

# A Surface-Water Index of Permanence (SWIPe)

to assess surface-water availability for ecohydrological refugia in the upper Missouri River basin

*Montana AWRA*

*October 10-12, 2023*

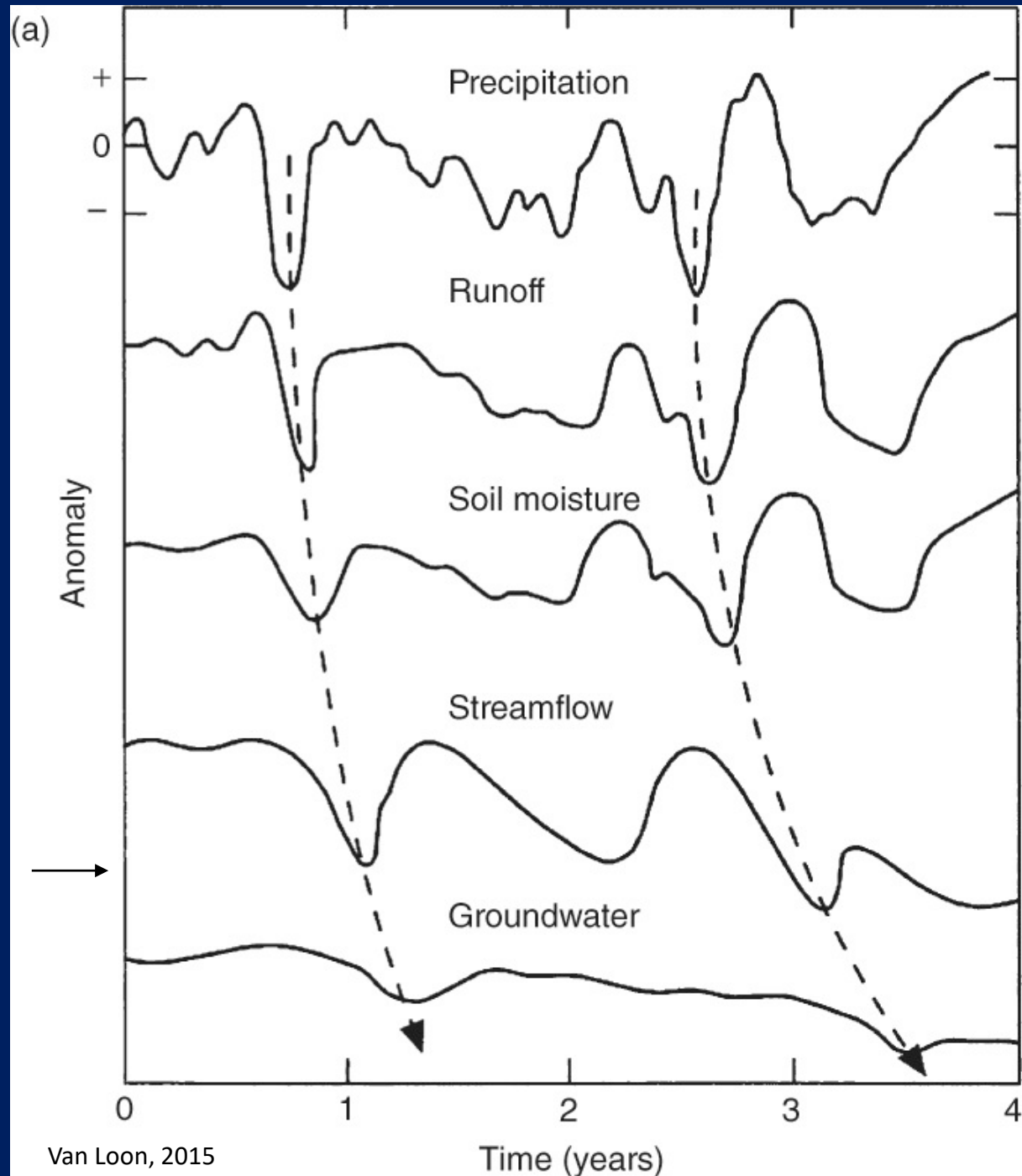
*Missoula, Montana*

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Erin Poor, Anteneh Sarbanes, Lindsey Thurman, Patrick Wurster

# Introduction to drought

- Common to all types of drought is a deficiency of precipitation.
- Rain gauges used to determine potential crop yields in Korea in the 1600s.
- Reliable rainfall observations became available almost 200 years ago.

Surface-water storage  
→



# Existing drought indices

## Hydrologic Drought

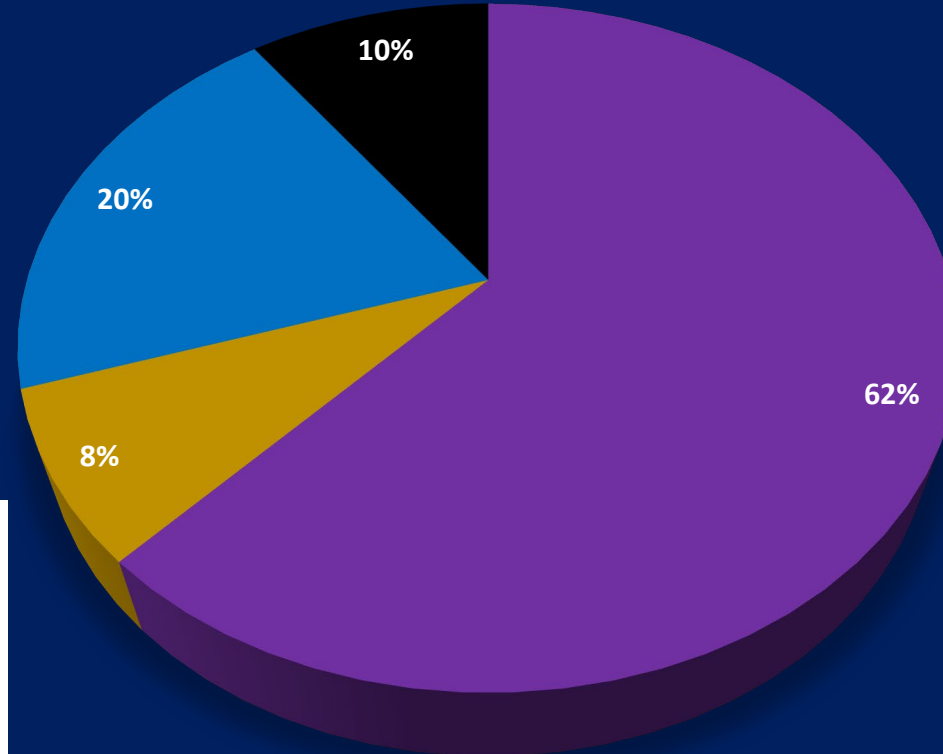
- Surface-Water Supply Index
- Palmer Hydrological Drought Index
- Standardized Runoff Index
- Low-Flow Index
- Standardized Reservoir Supply Index
- Standardized Streamflow Index
- Standardized Water-level Index
- Streamflow Drought Index
- Aggregate Dryness Index
- Standardized Snowmelt and Rain Index

## Composite or Modeled Products

- Combined Drought Indicator
- Global Integrated Drought Monitoring and Prediction System
- Global Land Data Assimilation System
- Multivariate Standardized Drought Index
- United States Drought Monitor

## Soil Moisture Drought

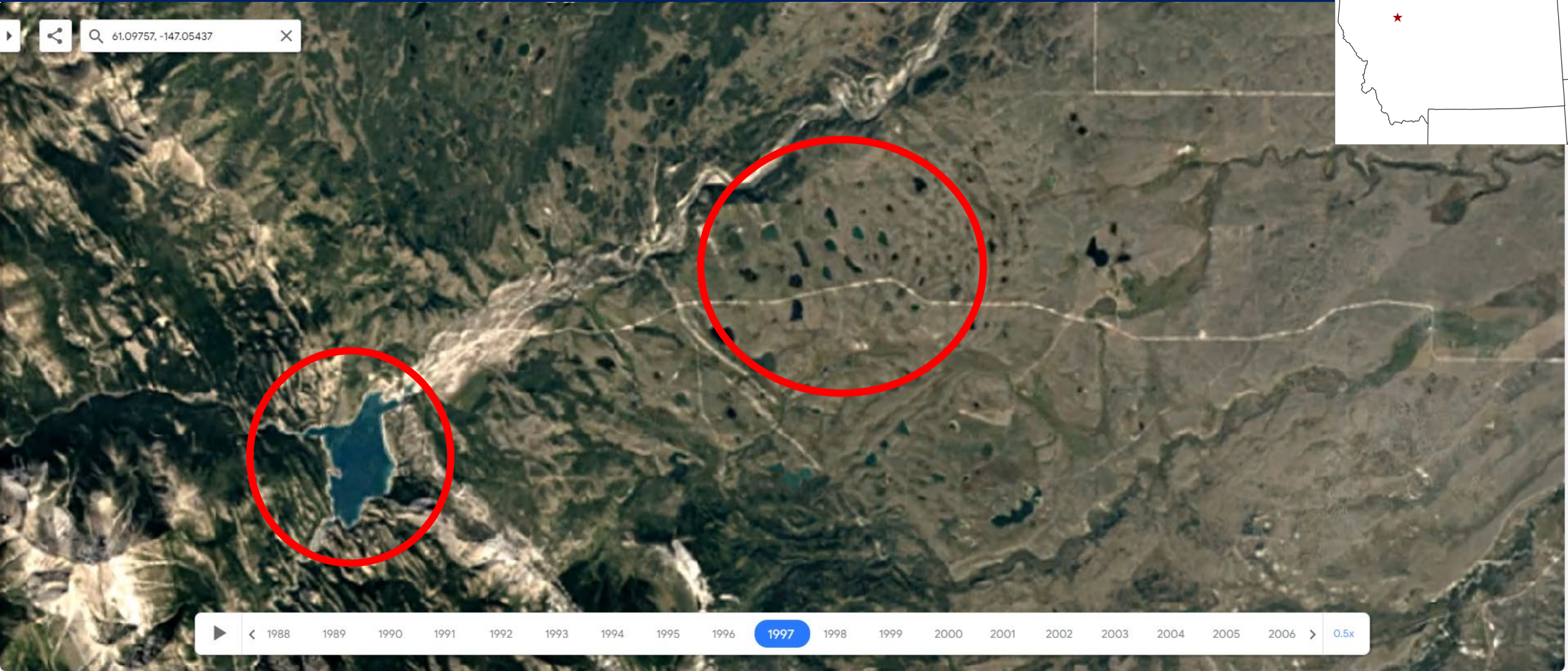
- Soil Moisture Deficit Index
- Soil Water Storage
- Evapotranspiration Deficit Index
- Soil Moisture Anomaly



## Meteorologic Drought

- Aridity Anomaly Index
- Deciles
- Keetch-Byram Drought Index
- Weighted Anomaly Standardized Precipitation
- Aridity Index
- China Z Index
- Crop Moisture Index
- Drought Area Index
- Effective Drought Index
- Hydro-thermal Coefficient of Selyaninov
- NOAA Drought Index
- Palmer Modified Drought Index
- Self-Calibrated Palmer Drought Index
- Standardized Anomaly Index
- Agricultural Reference Index for Drought
- Rainfall Anomaly Index
- National Rainfall Index
- Reconnaissance Evapotranspiration Index
- Standardized Precipitation Index
- Standardized Precipitation Evapotranspiration index
- Objective Blend of Drought Indicators
- Reclamation Drought Index
- Crop-Specific Drought Index
- Aggregate Drought Index
- Joint Drought Index
- Integrated Surface Drought Index
- Drought Severity Index
- Anomaly of Vegetation Condition
- Heat and Cold Wave Index
- Risk of Drought Impact for Agriculture
- Indicator for Forecasting Unusually Wet and Dry Conditions

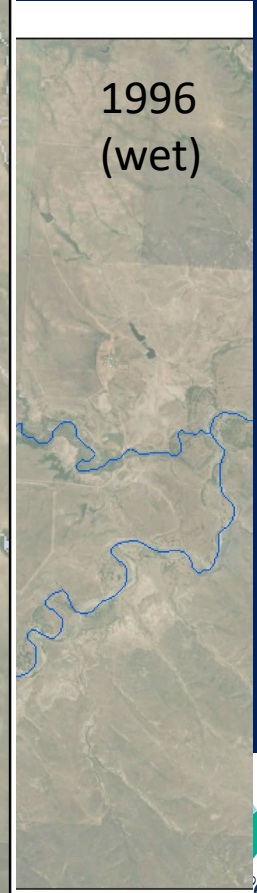
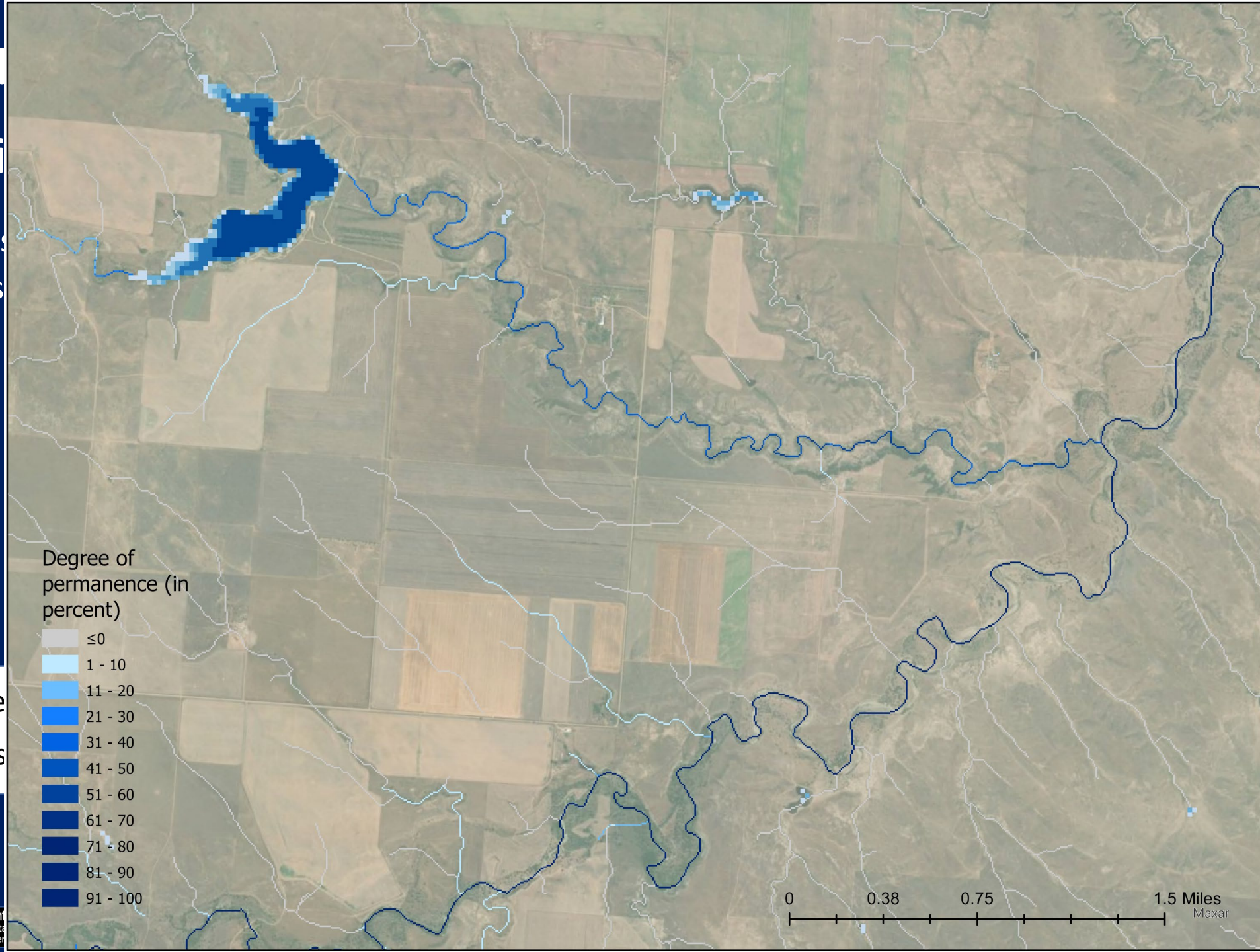
Landsat 5, 7, 8, 9 annual median R, G, B composite reflectance  
Displayed with Google Earth Engine





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- Dynamic
- Landsat-based
- Minimum s

e)  
anence



 Open water

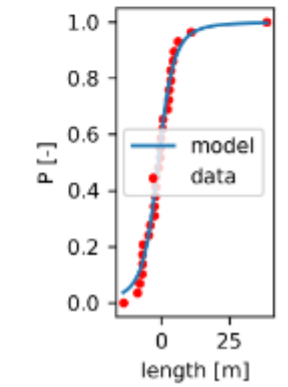
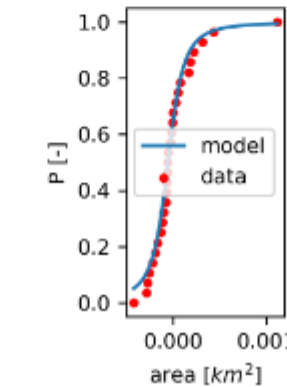
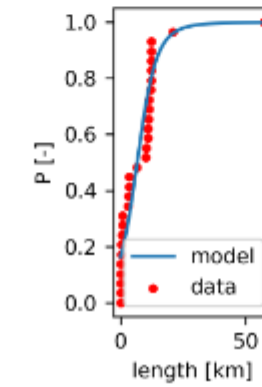
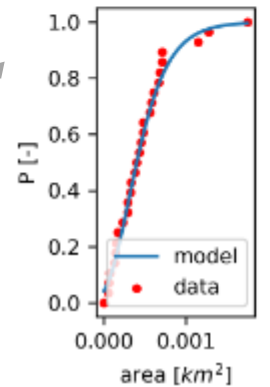
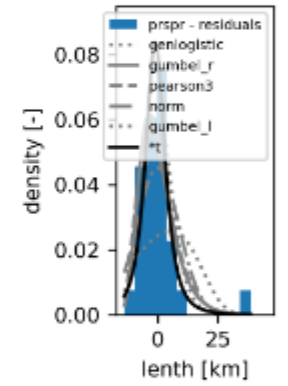
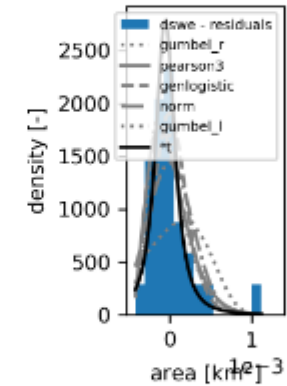
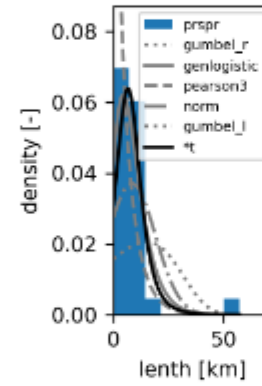
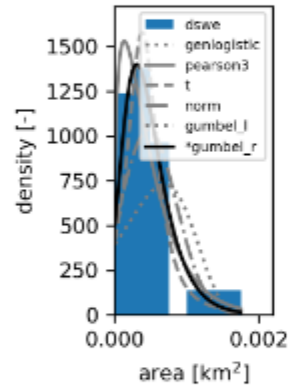
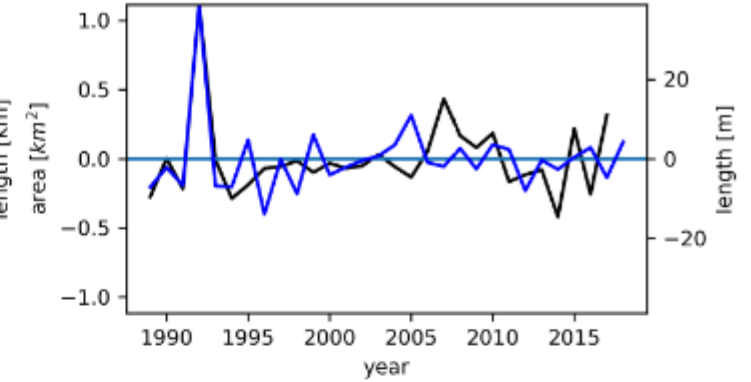
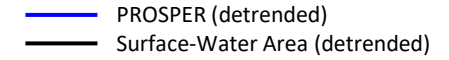
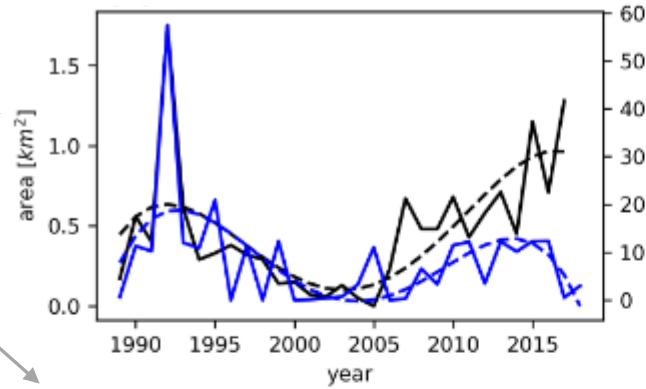
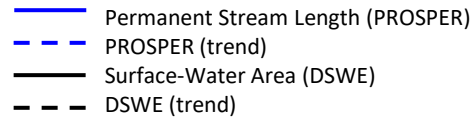
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# Index Development

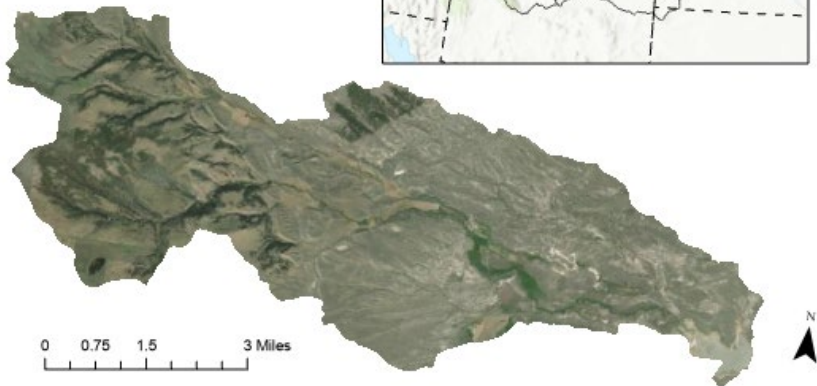
Step 1: Plot and detrend the data

Step 2: Determine optimal distribution

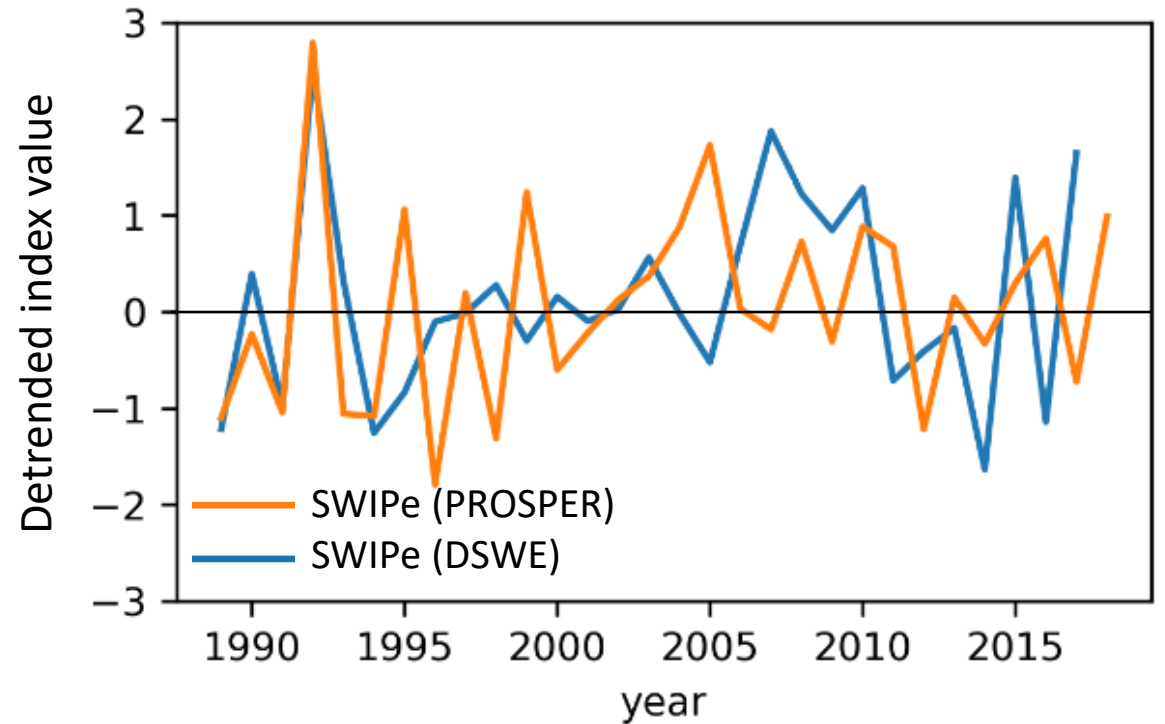
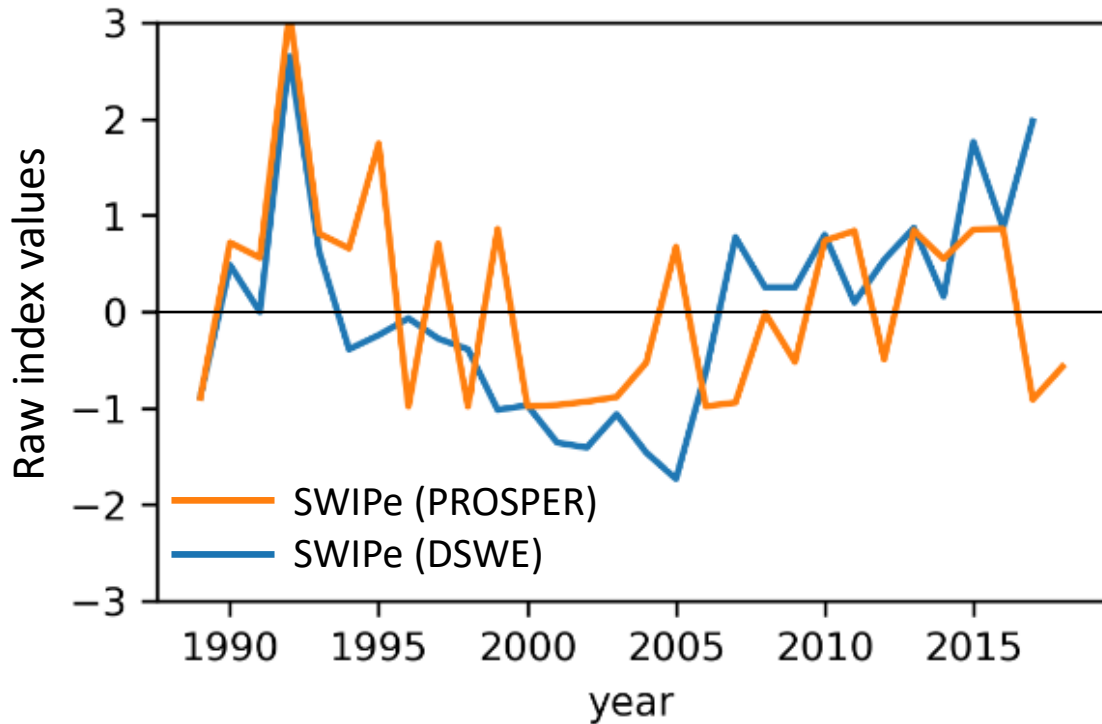
Step 3: Fit the data to selected distribution



Yellow Water Creek  
HUC12 - 100402030202



# Preliminary results for Yellow Water Creek

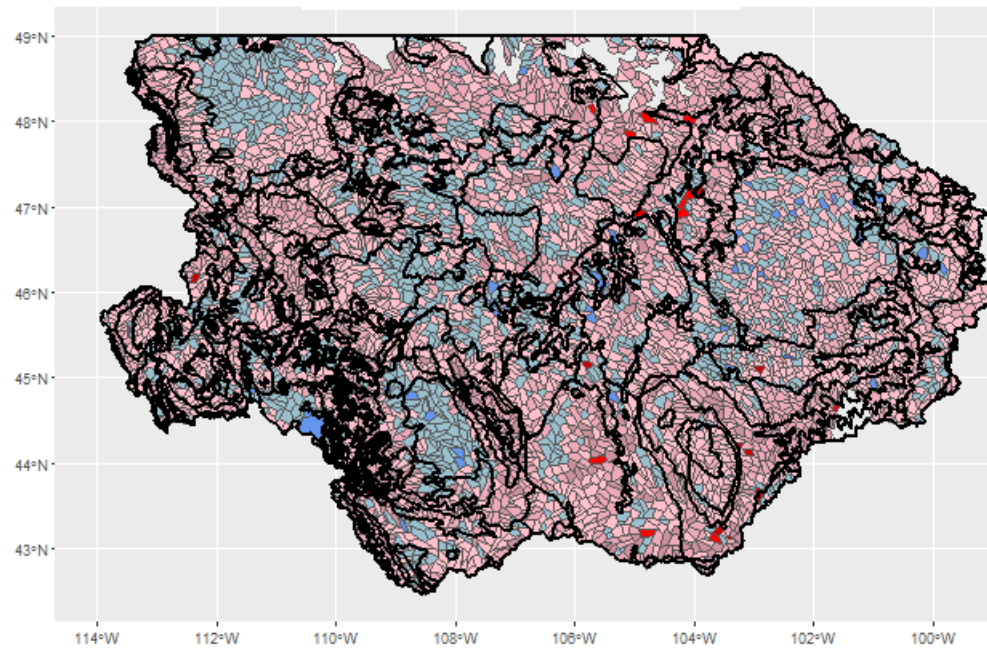


Distinct geographic variability between modeled stream permanence and surface-water extent

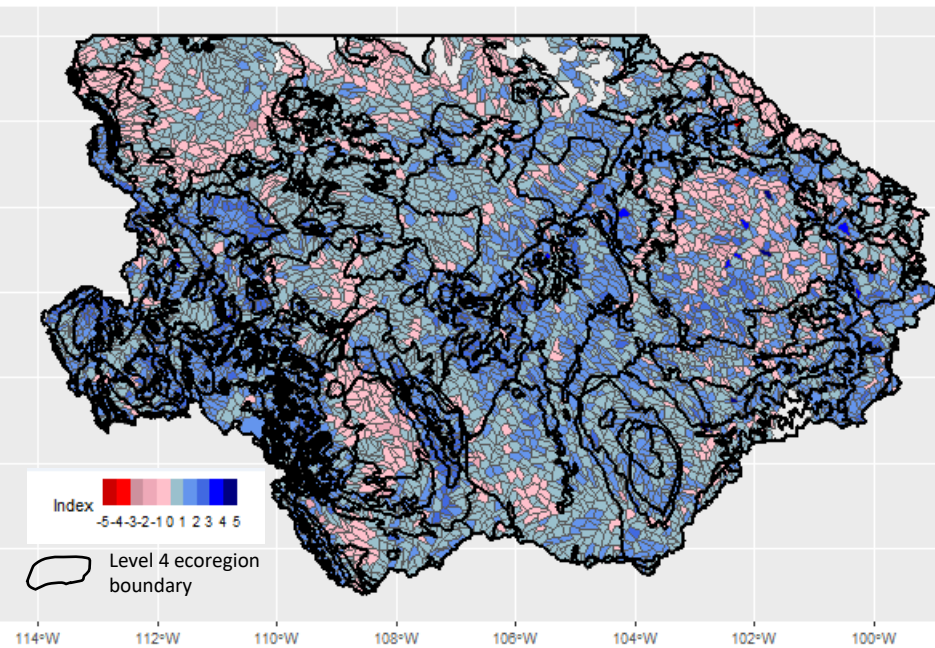
Possible explanations for differences:

- A. Altered vs. natural systems
- B. Differences in response lags
- C. Model vs. observations
- D. Others

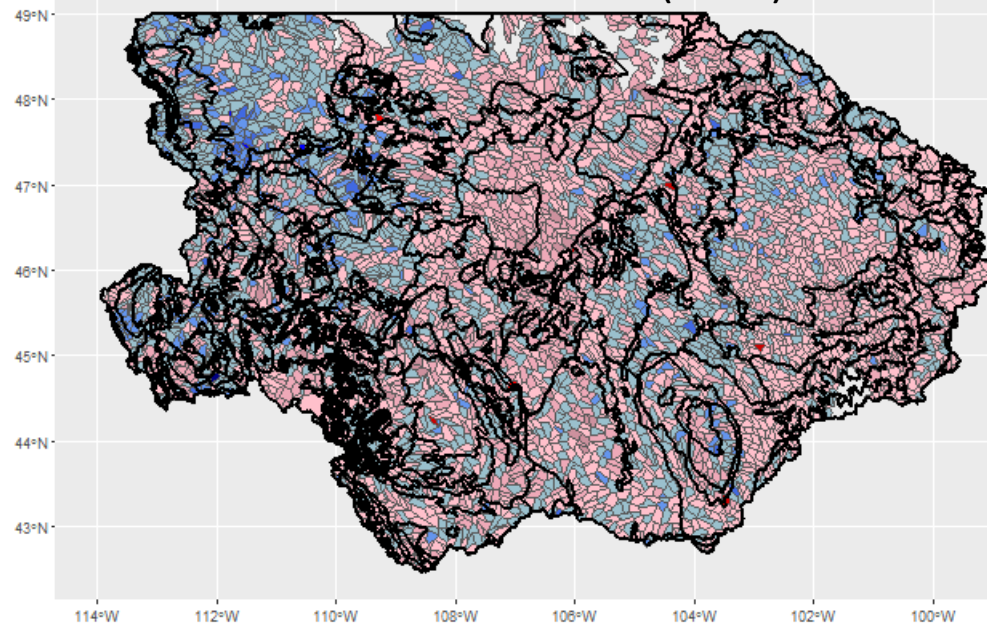
Stream Index (2006)



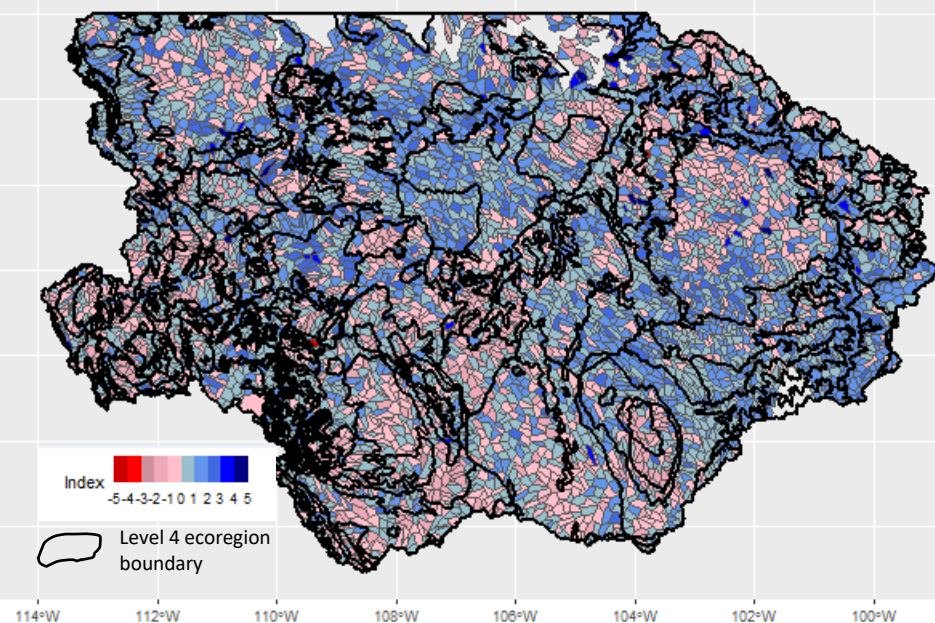
Stream Index (2011)



Surface-Water Index (2006)

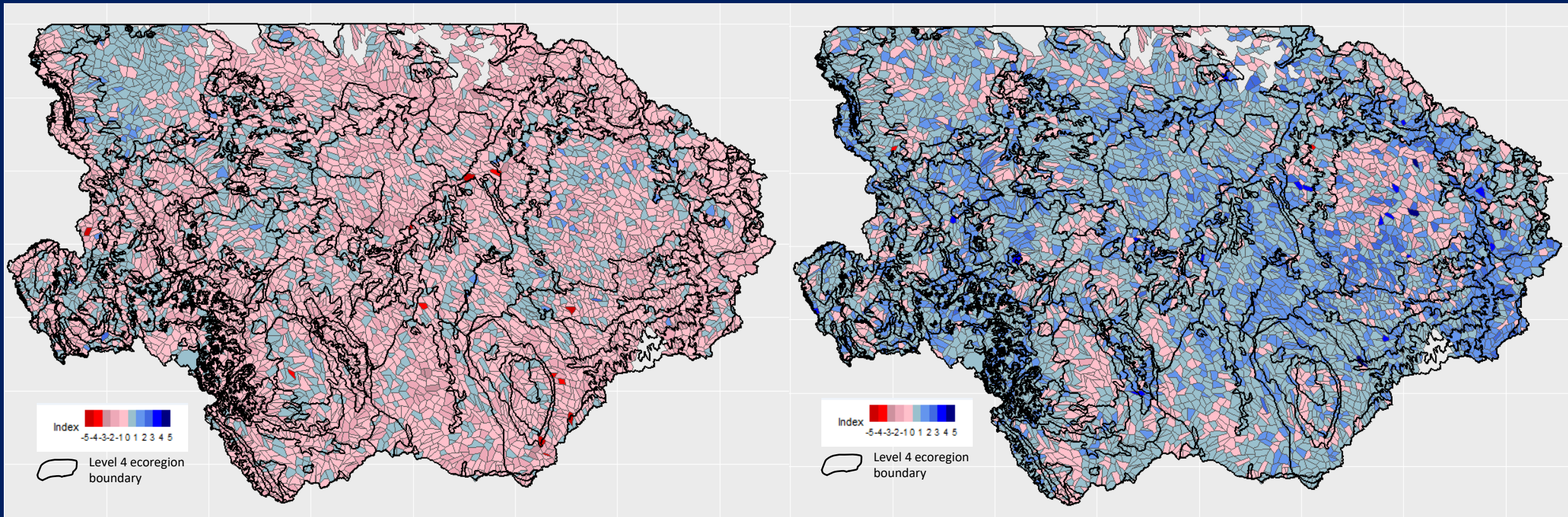


Surface-Water Index (2011)



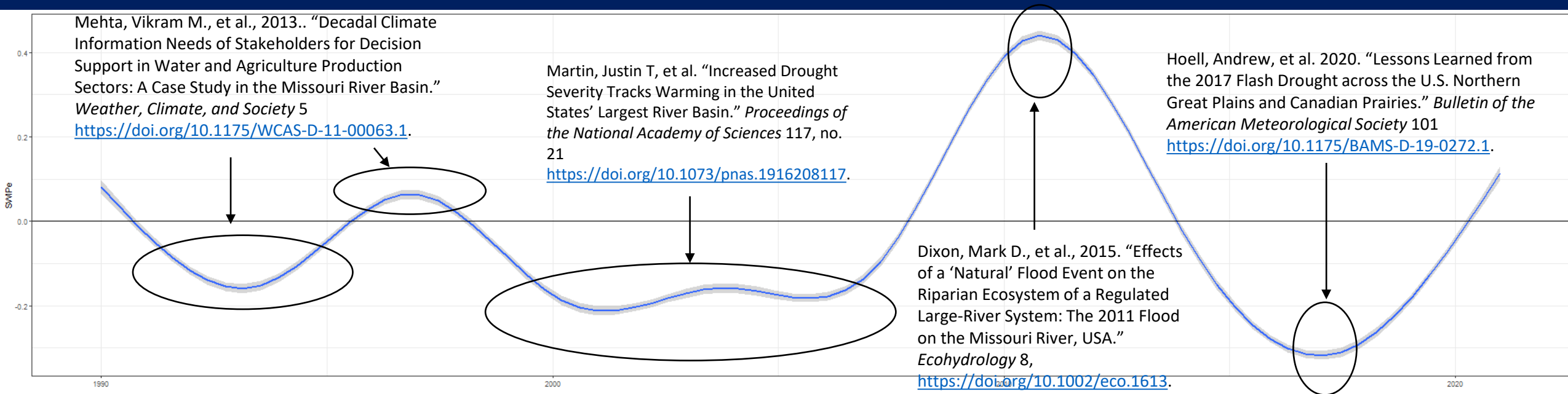
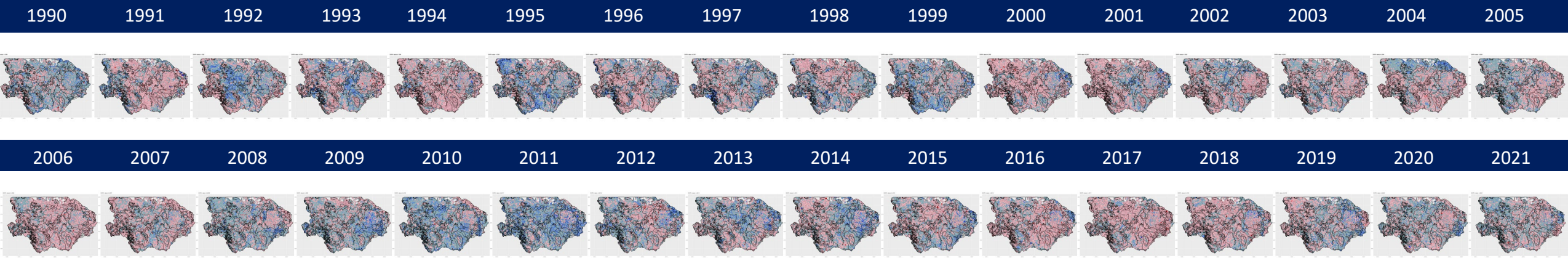
# SWIPe (2006)

# SWIPe (2011)



Displayed at HUC12 scale

# Regional Characterization



# Moving forward

- Ecological Applications

Bison behavior in Badlands National Park



Photo: Roy Sando, USGS

Northern Leopard Frog species distribution modeling

# Thank you!

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