Sierra Valley GSP Groundwater Dependent Ecosystems

Christian Braudrick

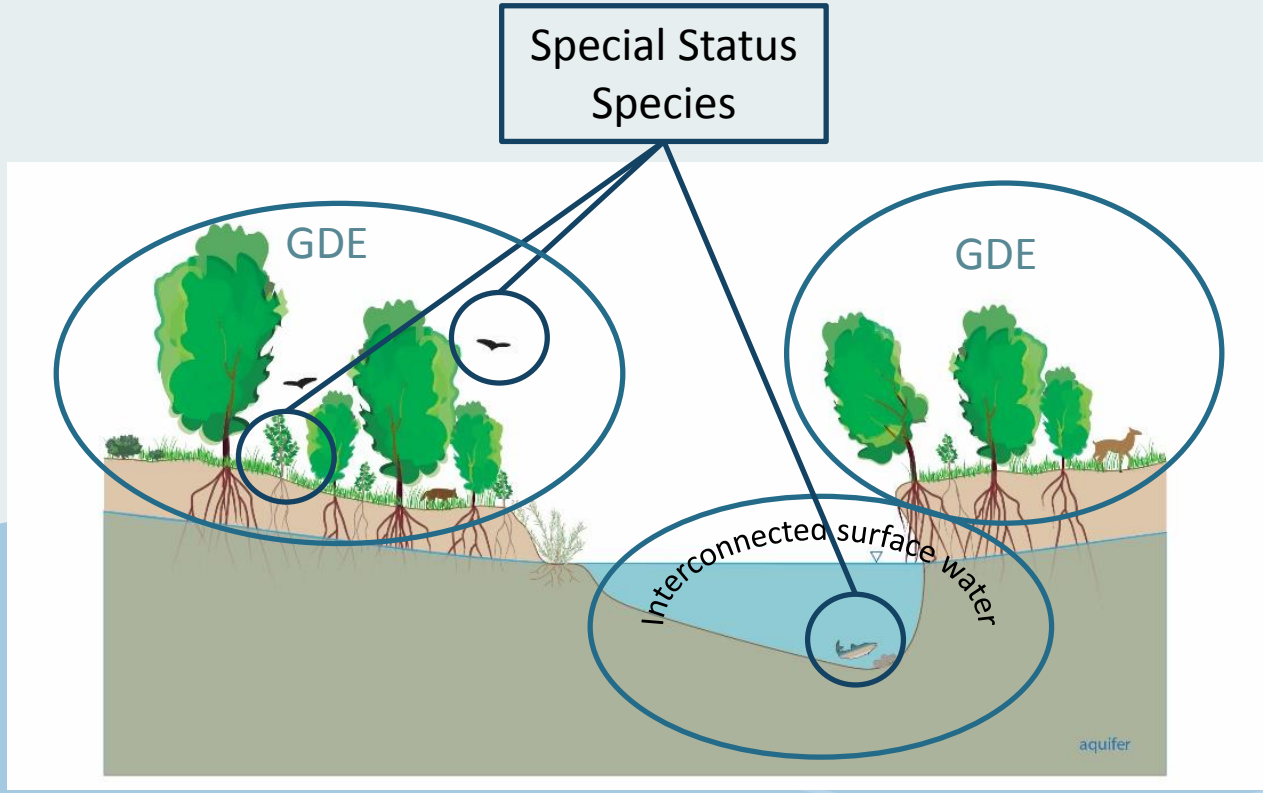
Stillwater Sciences

Outline

- What are GDEs
- Approach to mapping GDEs
- Source Data
- Preliminary GDE map
- Sensitive Species
- Assessing GDE change

Groundwater Dependent Ecosystems (GDEs)

DWR defines GDEs as ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface for some of their water needs.



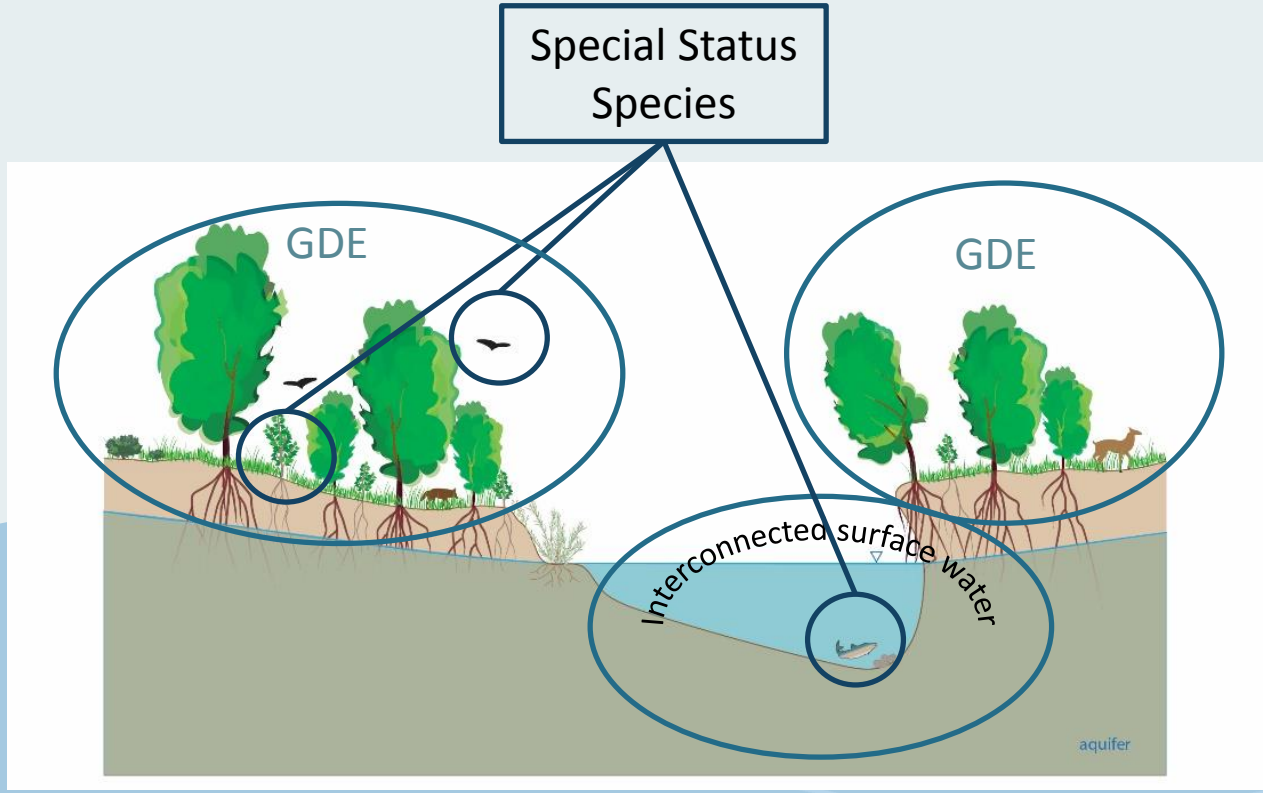
Braudrick et al., 2018 (figure by K. Rodriguez and A. Merrill)

GDEs occur in a variety of different environments ranging from seeps and springs, to groundwater-dependent wetlands, to aquatic and riparian ecosystems associated with rivers that partially or entirely rely on groundwater.

Why do we assess GDEs?

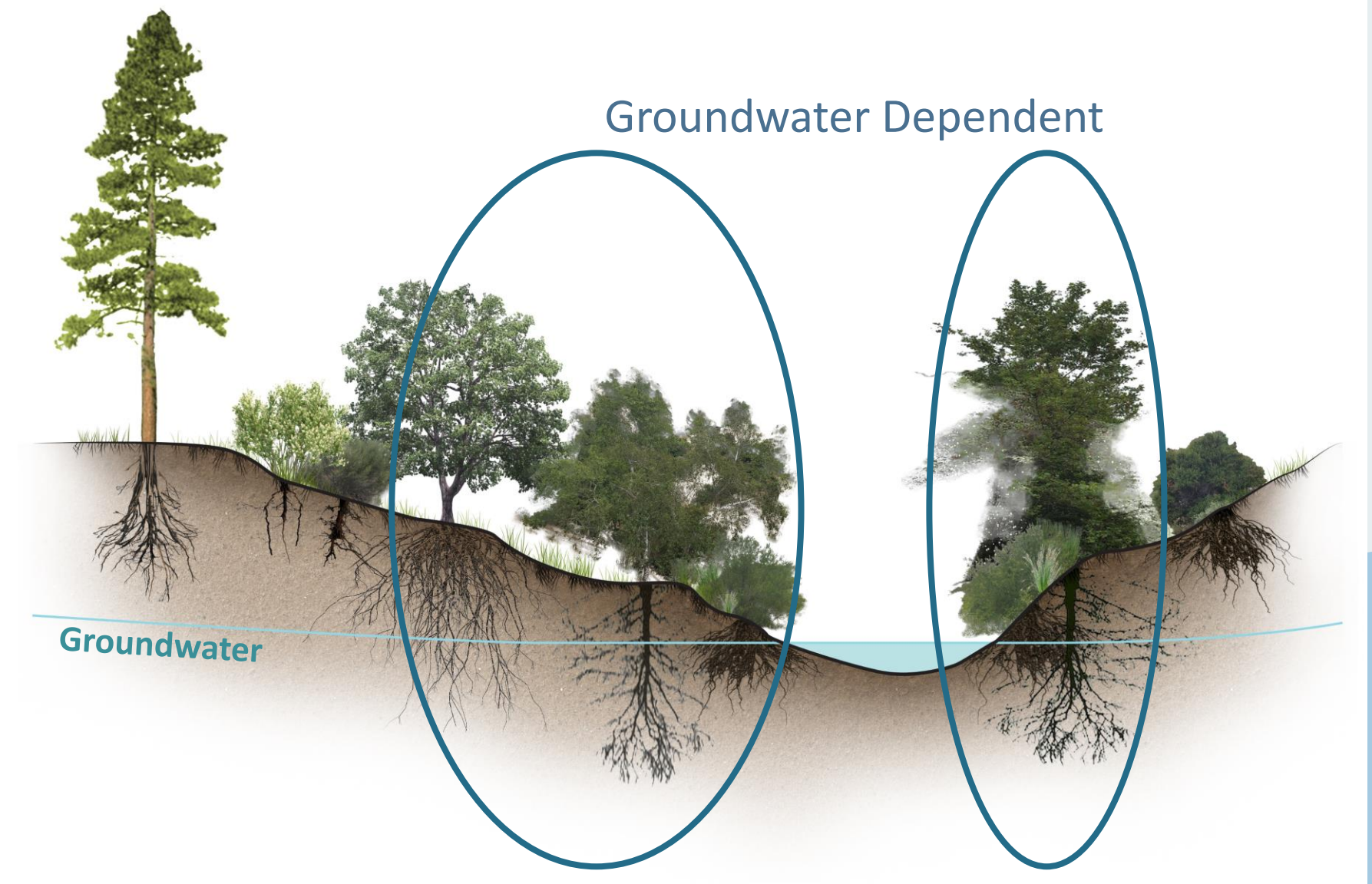
"SGMA requires that all beneficial uses and users, including GDEs, be considered in the development and implementation of GSPs (Water Code § 10723.2). The GSP Regulations include specific requirements to identify GDEs and consider them when determining whether groundwater conditions are having potential effects on beneficial uses and users."

-Rohde et al. 2018



Braudrick et al., 2018 (figure by K. Rodriguez and A. Merrill)

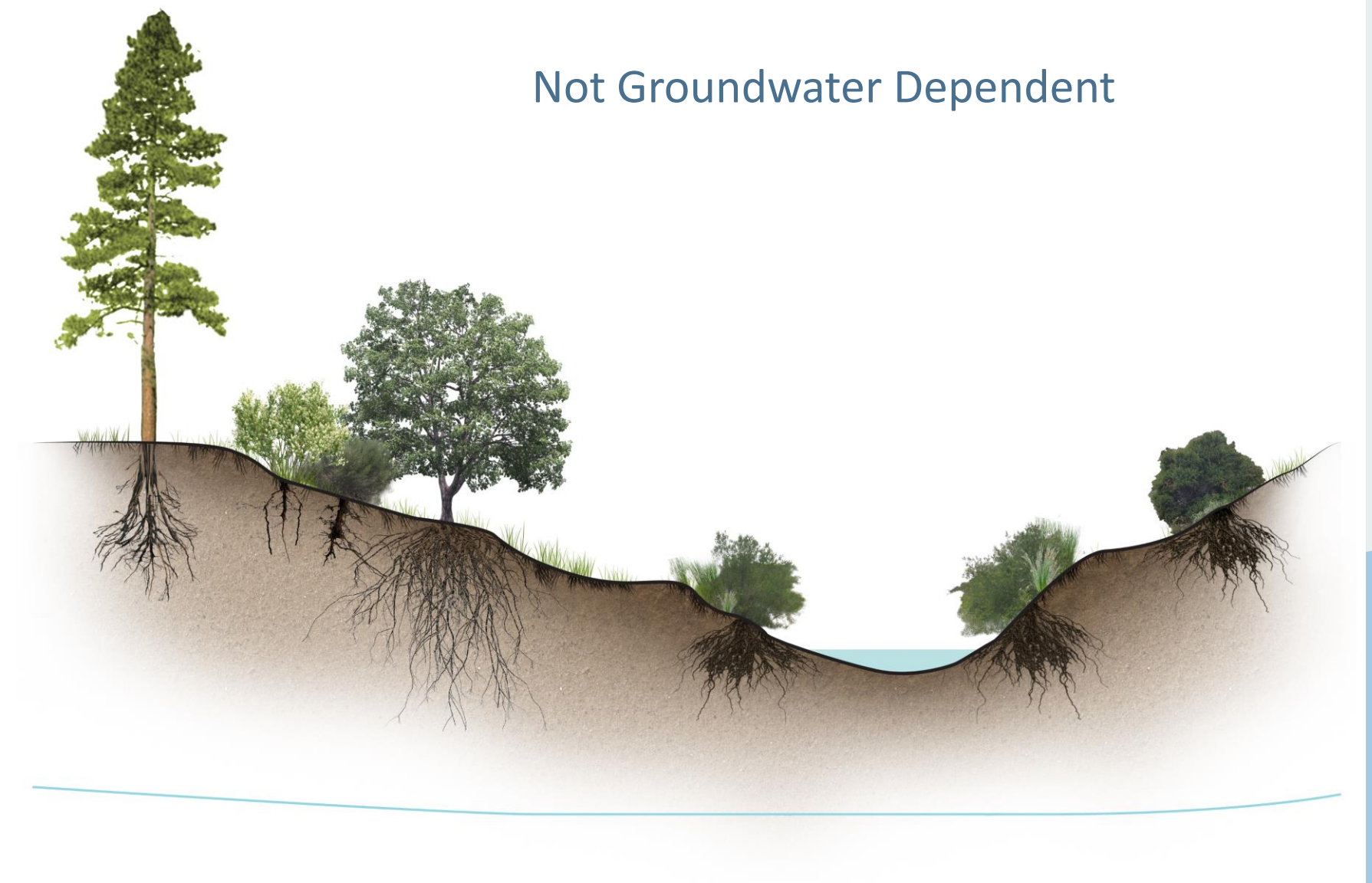
GDE Mapping: Where is the groundwater dependent vegetation in Sierra Valley



Based on species present plant communities can be:

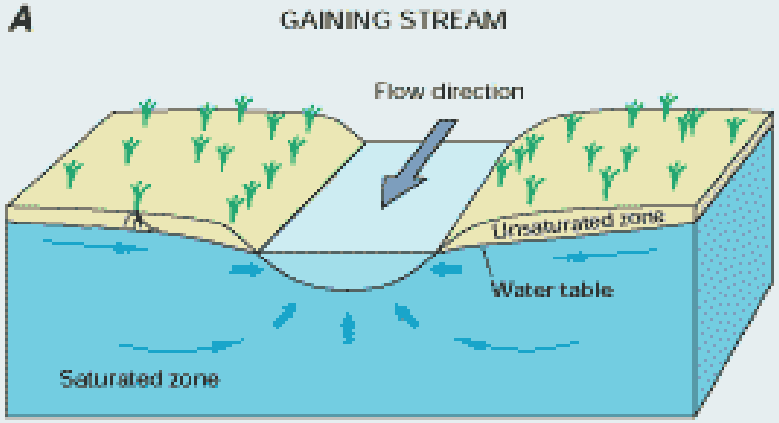
1. Dependent on groundwater
2. Potentially dependent on groundwater
3. Not dependent on groundwater

GDE Mapping: Some plants can rely on surface water or groundwater

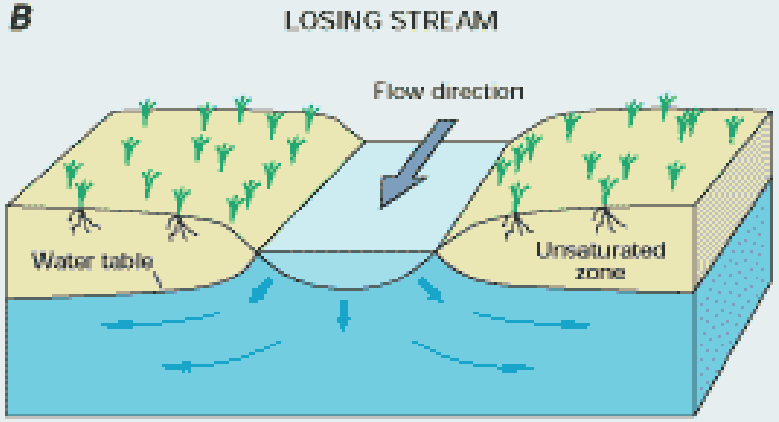


Plants rely on stream water or water in the soil

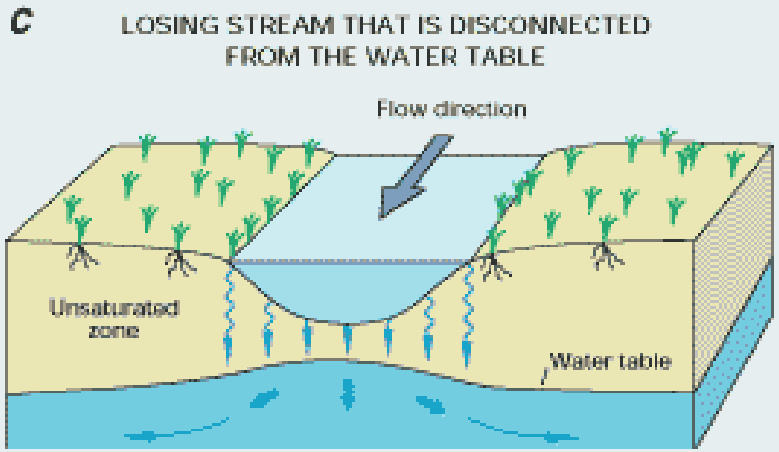
Interconnected surface water



Interconnected surface water



Surface water recharging groundwater

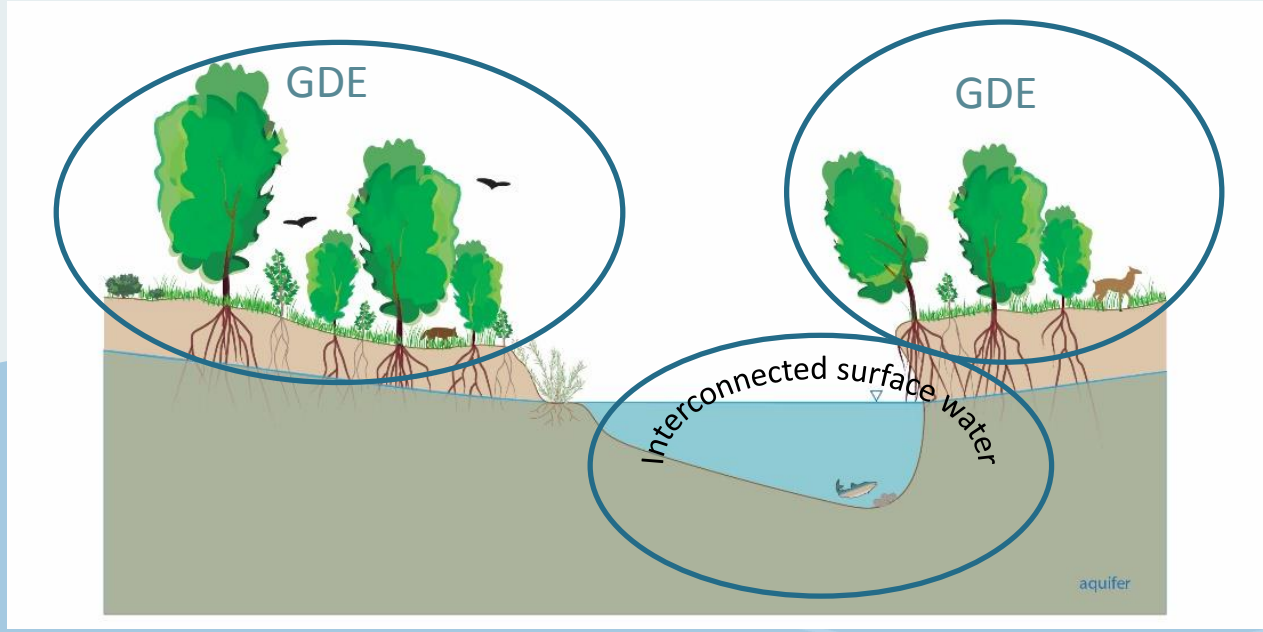


Disconnected (some recharge)

Interconnected surface water can be assessed using measurements of flow down a channel and/or groundwater-surface water models

Part 1. GDE Mapping

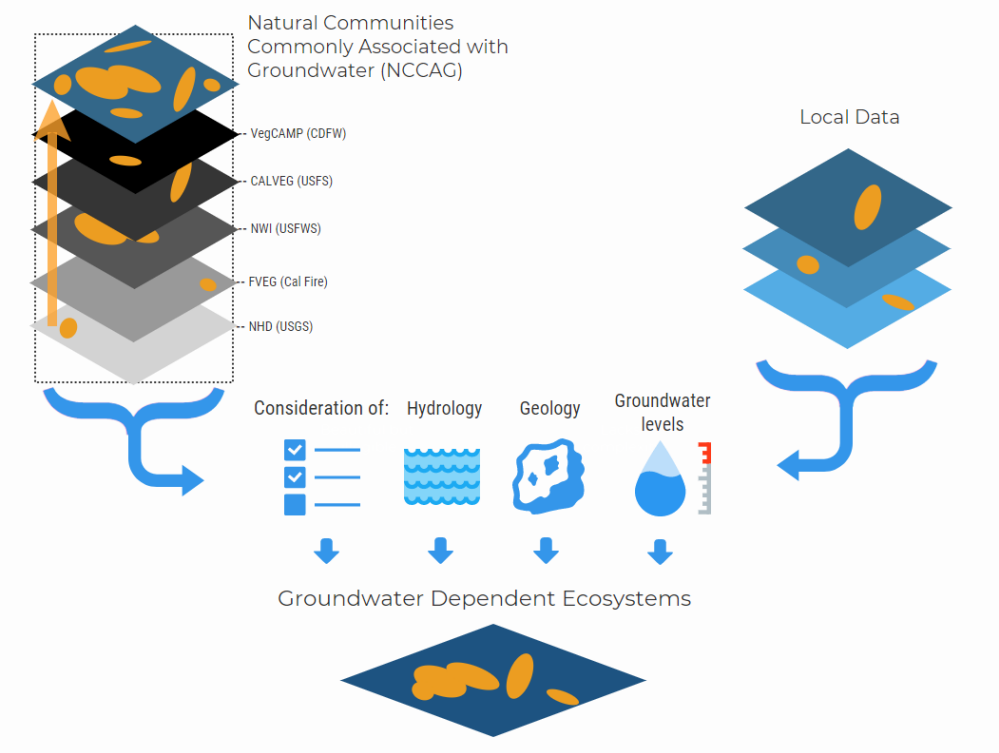
1. What plants occur in Sierra Valley Groundwater Basin?
2. Are the plant species likely to be connected to groundwater ?
   - How deep are their roots?
   - How deep is the groundwater?
3. What is the extent of interconnected surface water?

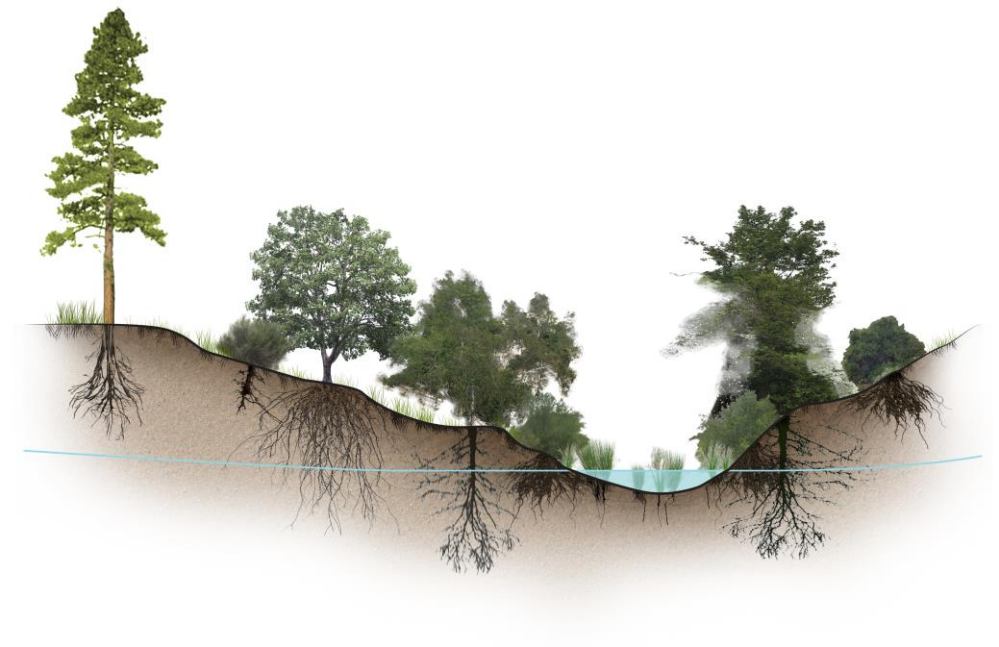


Braudrick et al., 2018 (figure by K. Rodriguez and A. Merrill)

Mapping Approach

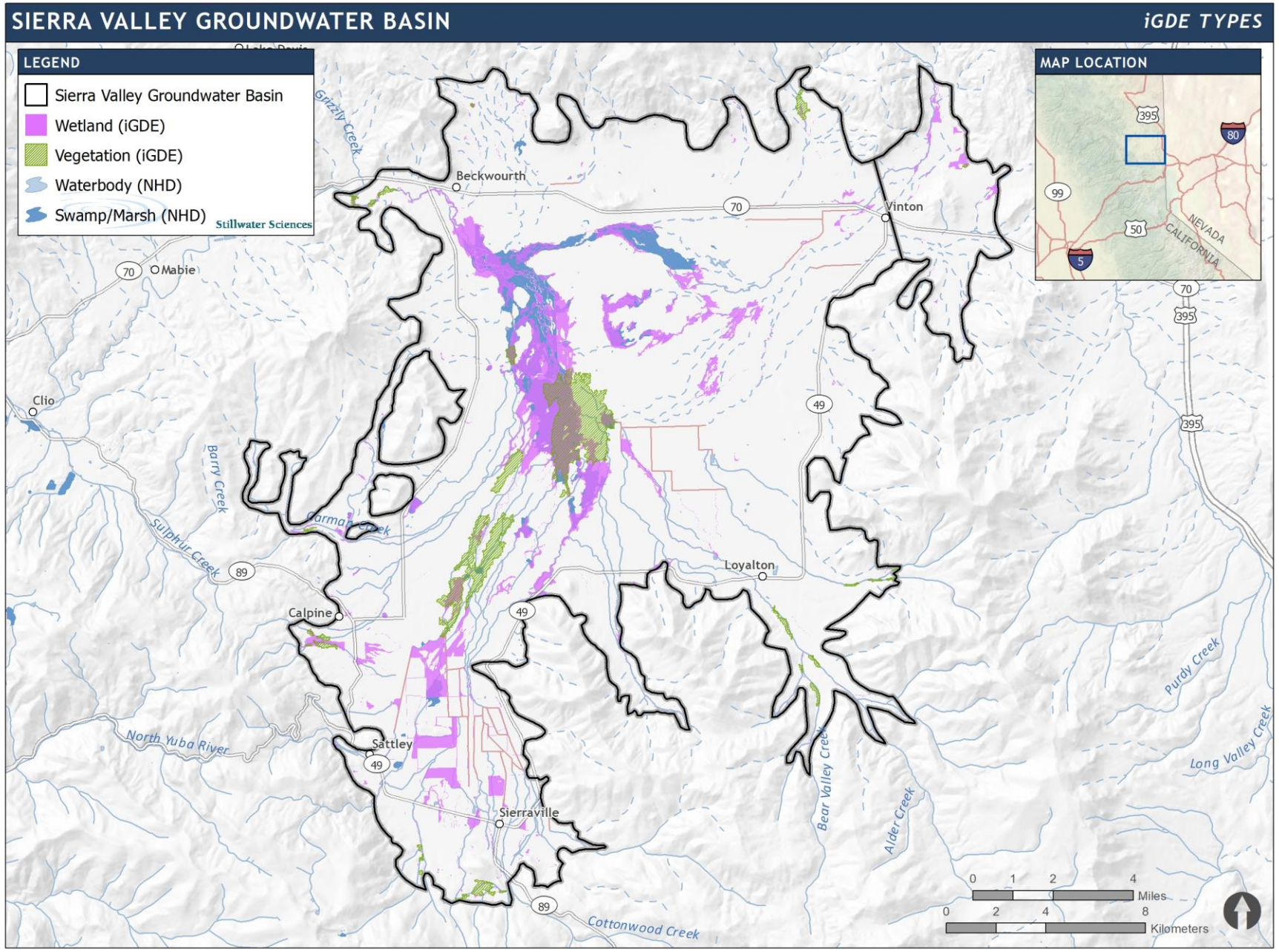
1. Overlay statewide vegetation maps (VEGCAMP, CalVeg, National Wetland Inventory, FRAP) based on map quality and age
2. Assess ***potential GDEs*** based on mapped vegetation type (e.g., phreatophytes)
3. Add local vegetation data not in DWR database and assess ***potential GDEs*** based on mapped vegetation type (e.g., phreatophytes)
4. Assess groundwater dependence of Potential GDEs based on
   - Species present
   - Measurements of depth to groundwater (if known)
   - Local geology, presence of springs, seeps
5. Create a single map of GDEs
6. Identify GDE units based on common hydrology





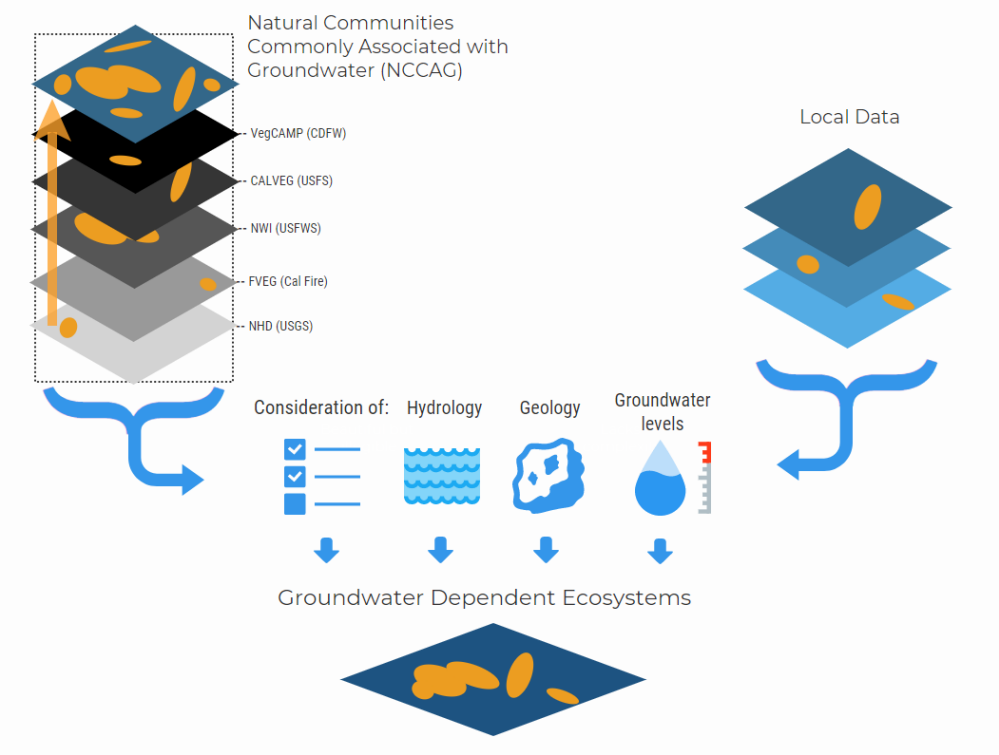
Potential GDEs

- CalVeg mapping was conducted in 2000
- NWI was conducted in 1984
- Potential GDEs based on vegetation type
- This map does not account for groundwater depth or other factors



Mapping GDEs in Sierra Valley

1. Groundwater data and interconnected surface water data are sparse, particularly near potential GDEs
2. Vegetation maps are somewhat old (CalVeg=2000 and NWI from 1984). A new vegetation map was being prepared but is currently on hold and won't be available until the 5-year update.

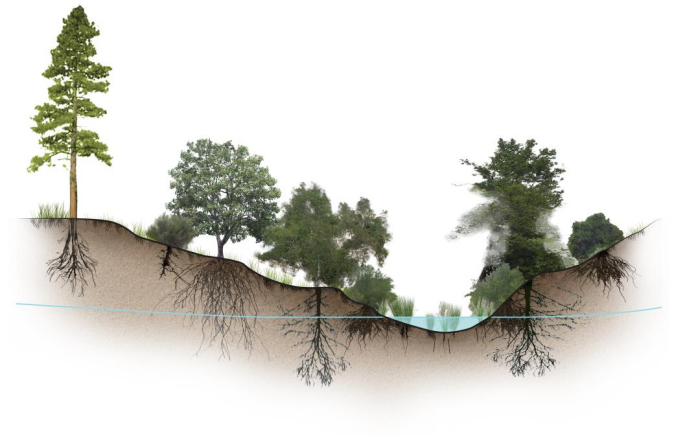


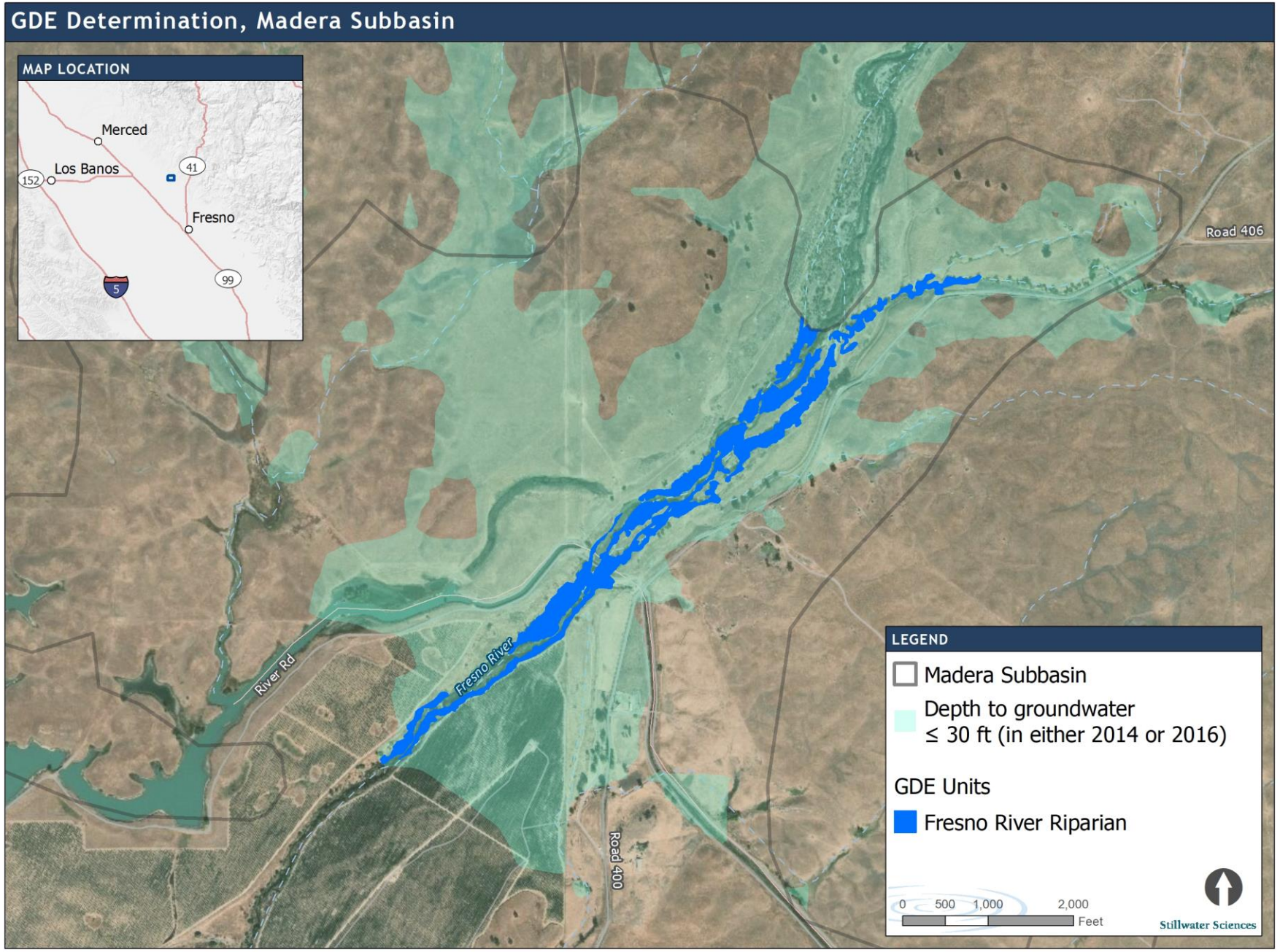
Next Steps

- We are currently reviewing the vegetation maps to assess groundwater dependence.
- Need to account for groundwater depth
- Need to define GDE units

GDE Determination

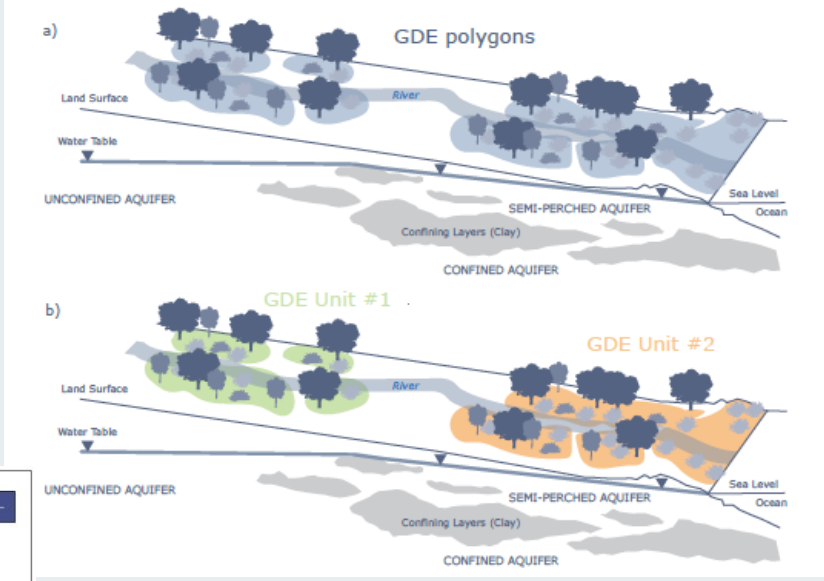
- Madera Subbasin Map GDEs where groundwater depth was < 30 ft and vegetation are potential GDEs

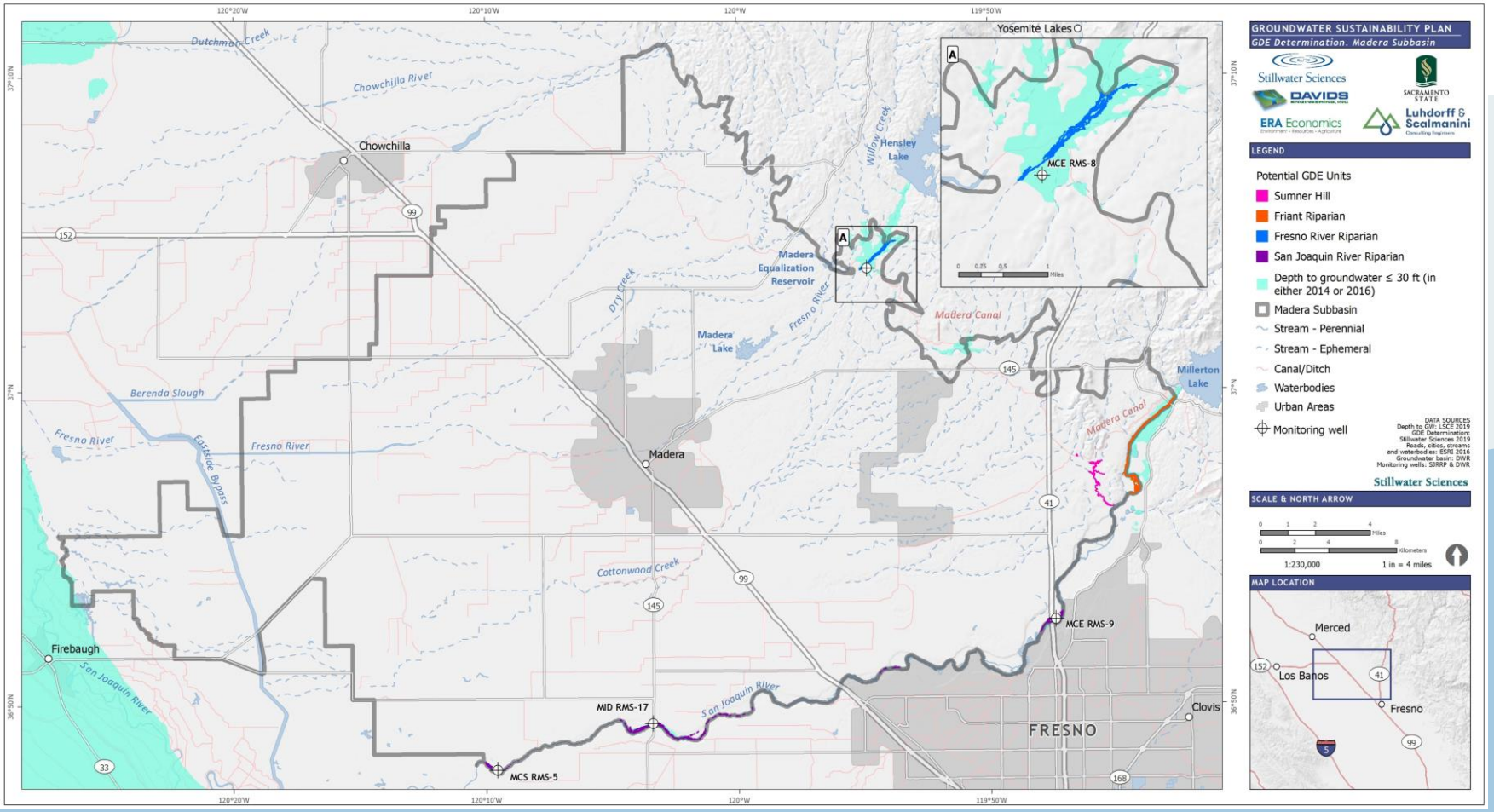




Assign GDE units

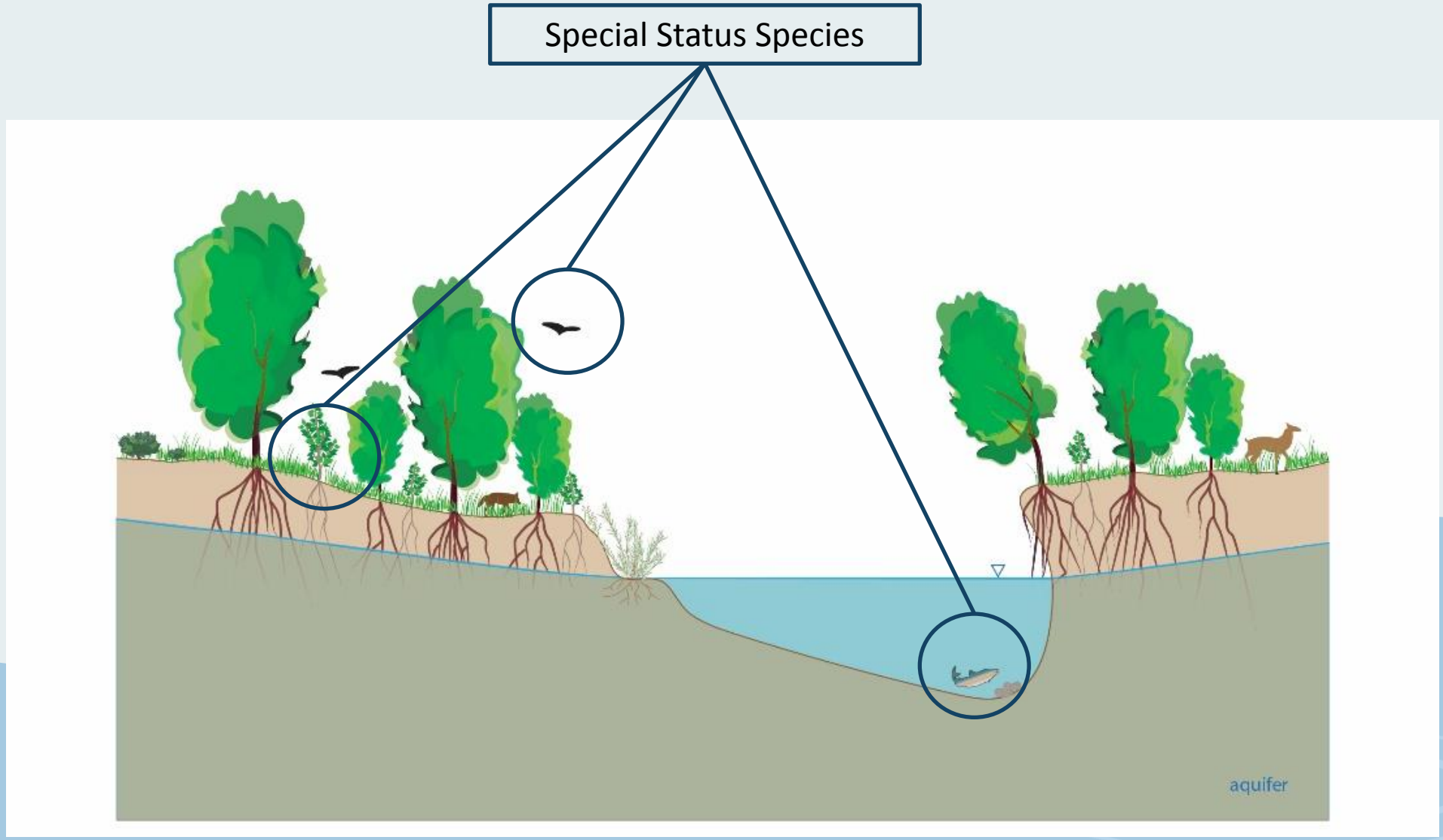
Identify GDEs with similar hydrological conditions to help assess the impact of potential management





Rhode et al. 2018

Part 2: Sensitive Species



Braudrick et al., 2018 (figure by K. Rodriguez and A. Merrill)

Sensitive Species

	Number of species
Plants	20
Invertebrates	3
Amphibians	4
Birds	15
Mammals	8
Mollusks	2
Total	**56**

Next Steps

- Determine the groundwater dependence of these species
- Assign to GDE units

What Special Status Wildlife Species are Present? (Draft)

Invertebrates	
Western bumble bee	Bombus occidentalis
Brownish Dubiraphian riffle beetle	Dubiraphia brunnescens
Pinnacles Optioservus riffle beetle	Optioservus canus

Amphibians	
Foothill yellow-legged frog	Rana boylii
Northern leopard frog	Lithobates pipiens
Southern long-toed salamander	Ambystoma macrodactylum sigillatum
Sierra Nevada yellow-legged frog	Rana sierrae

Birds	
American white pelican	Pelecanus erythrorhynchos
Bald eagle	Haliaeetus leucocephalus
Bank swallow	Riparia riparia
Black tern	Chlidonias niger
California spotted owl	Strix occidentalis occidentalis
Canvasback	Aythya valisineria
greater sandhill crane	Antigone canadensis tabida
northern goshawk	Accipiter gentilis
Redhead	Aythya americana
Swainson's hawk	Buteo swainsoni
Tricolored blackbird	Agelaius tricolor
Western least bittern	Ixobrychus exilis hesperis
Willow flycatcher	Empidonax traillii
Yellow rail	Coturnicops noveboracensis
Yellow-headed blackbird	Xanthocephalus xanthocephalus

Mammals	
American badger	Taxidea taxus
Fringed myotis	Myotis thysanodes
long-eared myotis	Myotis volans
pallid bat	Antrozous pallidus
Sierra marten	Martes caurina sierrae
Sierra Nevada red fox	Vulpes vulpes necator
Spotted bat	Euderma maculatum
Yuma myotis	Myotis yumanensis

Western pearlshell	Margaritifera falcata
Western ridged mussel	Gonidea angulata

Data sources:
California Freshwater Species Database (TNC 2021)
California Natural Diversity Database (CDFW 2020)

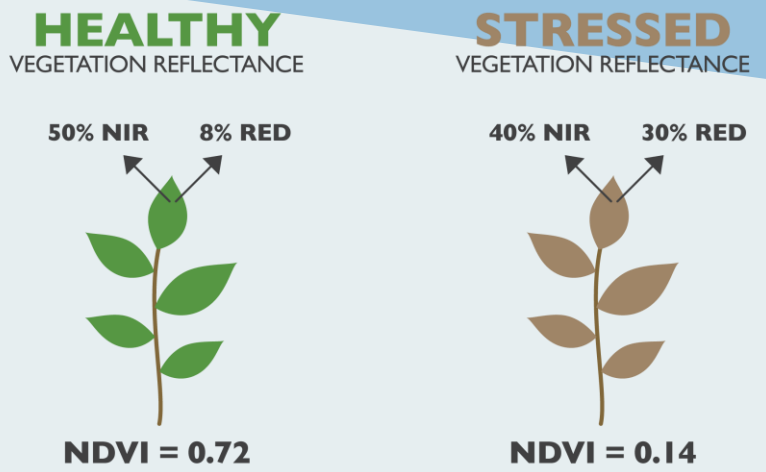
Tracking GDE Health

NDVI

Normalized **D**ifferential **V**egetation **I**ndex

How green are the plants?

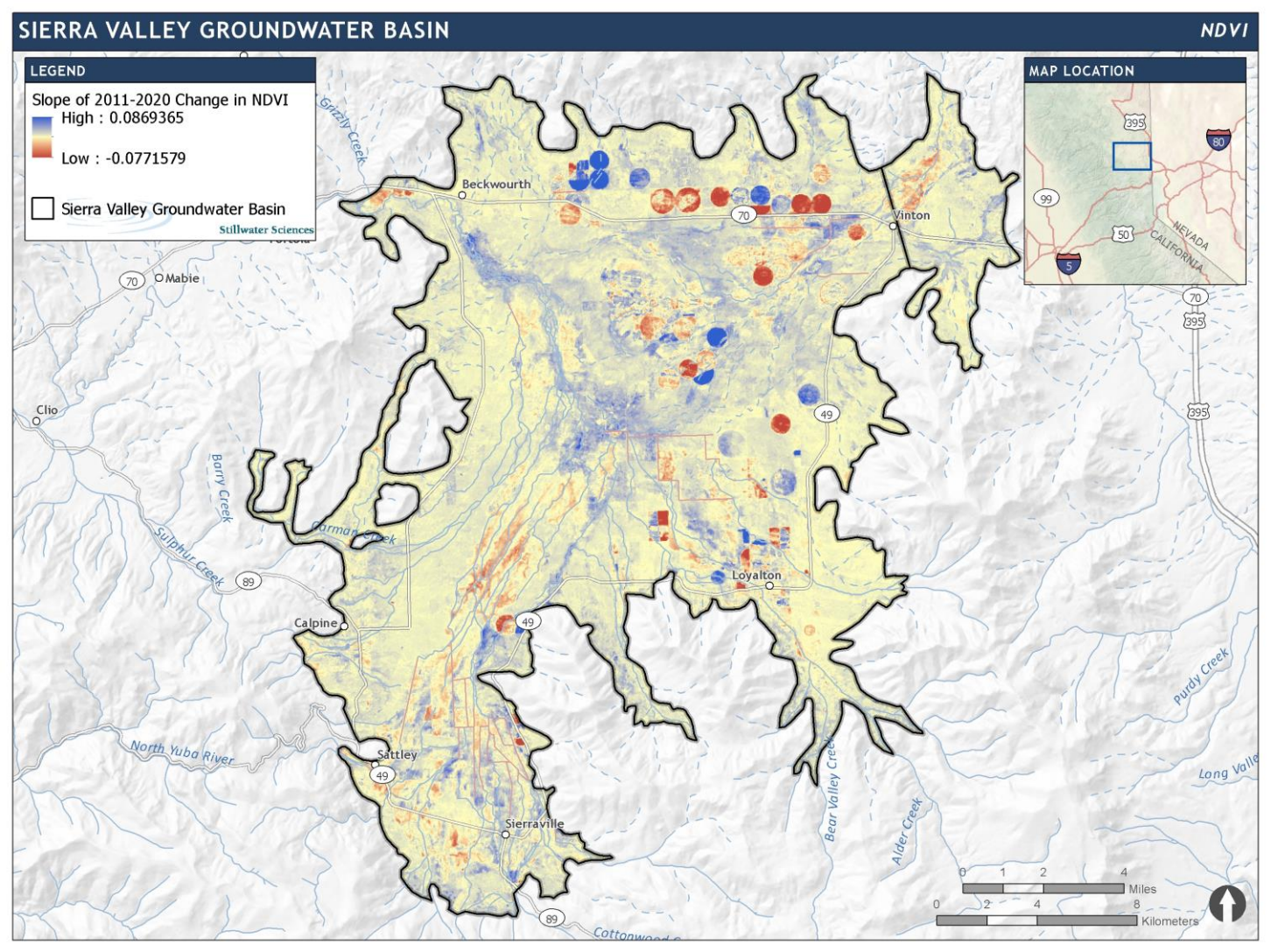
❖ Increases in NDVI correspond to higher plant density and leaf area



$$\text{NDVI} = \frac{\text{NIR} - \text{RED}}{\text{NIR} + \text{RED}}$$

Source: https://www.agricolus.com/en/indici-vegetazione-ndvi-ndmi-istruzioni-luso/

Tracking GDE health: NDVI change from 2011-2020



- Summer (July-September) NDVI from Landsat imagery
- 30-m resolution
- Data Processed in Google Earth Engine

Preliminary data for illustrative purposes only

Summary

- Vegetation mapping is fair quality, a new map might be available by the 5-year update
- We are currently adapting the GDE map to refine groundwater dependent vegetation based on species composition, interconnected surface water extent, and groundwater elevations.
- GDEs are concentrated in the western half of the basin
- There are 56 sensitive species in the basin, we are currently determining their groundwater dependence
- Remote sensing data can be used to assess changes in GDE health

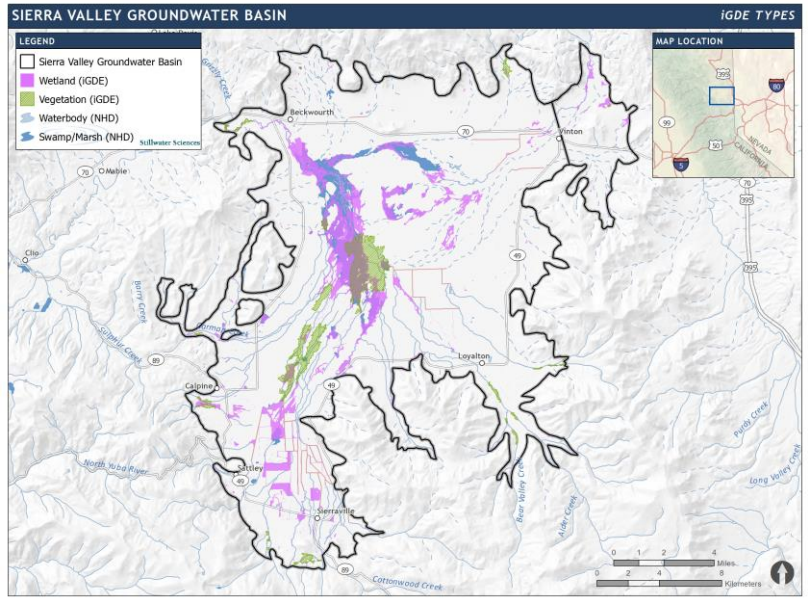
Next Steps

Mapping GDEs

- Compare potential GDE map with groundwater depth
- Finalize the GDE map
- Assess rooting depth of mapped vegetation
- Identify GDE Units
- Track changes in NDVI through time

Special Status Species

- Determine groundwater dependence based on scientific literature.



Thanks