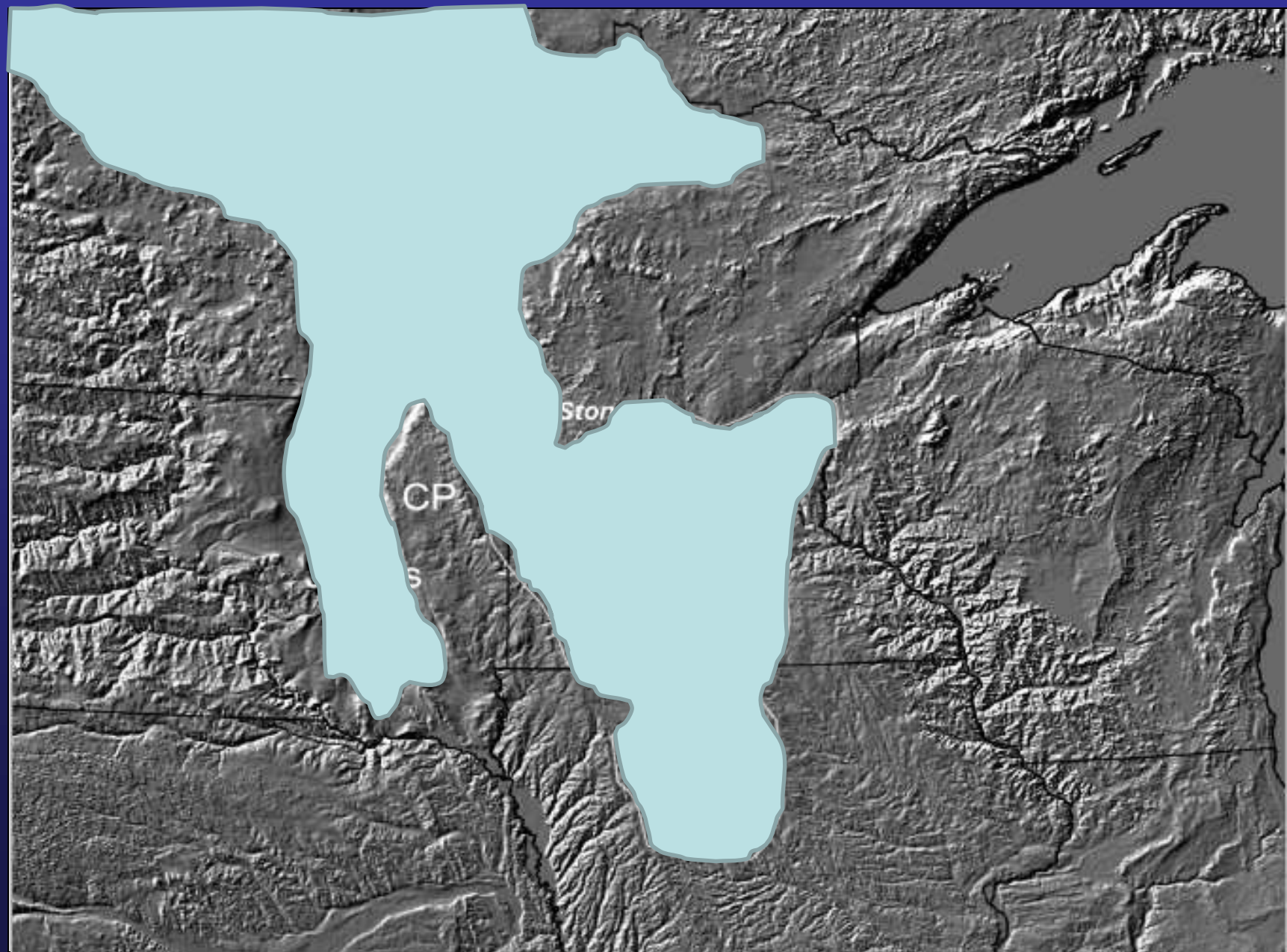
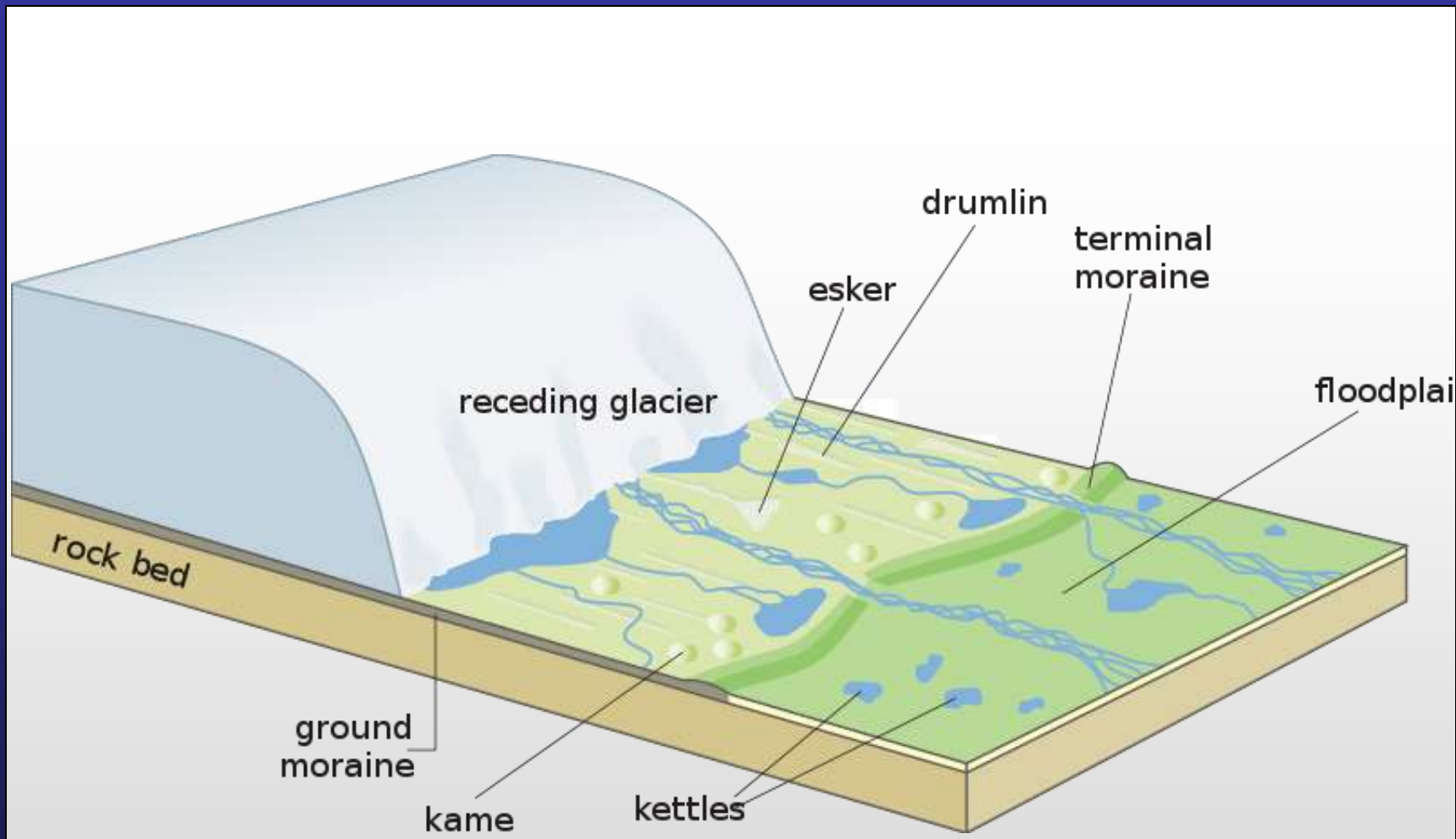
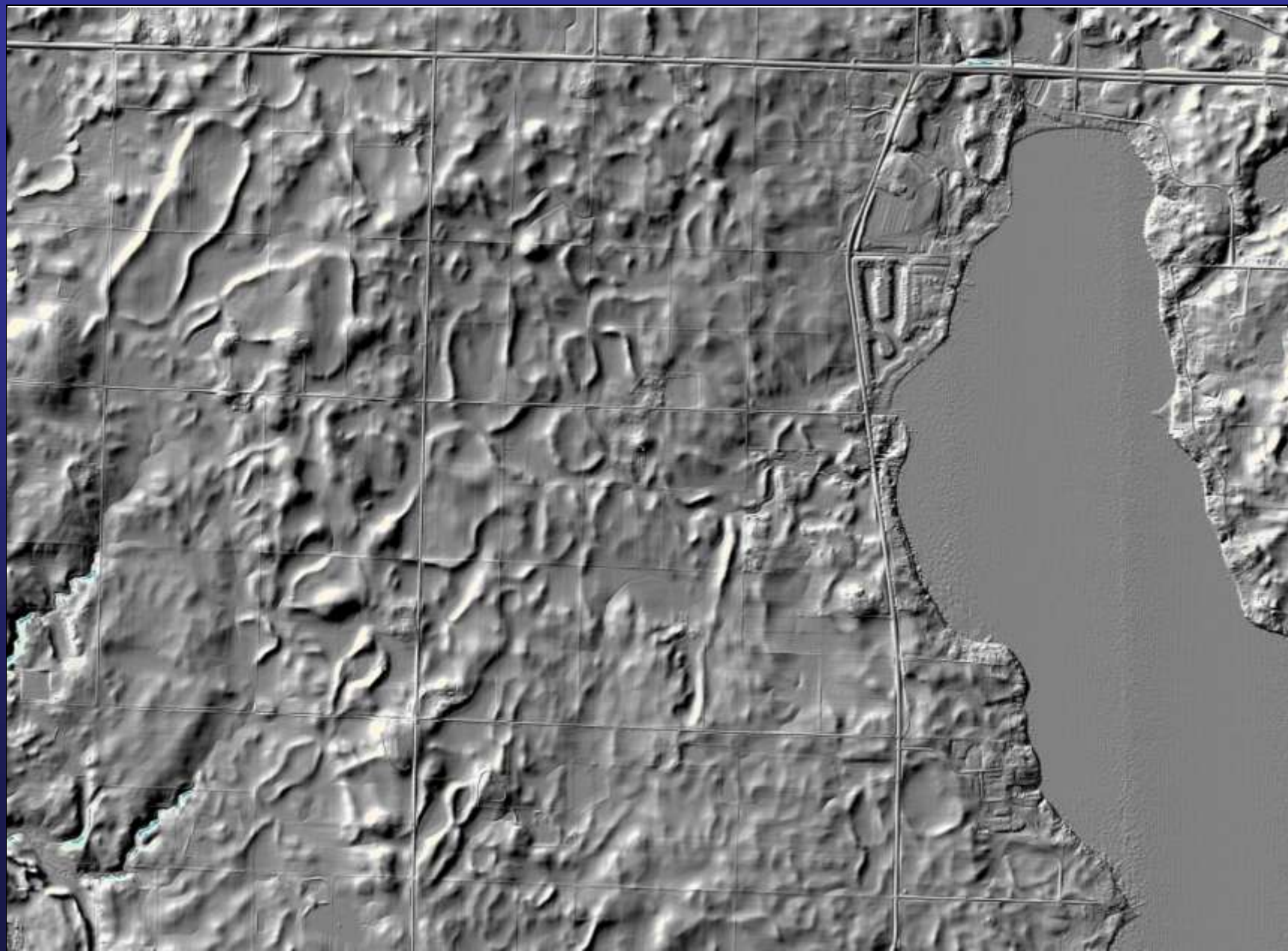
Glacial Origins



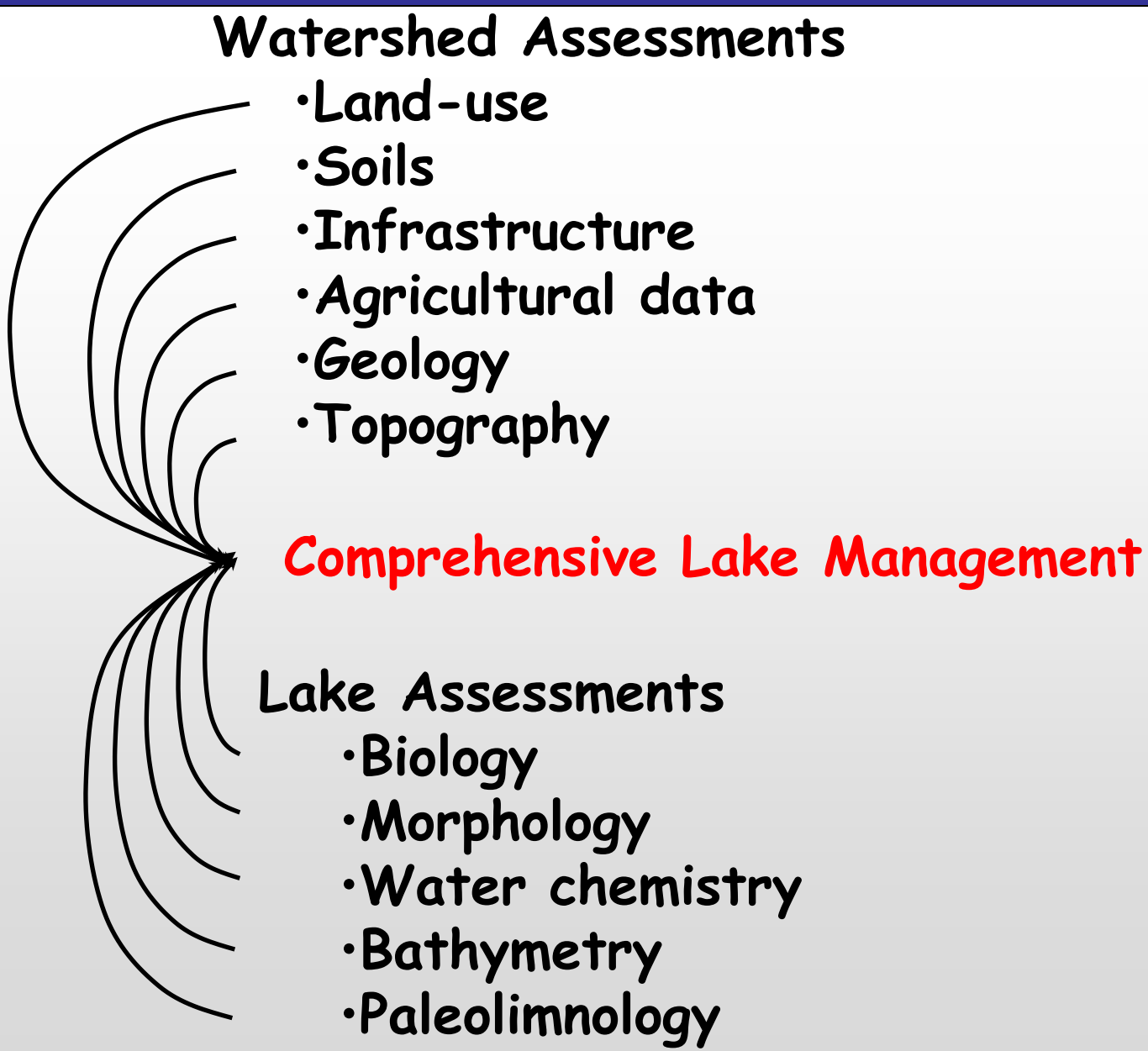
Glacial Landform Features of the Great Lakes Region

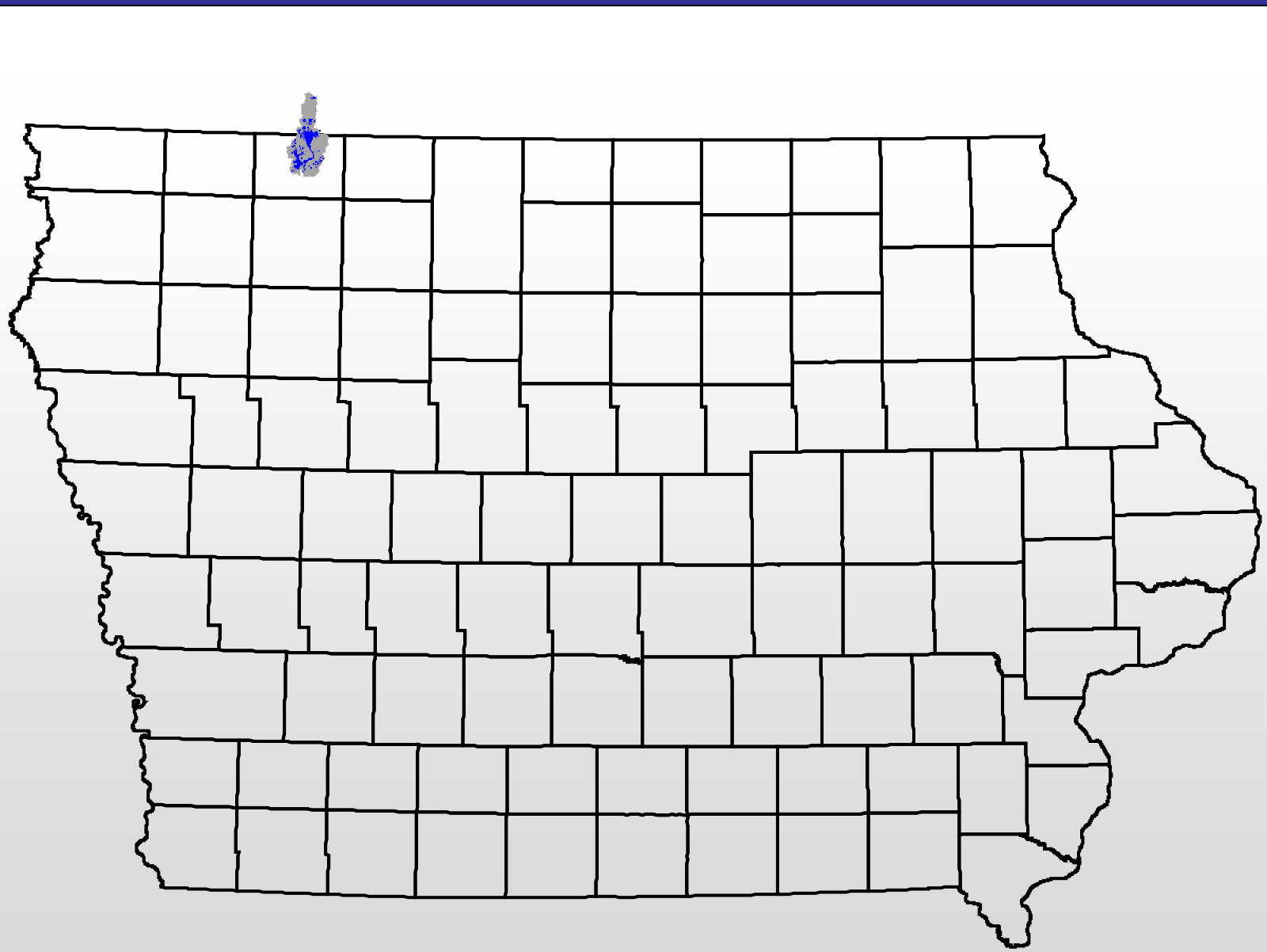
Kettleholes, Eskers, Kames and Hummocky Topography

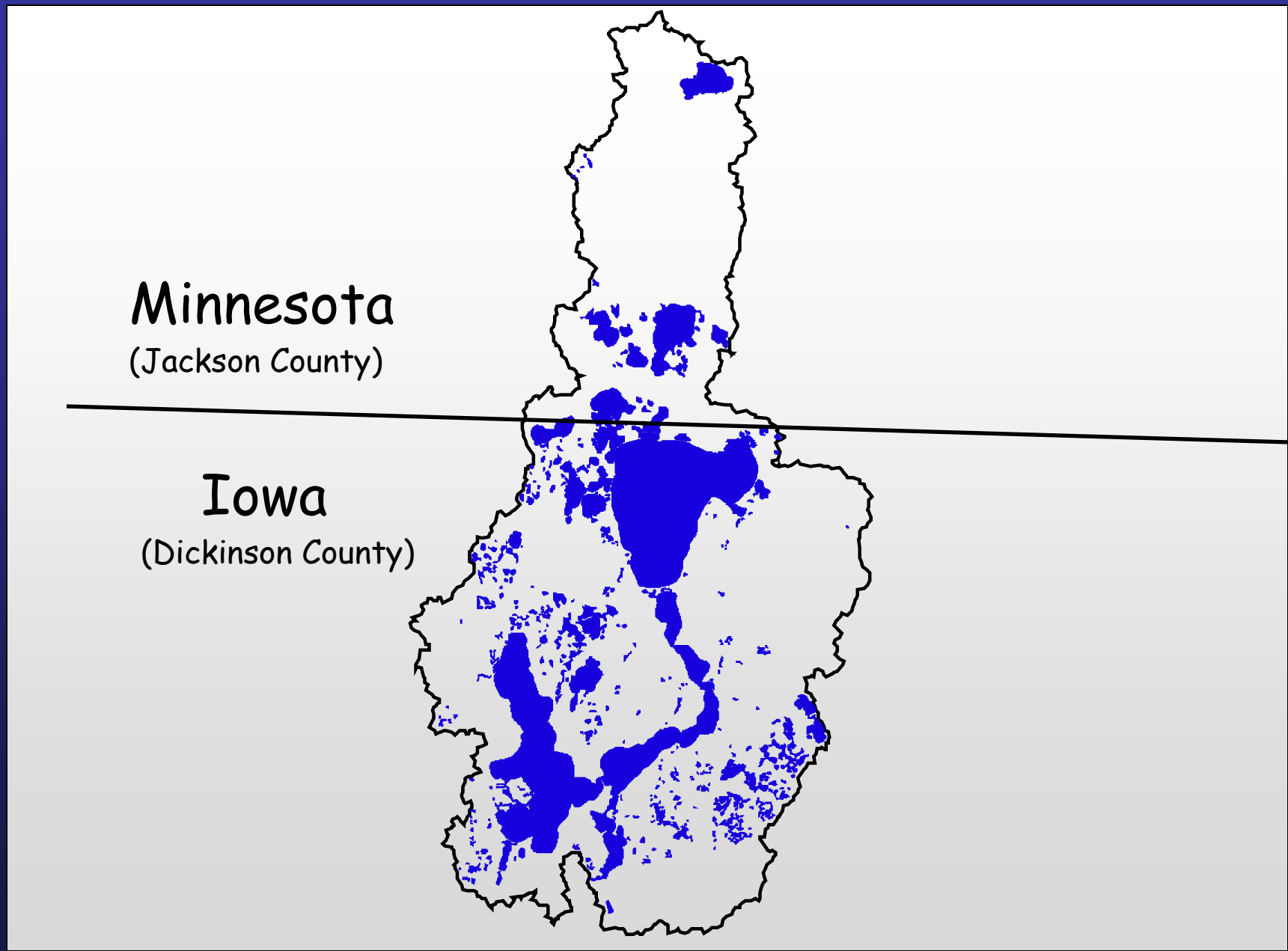

drumlin
terminal moraine
esker
receding glacier
floodplai
rock bed
ground moraine
kame
kettles

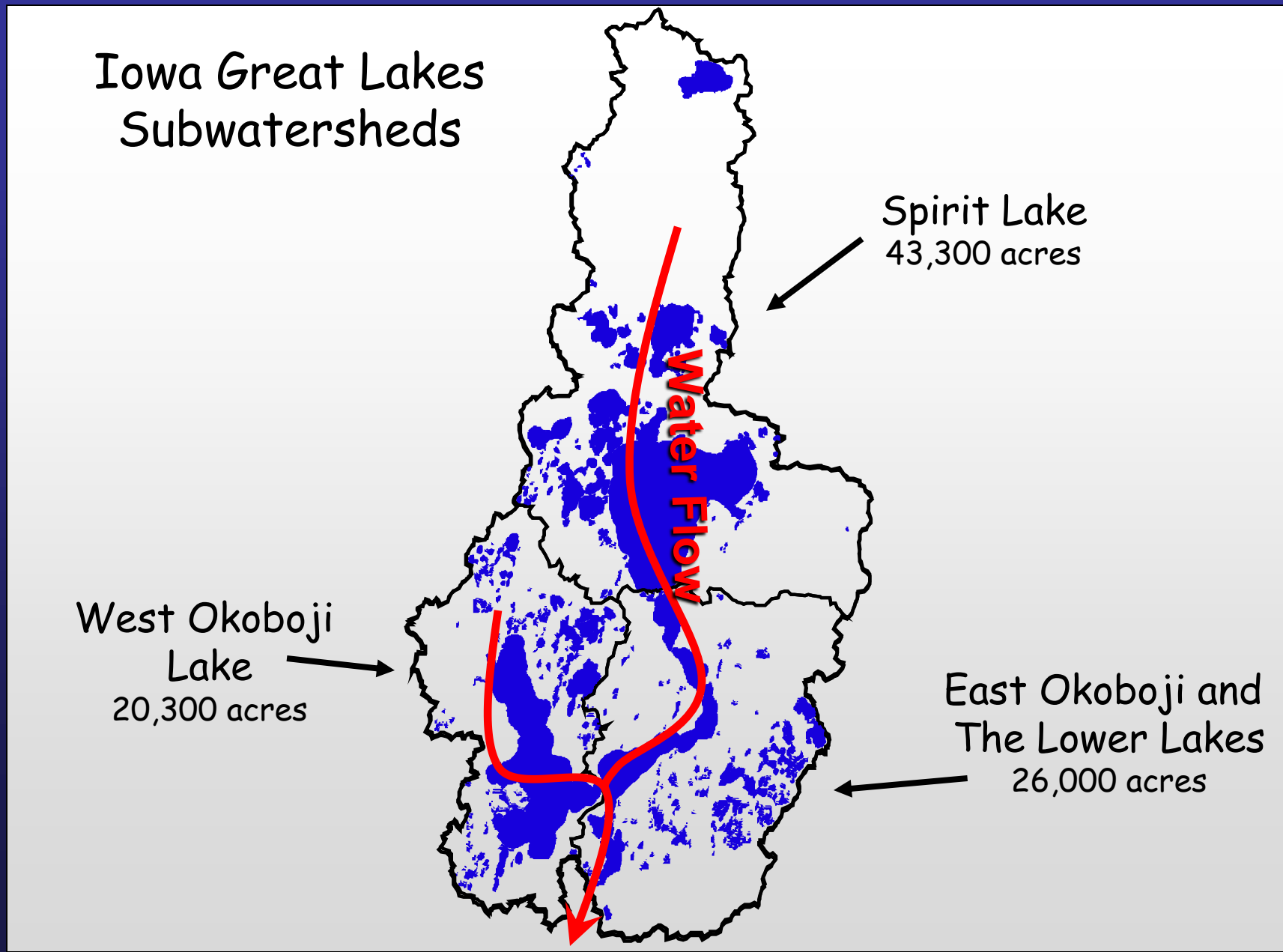


Iowa Great Lakes Watershed Assessment


Watershed Assessments
•Land-use
•Soils
•Infrastructure
•Agricultural data
•Geology
•Topography
Comprehensive Lake Management
Lake Assessments
•Biology
•Morphology
•Water chemistry
•Bathymetry
•Paleolimnology




Minnesota
(Jackson County)
Iowa
(Dickinson County)


Iowa Great Lakes
Subwatersheds
Spirit Lake
43,300 acres
Water Flow
West Okoboji
Lake
20,300 acres
East Okoboji and
The Lower Lakes
26,000 acres

1939

1950s

1960s

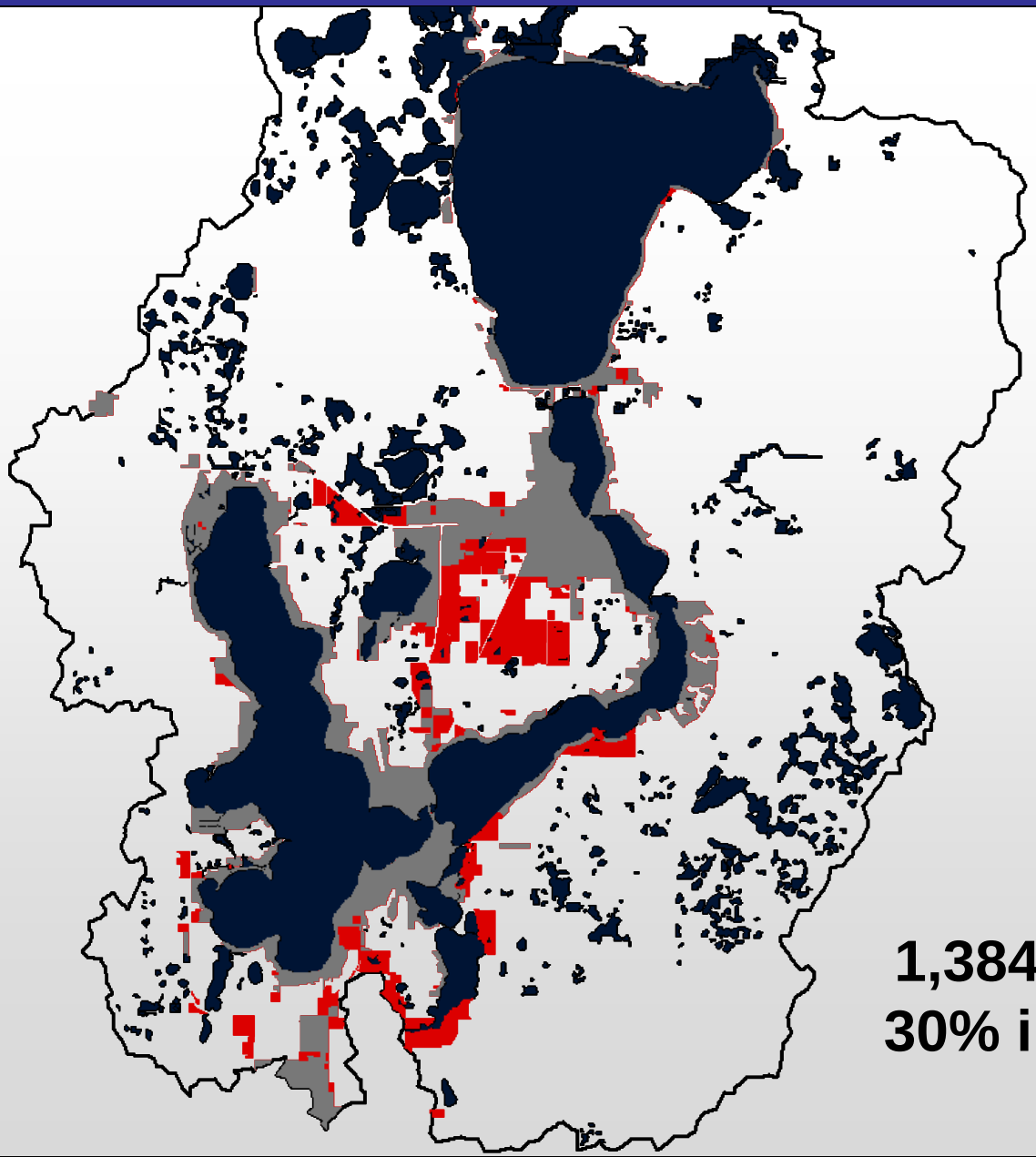
1990s

2002

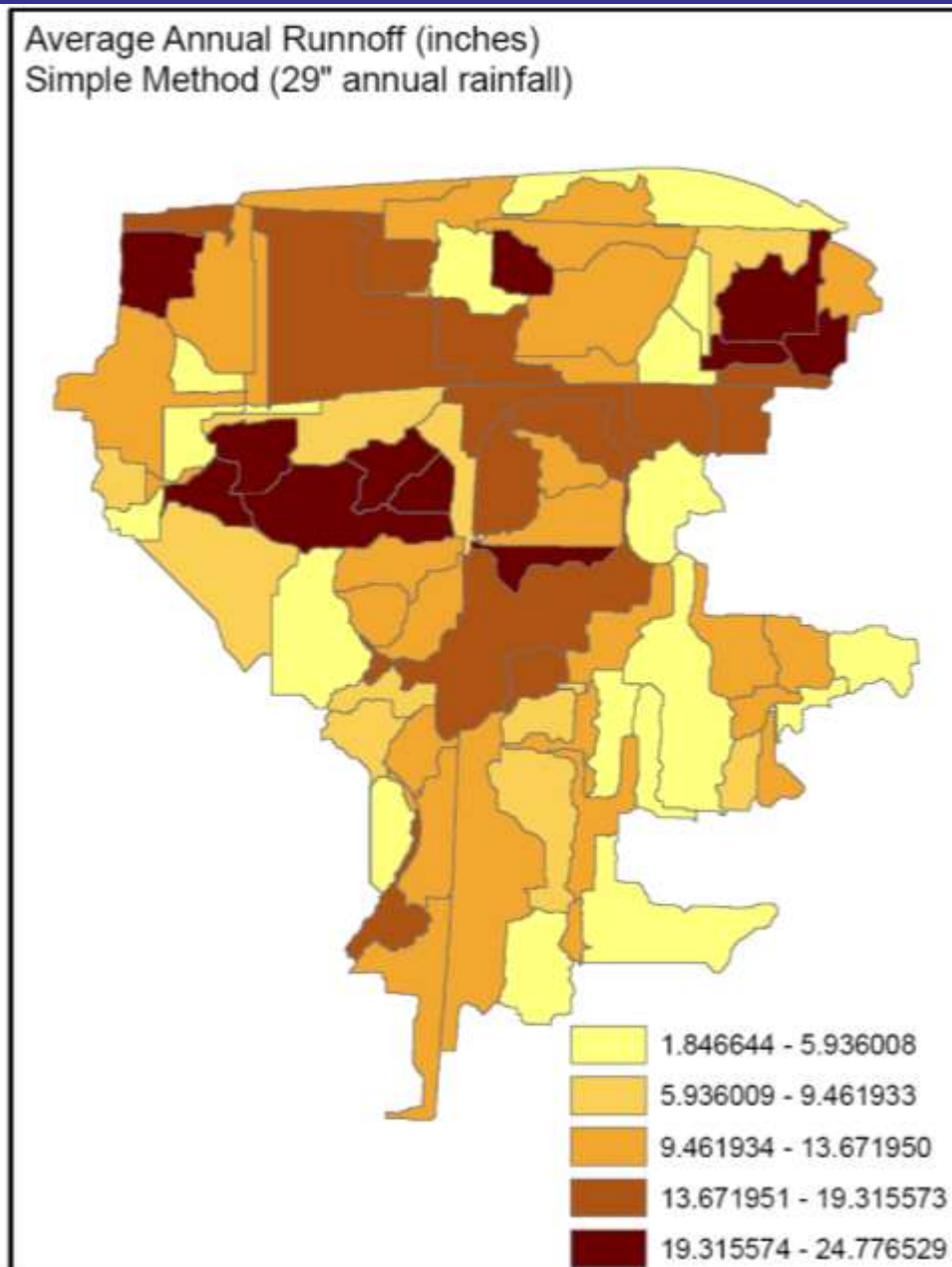
2006

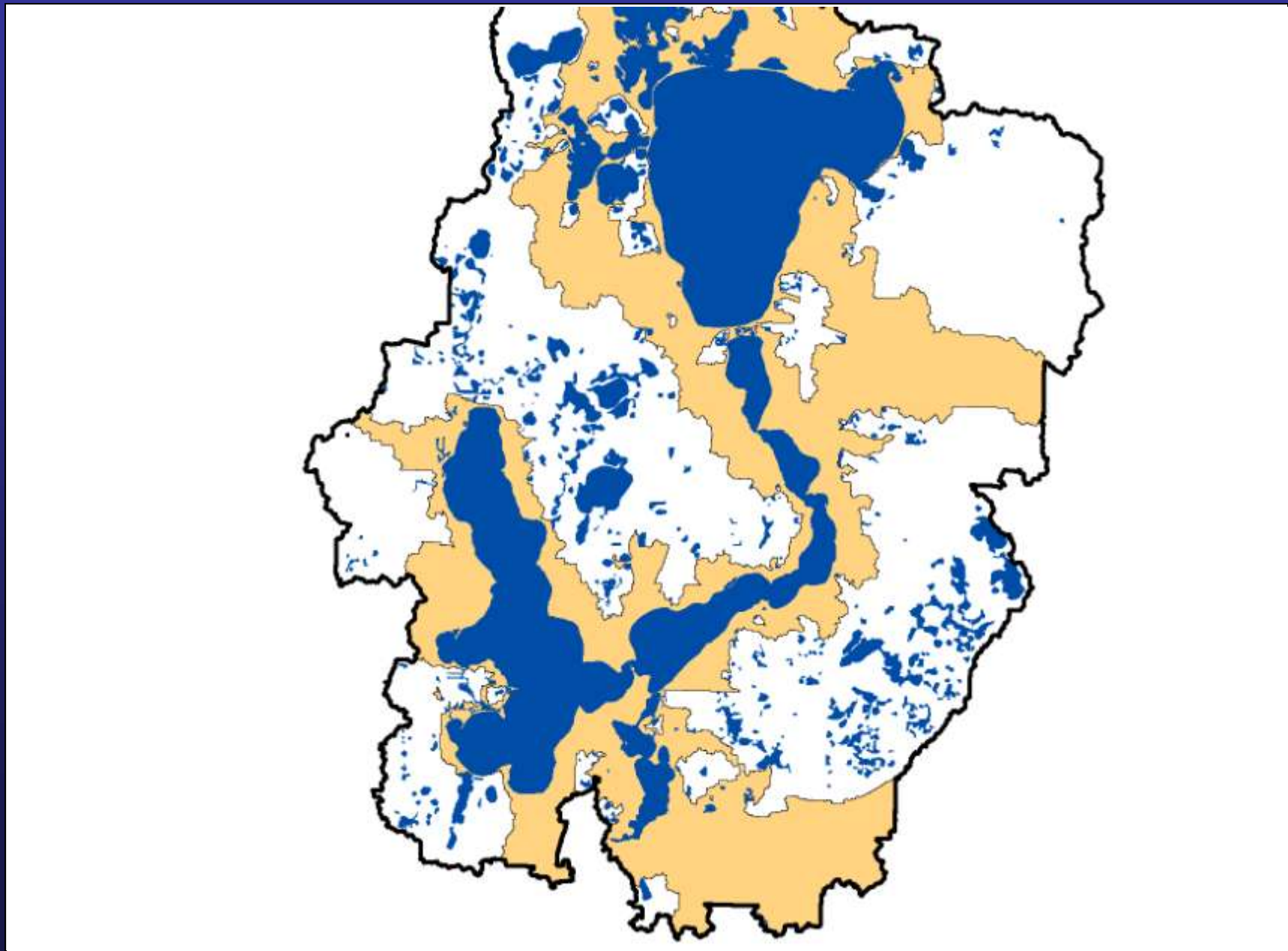
2012

1992 1998 2006



1,384 acres
30% increase

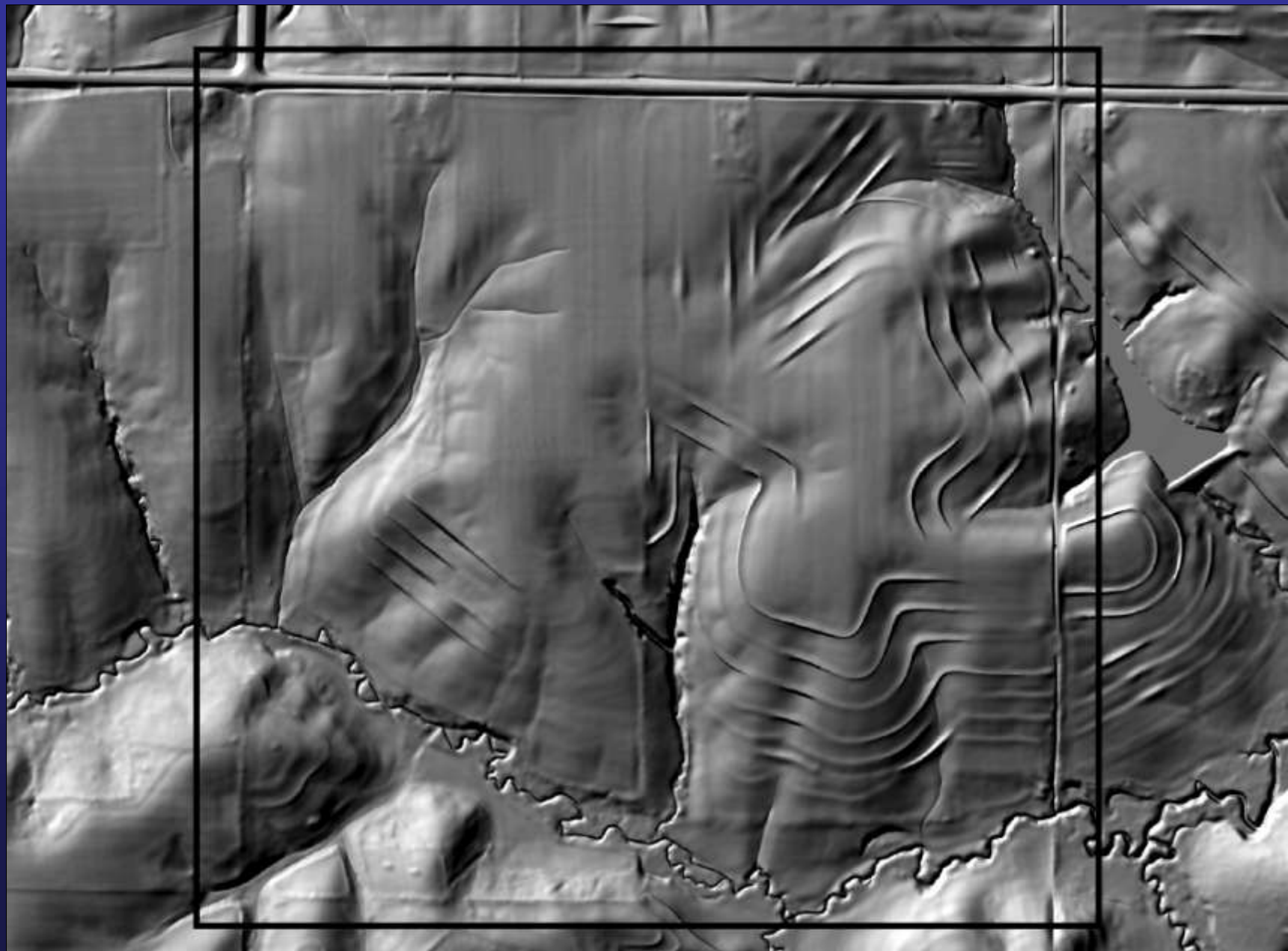

Average Annual Runnoff (inches)
Simple Method (29" annual rainfall)
1.846644 - 5.936008
5.936009 - 9.461933
9.461934 - 13.671950
13.671951 - 19.315573
19.315574 - 24.776529



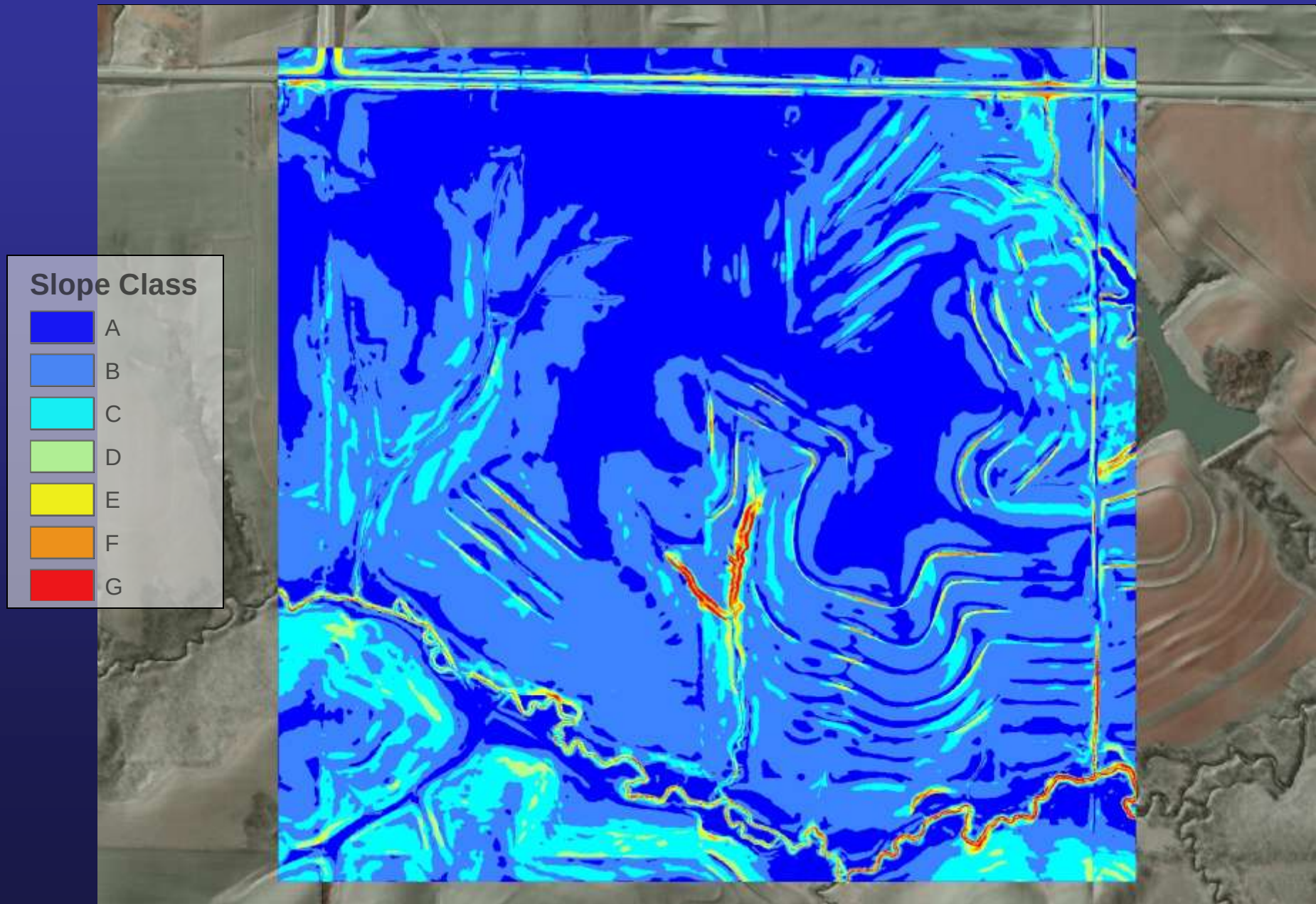
Watershed Statistics

- Watershed Area (Lakes and Land) – 85,933 acres
- Pre-settlement – 32,366 acres of water (37%)
- Today – 17,930 acres of water (45% reduction)
  - 1,231 acres restored since 1980
- 81% of upland wetlands drained

Agricultural Modeling



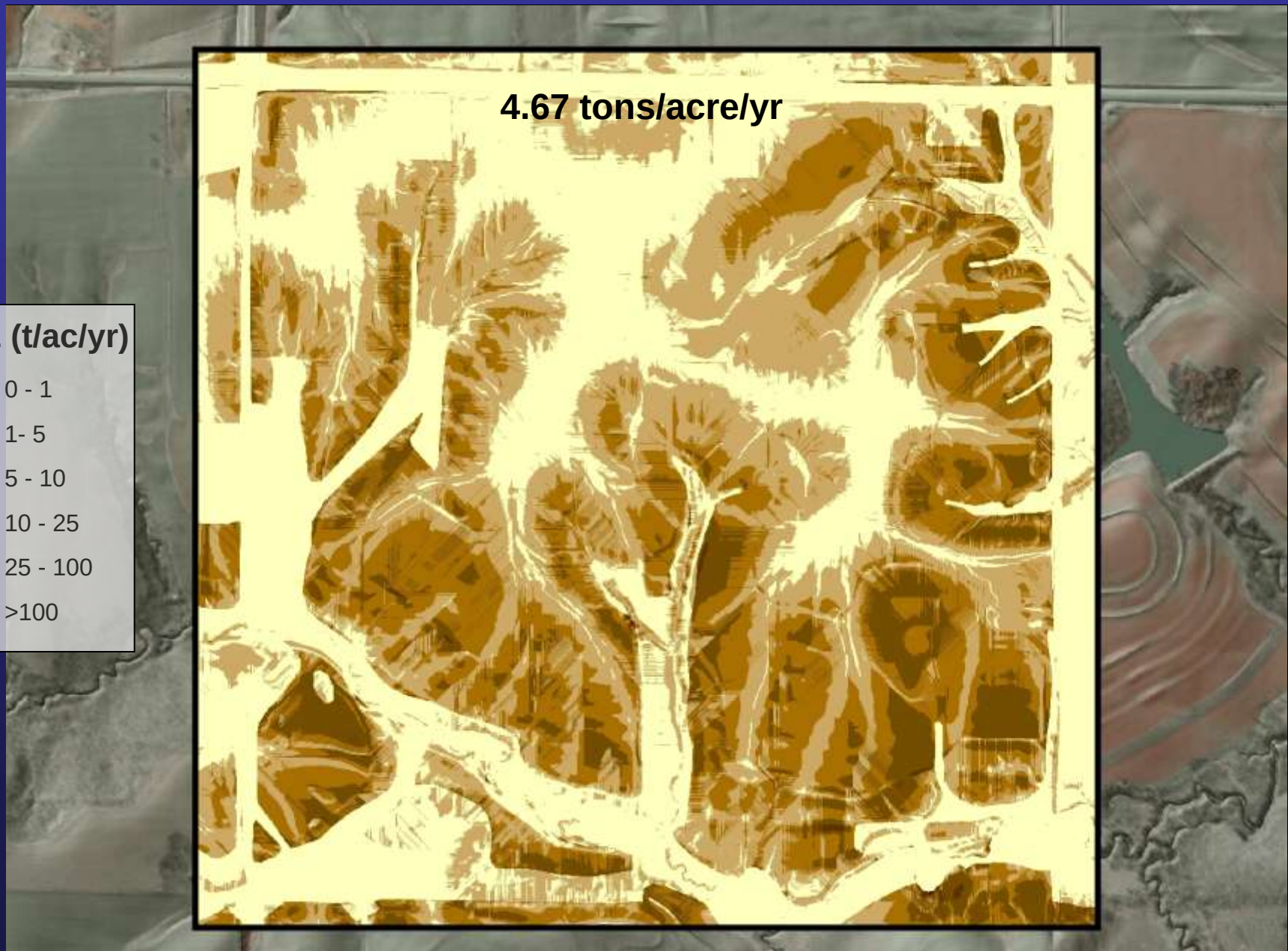
Soil Survey Slope

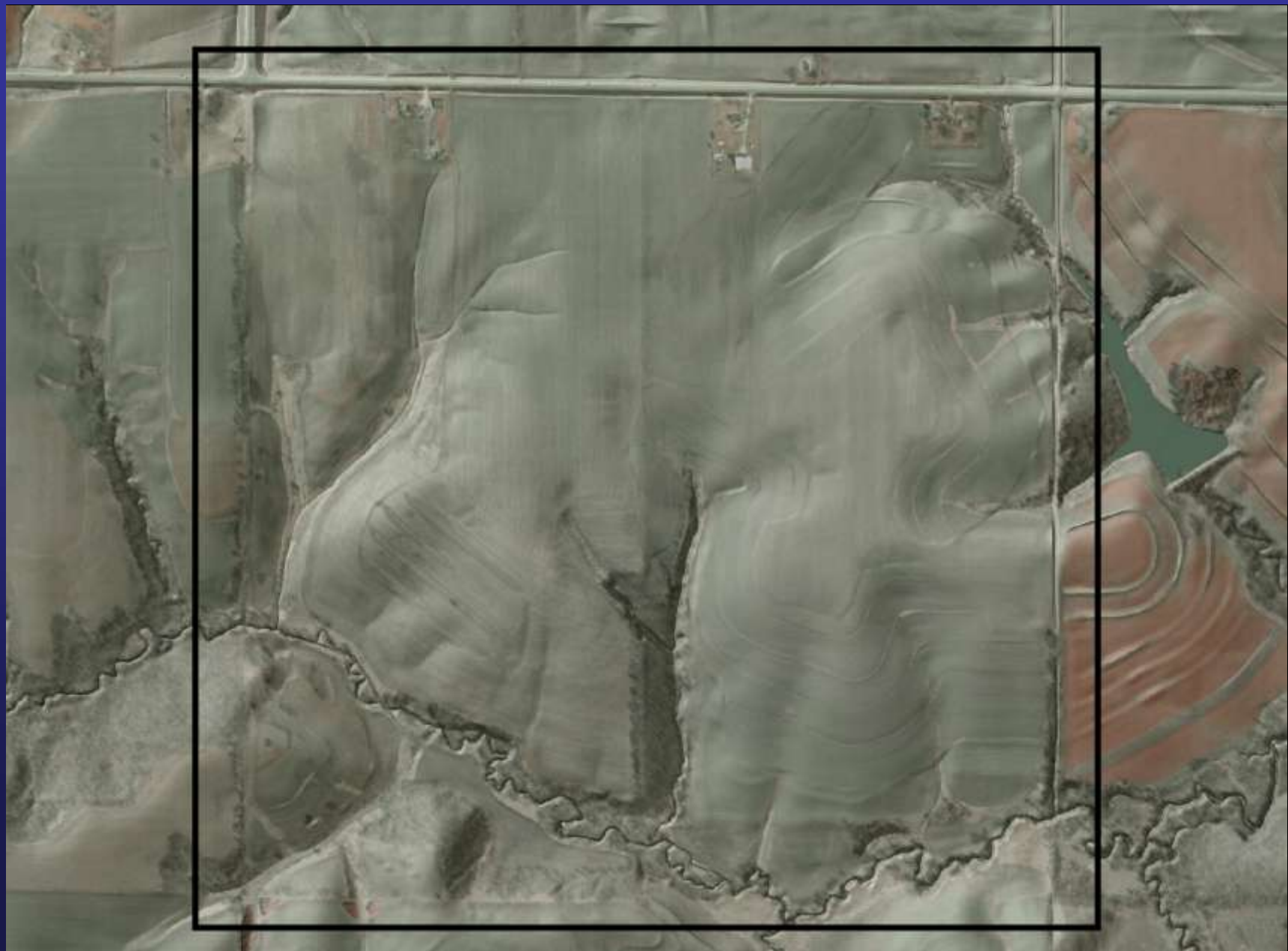


Land Use Delineation

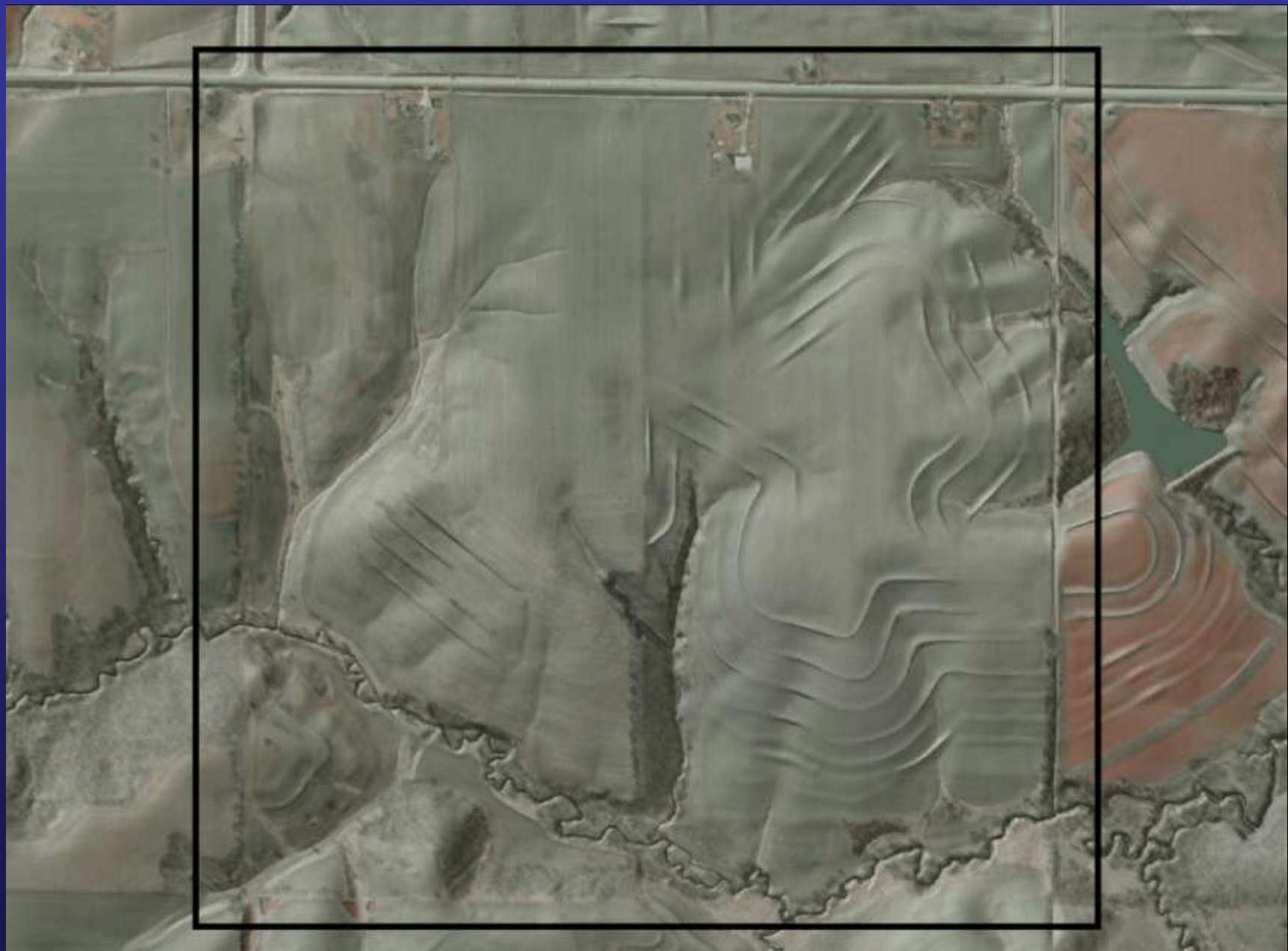
Land Use Classification

RUSLE – 10% Residue

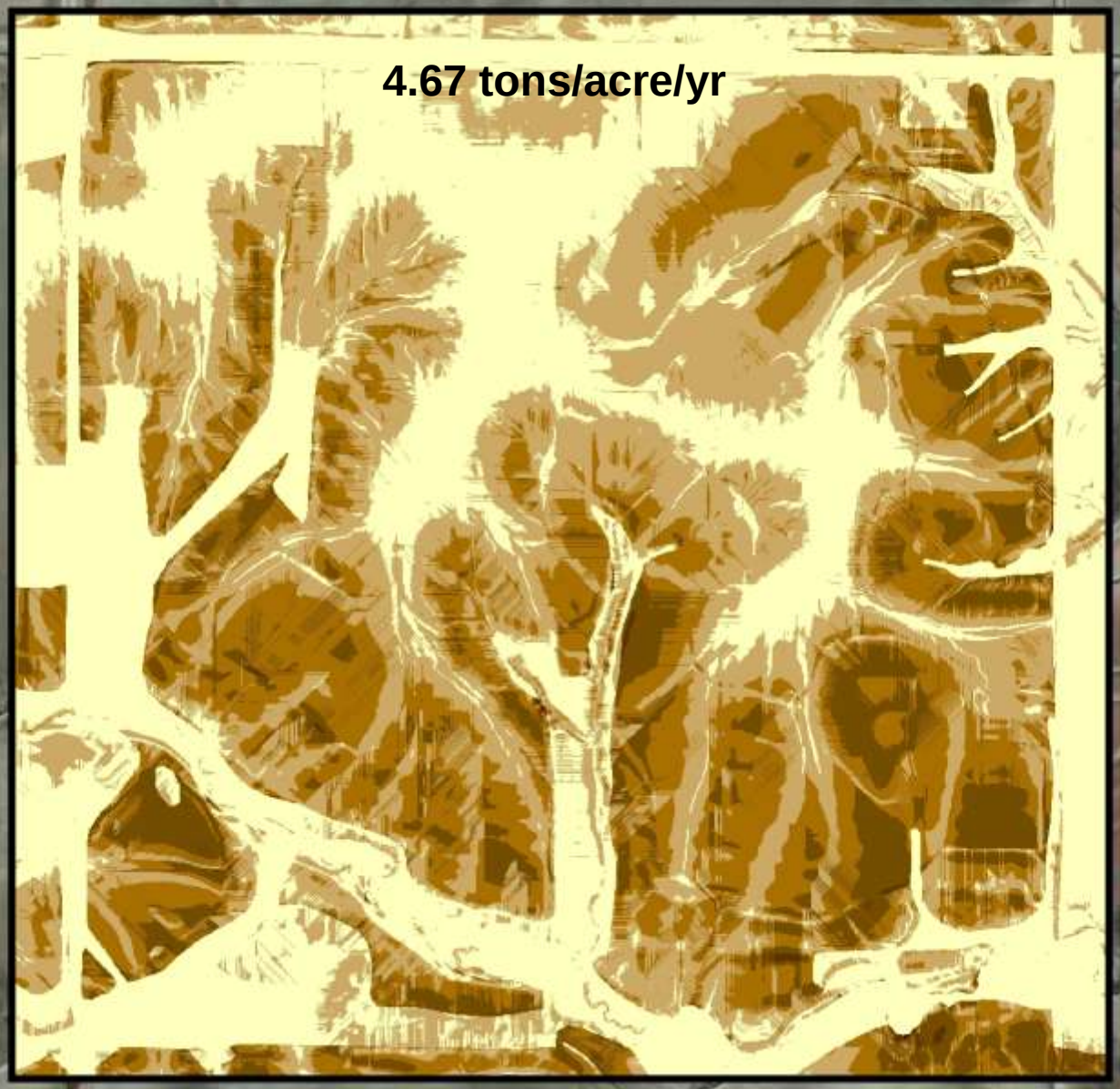




Terraces



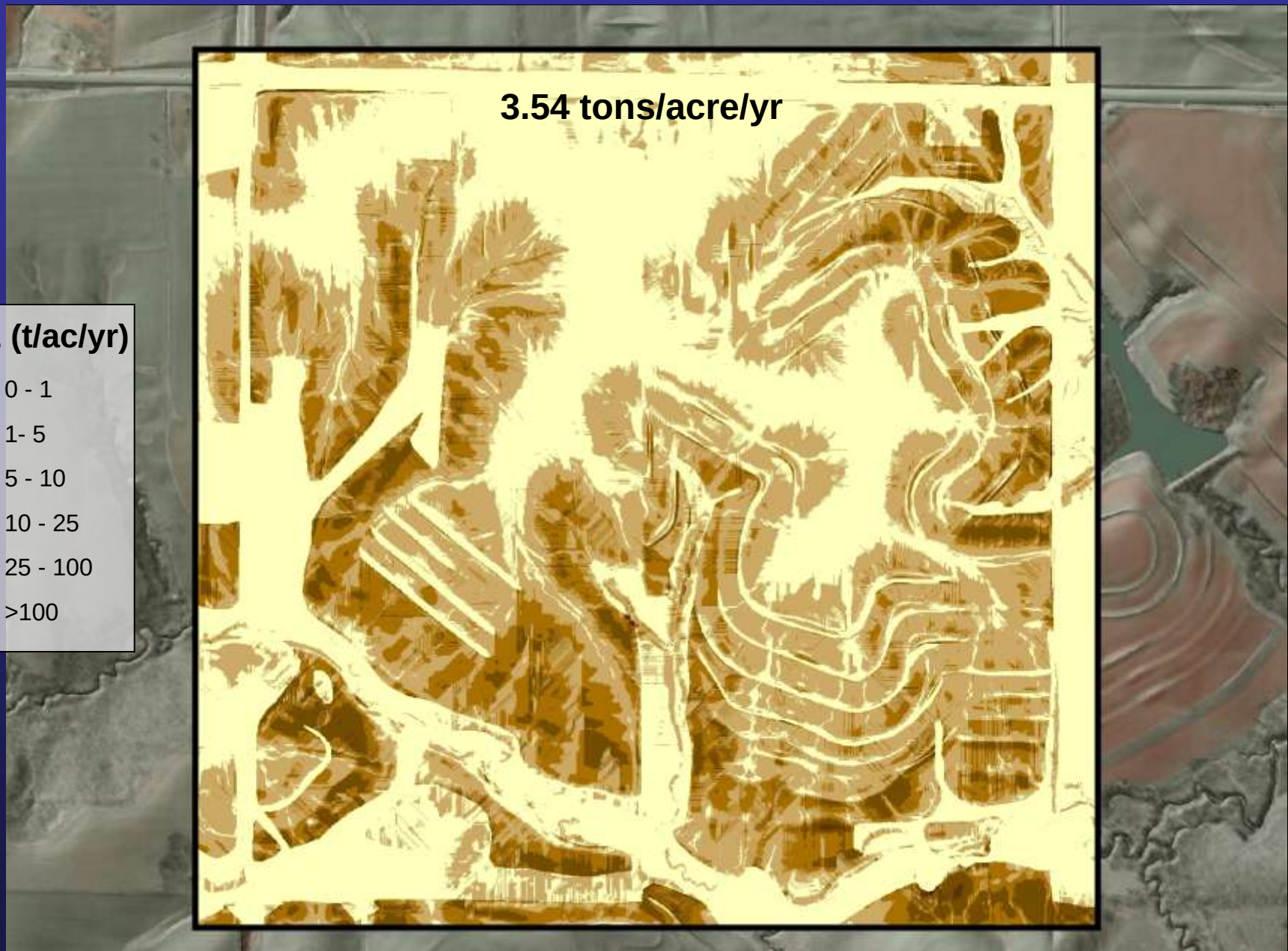
RUSLE – 10% Residue



RUSLE (t/ac/yr)

- 0 - 1
- 1- 5
- 5 - 10
- 10 - 25
- 25 - 100
- >100

RUSLE – 10% Residue – With Terraces



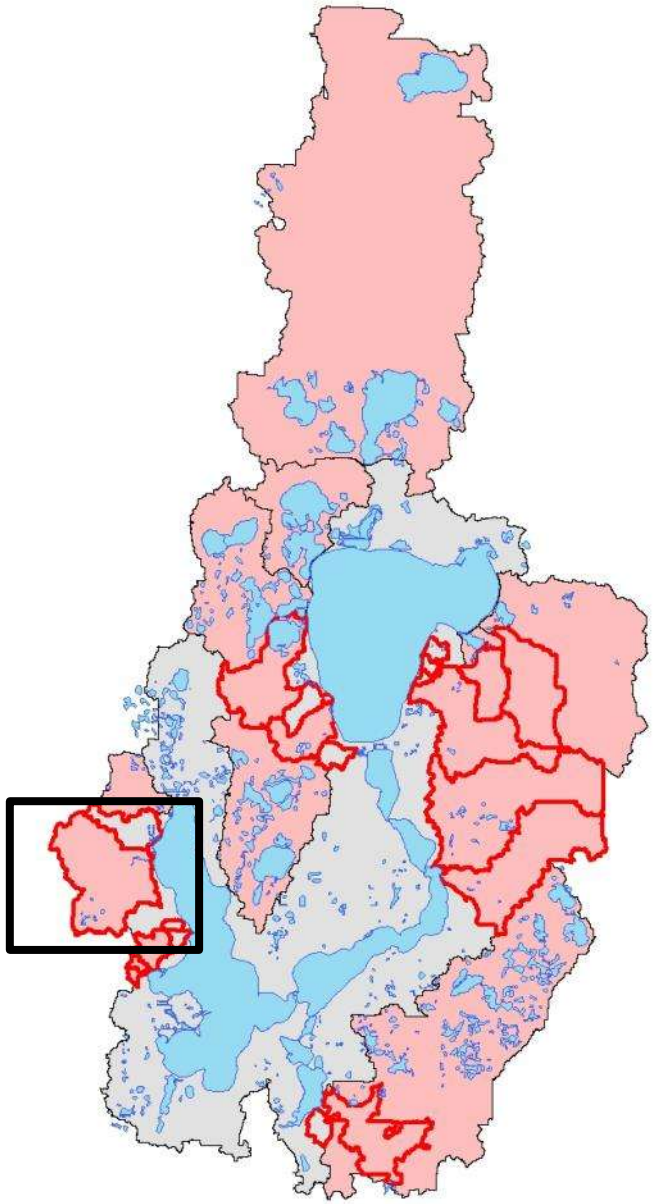
RUSLE – 10% Residue – Over T

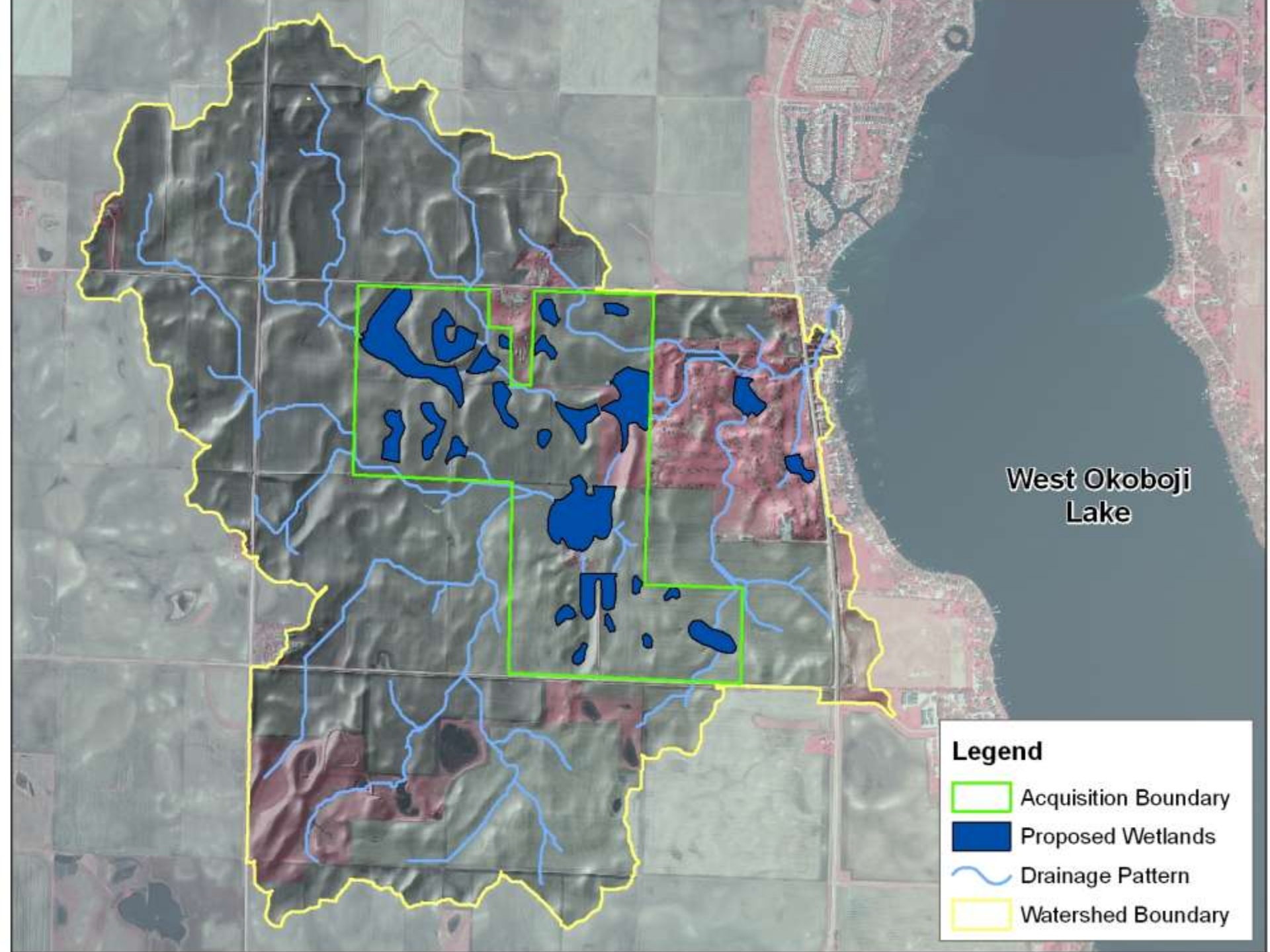
Watershed Management

In-lake Management

The Result

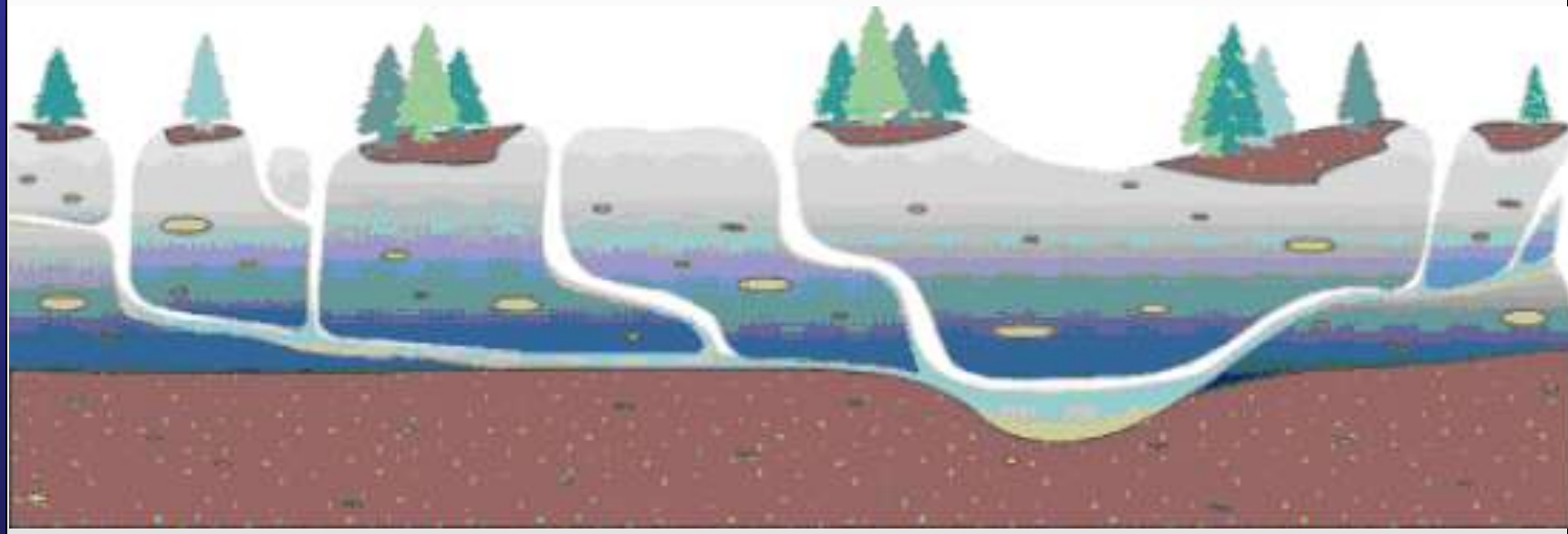
Watershed Management




West Okoboji Lake
Legend
Acquisition Boundary
Proposed Wetlands
Drainage Pattern
Watershed Boundary

David Thoreson

Back to Geology



Groundwater-Lake Interaction

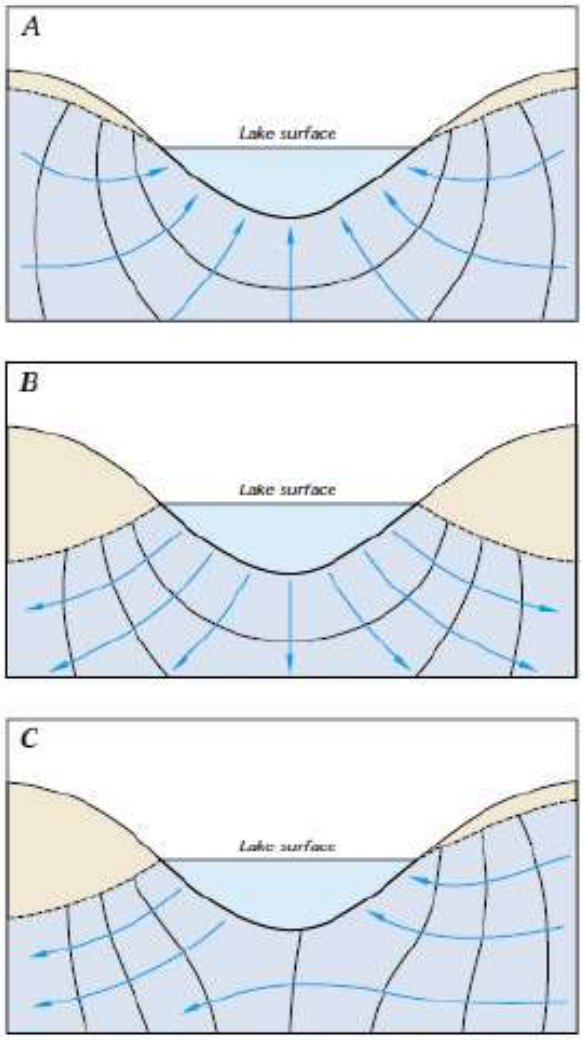


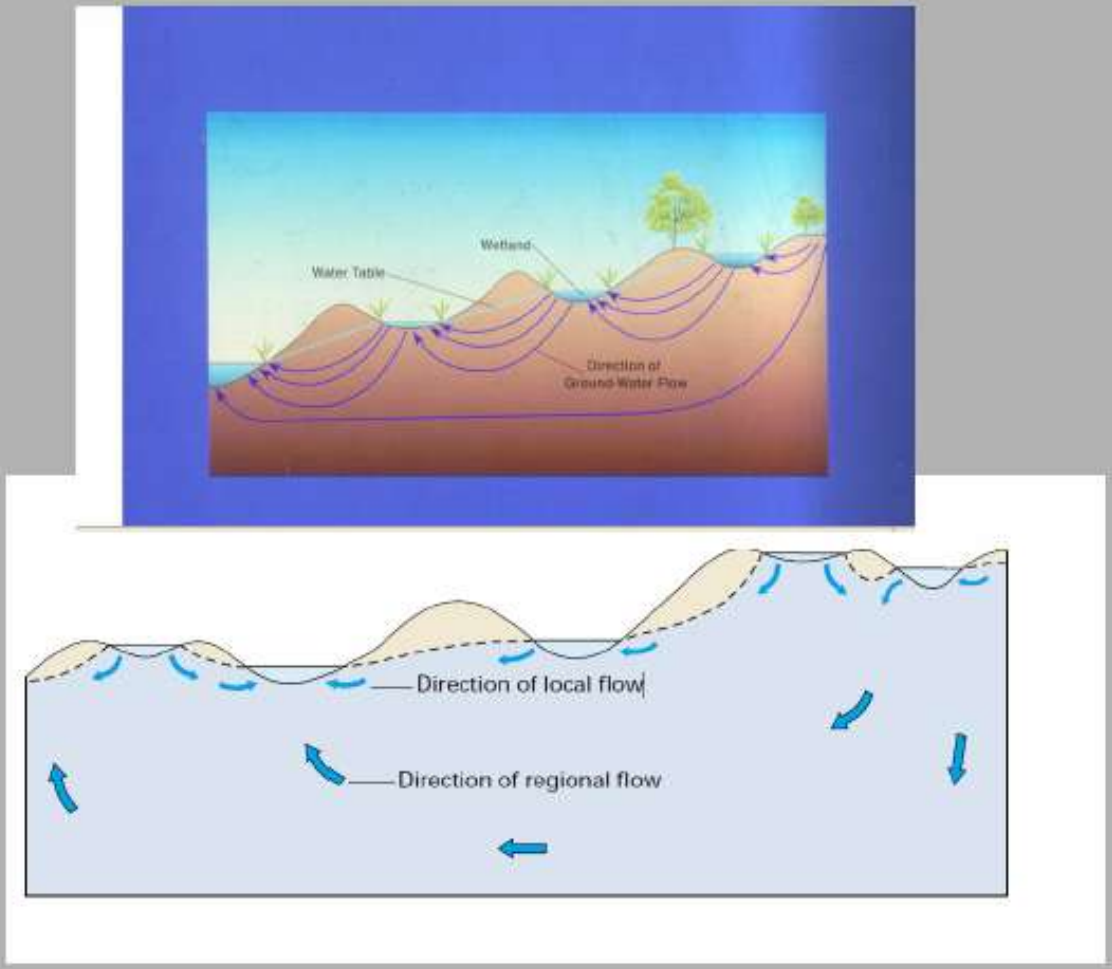
Figure 16. Lakes can receive ground-water inflow (A), lose water as seepage to ground water (B), or both

Lakes can be fed by groundwater inflow

Lakes can lose water by groundwater seepage (outflow)

Lakes can both receive and lose water as part of regional groundwater flow system

Lakes as part of regional groundwater flow systems



Lakes in undulating terrain can be part of series of water bodies where the water table intersects the land surface downslope

Groundwater Investigation Activities

- Install shallow monitoring wells and in-lake piezometers around the lake perimeter
- Measure water levels, establish hydraulic gradients and determine hydraulic conductivity of the aquifer system
- Estimate ambient groundwater inflow and outflow rates
- Measure water level recoveries during infilling to quantify the rate of groundwater inflow and hydraulic connection of groundwater to lake surface water
- Collect groundwater samples from wells and piezometers on a regular basis for field parameters and nutrients before, during and after restoration