



Wetland Restoration as a Climate Change Mitigation Strategy for Water Sustainability in the Kankakee River Watershed

a.k.a. Kankakee Project



Changes in Hydrology & Recreational Value

Project Team:



Alan F. Hamlet, Surface Water Hydrologist, University of Notre Dame

Chun-Mei Chiu, Post Doc. Hydrologist, University of Notre Dame

Diogo Bolster, Groundwater Hydrologist, University of Notre Dame

Zachary Hanson, PhD. Student Hydrologist, University of Notre Dame

Kyuhyun Byun, Post Doc. Hydrologist, University of Notre Dame

David Lampe, USGS Kentucky-Indiana Water Science Center

Jason McLachlan, Paleobotanist, University of Notre Dame

Jody Peters, PalEON project manager, University of Notre Dame

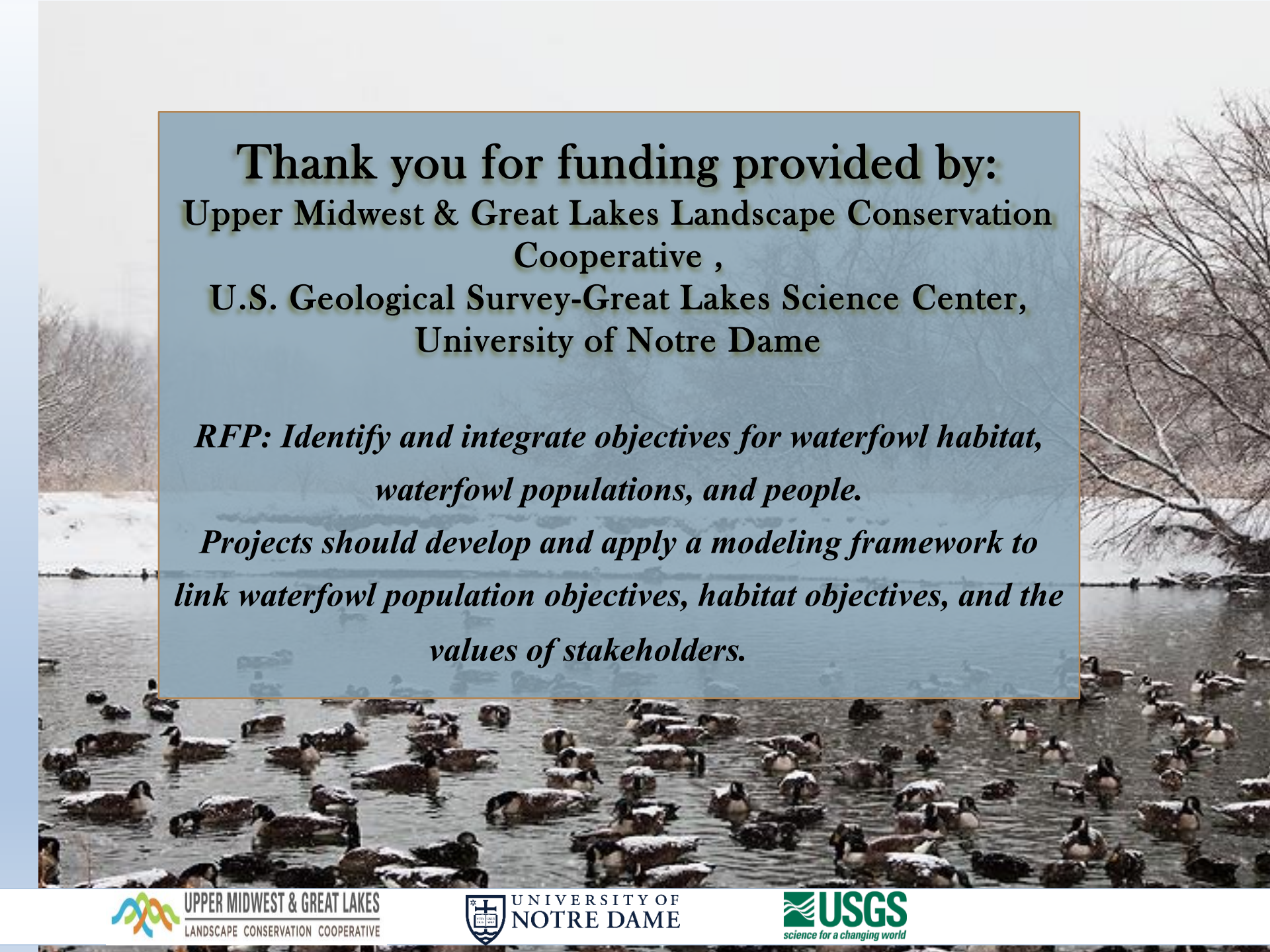
Mark Schurr, Archeologist, Department of Anthropology, University of Notre Dame

Ralph Grundel, Ornithologist/Ecologist, U.S. Geological Survey, Great Lakes Science Center

Noel Pavlovic, Botanist/Ecologist, U.S. Geological Survey, Great Lakes Science Center

Jessica Hellmann, Climate Change Ecologist, University of Minnesota

Tammy Patterson (ME!), Conservation Ecologist, U.S. Geological Survey, Great Lakes Science Center



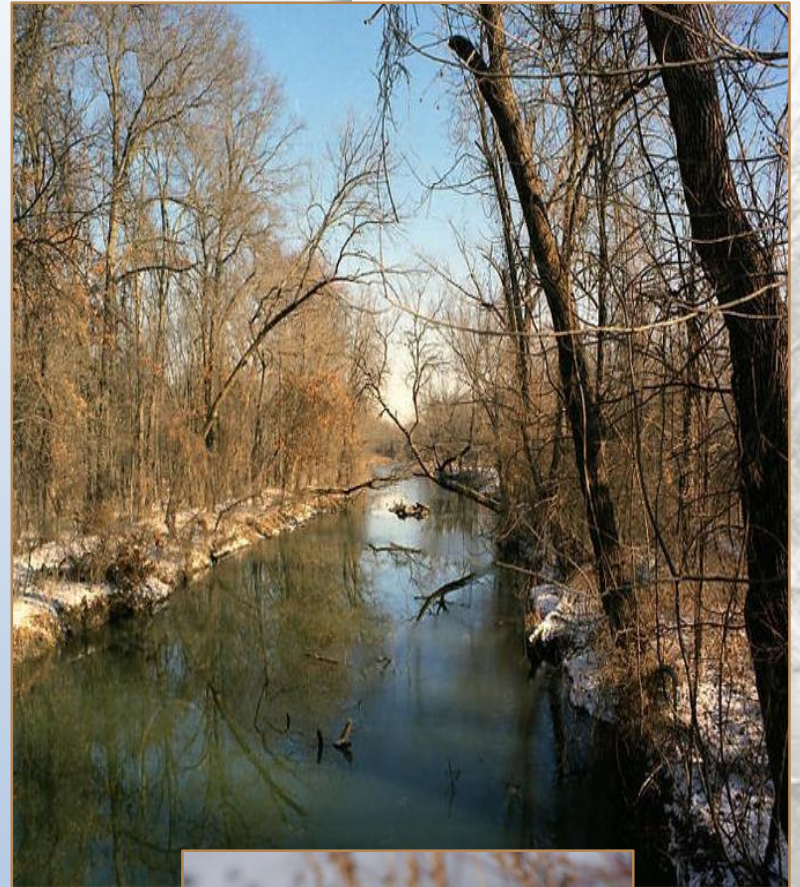
Thank you for funding provided by:
Upper Midwest & Great Lakes Landscape Conservation
Cooperative ,
U.S. Geological Survey-Great Lakes Science Center,
University of Notre Dame

*RFP: Identify and integrate objectives for waterfowl habitat,
waterfowl populations, and people.*

*Projects should develop and apply a modeling framework to
link waterfowl population objectives, habitat objectives, and the
values of stakeholders.*

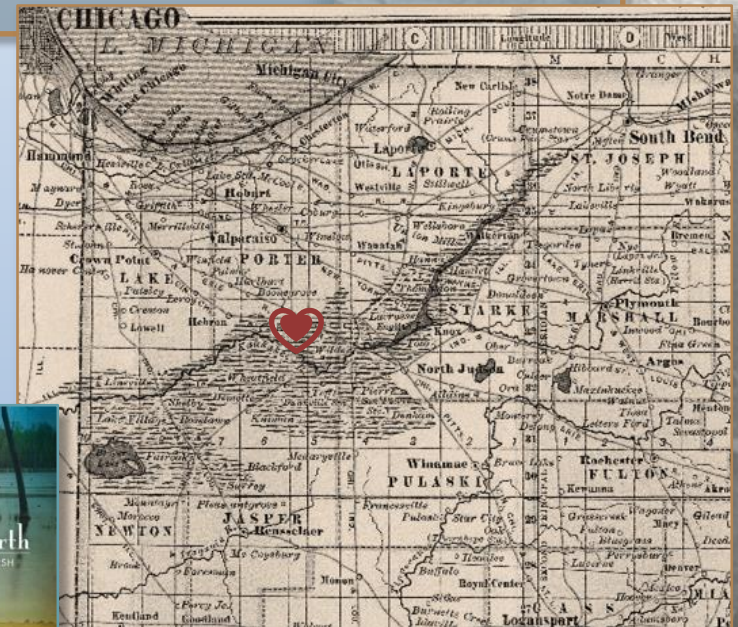
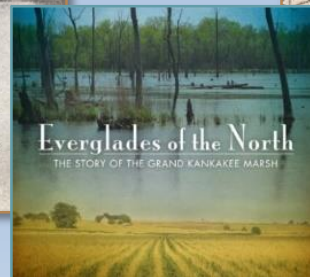
Project Goals:

- Build surface & groundwater models
 - surface water storage
 - groundwater recharge
 - aquifer storage & use
- Couple to ecosystems service models
 - waterfowl production/habitat
 - waterfowl hunter value
 - recreational user value
 - agricultural production
- Identify wetland restoration scenarios
 - improved historic knowledge
 - peer-input
- Assess scenarios
 - at present
 - under climate change projections
- Inform watershed planning efforts to create a resilient, sustainable future!

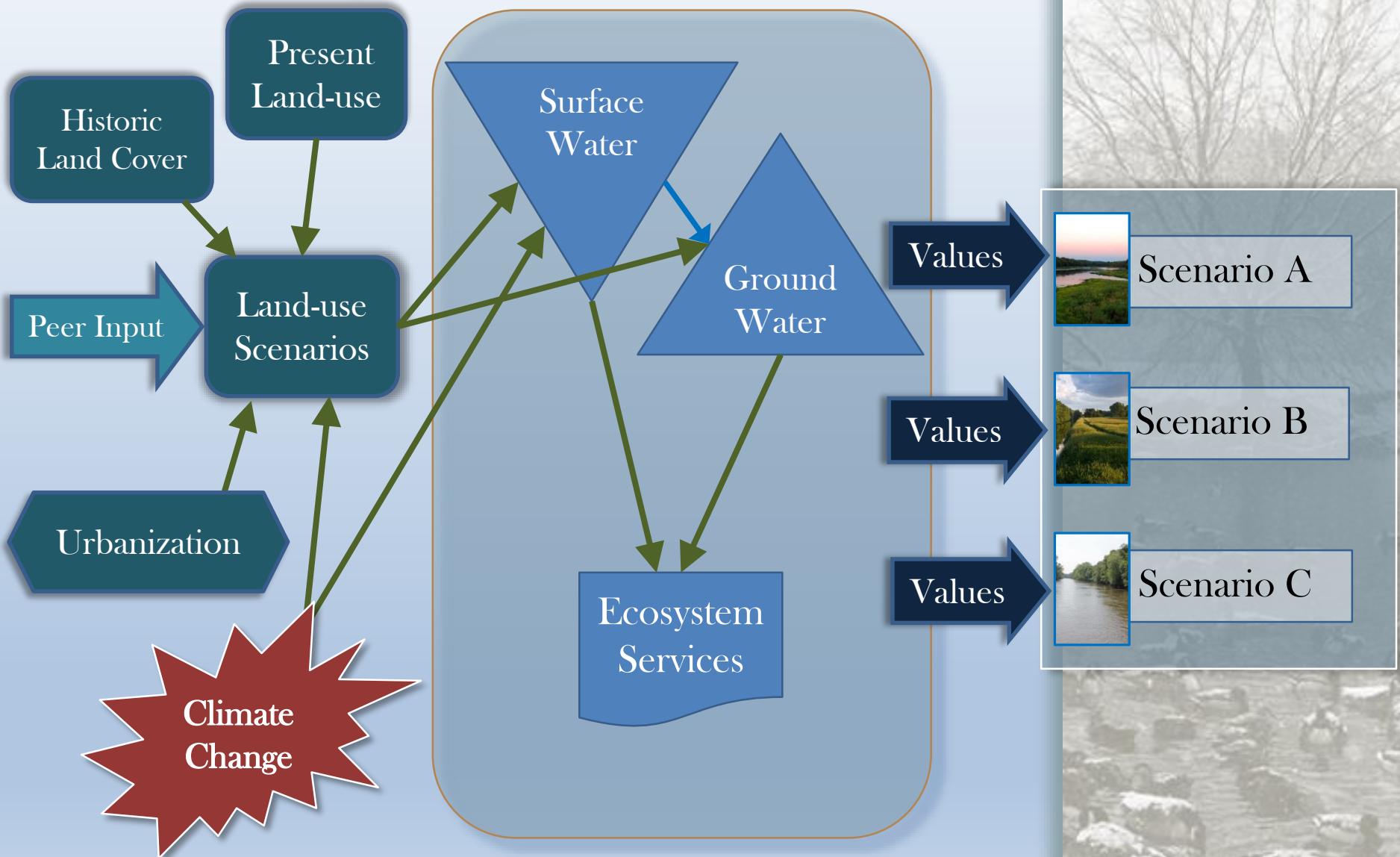


Why Kankakee River?

- Once home to Grand Kankakee Marsh
- Hydrology is highly modified system
- Predominantly agricultural landscape
- Some quality remnant wetlands remain
- Wetland restorations completed in watershed
- Potential for National Wildlife Refuge



Modeling Scheme



Hydrology Modeling Methods

Surface Water Model–Variable Infiltration Capacity (VIC)

- Value for surface water storage & recharge to groundwater

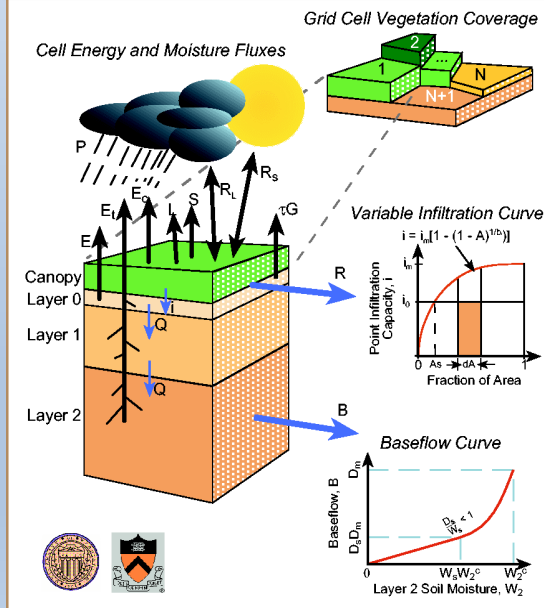
Ground Water Model–MODFLOW

- Water table heights
- Groundwater storage

Surface
Water

Ground
Water

Variable Infiltration Capacity Hydrologic Model

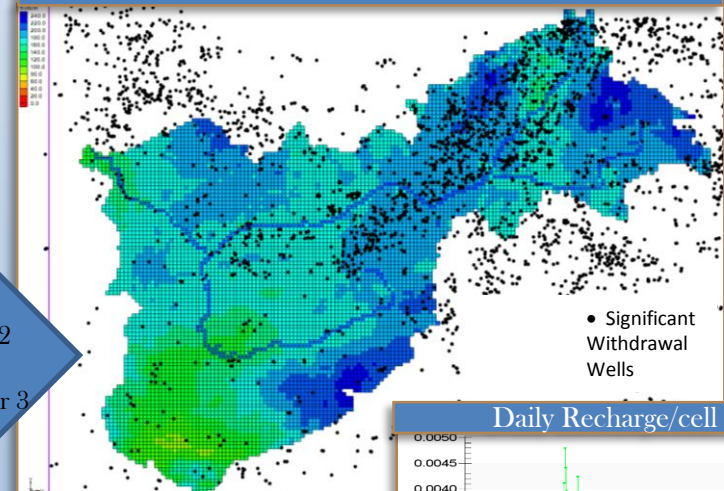


$$\text{Recharge} = Q_2 - ET_2$$

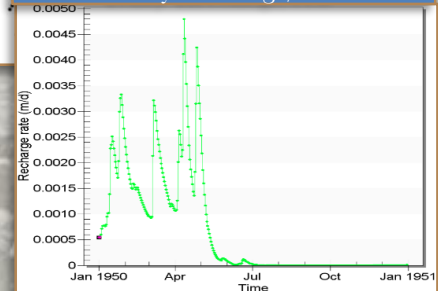
Q₃ = flow into layer 2

ET₂ = evapotranspiration from layer 3

MODFLOW Groundwater Hydrologic Model



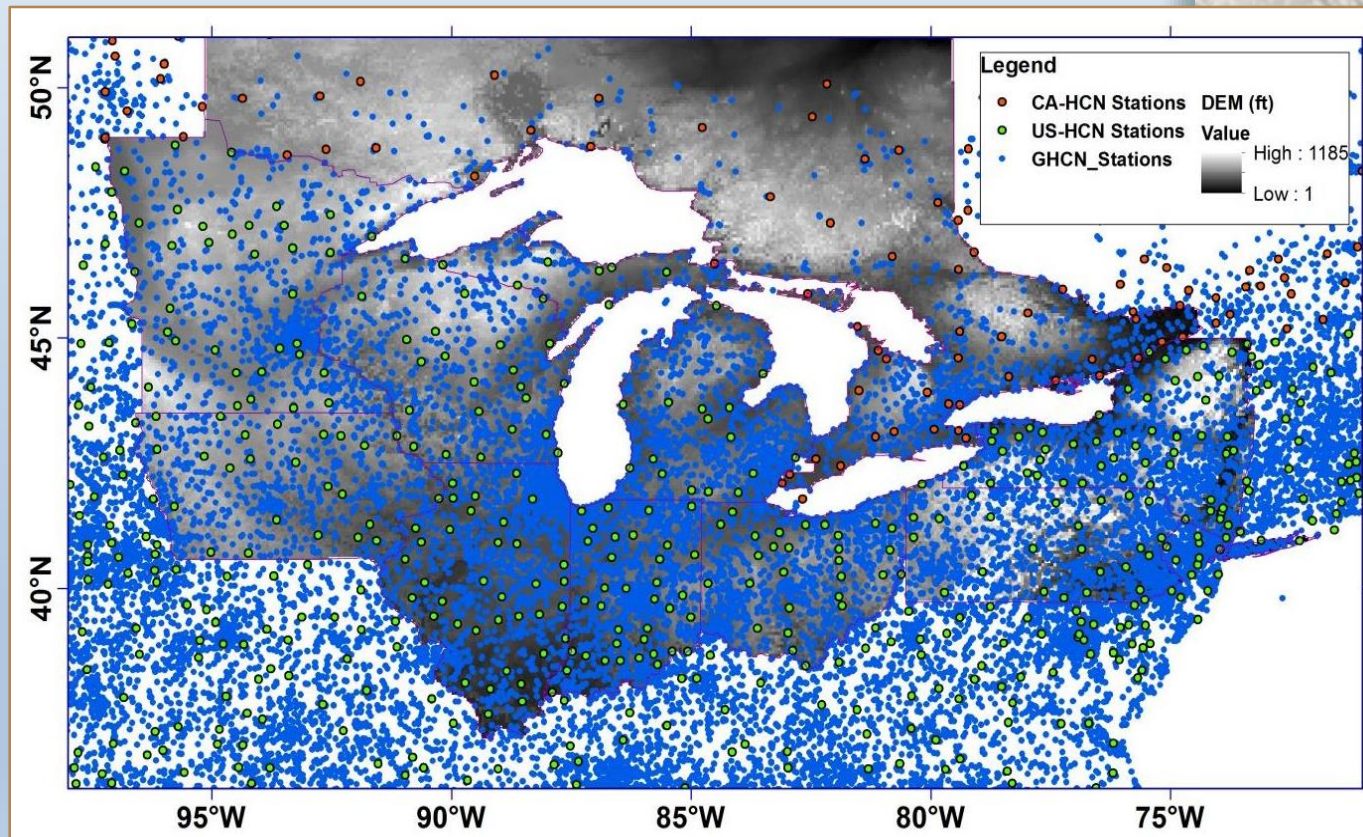
Daily Recharge/cell





VIC Surface Water Meteorological Driving Data

- Interpolate weather data from Co-oP, HCN, and PRISM
- Timescale: 1915-present
- Area of interest: Great Lakes states



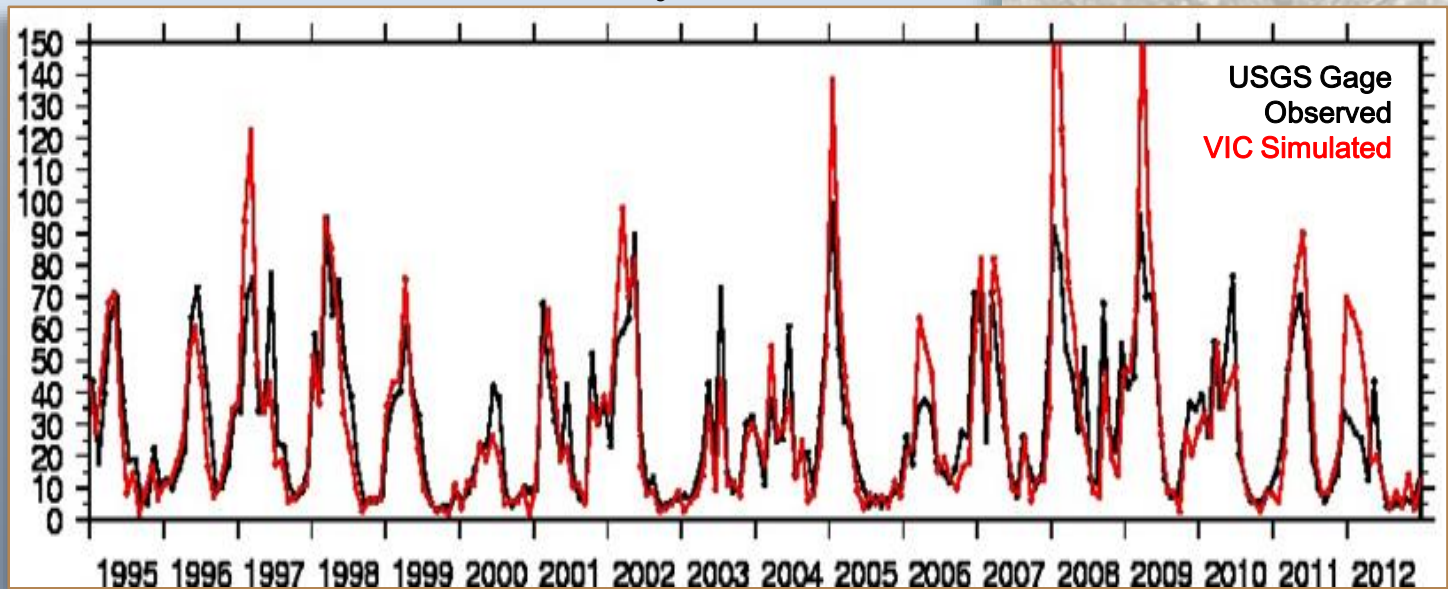
Chiu, C.-M., A.F. Hamlet, Macro-scale precipitation gauge undercatch corrections for the Midwest and Great Lakes region, 2016, J. of hydrometeorology (In processed) <http://www.crc.nd.edu/~cchiu2/DownloadSite.html>



Surface Water Balance

- VIC model corrected for spatial variability, precipitation undercatch, & height of wind velocity measurements
- $R^2 = 0.892$ NSE = 0.730 Ratio of means (sim/obs) = 0.862

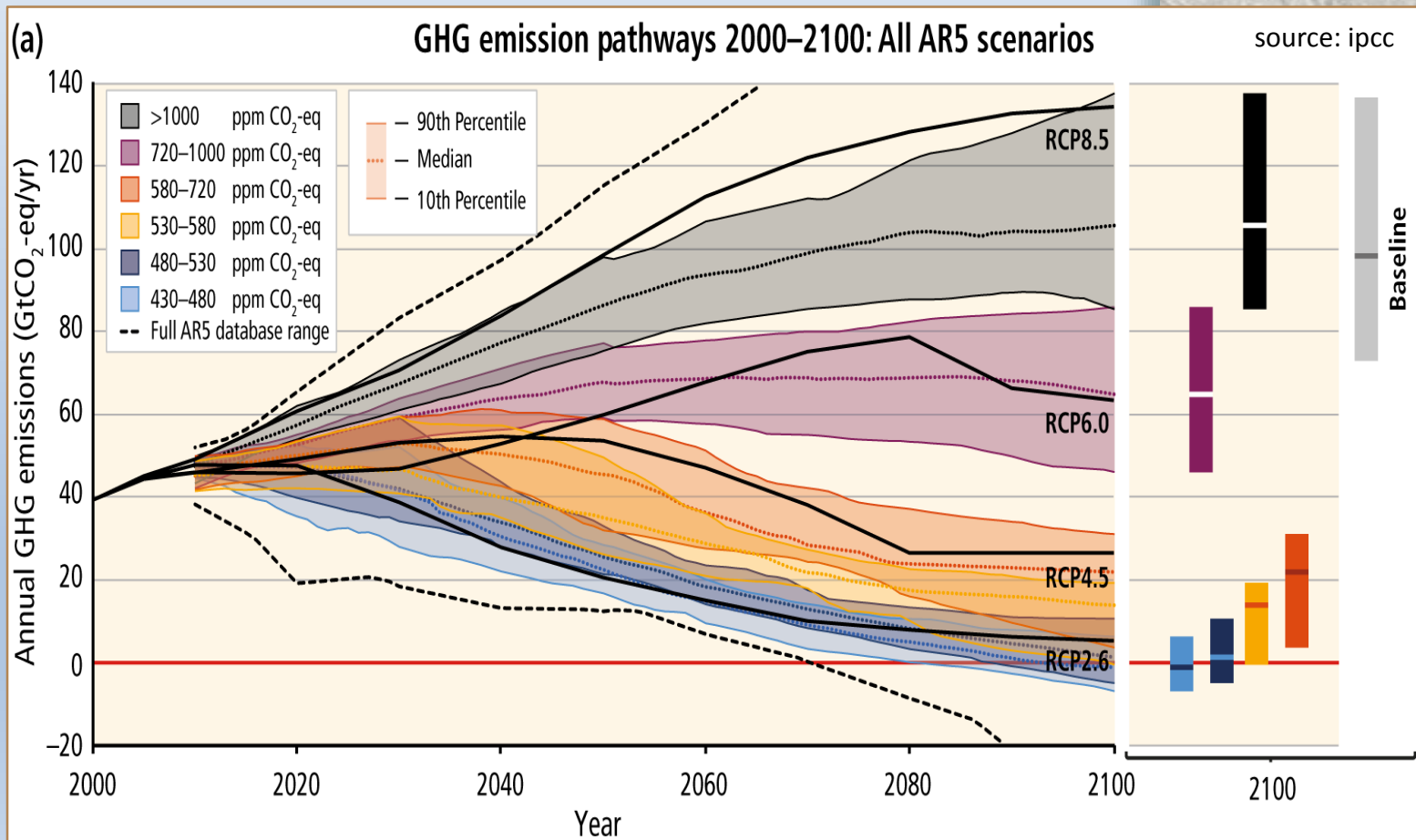
Monthly Streamflow



Climate Change Emissions:

- Emission Scenarios: RCP 2.6, RCP 4.5, RCP 6.0, RCP 8.5
- Multiple General Climate Models (GMCs)
- Downscale to region of interest

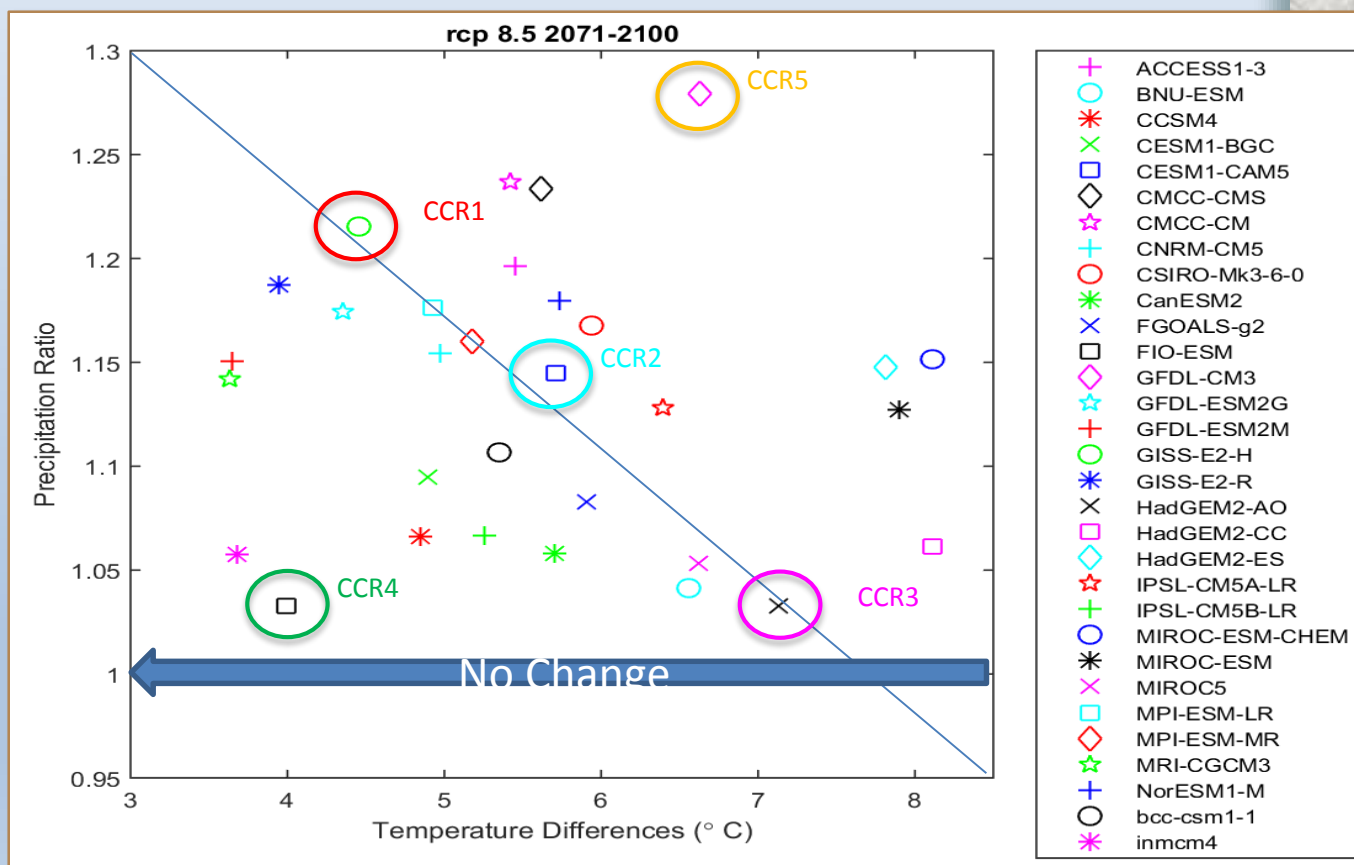
Climate
Change



Climate Change Simulation:

- Emission Scenarios = RCP 8.5
- Multiple General Climate Models (GMCs) = 31
- Downscale to region of interest (hybrid delta method)

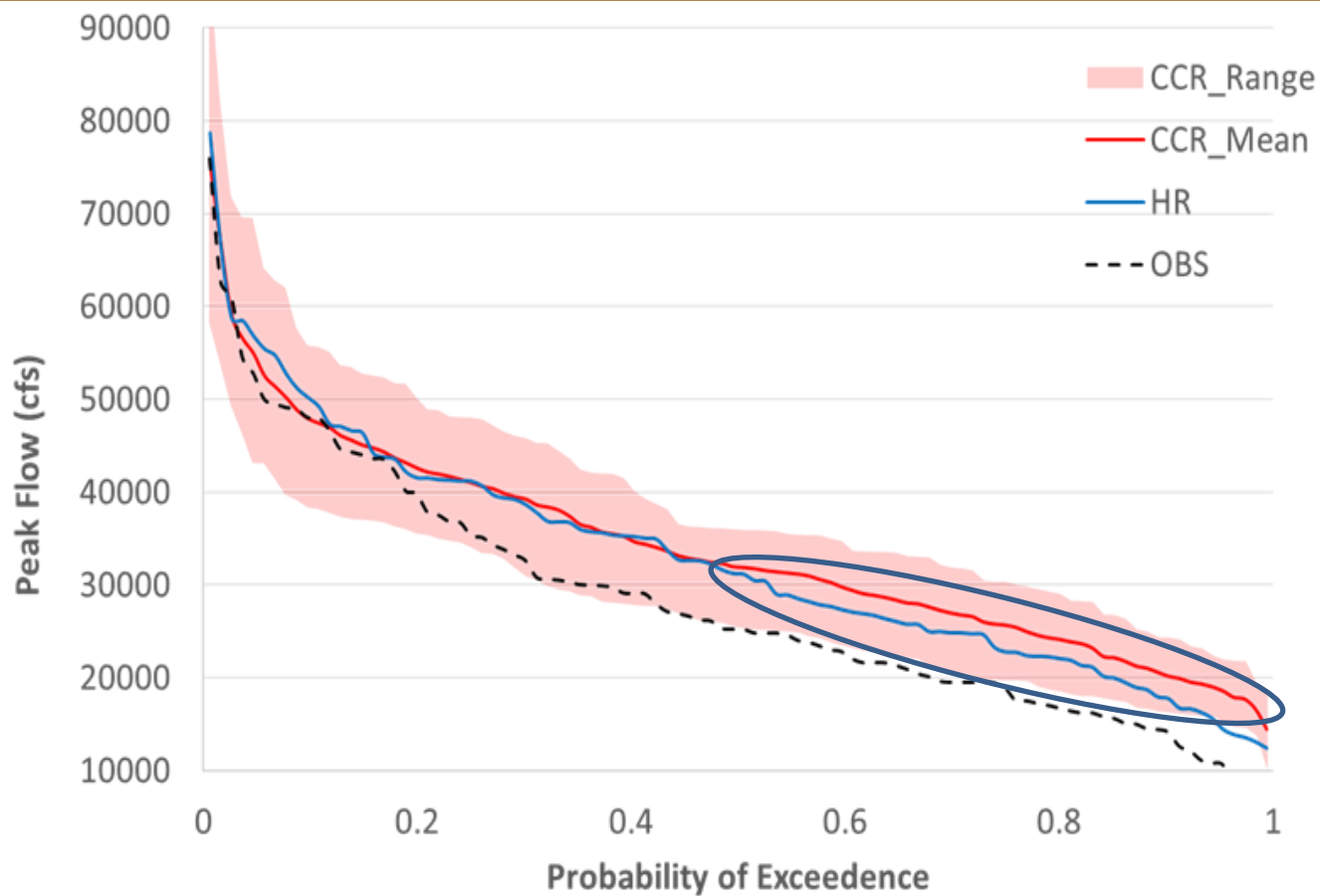
Climate
Change



Projected Peak River Flows:

- Projected Period: 2020s
 - 20% increase in peak flow = more small floods

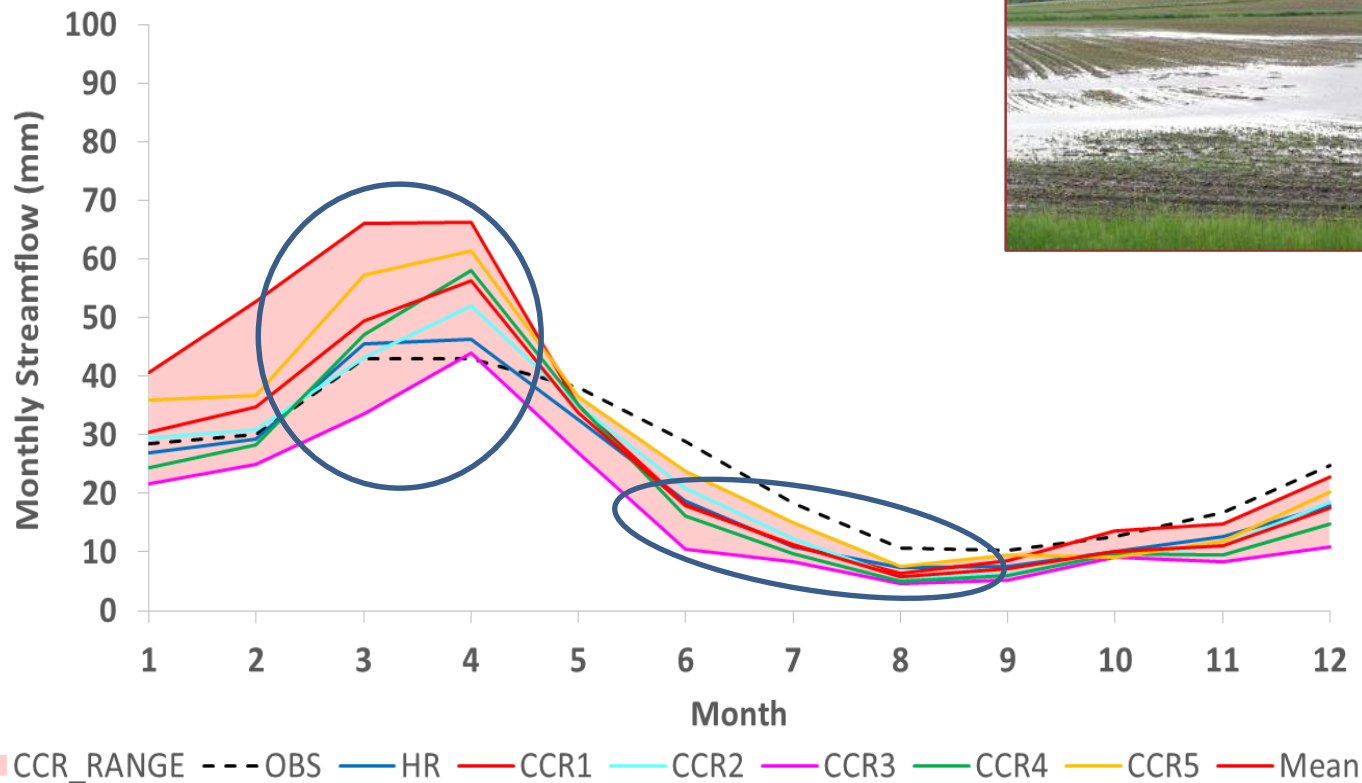
Climate
Change



Seasonal Flows:

Climate
Change

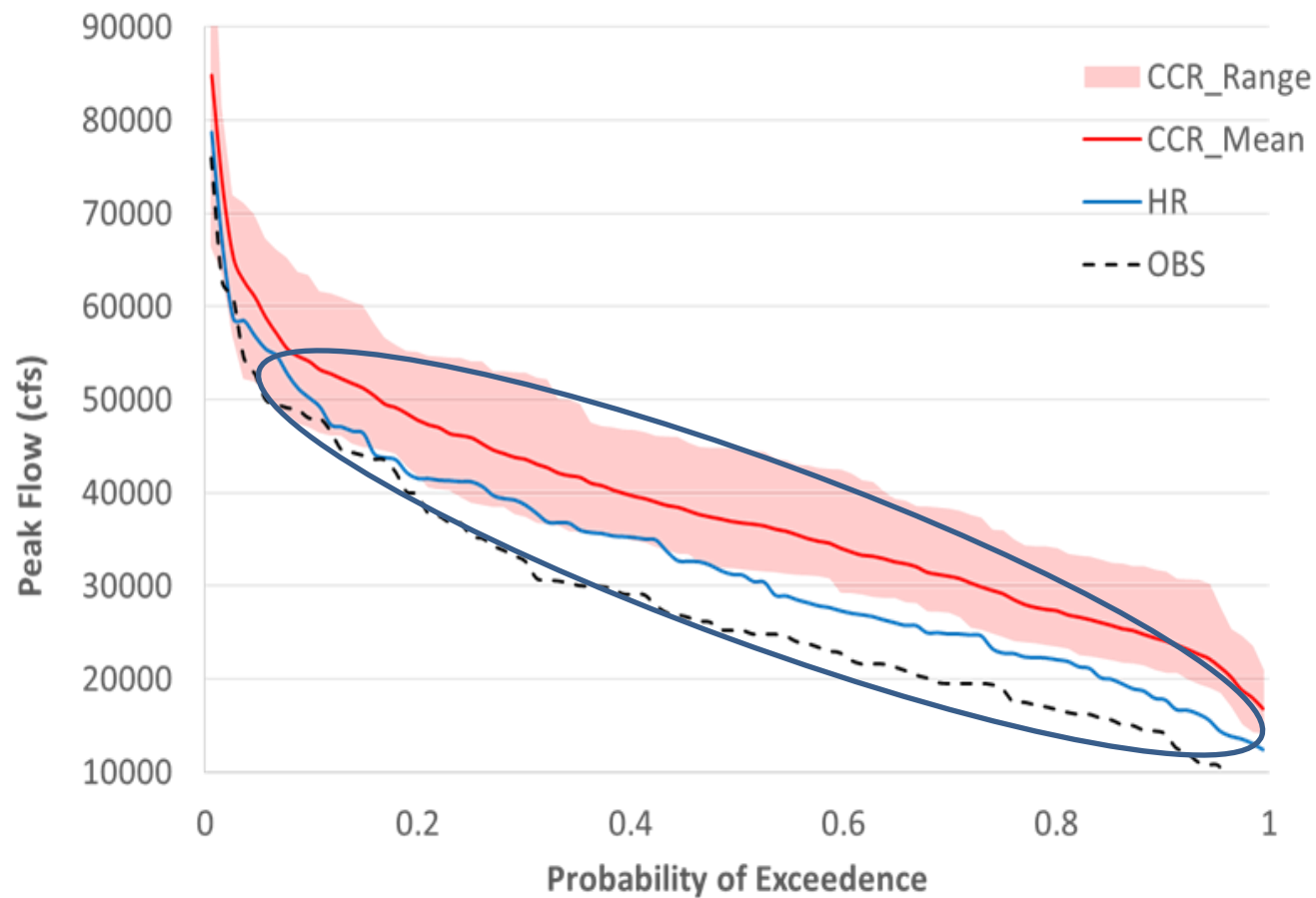
- Projected Period: 2020s
 - More springtime rain events
 - Heavy springtime rain events
 - Decrease in summer/fall rain events



Projected Peak River Flows:

- Projected Period: 2050s
 - Increase in flooding
 - Annual flood = 40% increase

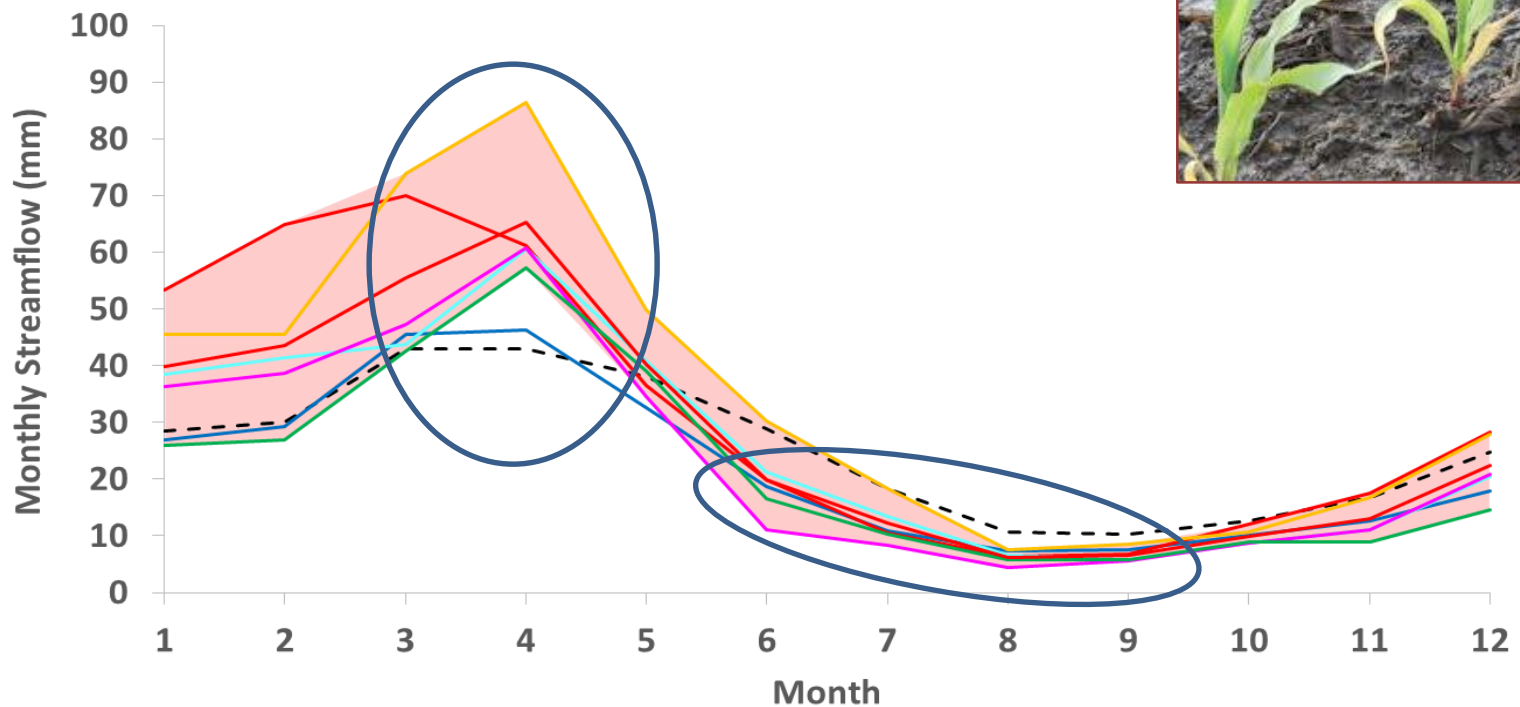
Climate
Change



Seasonal Flows:

- Projected Period: 2050s
 - **MORE** spring rain events
 - **HEAVIER** springtime rain events
 - Decrease in summer/fall rain events

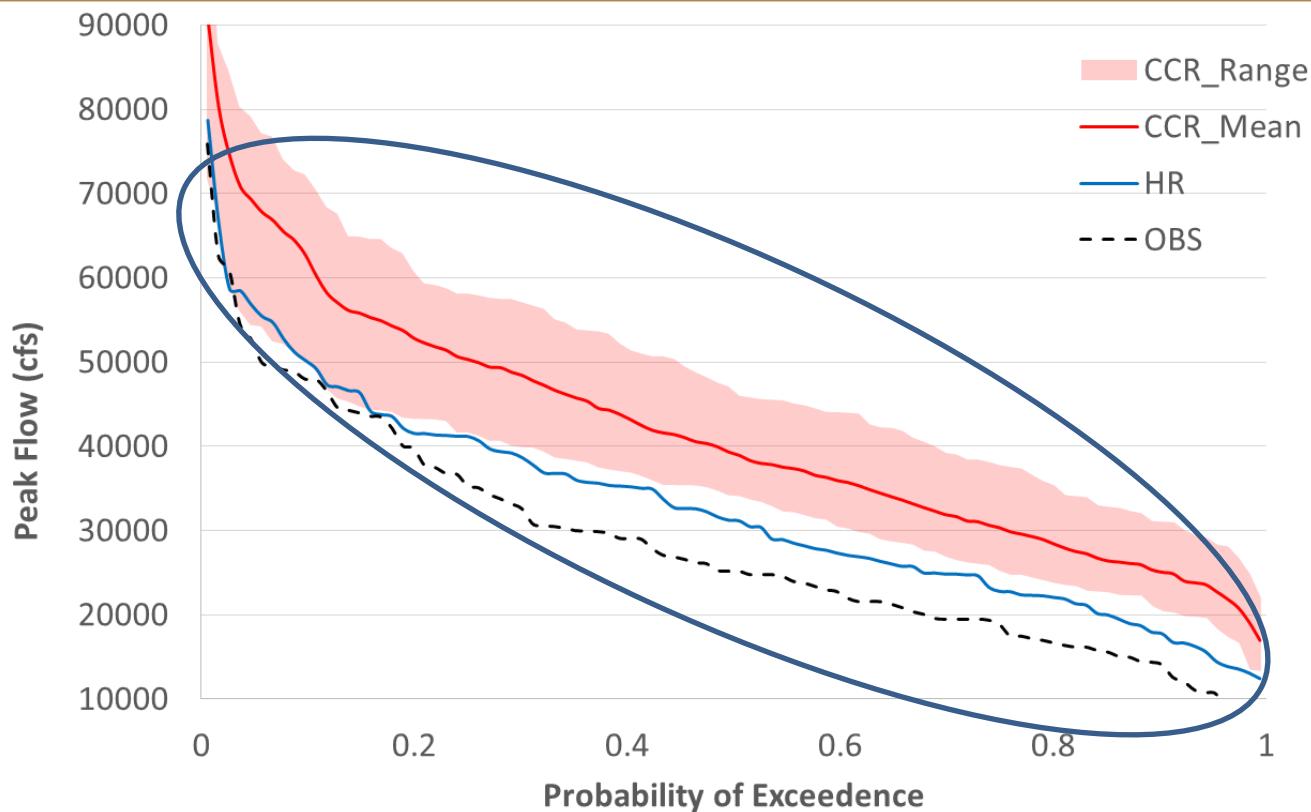
Climate
Change



Projected Peak River Flows:

- Projected Period: 2080s
 - 50% increase in peak flows
 - **LARGE** Increase in flooding events

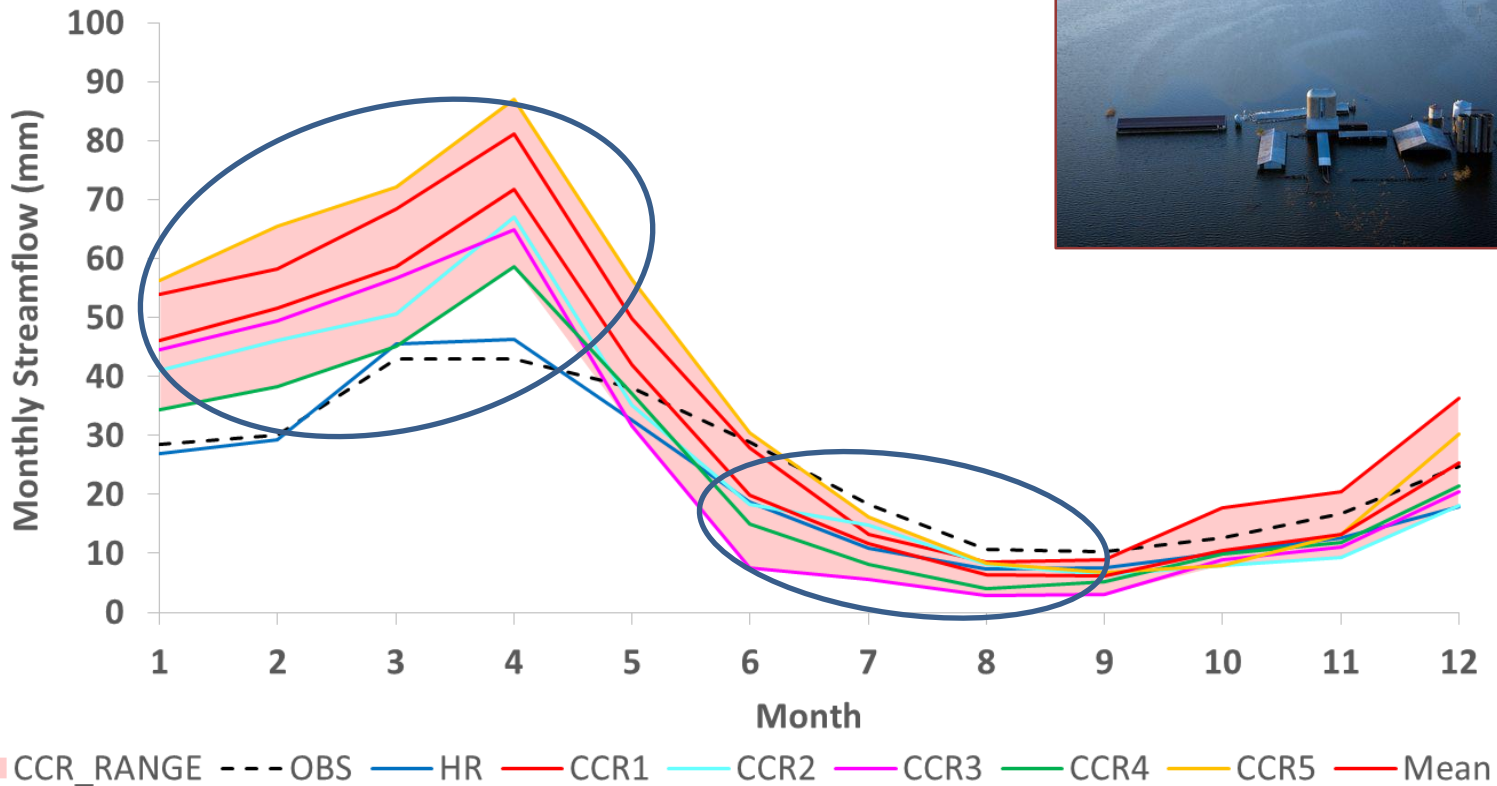
Climate
Change



Seasonal Flows:

- Projected Period: 2080s
 - Doubling of springtime rain
 - WET, earlier winters
 - Dry summers

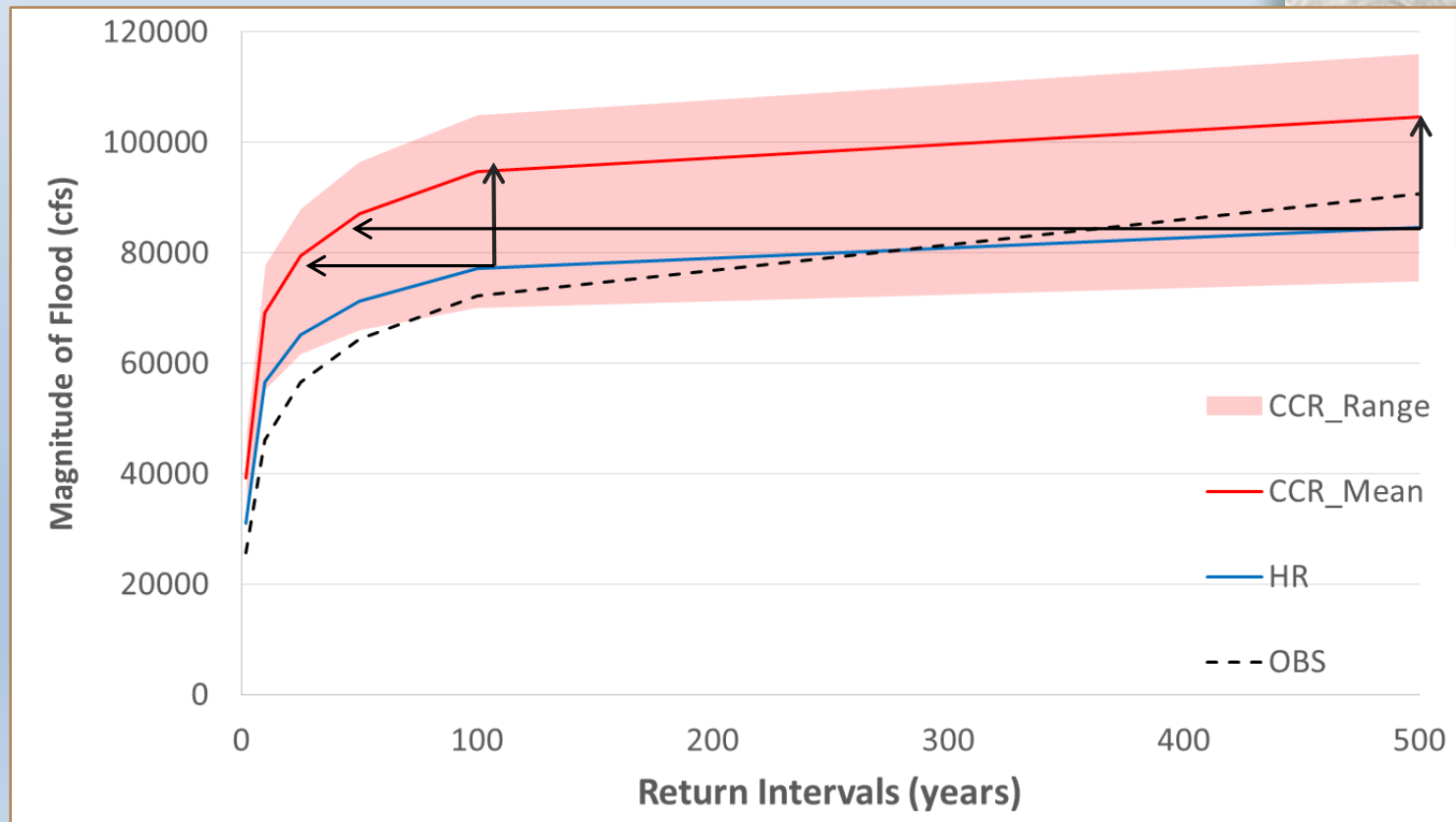
Climate
Change



Projected Peak River Flows:

- Projected Period: 2080s
 - Present 100 yr flood = new 20 yr flood
 - Present 500 yr flood = new 50 yr flood
 - New 100 yr & 500 yr flood = 25% increase

Climate
Change



Wetland Restoration Scenarios

Peer Input

Land-use
Scenarios

Peer-identified Scenarios

- Current landcover (no change)
- Historic Pre-settlement land cover
- Chicago Wilderness Green Infrastructure Vision (GIV)
- Upstream, non-prime farmland restoration (vs. riverside)
- Downstream, non-prime farmland restoration (vs. upstream)
 - Marginal and poor farmland
 - Frequently flooded farmland
 - Hydric soils

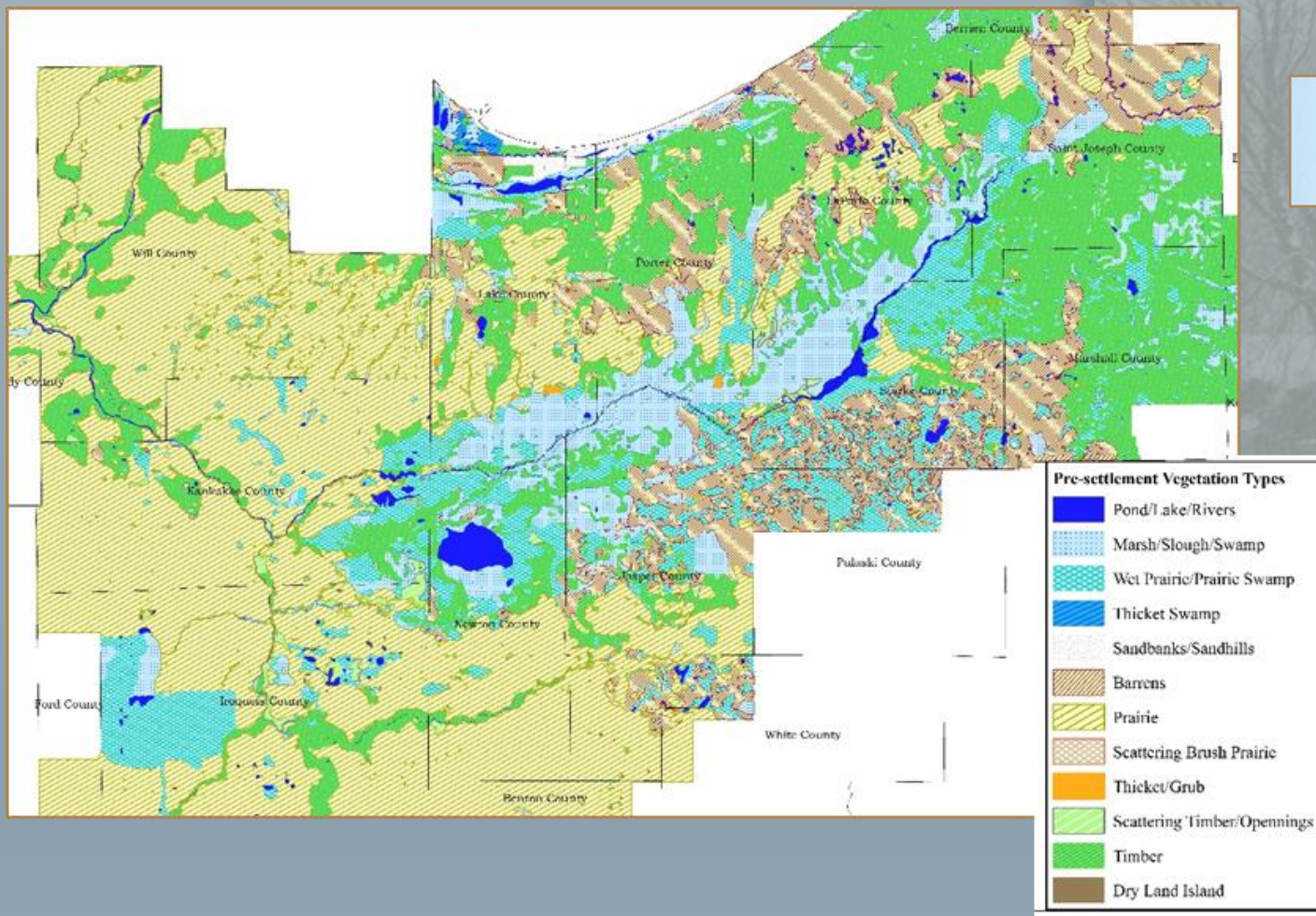




Historic Pre-Settlement Scenario

Land-use
Scenarios

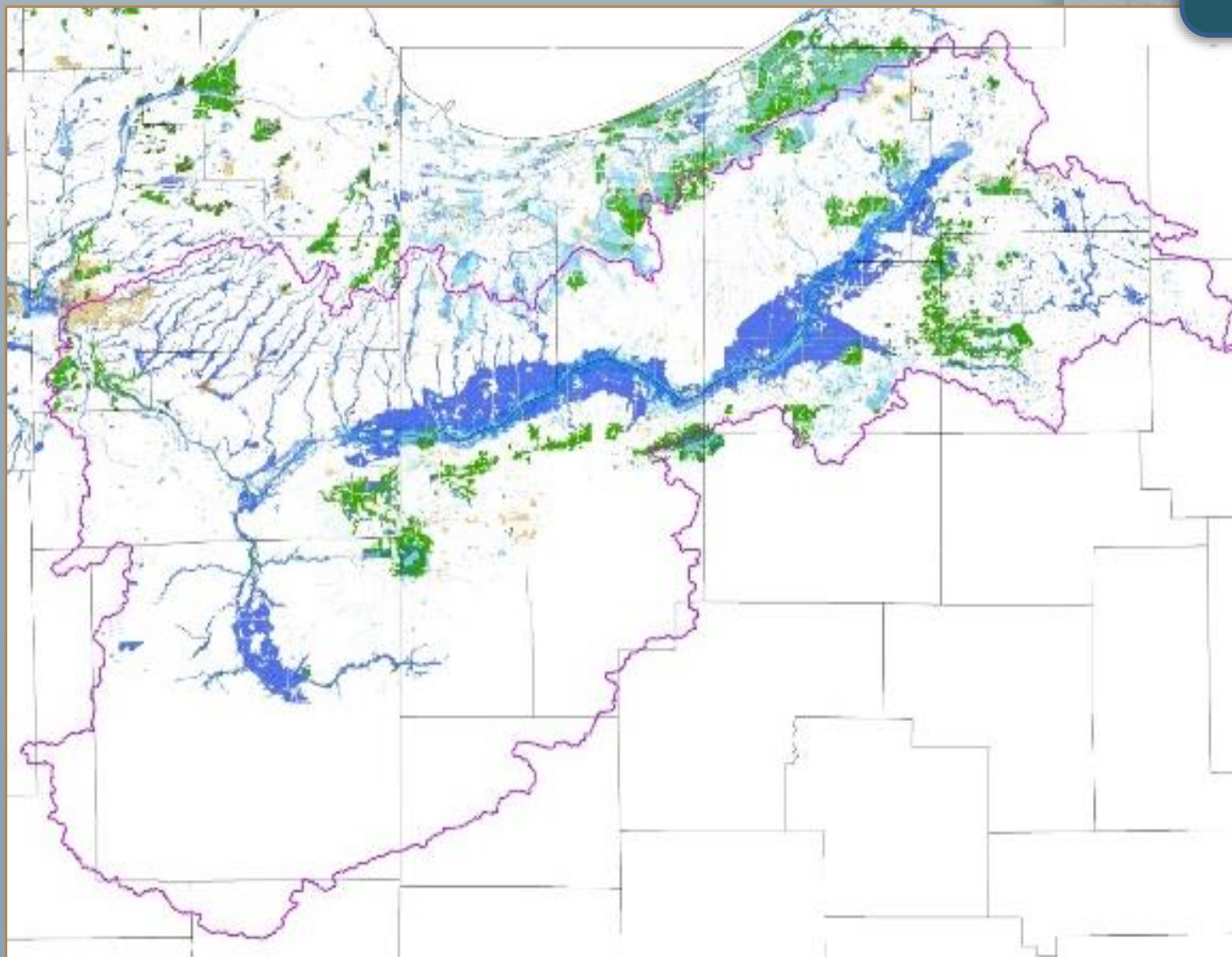
PaLEON





Chicago Wilderness GIV Scenario

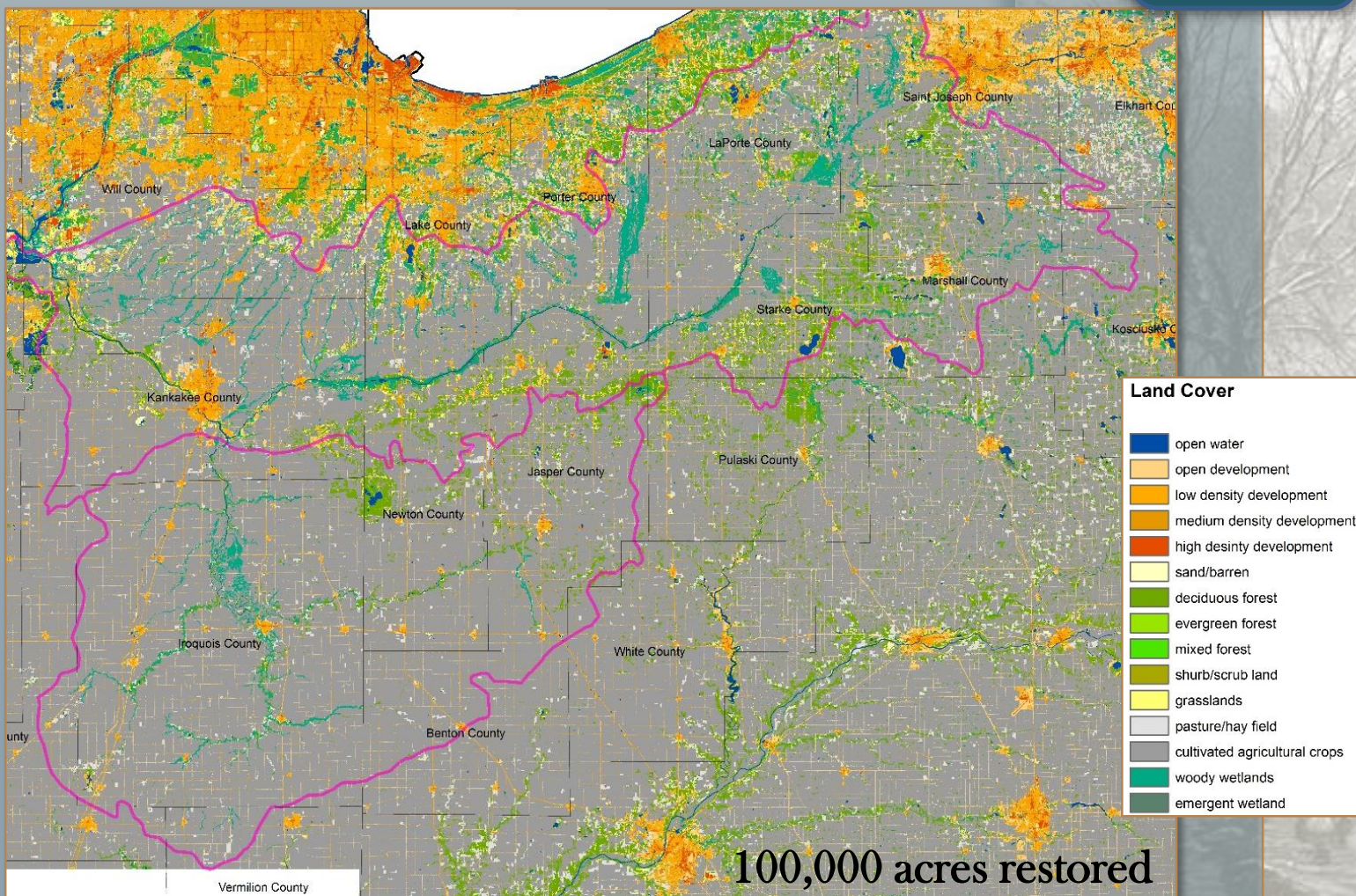
Land-use
Scenarios





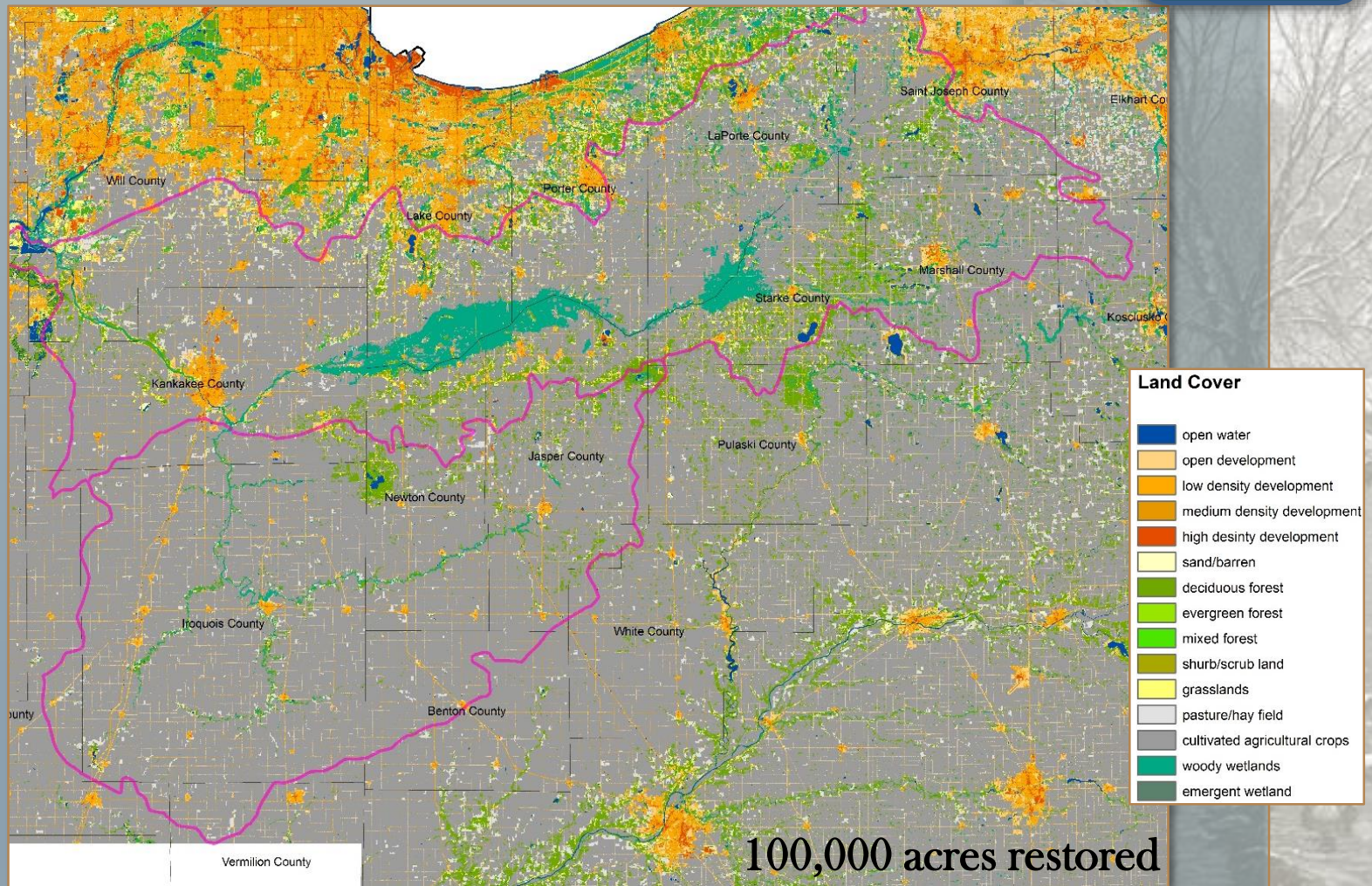
Upstream Non-prime Farmland Scenario

Land-use
Scenarios



Downstream Non-prime Farmland Scenario

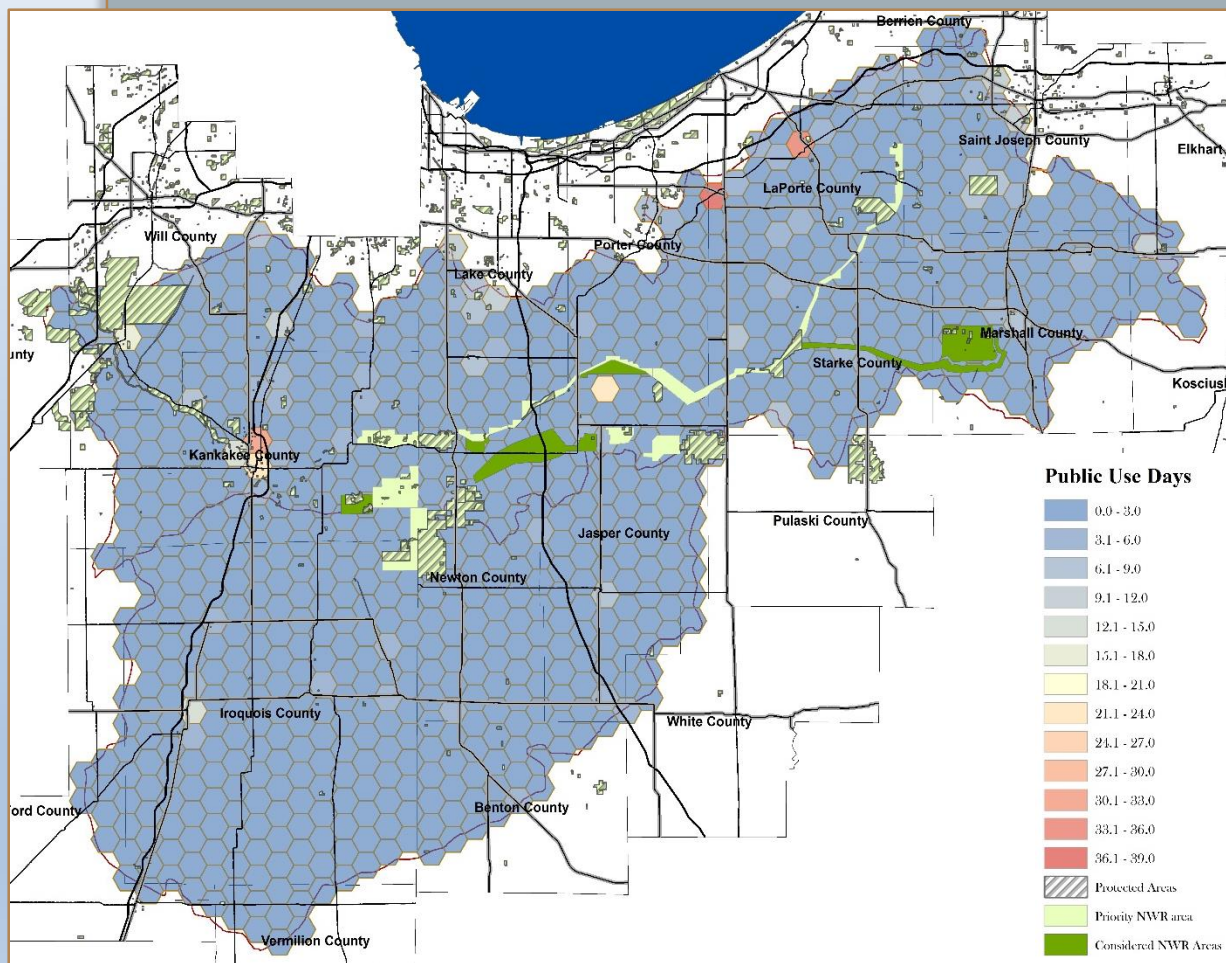
Land-use
Scenarios



Recreational Ecosystem Service Value

Ecosystem Services

- Based on Natural Capital Project InVEST Recreational Model
 - Predictive Grid (below)

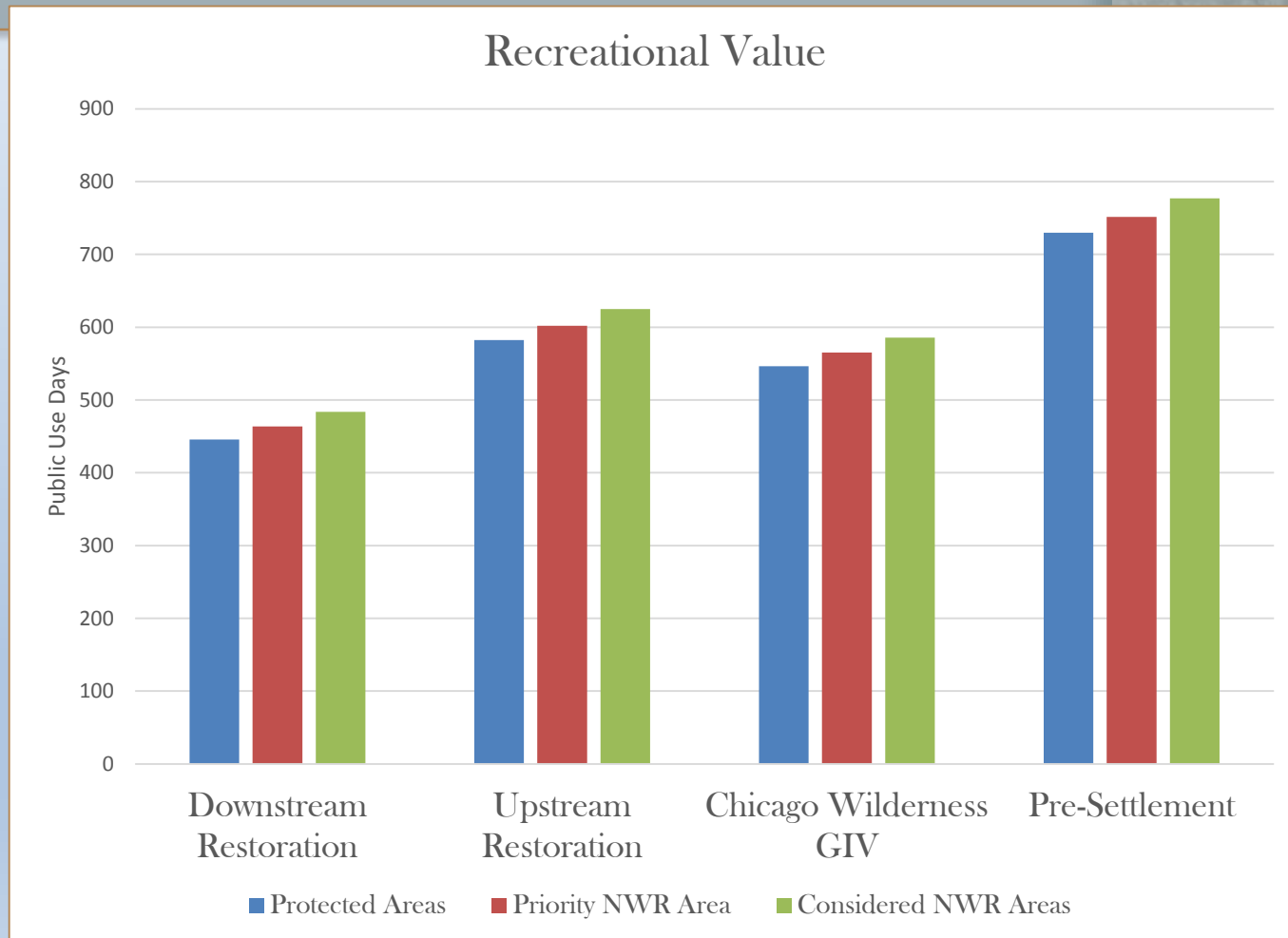




Recreational Value of Scenarios

Ecosystem
Services

- Predictors = wetlands, developed & agricultural landcover, population, highways, naturalness, & protected areas





Conclusions

- Climate Change = higher temperature
- Climate Change in Kankakee = more water, but in large, severe **SPRINGTIME** rainfall events, & dryer, hotter summers
- Current Kankakee basin **NOT** designed for water retention, groundwater recharge, nor flood control
- Wetlands can provide water retention, help reduce flooding & improve water recharge to groundwater
- Conservation lands provide recreational value & opportunity

Tammy Patterson

tpatterson@usgs.gov