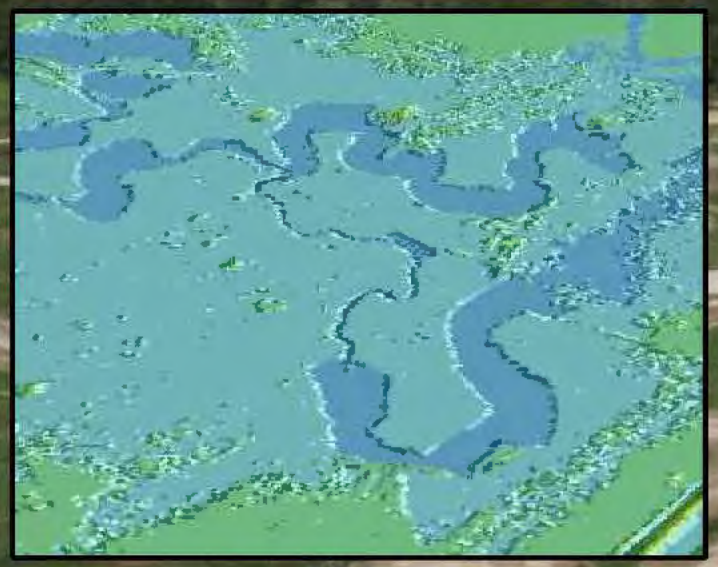
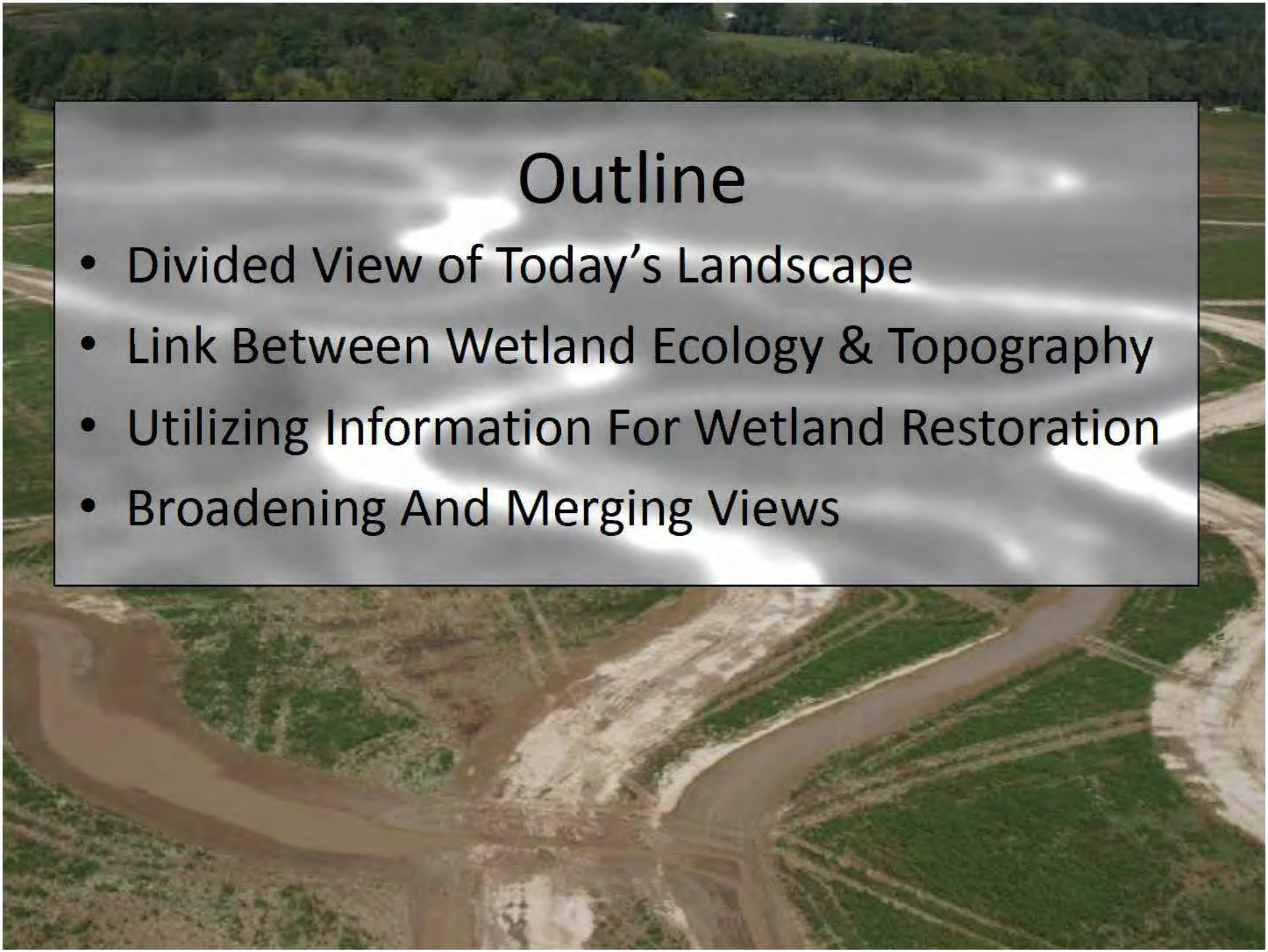


Using Lidar to Understand the Landscape: Mingo Basin Example

Frank Nelson, Wetland Ecologist, Big Rivers/Wetland Field Station

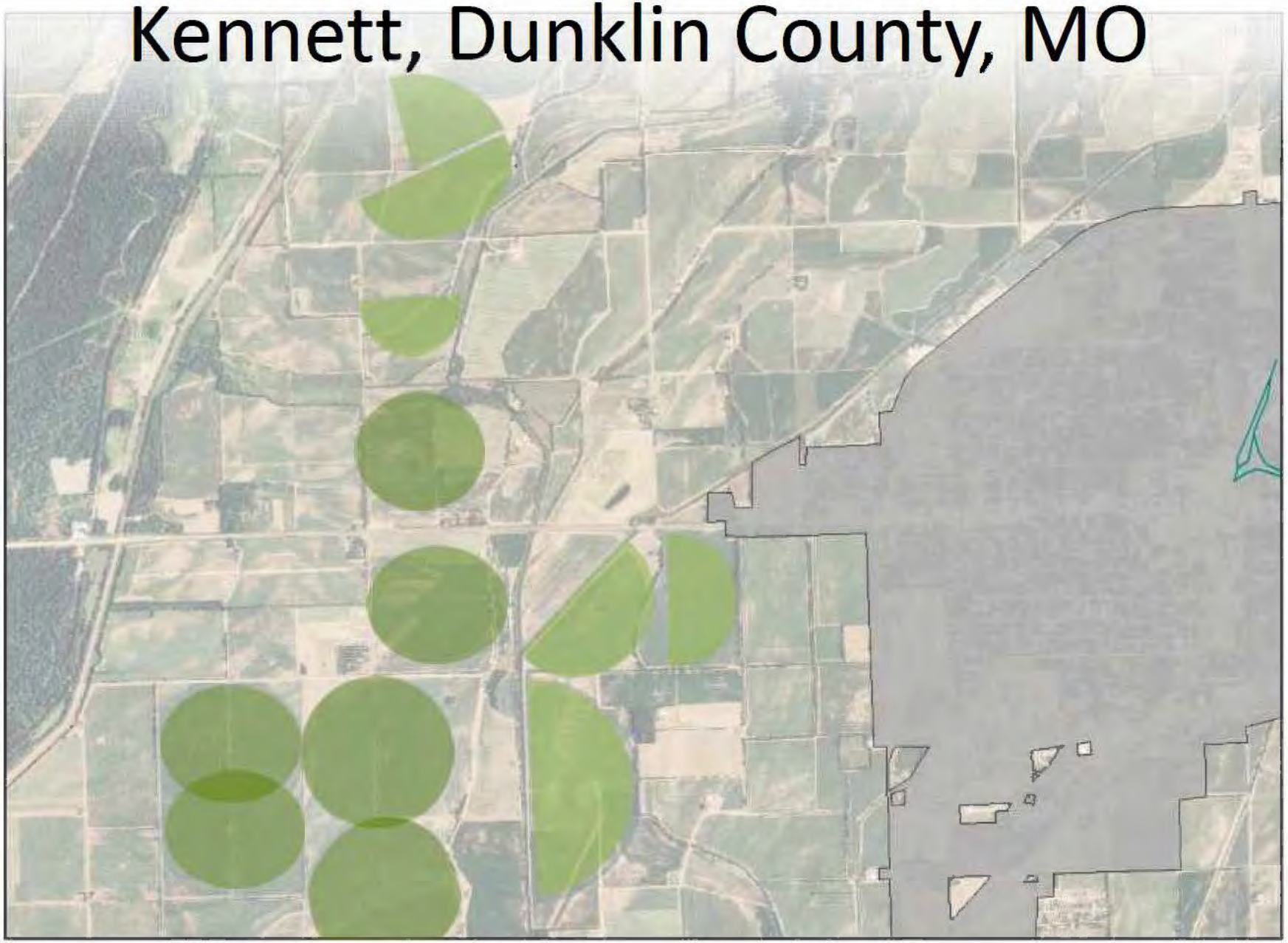


Outline

- Divided View of Today's Landscape
- Link Between Wetland Ecology & Topography
- Utilizing Information For Wetland Restoration
- Broadening And Merging Views

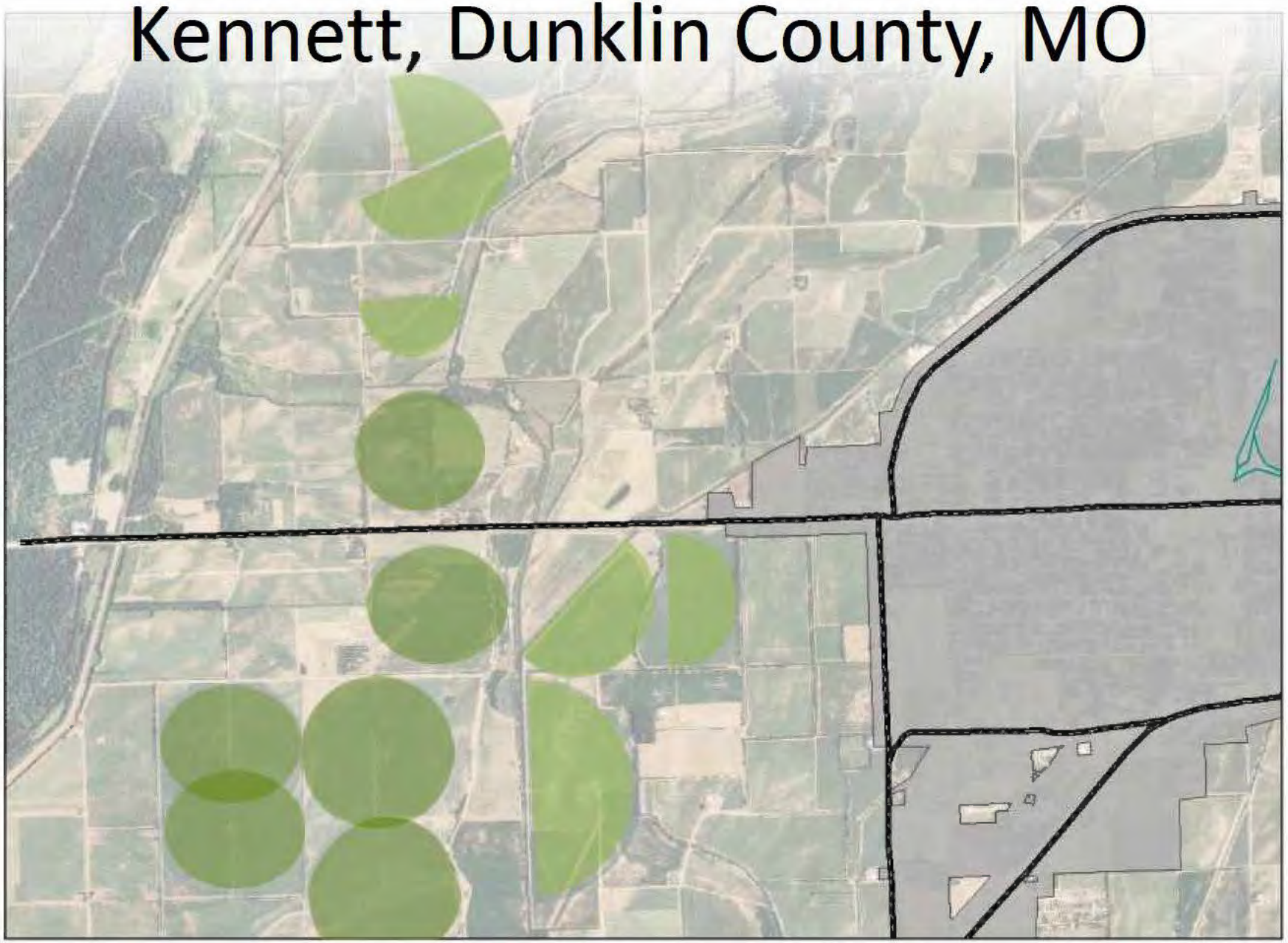
Kennett, Dunklin County, MO

Kennett, Dunklin County, MO



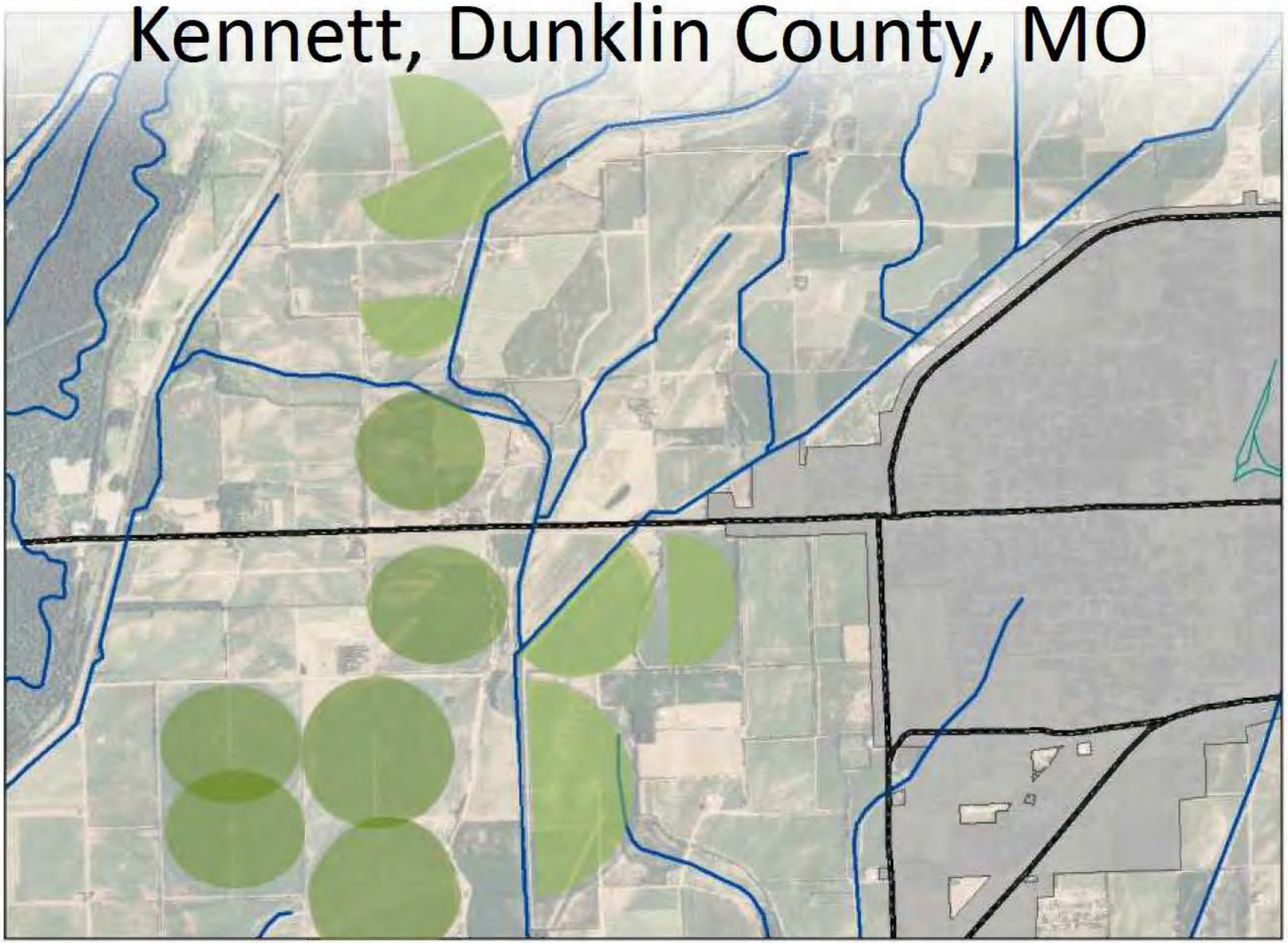
Kennett is in the heart of agriculture, utilizing center pivot system

Kennett, Dunklin County, MO



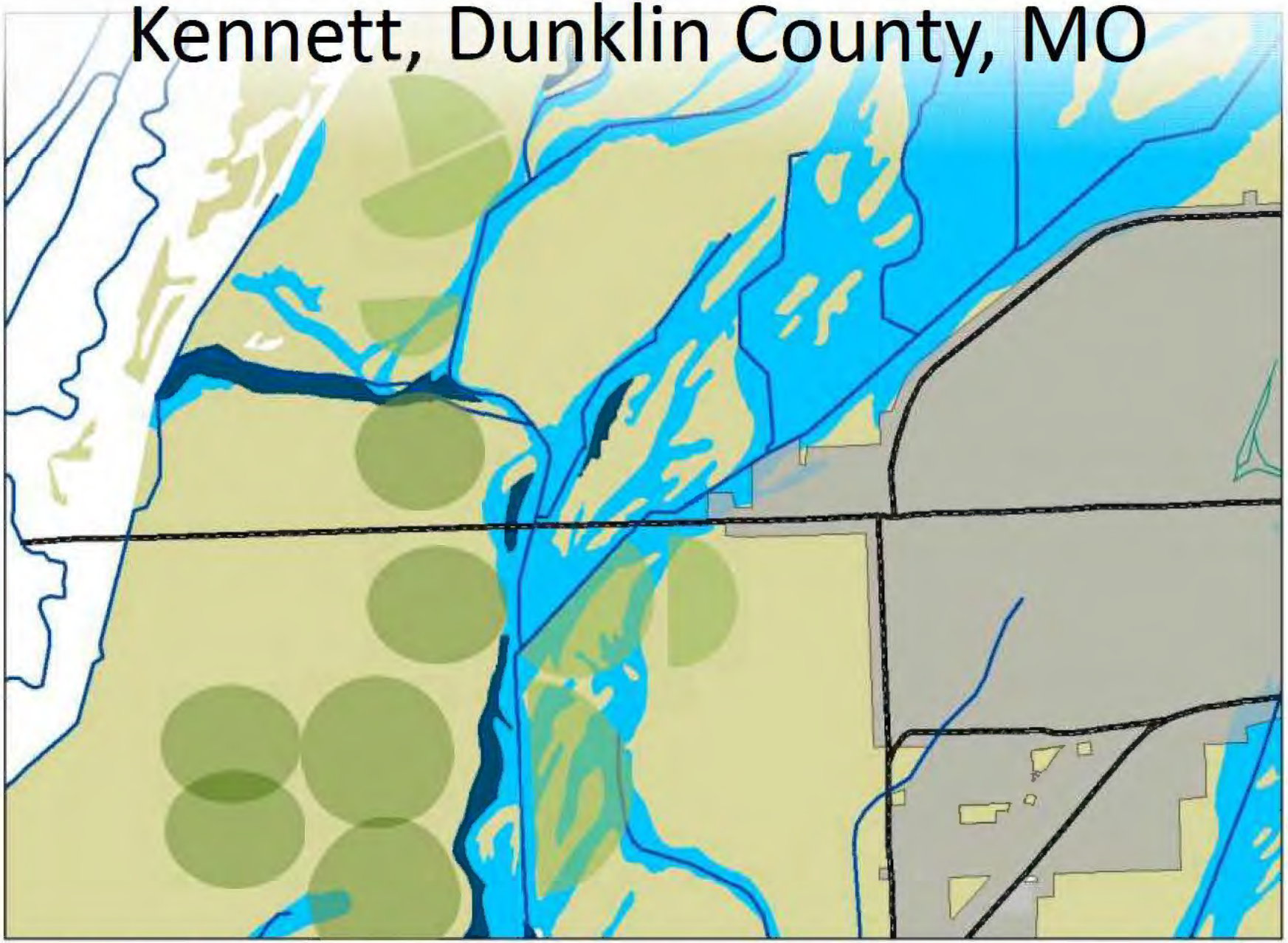
Major highways going to and through the community

Kennett, Dunklin County, MO



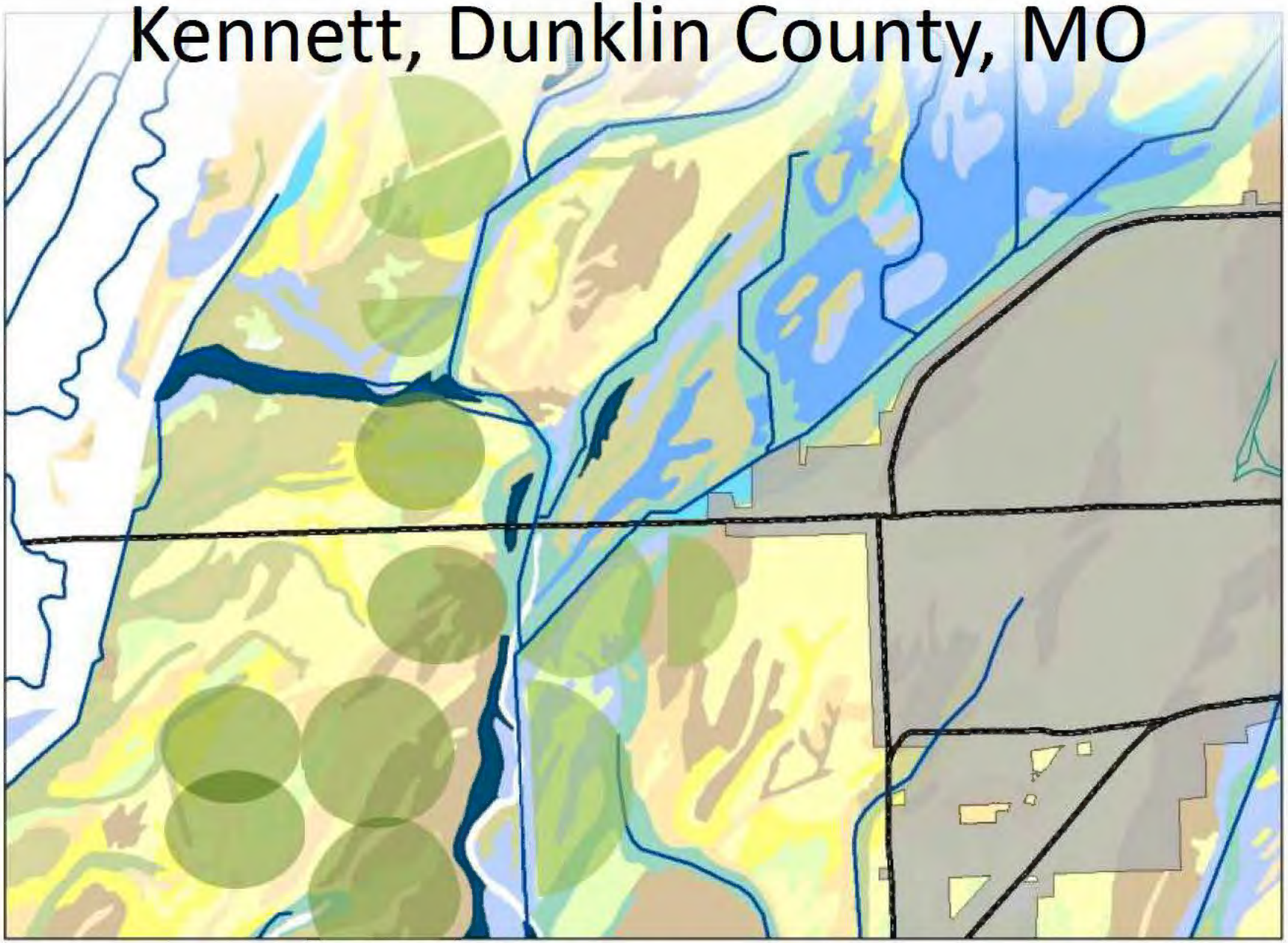
Major waterways bisecting the agriculture

Kennett, Dunklin County, MO



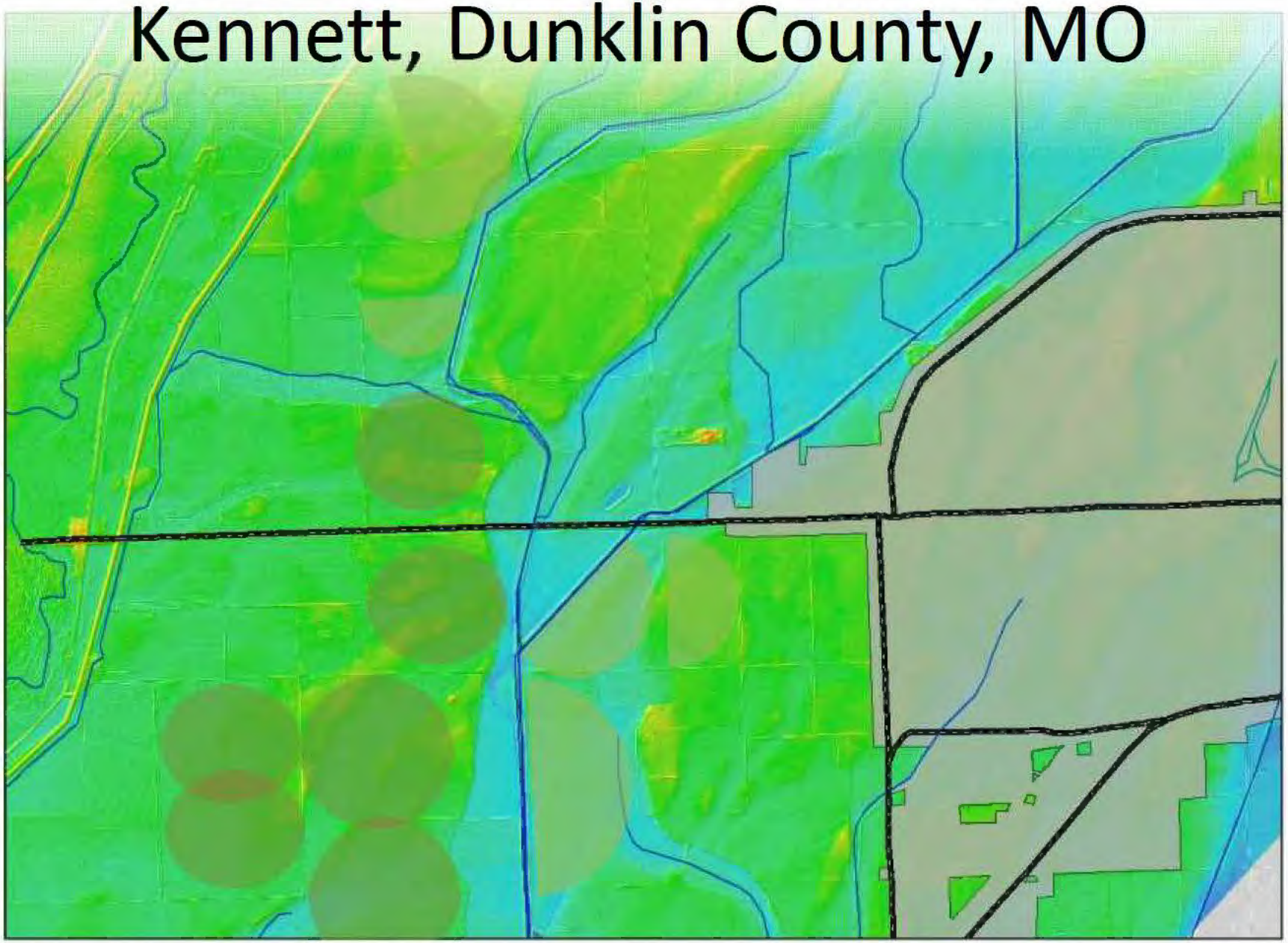
Major Landforms: Low Terrace, Terrace channel, Backswamp

Kennett, Dunklin County, MO



Variable soils distributed throughout these landforms

Kennett, Dunklin County, MO



Lidar can give you a better appreciate of these landscape patterns

Kennett, Dunklin County, MO

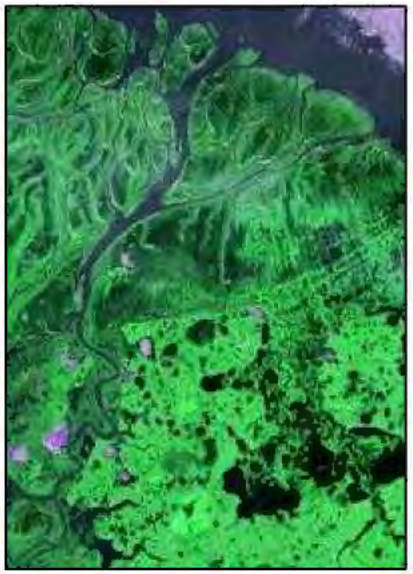
Separation of Natural & Engineered Features

Altered Landscape:

We tend to compartmentalize

- Natural Features
- Engineered Features

Differences in scale

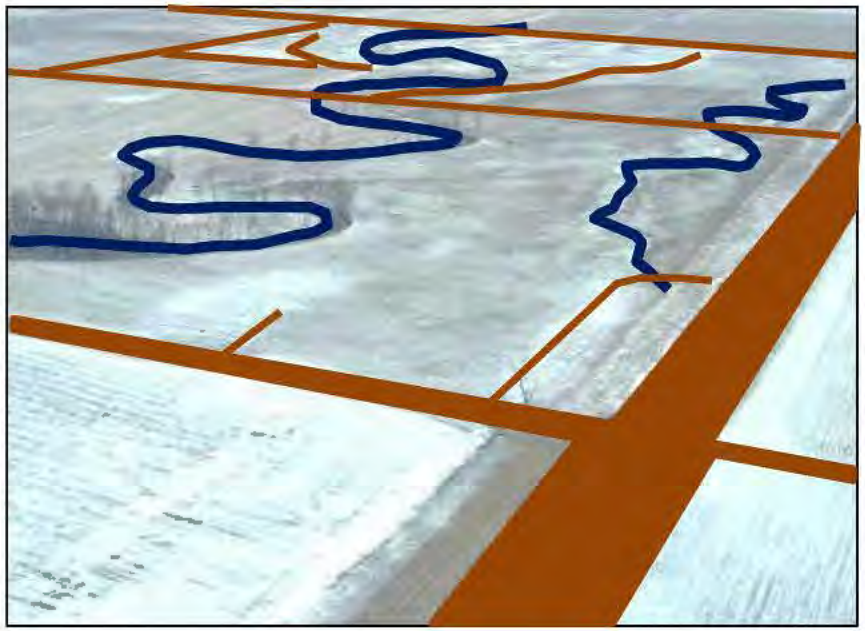


ALTERED LANDSCAPE	Engineered Features (roads and ditches)	Natural Features (ridges and sloughs)
Forming	Dirt Pans, Dozers	Water
Scale	Feet, Miles, Acres	Regions, Land- types
Boundary	Fixed (property lines)	Gradient
Parameters	Standard Spec.	Variable
Shape	Linear	Non-linear
Profile	Regular	Undulating (pool/riffle)
Width	1-60 ft	40-246 ft
Depth	1-20 ft	4 in- 3 ft
Temporal	Static	Evolving

Altered Landscape:

Natural features

- Diminished function
- Engineering attempts to overpower rather than interact landscape



ALTERED LANDSCAPE	Engineered Features (roads and ditches)	Natural Features (ridges and sloughs)
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Width	1-60 ft	40-246 ft
Depth	1-20 ft	4 in- 3 ft
Temporal	Static	Evolving

Utilized Landscape:

Reality is a merged footprint

Treat them as such

More likely to succeed

Kallang River at Bishan-Ang Mo Kio Park

Morphological Features/Soils

+

Hydrology

+

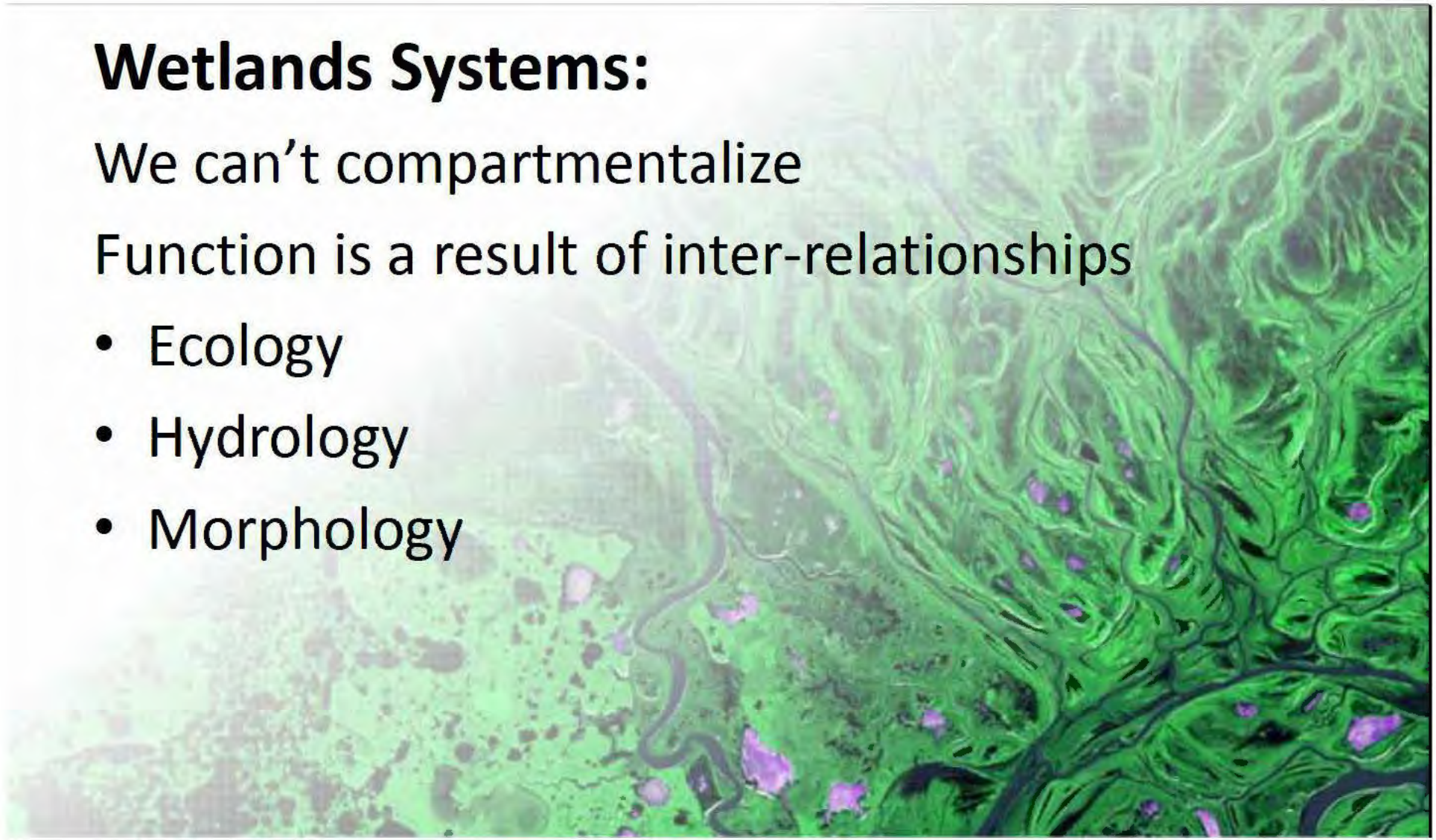
Ecology

+

Engineering

Higher Chance of Ecological Function

Ecological Understanding



Wetlands Systems:

We can't compartmentalize

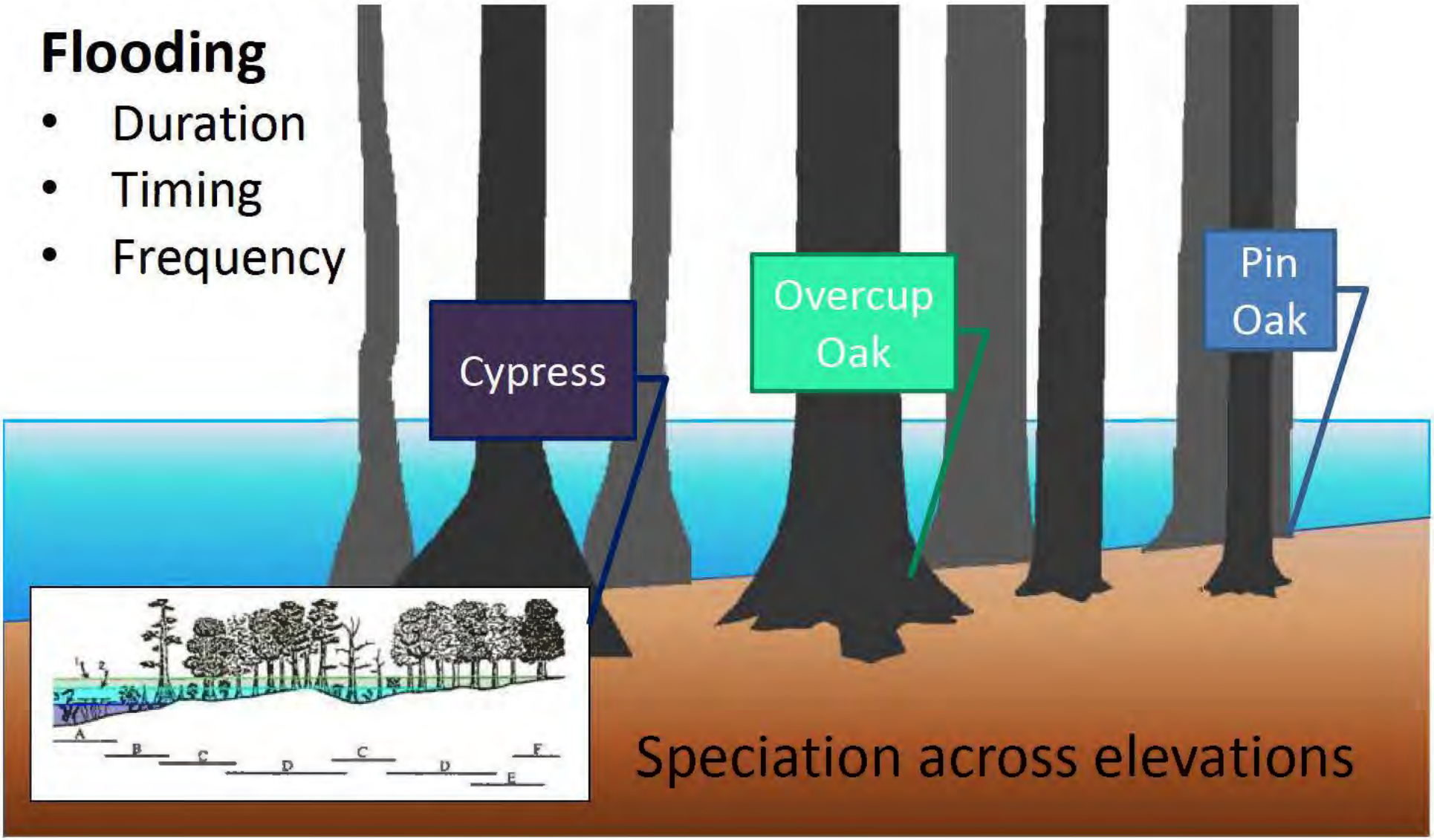
Function is a result of inter-relationships

- Ecology
- Hydrology
- Morphology

Bottomland Hardwood Communities

Flooding

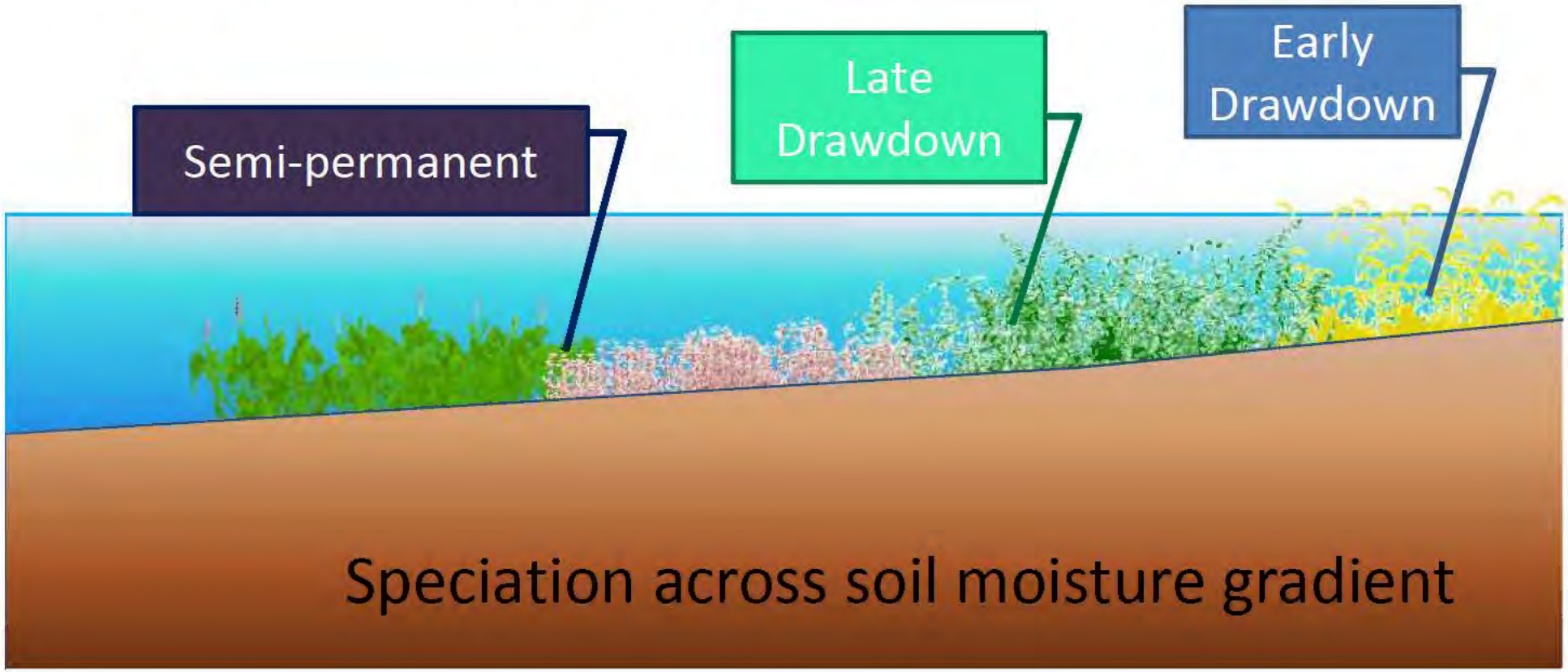
- Duration
- Timing
- Frequency



Herbaceous Wetland Communities

Flooding

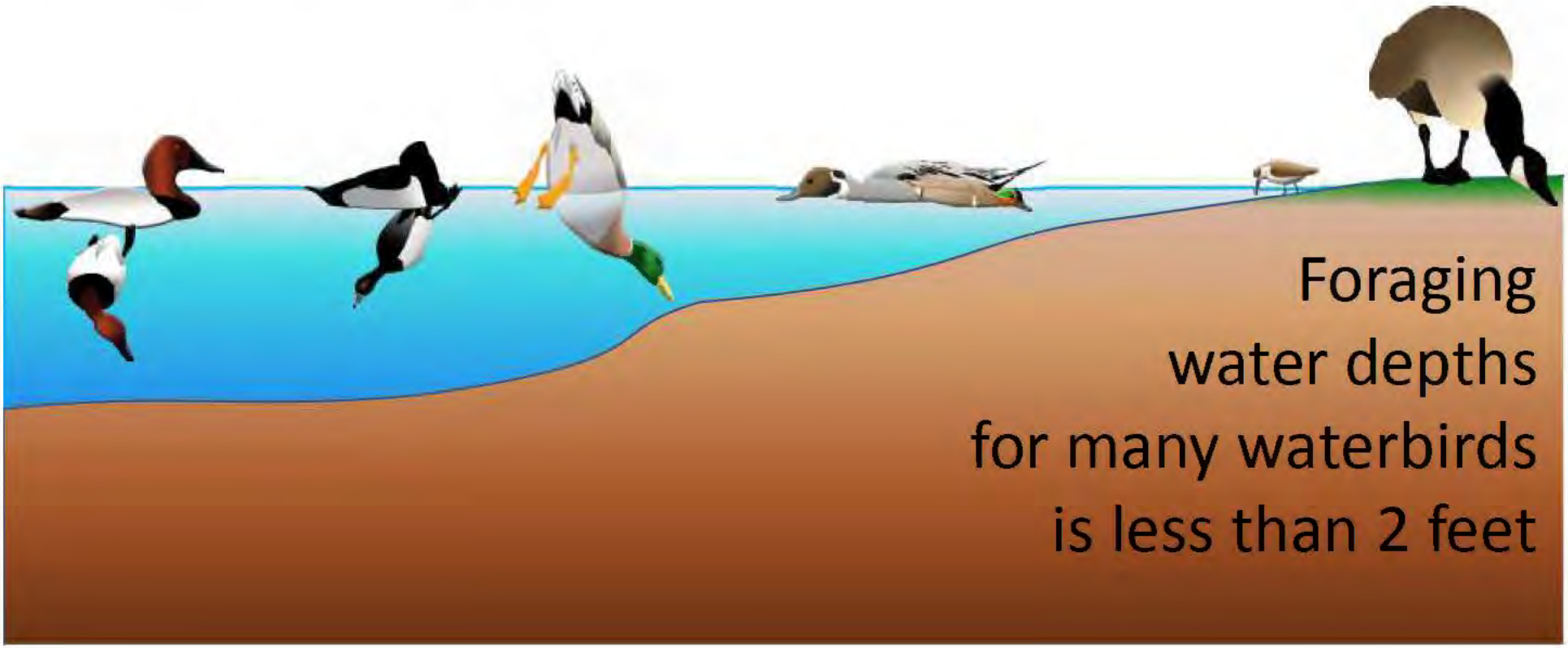
- Duration
- Timing
- Soil Type
- Water Depth



Waterbird Foraging Depth

Reduced Interspecific Competition

- Behavior
- Body Morphology

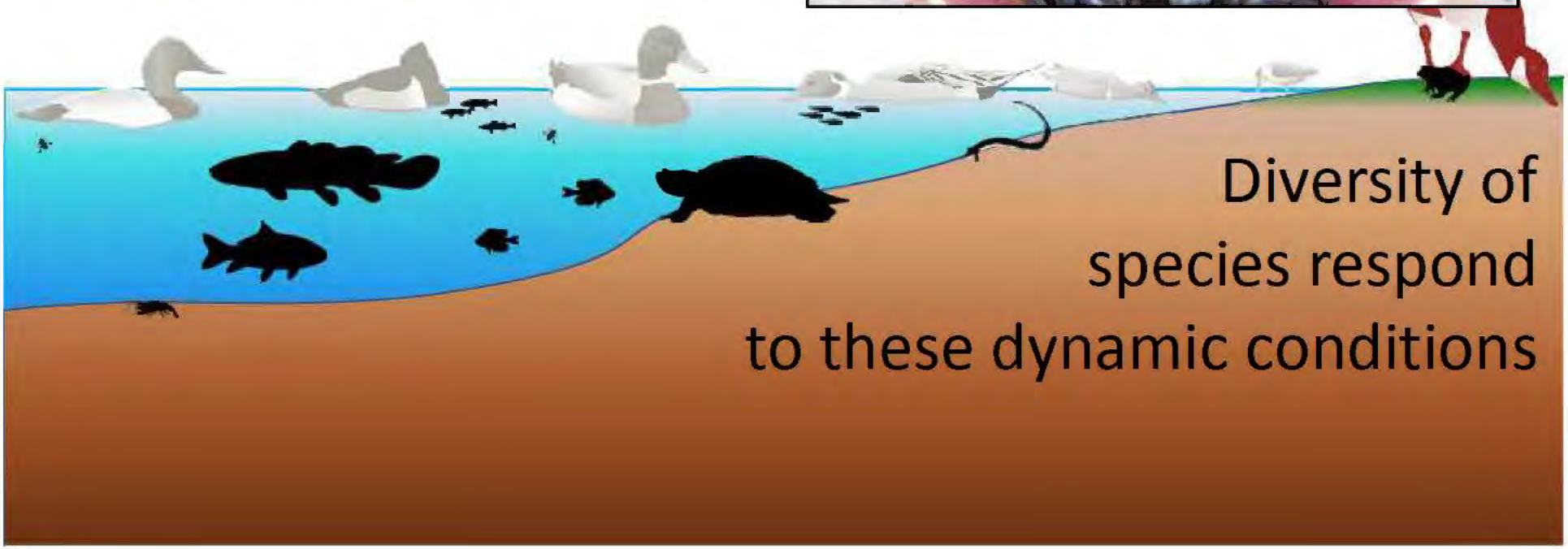


Other Wetland Critters

Bucket 'O Biomass

Topography Influences Flood:

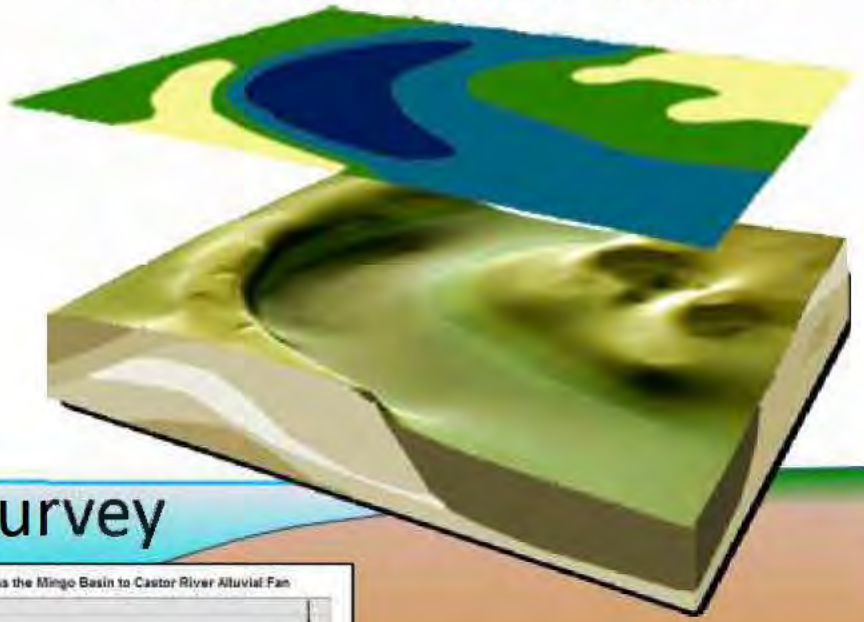
- Duration
- Velocity
- Connectivity
- Structure

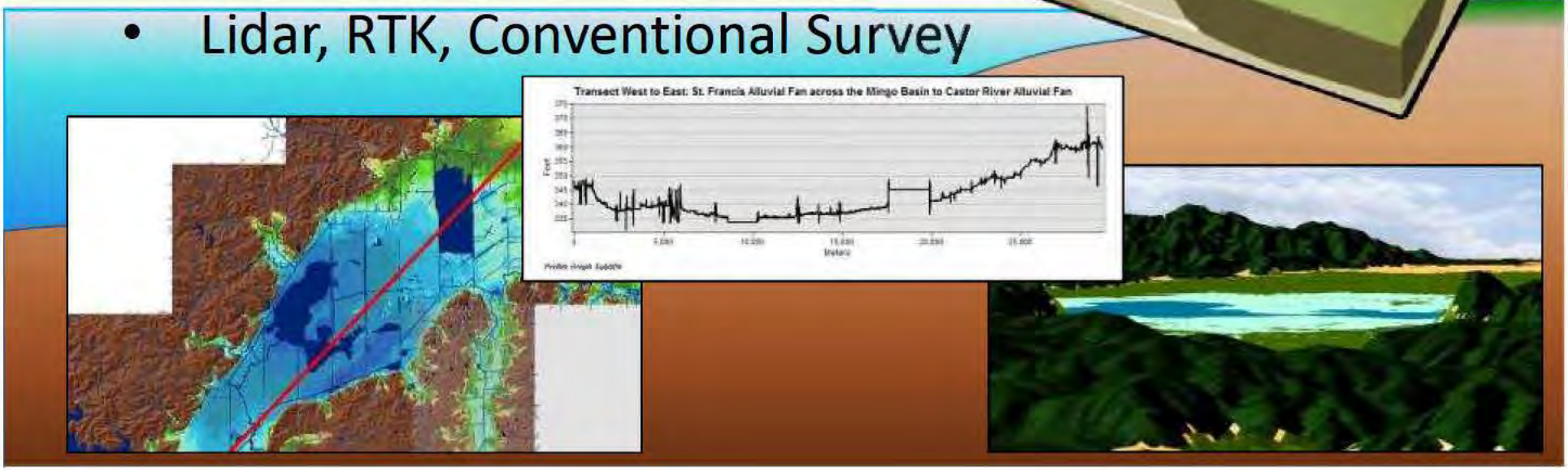


Managing water

Topography

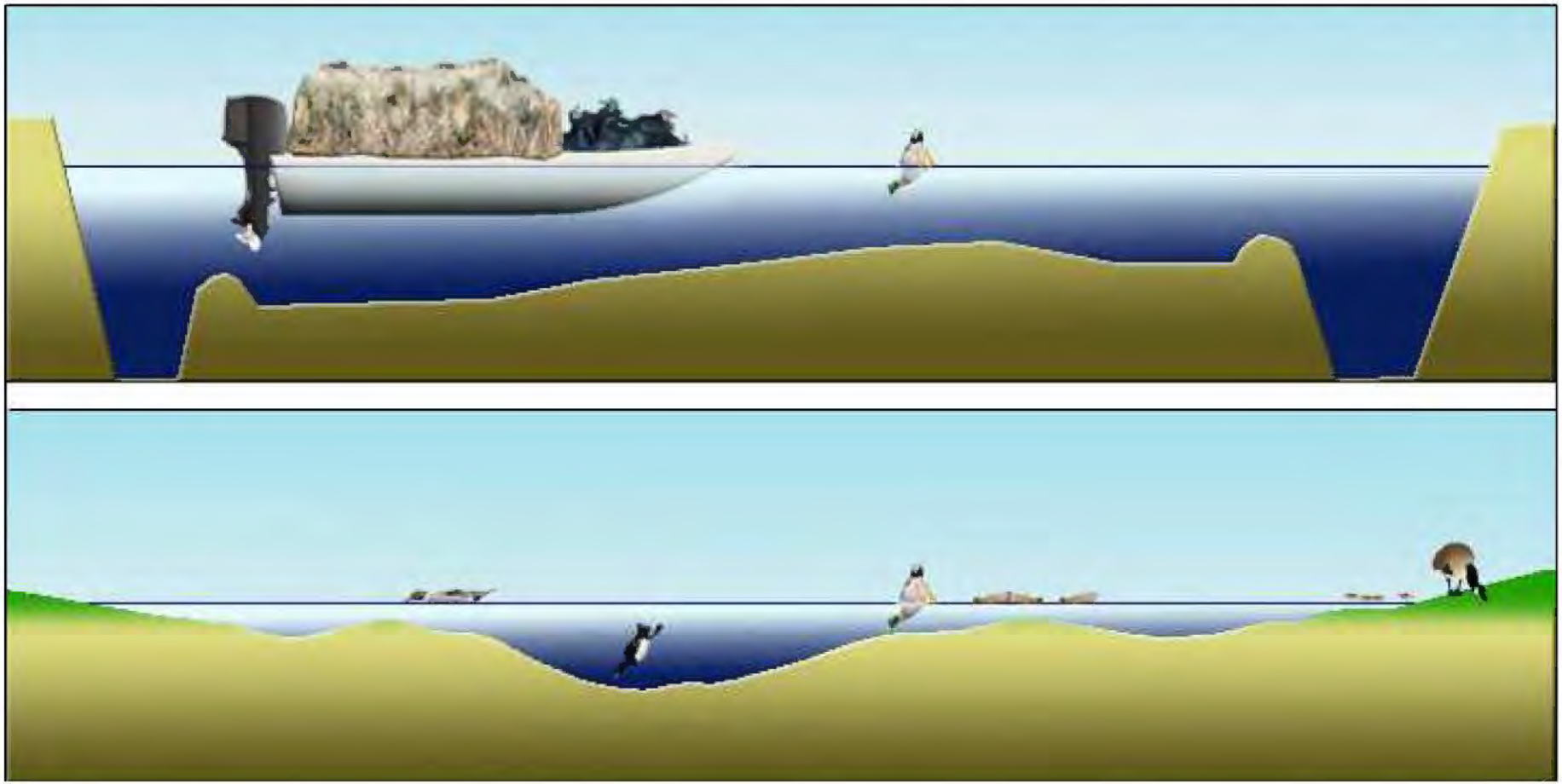
- One underlying factor for management
- Understanding is critical
- Digital Elevation Models
  - Lidar, RTK, Conventional Survey





Learning to work with the landscape

- Wetland management has evolved over time
  - From primarily hunter access to species requirements



Learning to work with the landscape

- Wetland management has evolved over time
  - From hunter access to species requirements
  - Understanding our place in the landscape (HGM)

Interaction of soils, topography, and water:

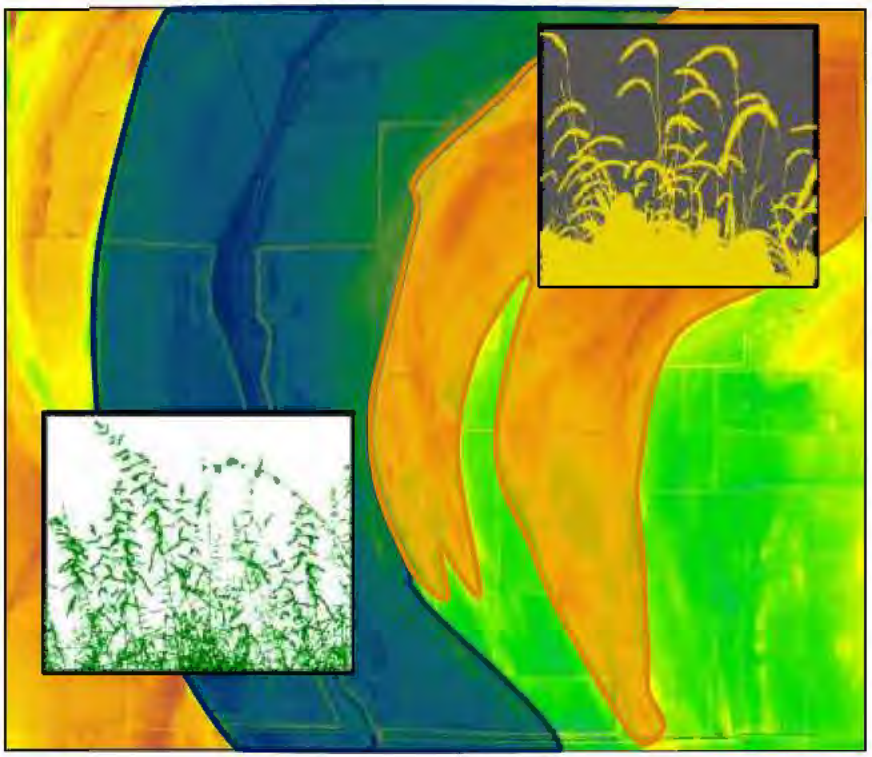
Habitat Potential is Different

Abandoned Channel

- (wetter, lower, tight soils)

Point Bar

- (dryer, higher, sandy soils)



Learning to work with the landscape

- Wetland management has evolved over time
  - From hunter access to species requirements
  - Understanding our place in the landscape (HGM)
  - Mimicking natural systems

Read the Lay of the Land

Lidar and photos provided insight to Landforms

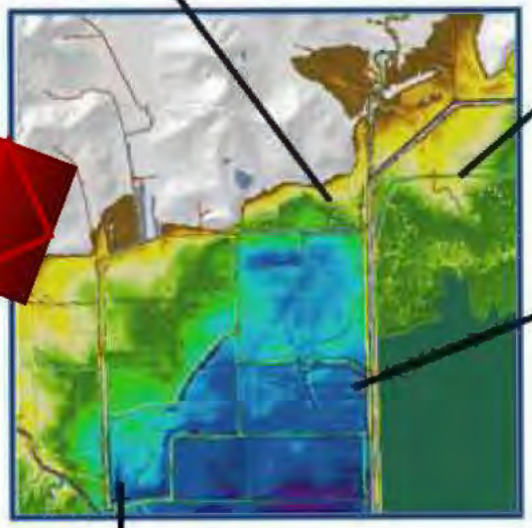
Stilts Woods:
Mima mounds

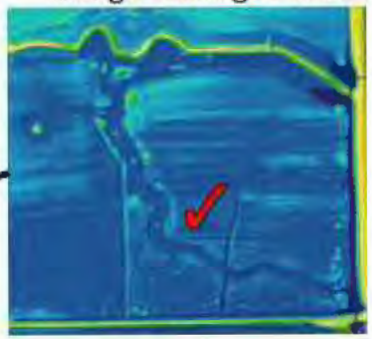
North Pool 1:
Sloughs and mima mounds

Unique Features

Fall of Land

Unit A, SE:
Slough through L woods





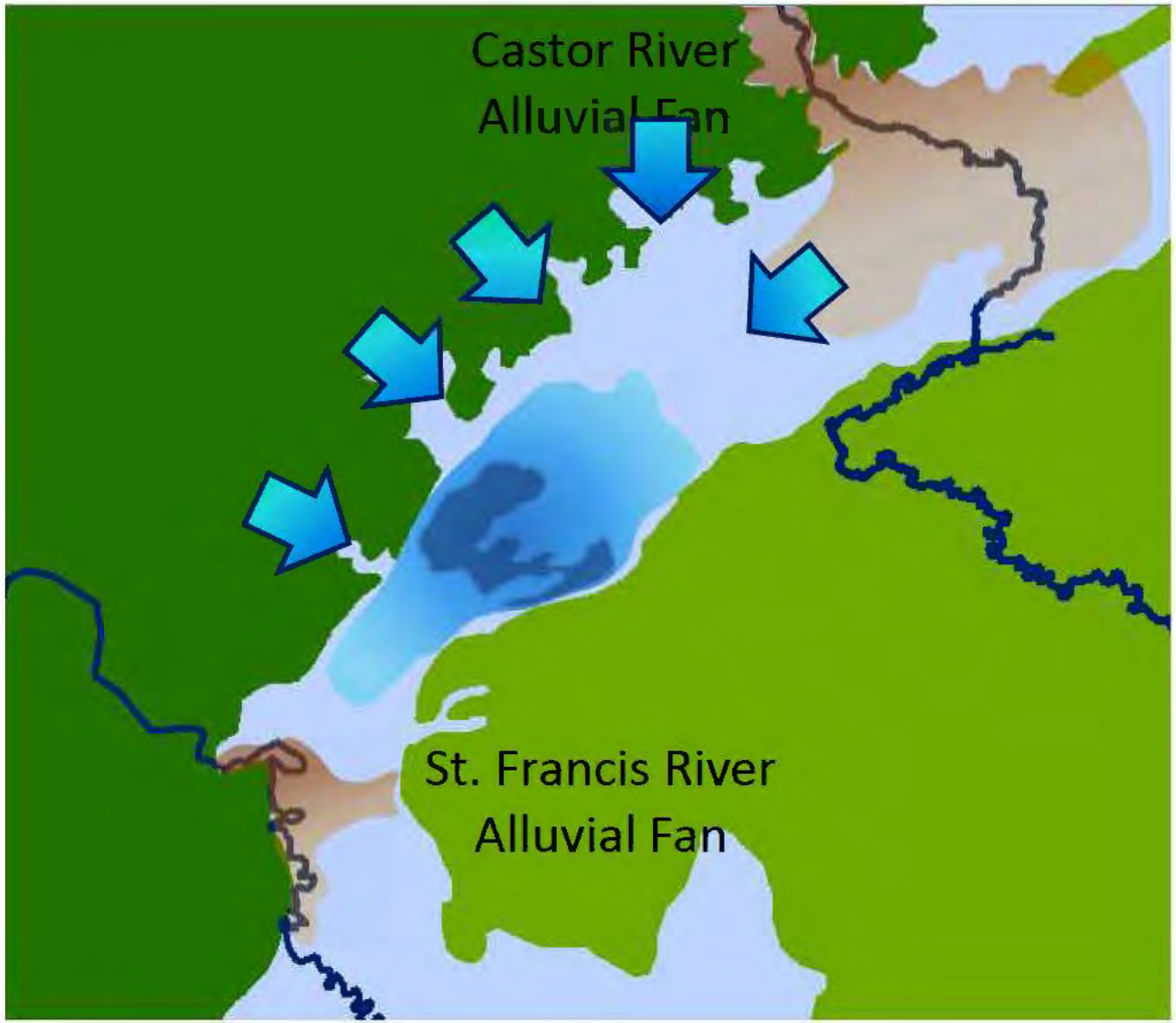
First:

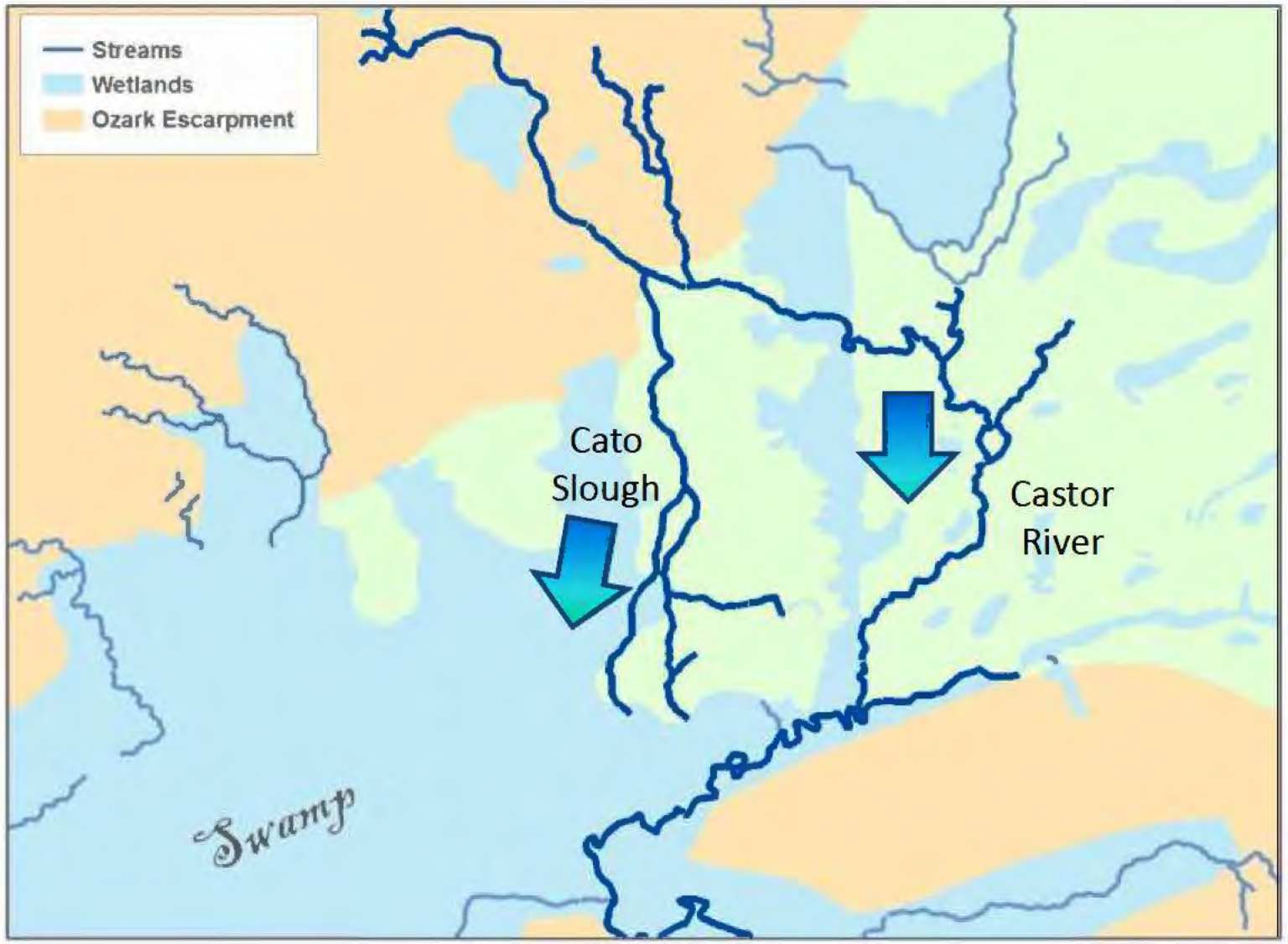
Must Understand Landscape Setting and Alterations

The Mingo Basin

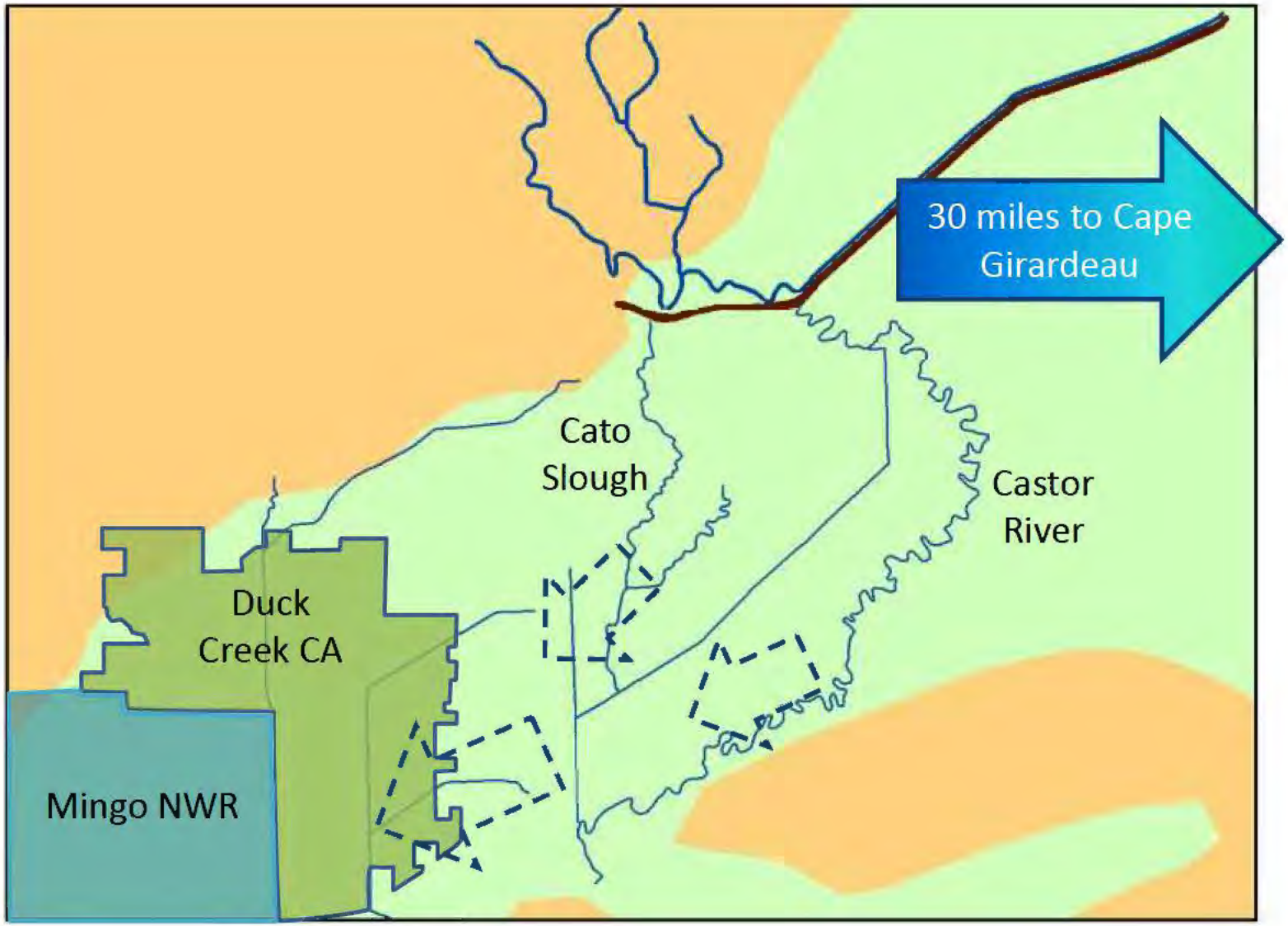
Mississippi
Alluvial Valley

The Mingo Basin





Historic Mingo Basin: Castor and Cato River Flooding



LRRD 1918: Castor River Headwater Diversion

Duck Creek CA:

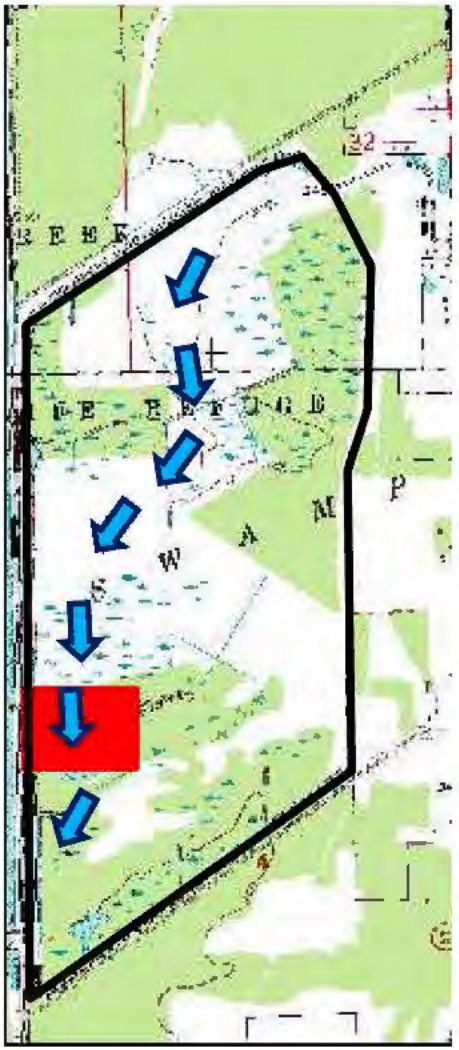
Renovation Objectives

- Restoring Natural Water Flow Patterns
- Mimicking Natural Water Regimes
- Restoring Natural Vegetation Communities
- Accommodating Multiple Public Uses

Redirecting Focus:

Prior to Lidar

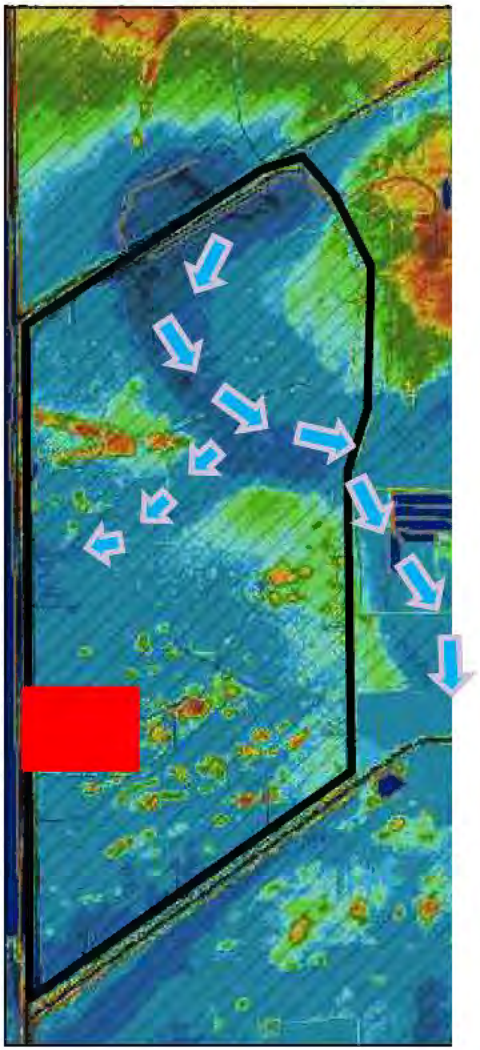
- Our focus was *SW*
- Remove obstacles to sheetflow *within* Pool 2



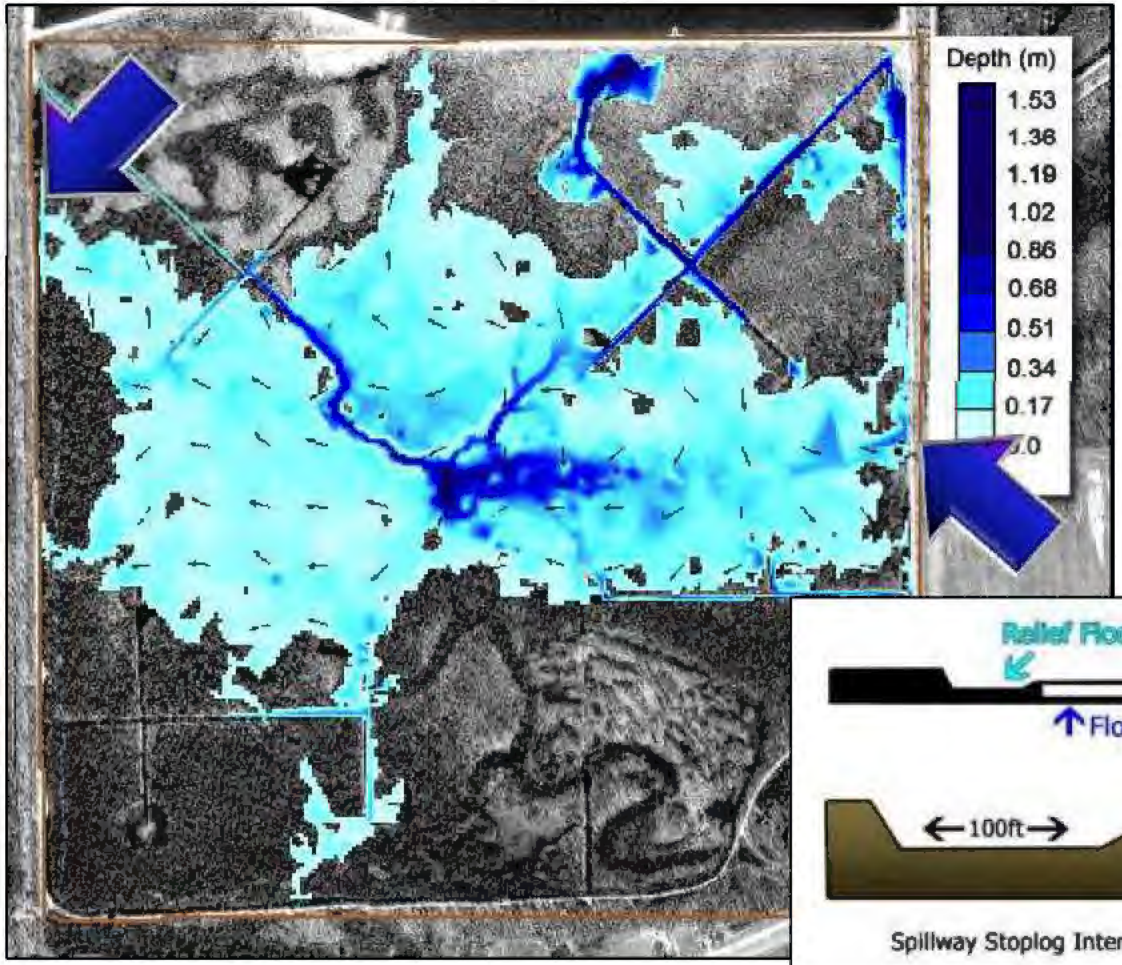
Redirecting Focus:

After Lidar

- Lidar widened our view
- Historic drainage went across levee to the east
- Switched our focus to the NE…almost 180°

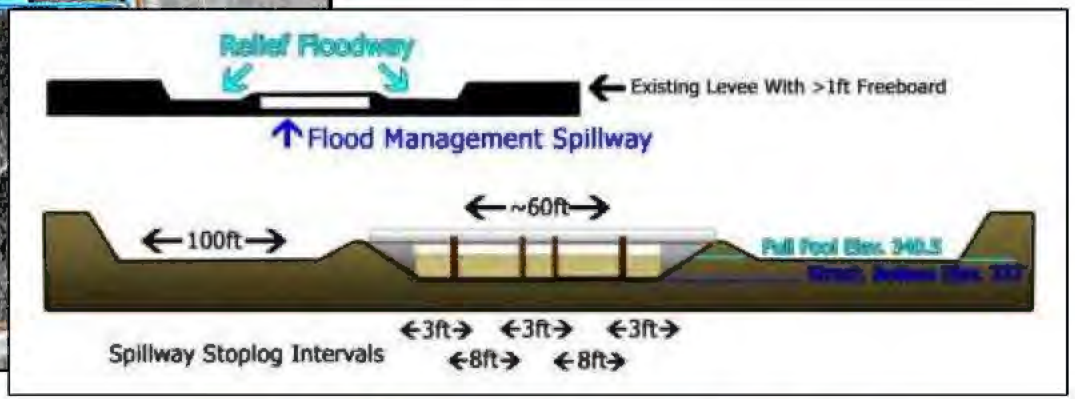


Placement of Structures



Pool 3 Flow Modeling:

- Simulate overland flow
- Something previously not always considered or possible

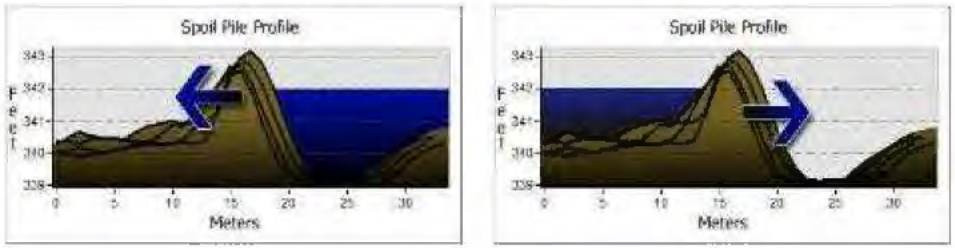


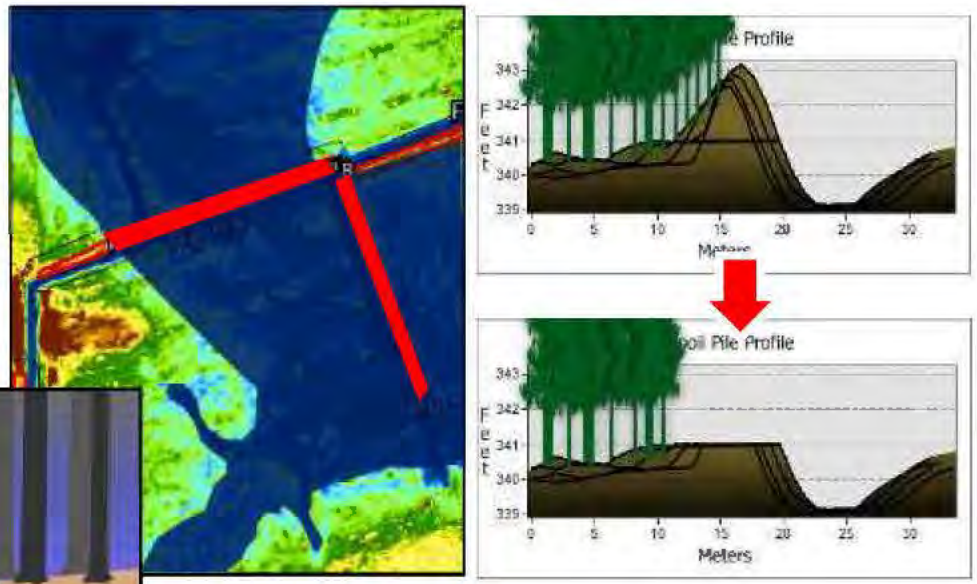
Restoring Natural Water Flow Patterns

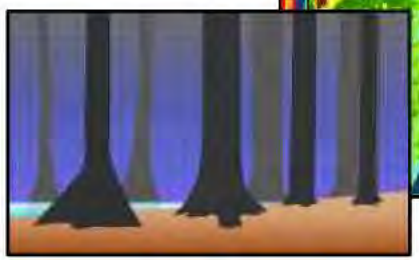
Identifying Obstructions

- Areas of pin oak mortality were places water was trapped
- Lidar helped prioritize which spoil piles were causing problems
- Understanding flow is critical

Blocking water on or off

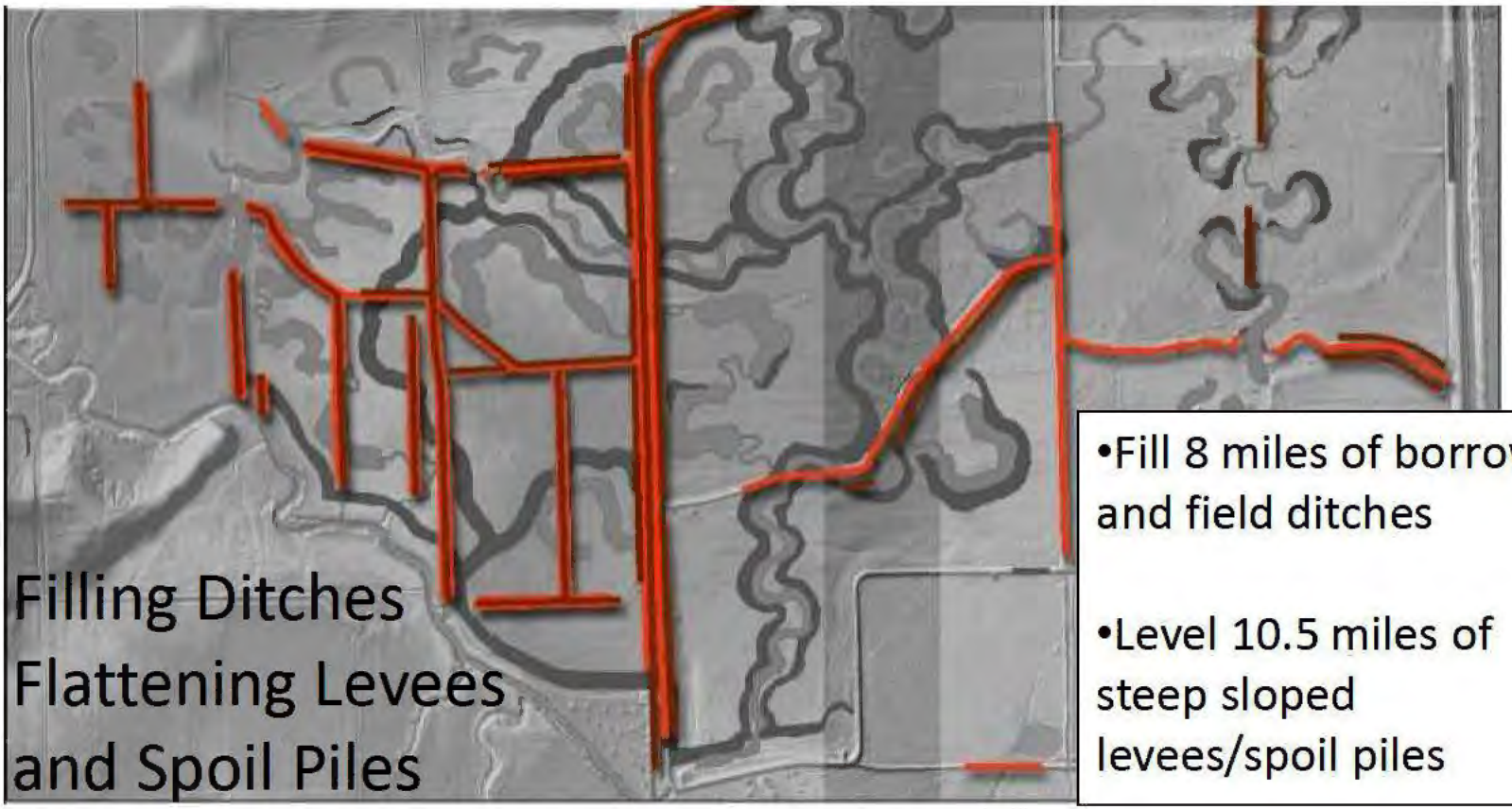






Mimicking Natural Water Regimes

Leveling spoil and field ditches to the natural ground to accommodate sheetflow



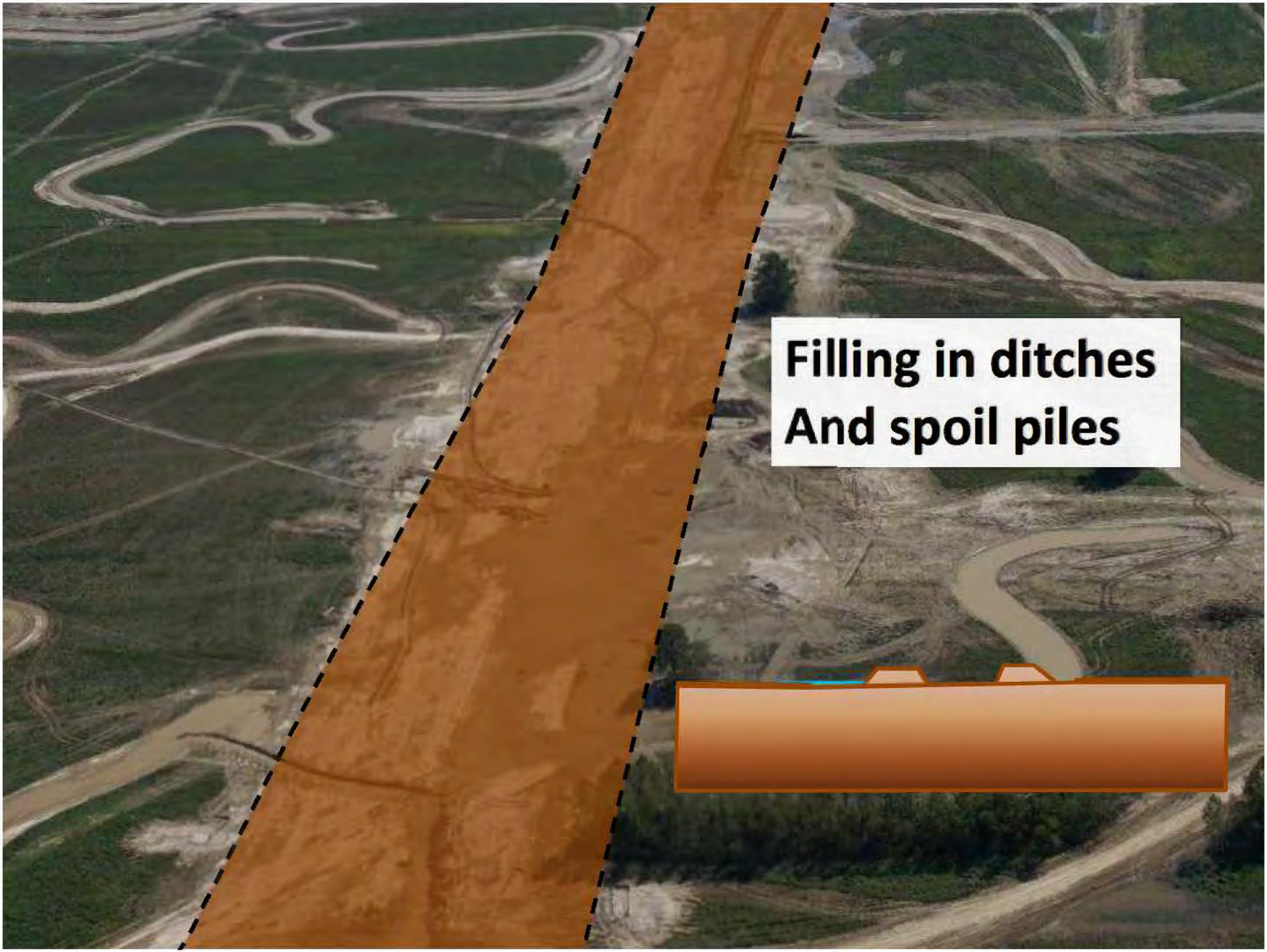
- Fill 8 miles of borrows and field ditches
- Level 10.5 miles of steep sloped levees/spoil piles

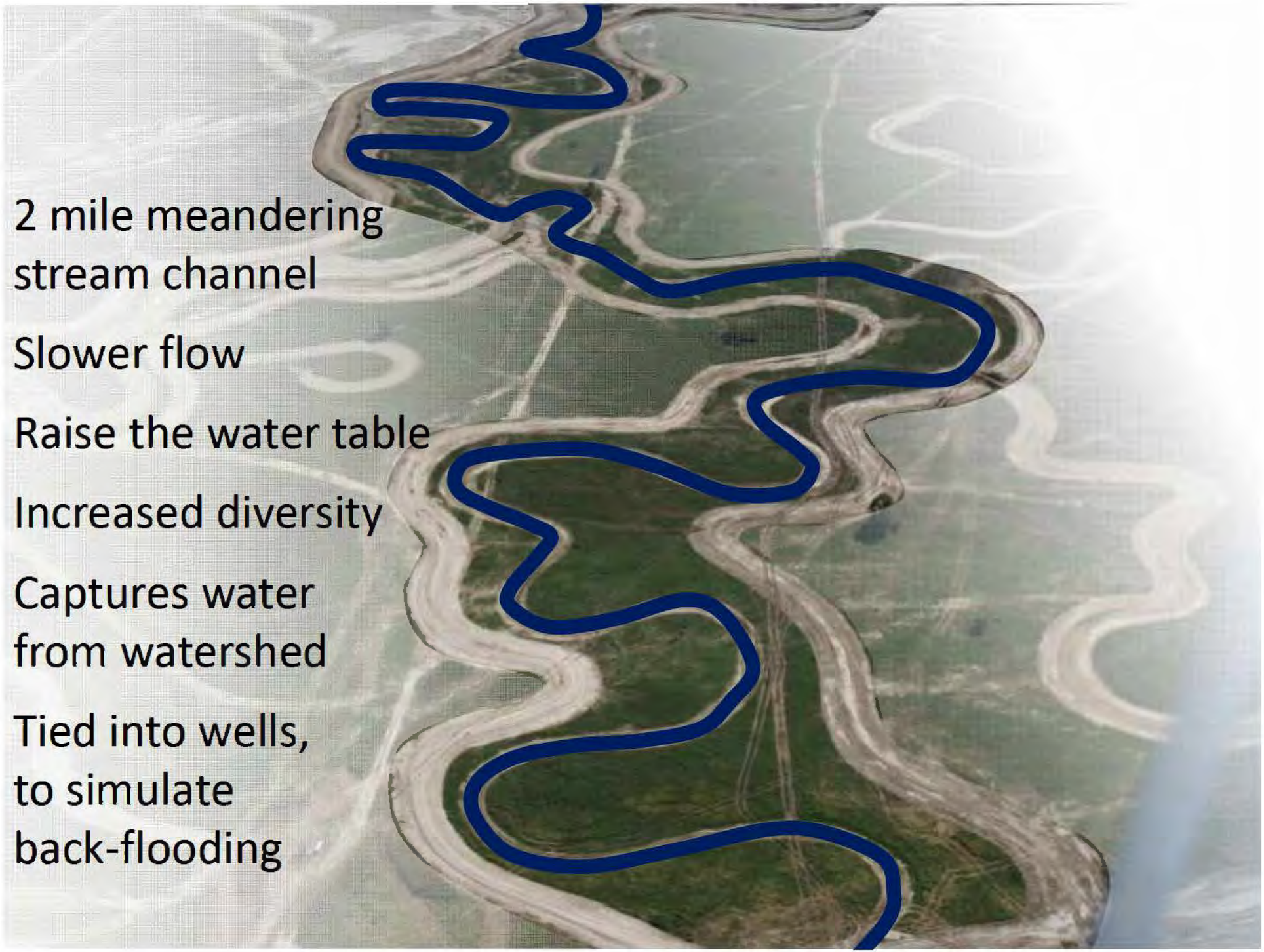
- The ditches purpose was efficiency
- Sinuosity will encourage ecological functions

Stream Restoration

- Fisheries staff idea
- WETS team design
- Incorporated by engineer

Wells

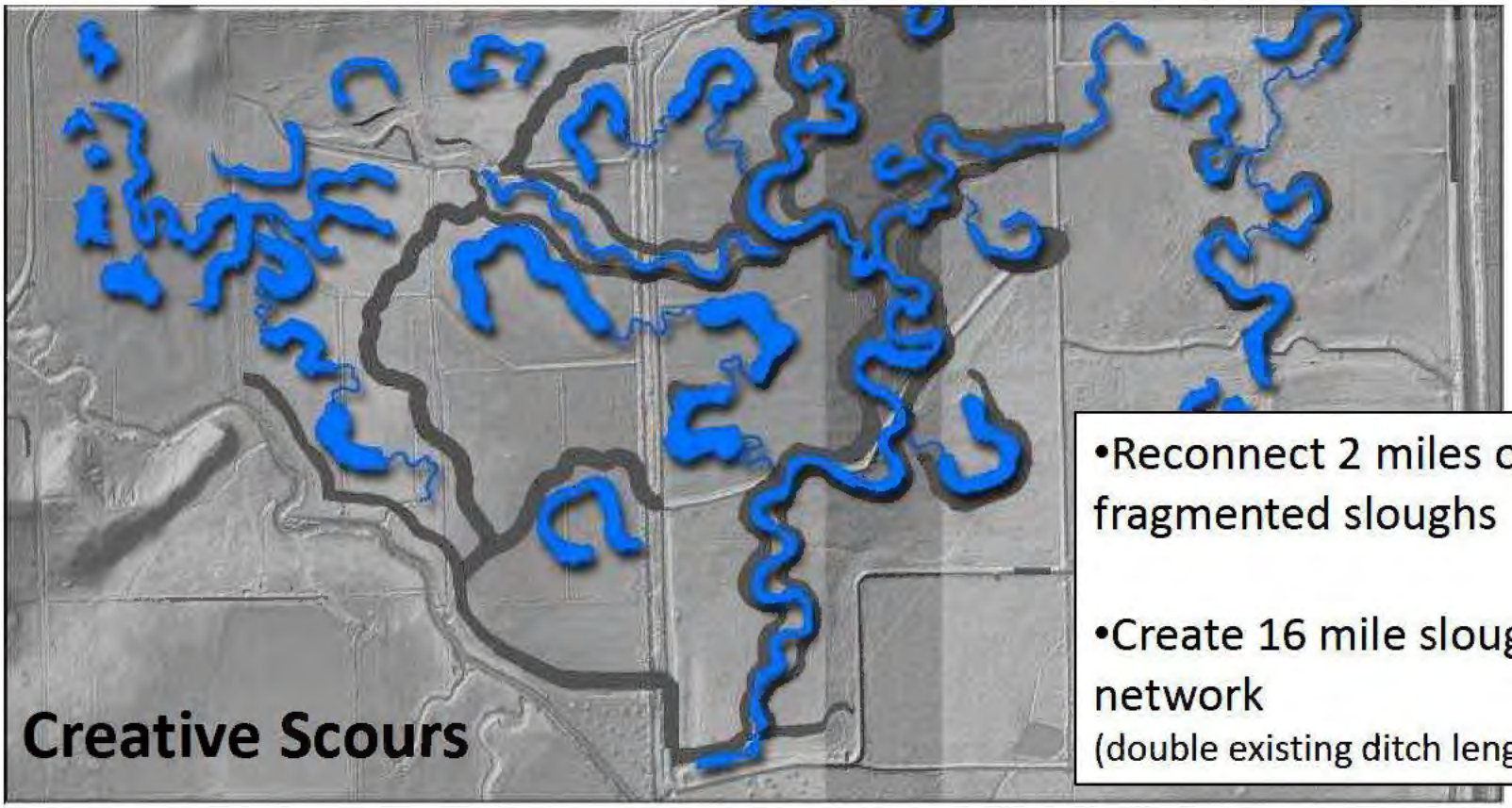

Filling in ditches
And spoil piles


2 mile meandering stream channel
Slower flow
Raise the water table
Increased diversity
Captures water from watershed
Tied into wells, to simulate back-flooding

Mimicking Natural Water Regimes

Stream Restoration and Creative Scours:

Allow for independent water control, slow down water, spread it out, increase habitat diversity



Creative borrowing:

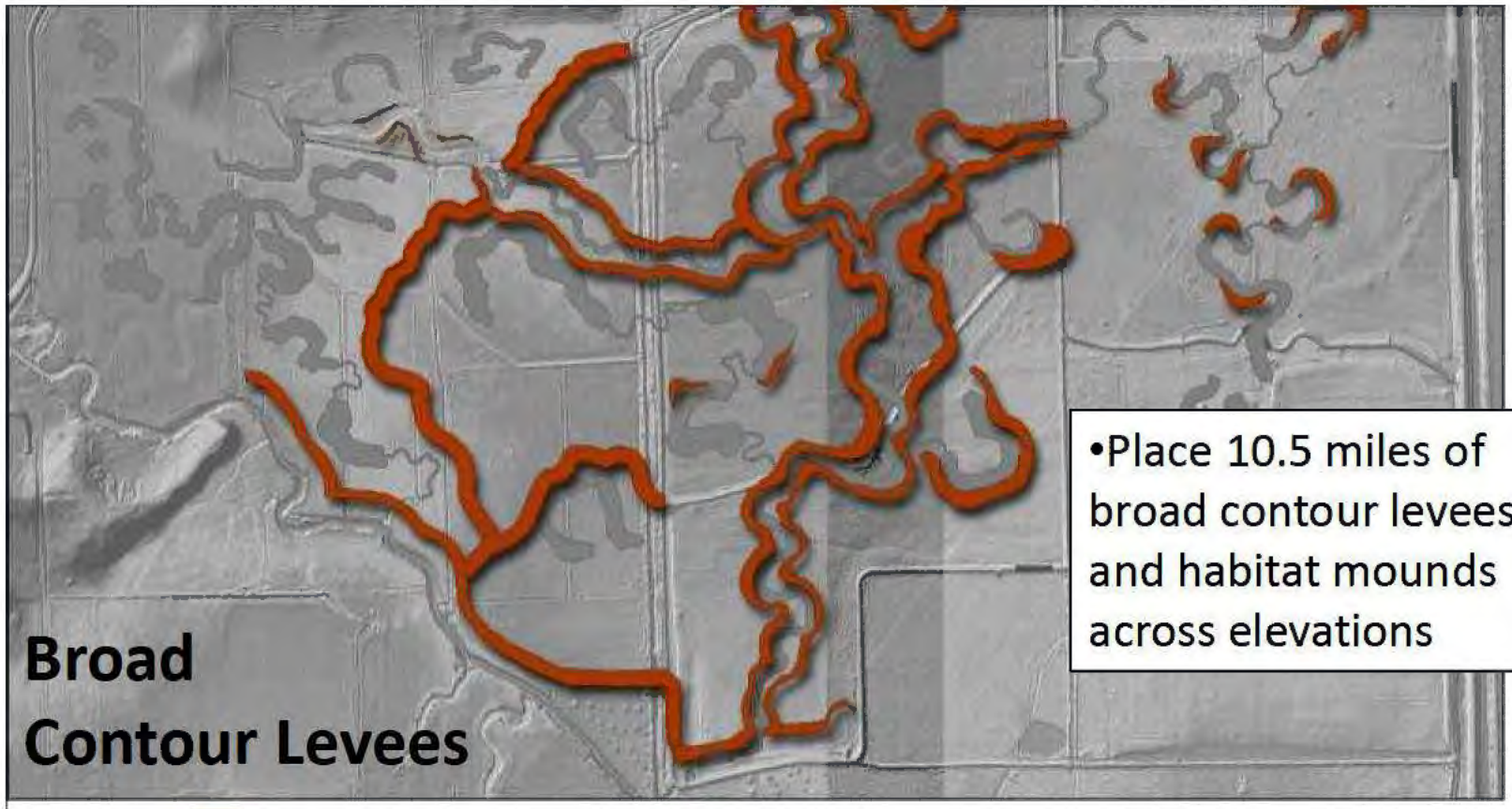
- Broad
- Shallow <2 ft

Topographic Diversity

Variety of Niches

Mimicking Natural Water Regimes

Contour levees: 10:1 side slopes, located along 2-2.5 contours, <6 inch freeboard



•Place 10.5 miles of broad contour levees and habitat mounds across elevations

Contour or Landscape Levees

- Broad features
- Gradual slopes

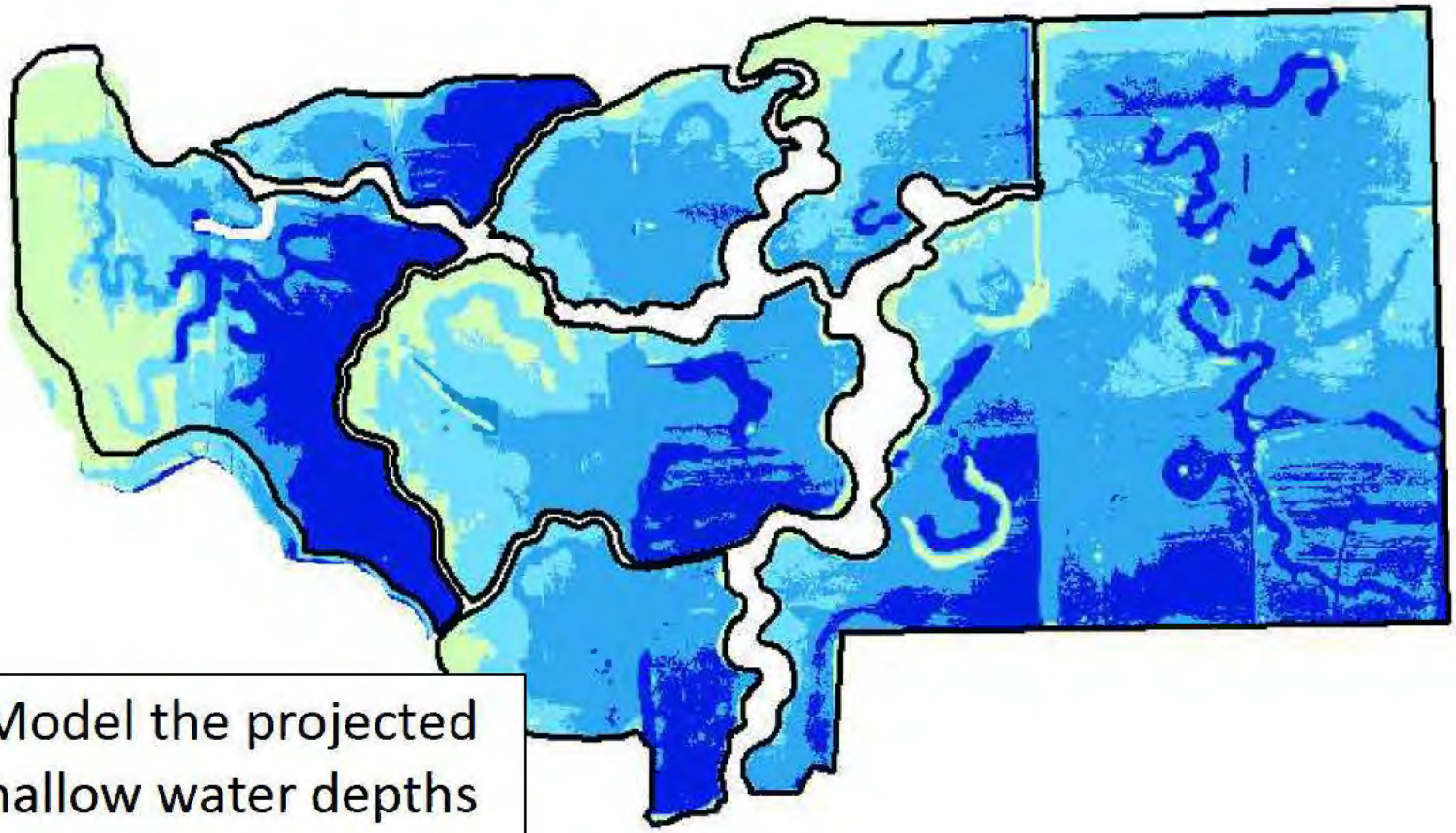
Reduce long-term maintenance problems

- Burrowing
- Erosion

Transitional Upland:

Allow floodwaters to spread out

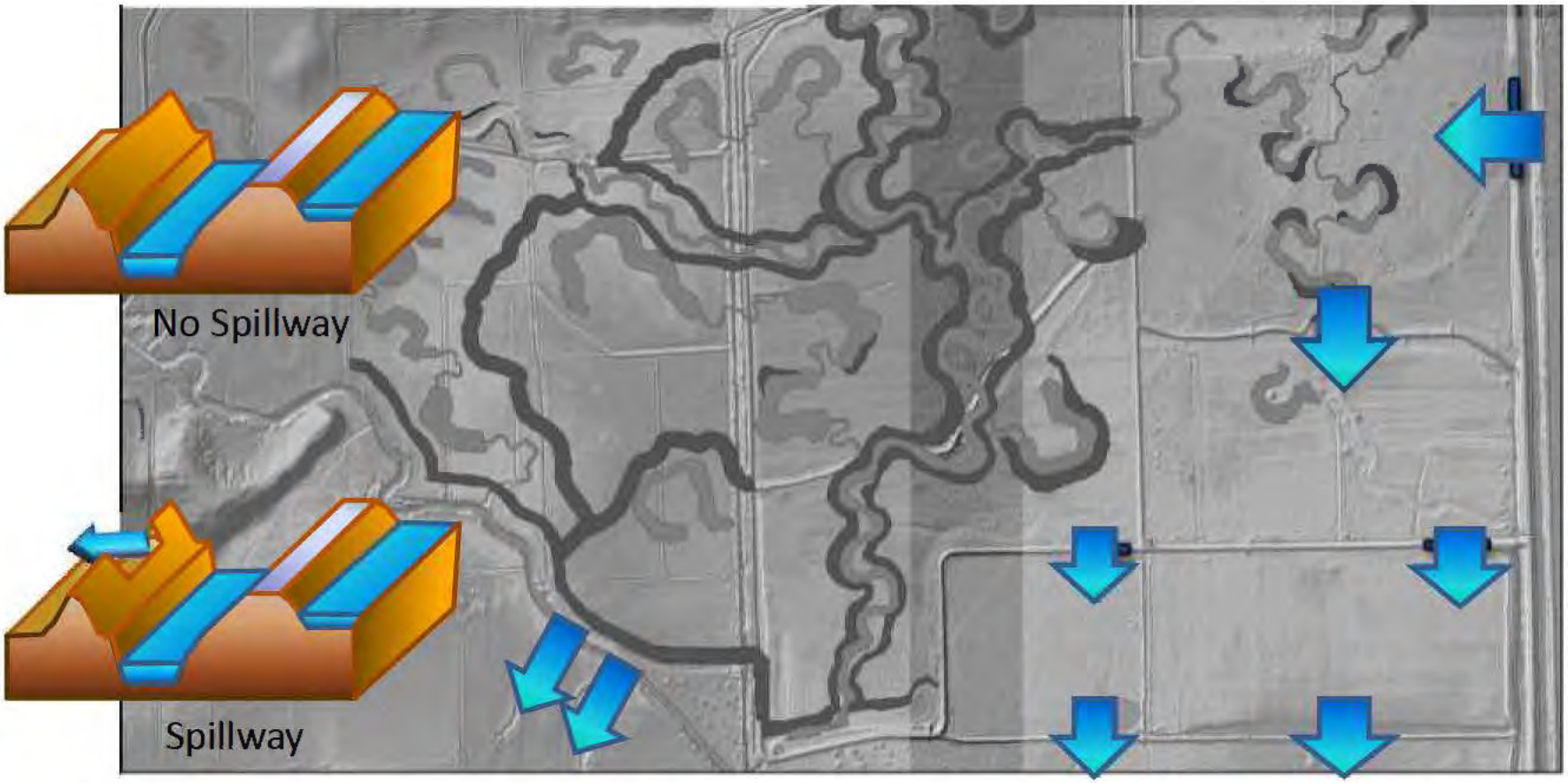
Distribute Shallow Water Habitat



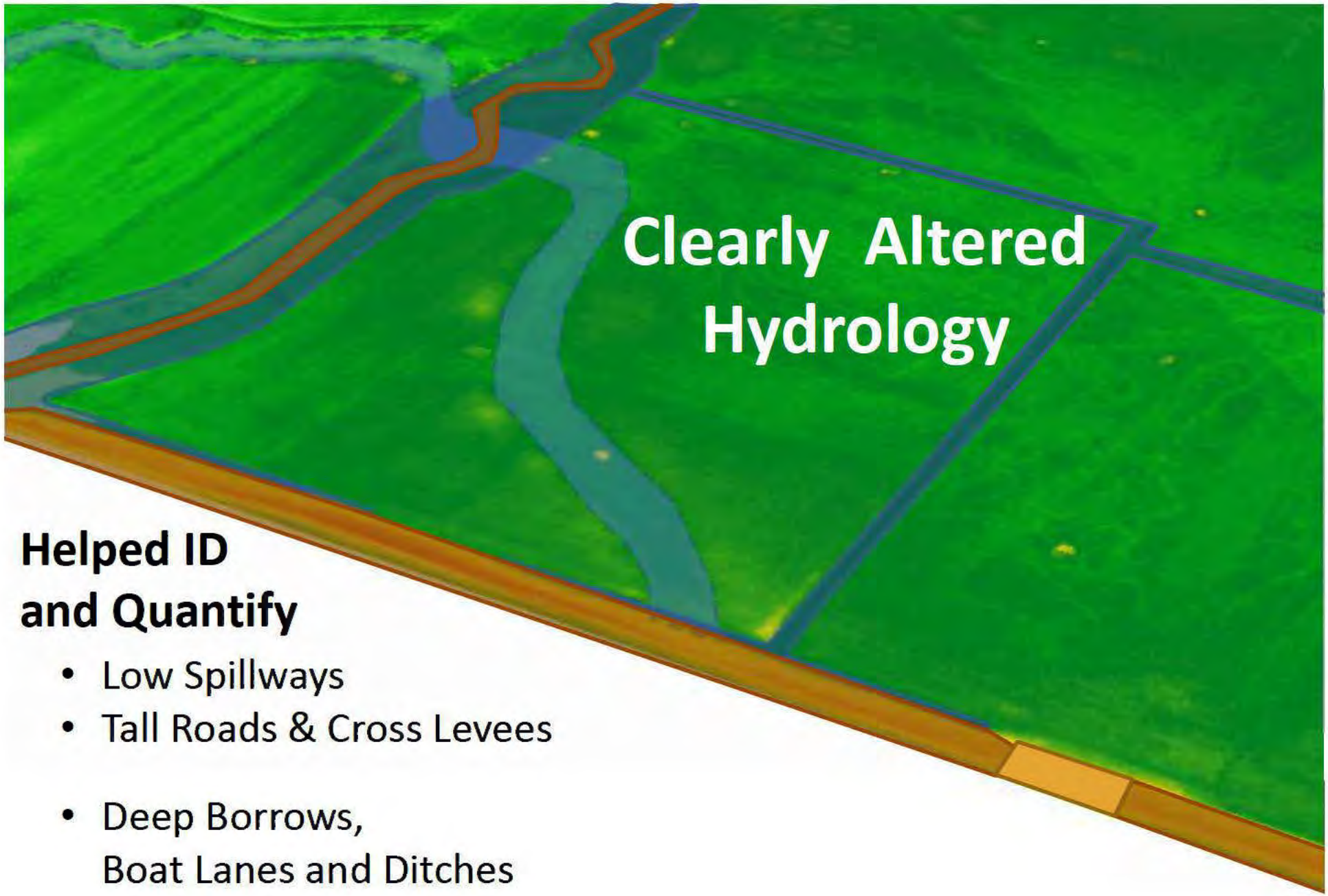
- Model the projected shallow water depths across the new pools

Restoring Natural Water Flow Patterns

Notching Levees for Flood Relief: Cut down to full pool elev. Allow flood waters to spreadout

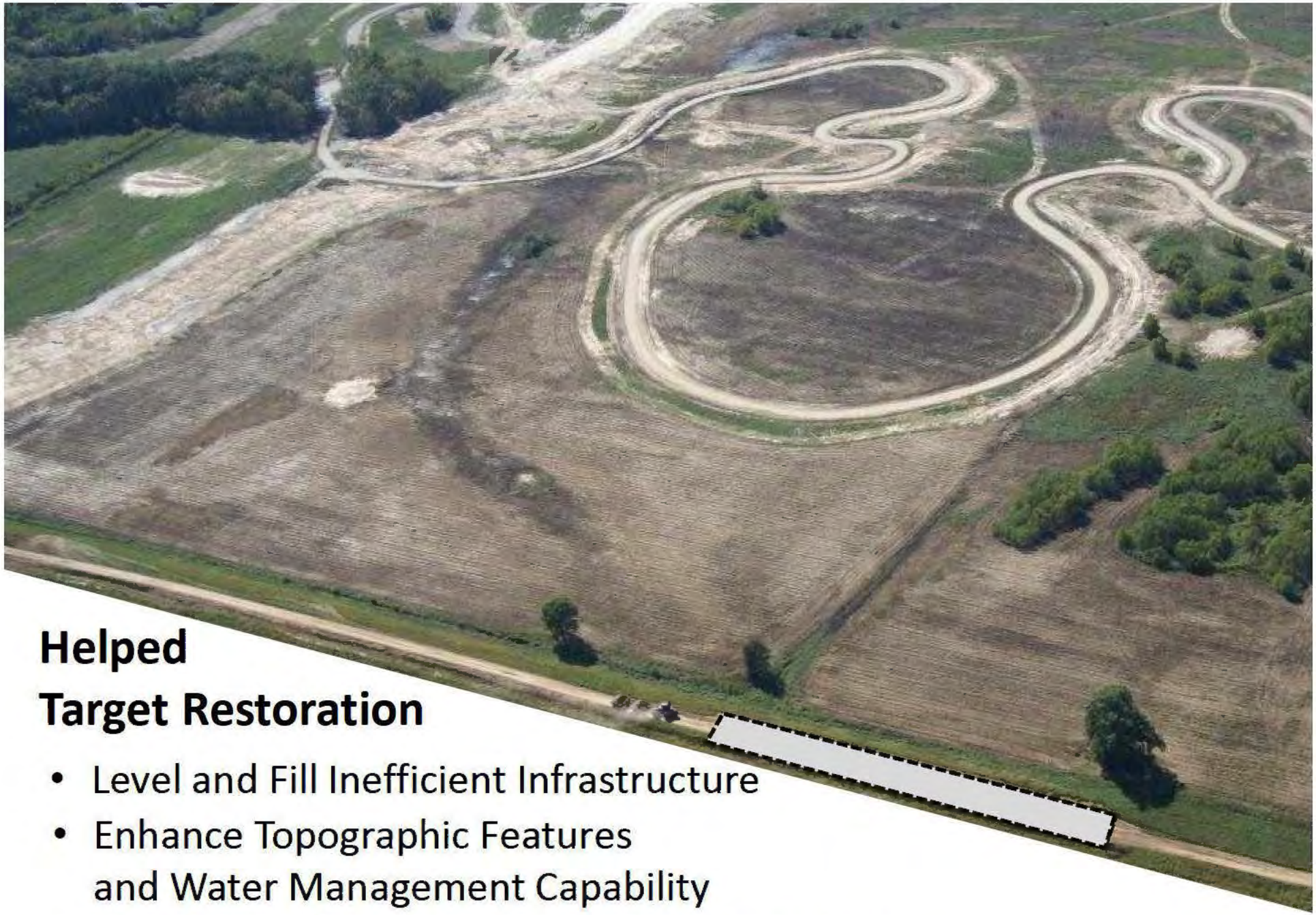


Creating Spillways



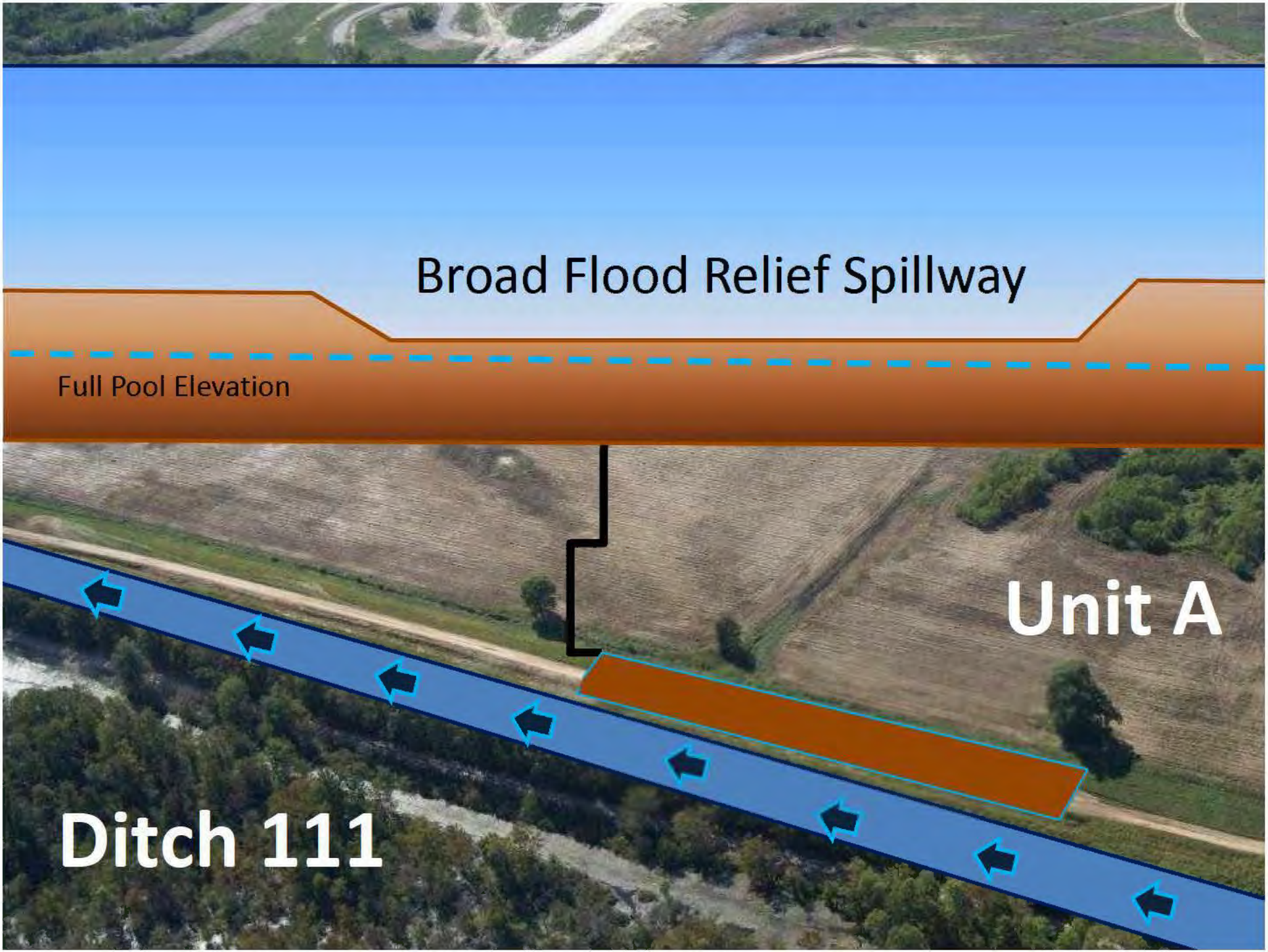
Helped ID and Quantify

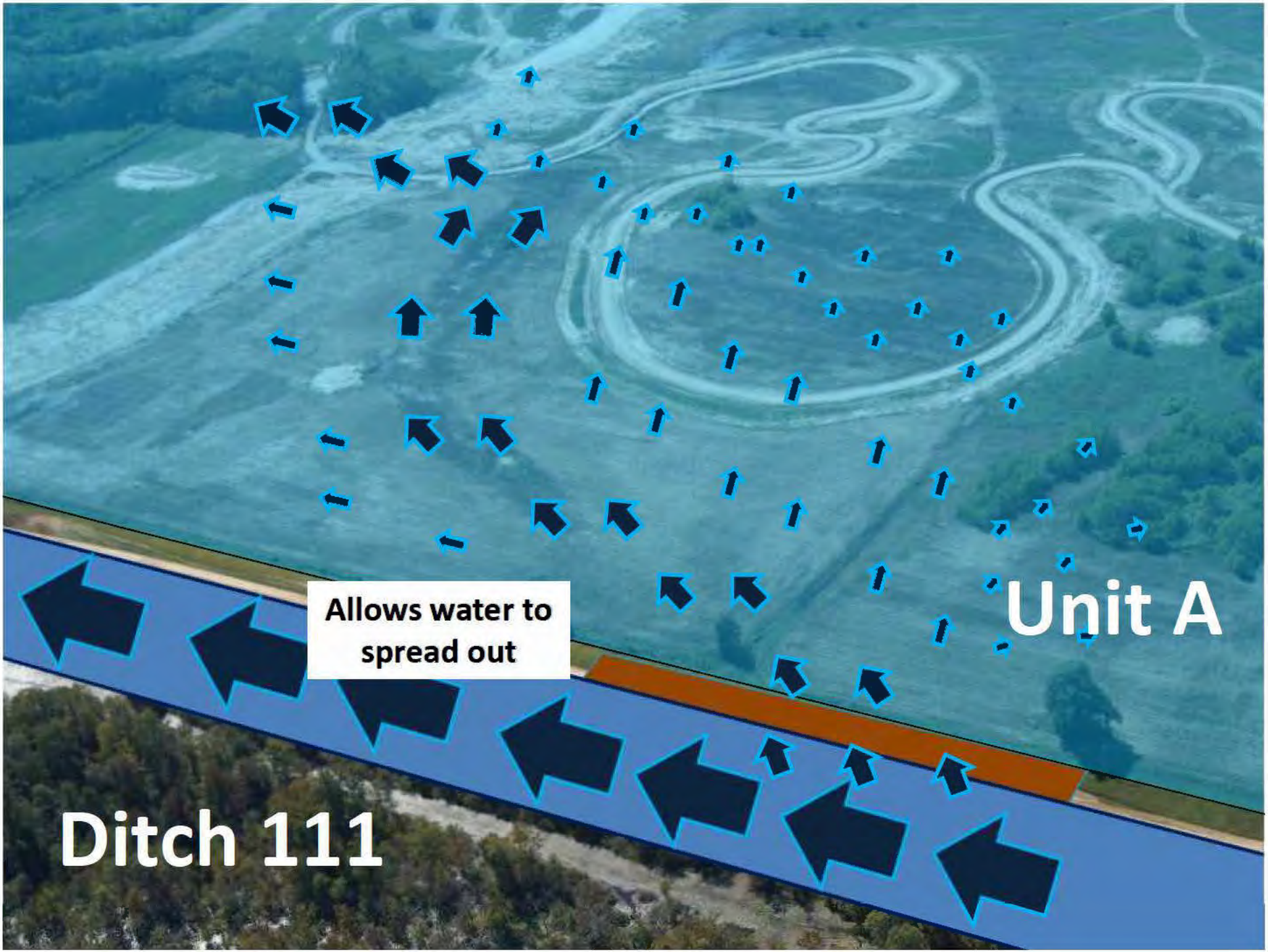
- Low Spillways
- Tall Roads & Cross Levees
- Deep Borrows, Boat Lanes and Ditches
- Footprint of Fragmented Meandering Sloughs

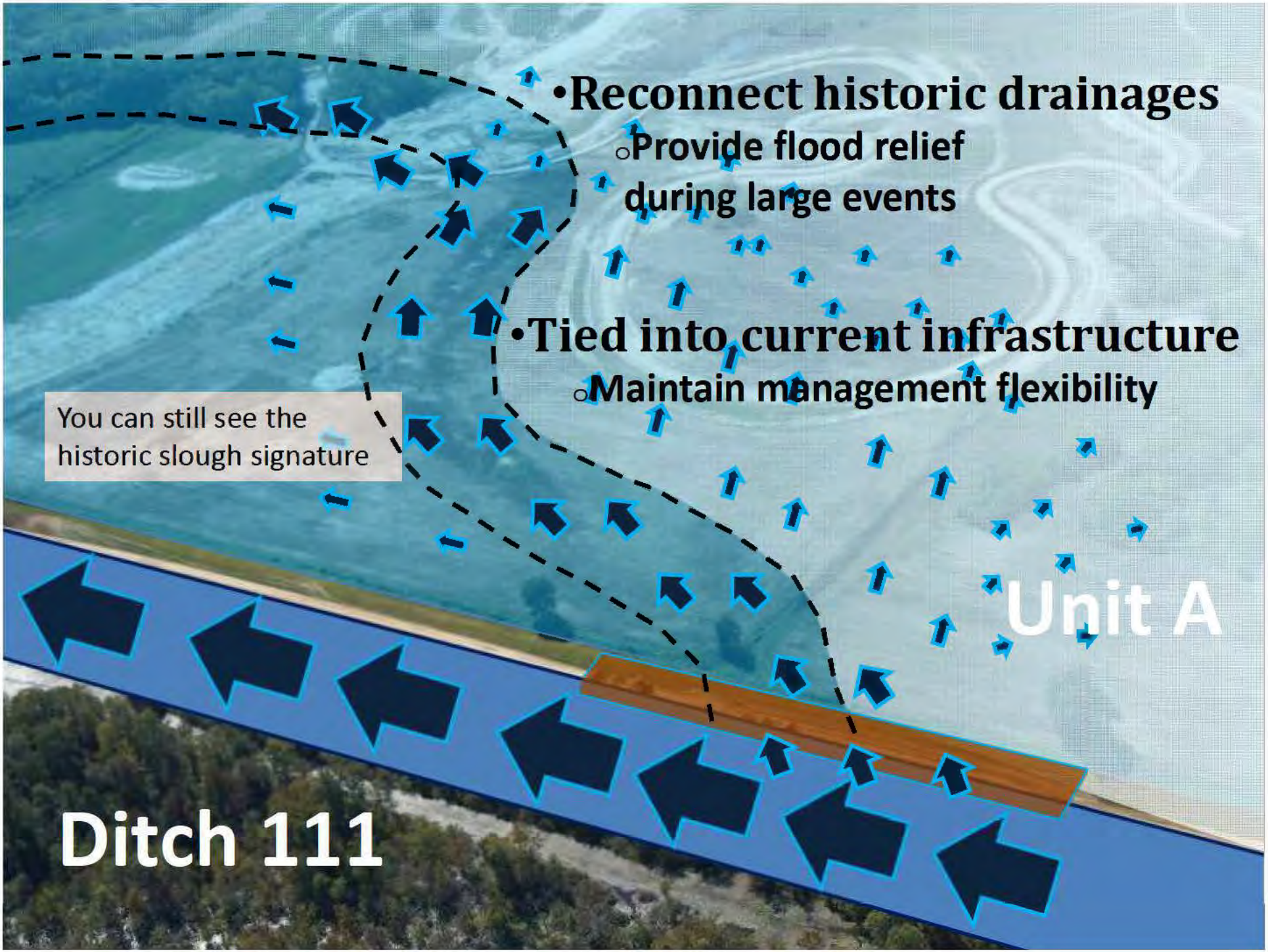


Helped Target Restoration

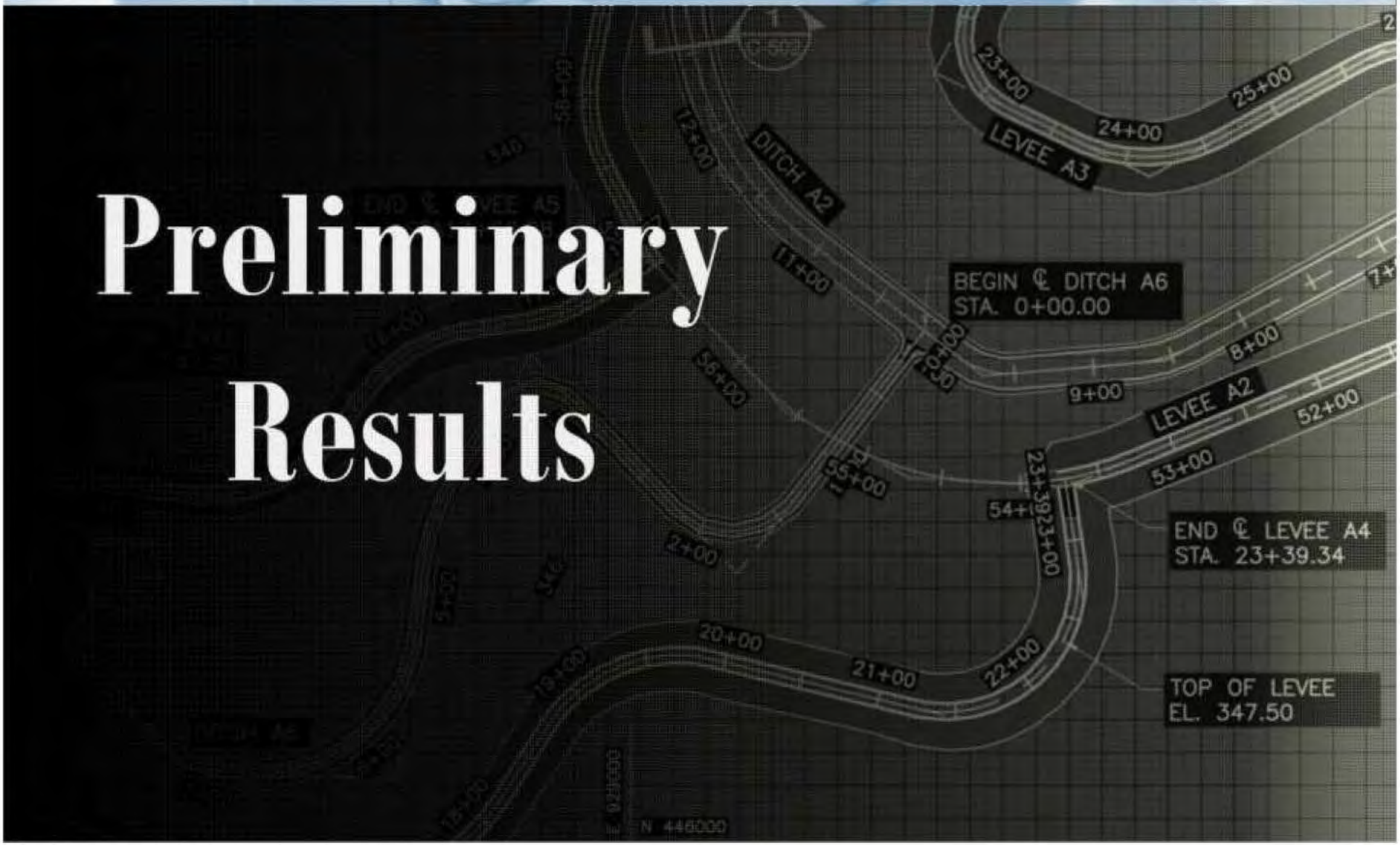
- Level and Fill Inefficient Infrastructure
- Enhance Topographic Features and Water Management Capability
- Broaden Spillway To Connect Hydrological Flows


Broad Flood Relief Spillway
Full Pool Elevation
Unit A
Ditch 111


Allows water to spread out
Unit A
Ditch 111


•Reconnect historic drainages
Provide flood relief during large events
•Tied into current infrastructure
Maintain management flexibility
You can still see the historic slough signature
Unit A
Ditch 111

Preliminary Results

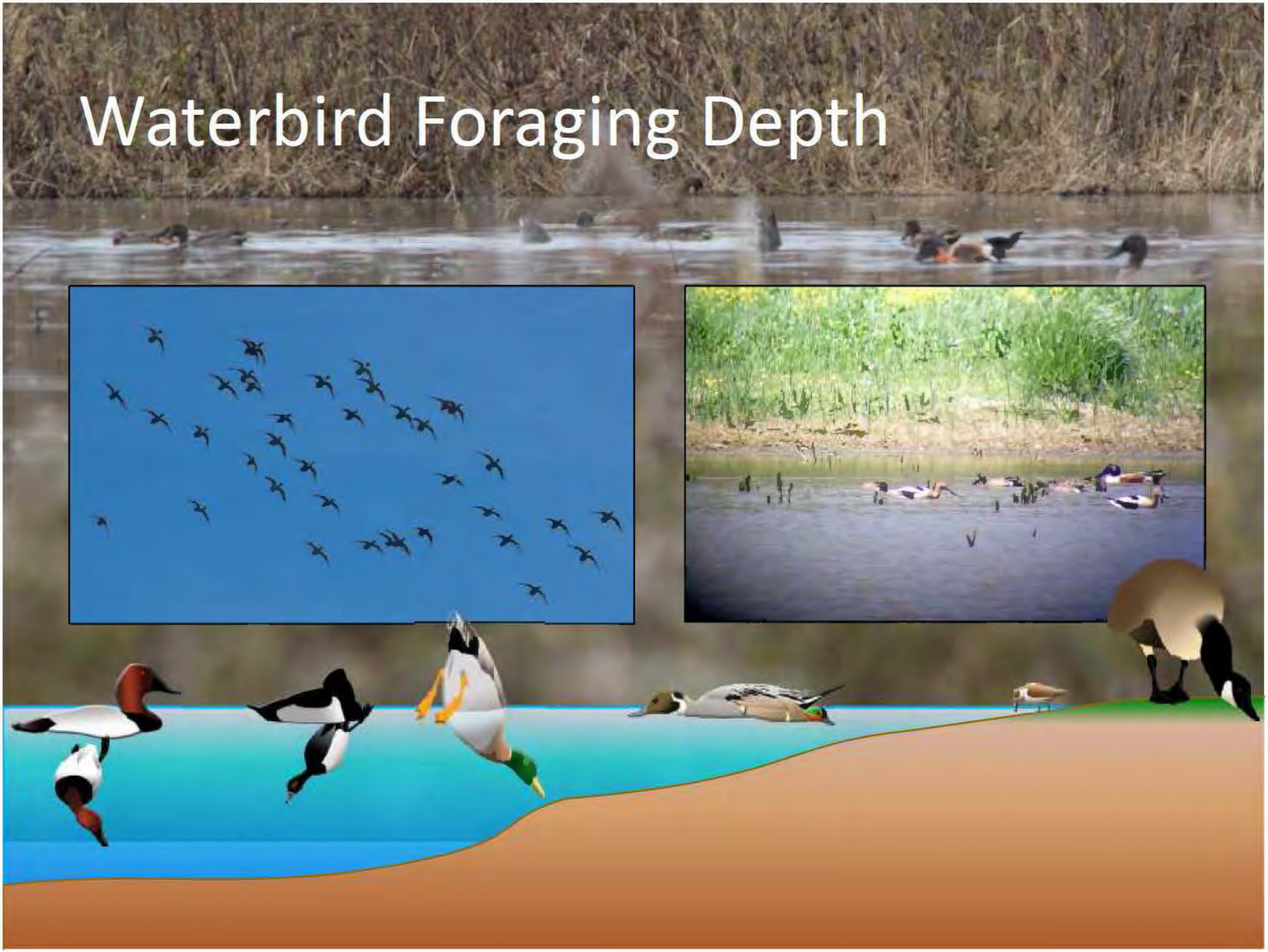


Herbaceous Wetland Communities

Herbaceous Wetland Communities

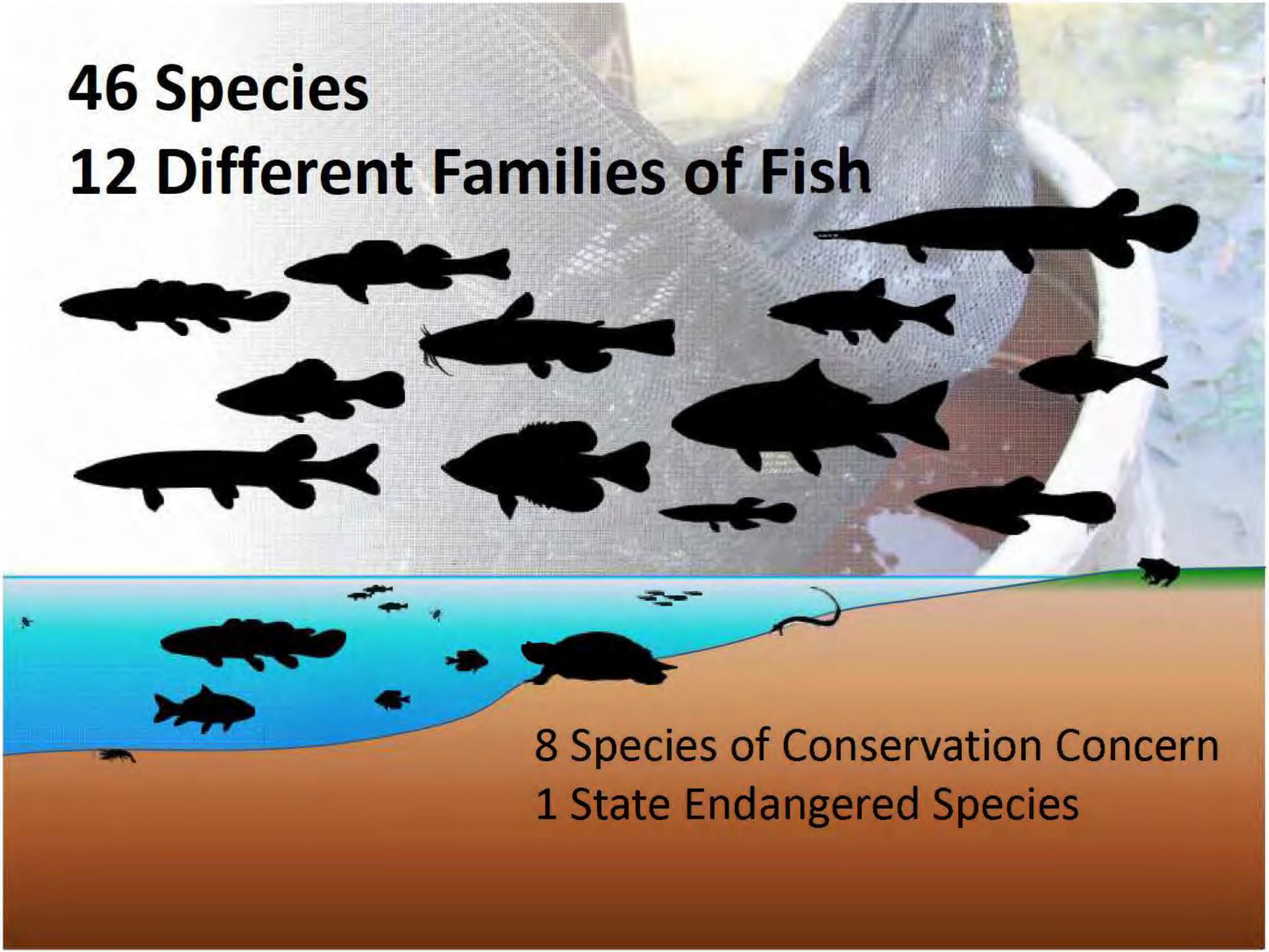
Herbaceous Wetland Communities

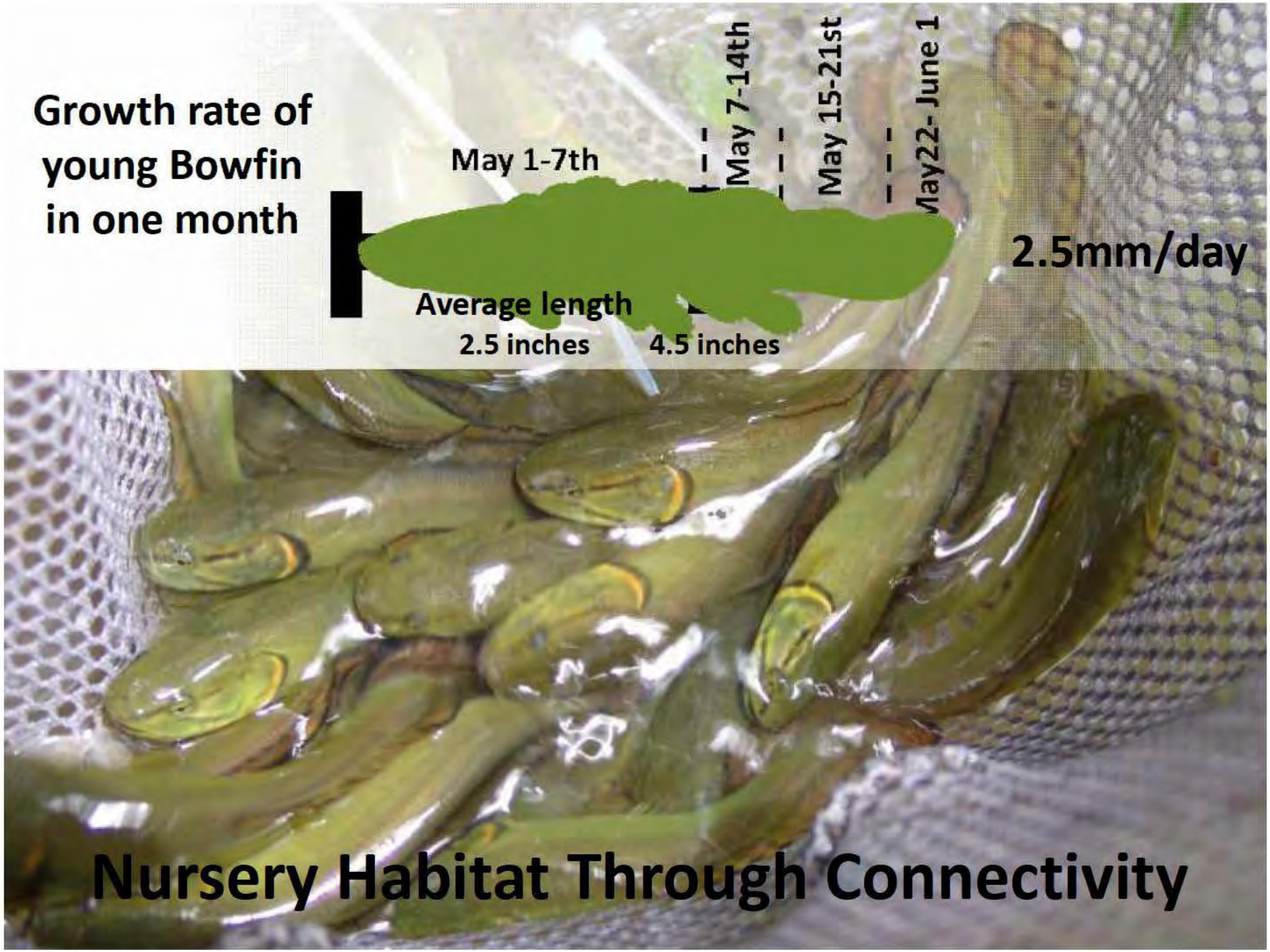
Waterbird Foraging Depth



Connectivity During April 2011's Historic Flooding

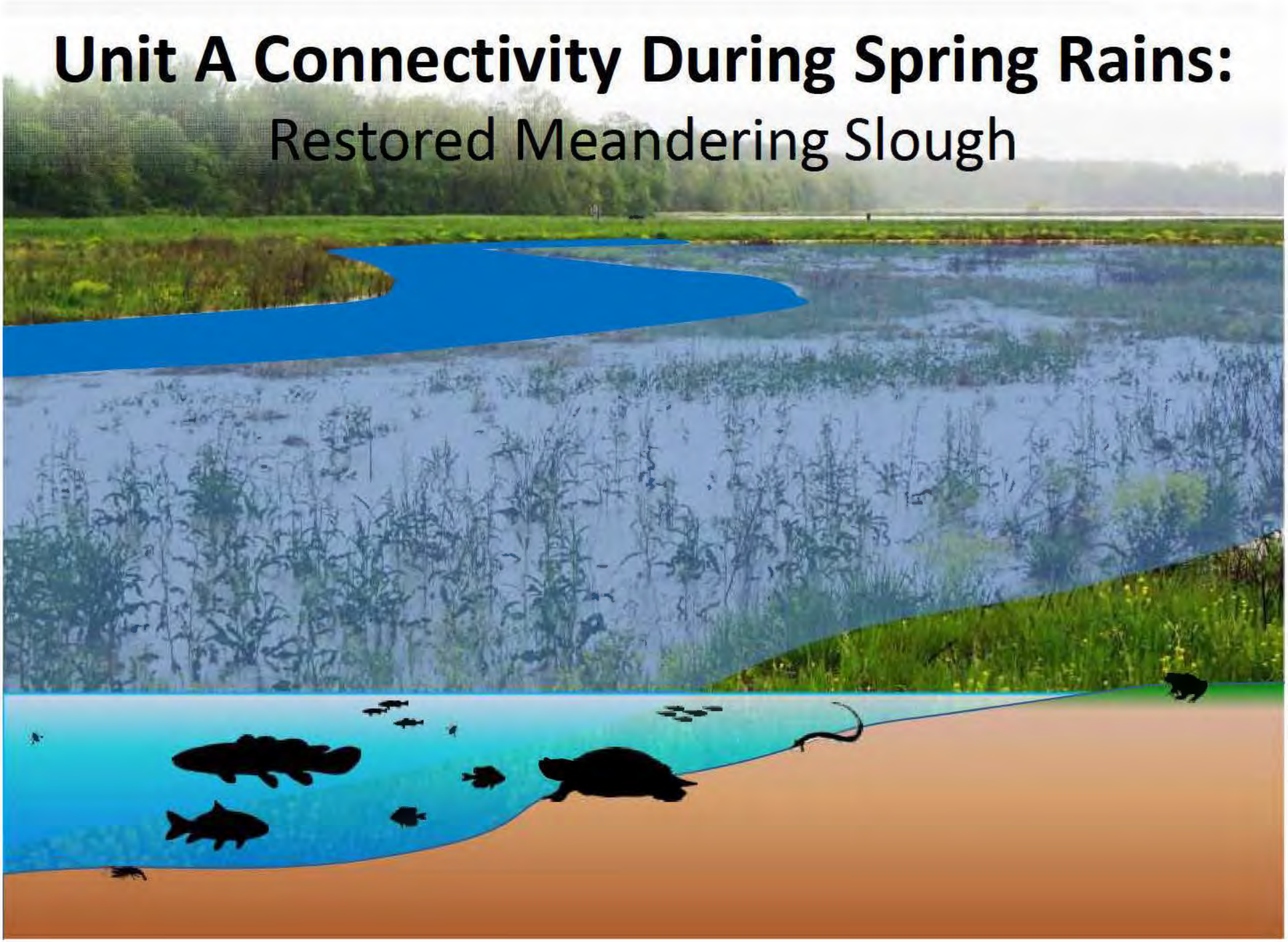
Spillways al


46 Species
12 Different Families of Fish
8 Species of Conservation Concern
1 State Endangered Species


Growth rate of young Bowfin in one month
May 1-7th
May 7-14th
May 15-21st
May22- June 1
2.5mm/day
Average length
2.5 inches
4.5 inches
Nursery Habitat Through Connectivity

Unit A Connectivity During Spring Rains:

Restored Meandering Slough



Species Occurrence Due to Connectivity

2013-2014 Fish Documentation:

- 11 Different Families
- 29 Different Fish Species
  - 21 in 2013
  - 25 in 2014
- 6 Species of Conservation Concern
  - 2 in 2013
  - 6 in 2014

Progress Over Time: Ground Zero

rogress Over Time: Growing Season 201

Progress Over Time: Early Fall (Sept)

Progress Over Time: Fall (Nov)

Progress Over Time: Winter (Dec-Jan)

Using Lidar at Duck Creek

Putting the plan on the ground

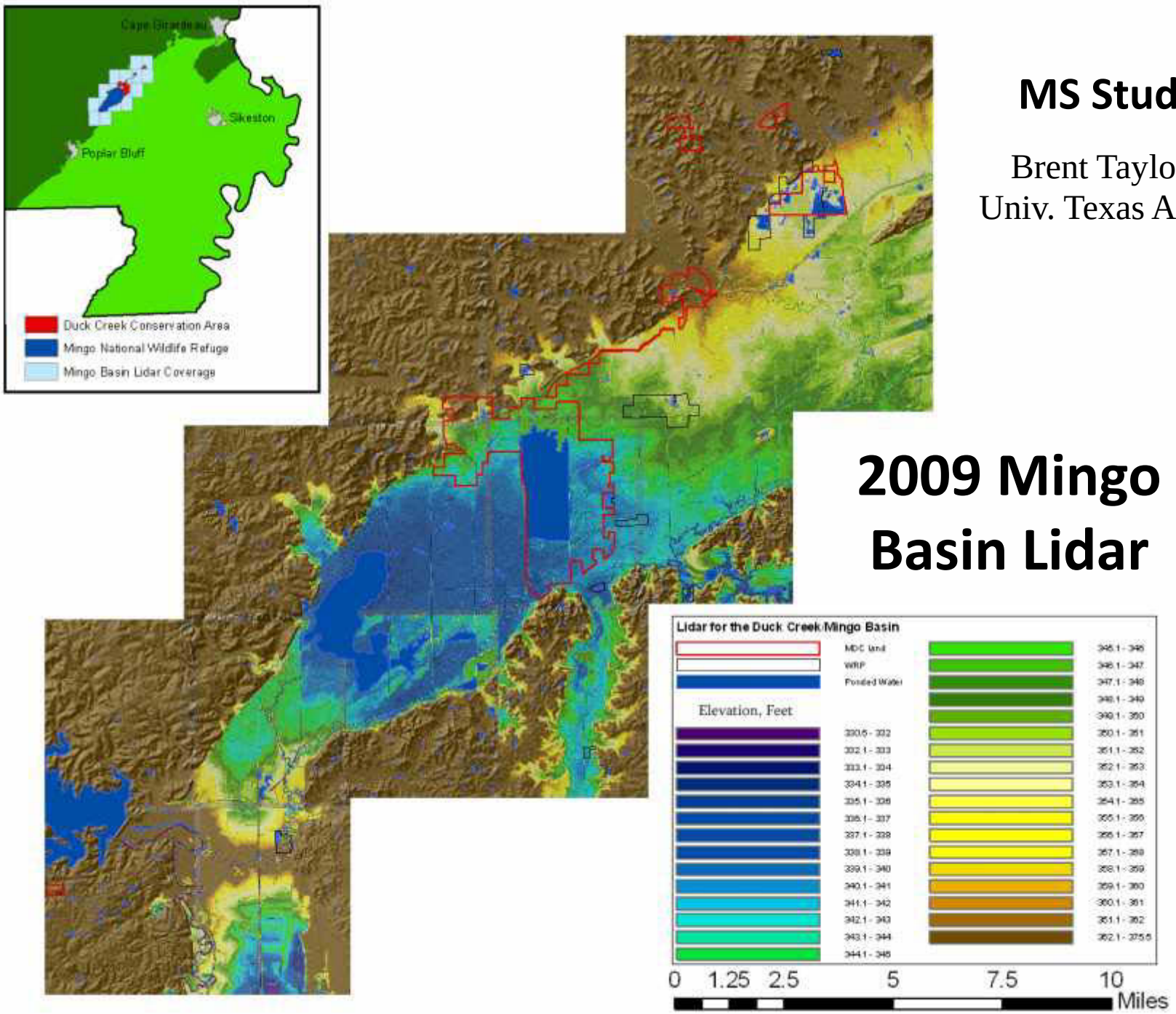
- Used same tools to create surface roughness that are often used to diminish natural variability

Broader Applications

How much topography alteration has occurred?

At what point do these individual efforts have a cumulative impacts in water and nutrient cycling?

Where might conservation or alternative agriculture practices fit best on the landscape?



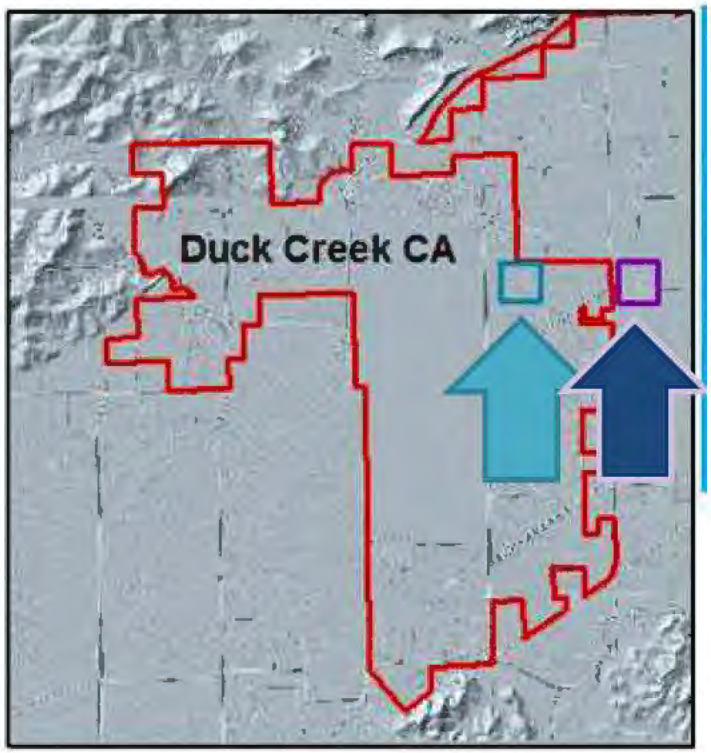
MS Study

Brent Taylor,
Univ. Texas A&M

2009 Mingo Basin Lidar

Natural Topography Vs. Altered Topography

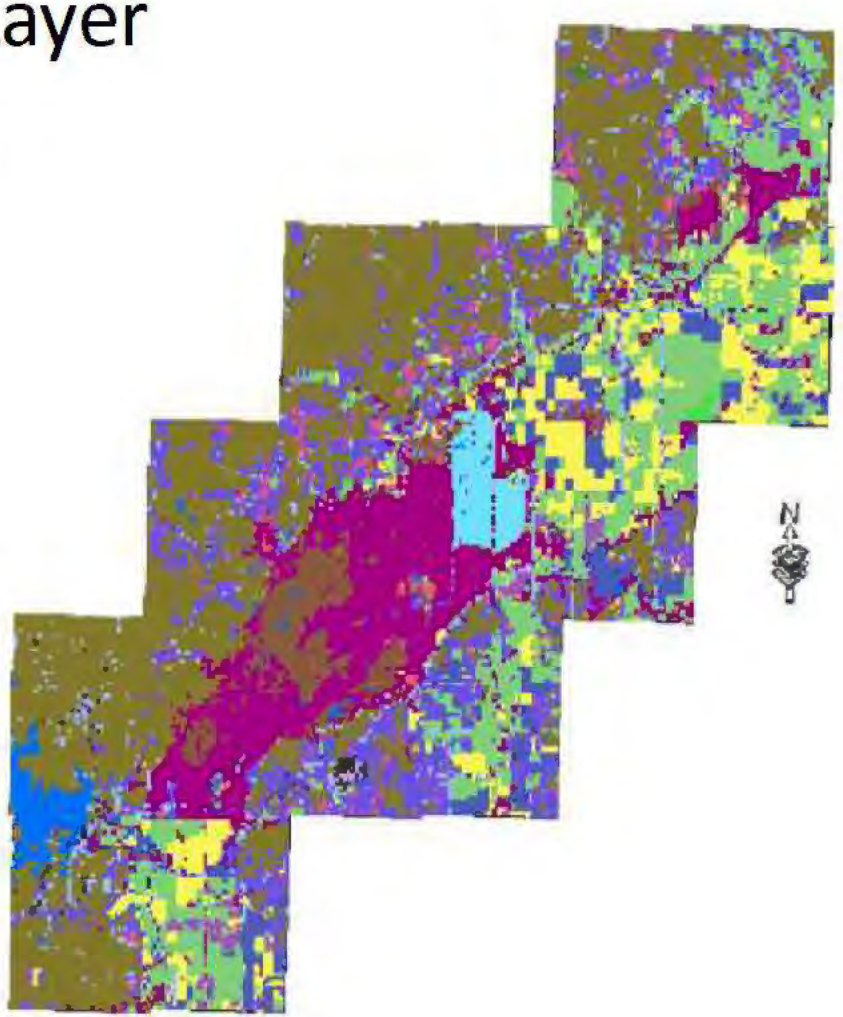
Large Scale Map of Area



Blue and purple boxes show location of two different surfaces (shape and profiles)

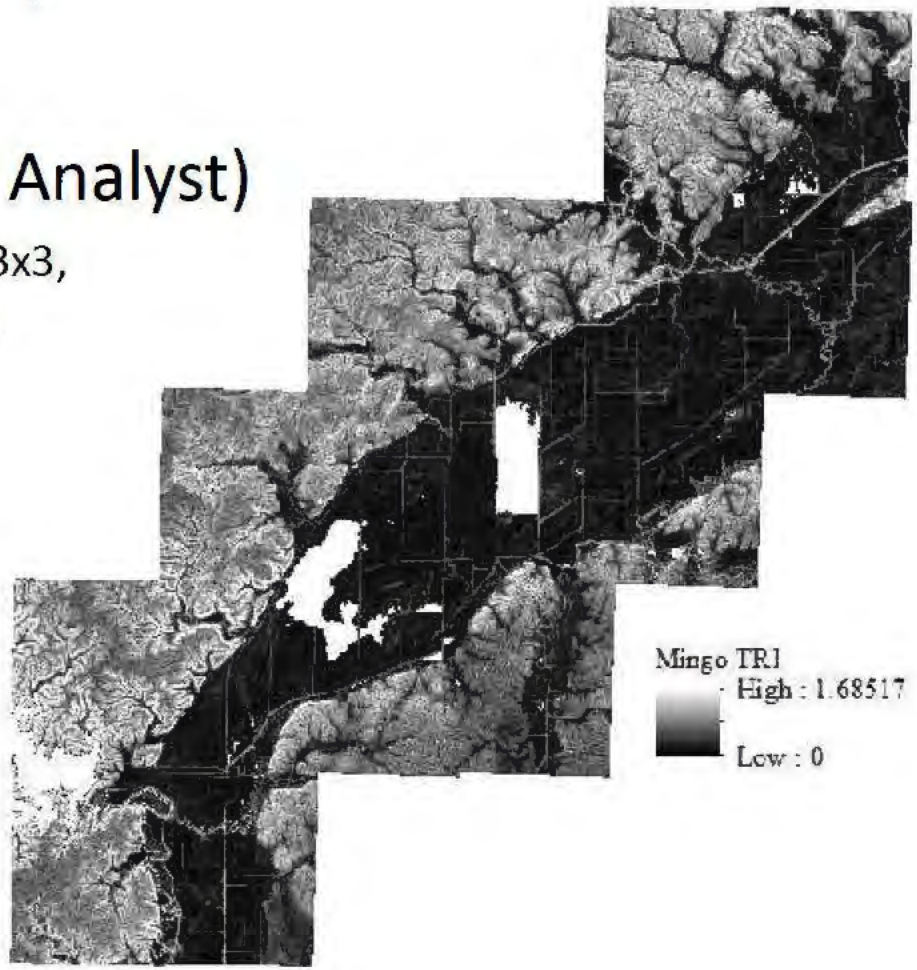
Mingo Basin Landuse Data Layers

- 2013 NASS Cropland Data Layer
- USFWS National Wetlands Inventory
- High Resolution National Hydrology Dataset



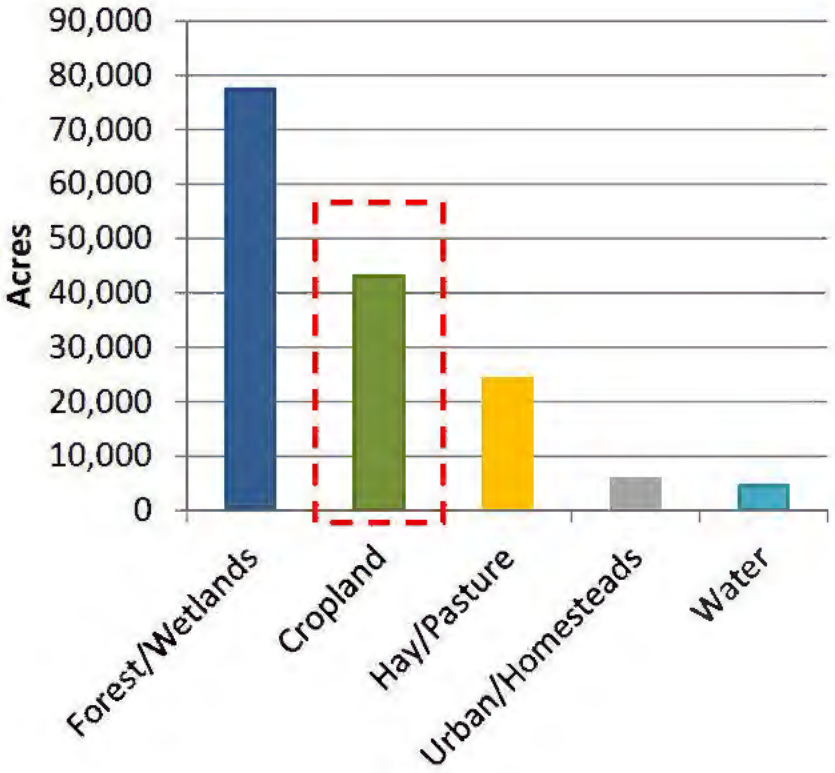
Identifying Precision Leveled Farmland

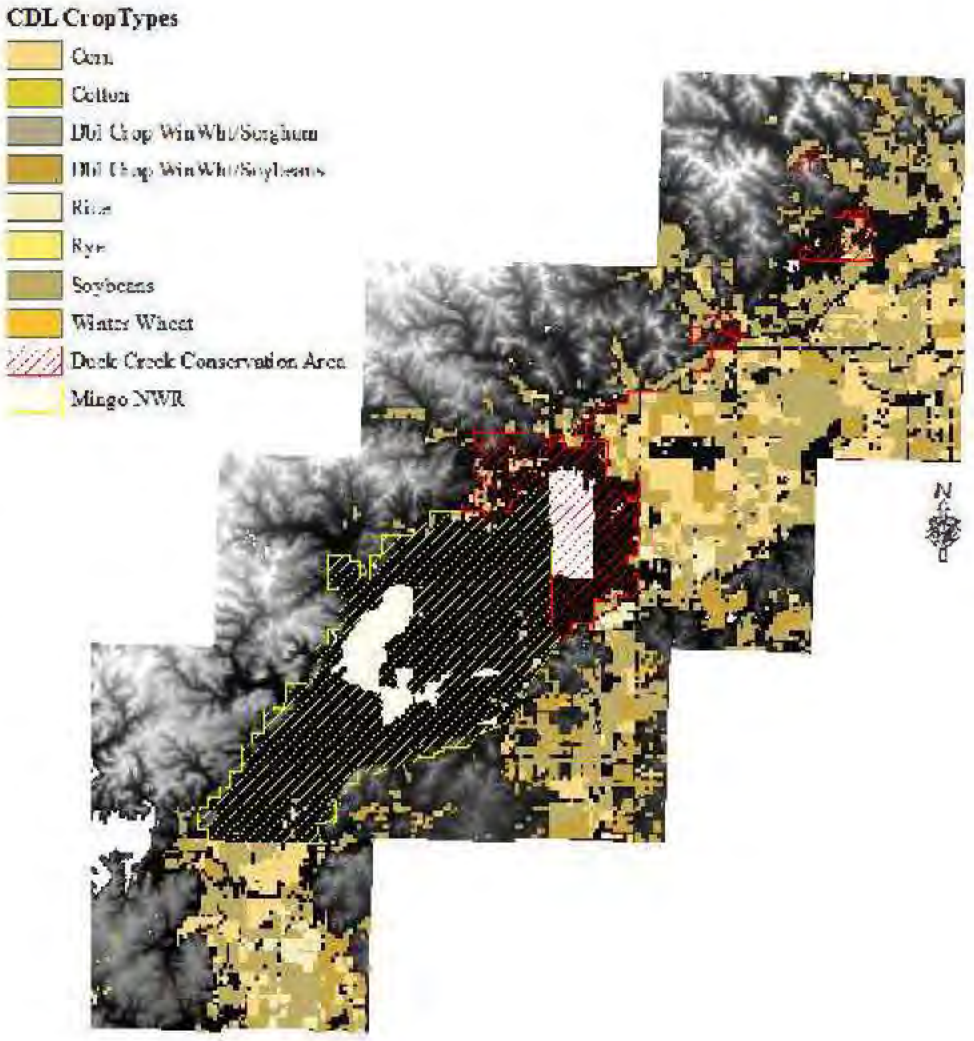
- Terrain Ruggedness Index (TRI)
  - Riley et al. 1999
- Using Focal Statistics (Spatial Analyst)
  1. DEM, Neighborhood = Rectangle, Size = 3x3, Units = Cells, Statistics Type = **Minimum**, Output = 3x3min
  2. DEM, Neighborhood = Rectangle, Size = 3x3, Units = Cells, Statistics Type = **Maximum**, Output = 3x3max
- Using Raster Calculator



SquareRoot(Abs((SquareRoot("3x3max")-SquareRoot("3x3min"))))

Results – Landuse Summary

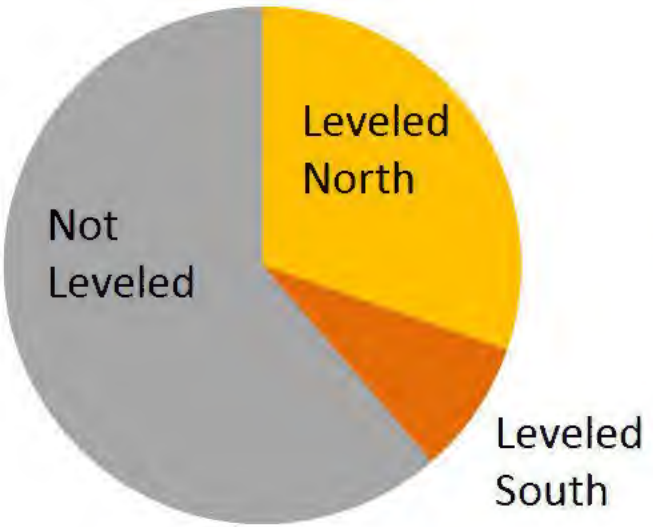


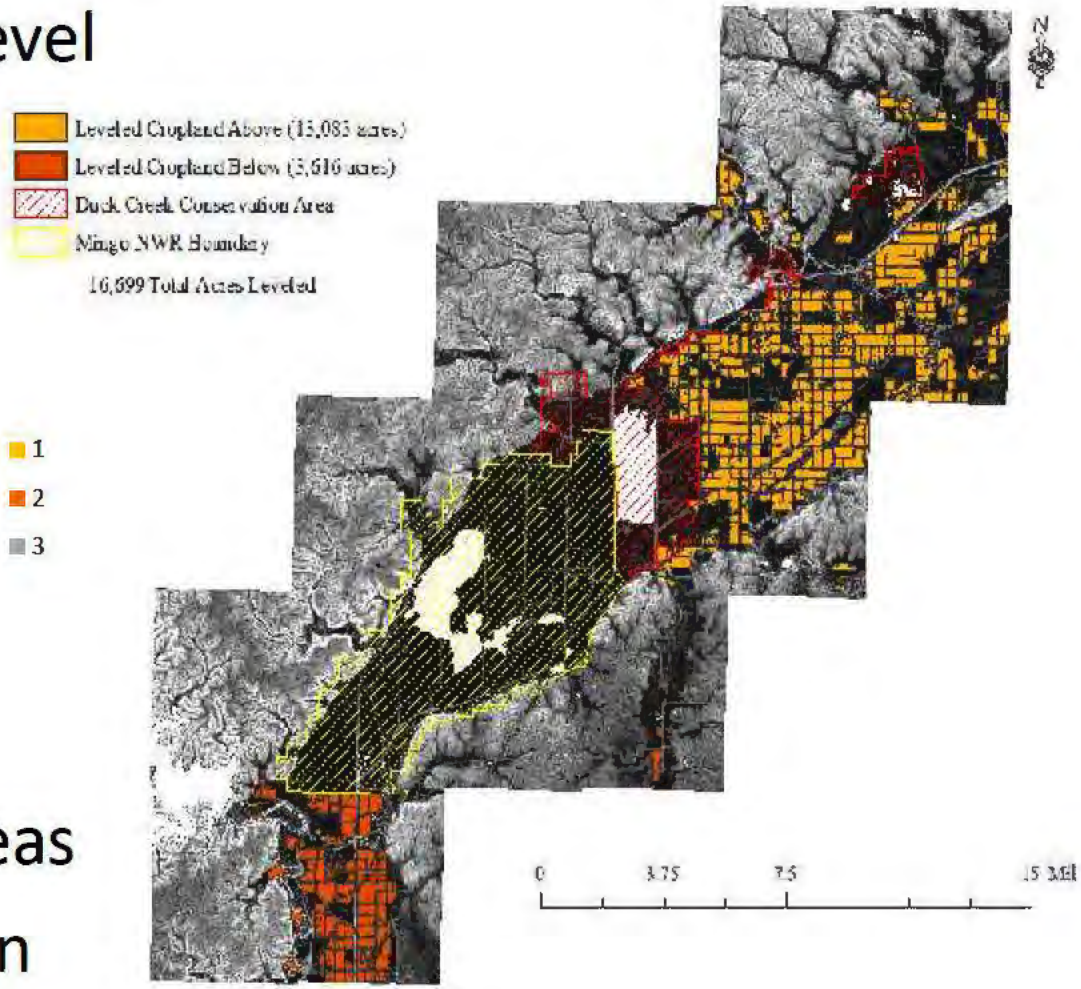


Agricultural Development – Precision Leveling

- ~42,864 Total Cropland Acres
- 39 % Acres Uniformly Level

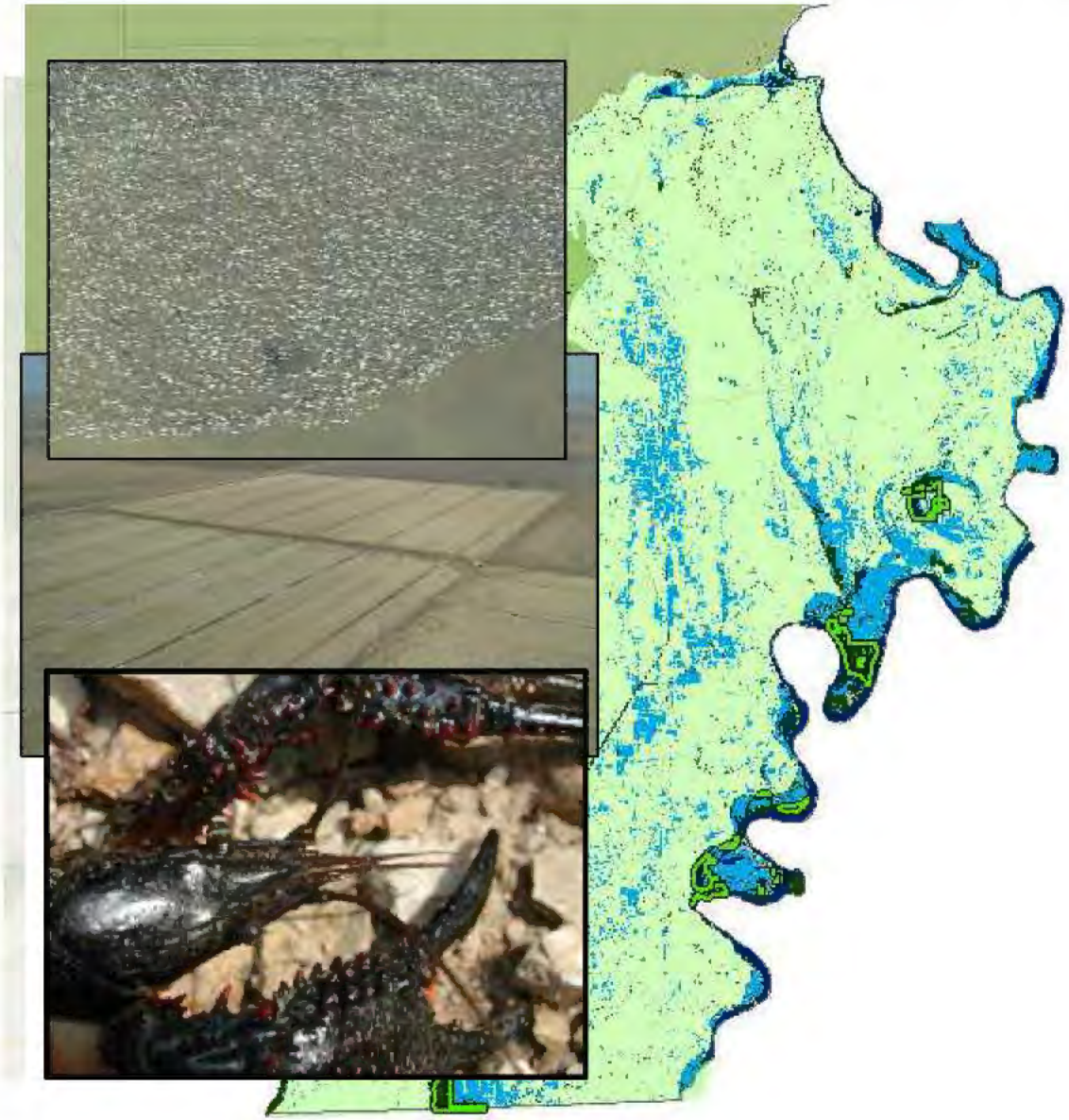
  = 16,699 Acres





- Highlight non-leveled areas
- Potential for conservation
- Just the start/ identified steps

Diverse Geomorphology/Typography



Overlain by agriculture

Connected through a network of ditches

Providing food to people and critters

Understanding how the land functions with these modifications is important…

…And now quantifiable

Utilized Landscape:

This isn't something foreign

Morphological Features/Soils
+
Hydrology
+
Ecology
+
Engineering

Higher Chance of Success

But an approach that can be applied

Lidar is a useful tool to merge the natural and engineered worlds


Questions
DITCH A2
LEVEE A3
BEGIN ℄ DITCH A6
STA. 0+00.00
LEVEE A2
END ℄ LEVEE A4
STA. 23+39.34
TOP OF LEVEE
EL. 347.50
23+00
24+00
25+00
9+00
52+00
53+00
54+00
20+00
21+00
22+00