Projecting the Spread of Aquatic Invasive Species Using Remote Sensing, Genetics, and Climate Modeling

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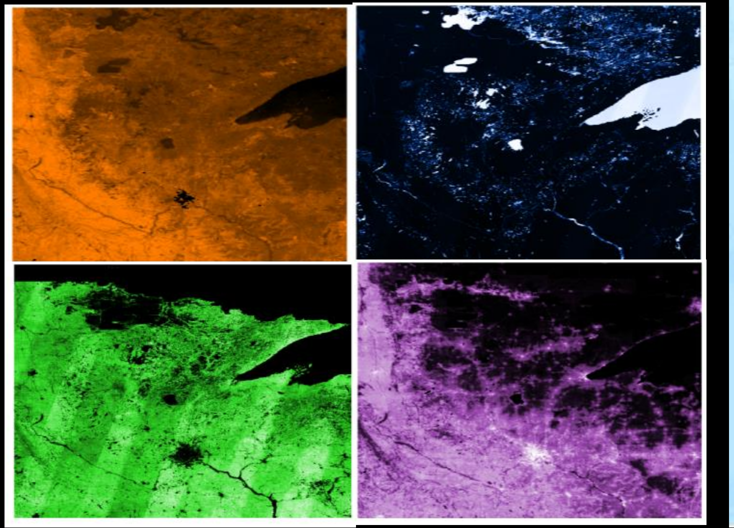

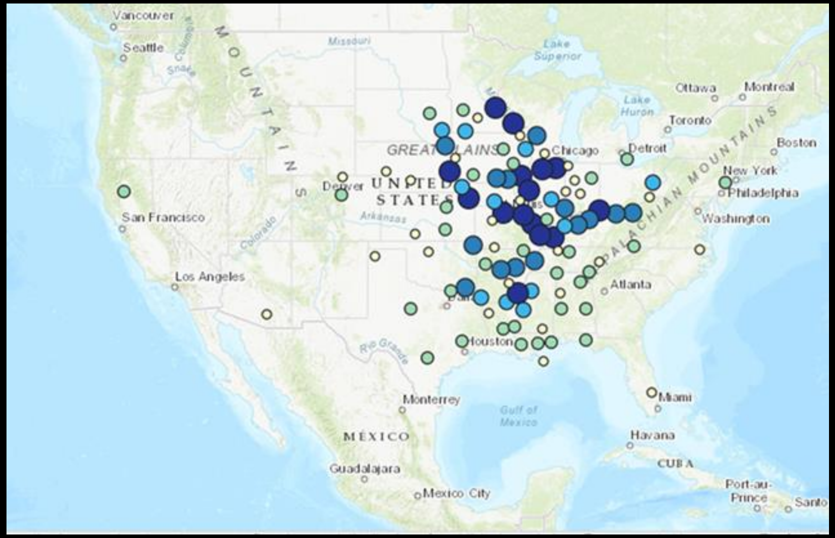

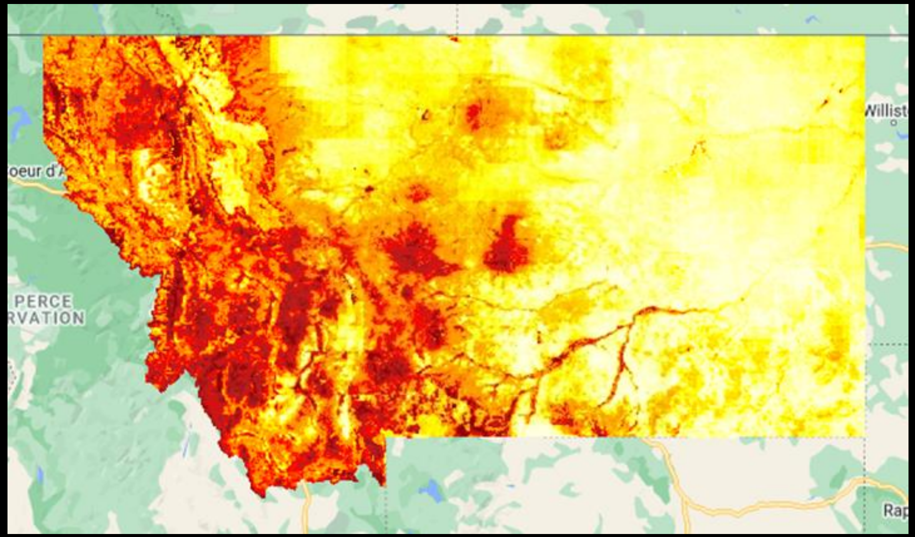

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USGS
science for a changing world

NASA

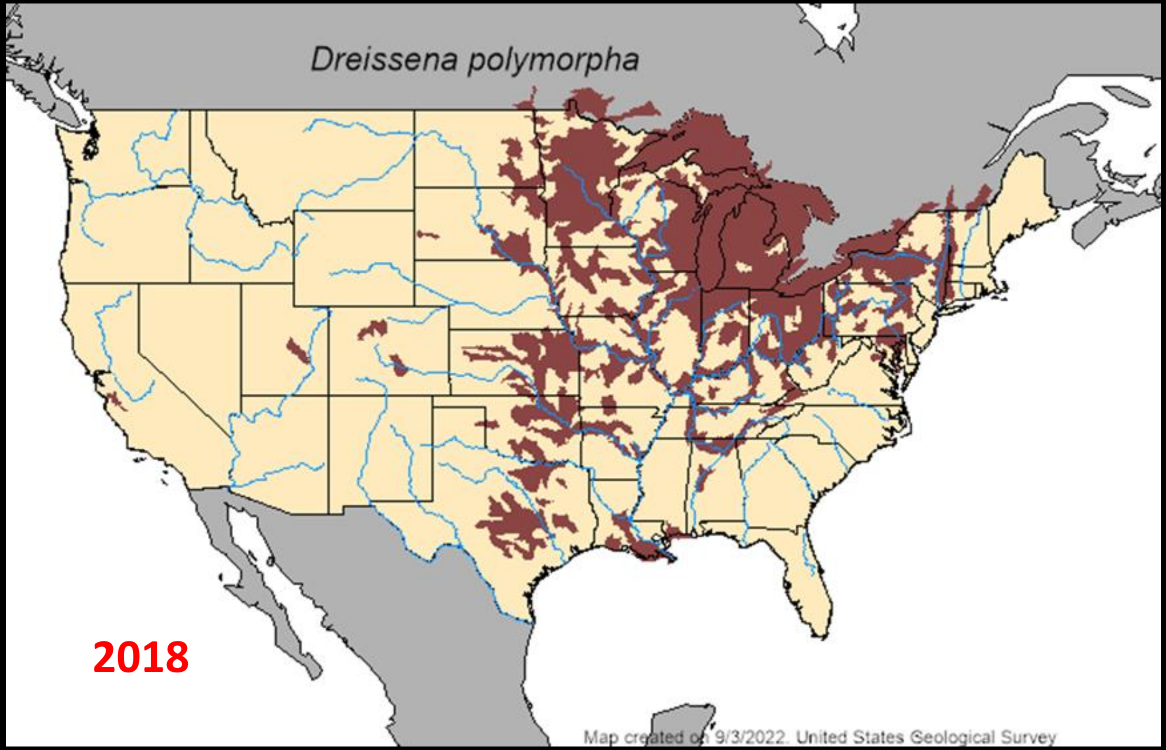
Urgent need to prioritize monitoring across invasive taxa

- Invasives drive biodiversity loss (40% of ESA-listed species threatened by invasives
- Billions spent annually on mediation of damage by invasives (Sepulveda et al. 2020)
- Rate of spread is accelerating with climate/environmental change
- Inadequate funding doesn’t allow monitoring everywhere
- Tools to assist management across taxa and at relevant spatial scales are needed

Non-Indigenous Aquatic Species (NAS) Database

1989

2000



2018

NAS time series data From Dursun Yıldız 2018

NASA Satellites = Biologically Relevant Environmental Covariates

RSD Source	Environmental Covariates
MODIS AQUA LST MYD11A2 (V6)	Land Surface Temperature
MODIS AQUA MYD13A2 (V6)	Normalized Vegetation Index
MODIS AQUA MYD13A2 (V6)	Enhanced Vegetation Index
MODIS TERRA MOD44B	Percent Tree Cover
National Land Data Assimilation System	Precipitation
MODIS Surface Reflectance (CONUS)	Gross Primary Productivity
Shuttle Radar Topography Mission (SRTM)	Heat Insolation Load
Shuttle Radar Topography Mission (SRTM)	Topographic Diversity
Landsat 5, 7, and 8	Flashiness

Study Design

5 Taxa

Zebra mussels

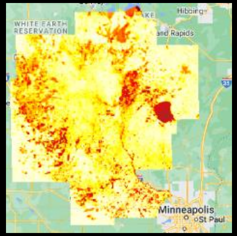
Asian carp

Eurasian milfoil

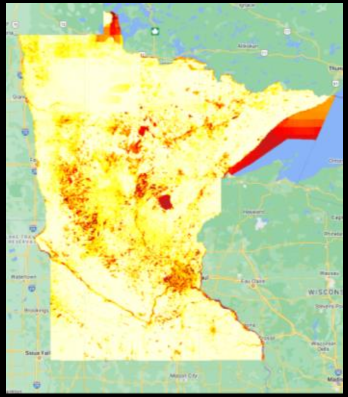
Rainbow trout

Brook trout

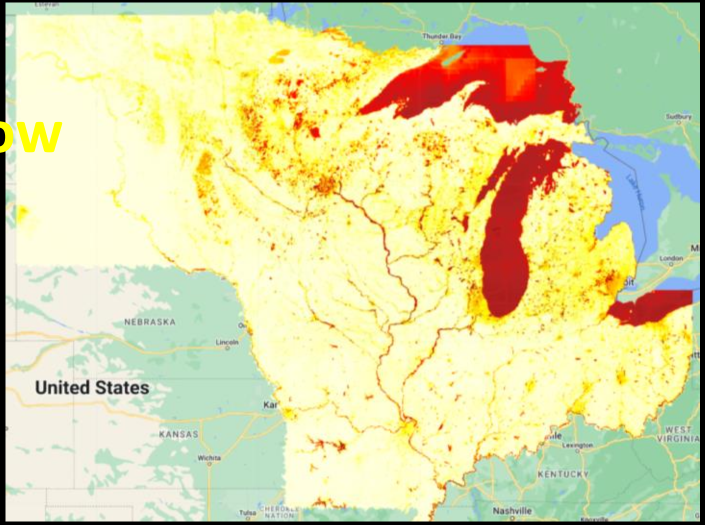
3 Spatial Scales



Local



State

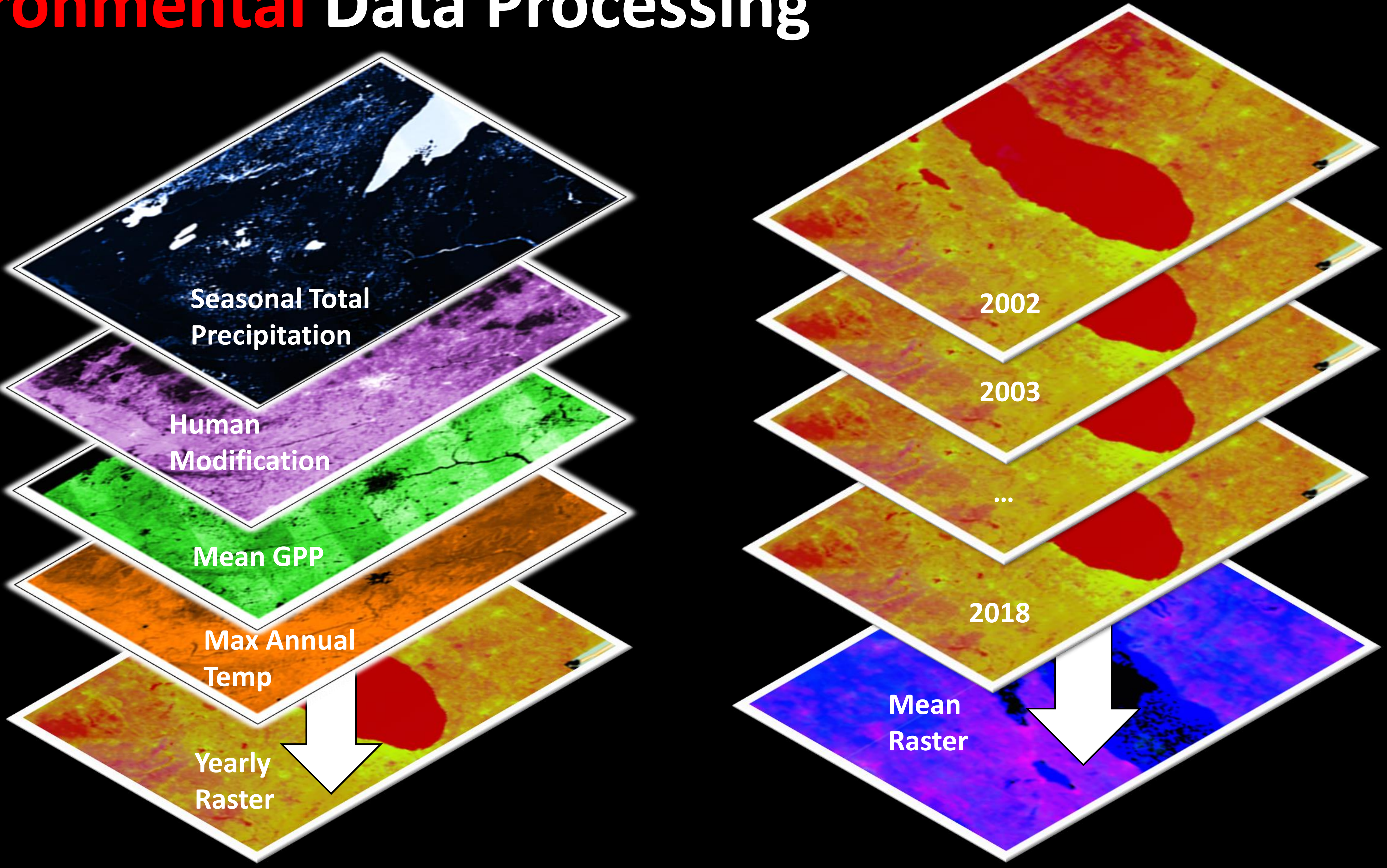


Regional

3 Pixel Resolutions

- 500-meter
- 2500-meter
- 5000-meter

Environmental Data Processing

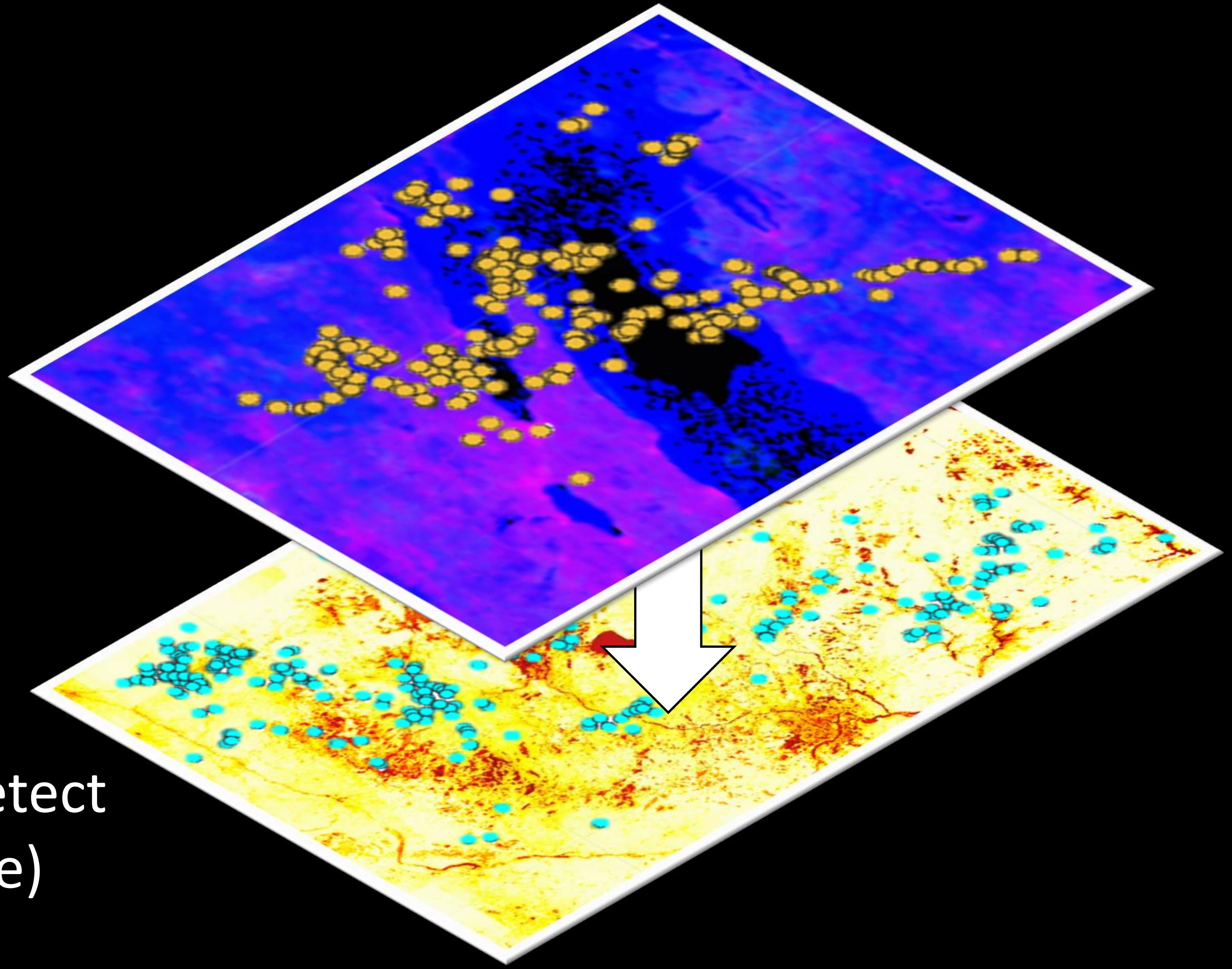


Modeling (MaxEnt ML SDM)

Inputs
- NAS Occurrence Data
- Environmental Raster

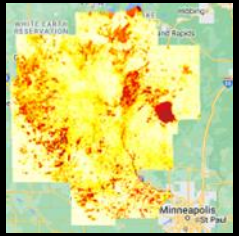
Output
- Heatmap of Suitability
- Covariate Contribution

Validation
- Independent Presence Data
used to quantify failures to Detect presences (False Negative Rate)



Decision Support for 5 taxa at 3 spatial scales

Local



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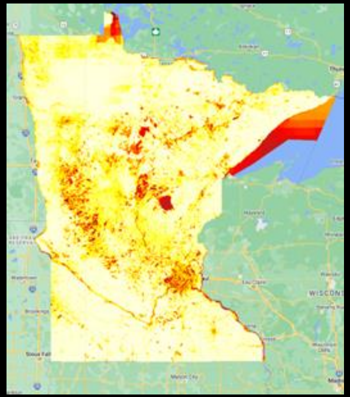

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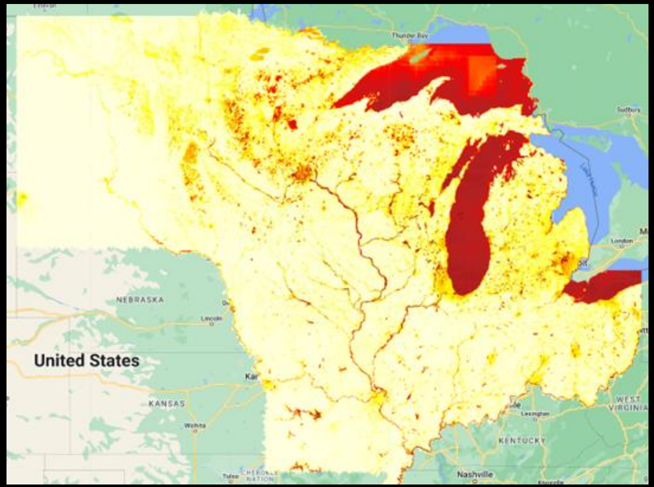
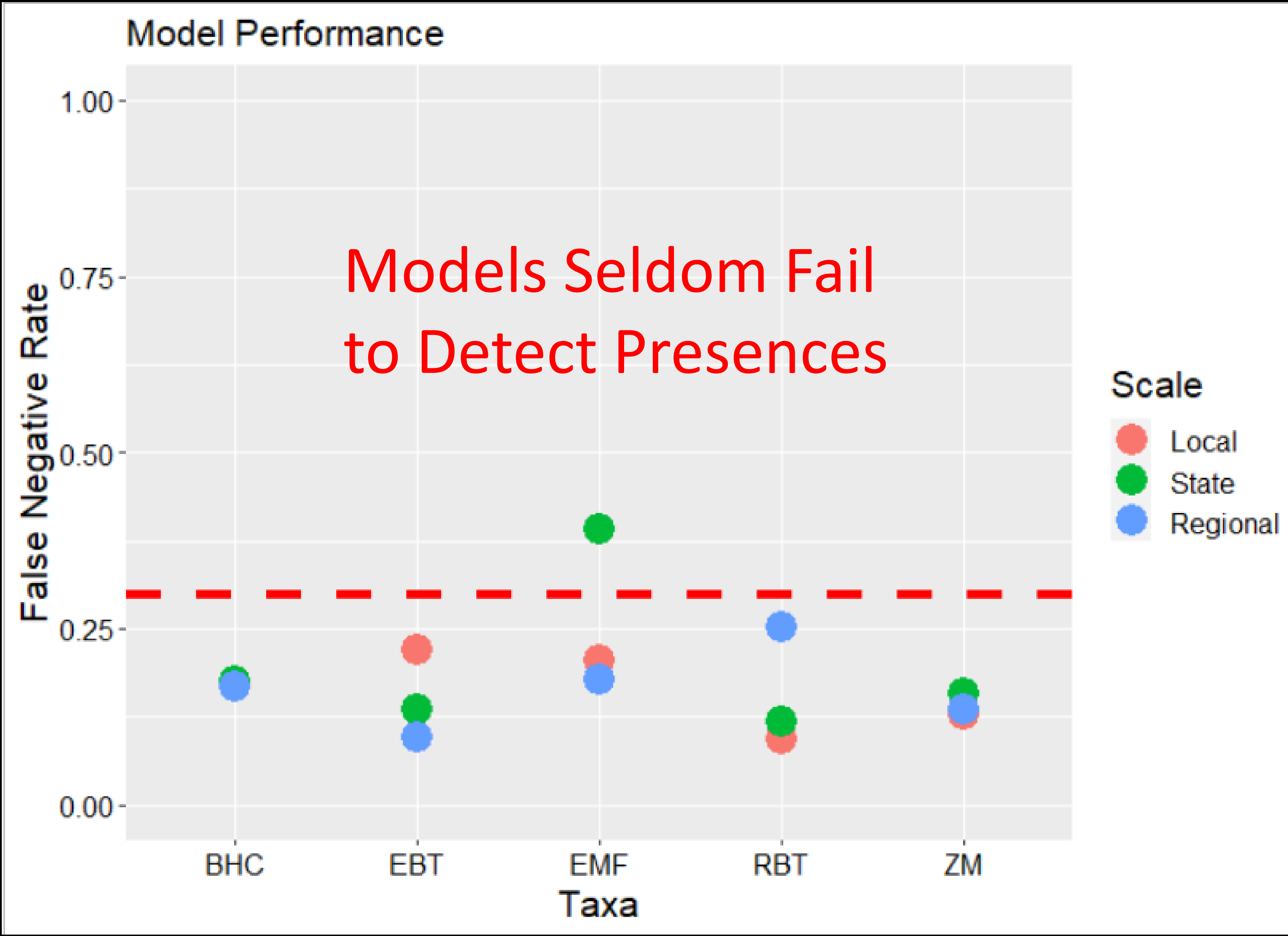
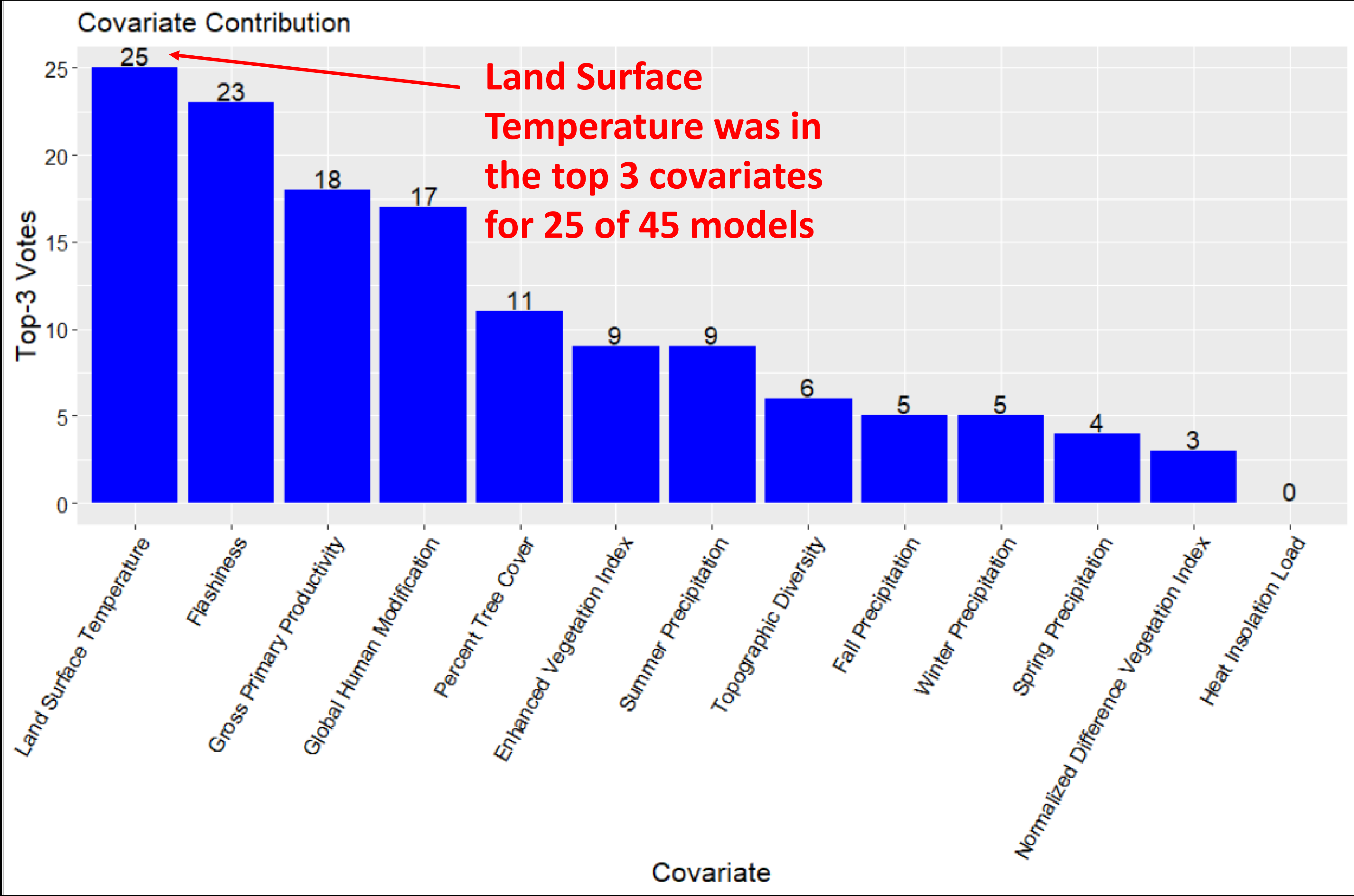




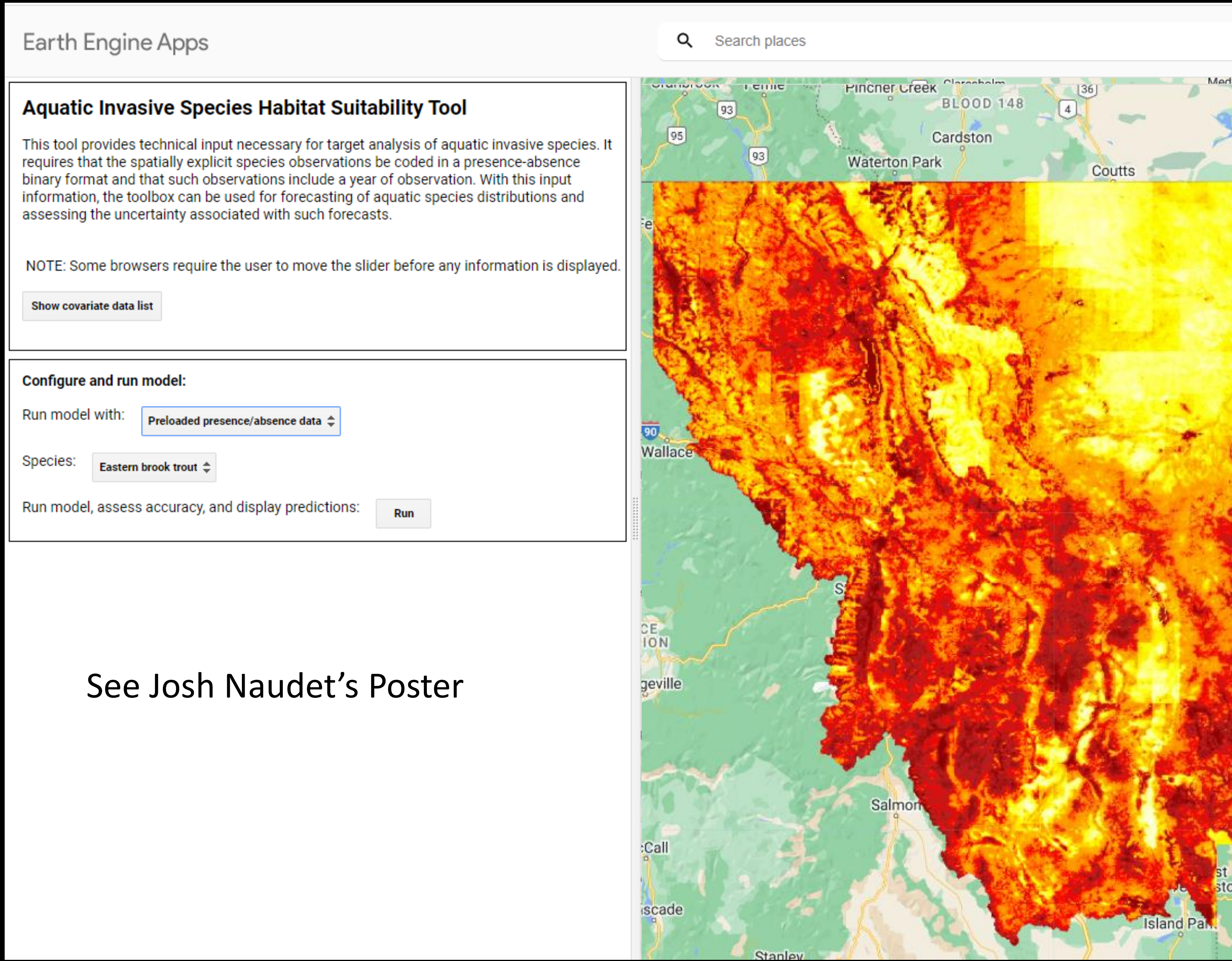
Multiple Covariates are Correlated w/ Invasive Species Presence



Next Steps

- Integrate RS Data into USGS's NAS Webtools
- Integrate eDNA into USGS's NAS database
- Test More Invasives
- Deliver ML pipeline Webtool & App

App for Managers to Map Hotspots of Spread



See Josh Naudet's Poster

In Conclusion:

We developed and evaluated a machine learning (MaxEnt) pipeline combining RS data with N. America's largest aquatic invasive species database (NAS) to help managers control spread

- Remotely Sensed Covariates are Useful for Predicting Habitat Suitability of Worst Aquatic Invasives in N. America

- ML Pipeline is Predictive for Multiple Invasive Taxa & Across Multiple Spatial Scales

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