



JEMEZ PUEBLO AGRICULTURE

Monitoring Rangeland Conditions
to Inform Drought and Land
Management in New Mexico

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PROJECT BACKGROUND

- Colorado Plateau in North America is a semi-arid region primarily consisting of high desert
- Large herds of megafauna historically roamed this harsh landscape
- Grazing management can have a significant impact on the ecosystem's services, plant community composition, wildlife biodiversity, and overall resiliency
- Remote sensing is a modern tool that can help track vegetation trends for grazing management
- Virtual fencing has the potential to be used in combination with interpreted remote sensing data



Image Credit: Pueblo of Jemez Natural Resource Department

PROJECT PARTNERS



Image Credit: Dayna Dominguez

- **Pueblo of Jemez, Natural Resources Department**
 - Jonathan Romero: Agriculture Manager
 - AJ Baca, Jonathan Baca, Tyler Loretto, & Ethan Romero: Rangeland Technicians
- **The Nature Conservancy**
 - Tegan May: North America Regenerative Grazing Lands Project Manager

COMMUNITY CONCERNS

- What are the ground cover type trends within each pasture?
- What are the relative potentials for bare ground cover percentage and herbaceous biomass under climatic extremes?
- Is there a relationship between bare ground cover percentage and annual forage production to distance from water sources?
- How to combine virtual fencing technology and remotely-sensed data to improve rangeland conditions?

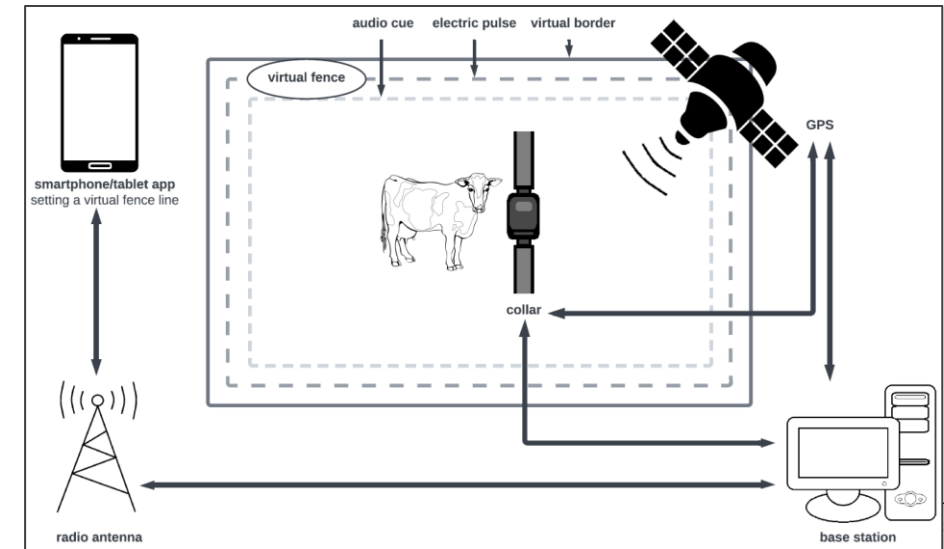
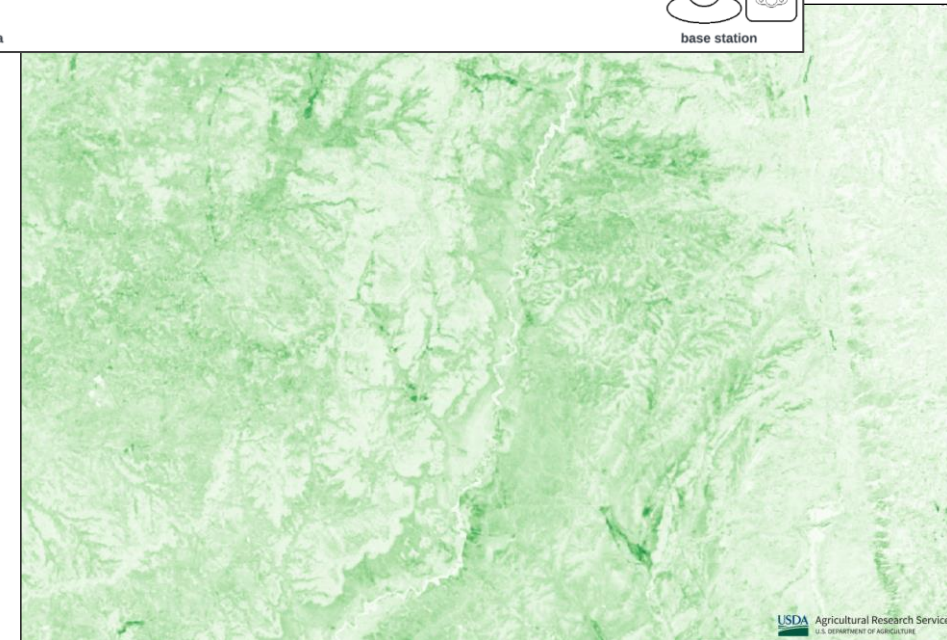


Image Credit:
Golinski et al., 2023

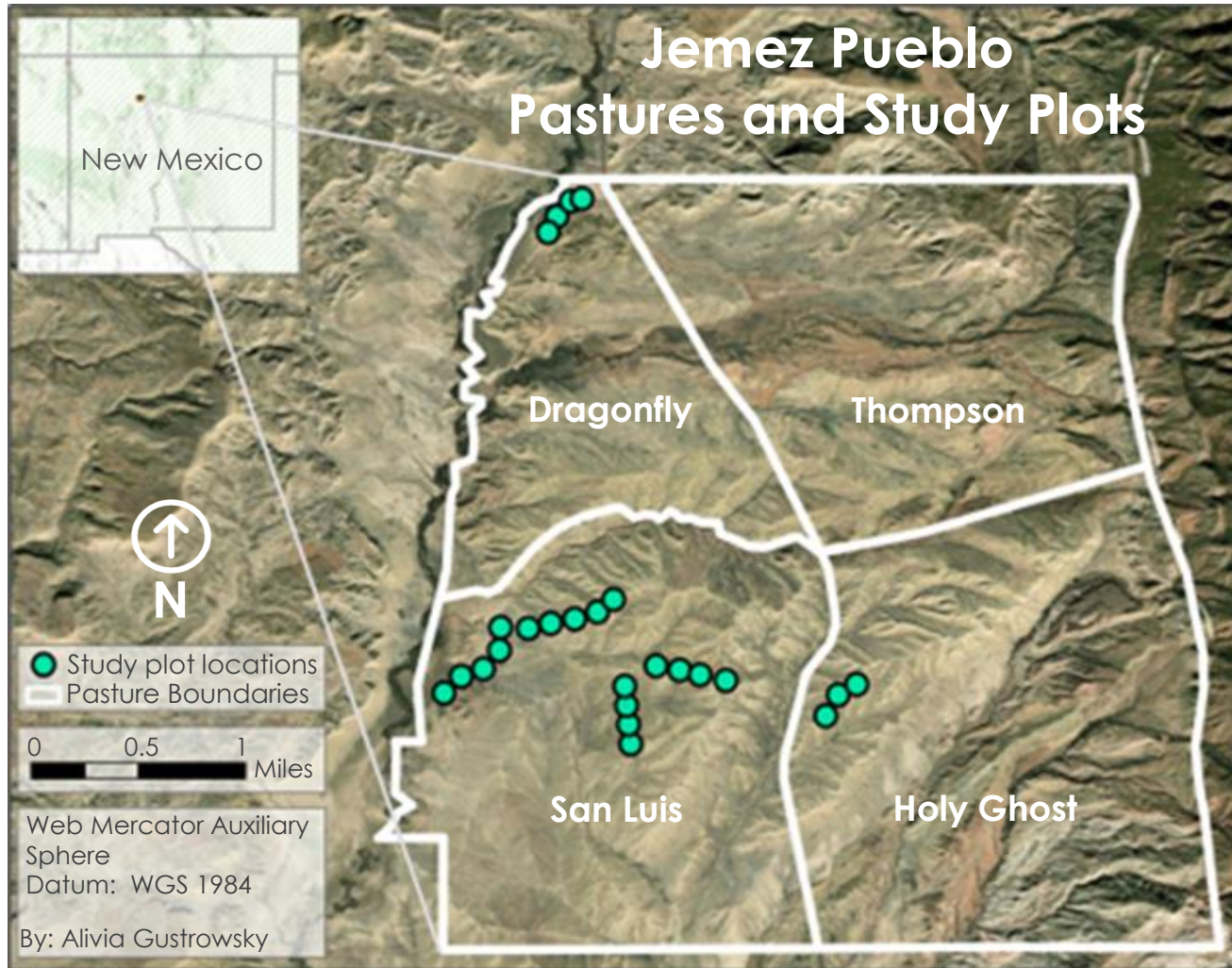
Image Credit:
Dayna Dominguez



OBJECTIVES

- Evaluate biomass and bare ground Rangeland Analysis Platform (RAP) products to collected field data
- Summarize ground cover trends over the study timeline within each pasture
- Summarize historic forage production and bare ground cover under climatic extremes (dry vs. wet years)
- Examine the trends between bare ground cover and herbaceous biomass from distance to water sources

STUDY AREA & PERIOD



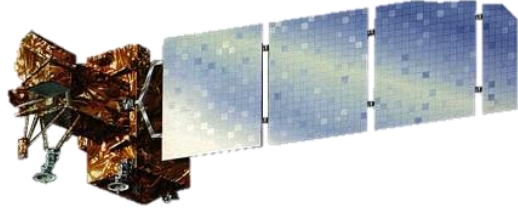
- **Study Area – NW Jemez Pueblo**
 - ~26,763 acres
 - Non-irrigated rangeland
 - Elevation: 6,000 – 7,200 feet
 - Precipitation: ~16 inches annually
 - Characterized by sandy loam soils
- **Study Period**
 - 1986 through 2023

Basemaps: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Maxar Earthstar Geographics, TomTom, Garmin, FAO, NOAA, OpenStreetMap contributor, Intermap and the GIS user community

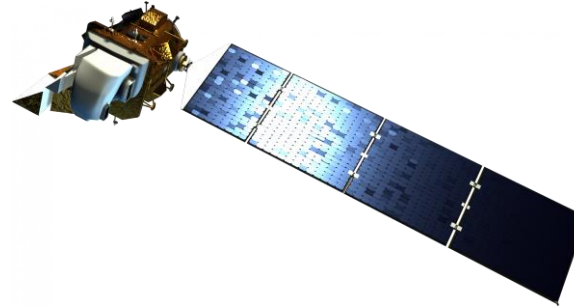
EARTH OBSERVATIONS



Landsat 5 TM



Landsat 7 ETM+



Landsat 8 OLI



Landsat 9 OLI-2

1984 – 2012

Spatial Resolution:

30m²

Temporal Resolution:

16 days

1999 – 2022

Spatial Resolution:

30m²

Temporal Resolution:

16 days

2013 – Present

Spatial Resolution:

30m²

Temporal Resolution:

16 days

2019 – Present

Spatial Resolution:

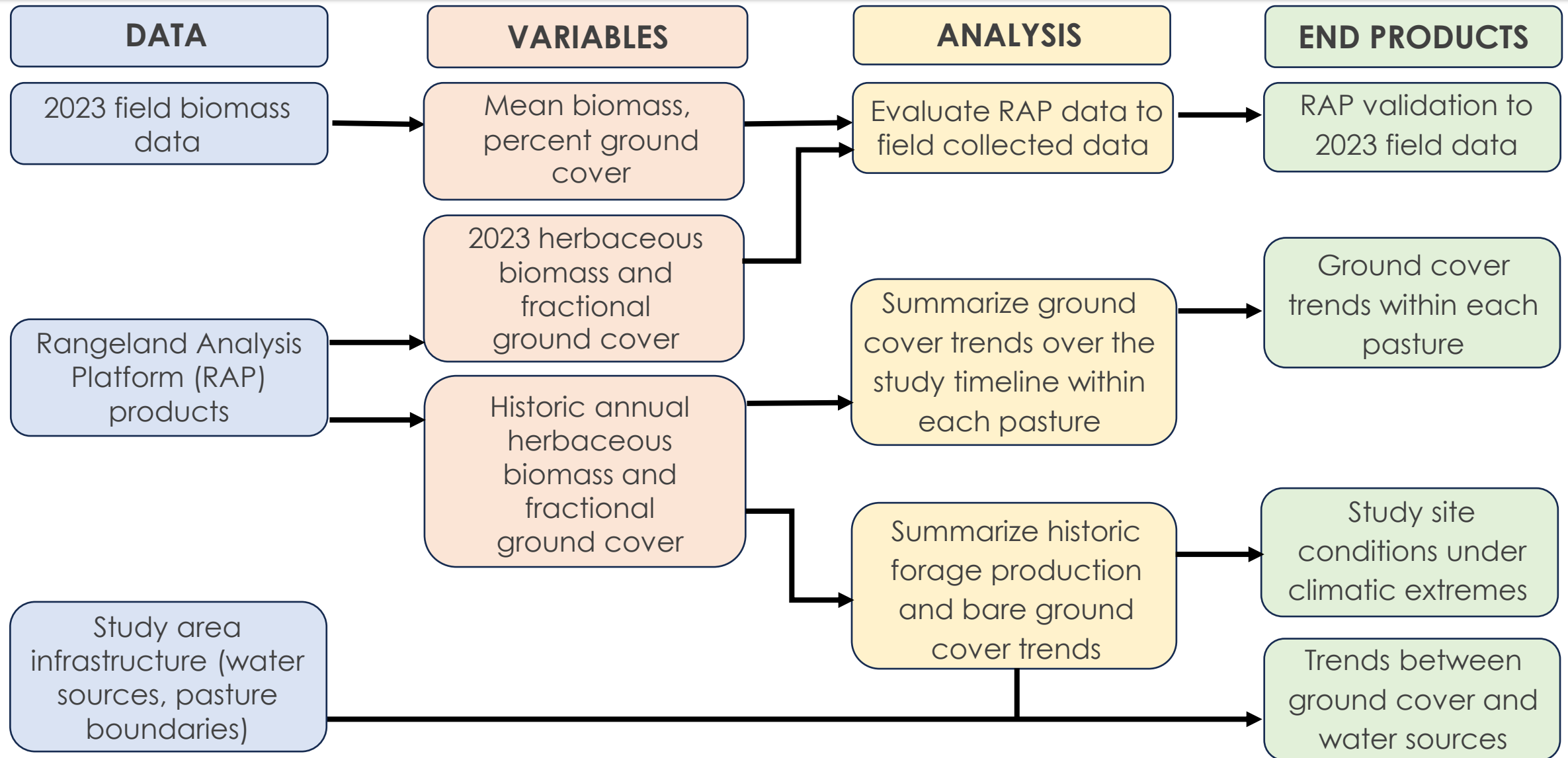
30m²

Temporal Resolution:

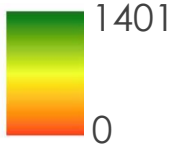
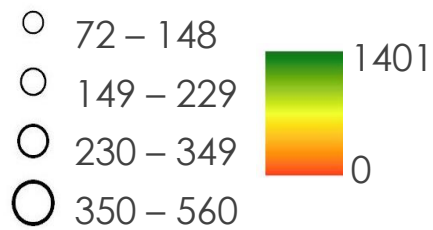
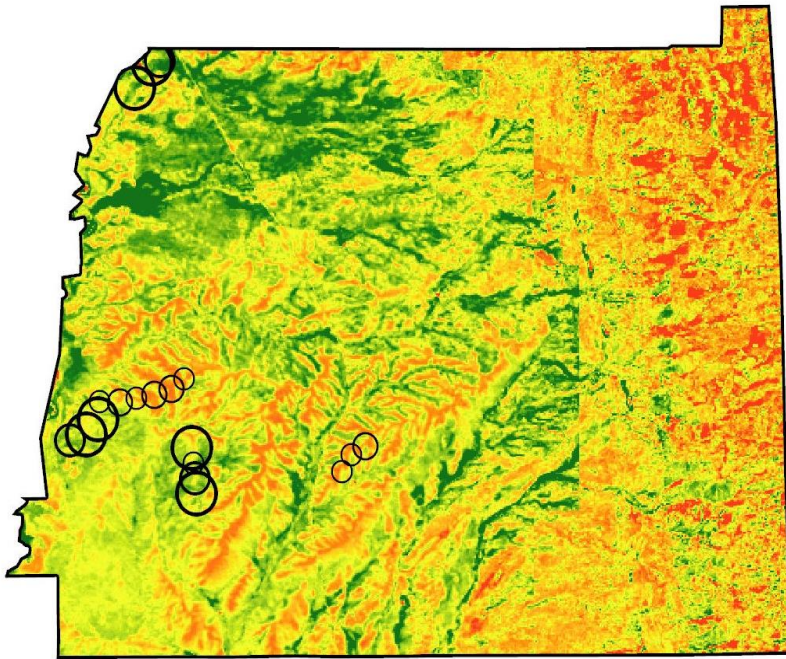
16 days

FUN FACT: Landsat 5 holds the Guinness World Records title of “Longest-operating Earth observation satellite” of 28 years and 10 months before decommissioning in June 2013

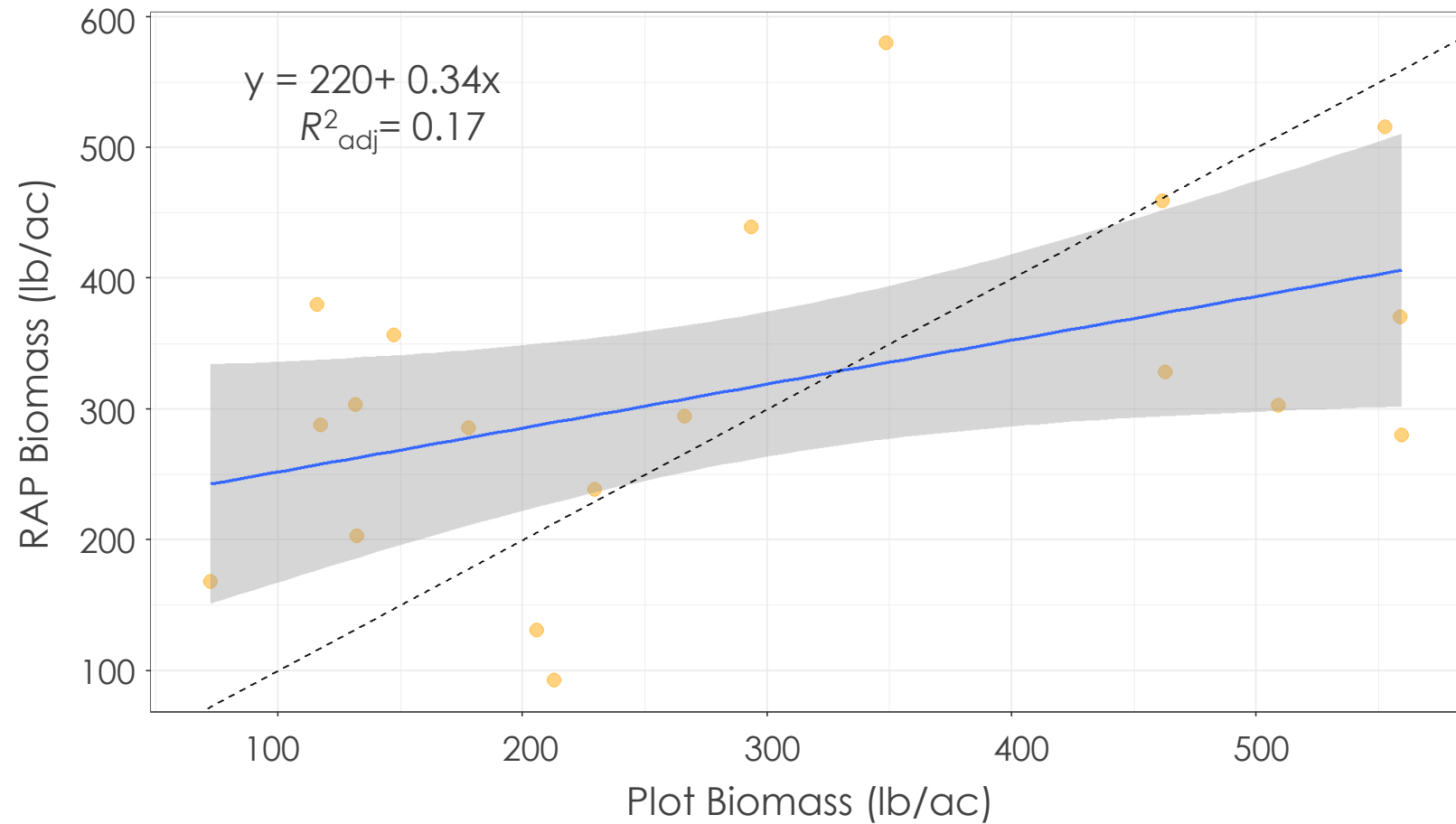
WORKFLOW



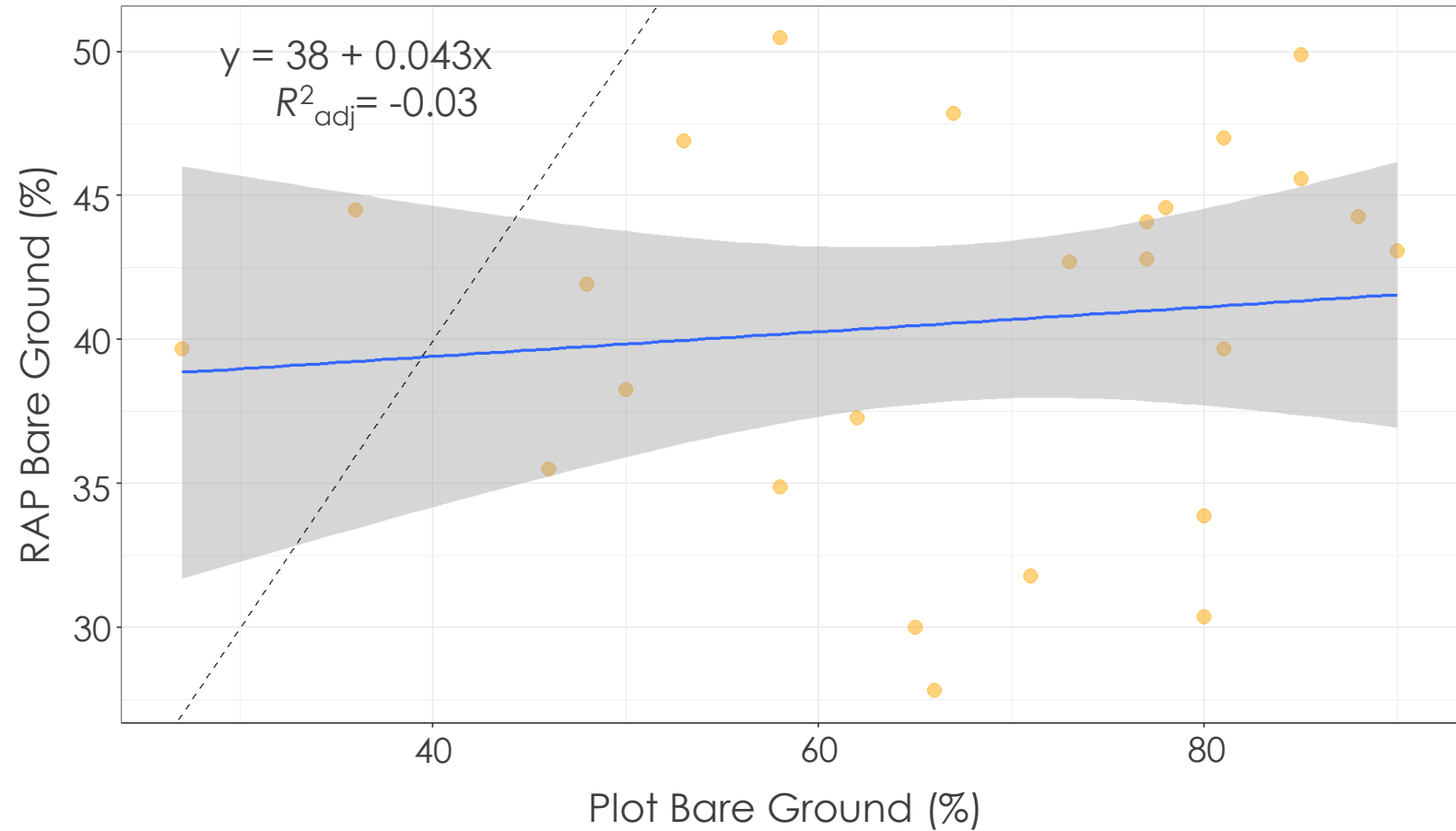
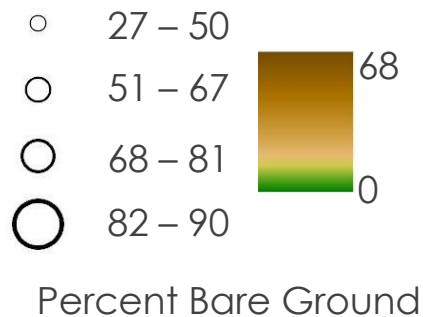
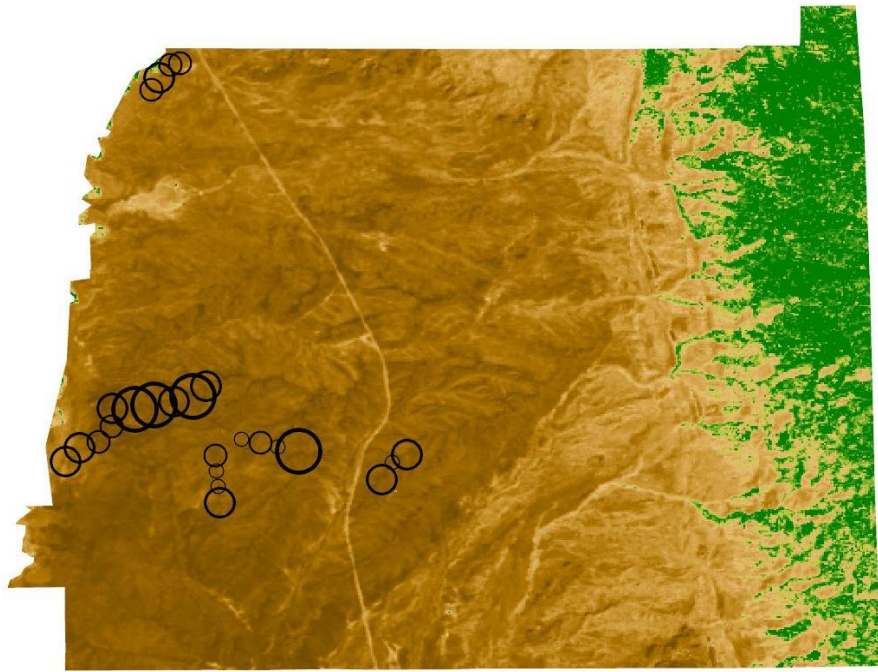
RESULTS: 2023 RAP DATA VALIDATION



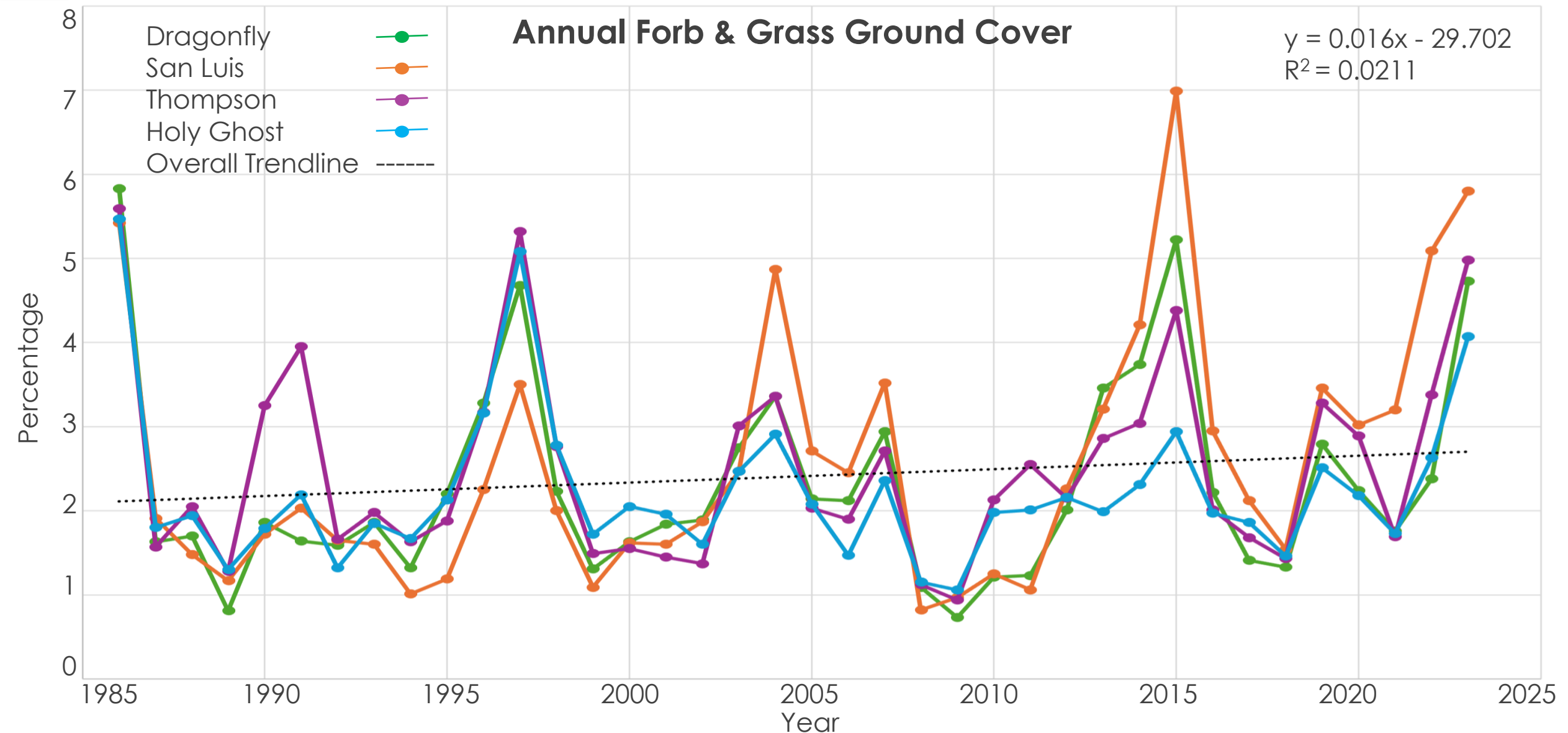
Herbaceous Biomass (lb/ac)



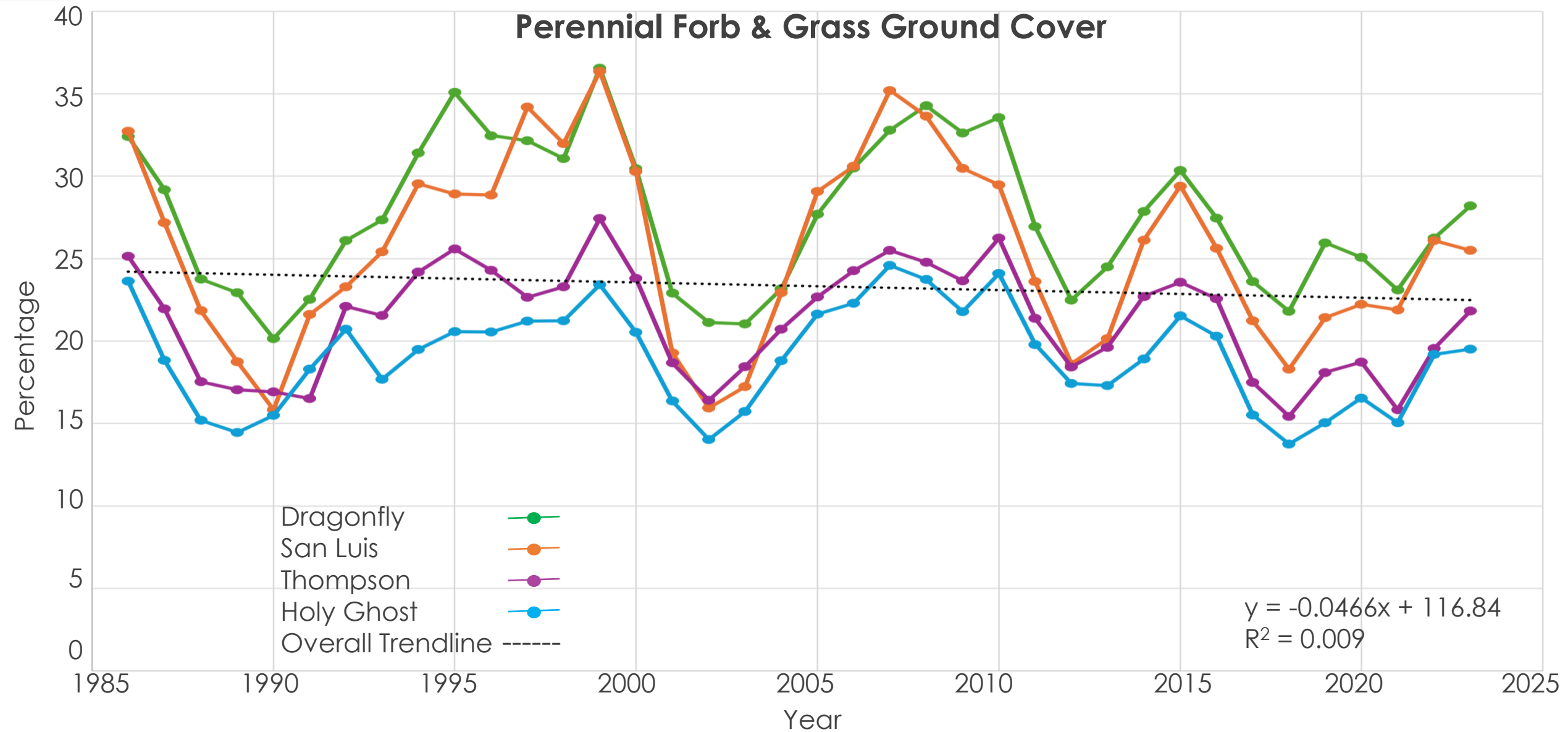
RESULTS: 2023 RAP DATA VALIDATION



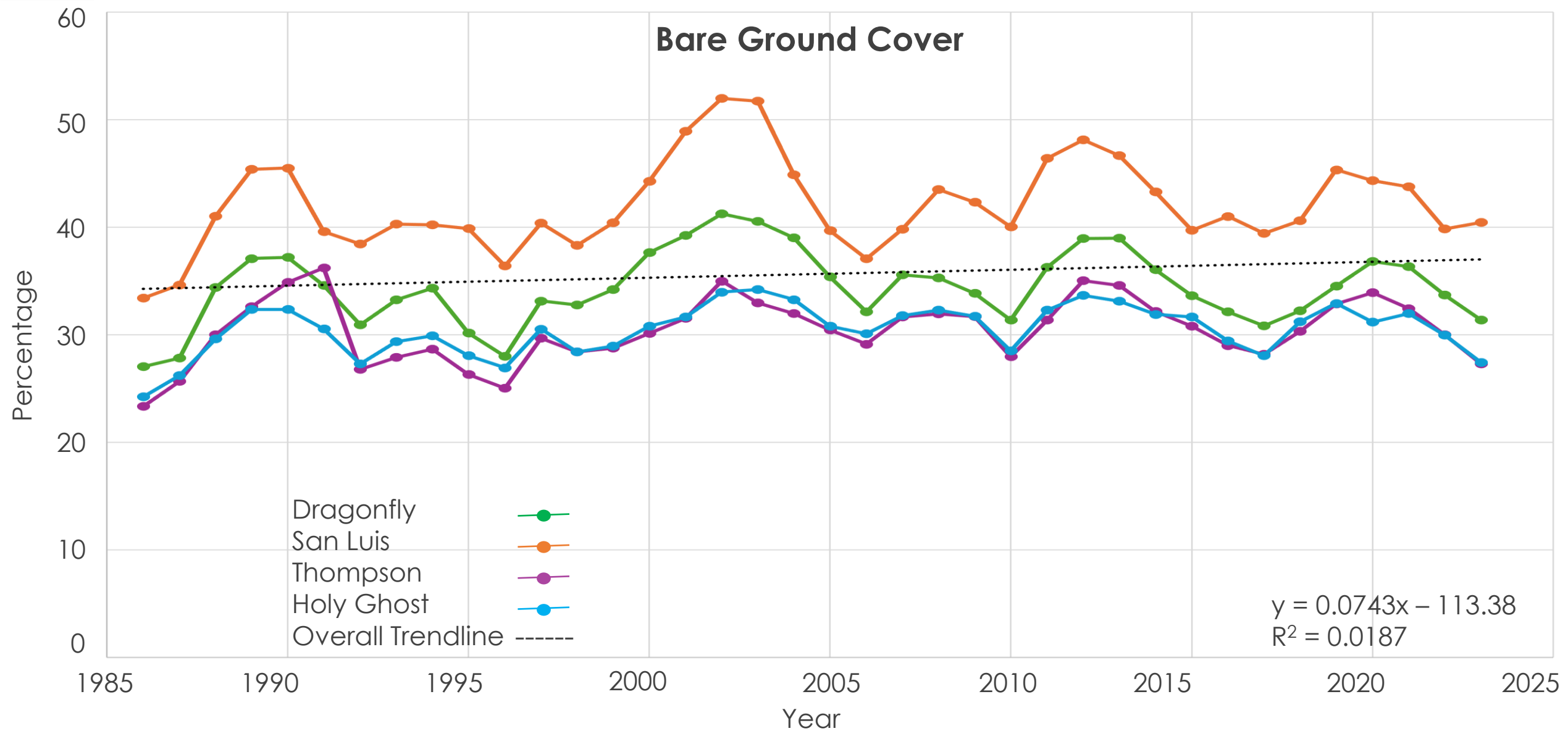
RESULTS: GROUND COVER TRENDS



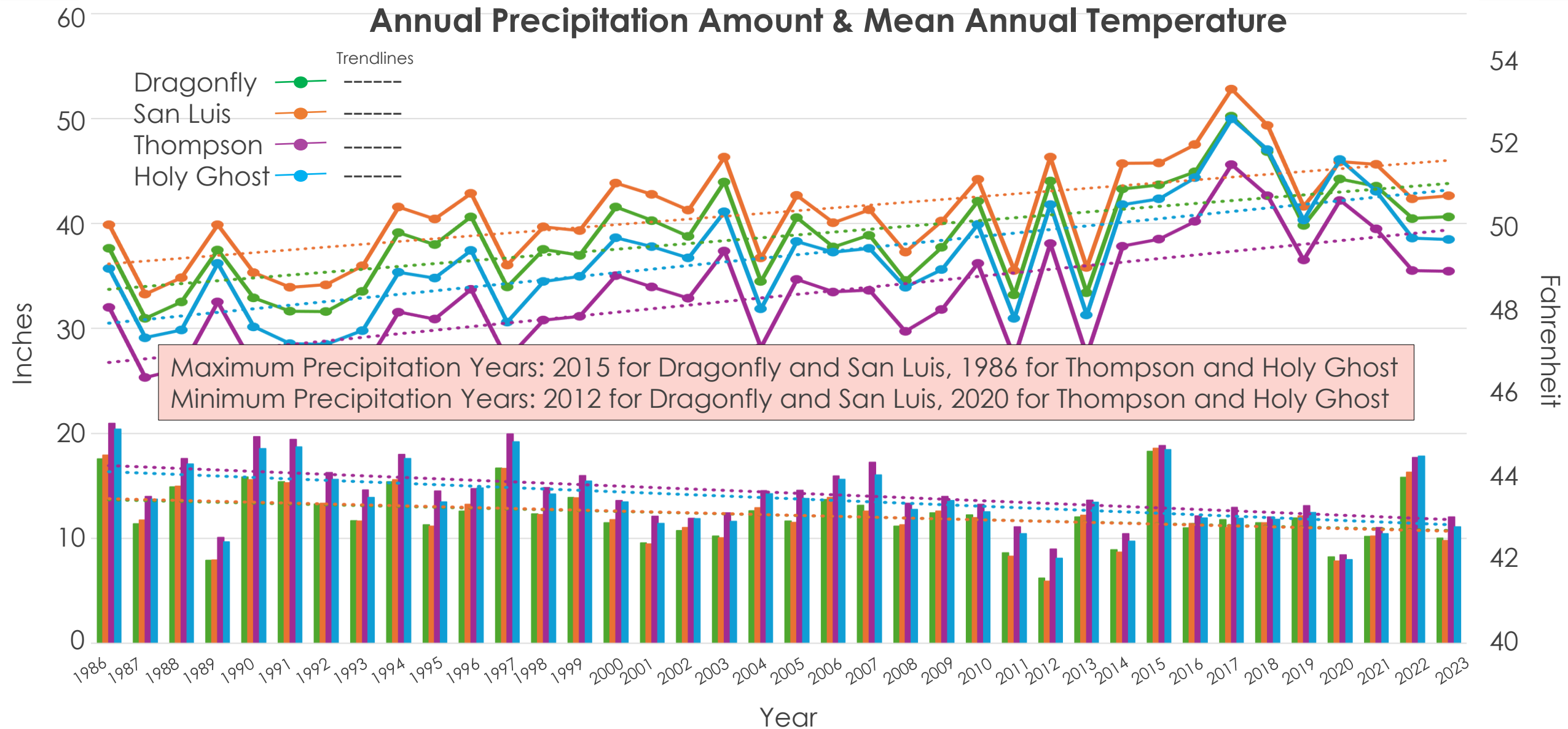
RESULTS: GROUND COVER TRENDS



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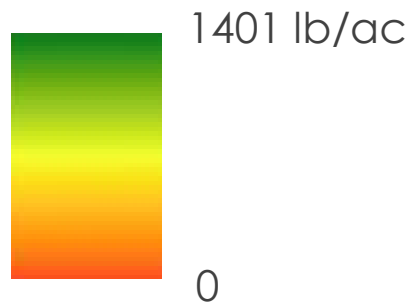
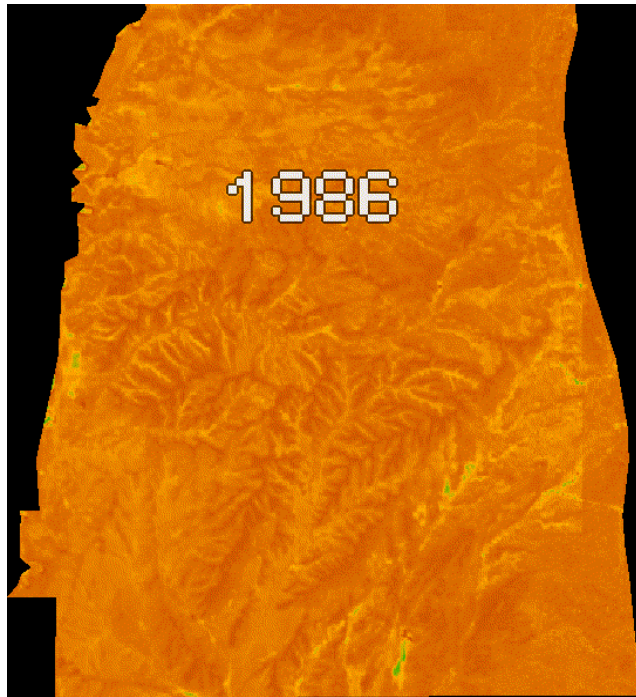


RESULTS: CLIMATIC TRENDS

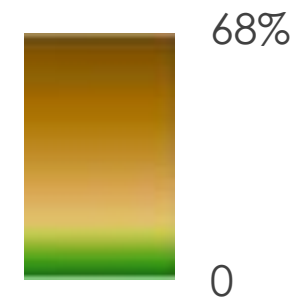
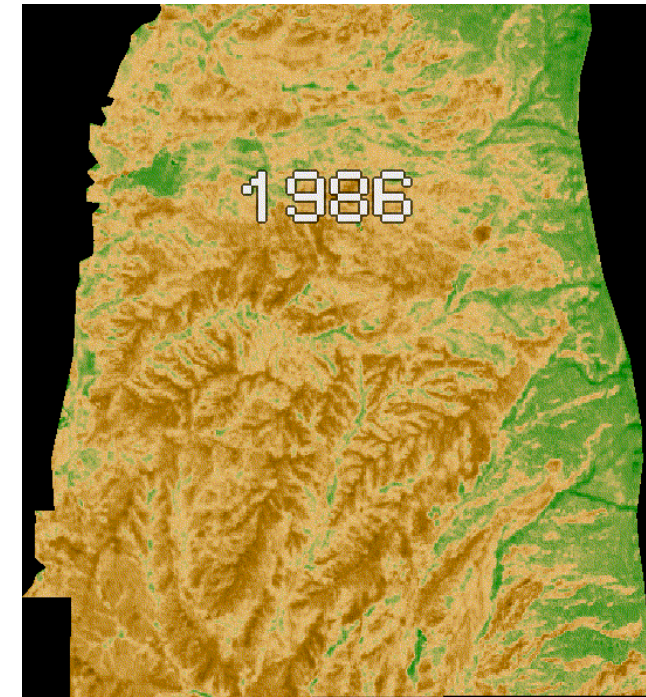


RESULTS: 1986 – 2023 TIME SERIES VISUALS

Herbaceous Biomass (lb/ac)

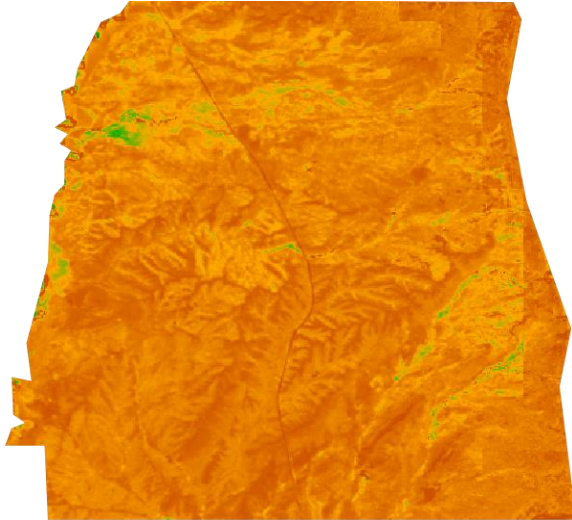


Bare Ground Cover (% cover)

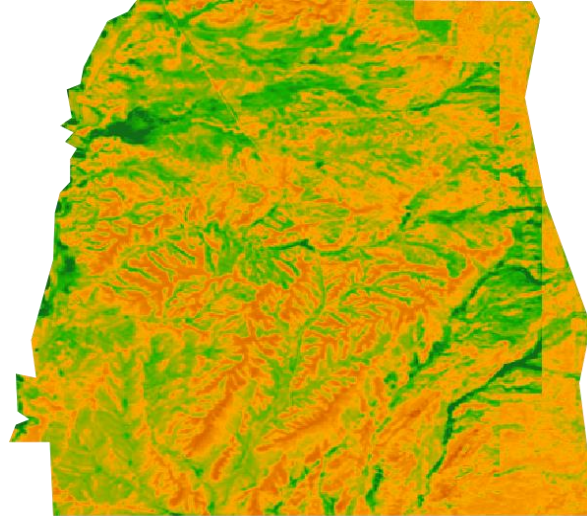


RESULTS: FORAGE PRODUCTION (lb/ac)

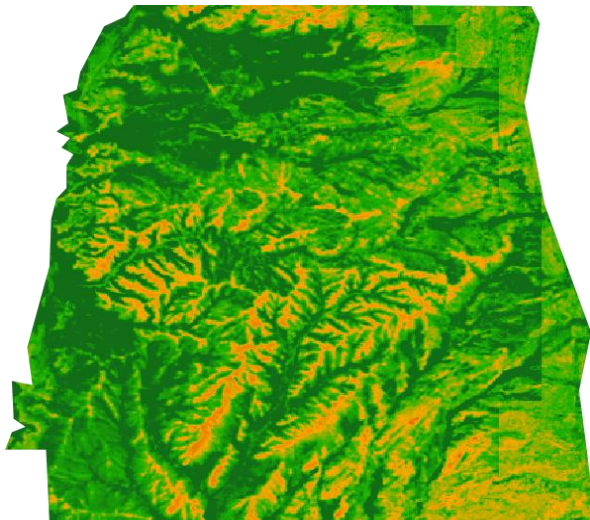
Minimum



Mean



Maximum

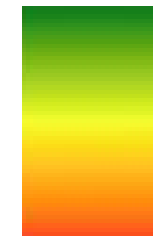


Range



Summary statistics of
herbaceous biomass from
1986 – 2023

Min-Mean-Max Legend



730 lb/ac

0

Range Legend

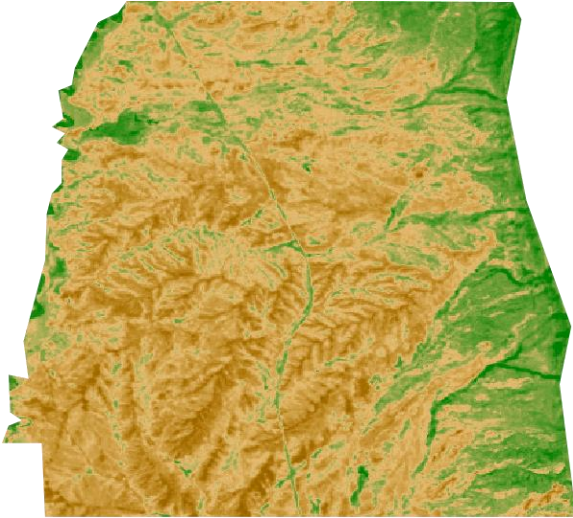


1401 lb/ac

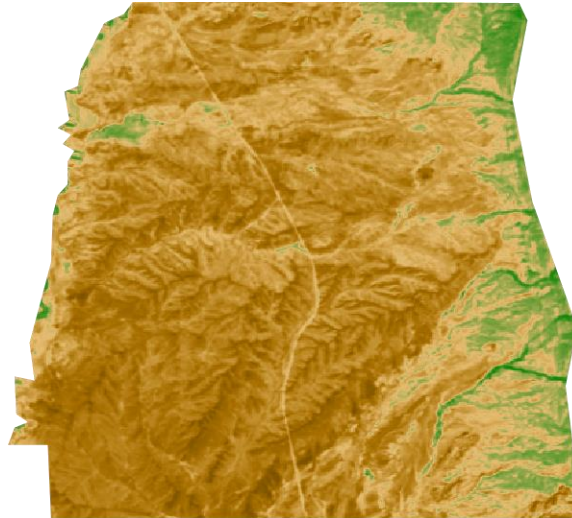
0

RESULTS: BARE GROUND COVER (% cover)

Minimum



Mean



Maximum

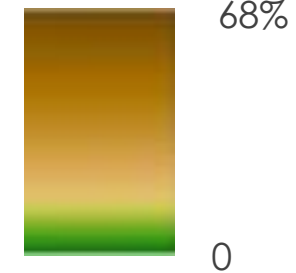


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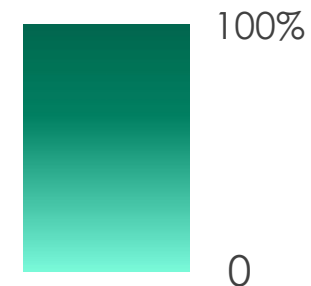


Summary statistics of
bare ground cover from
1986 – 2023

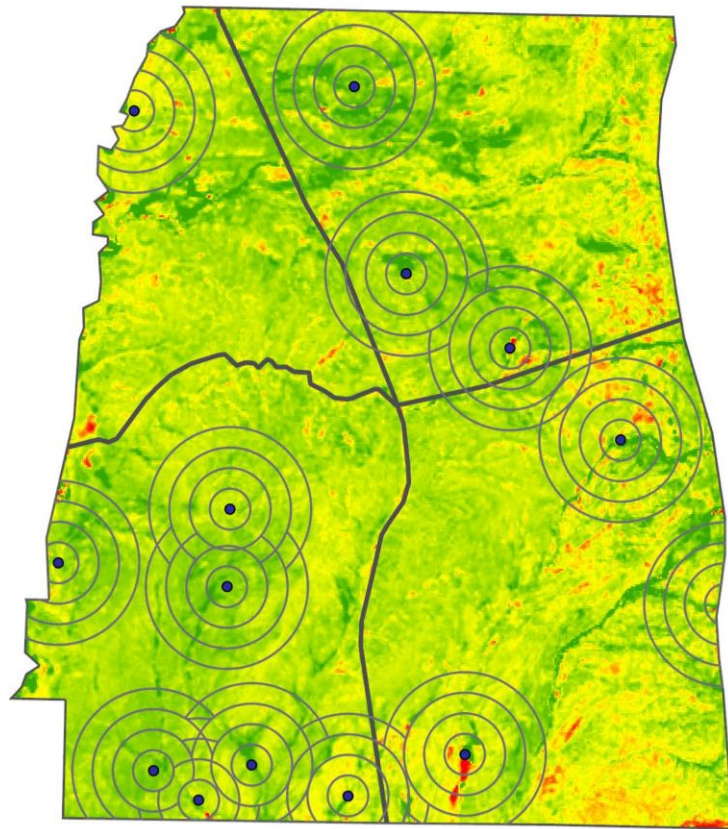
Min-Mean-Max Legend



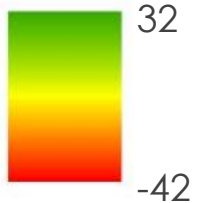
Range Legend



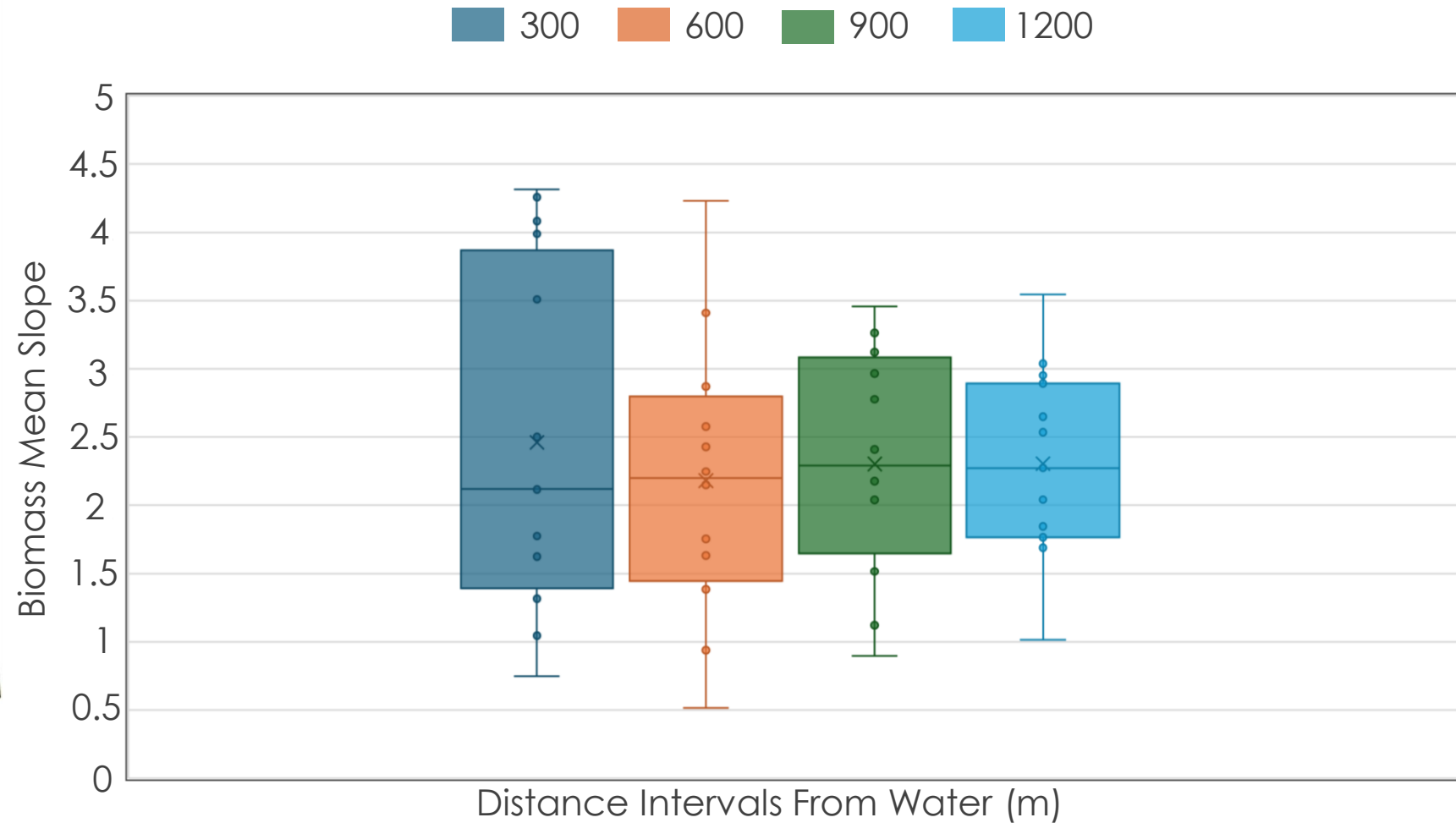
RESULTS: BIOMASS TRENDS NEAR WATER



Mean Slope



- Permanent Water
- 300 m
- 600 m
- 900 m
- 1200 m
- ▬ Pasture Boundaries



Averages per pasture:

- Dragonfly: 2.088
- Holy Ghost: 1.387
- Thompson: 2.150
- San Luis: 2.273

ERRORS & UNCERTAINTIES



Image Credit: Pueblo of Jemez Natural Resource Department

- Minimal field data to compare to RAP
 - Low sample size for the study area
 - Single year of field data
 - Limited pasture representation
- Lack of historical data on grazing management and impact
 - Stocking densities
 - Grazing timing
 - Other livestock and wildlife presence

FEASIBILITY & PARTNER IMPLEMENTATION

- RAP is a free remote-sensing rangeland assessment tool that is easy to use
- Interpreted RS data from RAP could be used to identify areas requiring livestock exclusion based on trends
- All RS data require ground truthing
- Future grazing management will require prudent record-keeping, funds for continual monitoring, and the use of an adaptive management plan

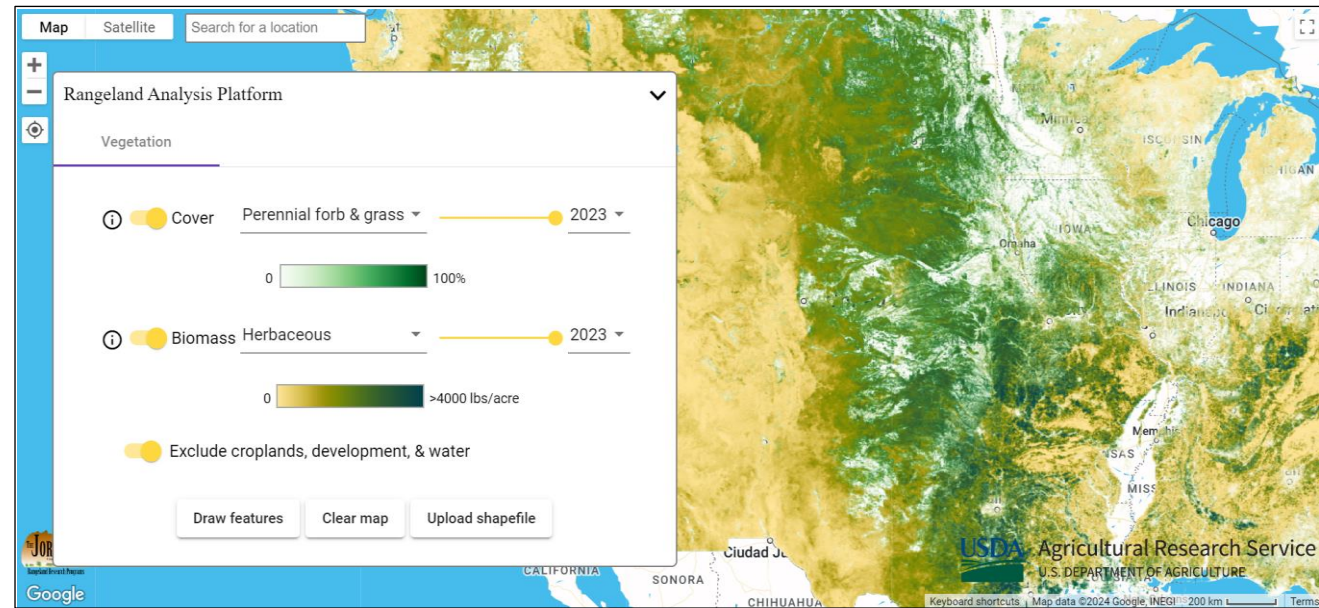


Image Credit: Alivia Gustrowsky

CONCLUSIONS

- RAP ground cover data products for 2023 did not strongly correlate to the field data
- Pasture trends demonstrated a shift towards increasing annual herbaceous presence with a decreasing perennial herbaceous presence while overall becoming barer, hotter, and drier
- Under extreme conditions, the study site supports a larger range of potential for herbaceous biomass than bare ground cover
- There is more variability of mean biomass the closer to a permanent water source
- Remotely-sensed imagery has the potential to help inform grazing management practices that utilize virtual fencing

ACKNOWLEDGMENTS

Our wholehearted thanks and gratitude to:

- **Partners:** Jonathan Romero, AJ Baca, Jonathan Baca, Tyler Loretto, Ethan Romero, & Tegan May
- **Advisors:** Nicholas Young (Colorado State University [CSU]), Dr. Tony Vorster (CSU), Dr. Paul Evangelista (CSU), Dr. Catherine Jarnevich (CSU), Chris Choi (CSU)
- **DEVELOP CO Node Lead:** Truman Anarella
- **DEVELOP PC Team:** Amanda Clayton, Marisa Smedsrud, and Jane Zugarek

