

Mapping Wetland Probabilities For Tribal Communities: Tools, Models, and Applications



Who Are We?

Three Affiliated Tribes:

- Mandan, Hidatsa and Arikara
- Independent with distinct histories unified by life along the Missouri River
- A farming tradition along the Missouri floodplains and hunters accessing the bison herds of the plains
- Also a significant trading center with goods from as far as South America



Who Are We...

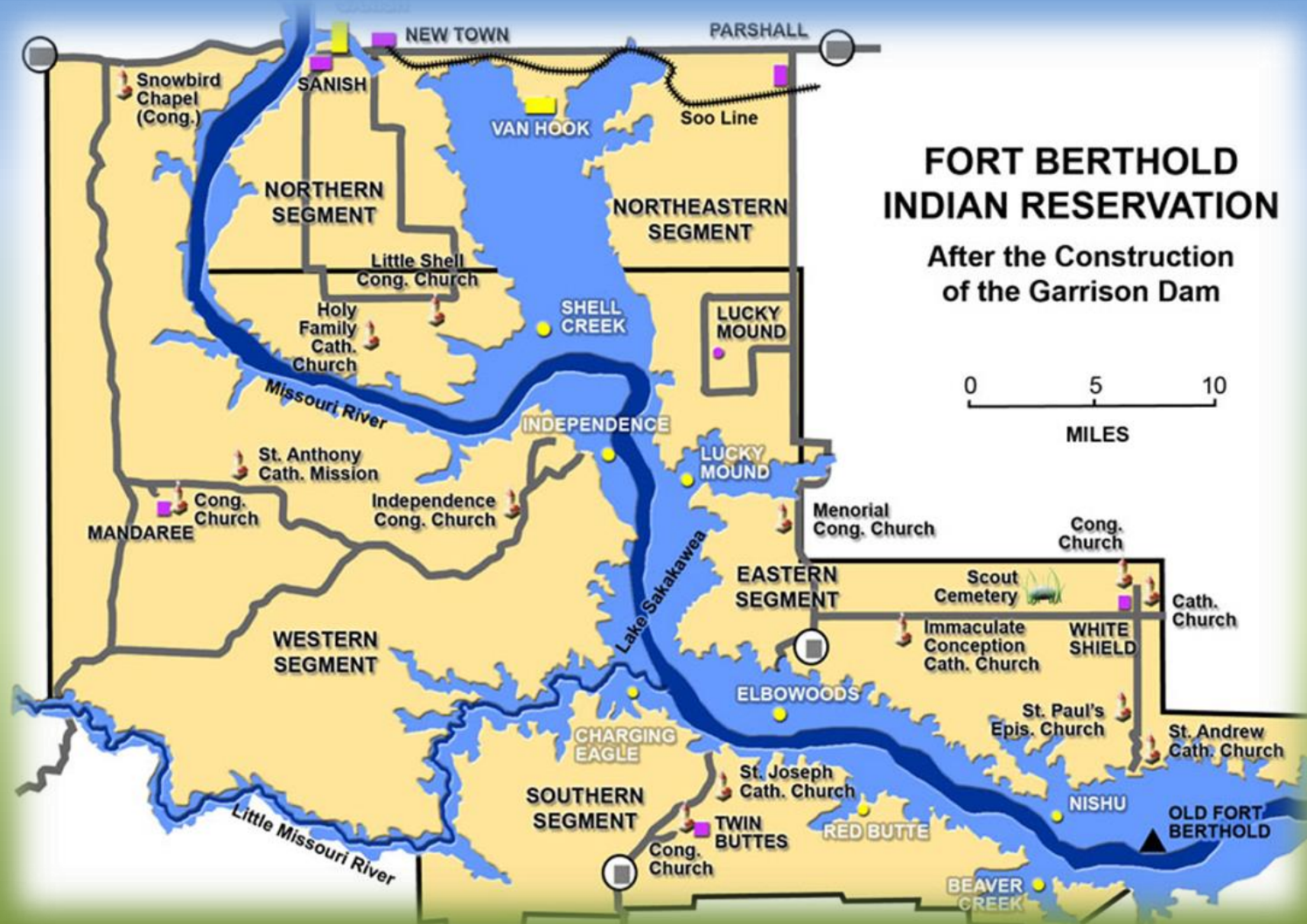
“Dating back to the tribe’s earliest years, environmental stewardship included wide-ranging efforts to protect, preserve, and conserve groundwater and surface water resources.”

“A culture that is intertwined with its natural surroundings”

“Our lives are aligned with the changing seasons”



Historical & Cultural Context





Historical & Cultural Context



**Saint Mary's
University**
GEOSPATIAL SERVICES



NATIONAL ASSOCIATION
OF WETLAND MANAGERS

Bakken Oil Boom

- Oil boom began in late 2000's with advent of hydraulic fracturing and horizontal drilling
- Large influx of people, resources & money to Reservation
 - Improved/expanded infrastructure
 - Improved tribal government & public facilities, schools
- At peak of boom (2012), approx. 400 wells within Reservation boundaries
 - Millions of barrels/month
 - Unprecedented construction activities
 - Increased traffic → more accidents
 - Pipelines → leaks
- Spills/leaks of produced water, oil
 - Thousands – millions of barrels of produced water, oil released to environment in some incidents



Bakken Oil Boom





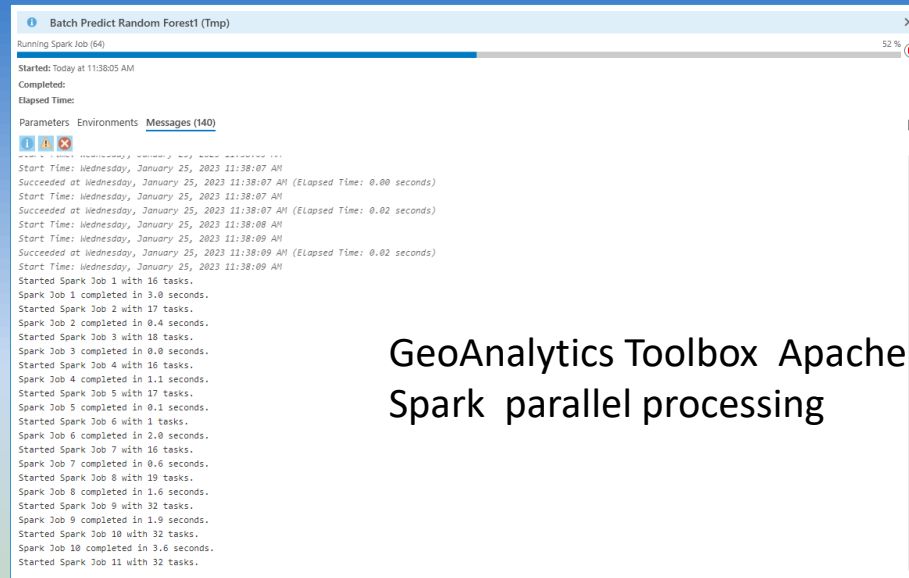
Basic Wetland Management Questions:

- Where are the current wetlands
- Where were wetlands historically
- How are they connected to surface hydrography
- How are they functioning ecologically
- How might they be impacted
- Where should management effort and funds be focused

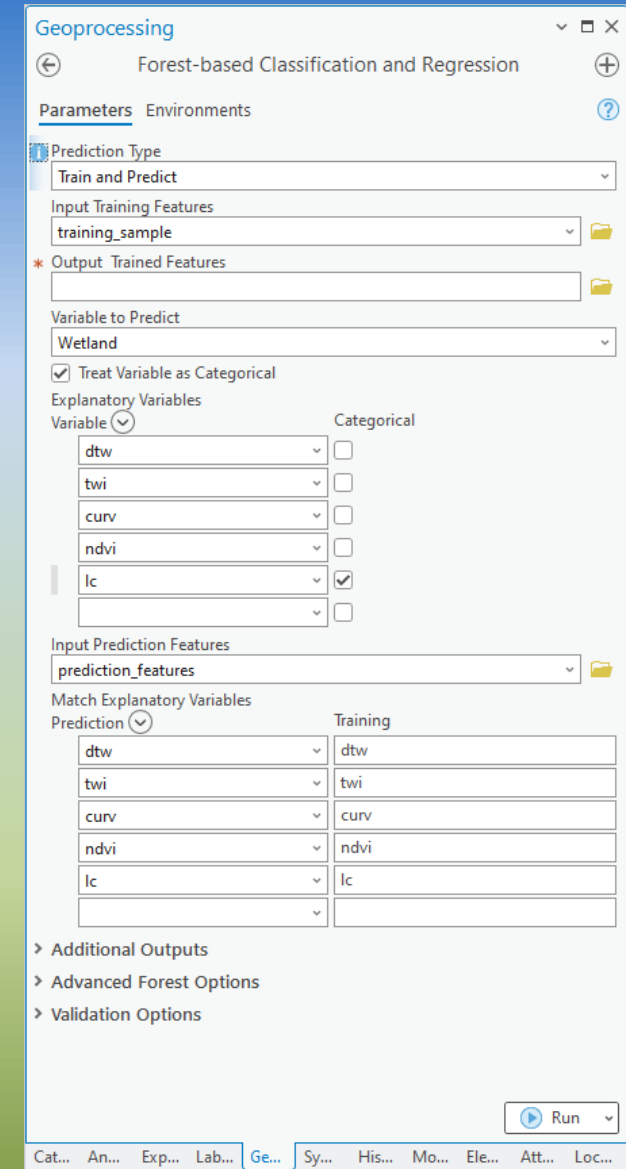
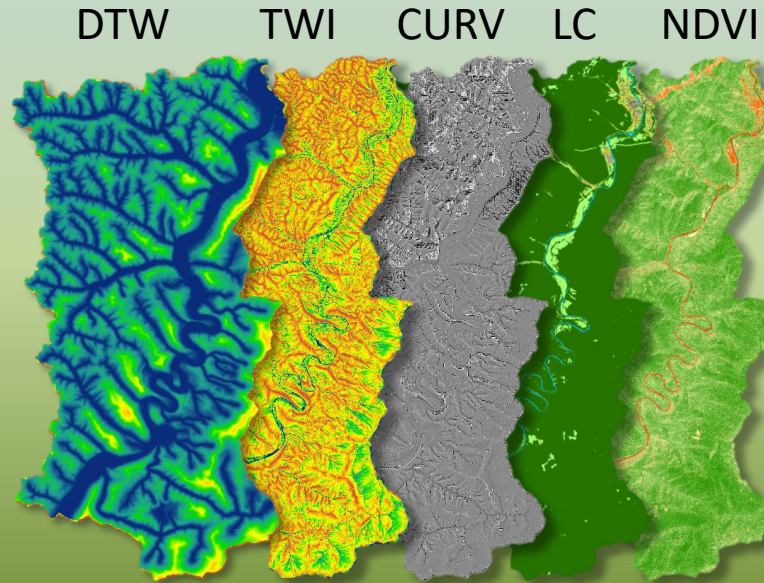


Potential Wetland Landscape Modeling

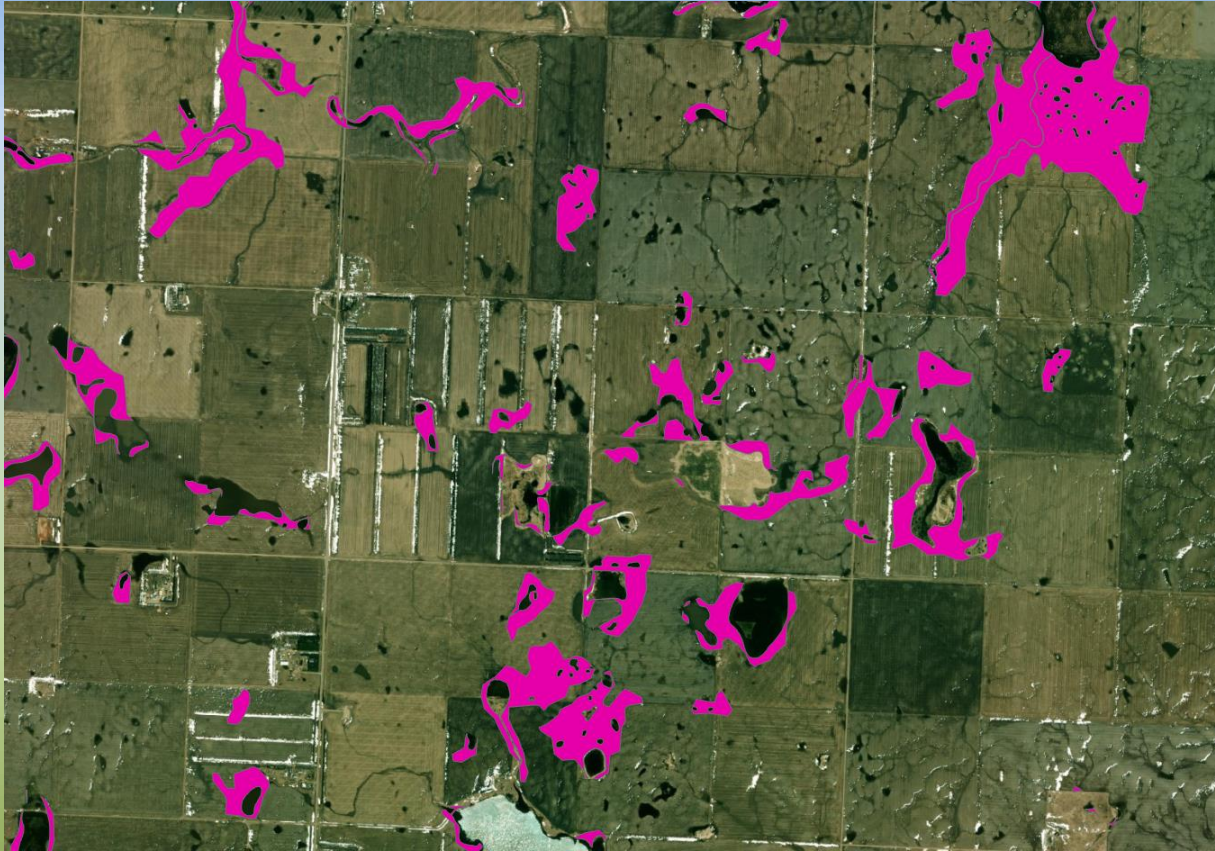
- Machine learning Random Trees algorithm using lidar derived predictor variables, NDVI and high resolution landcover.
- Based on Wetland Identification Model (WIM) processing methods in Arc Hydro – Gina O’Neil
- Modified WIM process to iteratively process multiple HUC12s for larger geographic areas and to overcome processing limitations.
- Processed large areas of VT (120 huc12s) and WV (360 huc 12s).
- Less accurate in agricultural and developed areas where hydrography has been modified.



GeoAnalytics Toolbox Apache Spark parallel processing



Potentially Restorable Wetlands

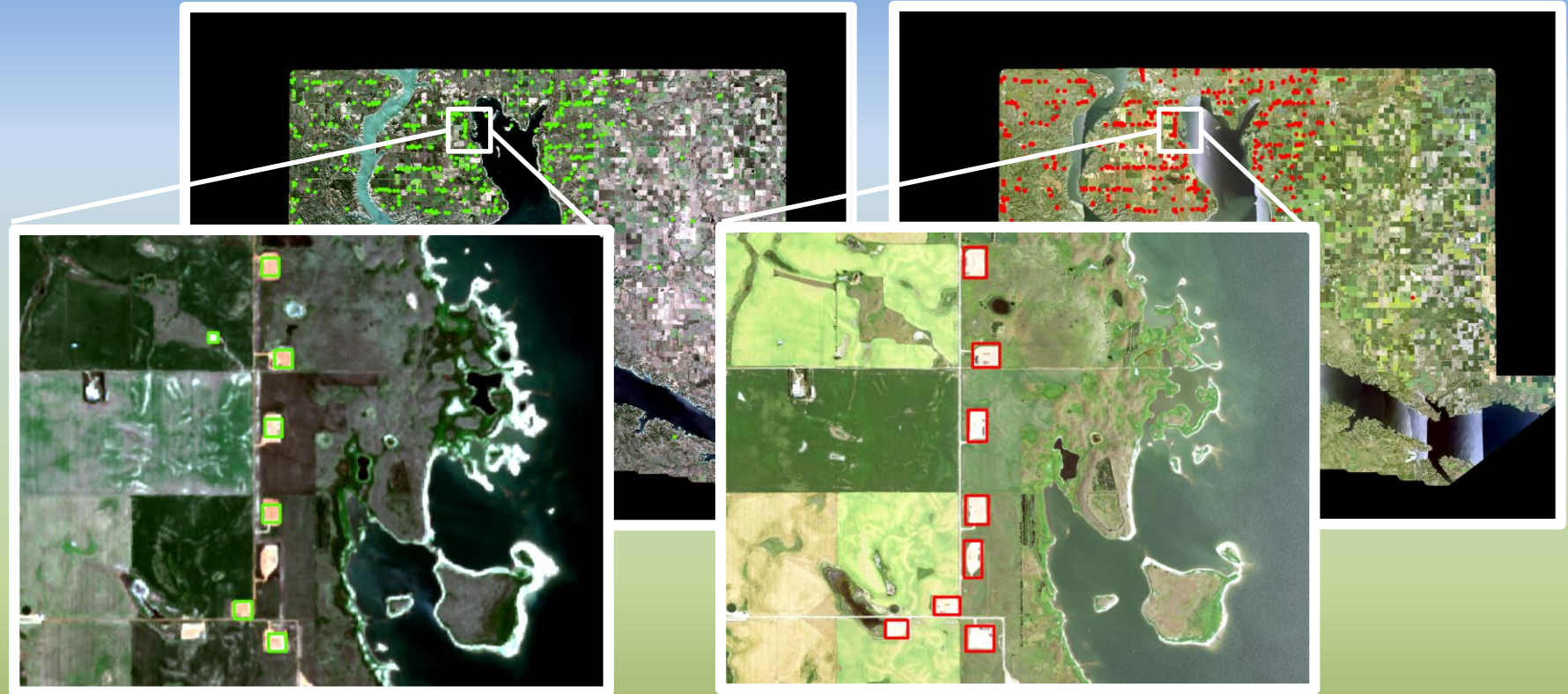


- Narrowed the wetland data layer to identify areas of focus for restoration
- Based on landscape level indicators derived from
 - DEM
 - SSURGO
- Excluding existing NWI polygons

Deep Learning, Oil Well Pad Object Detection

Sentinel Object Detection Model

NAIP Object Detection Model

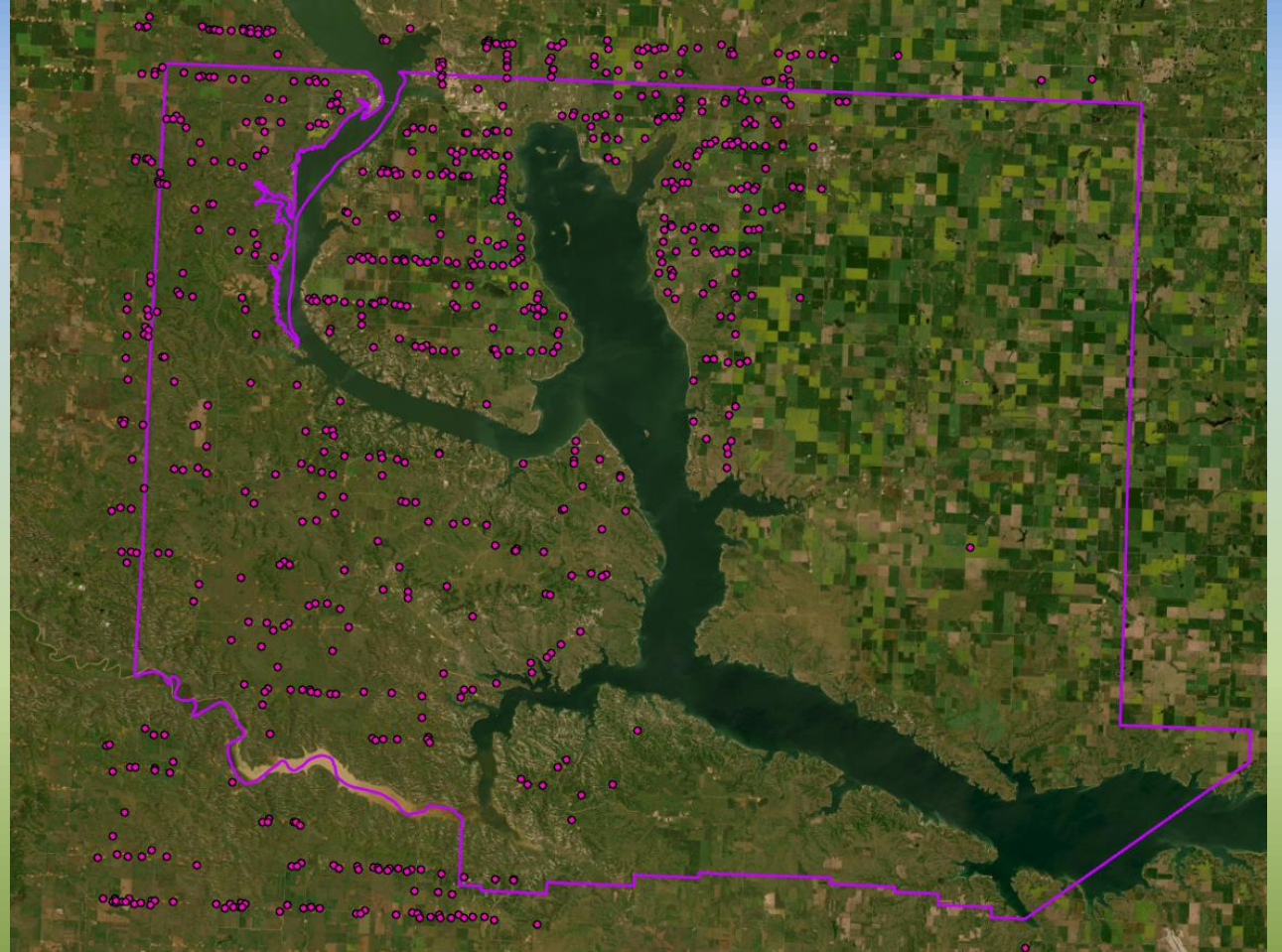


- Utilized pretrained oil well pad detection model for Sentinel data.
- Also created deep learning object detection model for NAIP imagery.
- Both models had issues with false positives and negatives but overall produce good results
- Combined model results for analysis

Oil/Gas Well Pad Identification

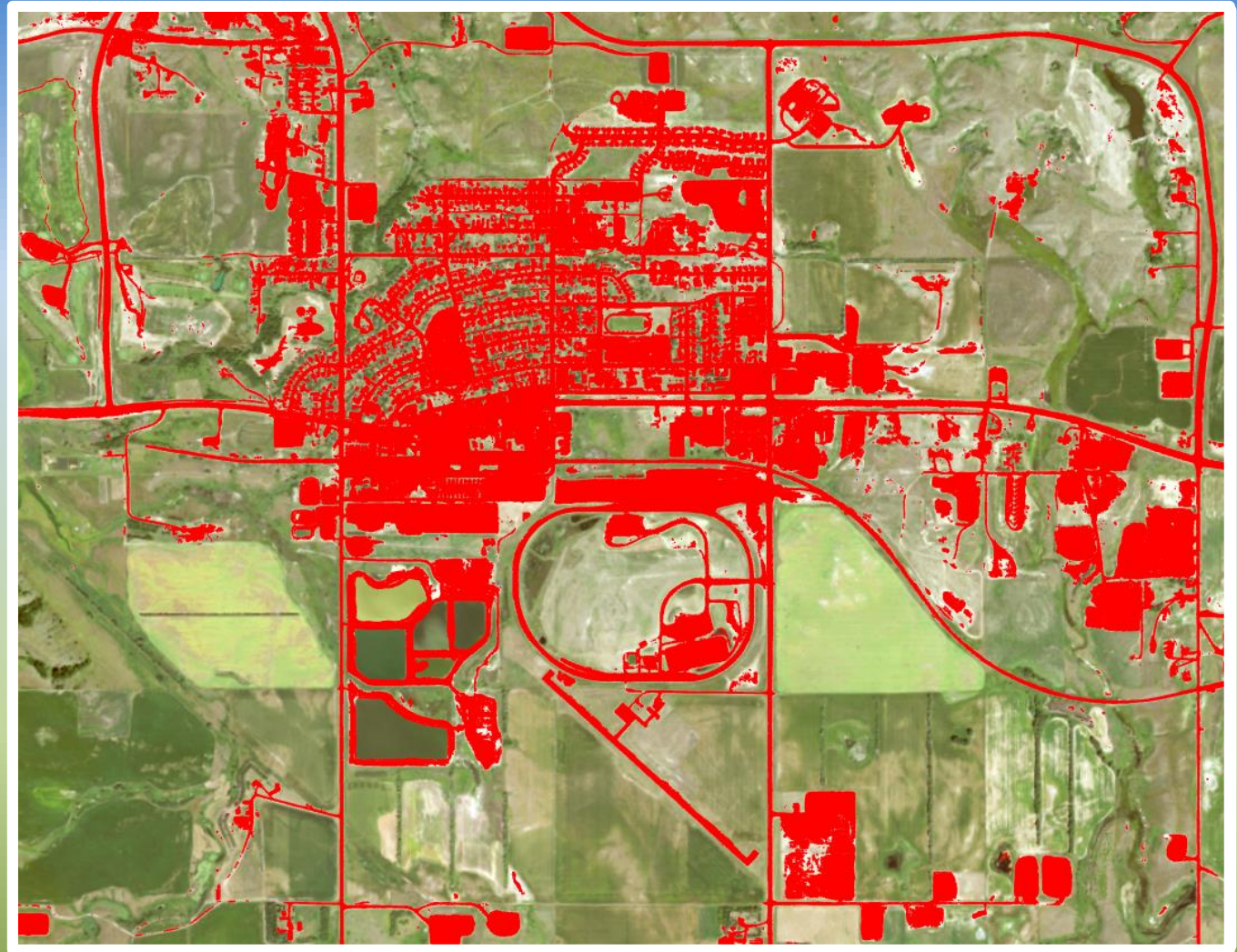
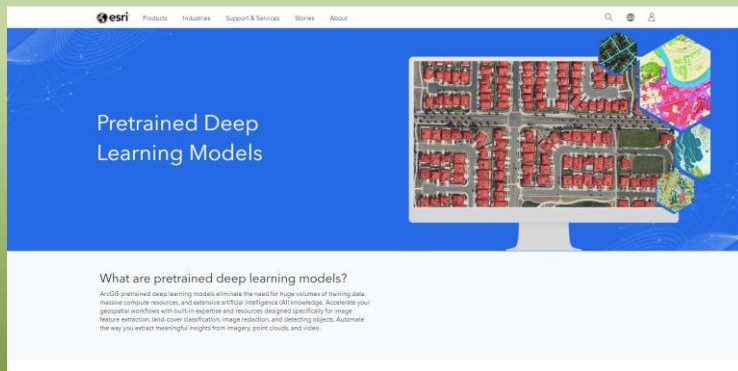
- 725 well pads were identified
- Concentrated on the west side

How do we analyze these well pads for their proximity to wetlands?



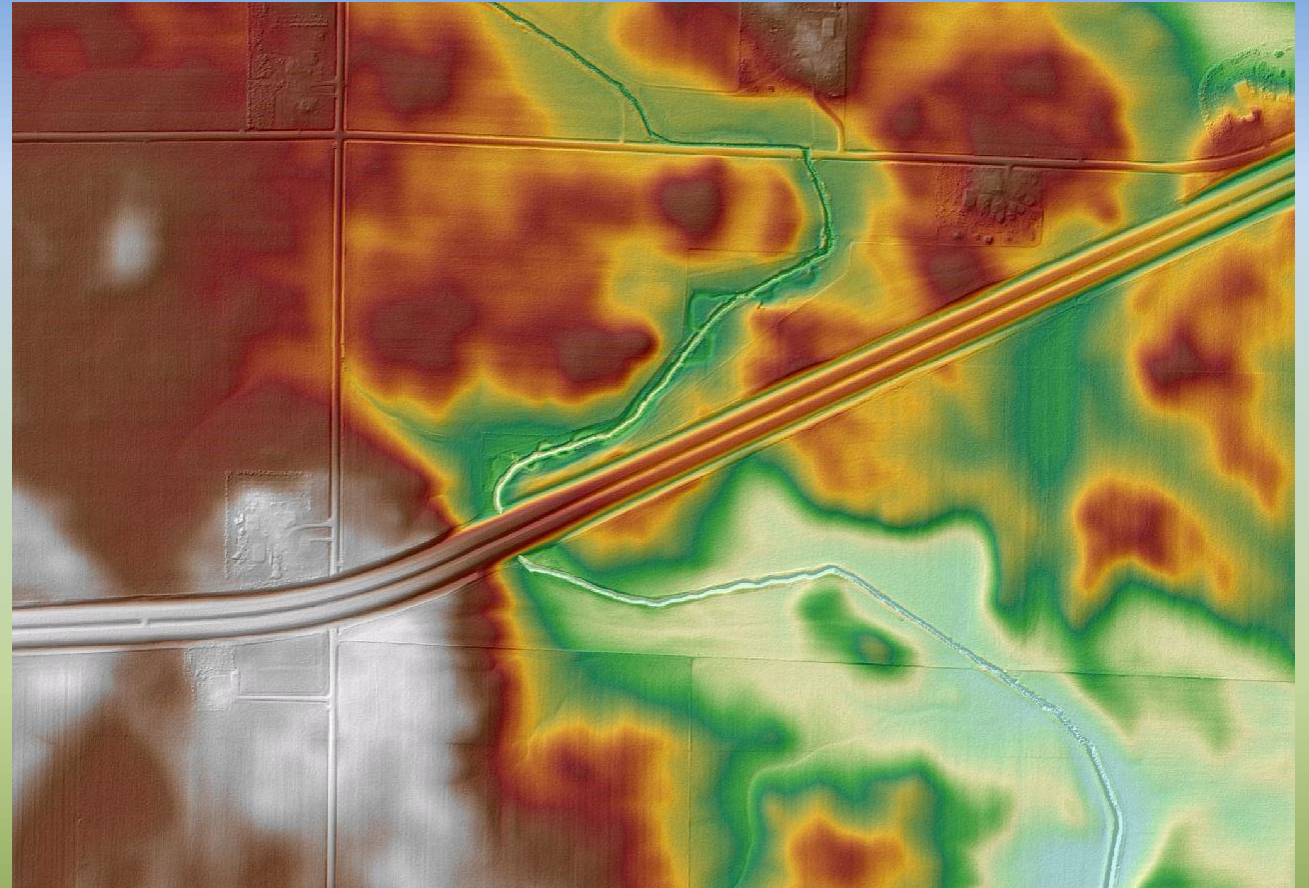
Deep Learning, Impervious Surface Extraction

- Pretrained ESRI deep learning model for pixel classification of high resolution imagery.
- Source imagery NAIP resampled to 1m
- Found that this model performs best in Eastern Temperate Forest biome but less accurate as you move into Great Plains biome

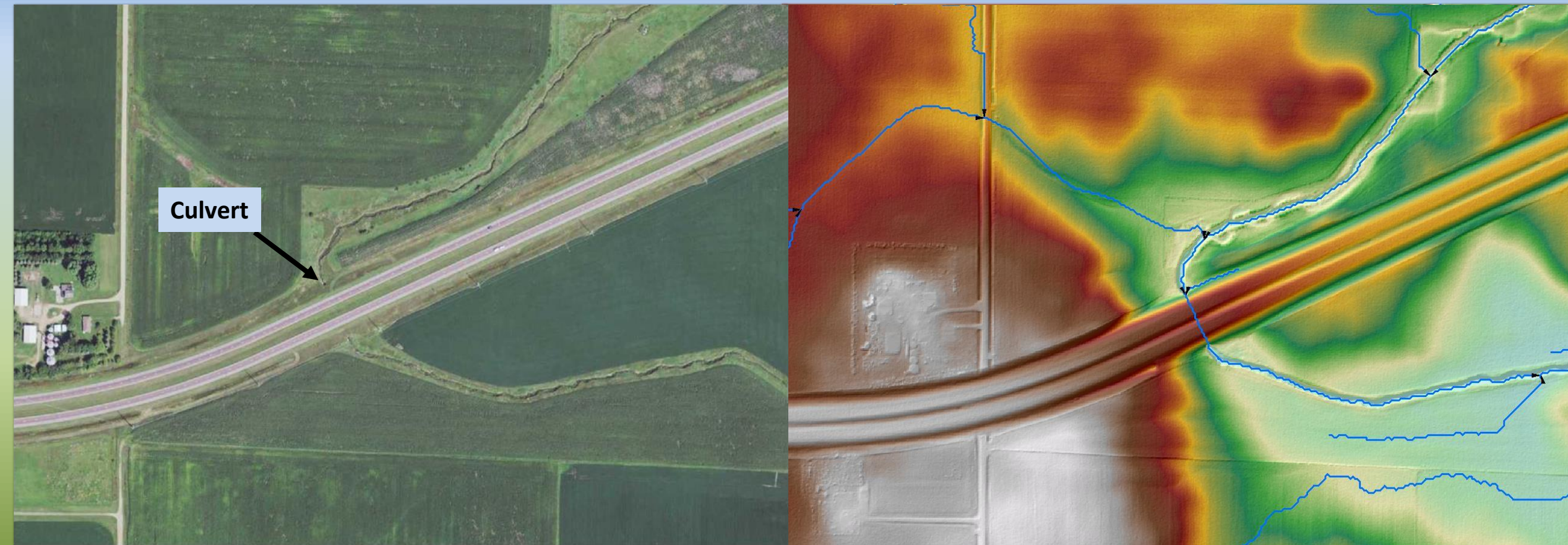


Hydro-Modification of DEM

- Goal is to create a contiguous surface that accurately models flow across the landscape.
 - Breach Digital Dams
 - Define accurate flow direction
 - Precision of flow lines



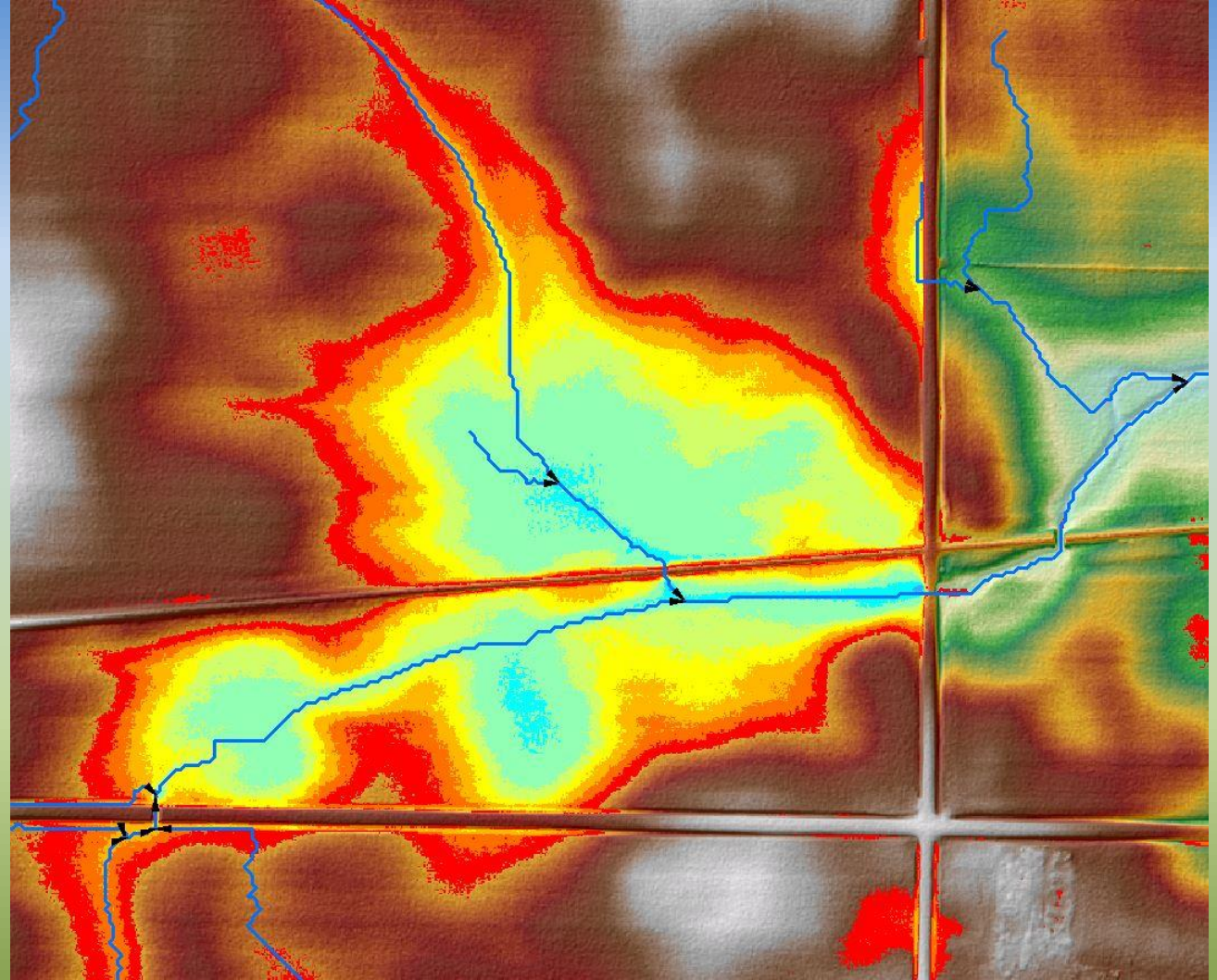
Digital Dams – Accurate Flow Direction



Accurate Flow Representation

- Enhance the precision of flow lines
- Accurate representation of surface flow
- Integrate with other spatially accurate data products

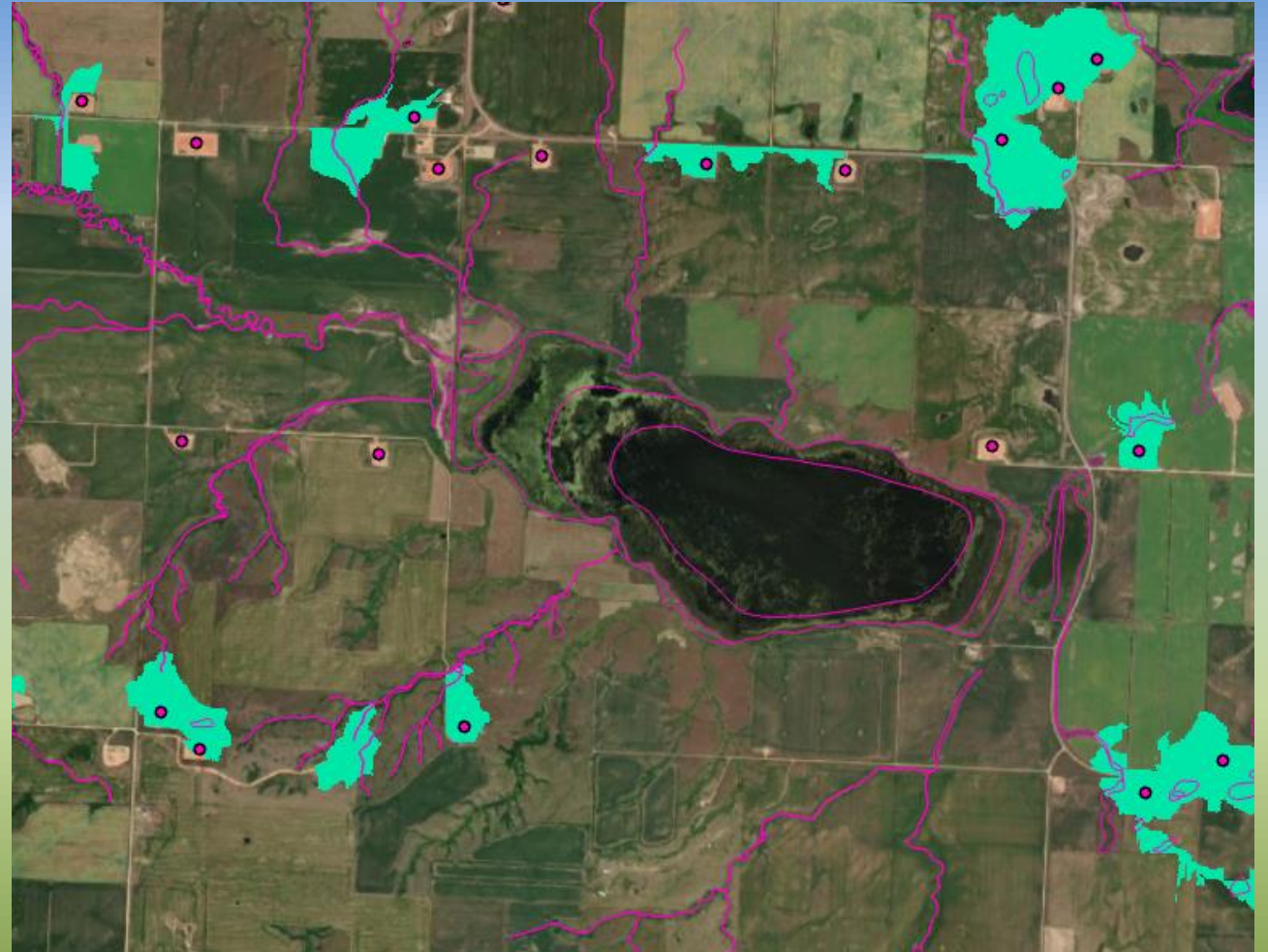
Why is this important for our assessments?



Oil/Gas Proximity Analysis

- 1- meter DEM, hydrologically modified
- Synthetic surface flow network
- Represents flow path and direction
- Pour points placed ~ 250 meters downstream and directly upstream of individual or groupings of well pads to identify potentially vulnerable catchments

What other landscape criteria are important to consider?



Wetlands Potentially Vulnerable to Oil/Gas

- Incorporated additional criteria variables in the vulnerability of wetlands to oil/gas
 - Proximity analysis – catchments
 - Proximity/Density analysis – kernel density
 - SSURGO – water table depth
 - SSURGO – drainage class
 - NLCD
- Used ESRI's Suitability Modeler within ArcGIS Pro to weigh criteria variables

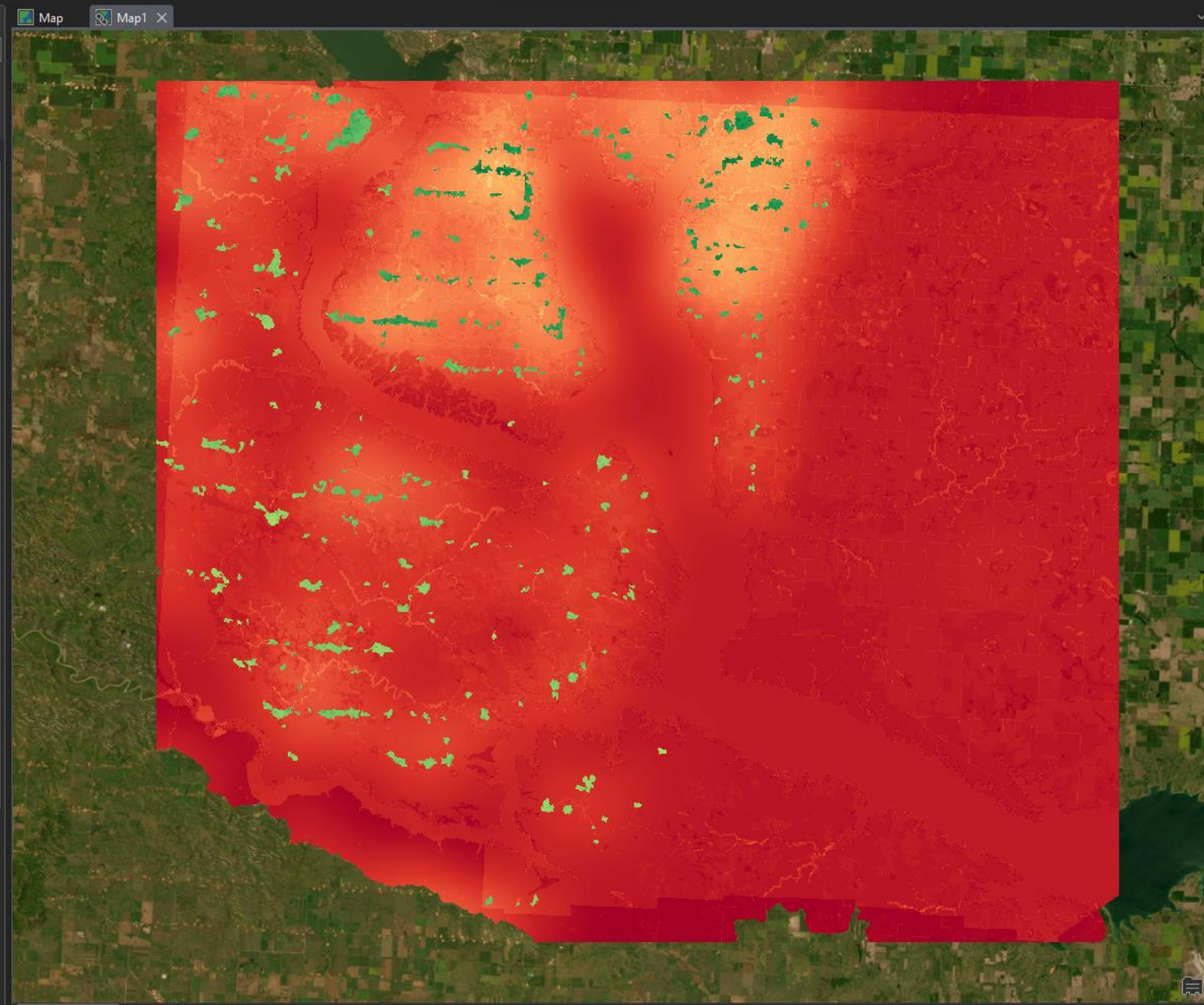


Contents

Search

Drawing Order

- Map1
- NWJ_LLWW_polygons
- OilGasAgain
 - OilGasVulnerability
 - Value
 - 8.09
 - 1
- Transformed DrainageClass_Resample_Reclas
 - 1
 - 2
 - 3
 - 4
 - 5
 - 6
 - 7
 - 8
 - 9
 - 10
- DrainageClass_Resample_Reclass
 - muaggatt_drclassdcd
 - Well drained
 - Moderately well drained
 - Very poorly drained
 - Somewhat poorly drained
 - Poorly drained
 - Excessively drained
 - Somewhat excessively drained
- Transformed Kernel
 - Value
 - 10
 - 1
- Kernel
- Transformed NLCD_Resample
- NLCD_Resample
- Transformed Vulnerable_Catchments
- Vulnerable_Catchments
- Transformed WaterTableDepth_Resample_Rec



Suitability Modeler

Settings Suitability Locate Sources

Parameters Environments

Criteria

Input Rasters	Weight	Percent
WaterTableDepth_Resample	10.00	10.00
Vulnerable_Catchments	50.00	50.00
NLCD_Resample	10.00	10.00
Kernel	20.00	20.00
Percent total		100

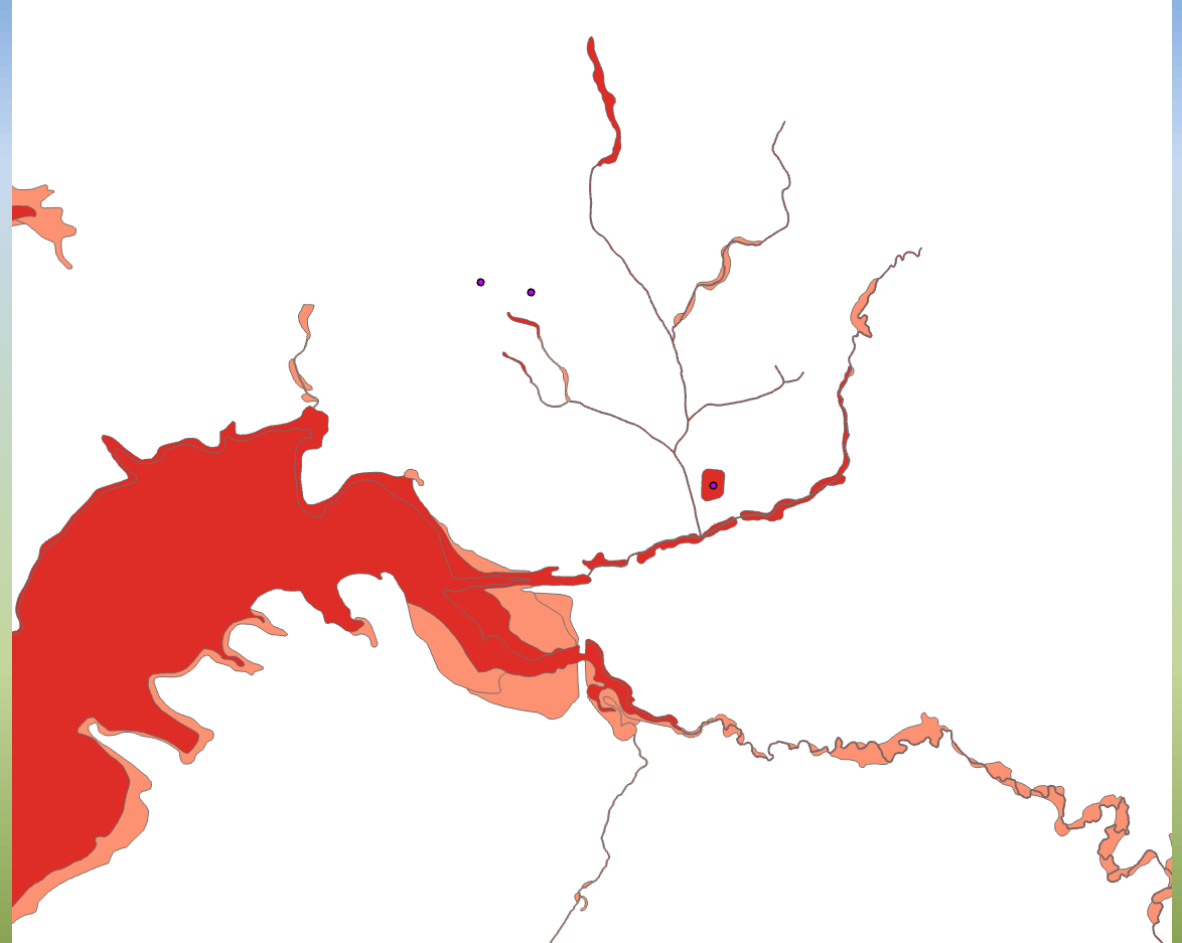
Explore model through queries

Output type: Raster dataset

Run

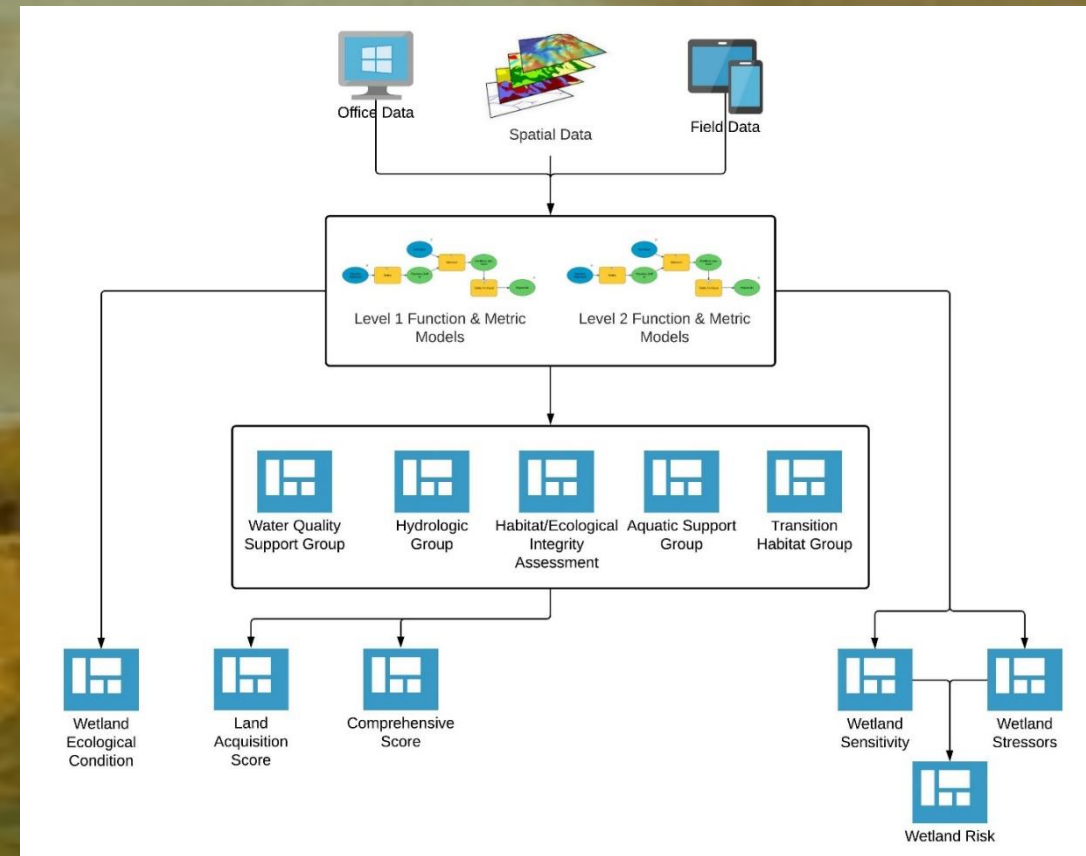
Wetlands Potentially Vulnerable to Oil/Gas

- Created output showing wetlands of low, medium and high vulnerability to oil/gas impacts
- Three Affiliated Tribes may use this data to help prioritize protection/restoration efforts



Wetland Rapid Assessment Method

- Quantitative Scoring of Wetland Resources
- Field and Office Based Metrics Assessed
- Survey 1-2-3 Field Application integrated with ArcPro
- 14 Different Wetland Functions Assessed
- Incorporates Cultural Significance and History
- Includes Curriculum for Engaging Tribal College and Youth



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