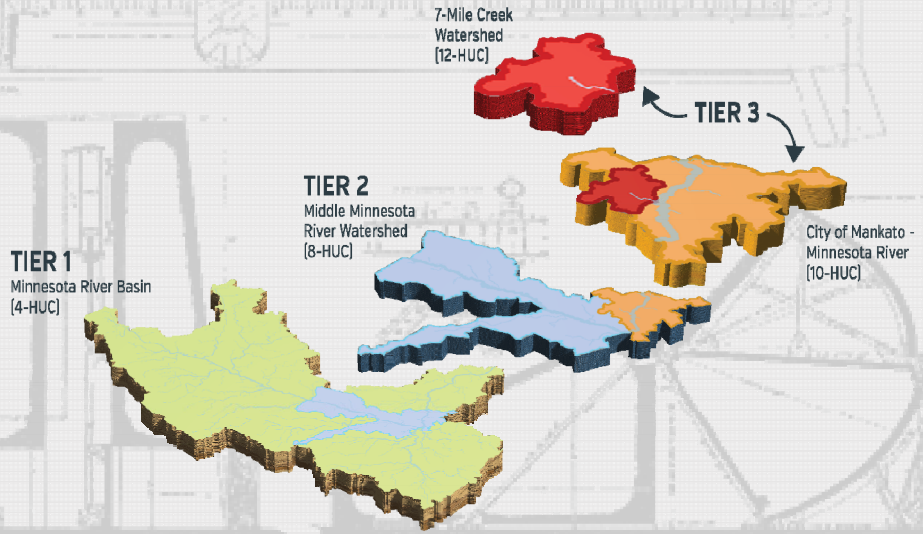
OU Water Center Visit

Chuck Theiling, PhD

Research Ecologist

ERDC-EL-Stream Ecology Team

15 April, 2019



U.S.ARMY

US Army Corps of Engineers

Theiling Research Interests

- Integrated ecological modeling
  - Conceptual model
  - Facilitation
  - Riparian Vegetation Simulation Module
  - E-Flows
- Watershed management
  - Illinois
  - Minnesota
  - Iowa-Cedar
  - Meremac
  - Lake Red Rock
- Ecosystem restoration
  - Upper Mississippi River Restoration (30+years, 70 projects)
  - Water level management
  - Comprehensive planning (Peoria Lake)
- Sustainability
  - Integrated water resource management
  - Mission integration
  - Beneficial use of dredged material
  - Infrastructure adaptation (levee district = water treatment plant)
  - Reservoir sustainability

HEC-RAS-1D – RVSM

Interactions among surface water, groundwater and riparian vegetation for land use planning

Hydraulic roughness
water quality improvement

Surface water: flood, drought, sediment burial, scour

Ground water: groundwater level

Riparian vegetation: seed dispersal, seedling establishment, growth, mortality

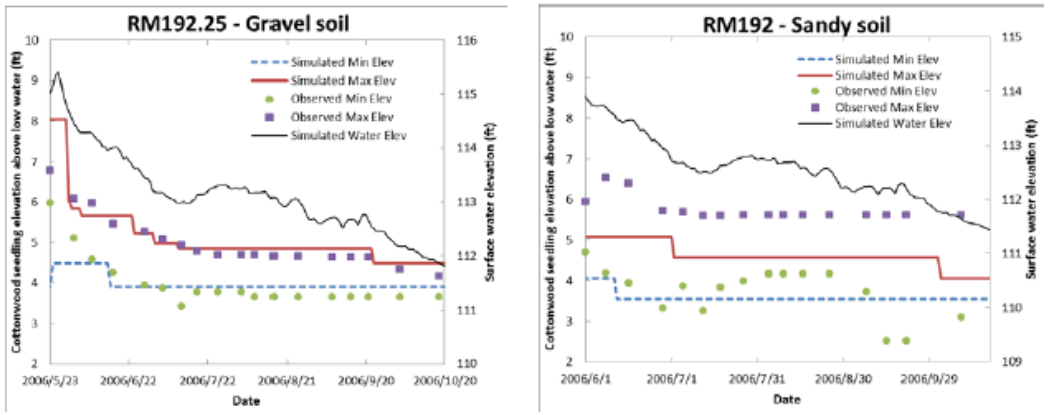
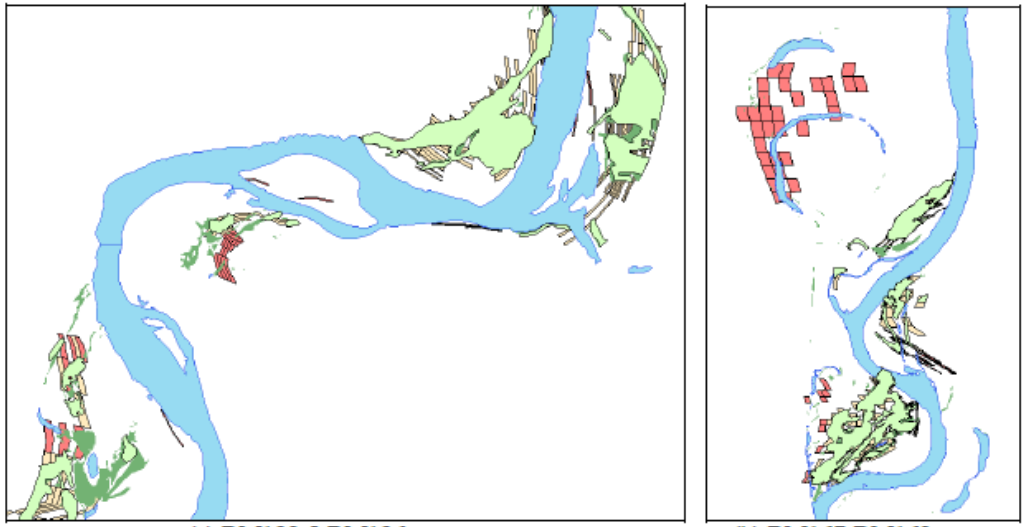


Fig. 8. A comparison between simulated and observed cottonwood seedling elevations on a gravel soil bar and those on a sandy soil bar in 2006



(a) RM183.5-RM186 (b) RM167-RM163

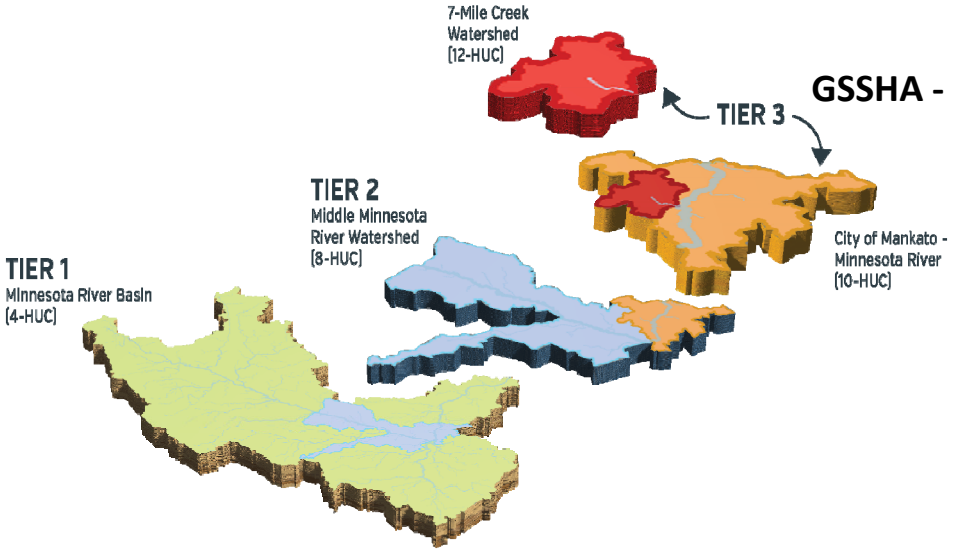
Fig. 9. Comparison of mapped and simulated spatial locations of cottonwood increase at two reaches.

Minnesota River Basin Interagency Study

2009 Recon Study, 2011 Start, Exec Summary in Review

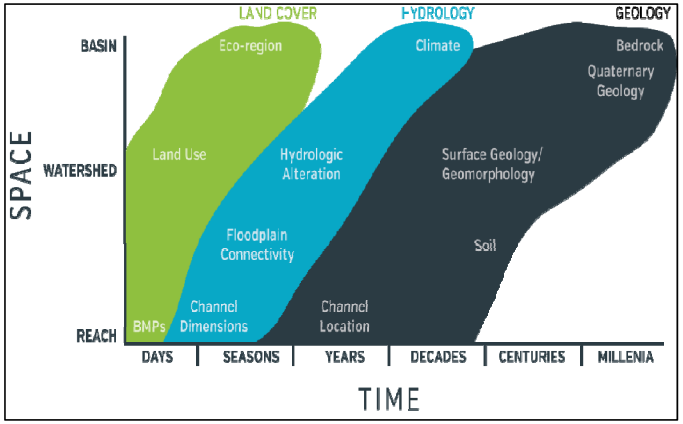
Can large landscape management (BMPs) achieve nutrient reduction goals?

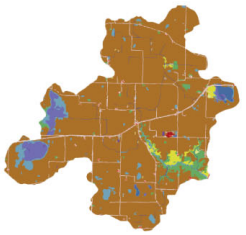
- Integrated hydrodynamic, sediment, and nutrient modeling
- Alternative landscape scenarios
- Tiered modeling approach for flow, sediment, nutrients, birds, and fish

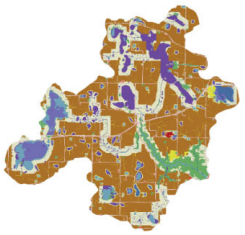


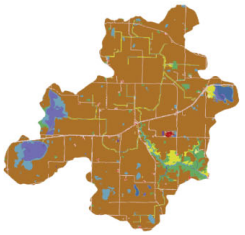
HSPF – State of MN

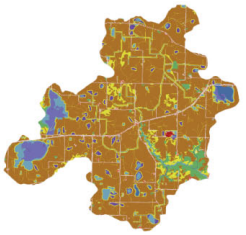
Minnesota Nutrient Reduction Objectives

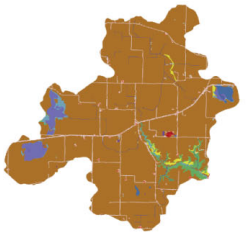






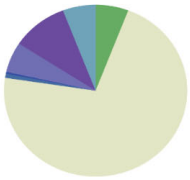






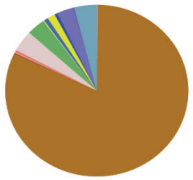
SEVEN MILE CREEK ALTERNATIVE LANDSCAPE SCENARIOS

PRESETTLEMENT



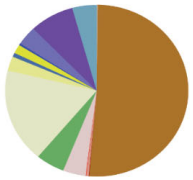
AREA %	LAND COVER CLASS
5.81%	Forest, Deciduous
71.6%	Grassland/Native Prairie
0.76%	Lake
0.37%	Riverine
5.7%	Wetlands, Seasonally Flooded
9.96%	Wetlands, Semipermanently Flooded
5.81%	Wetlands, Temporarily Flooded

EXISTING CONDITIONS



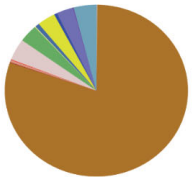
AREA %	LAND COVER CLASS
0.19%	Barren, Bare Rock/ Sand/Clay
81.94%	Cultivated Crops
0.10%	Developed, High Intensity
0.45%	Developed, Low Intensity
0.10%	Developed, Medium Intensity
4.03%	Developed, Open Space
3.29%	Forest, Deciduous
0.16%	Grassland/Reserve
0.75%	Lake
1.39%	Pasture/Hay
0.54%	Riverine
2.96%	Wetlands, Seasonally Flooded
0.13%	Wetlands, Semipermanently Flooded
3.98%	Wetlands, Temporarily Flooded

BIODIVERSITY



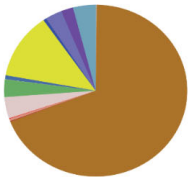
AREA %	LAND COVER CLASS
0.19%	Barren, Bare Rock/ Sand/Clay
51.12%	Cultivated Crops
0.10%	Developed, High Intensity
0.45%	Developed, Low Intensity
0.10%	Developed, Medium Intensity
4.03%	Developed, Open Space
5.08%	Forest, Deciduous
17.71%	Grassland/Native Prairie
2.71%	Grassland/Reserve
0.75%	Lake
1.67%	Pasture/Hay
0.35%	Riverine
3.56%	Wetlands, Seasonally Flooded
7.84%	Wetlands, Semipermanently Flooded
3.98%	Wetlands, Temporarily Flooded

FUTURE WITHOUT PROJECT



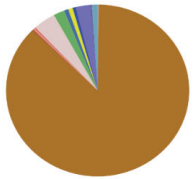
AREA %	LAND COVER CLASS
0.19%	Barren, Bare Rock/ Sand/Clay
80.11%	Cultivated Crops
0.10%	Developed, High Intensity
0.45%	Developed, Low Intensity
0.10%	Developed, Medium Intensity
4.03%	Developed, Open Space
3.29%	Forest, Deciduous
0.16%	Grassland/Reserve
0.75%	Lake
3.21%	Pasture/Hay
0.54%	Riverine
2.96%	Wetlands, Seasonally Flooded
0.13%	Wetlands, Semipermanently Flooded
3.99%	Wetlands, Temporarily Flooded

WATER QUALITY

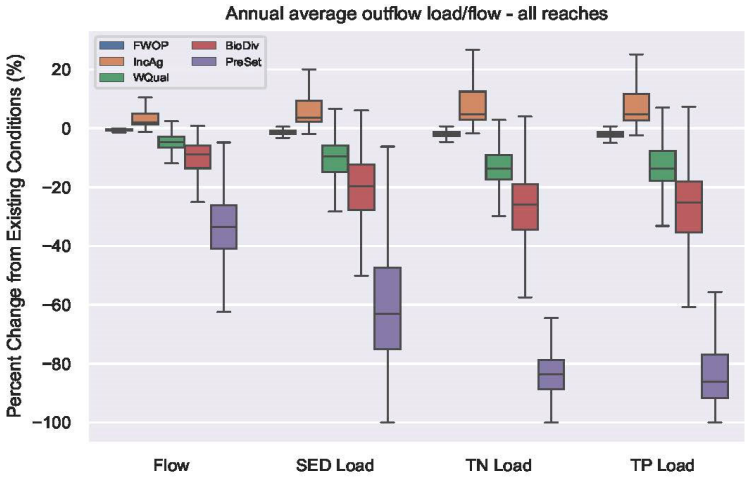


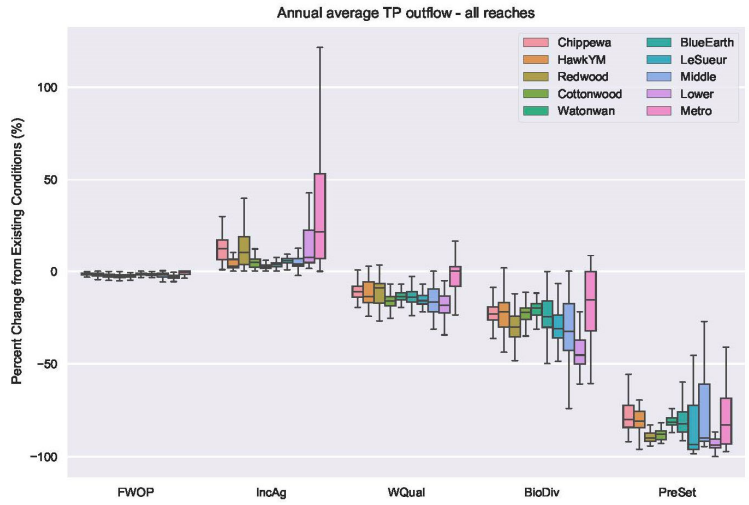
AREA %	LAND COVER CLASS
0.20%	Barren, Bare Rock/ Sand/Clay
68.95%	Cultivated Crops
0.10%	Developed, High Intensity
0.45%	Developed, Low Intensity
0.10%	Developed, Medium Intensity
4.03%	Developed, Open Space
3.29%	Forest, Deciduous
0.04%	Grassland/Reserve
0.75%	Lake
12.46%	Pasture/Hay
0.54%	Riverine
2.97%	Wetlands, Seasonally Flooded
2.15%	Wetlands, Semipermanently Flooded
3.99%	Wetlands, Temporarily Flooded

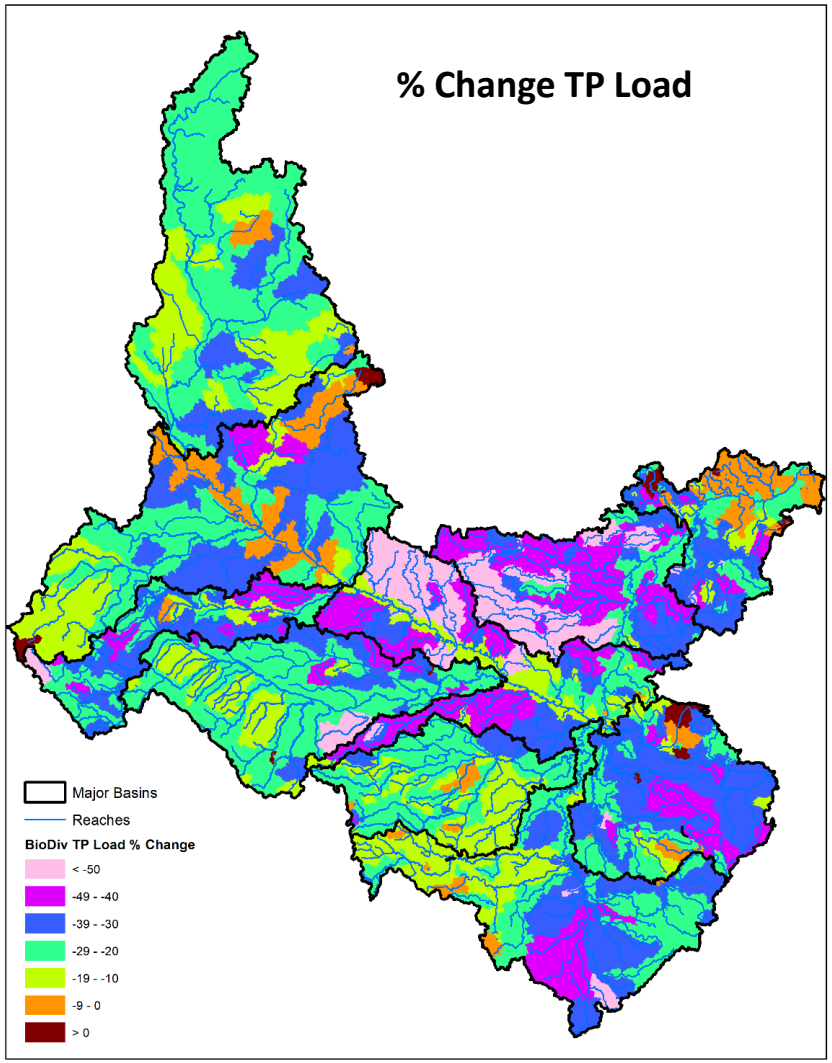
INCREASED AGRICULTURE



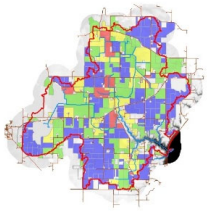
AREA %	LAND COVER CLASS
0.19%	Barren, Bare Rock/ Sand/Clay
87.24%	Cultivated Crops
0.10%	Developed, High Intensity
0.45%	Developed, Low Intensity
0.10%	Developed, Medium Intensity
4.02%	Developed, Open Space
1.90%	Forest, Deciduous
0.03%	Grassland/Reserve
0.75%	Lake
0.81%	Pasture/Hay
0.53%	Riverine
2.68%	Wetlands, Seasonally Flooded
0.13%	Wetlands, Semipermanently Flooded
1.06%	Wetlands, Temporarily Flooded


Annual average outflow load/flow - all reaches
FWOP
IncAg
WQual
BioDiv
PreSet
Percent Change from Existing Conditions (%)
20
0
−20
−40
−60
−80
−100
Flow
SED Load
TN Load
TP Load

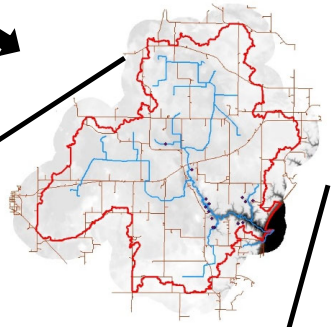

Annual average TP outflow - all reaches
Chippewa
HawkYM
Redwood
Cottonwood
Watonwan
BlueEarth
LeSueur
Middle
Lower
Metro
Percent Change from Existing Conditions (%)
100
50
0
−50
−100
FWOP
IncAg
WQual
BioDiv
PreSet

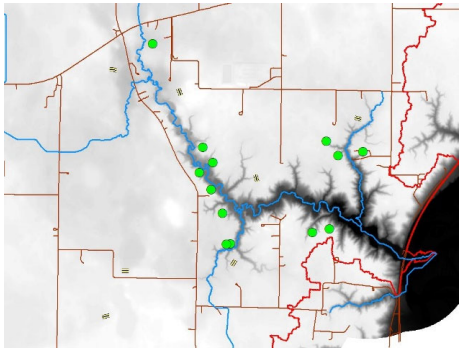

% Change TP Load
Major Basins
Reaches
BioDiv TP Load % Change
< -50
-49 - -40
-39 - -30
-29 - -20
-19 - -10
-9 - 0
> 0

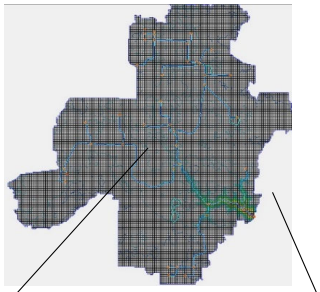
ACPF for BMP placement optimization → GSSHA for simulation

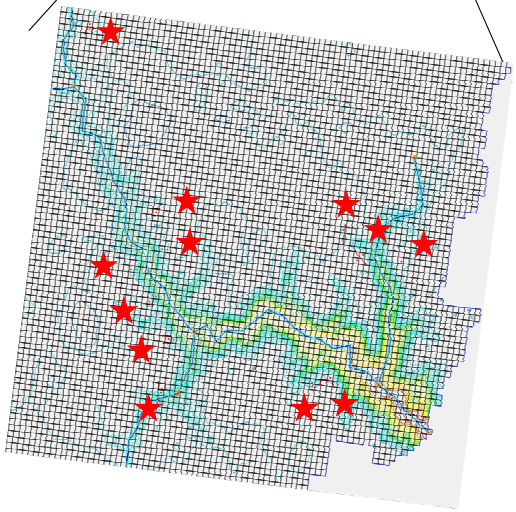


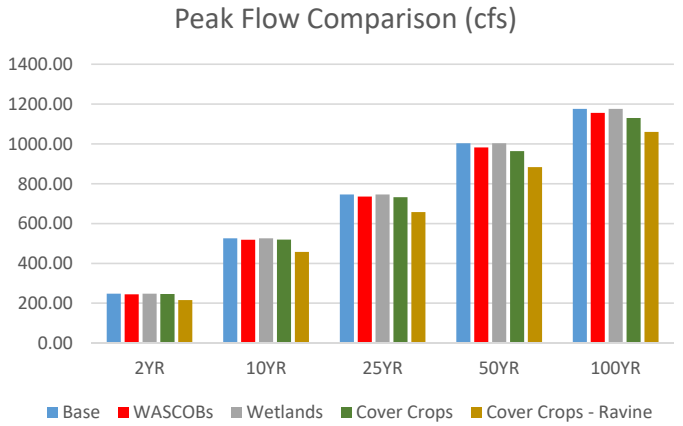
Land cover
Slope
Flow accumulation

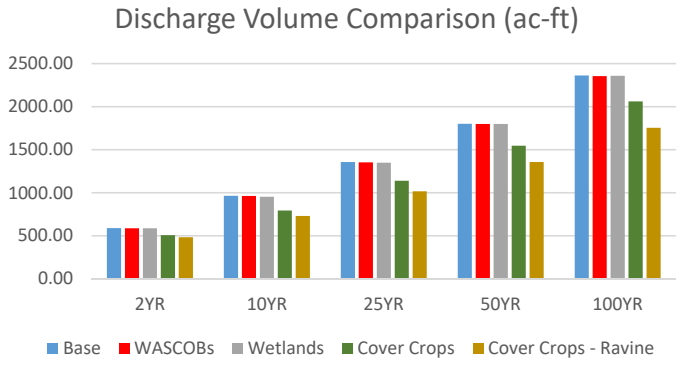






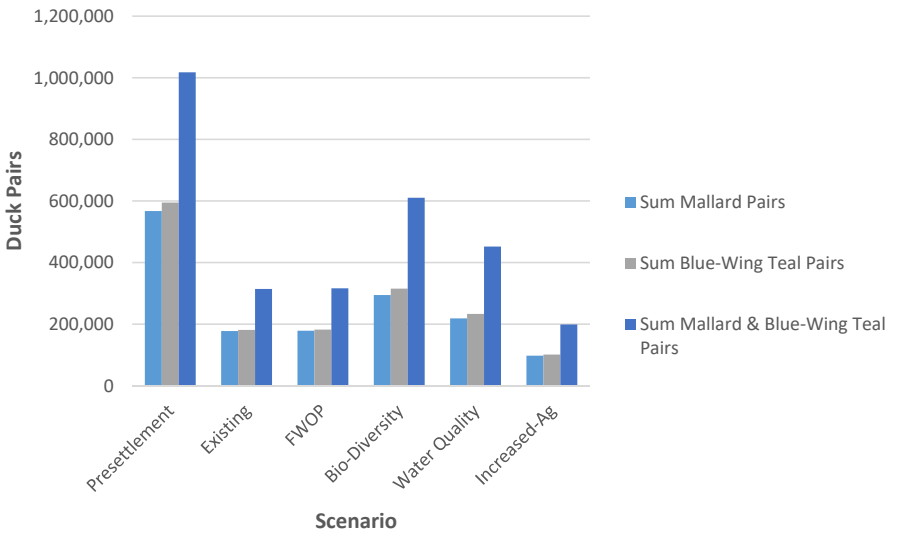




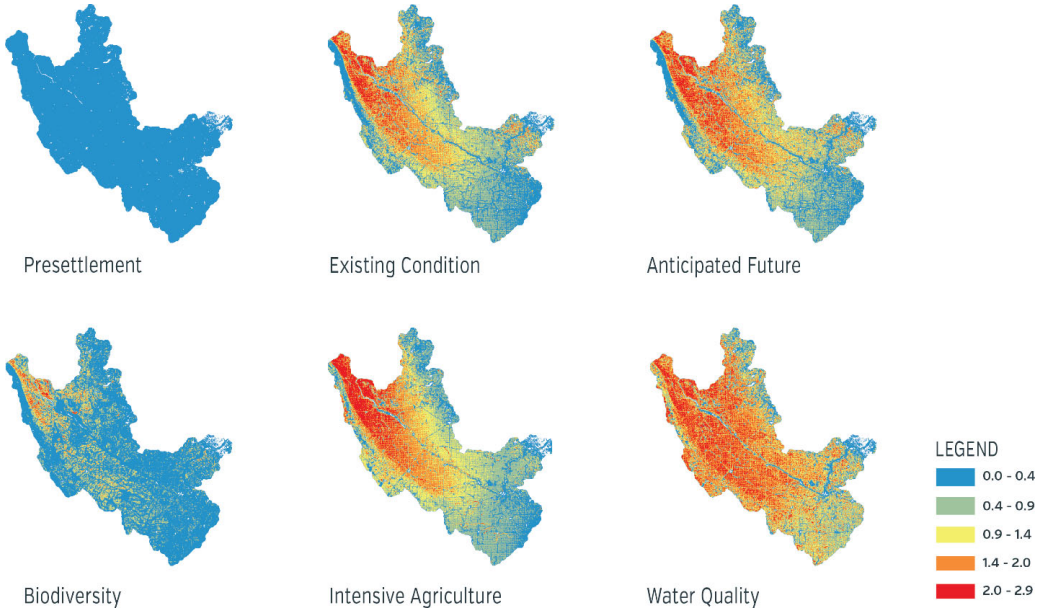


USFWS HAPET Team
Northern Prairie Research Unit

Waterfowl Pairs Models

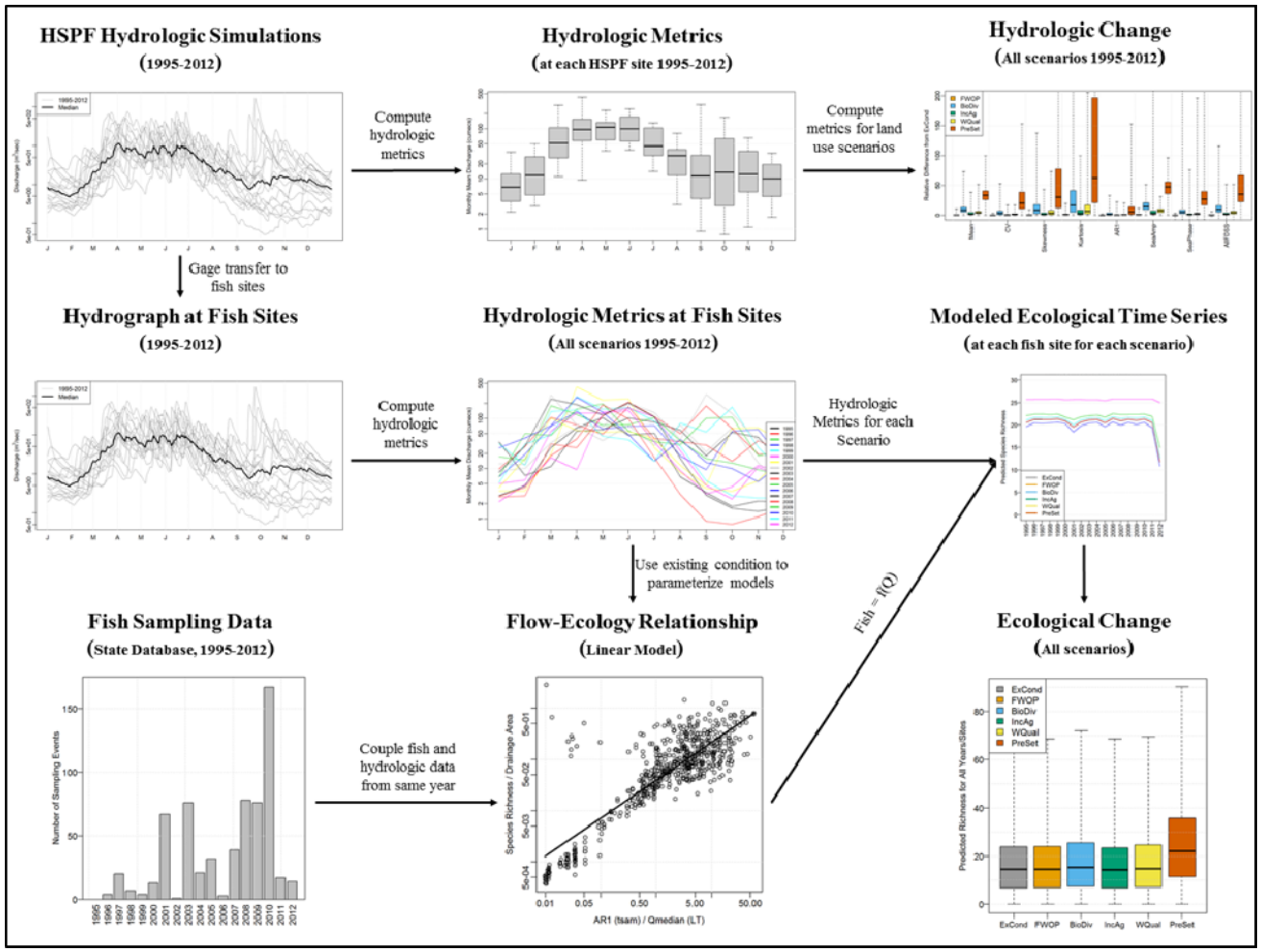


Grassland Bird Models



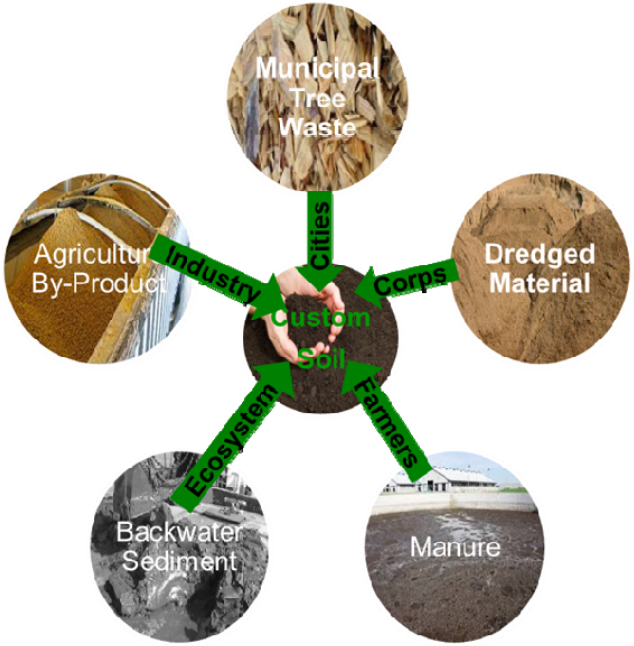
Scenarios ▼	Bobolink	Grasshopper Sparrow	Horned Lark	Savanna Sparrow	Sedge Wren
Presettlement	26%	>100%	-100%	-67%	-7%
Biodiversity	16%	>100%	-69%	-17%	13%
Water Quality	11%	4%	57%	9%	-5%
Anticipated Future	2%	3%	12%	4%	0%
Increased Ag	0%	55%	16%	-23%	-23%

Environmental Flows Analysis
Kyle McKay - ERDC

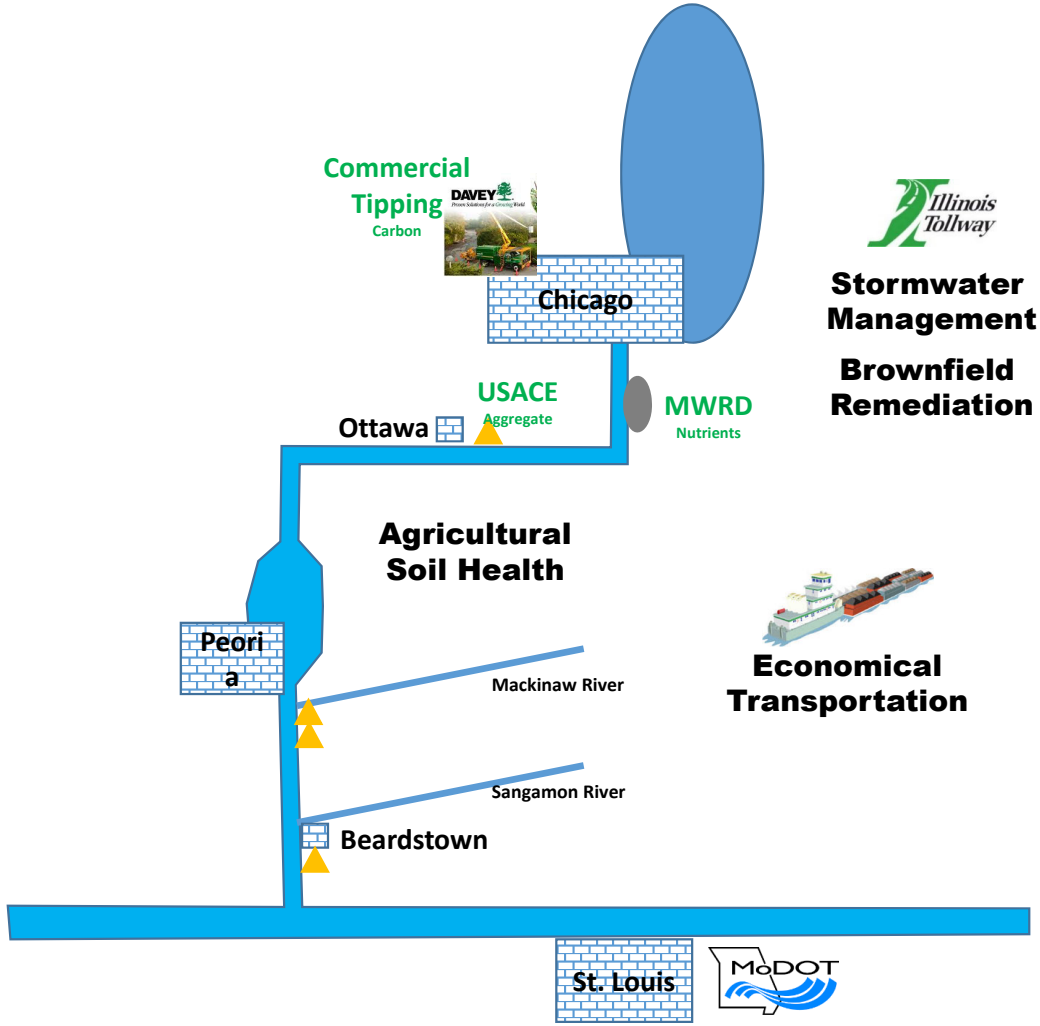


Environmental Sustainability

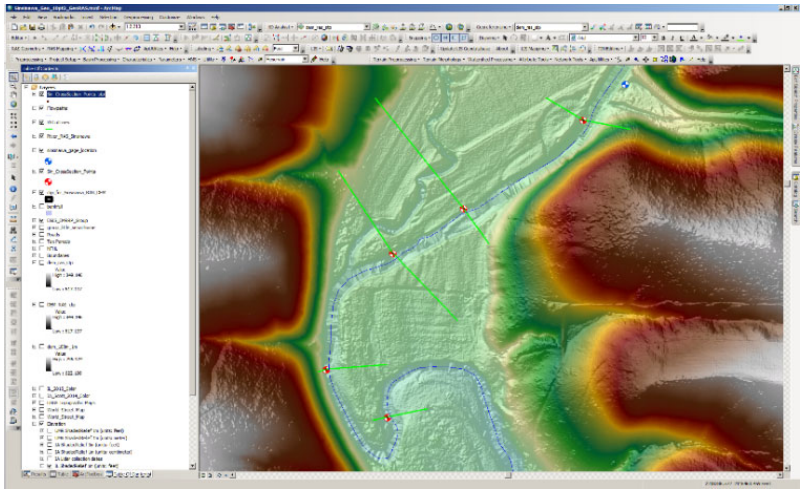
Recycling “waste” into useful products

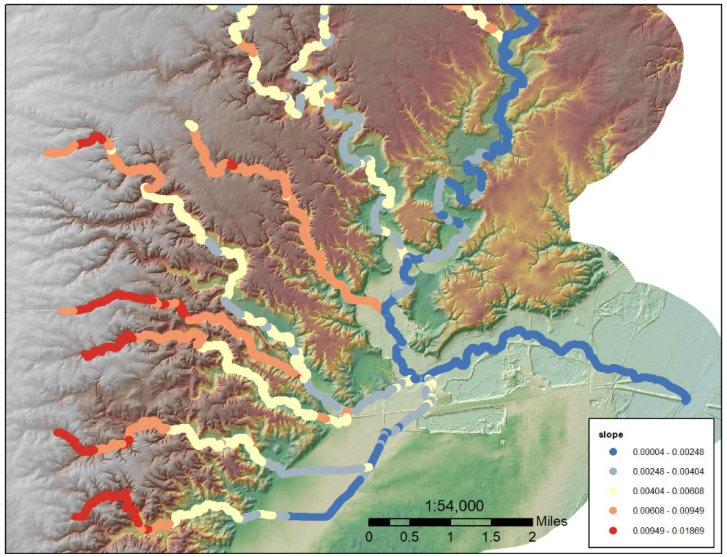


Reducing operational costs through mission integration


Commercial
Tipping
Carbon
DAVEY
Chicago
USACE
Aggregate
Ottawa
MWRD
Nutrients
Agricultural
Soil Health
Peoria
Mackinaw River
Sangamon River
Beardstown
St. Louis
MoDOT
Illinois Tollway
Stormwater
Management
Brownfield
Remediation
Economical
Transportation

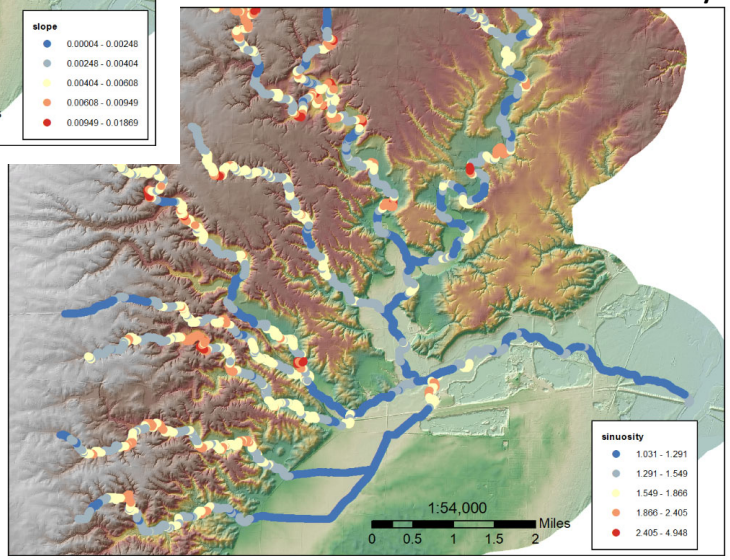
Rapid Watershed Assessment Planning Tools Based On High Resolution Terrain Analysis





Stream Slope

Stream Sinuosity



Channel Dimension	
Width, Mean Depth, Cross-sectional Area	Required for Regional Curve Development: Dimensions of bankfull width (ft) and mean depth (ft), cross-sectional area, and discharge (cfs) to drainage area (square miles)
Width to Depth Ratio	Shape of the channel based at bankfull width (ft) and mean depth (ft) at bankfull discharge because it is the most erosive condition.
Entrenchment Ratio	Depicts relative access to the active floodplain. Typically, for channel stability at 2 times the maximum bankfull depth, the water surface should be at least 2.5 times the water surface width at bankfull depth. Incised or degraded channel reaches will continue to laterally erode and build floodplains until the entrenchment ratio reaches 2.5
Planform Geometry:	
Sinuosity	Sinuosity is the ratio of stream length to valley length. It can also be described as the ratio of valley slope to channel slope for defined reaches. Less than 1.8 likely means a channelized reach and combined with the W/D ratio less than 10 may indicate incised channel reaches.
Radius of Curvature(R_C)/ Bankfull Width	The ratio value of R_C to bankfull width is commonly used as a diagnostic test for channel planform stability. The ranges that can occur in nature are highly variable but in general if the R_C/Bkfl ratio is less than 1.8 (<1.8), then the outside bend-channel banks will likely be eroding very agressively as the channel bend progresses erosion in a downvalley direction.
Stream Power (S x Q)	Stream Power is the (S) slope x (Q) discharge Variable in riffle and pool and other channel environments $Q_S Q_{50} \sim SQ$; Lanes-Balance of Dynamic River Forces