproduction, and then *intend* on long term archiving the data (georef, ortho, scans) in the future

Costs

- It takes resources to archive geospatial data, whether it is film or digital, historical or new acquisitions. It takes more resources to archive digital, but as was shown with this briefing, having the ability to reach back for this information when you need it can make a huge difference.

Questions?