Vina Groundwater Subbasin – Groundwater Dependent Ecosystem Technical Study

Prepared by

ESA in coordination with the Butte County Water and Resource Conservation Department

Funding provided by the California Department of Water Resources

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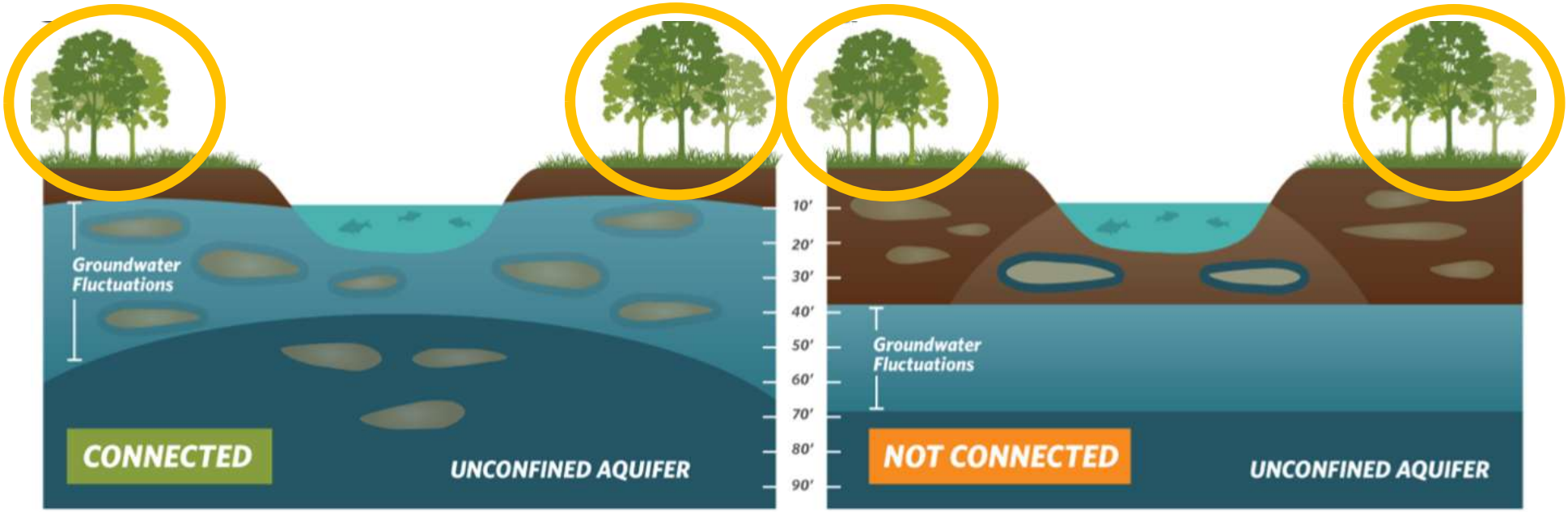
Agenda

- Background and Context
  - What is a groundwater dependent ecosystem (GDE)
  - Why do we need to identify and map GDEs
- Study Objectives and Scope
- Study Approach
  - How do we identify GDEs
  - Regional GDE “Health” Assessment
- Study Results
- Key Take Aways and Next Steps

Background and Context

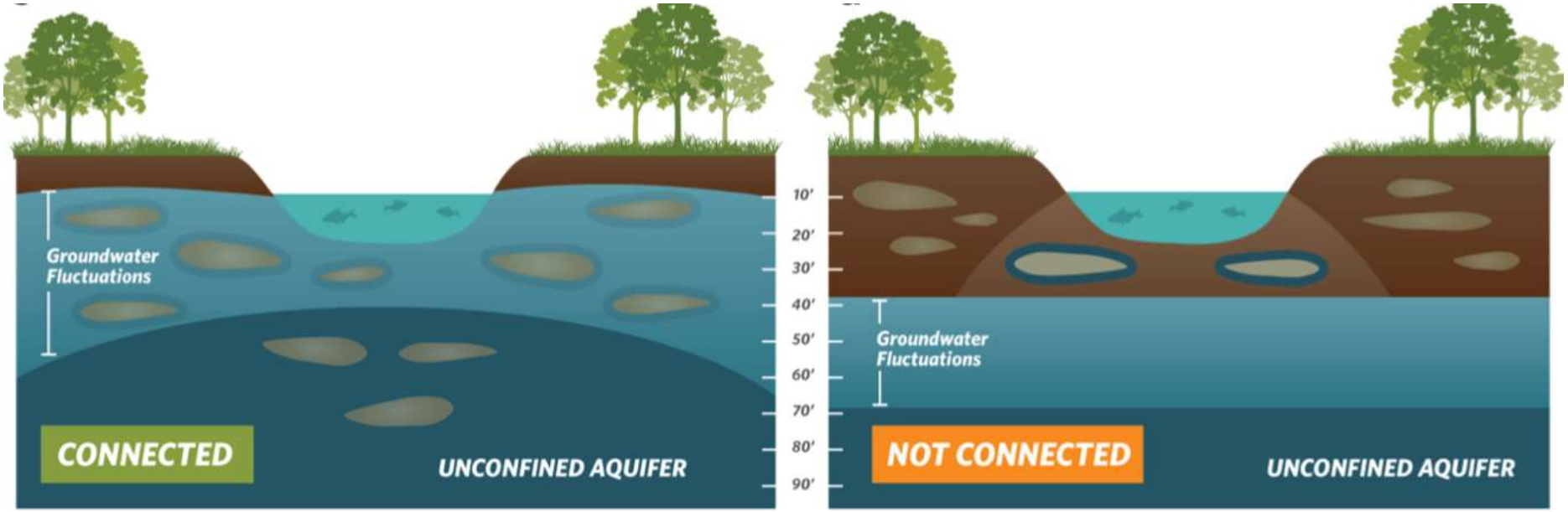
What is a Groundwater Dependent Ecosystem?

GDEs are specifically defined under SGMA as “ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface” (23 CCR § 351(m)).



Is it a GDE?

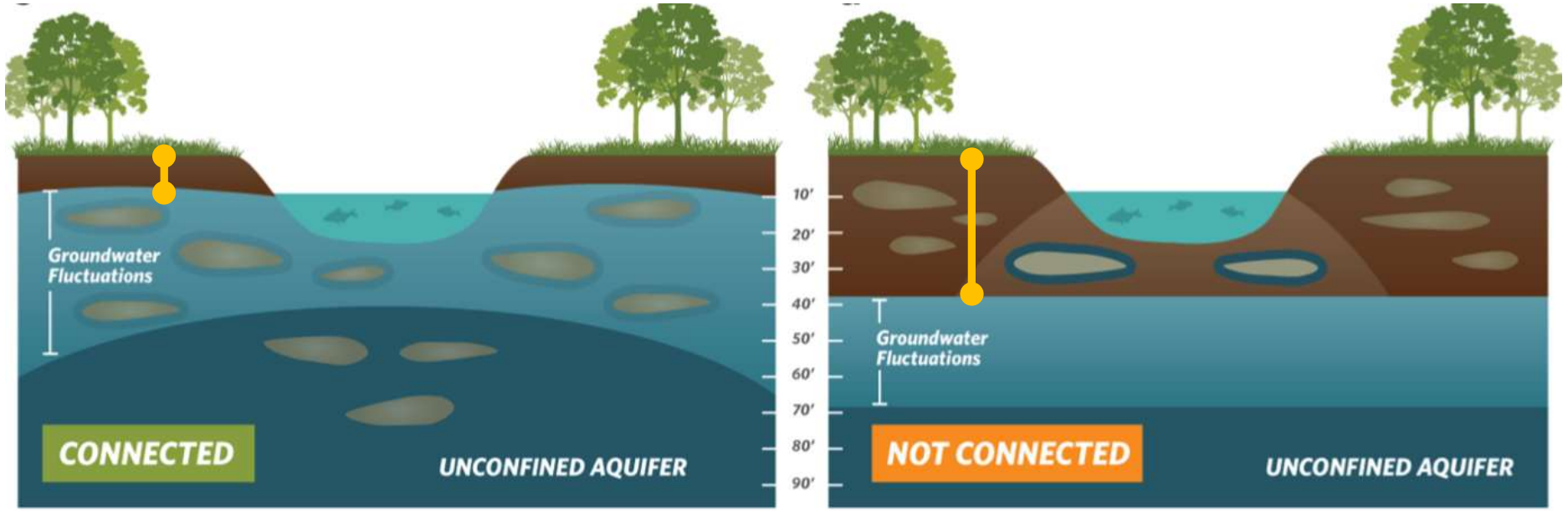
We need an objective, repeatable measure to determine if a particular vegetation patch is a GDE.



Is it a GDE?

Besides vegetation type there are two key measures:

- Depth to groundwater (DTG)
- Plant rooting depth



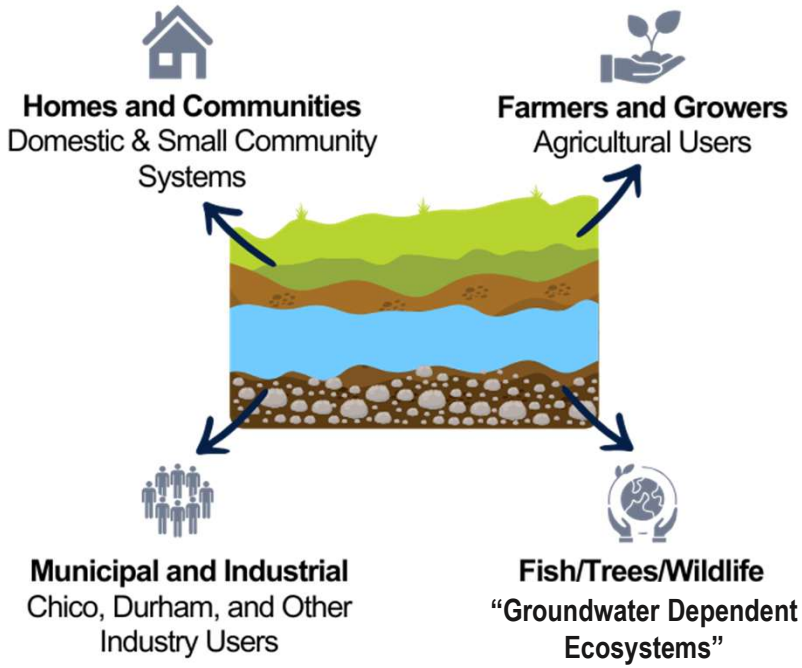
Why Map Groundwater Dependent Ecosystems?

SGMA requires that the interests of all beneficial uses and users, including environmental users of groundwater, be considered in the development and implementation of GSPs (Water Code § 10723.2).

Regulations include specific requirements for GSPs to identify GDEs and consider them when determining whether groundwater conditions are having potential effects on beneficial uses and users.

GSAs must also assess whether sustainable management criteria (including minimum thresholds and measurable objectives) may affect the interests of beneficial uses and users of groundwater such as GDEs.

Beneficial Uses and Users



Study Objectives and Scope

Study Objectives and Scope

GDE Technical Study focused on (1) updating and refining the GDE mapping, (2) addressing identified data gaps, and (3) addressing relevant agency comments.

Analytical Focus was:

- Characterizing shallow groundwater conditions to refine the location and extent of GDEs within the Subbasin.
- Characterizing regional ecological conditions and trends at GDEs within the Subbasin

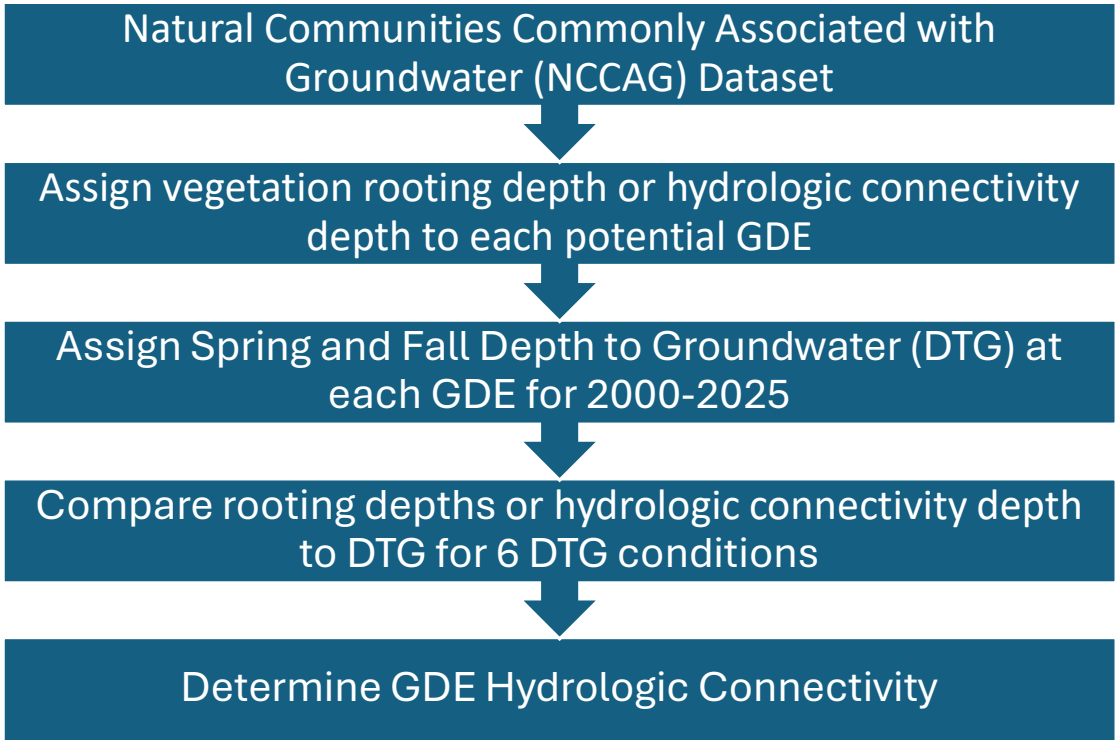
Study Goal: Improve identification and characterization of GDEs that GSA must consider as part of SGMA compliance and long-term monitoring and management:

- Provide a recommended set of GDEs
- Provide potential approaches for future long term GDE monitoring

Study Approach

Study Approach – How we Identify GDEs

- Determine Groundwater Connectivity of Mapped Potential GDEs



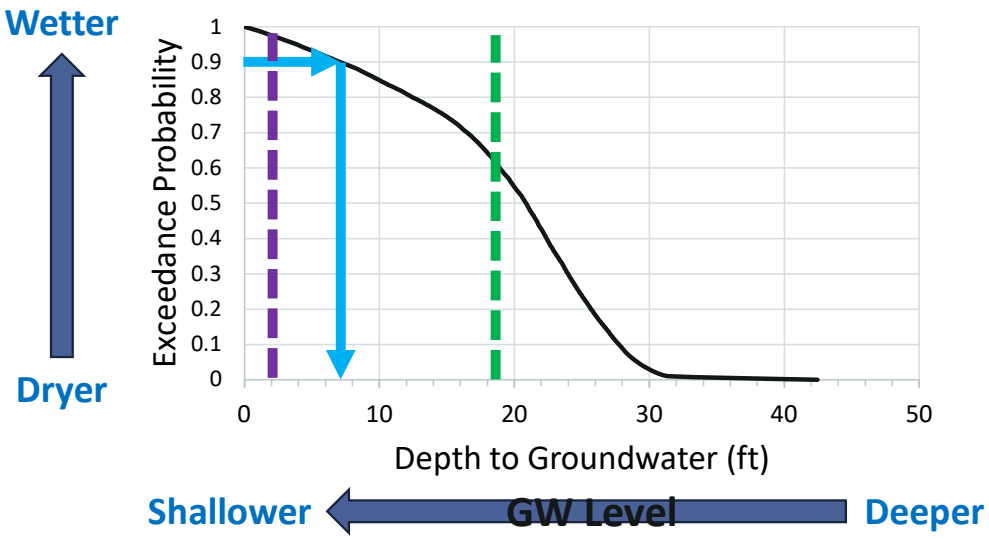
Rhode et al. (2024), TNC Rooting Database, Best Available Information

Spring and Fall: 90th percentile DTG, 2015 DTG, 2021 DTG

Is it a GDE?

If the DTG for a potential GDE is less than or equal to the assigned vegetation rooting depth or hydrologic connectivity depth it is likely a GDE.

However, which groundwater elevations are used to make the determination?



90th percentile DTG values: Reasonable upper threshold of supportive groundwater conditions

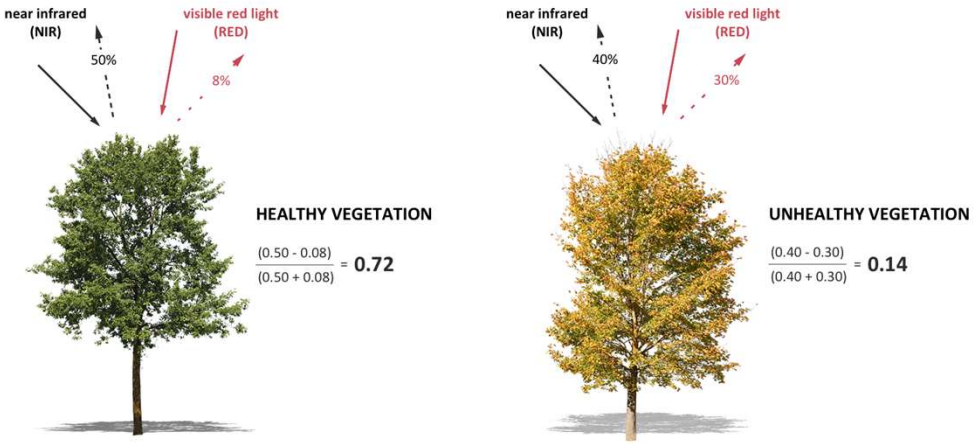
- Root Depth GDE-1: Likely a GDE
- Root Depth GDE-2: Not Likely a GDE

Study Approach – How we Identify GDEs

- Determine Groundwater Connectivity of Mapped Potential GDEs
  - Preliminary Analysis indicated high seasonal variability
  - **Spring 90th percentile DTG used to determine likely vs not likely GDEs based on hydrologic connectivity.**
  - Fall 90th Percentile - Included for comparative purposes
  - Spring and Fall 2015 and 2021 DTG Values
    - Both classified as critically dry water years by DWR and represent low and very low water table elevations
    - Included for comparative purposes.
    - Provide basis for documenting GDE conditions under drought conditions
    - Potentially inform how groundwater management and associated SMCs may affect the interests of beneficial uses and users of groundwater.

Study Approach – Regional GDE Assessment

- Remotely sensed vegetation metrics used to infer ecosystem health and characterize region-scale, long-term temporal trends.
  - Normalized Derived Vegetation Index (NDVI) – Common metric used to infer ecosystem health (Greenness)



https://gde.codefornature.org/#/methodology

NDVI values range from +1.0 to -1.0

- 0.2 - 0.5: Sparse vegetation such as shrubs and grasslands or senescing crops
- 0.6 to 0.9: Dense vegetation or crops at their peak growth stage

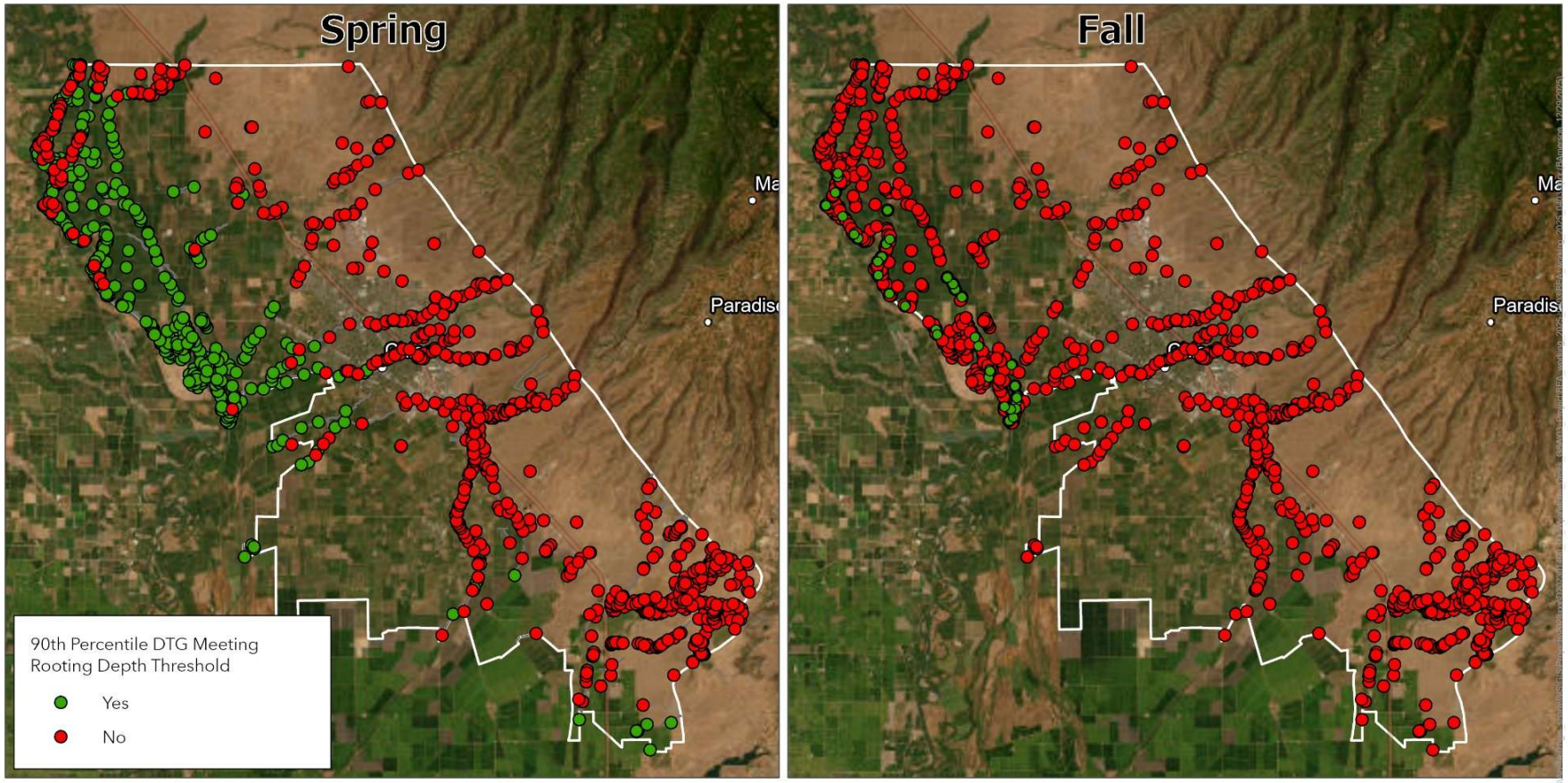
Study Approach – Regional GDE Assessment

- NDVI from TNC GDE Pulse Tool
  - Landsat based NDVI values at potential GDEs for 1985-2024 (one NDVI value for each potential GDE per year)

- Compare NDVI values between GDEs identified as likely GDEs and not likely GDEs
- Compare GDE-NDVI data to other variables (precipitation, shallow groundwater levels) – assess interplay and correlations between variables.

Study Results

Results - Identifying GDEs in Vina Subbasin



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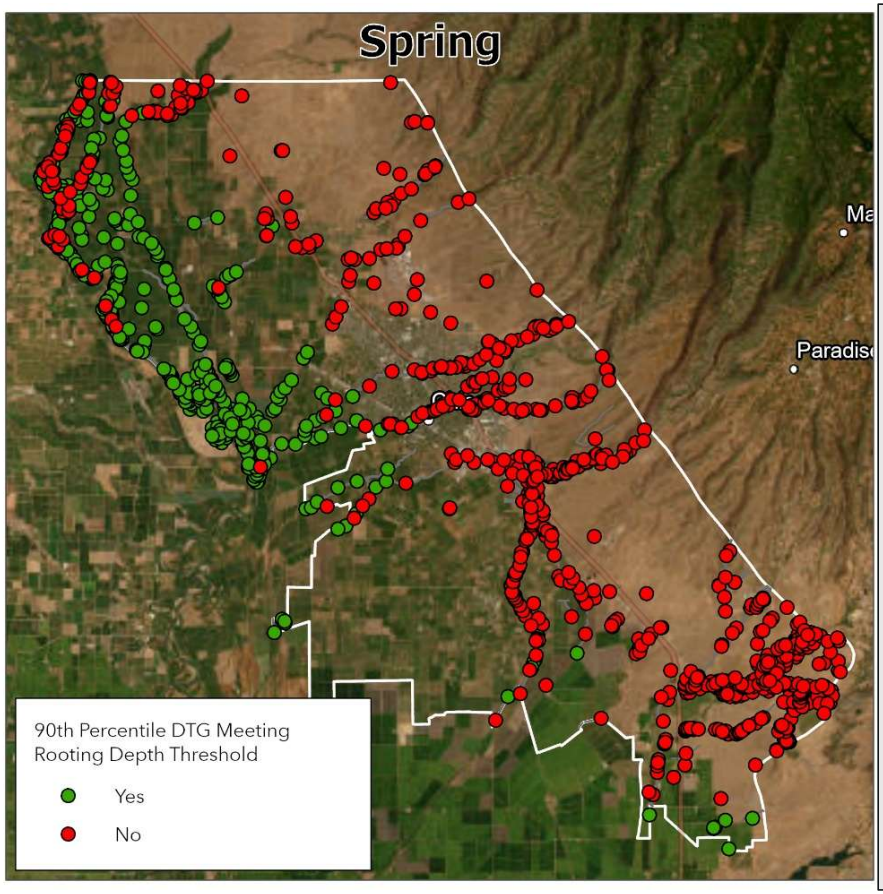
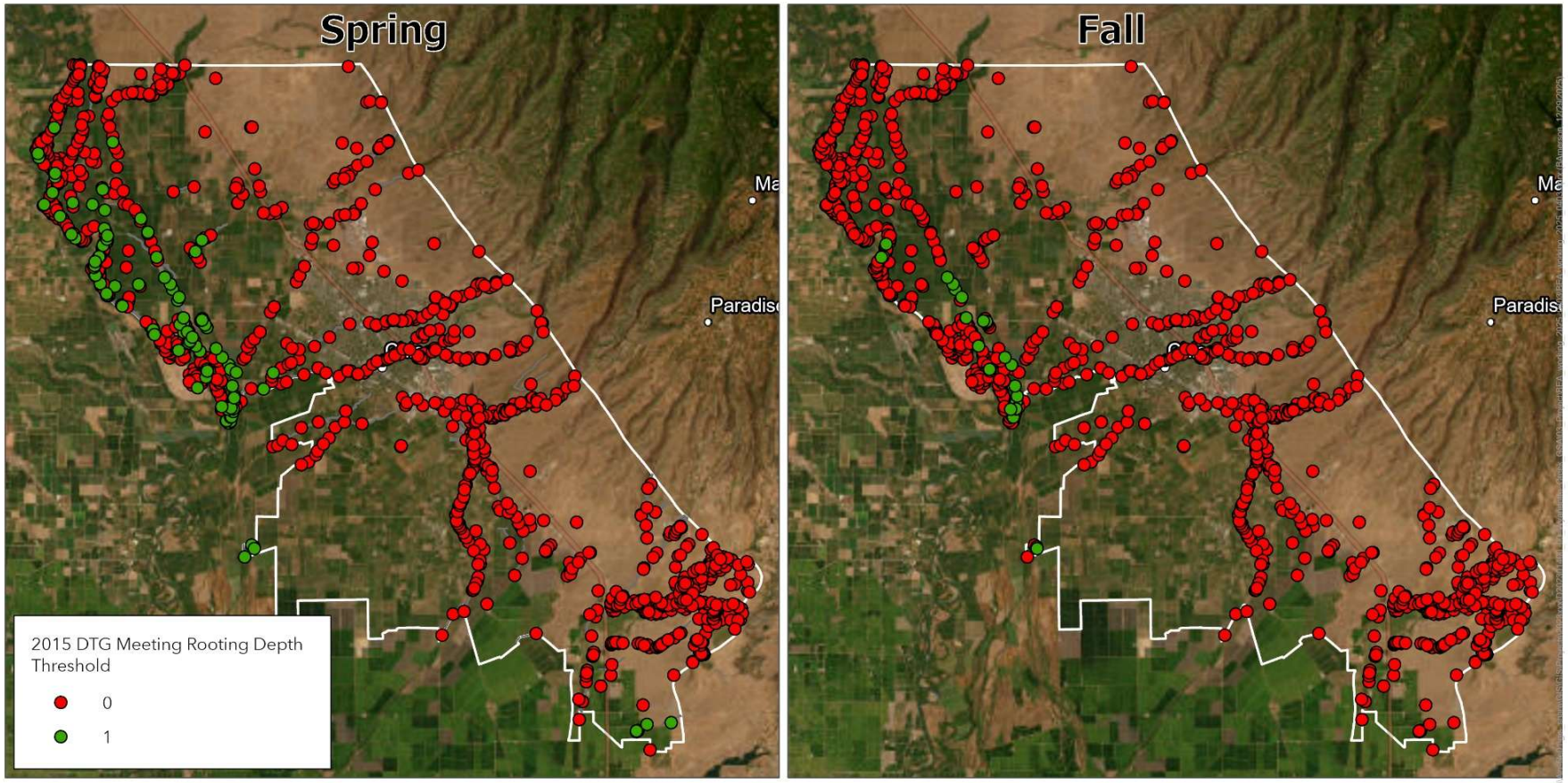


The number and pattern of GDEs identified as connected depended on the season (spring or fall) and the DTG condition used for evaluation (90th percentile, 2015, or 2021).

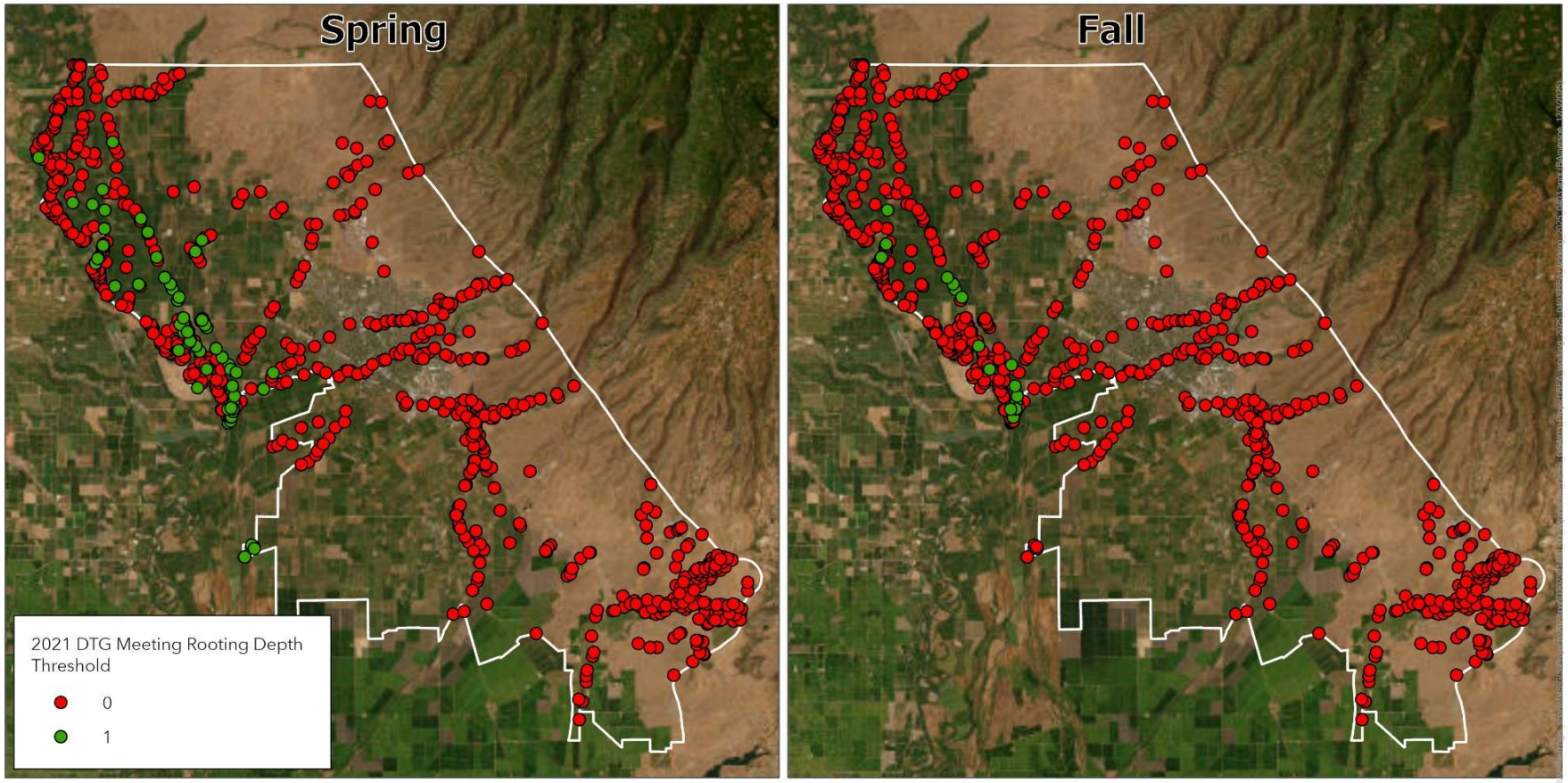
Spring 90th percentile condition findings:

- DTG remained within the rooting zone for potential GDEs in the northwestern portion of the Subbasin along the Sacramento River
- Additional likely GDEs occur in the western portion of the Subbasin along many of the surface waters that are tributary to the Sacramento
- Vegetation in the eastern foothills are not likely GDEs, with respect to regional groundwater table conditions

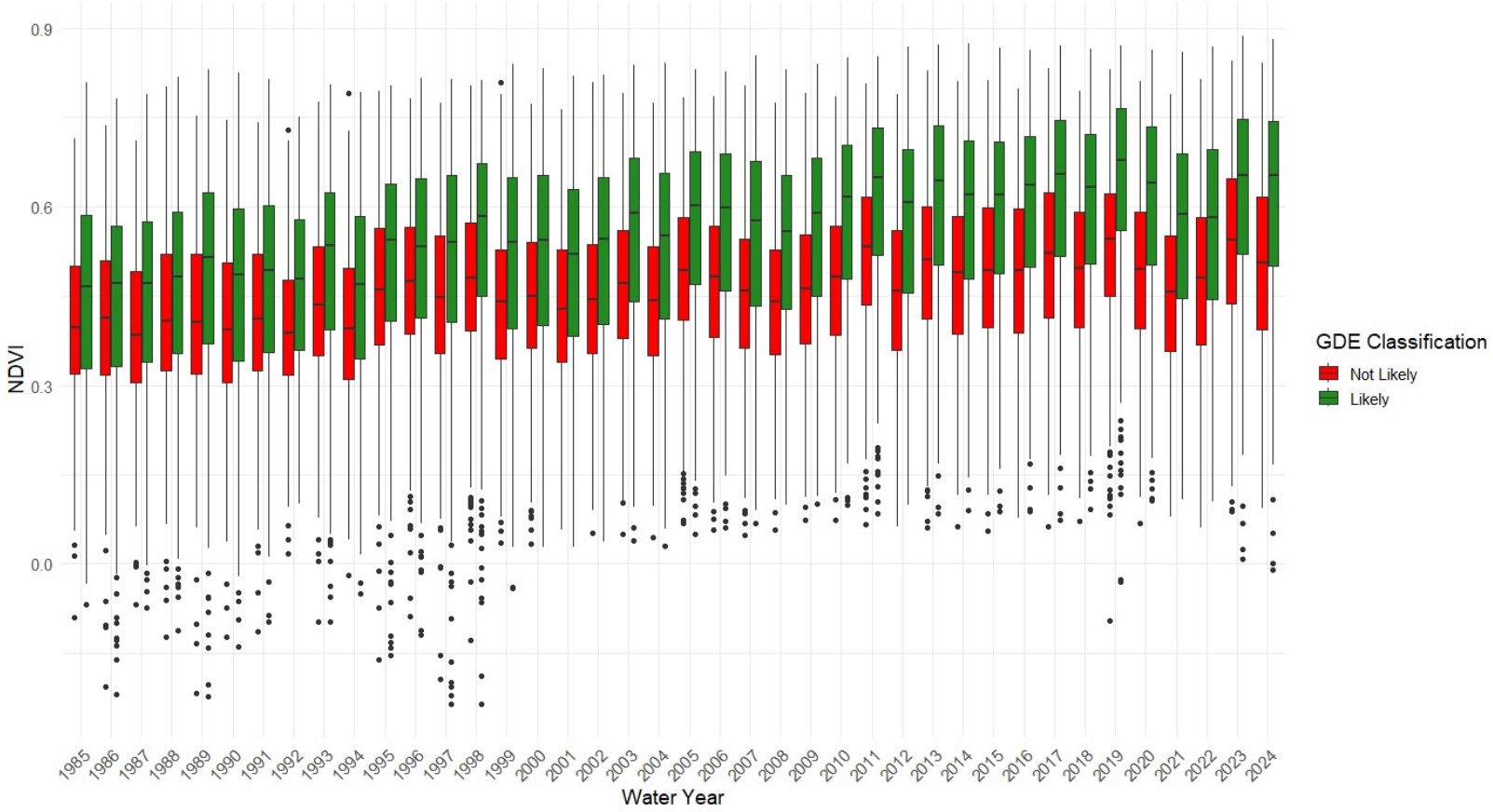
Results – Dry Year Comparisons (2015)



Results – Dry Year Comparisons (2021)



Study Results – Regional GDE Assessment



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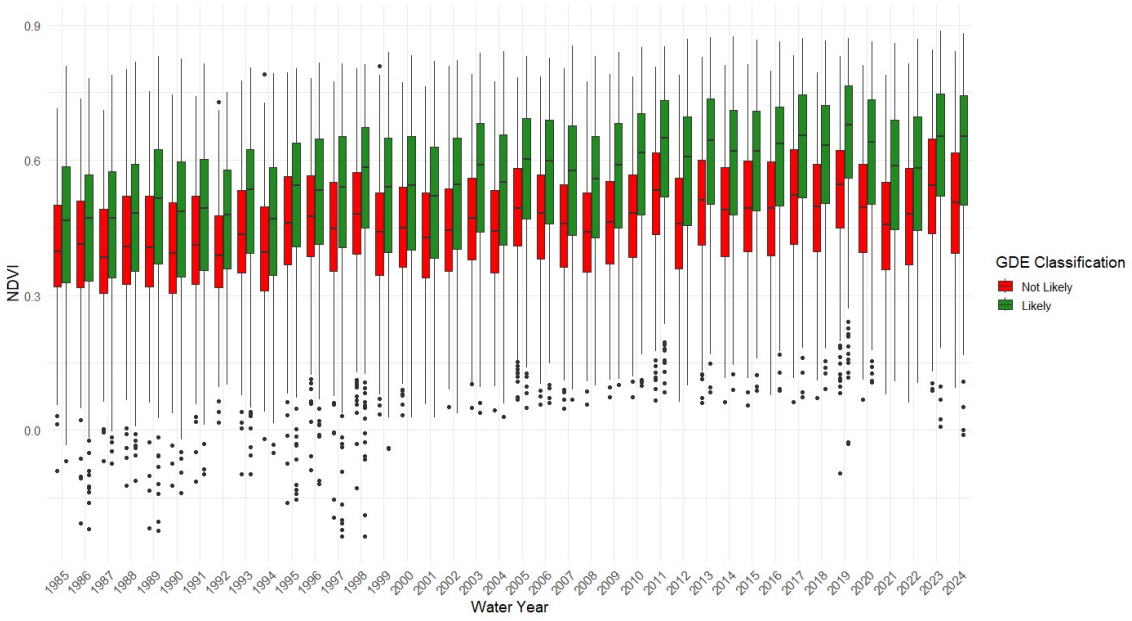
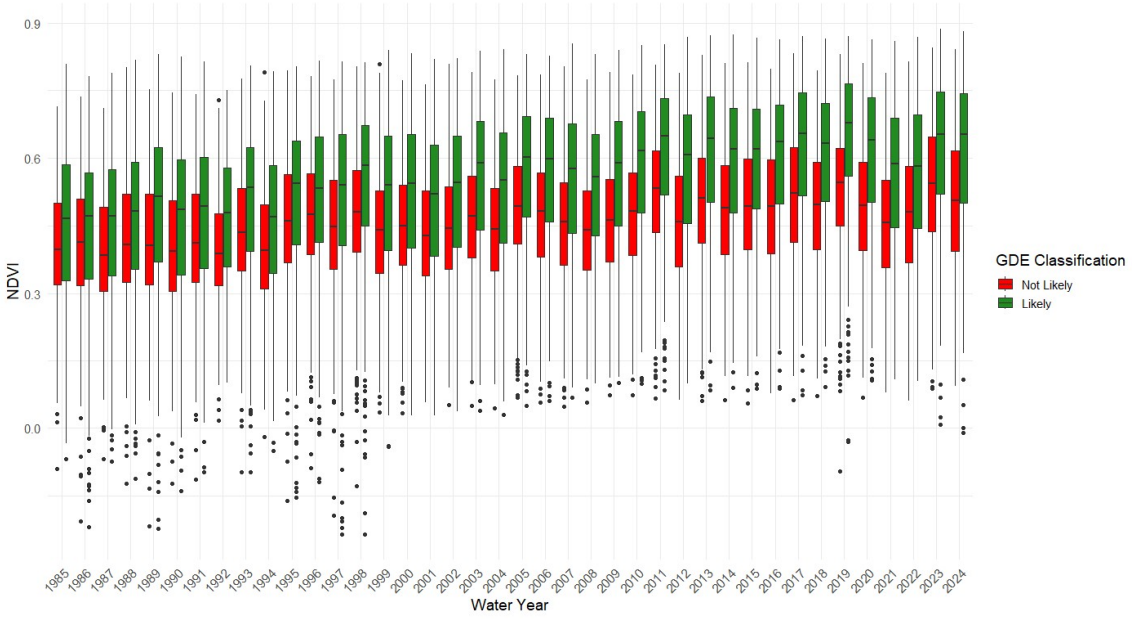


Preliminary Findings:

- Median NDVI at likely GDEs is greater than median NDVI at not likely GDEs for all years
- The overall trend over the period of record is that of increasing NDVI values
- Year-to-year changes in median NDVI at likely GDEs and not likely GDEs are strongly correlated ➔ suggesting non-groundwater related factors play a strong role in regional NDVI trends across all potential GDEs
- While NDVI values generally decreased during 2021 and 2022, values rebounded in 2023 and 2024 to pre-drought levels.

Study Results – Regional GDE Assessment



Preliminary Findings:

- At the Subbasin scale the relationship between shallow groundwater elevations and GDE NDVI values is not straightforward or linear
- Other factors likely also influence GDE ecological health:
  - Antecedent conditions (e.g., previous conditions) may result in delayed responses
  - Ecological resiliency (e.g., lack of response)
  - Masked responses due to mortality, recovery, or succession.
  - Covariates (climate, land management, etc.)
- NDVI valuable tool but involves complexity and a need to establish clear linkages

Take Aways and Next Steps

Key Take Aways and Next Steps

- The GDE mapping refinement for the spring 90th percentile groundwater conditions identified a total of 464 of the 1,228 potential GDEs from the NCCAG dataset as being identified as likely GDEs.
  - Hydrologic conditions at these GDEs exhibit high seasonal and drought condition variability that should be accounted for when considering monitoring and potential effects of groundwater management.
  - Most common likely GDE vegetation types identified were: Valley Oak, Sycamore, and Willow *sp.*

- Remote Sensing (NDVI) is a valuable and promising monitoring tool but developing clear linkages between GDE ecological health and groundwater in the Vina Subbasin requires more study.

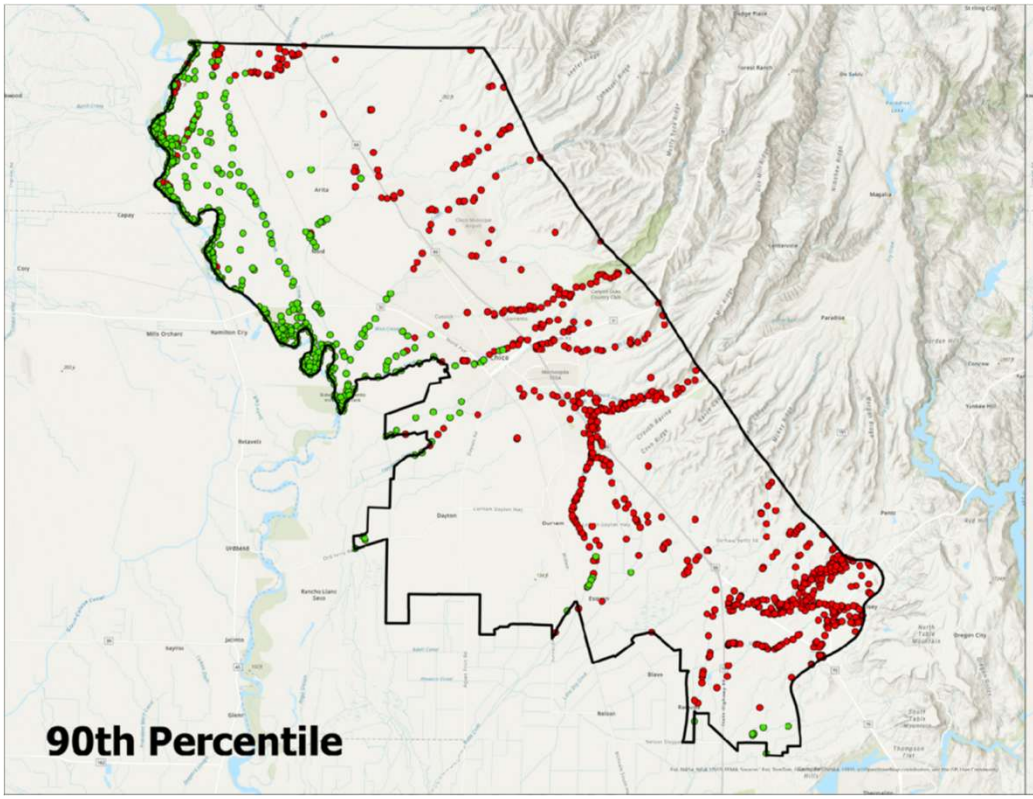
Key Take Aways and Next Steps

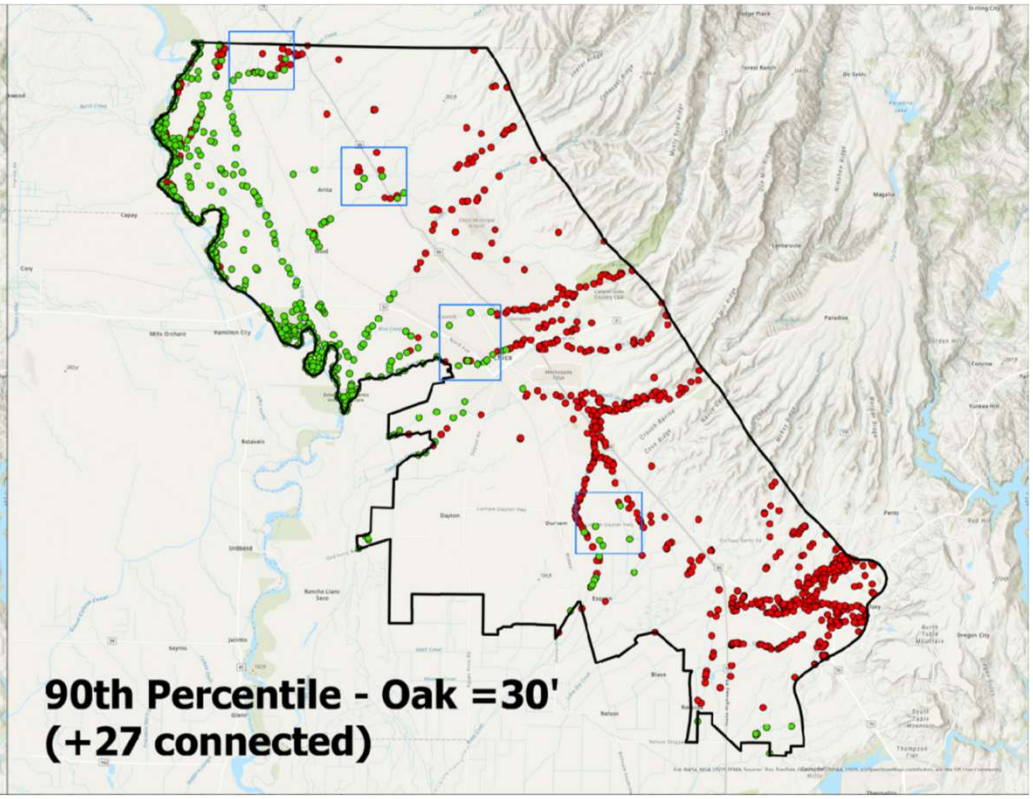
- Consider further study to assess GDE ecological conditions to define ecological value of likely GDEs and inform possible future GDE monitoring (some of this is ongoing).
- Consider establishing fixed field monitoring locations to assess ecological baseline conditions at representative GDEs and conduct subsequent periodic monitoring to provide insight into how environmental conditions and groundwater management may be influencing GDE function, integrity, and ecological health through time.
- Continue to evaluate approaches for monitoring impacts and managing groundwater in consideration of GDEs.


Questions

Extra Slides – As Needed

Results – Sensitivity Analysis





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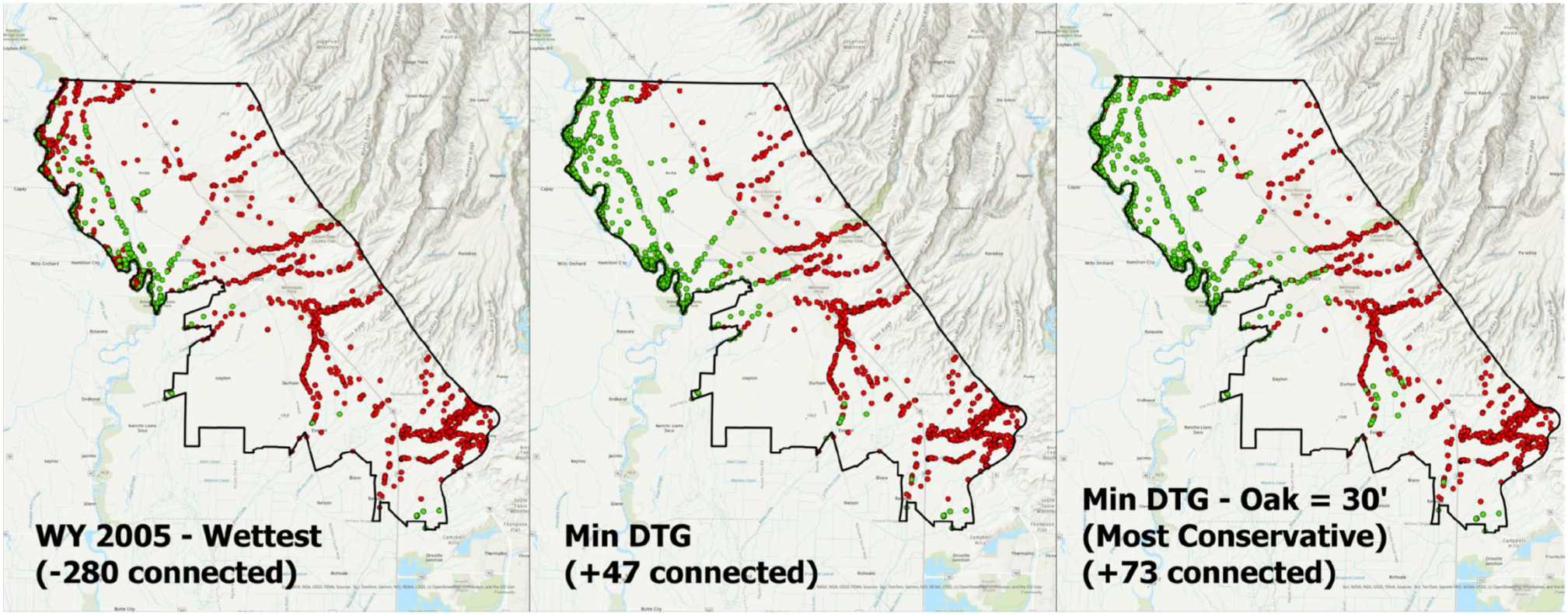

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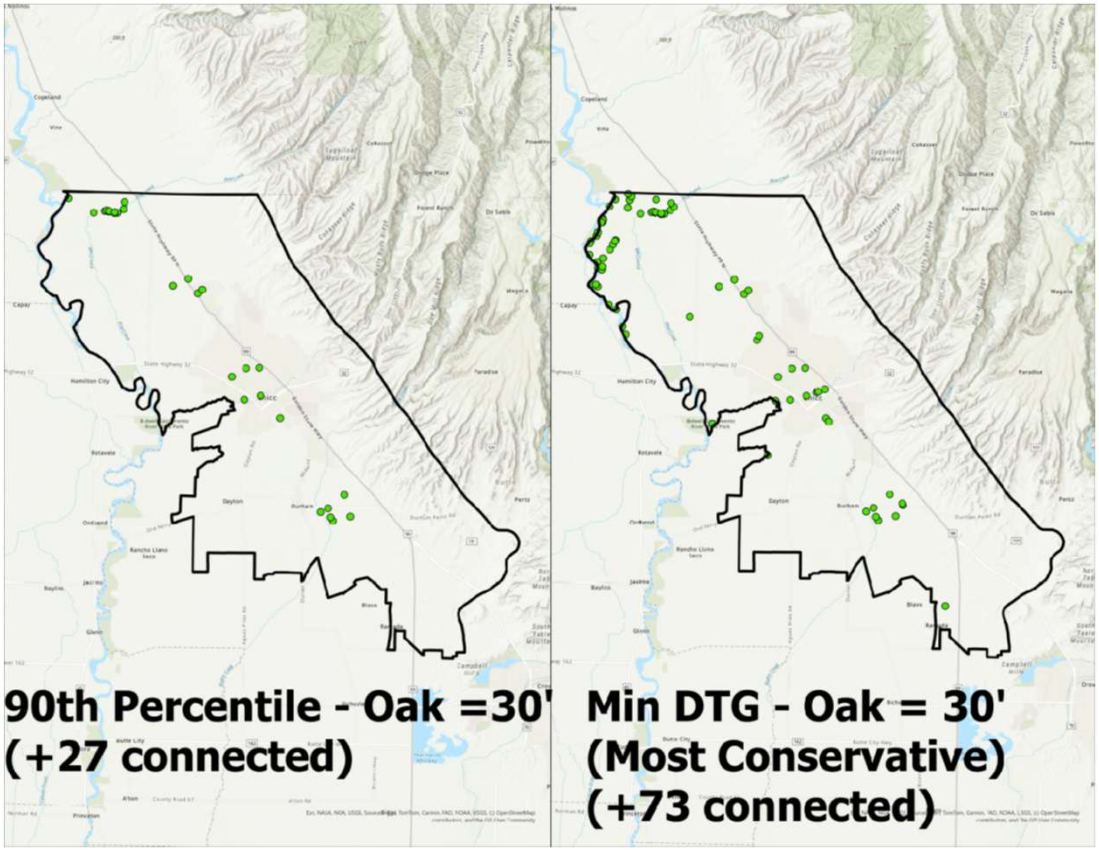

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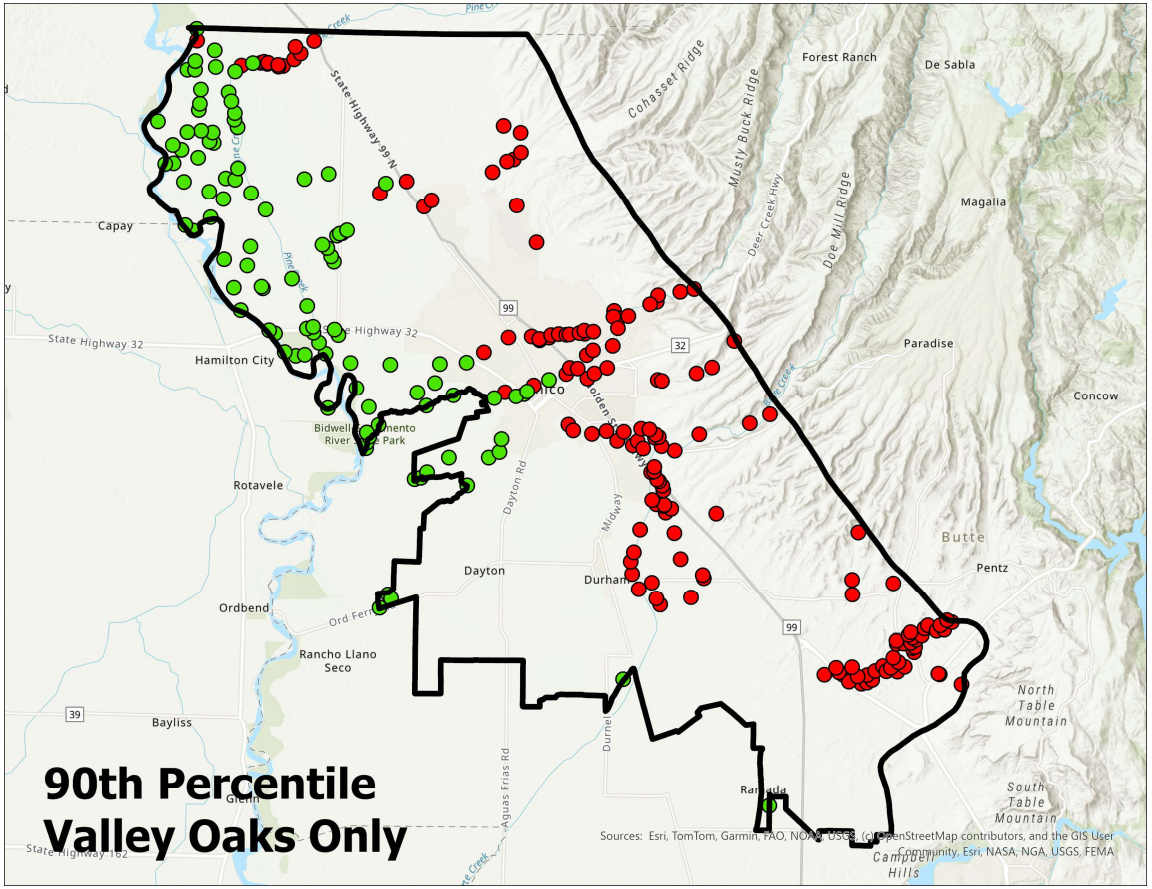
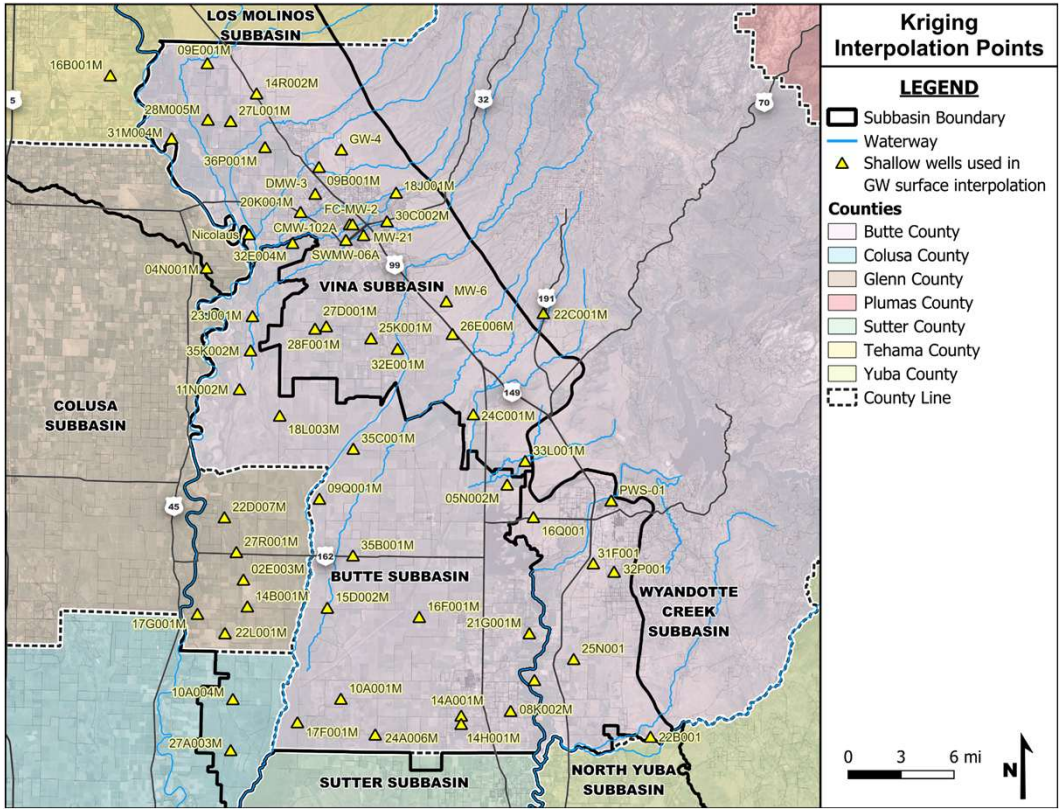
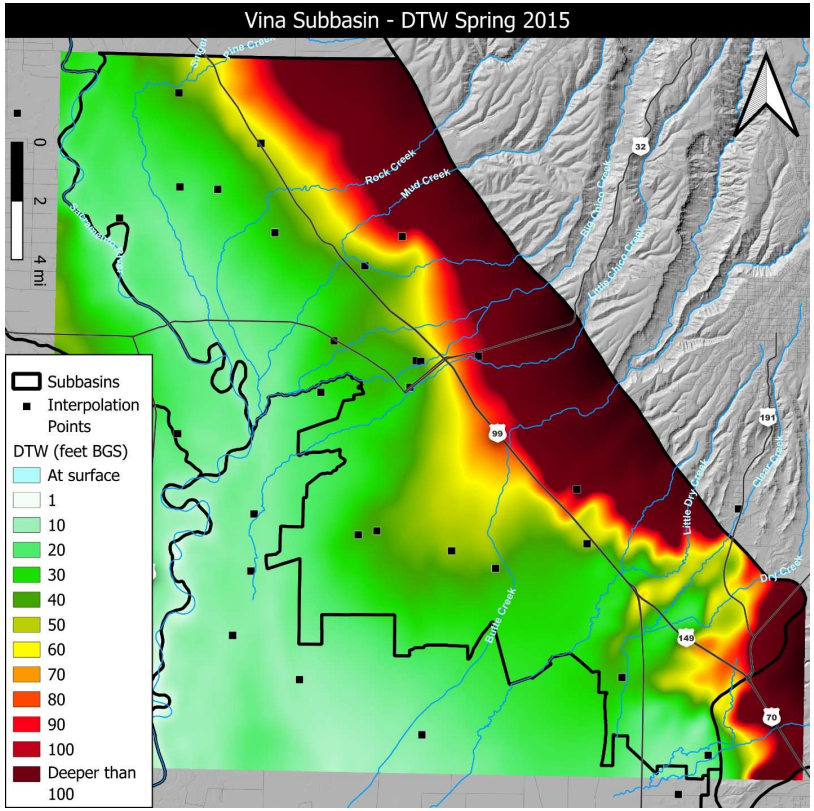
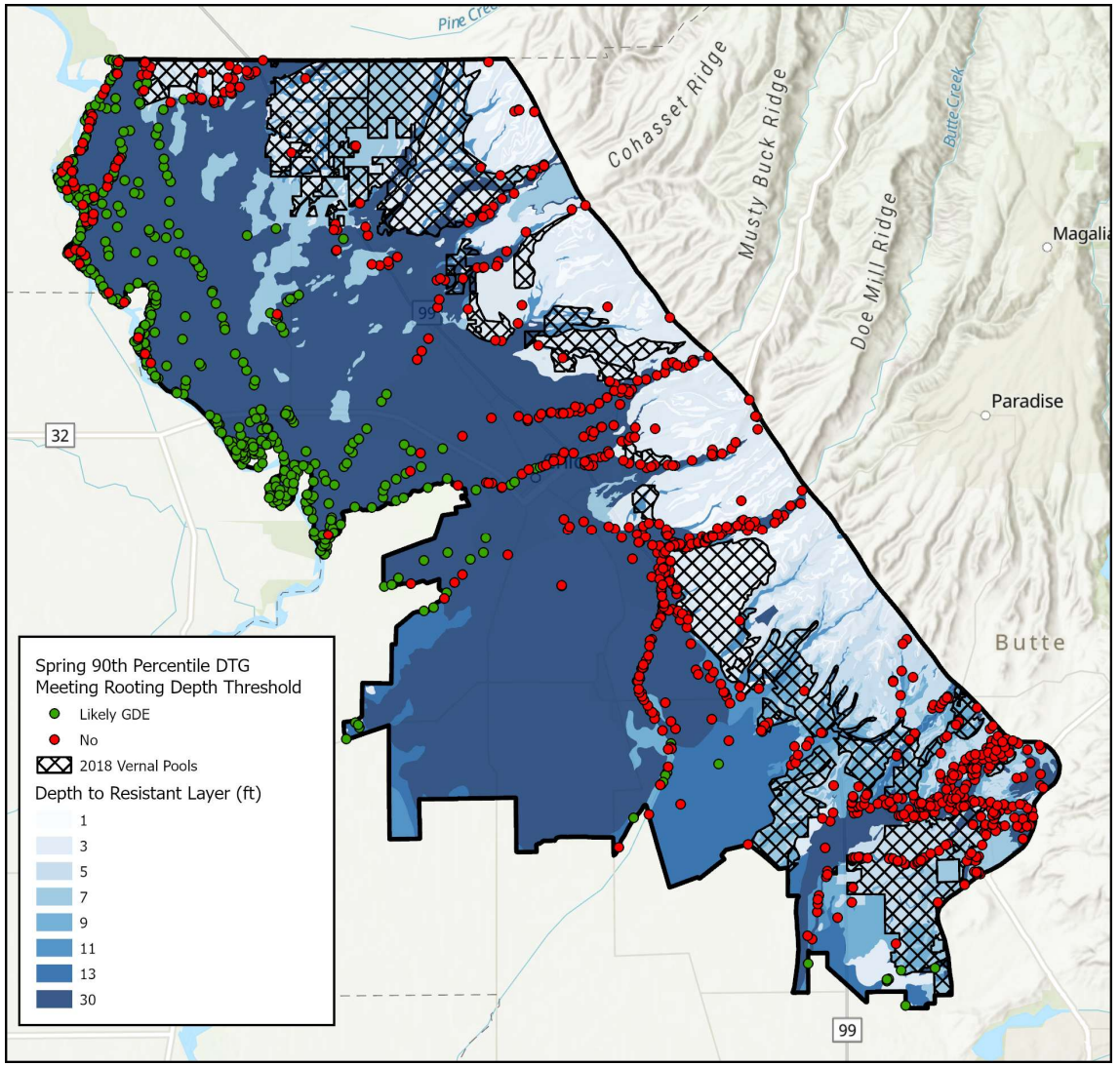


Results – Shallow GW Levels





Extra Slide – Resistant Soils and Vernal Pools

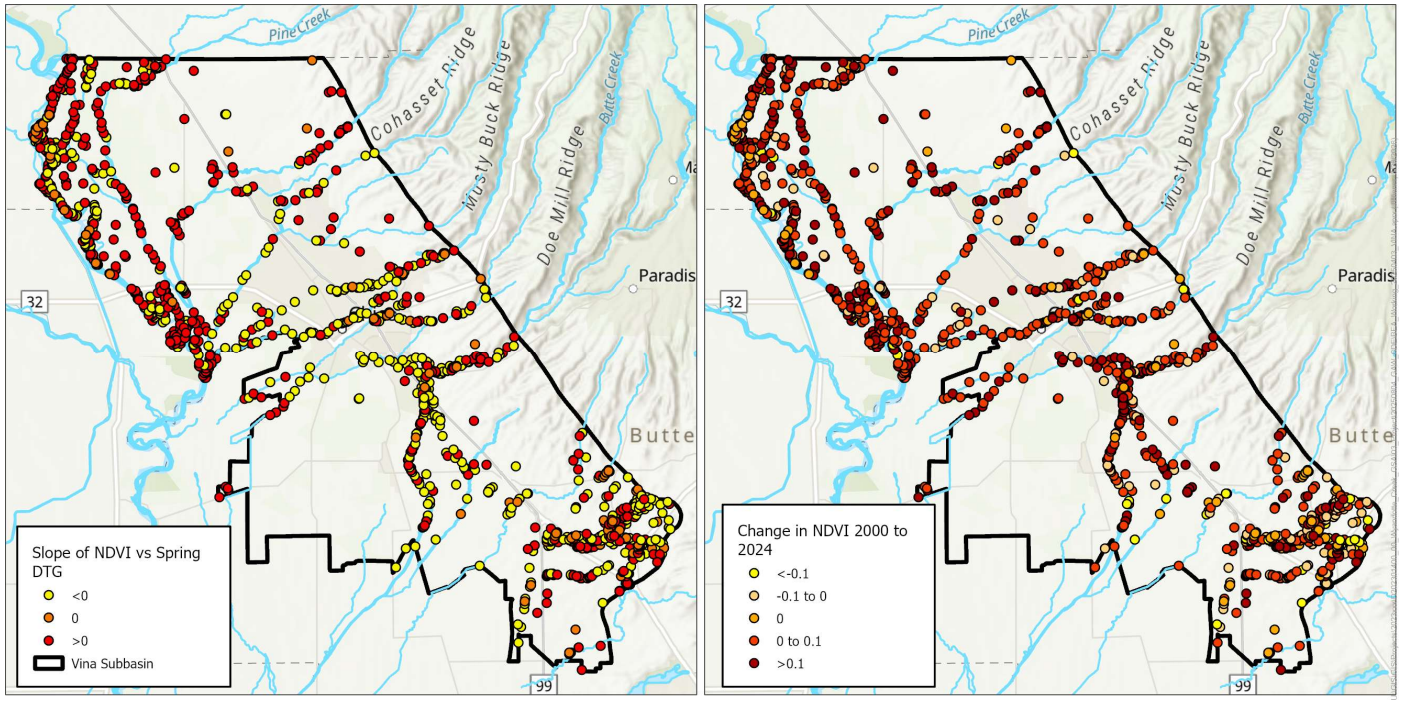


Extra Slide – Refined Mapping vs 2022 Vina GSP

COMPARISON OF LIKELY AND NOT LIKELY GDES IDENTIFIED IN THIS ANALYSIS AND 2022 VINA GSP

Counts		2022 Vina GSP GDE Mapping	
		Likely	Not Likely
Refined GDE Mapping	Likely	406	58
	Not Likely	640	124

Study Results – Regional GDE Assessment



Notes: Negative slopes indicate NDVI decreased as DTG increased and positive slope indicate NDVI increased as DTG increased.

Left Panel: Linear regression slope of NDVI vs spring DTG from shallow groundwater rasters at all potential GDEs from 2000 to 2024. Right Panel: Change in NDVI from 2000 to 2024 at all potential GDEs.