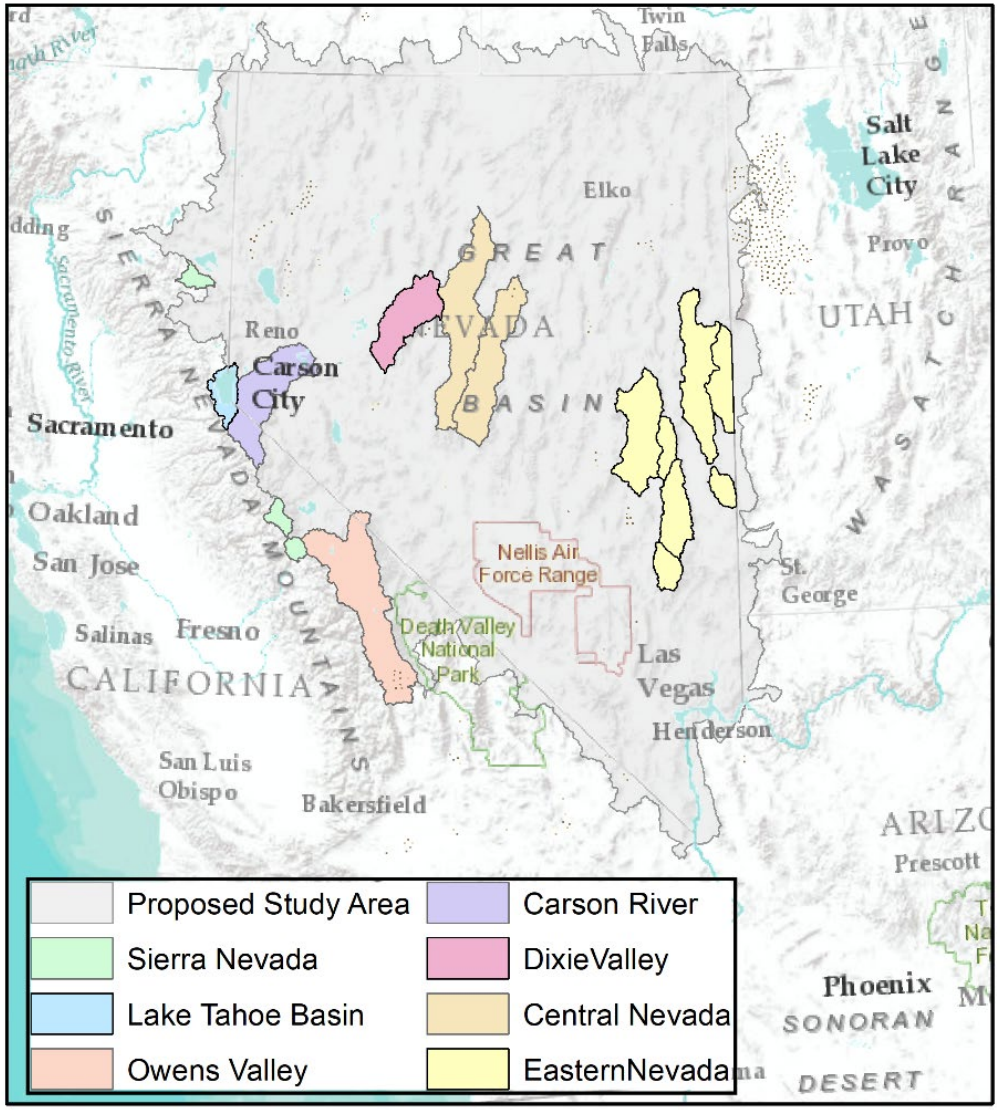
Approach and Research Design

Dixie Meadows, NV (Christine Albano, DRI)

Approach

- Develop and test mechanistic models of GDE root water uptake and biomass production
  - Generate estimates of water needs for range of GDE types and environmental settings
  - Assess GDE sensitivities to changing GW availability
  - Translate results into useable framework

Study area and locations with field data that may be used for the project

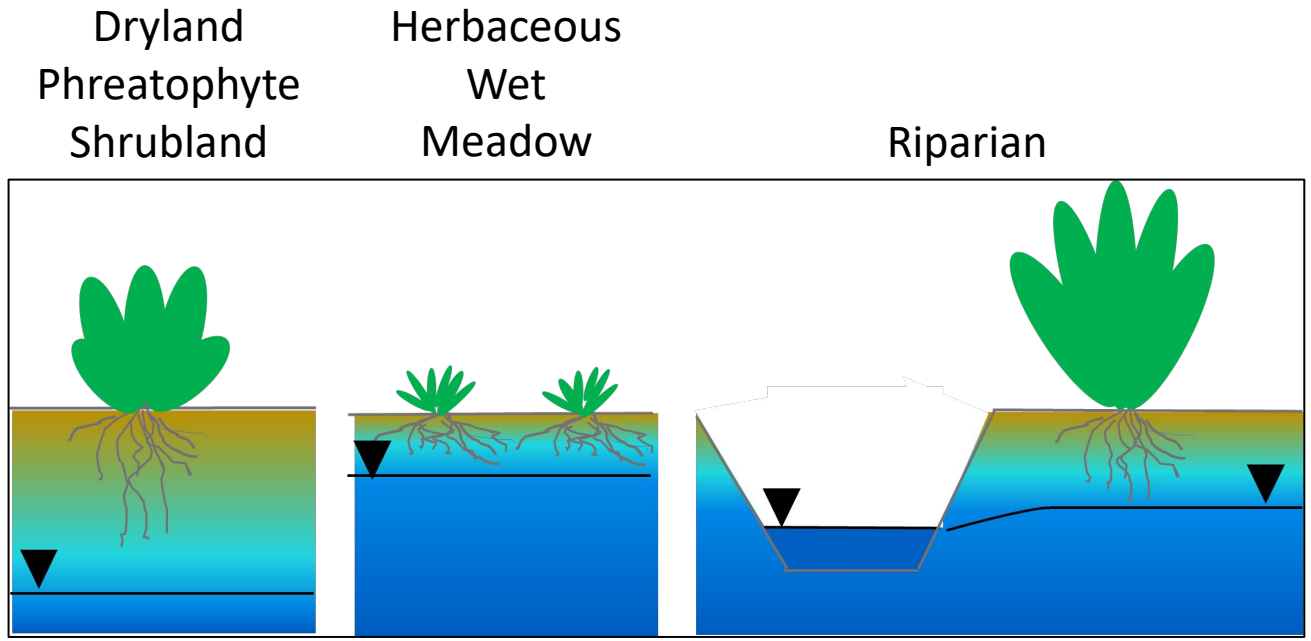


Proposed Research Design

- Model 3 GDE archetypes
- 3-5 models each, spanning gradient of environmental settings

Wetter ⟷ Drier Climate
Coarse/Shallow ⟷ Fine/Deep Soils

GDE Archetypes:
characteristic soils, species traits, ranges of GW depths



Adapted from illustration by J Huntington

Modeling Approach

(Lowry and Loheide 2010)

Model Inputs

Meteorological Obs

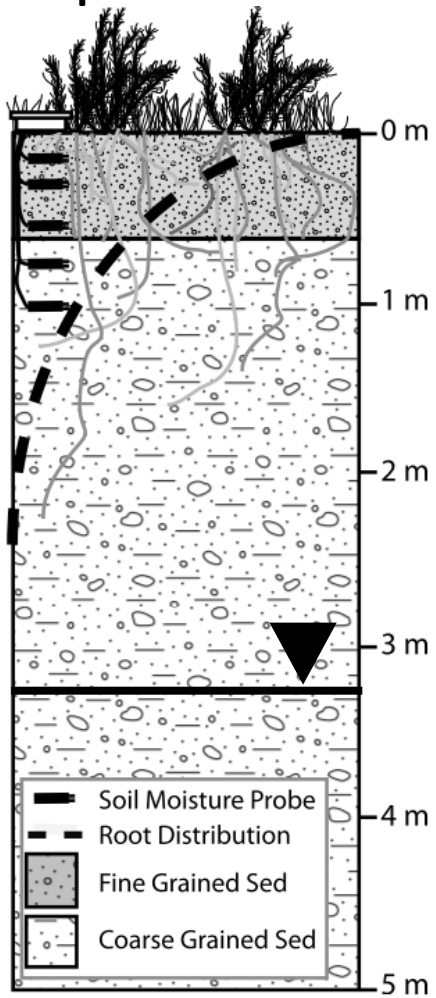
Physical Parameters based on soils, roots, vegetation attributes

θ_s θ_r λ b

ϕ S ψ K

Groundwater Level Obs within GDE

1-D Root Water Uptake Model



Model Outputs

ET_{total}
ET_g
Prd

Compare to free-draining scenario

GW_{sub} { ET_{total}, ET_g, Prd }

Model Validation

Field observations:

- vegetation cover/productivity
- soil moisture
- ET
- Stable isotopes

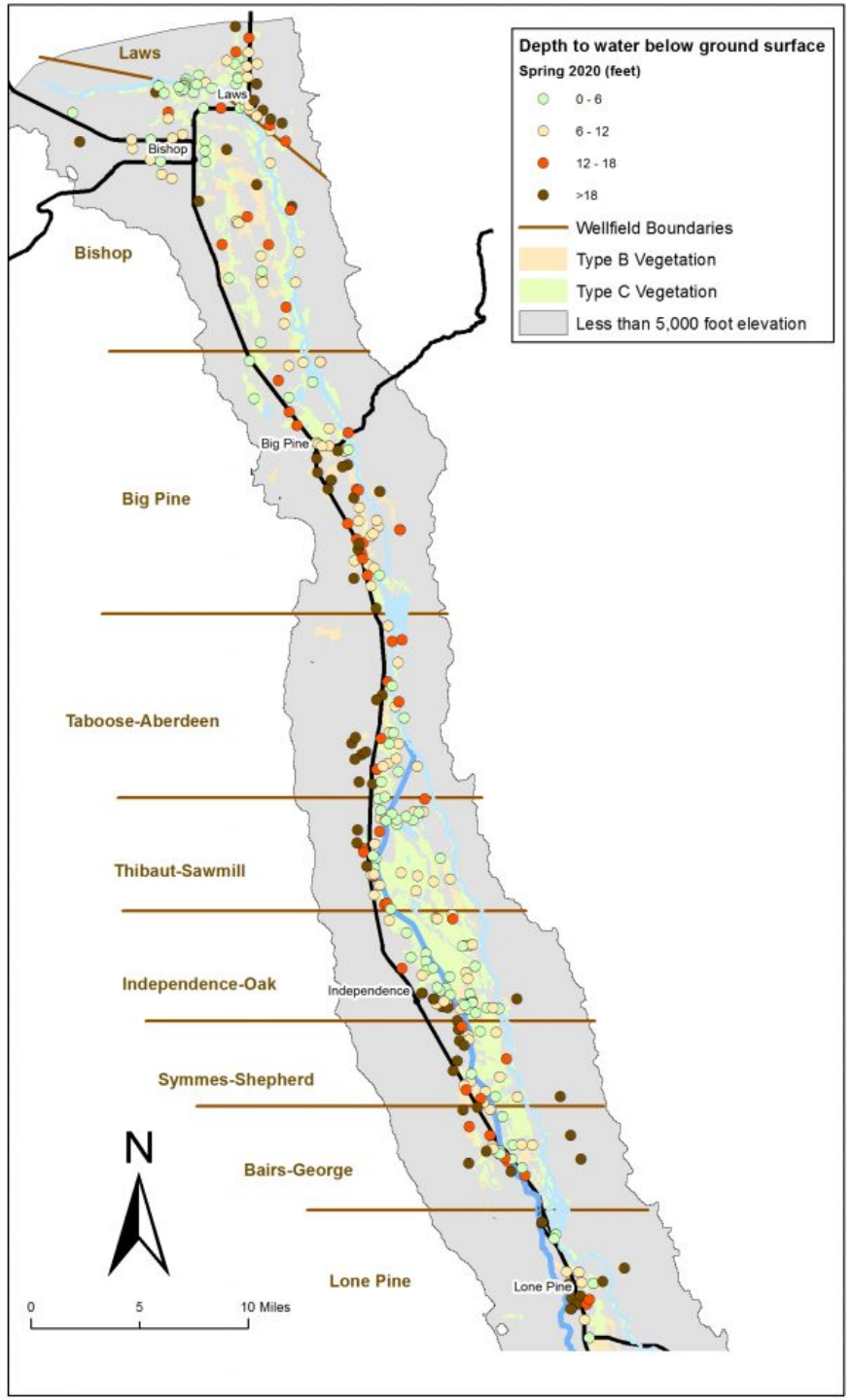
Remote sensing

Model Transferrability Assessment

Apply models to new sites and assess performance

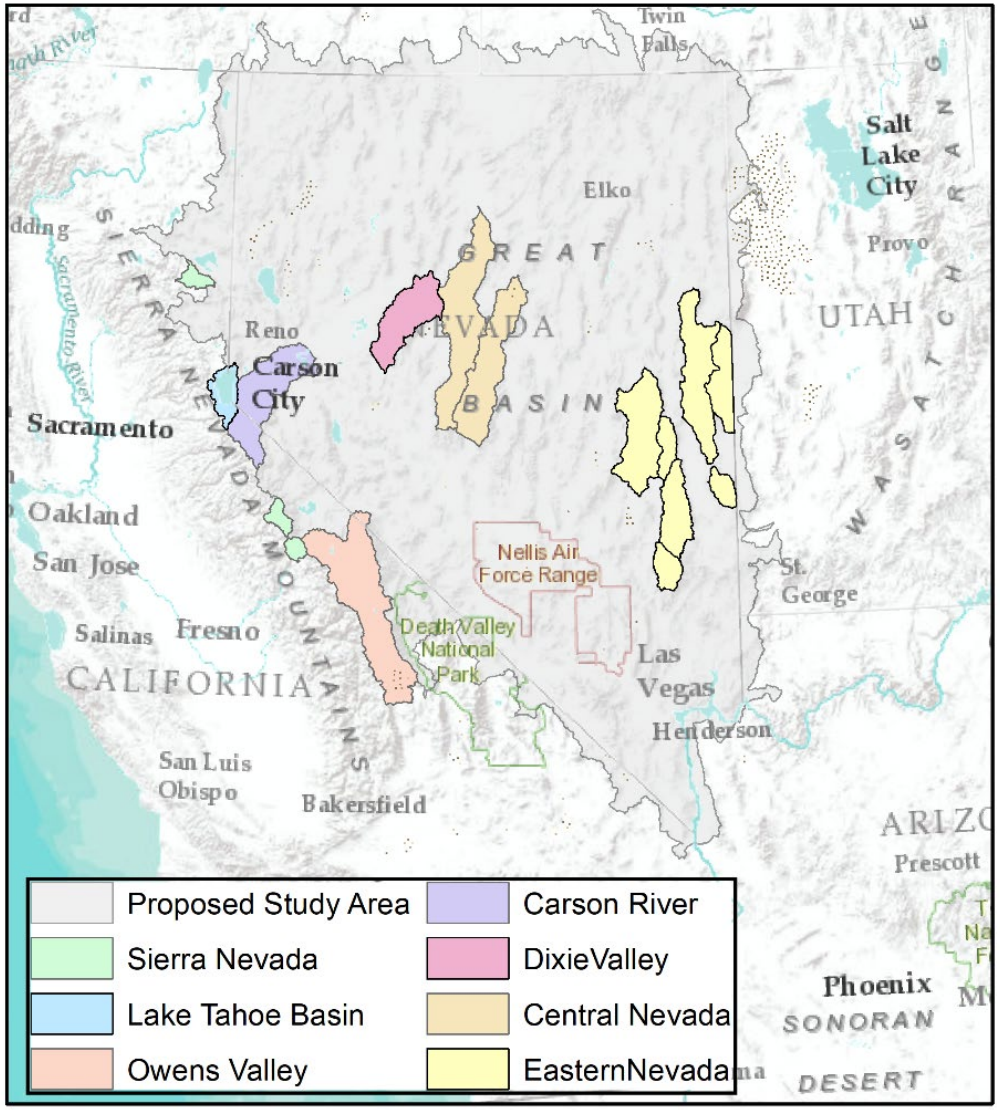
Owens Valley – Inyo County Water Dept.

- 28 core monitoring sites
  - Soil moisture (to 2 m; monthly)
  - Depth to water (monthly)
  - Vegetation (annual)
- Several hundred additional sites
  - Groundwater levels
  - Parcel vegetation
- ~1985 to present
- Classified as Riparian, GDE shrubland, GDE Meadow



Other Key Datasets

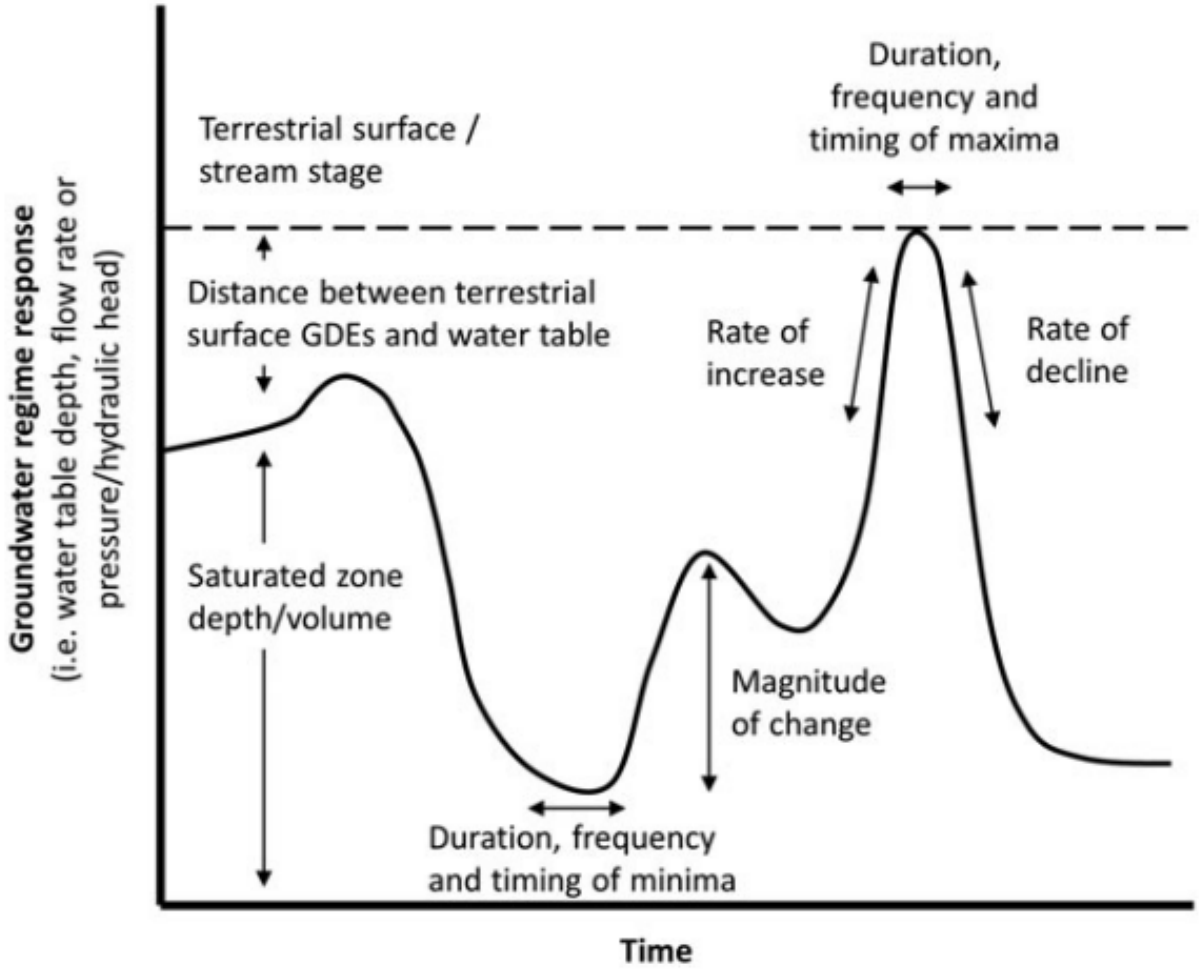
- Lake Tahoe Basin – Upper Truckee
- Sierra Nevada
- Dixie Valley – USGS/DRI studies
- Central NV montane meadows
- Eastern NV



The Natural Flow Regime

- Primary control on river ecosystem structure and function (Poff et al. 1997)

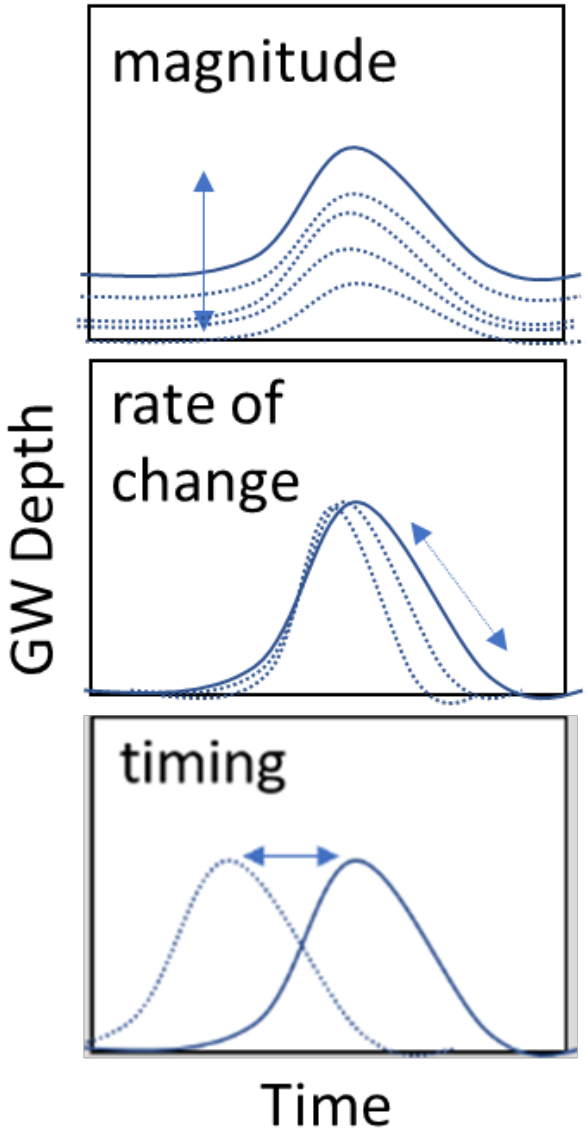
- Similarly applies to GDEs (Kath et al. 2018)
  - Germination
  - Establishment
  - Growth
  - Species Distribution



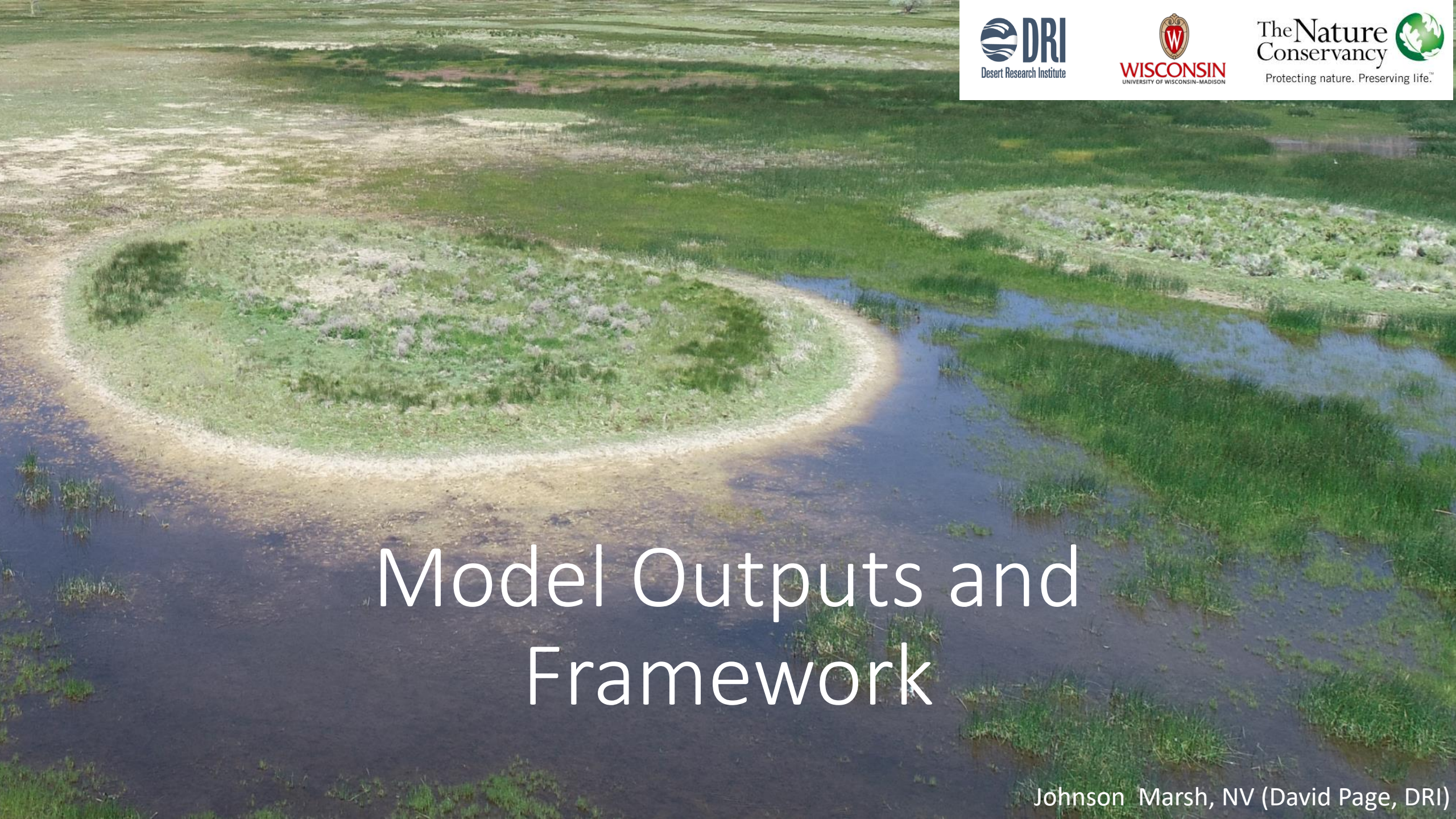
Kath et al. Ecohydrology **2018**, *11:e2010*; **https://doi.org/10.1002/eco.2010**

Model Scenarios of Changing GW Availability

- Quantify Model Outputs (GW_{sub}, Et_g, Prd) as functions of incrementally varying:
  - GW depths (magnitude)
  - Drawdown rates (rate of change)
  - Seasonality (timing) of GW availability



Model Outputs and Framework



Johnson Marsh, NV (David Page, DRI)

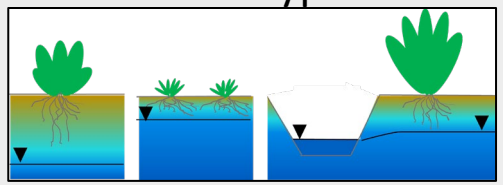
Objectives

- Synthesize existing data and knowledge into framework:
  - enables prediction to unsampled locations based on readily available characteristics
  - translated into tool accessible to managers

Hot springs at
River Fork Ranch (B. Bushman)

~10,000 simulations 1-D Root Water Uptake (RWU) Model

GDE Types



X

Soil texture/
layering schemes

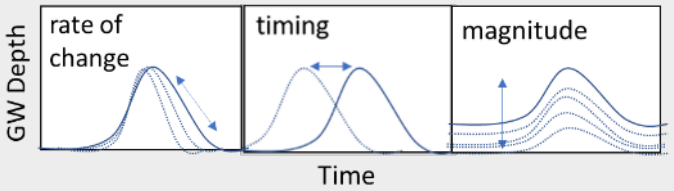
X

Climate Types

Wetter ↔ Drier

X

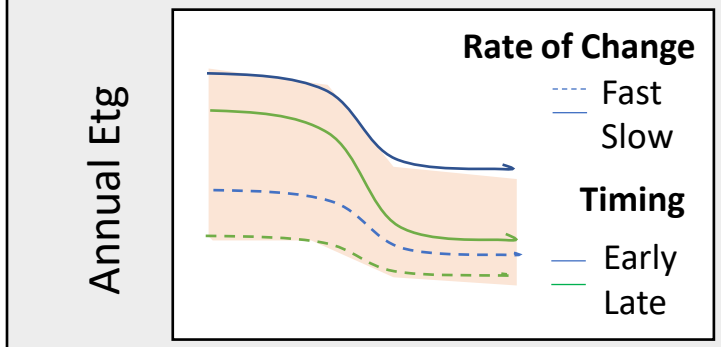
GW Regime Scenarios



Use Synthetic Dataset to Train Predictive Regression Models

RWU Model Inputs
=
Predictor Variables

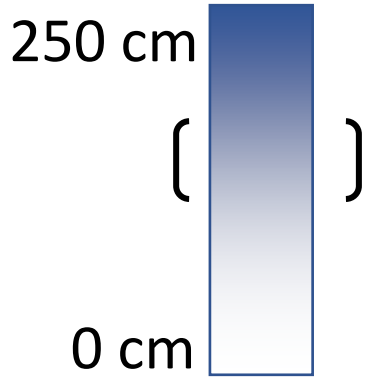
RWU Model Outputs
=
Response Variables



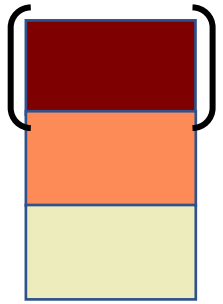
Groundwater Requirements for GDEs Framework

1. User identifies GDE and its attributes using readily available data
   - Type (wet meadow, etc)
   - Soil texture/depth (field obs, GIS data)
   - Climate (Precip/Potential ET; station or gridded)
   - Depth to GW
2. Framework provides a look-up table of model-based estimates of GDE GW subsidy and sensitivity based on those attributes

Estimated ranges of annual GW_{sub} or ET_g per area



Index of relative sensitivity of veg production to groundwater availability



DRI
Desert Research Institute

Expected Benefits

- Better quantification of GDE water use, needs, and sensitivities across environmental gradients
- Planning
- Refine representation of GDEs in other modeling efforts
  - Numerical GW Flow
  - Statistical estimates of Etg
  - State and transition models
- Identify data gaps

Big Warm Springs, NV (Blake Minor, DRI)

Project Timeline and Next Steps

	2021		2022		2023	
Conceptual Framework/Research Design	★					
Model Development and Validation		■	★	■		
Web Map Application				★	■	
State and Transition Modeling				■	■	
Reporting and Publications					■	■

★ Stakeholder Workshops

Soldier Meadows, NV
(David Page, DRI)

Thank You

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WISCONSIN UNIVERSITY OF WISCONSIN-MADISON

DRI Desert Research Institute

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We welcome your questions and feedback,

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