Integrating climate change projections with breeding waterfowl habitat models

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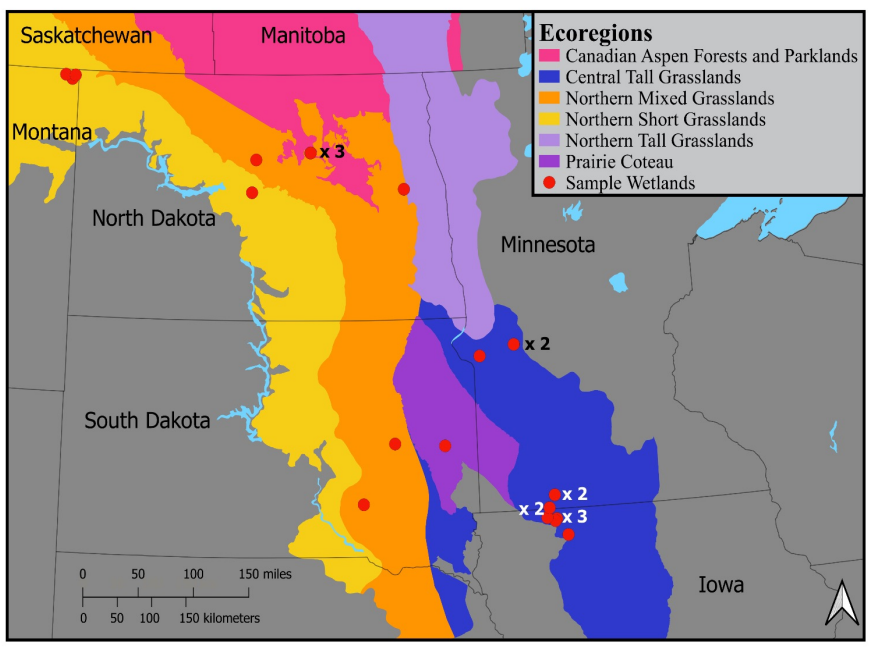
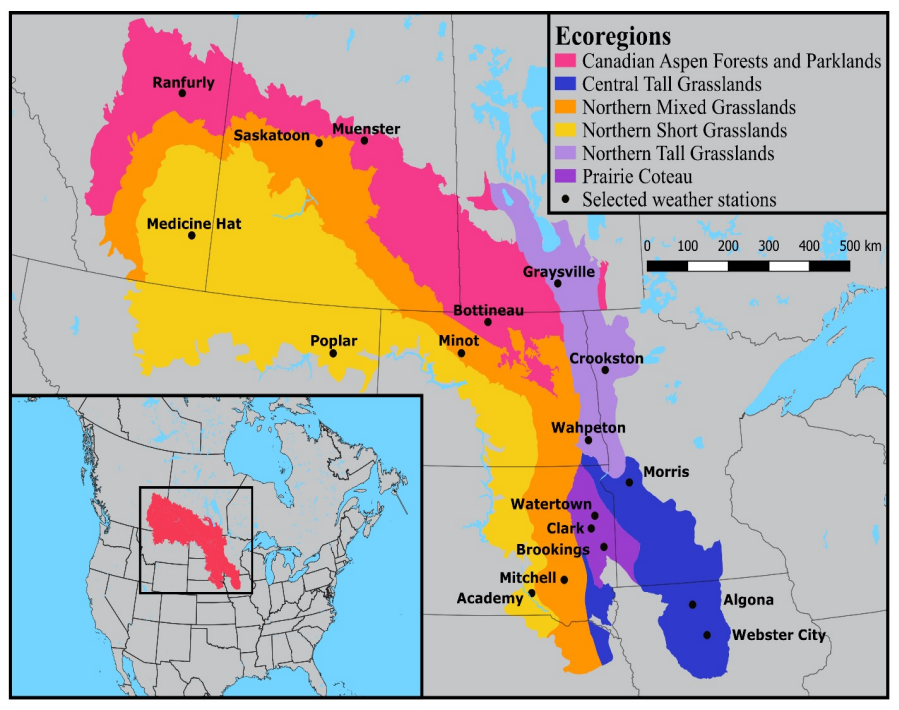


North American Prairie Pothole Region



McKenna et al. 2021, *Ecological Applications*

- 770,000 km^2 across five US states and three Canadian Provinces[1]
- More than 2.5 million wetlands[2]
- Estimated 50-80% of North American ducks breed in PPR[3]
- Highly variable inter-annual[4] and decadal[5] climate patterns

Ducks Unlimited

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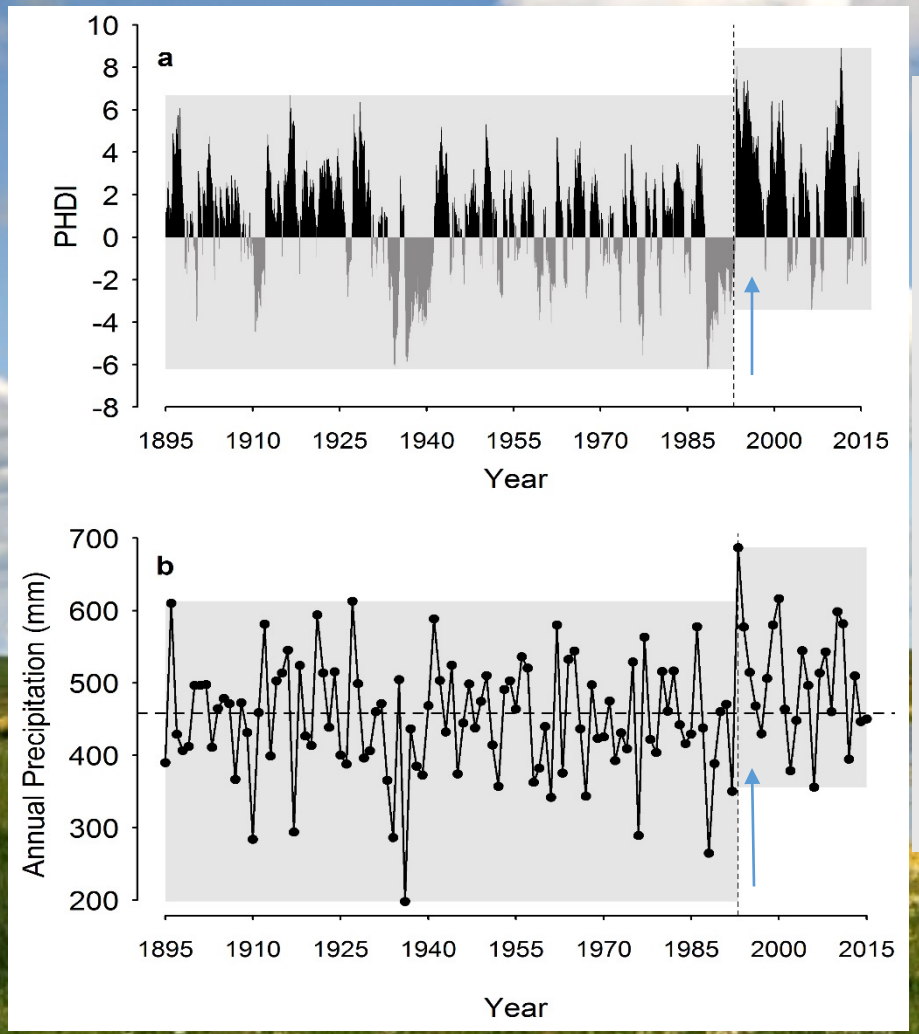
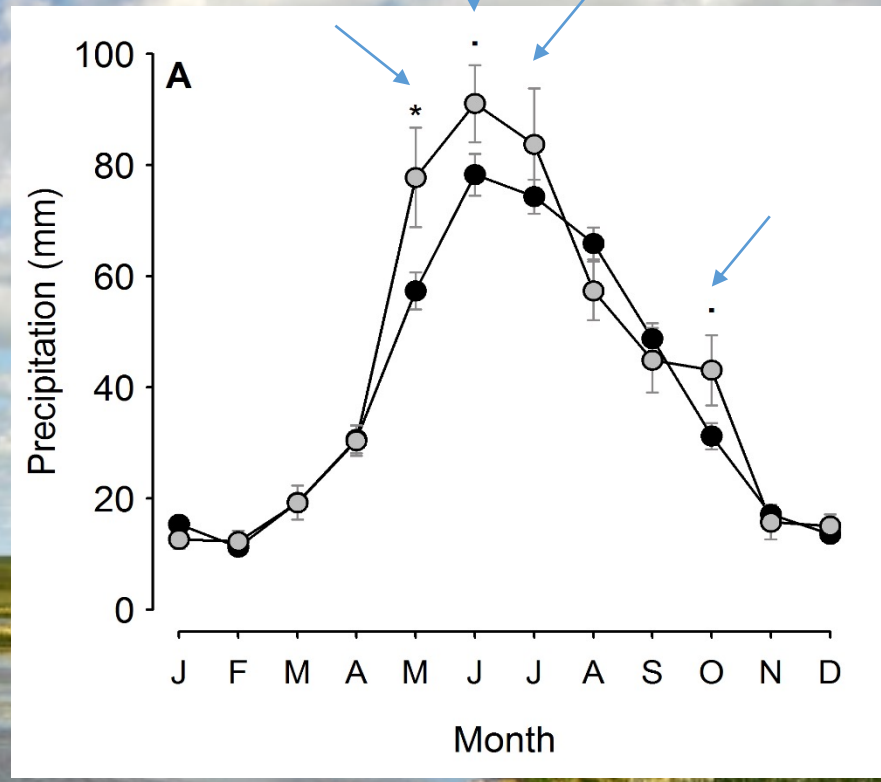
[1](Smith et al. 1964) [2](Dahl 2014) [3](Batt et al. 1989)
[4](Hayashi et al. 2016) [5](Winter and Rosenberry 1998)

Prairie Pothole Region Climate Shift



- 500% increase in mean monthly PHDI (0.41 – 2.18) (t=9.91, p<0.001)
- 12% Increase in mean annual precipitation (t=1.99, p<0.001)
- Increased precipitation in "dry" years starting in 1993
- Monthly precipitation increases occurred during May, June, July, October



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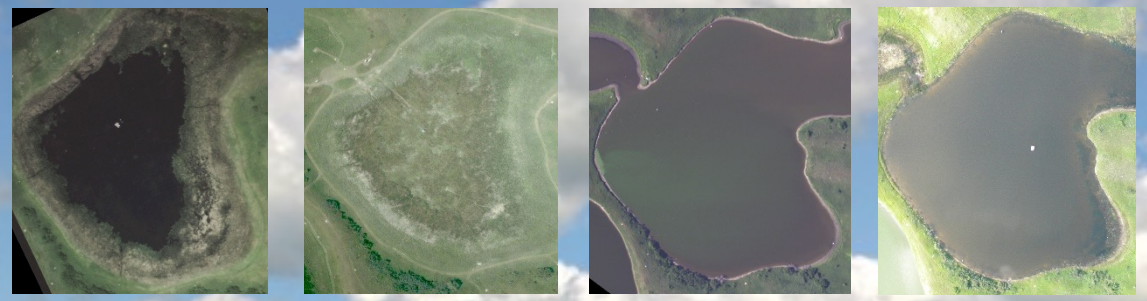
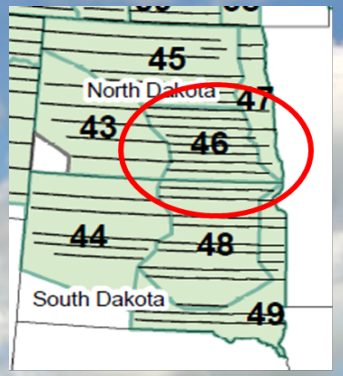
McKenna et al. 2017, *Climatic Change*

Prairie-pothole wetland response to climate shift

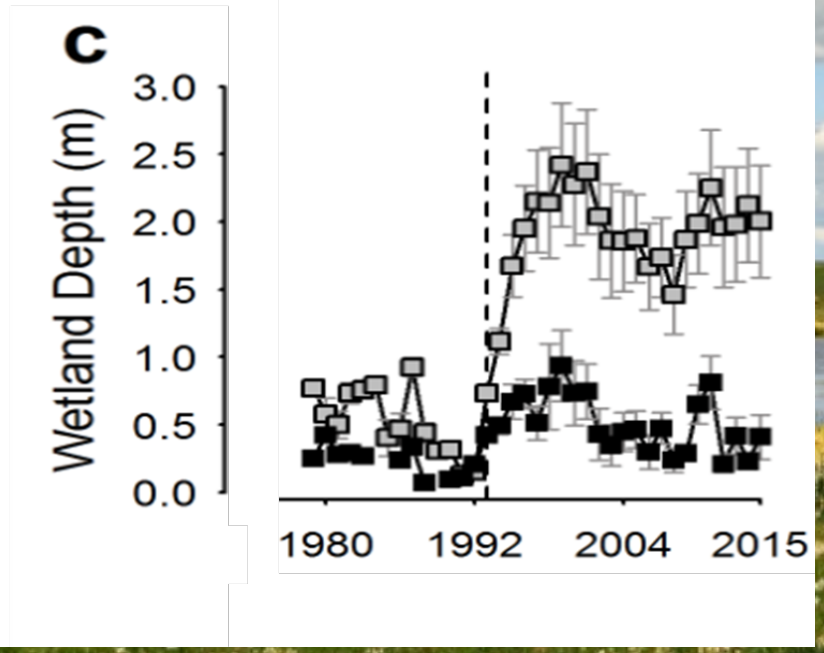
1982 1992 2002 2012



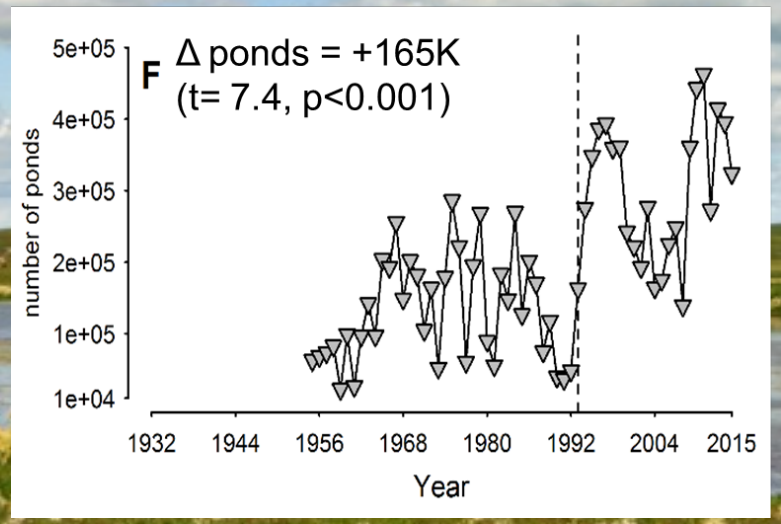


https://migbirdapps.fws.gov

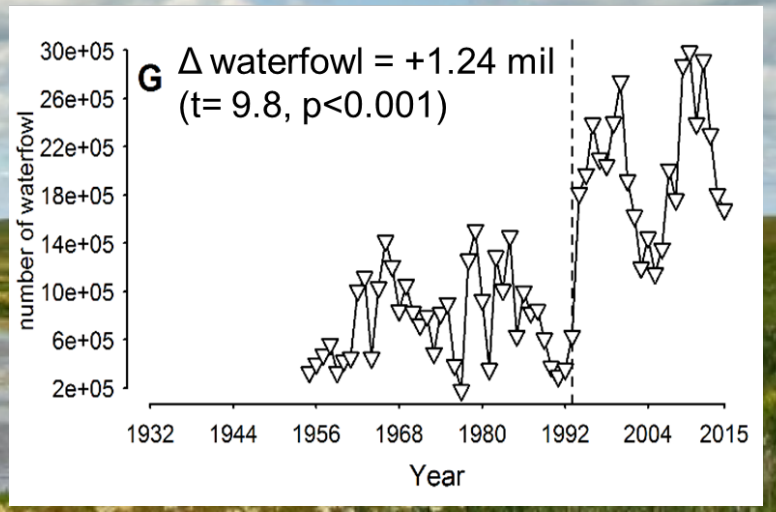
CLSA Wetlands



May Ponds



Waterfowl



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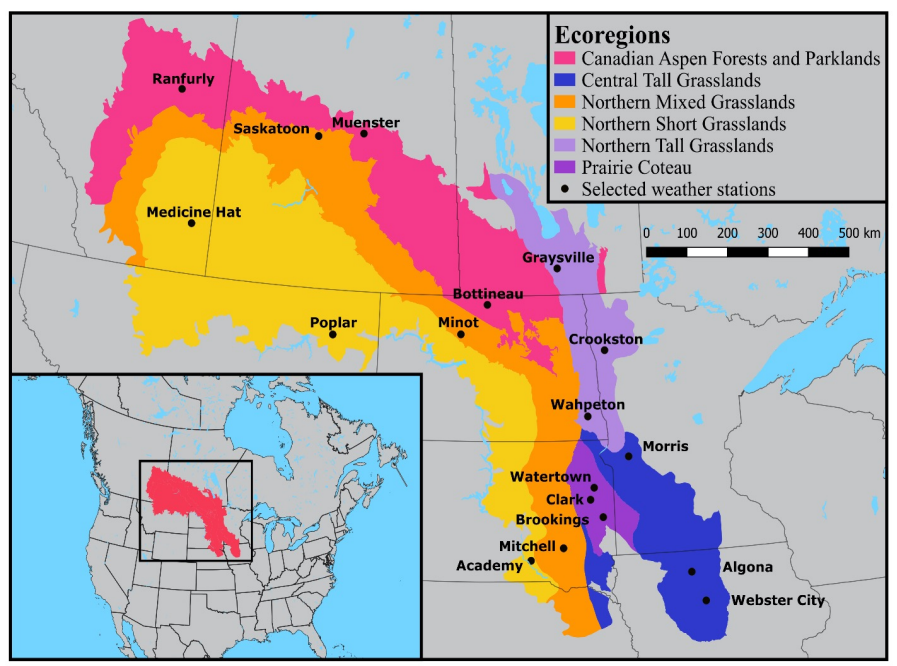
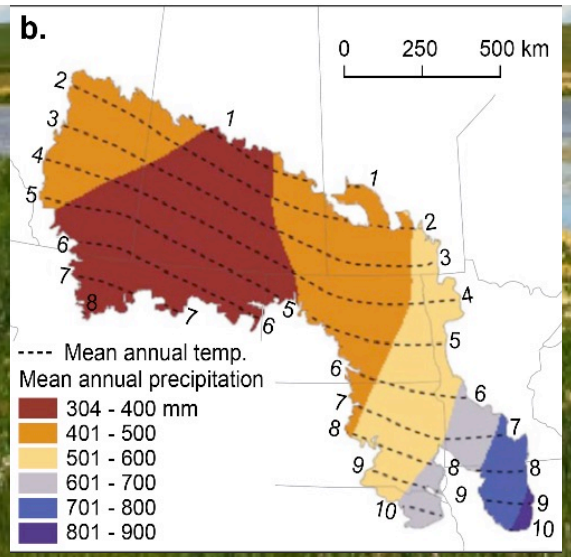
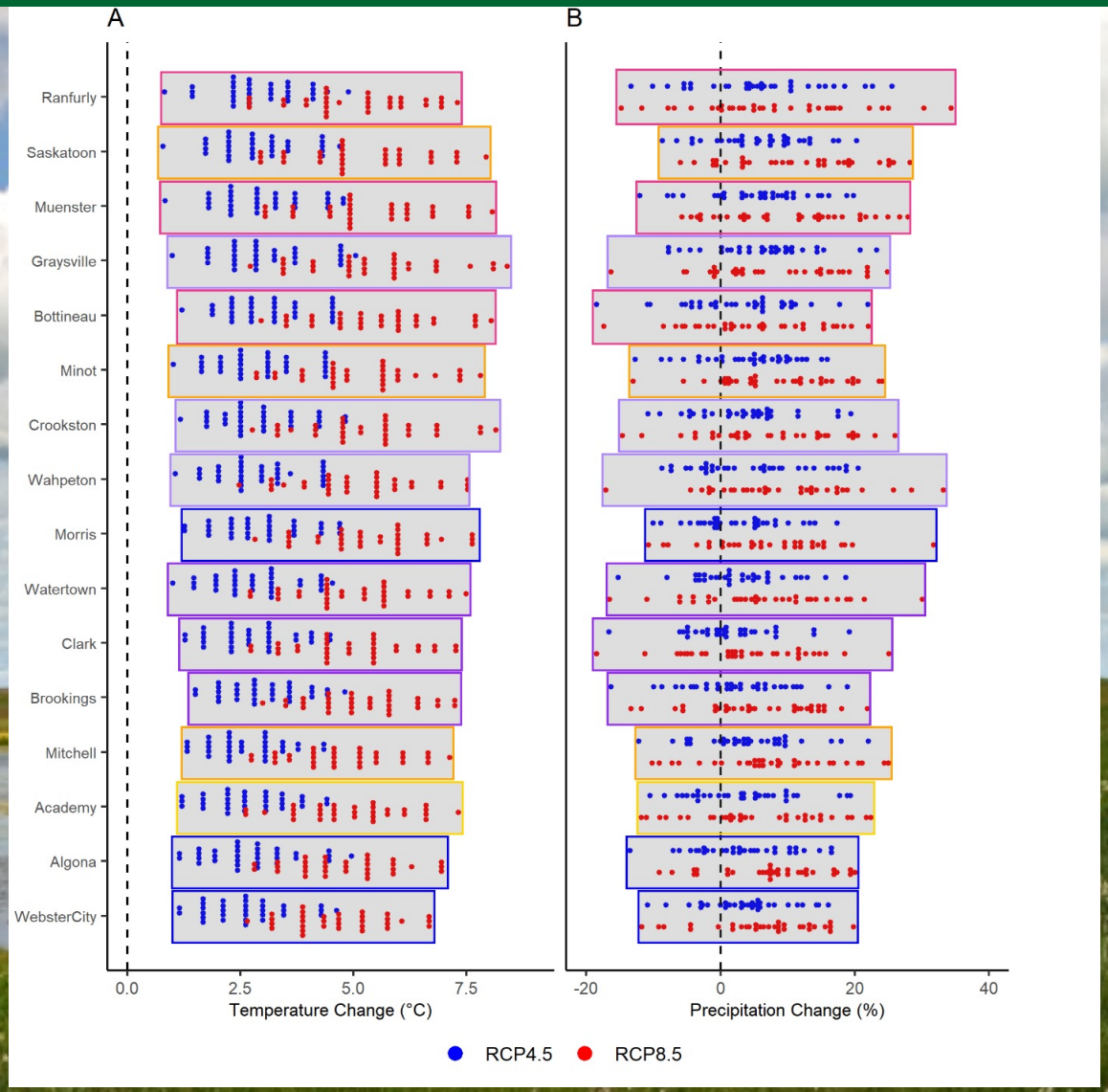
McKenna et al. 2017, *Climatic Change*

Future Climate projections for PPR







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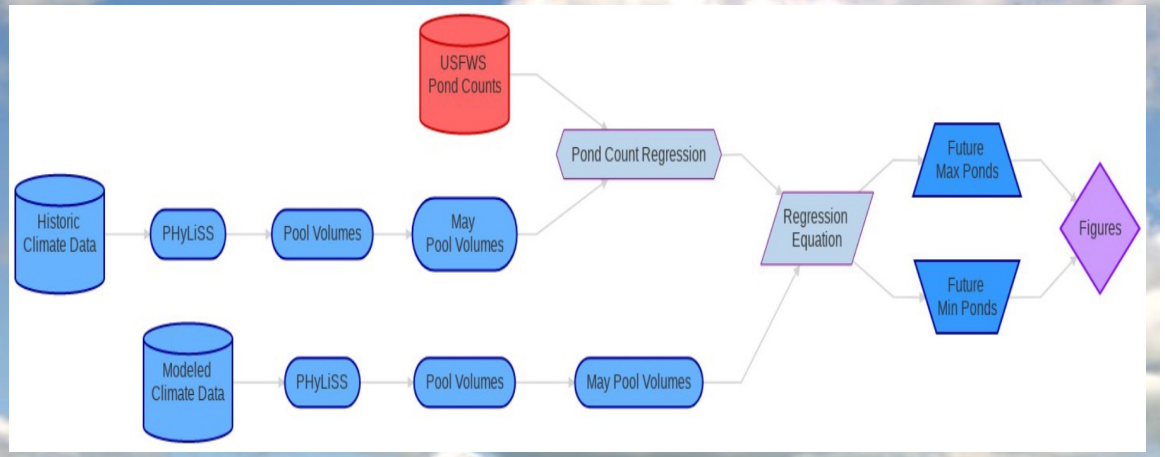
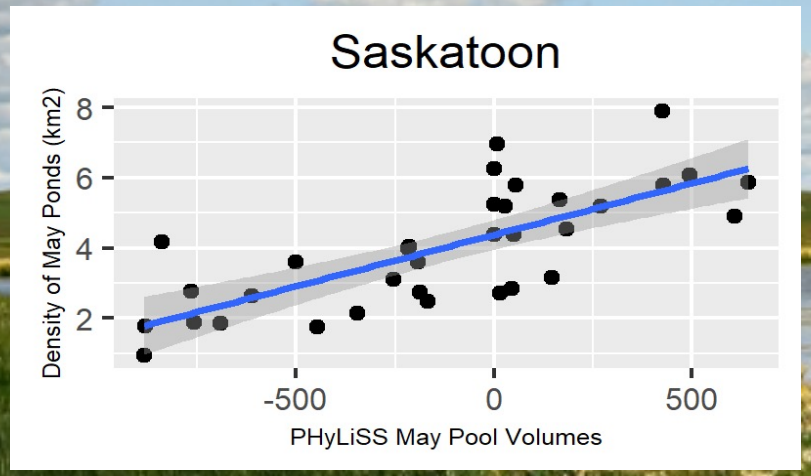
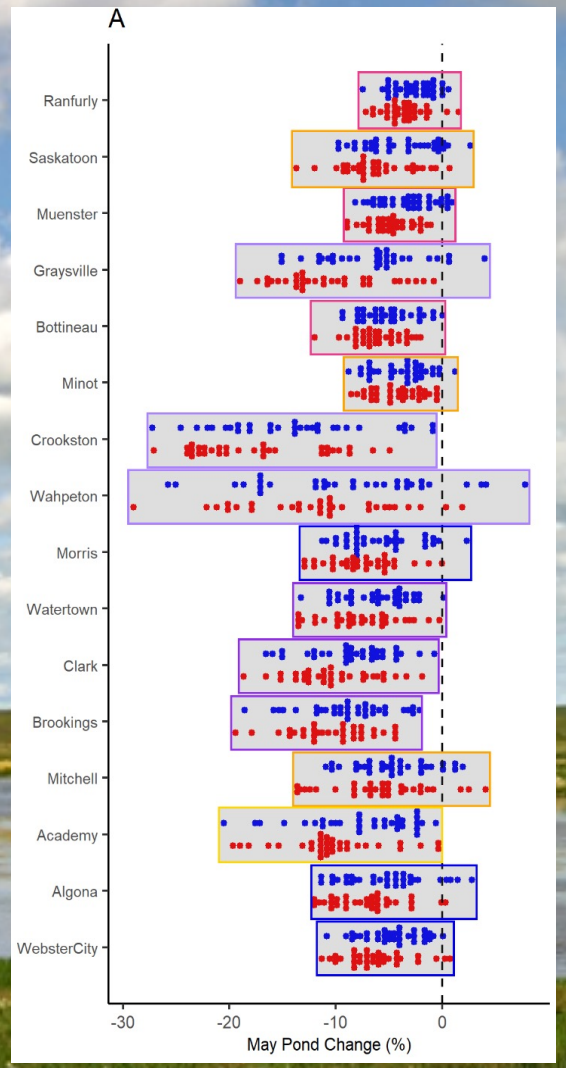
U.S. Fish & Wildlife Service

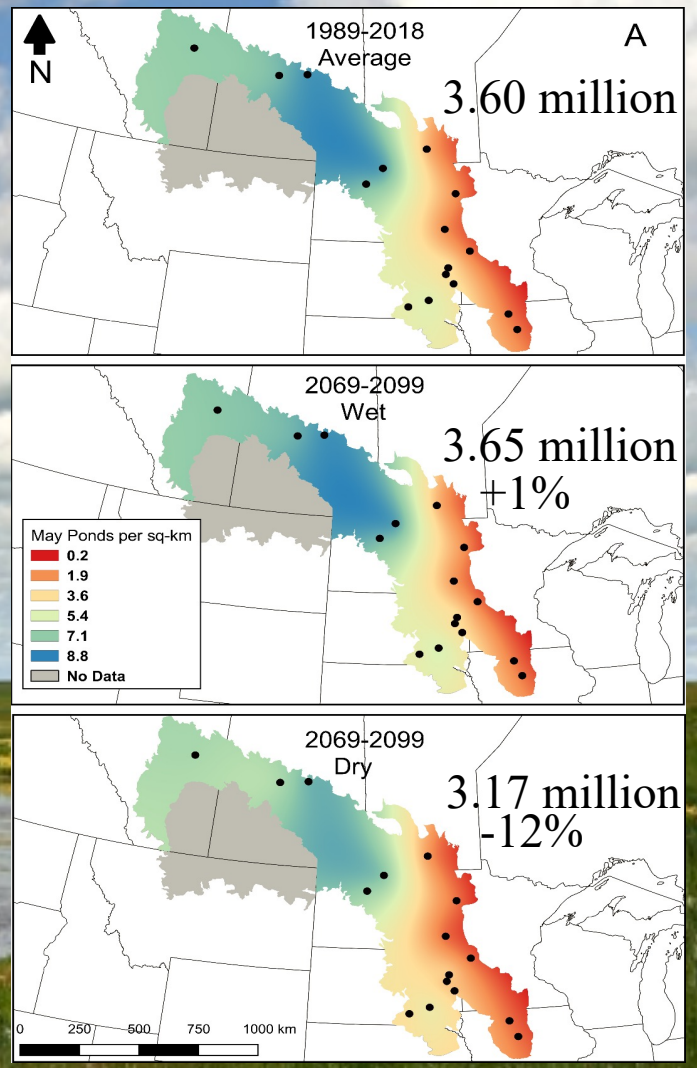
McKenna et al 2021, *Ecological Applications*

Model fusion to simulate future “May Pond” changes









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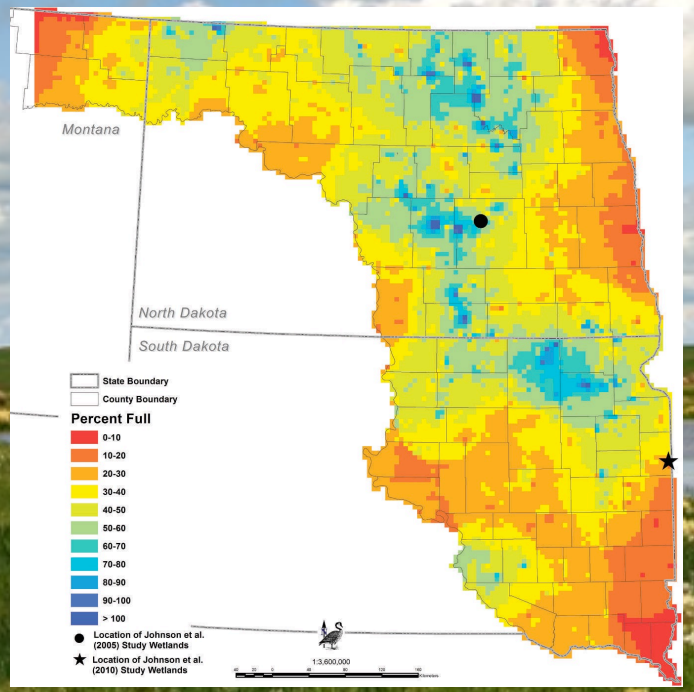
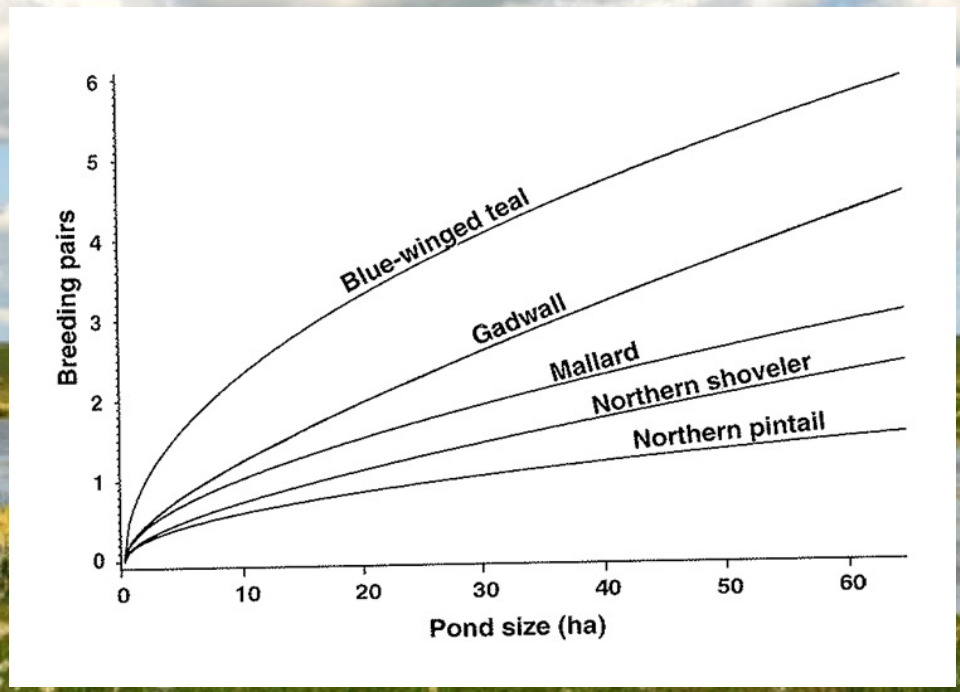
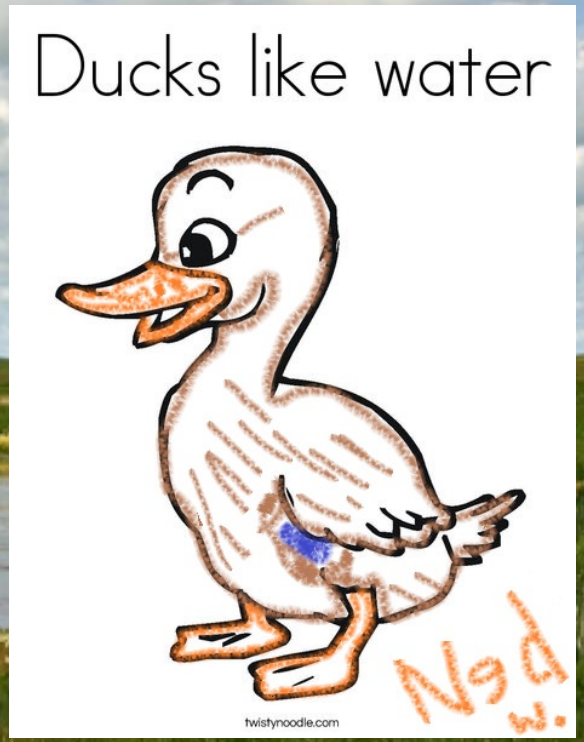
McKenna et al 2021, *Ecological Applications*

Moving from wetland hydrology to waterfowl responses

How do we translate local wet area changes under different climate futures to breeding pair responses?







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Four-square Mile Survey

AERIAL PHOTOGRAPHY

ANNUAL BREEDING WATERFOWL COUNTS

Annual Field Surveys

- Aerial
  - Pond Wetness
- Ground
  - Pair Counts
- Outcomes
  - Pair Estimates
  - Recruitment Estimates
  - Models of Pair-Wetland Relationships

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Four-square Mile Survey

Breeding Pair Estimates (13 Species)
Gamma Values

γ

= ∑ observed pairs / ∑ predicted pairs

= The annual correction factors for each species and district.

Gamma values are derived from the annual pair pond observations.

The baseline regressions are corrected by gamma values to determine number of individuals of each species that are modeled to the wetland habitat (wet area and number of wet basins) measured from aerial photography for each plot.

Plots are then expanded out to the universe to produce pair estimates for the WMD.

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Four-square Mile Survey

Recruitment Estimates (5 Species)

- Recruits = 2RN
  - N = number of breeding pairs
  - R = recruitment rate (number of ducklings females fledged per female in the population)
- R = HZB/2
  - H = hen success
  - Z = proportion of broods that survive to fledge
  - B = average brood size at fledging

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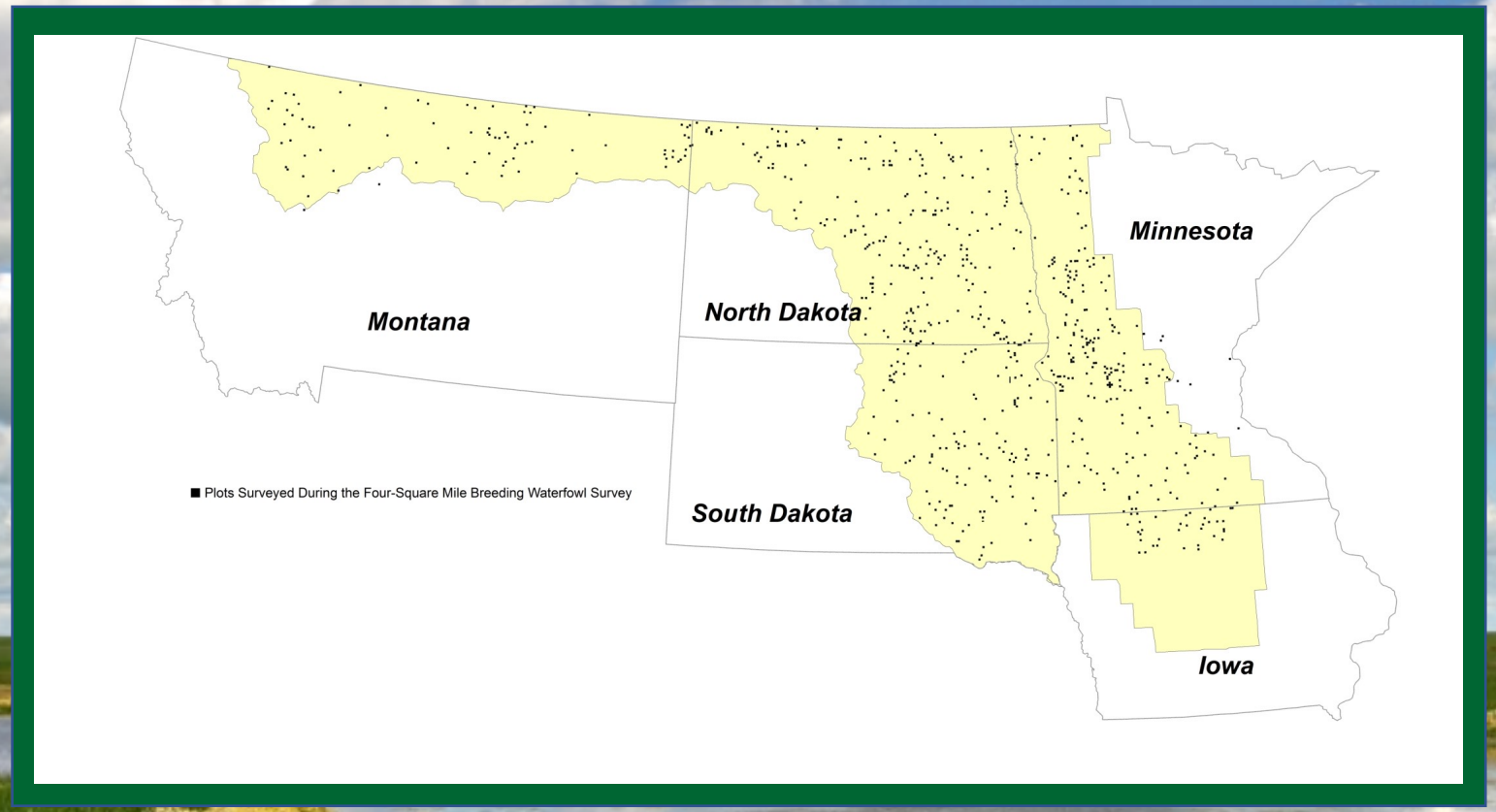
Four-square Mile Survey



1987-2021 Millions of Wet Acres Mapped Across 710 plots in 5 states.

Recognized as the primary method to monitor abundance and distribution of waterfowl by Prairie Pothole Joint Venture.

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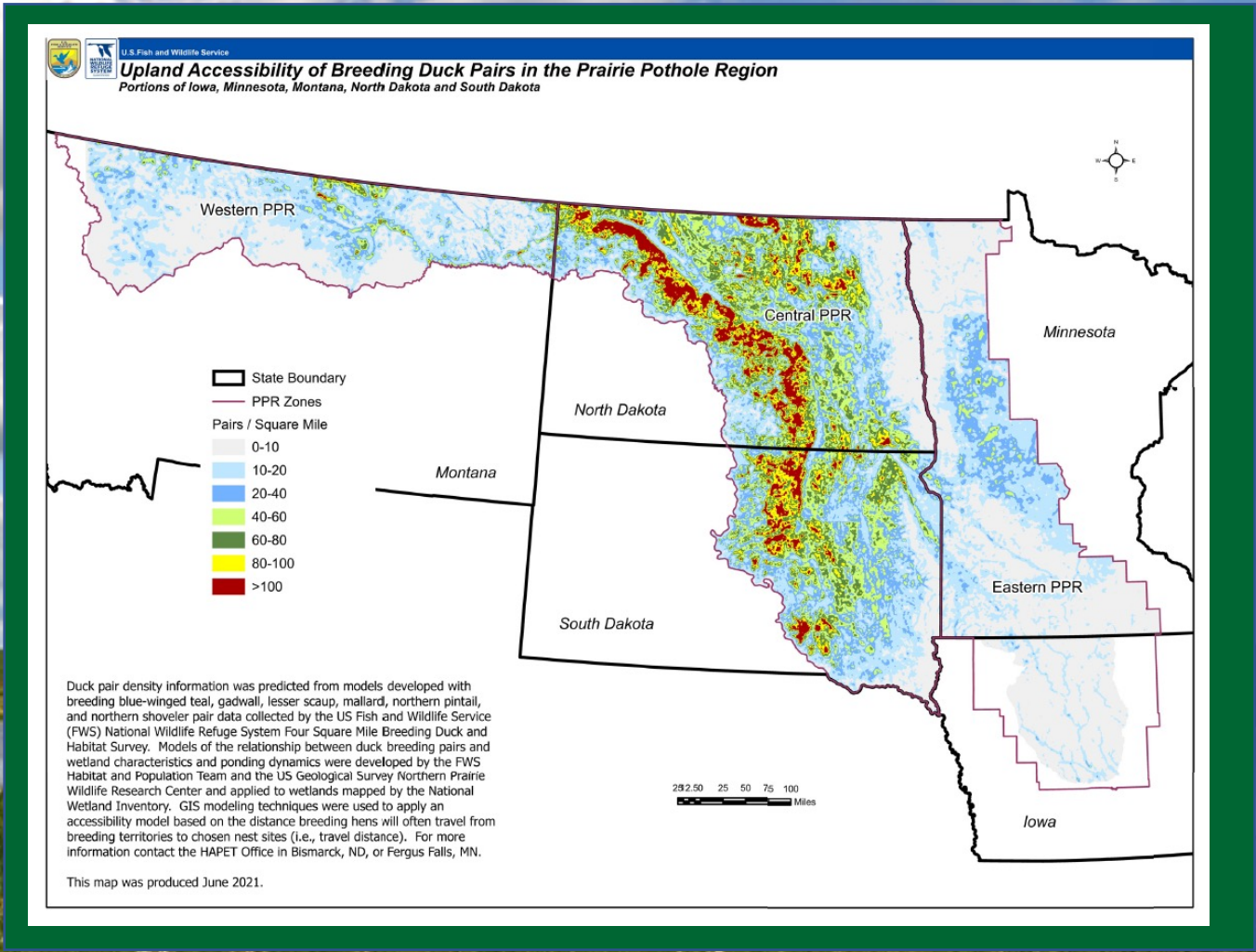
Four-square Mile Survey



Upland Accessibility By Breeding Duck Pairs – Thunderstorm Map

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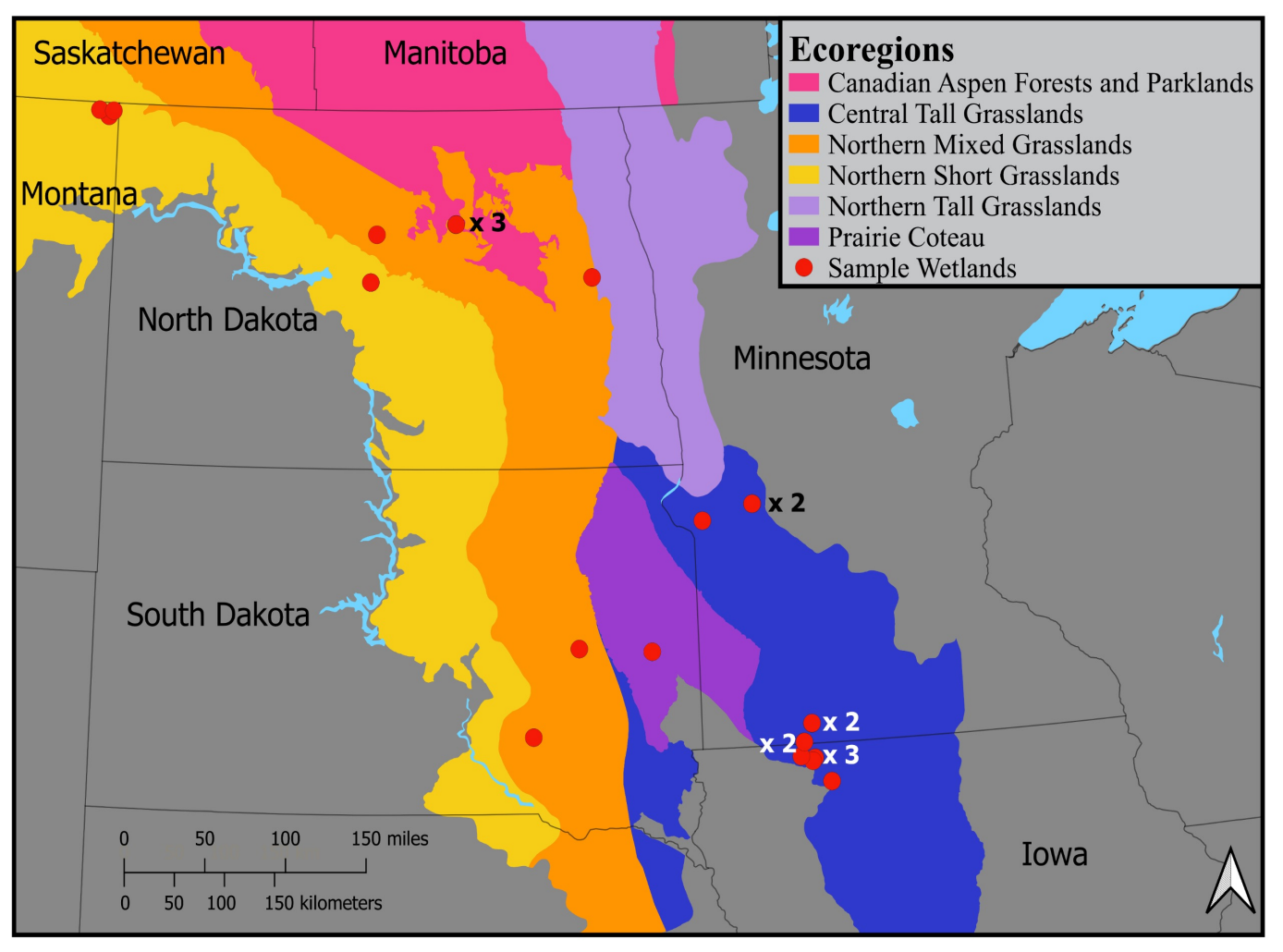
Study Design



- 25 wetlands across all US PPR
  - Within FSMS plots
  - Bathymetry, wetland areas, catchment areas from Gleason and Tangen surveys
  - Additional lidar-derived wetland and catchment delineations and wetland complexes
  - 23/25 are NWI wetlands

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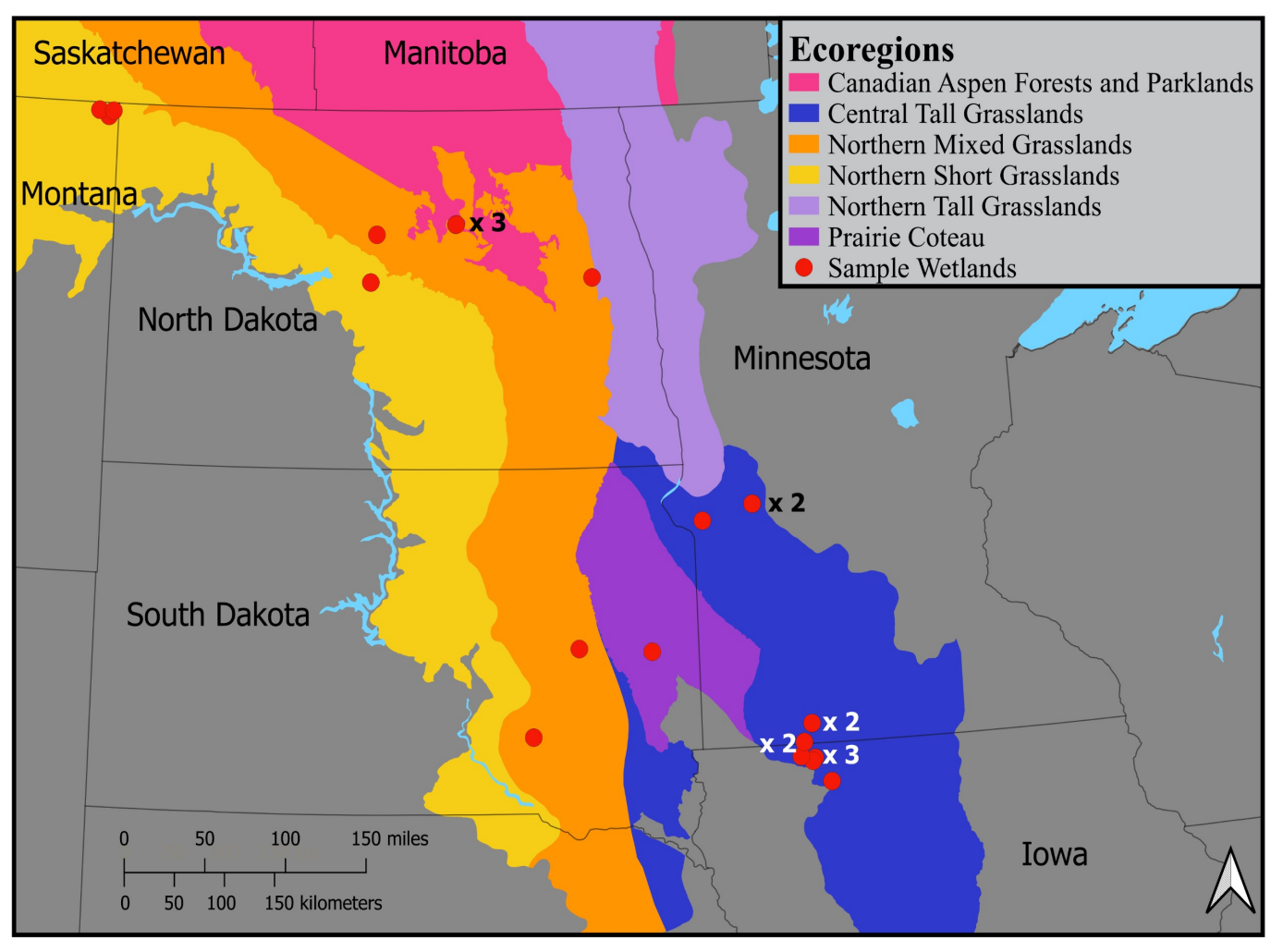
Study Design



- Co-investigators:
  - ***David Mushet***, U.S. Geological Survey, Northern Prairie Wildlife Research Center
  - ***Chuck Loesch***, US Fish & Wildlife Service, Habitat and Population Evaluation Team
  - ***Imtiaz Rangwala,*** University of Colorado-Boulder, NC CASC
- Modeling Team
  - ***Caryn Ross***, U.S. Geological Survey, Northern Prairie Wildlife Research Center
  - ***Elyssa McCulloch***, U.S. Geological Survey, Northern Prairie Wildlife Research Center
  - ***FSMS GIS Team***, US Fish & Wildlife Service, Habitat and Population Evaluation Team
  - ***Brian Tangen***, U.S. Geological Survey, Northern Prairie Wildlife Research Center

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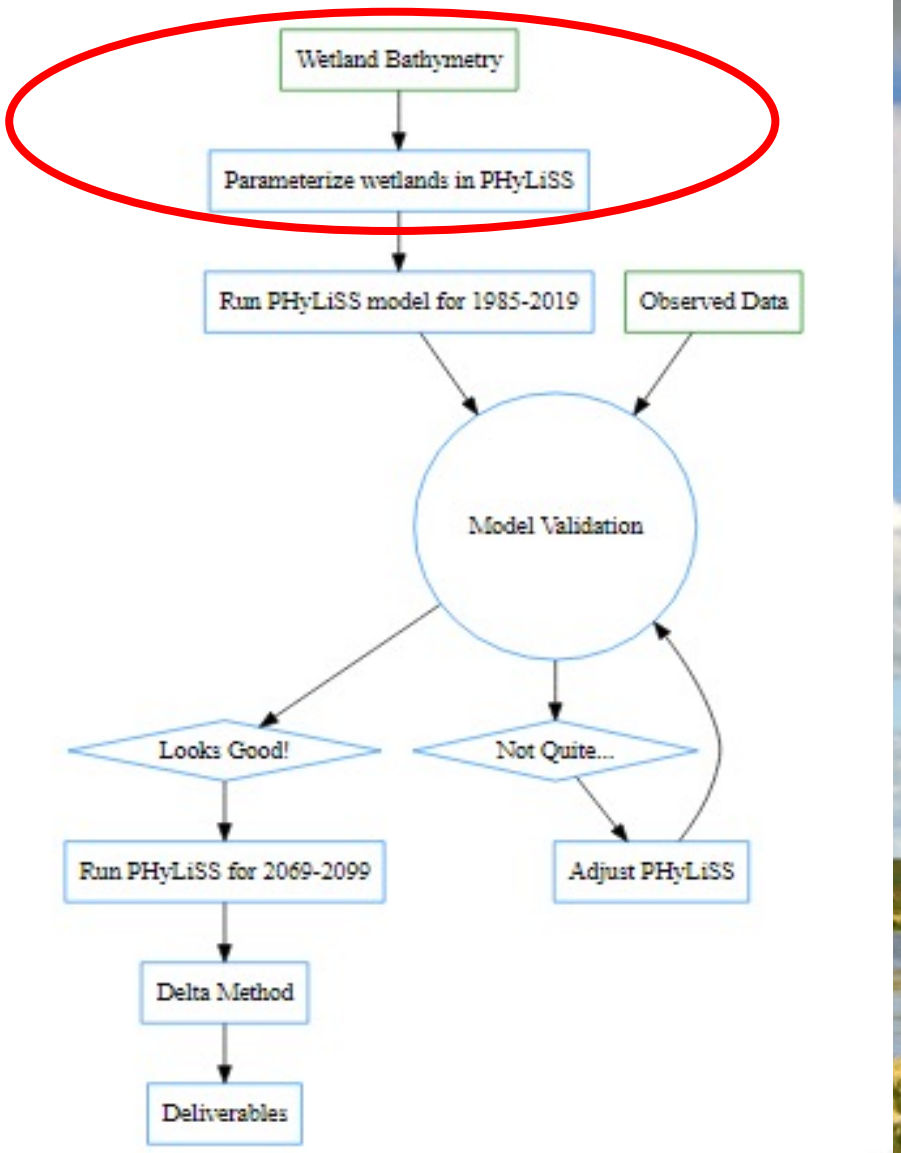
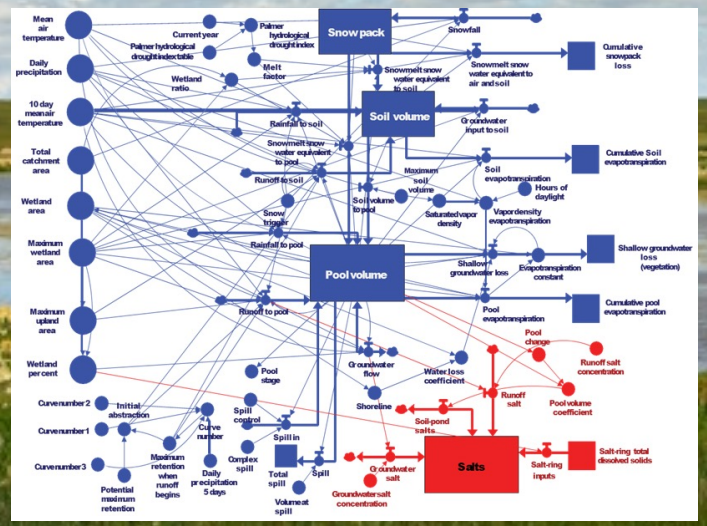


Data Questions

1. Which Data sources do we use for this project?
2. How will model results differ if we don't have wetland bathymetry for future projects?
3. Can we accurately estimate wetland and catchment data with digital elevation model data?
4. Would NWI be helpful at all for max wetland area?

PHyLiSS Model



McKenna et al. 2018, *USGS OFR*

Catchment Delineation

3m DEM Lidar → Whitebox Python →
- Streams
- Depressions
- Flow Accumulation
- Watersheds

(Wu et al. 2018)

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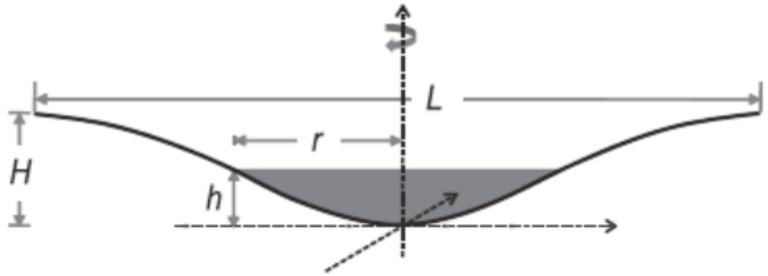
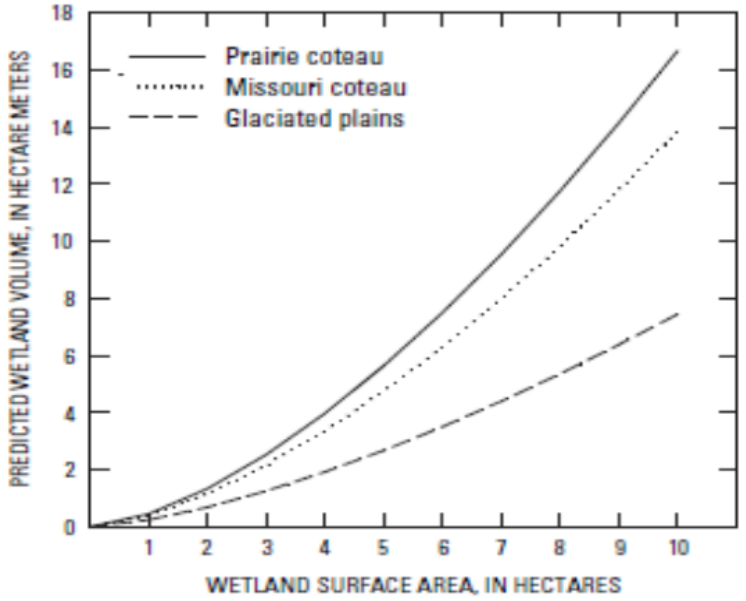
Brian Tangen has been helping us unearth these data

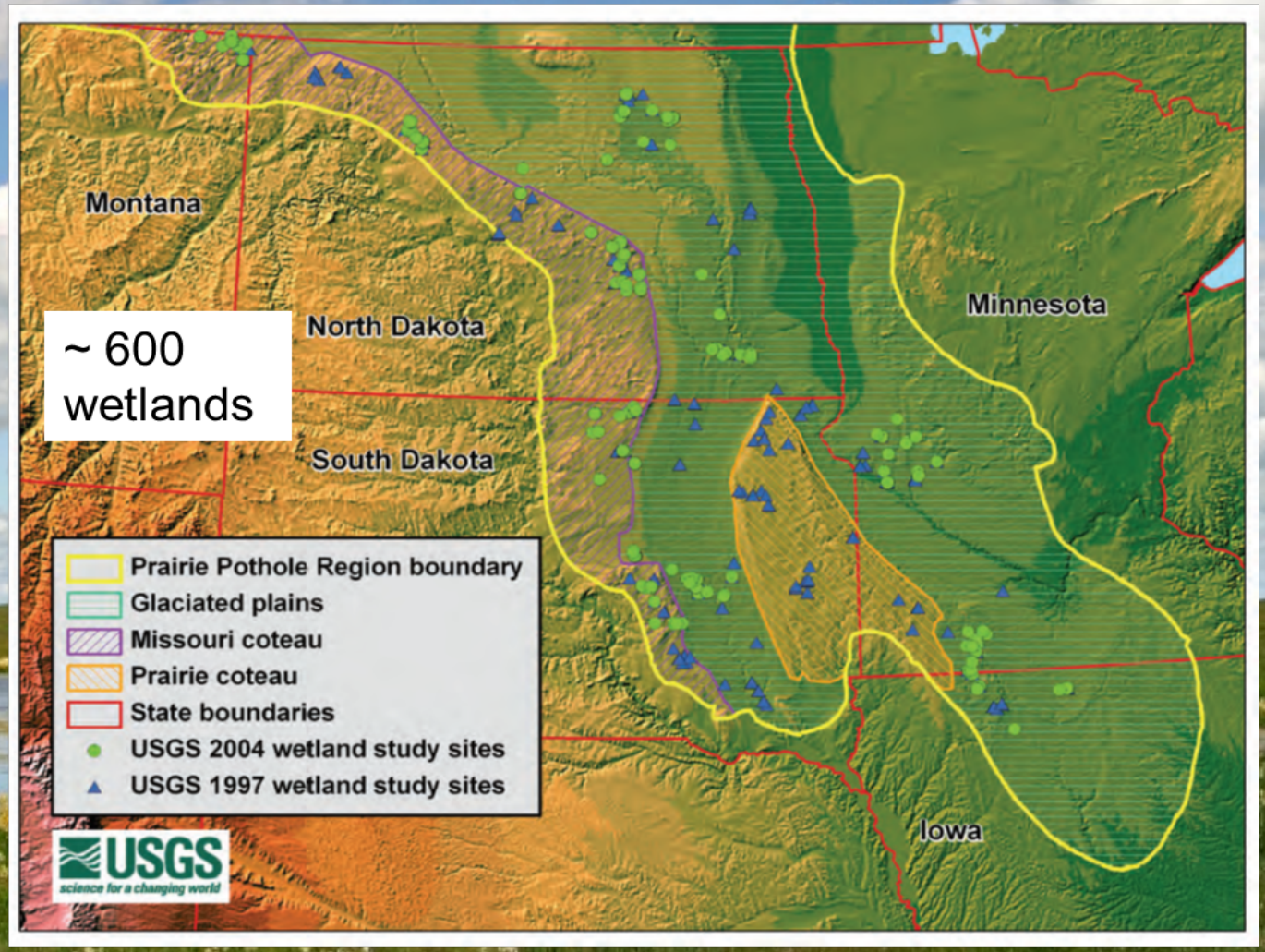


H - relief across the watershed;
L - watershed diameter;
r - water body radius when water depth equals to *h*.

Liu and Schwartz, 2011, *WRR*



Model inputs: Volume to Area and Upland Area to Wetland Area



Gleason et al. 2008, *USGS Professional Paper*

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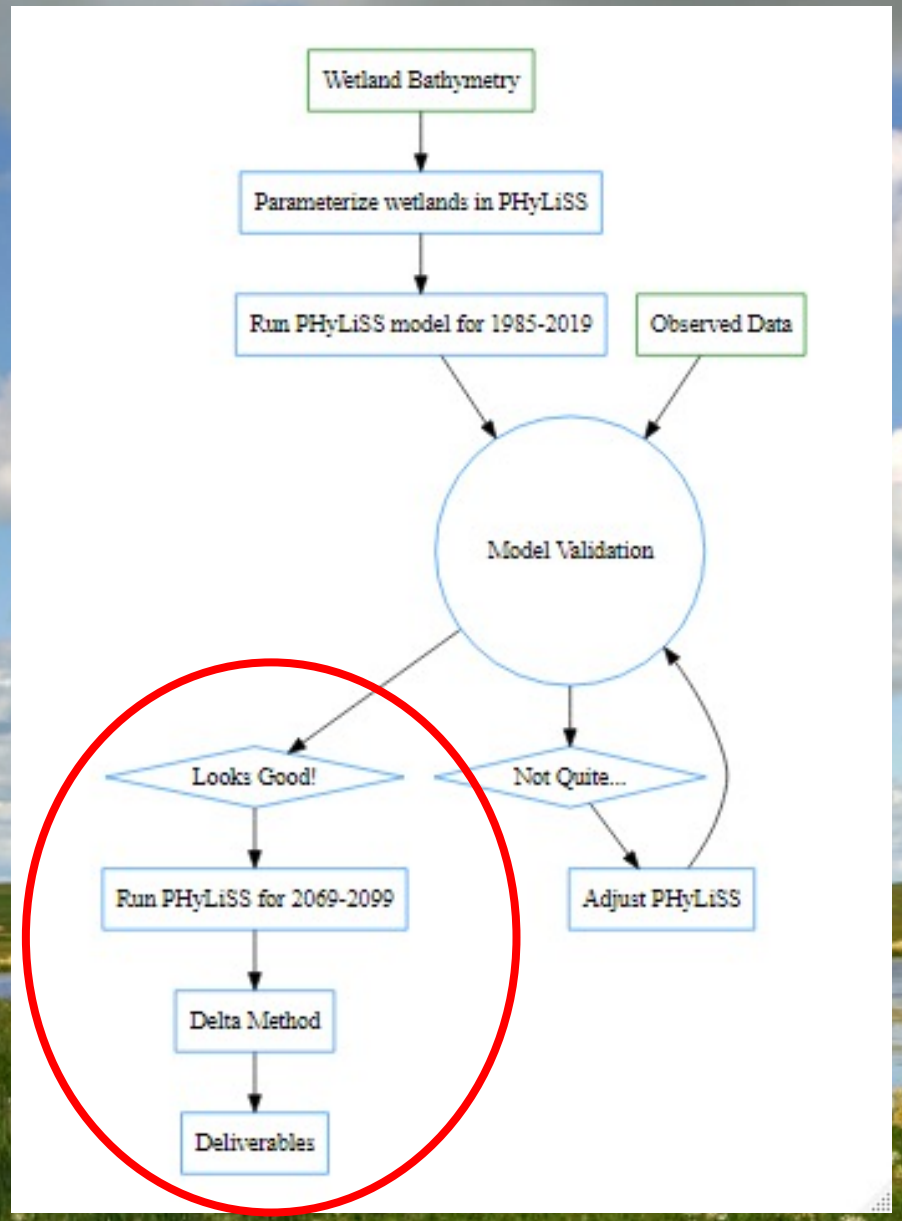

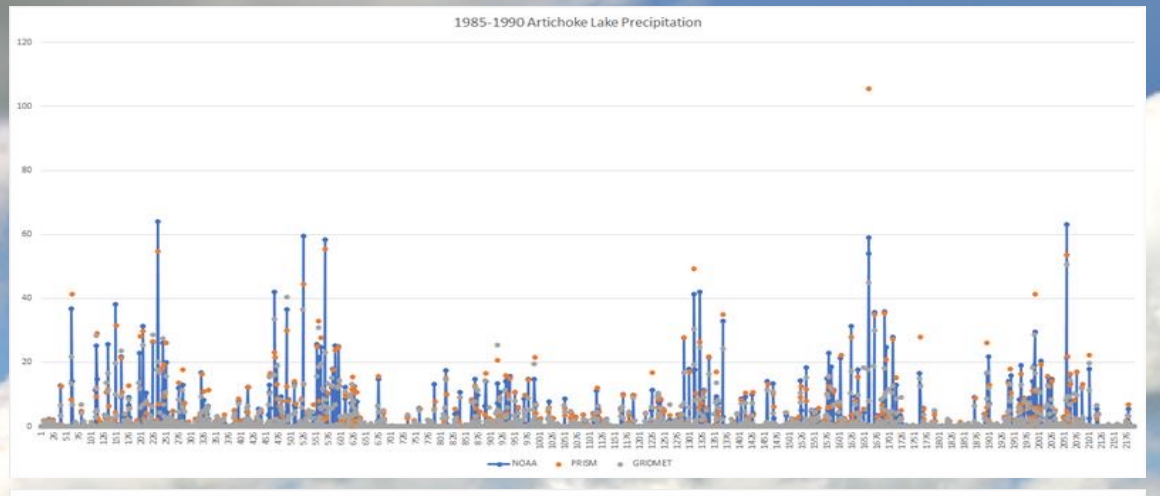

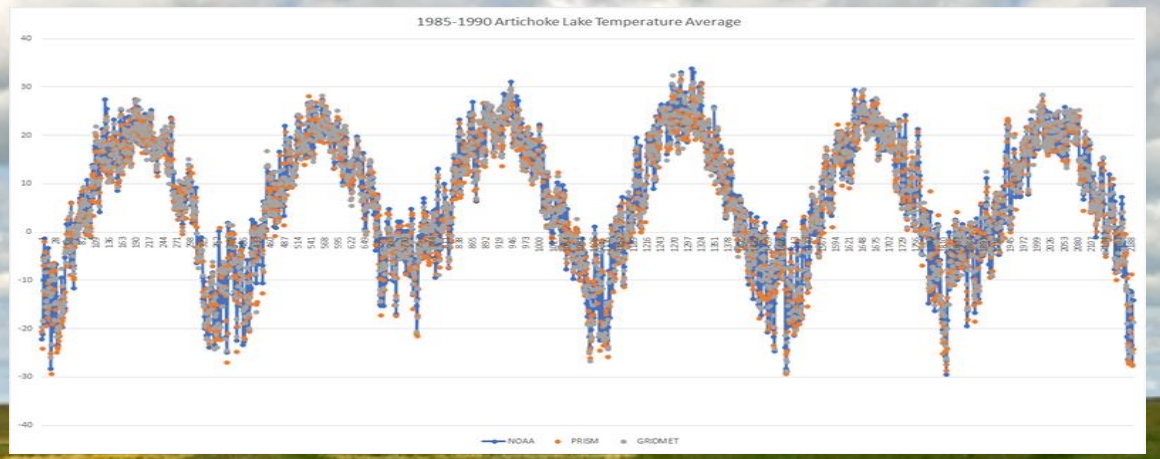

- Historical Gridmet temp/precip data 1990-2019
- CMIP5 modeled Daily GCM data downscaled from MACA **(1990-2019)** and **(2070-2099)**
- 32 Global Circulation Models and 2 emission scenarios
- Adjust Observed Historical data by % or degree change from modeled data

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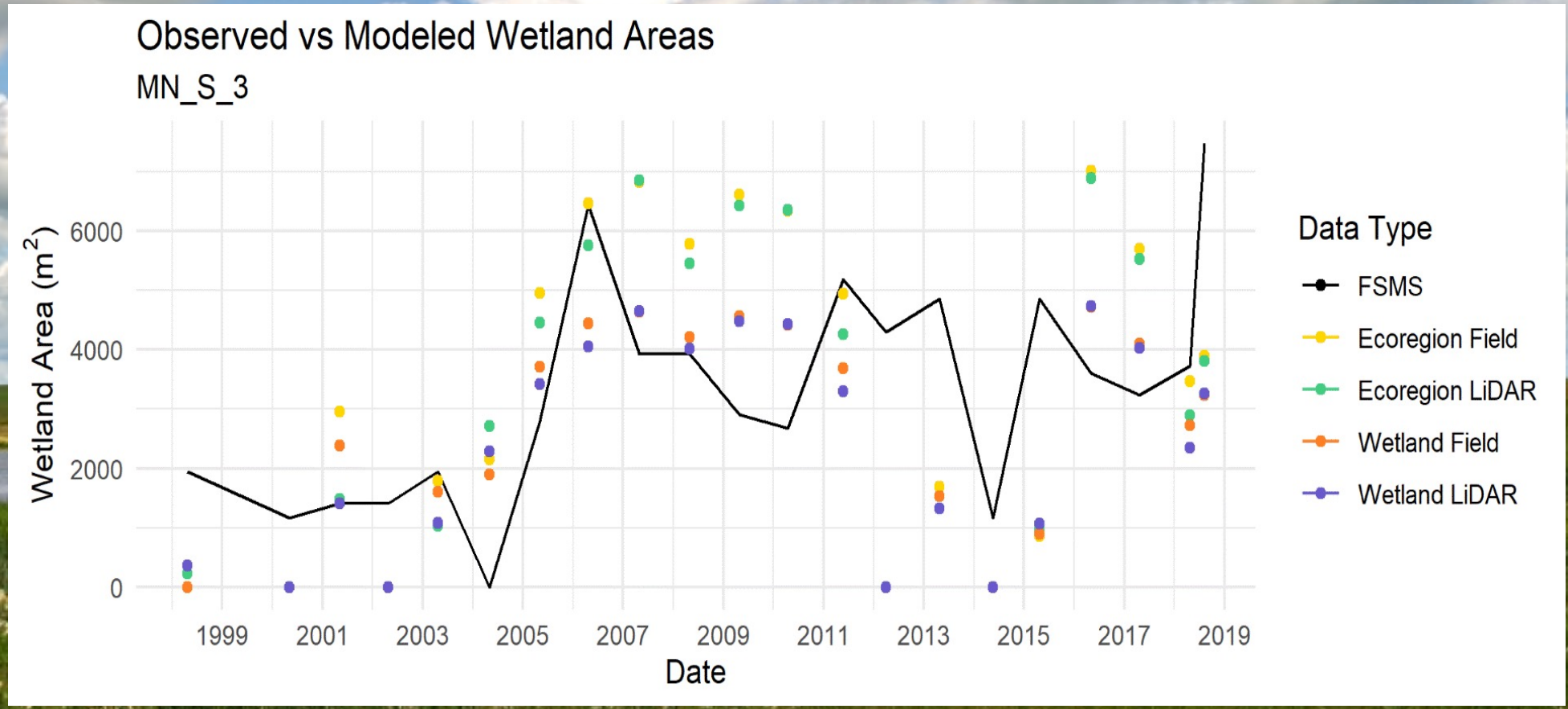
Methodological development

Wetland Area PHyLiSS model outputs using different bathymetric inputs compared to aerial delineations from FSMS



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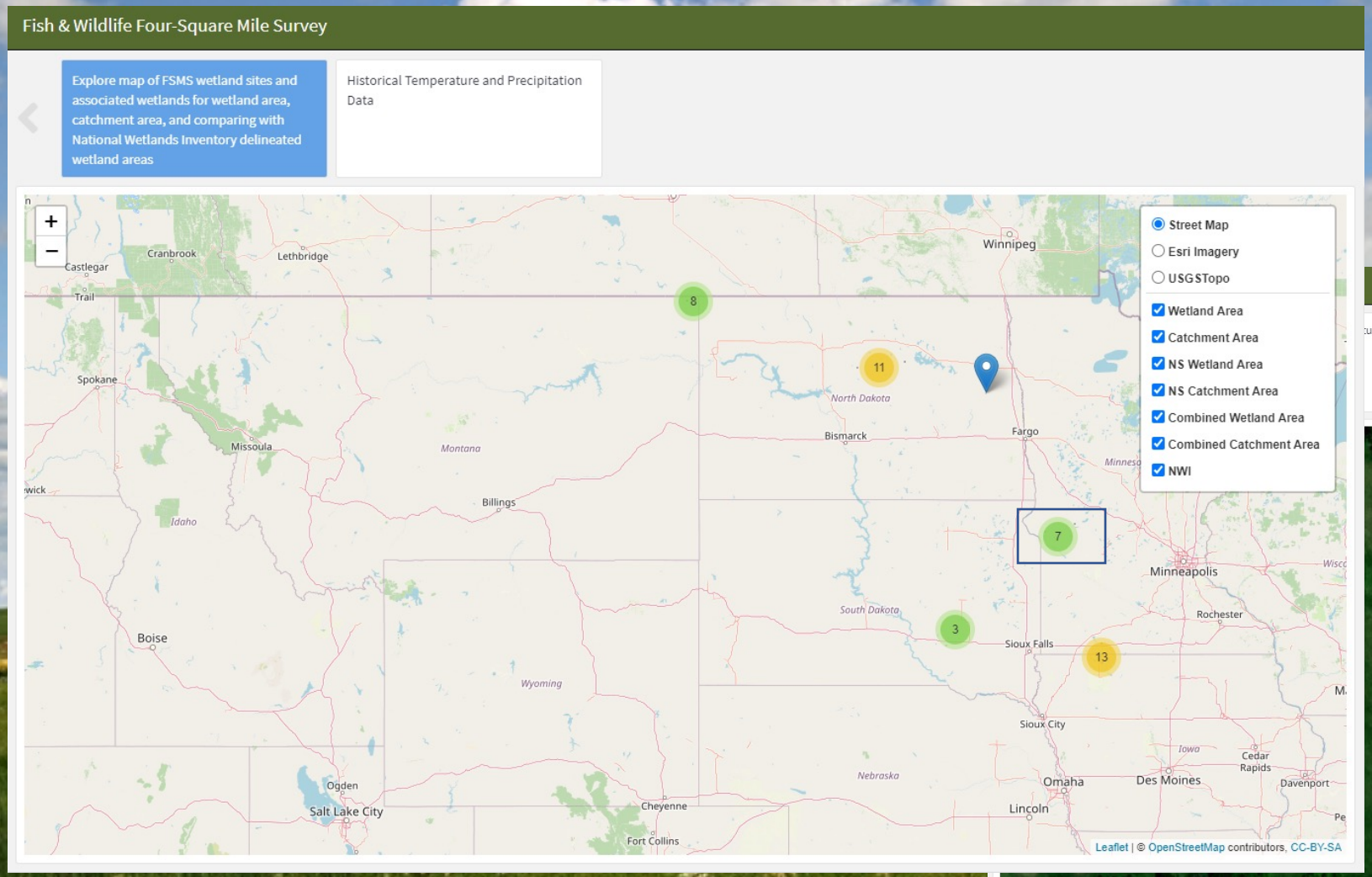
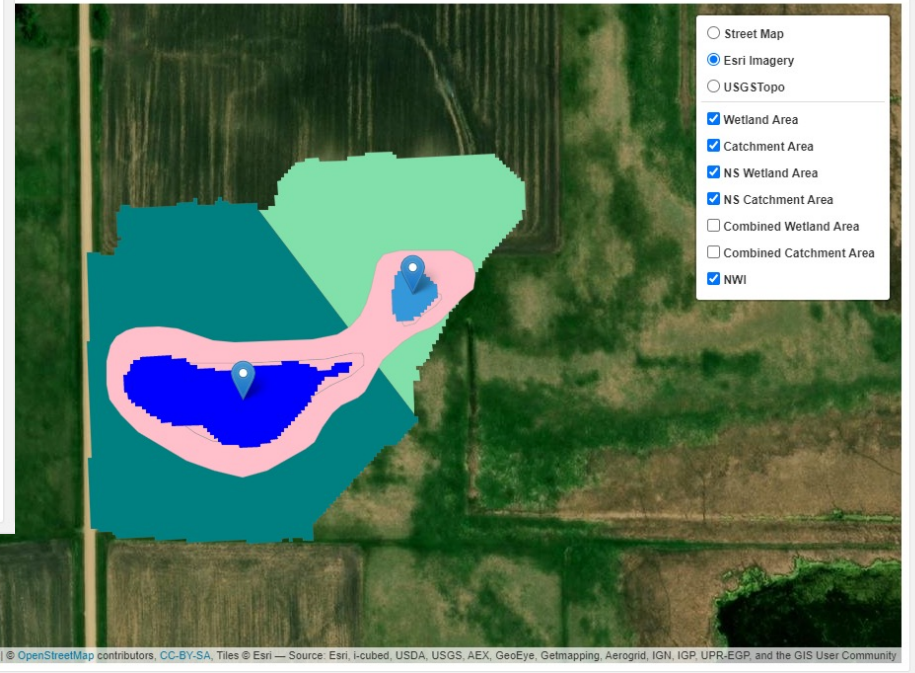
Data Visualization Tools



Rshiny app for data visualization and future climate dashboard development



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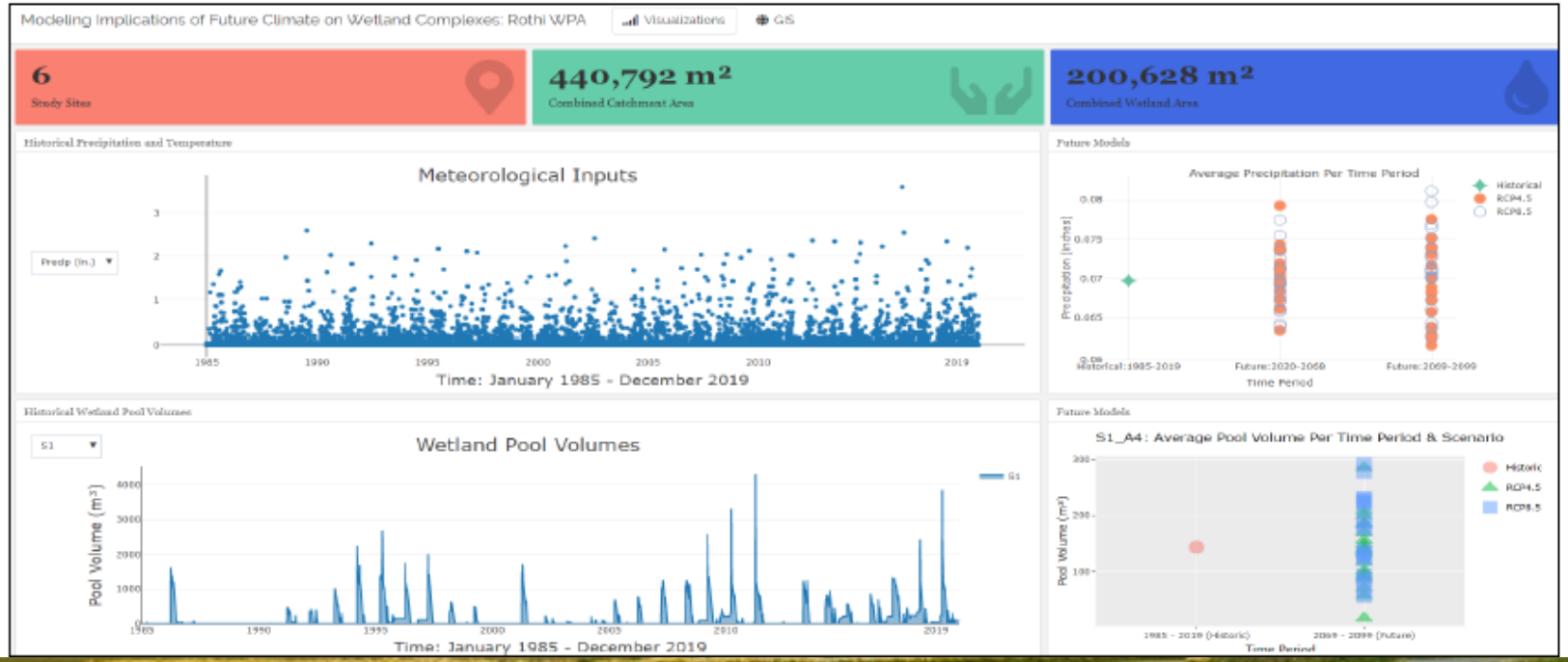
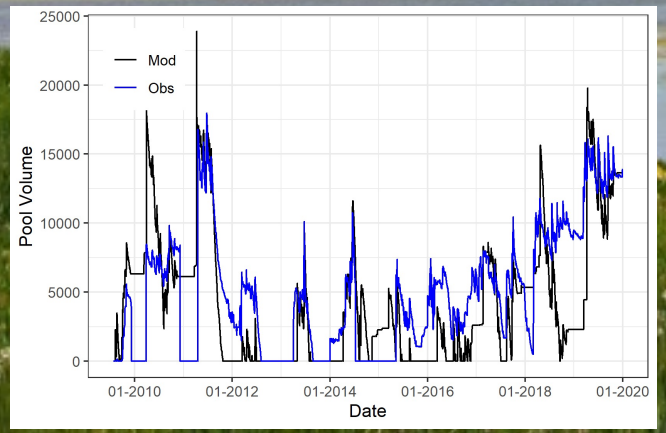
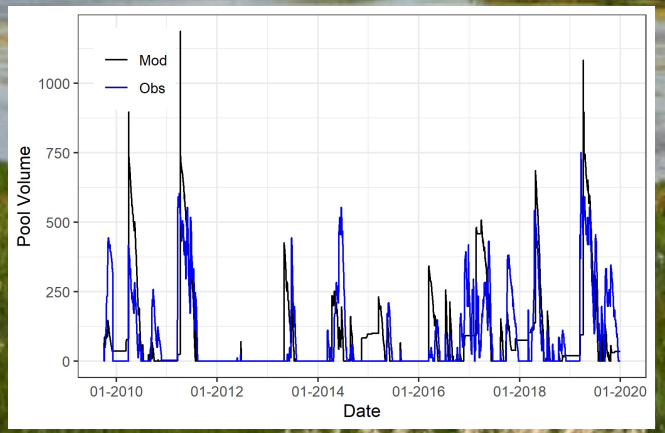
Examples from other USFWS/USGS Collab

Dashboard for historical and future climate and wetland water levels



- MW CASC funded project
- FWS R3 Hydrologist
  - Josh Eash
- Morris, MN WMD Biologist
  - Sara Vacek





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How HAPET, USFWS and Public Benefit

Conservation Delivery Prioritization

Migratory Bird Conservation Fund

- Grassland Easements
- Wetland Easements
- Fee-Title Acquisition

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Thanks for watching!
Questions?
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