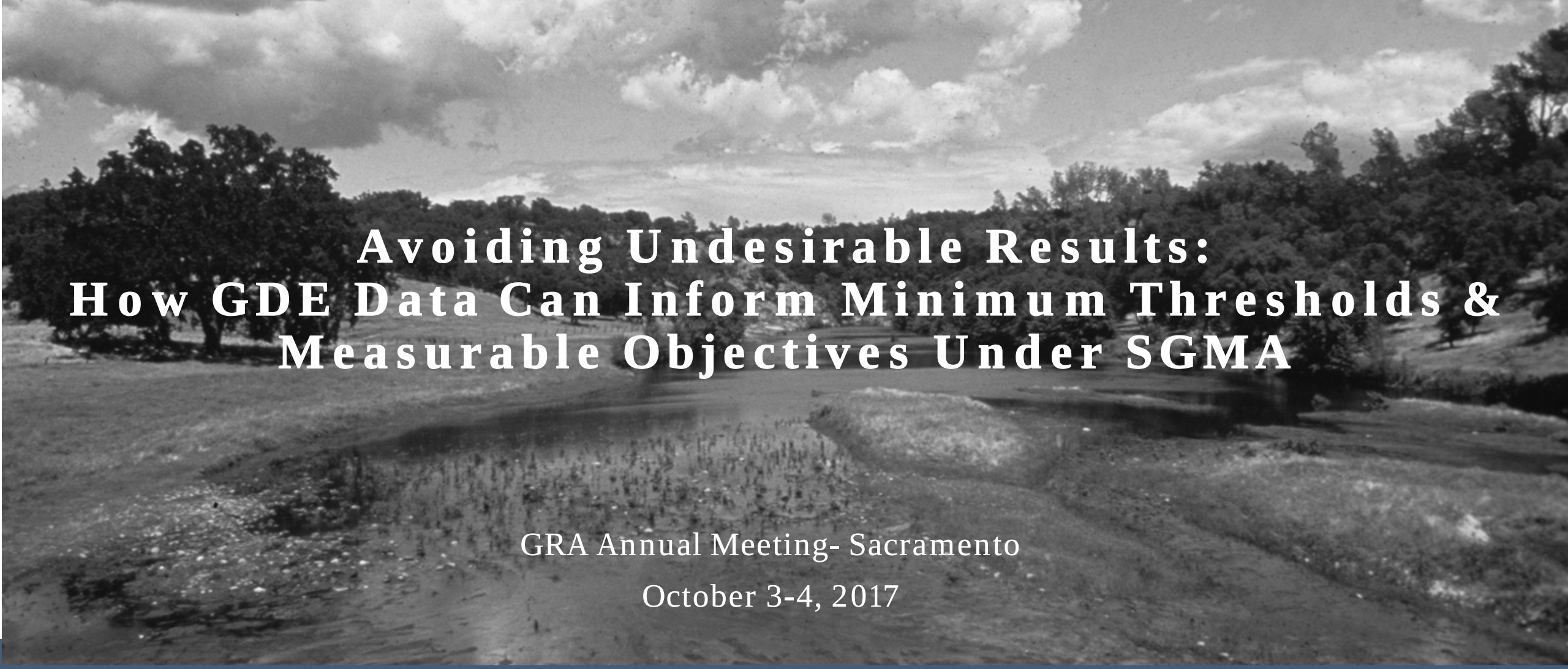


Avoiding Undesirable Results: How GDE Data Can Inform Minimum Thresholds & Measurable Objectives Under SGMA

GRA Annual Meeting- Sacramento

October 3-4, 2017

The Nature Conservancy
Protecting nature. Preserving life.

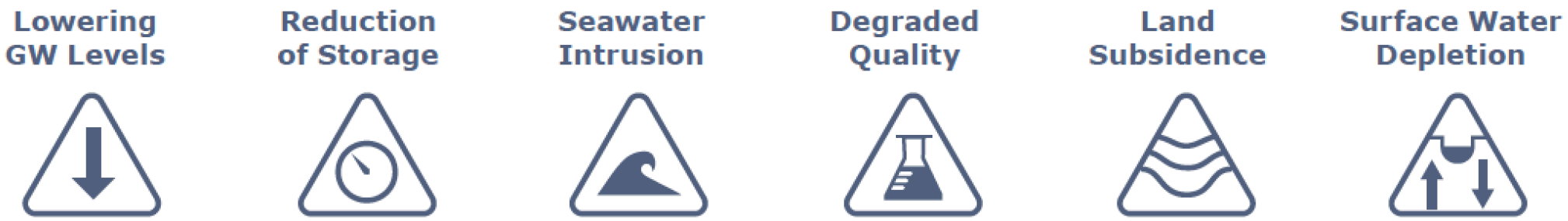
BERKELEY LAB
Lawrence Berkeley National Laboratory

Melissa M. Rohde

GROUNDWATER SCIENTIST

melissa.rohde@tnc.org

SUSTAINABLE GROUNDWATER MANAGEMENT



- **Undesirable Results occur when groundwater conditions are 'Significant and Unreasonable'**
- **Minimum thresholds indicate when Undesirable result is occurring**
- **Potential effects on beneficial uses and users of groundwater**

SUSTAINABLE GROUNDWATER MANAGEMENT

Lowering GW Levels

Reduction of Storage

Seawater Intrusion

Degraded Quality

Land Subsidence

Surface Water Depletion

POTENTIAL EFFECTS

LITTLE-TO-NO IMPACT

Healthy ecosystem

SHORT-TERM ADVERSE IMPACTS

Water stress

PROLONGED ADVERSE IMPACTS

Reduced growth

Reduced reproduction

Habitat loss

SEVERE ADVERSE IMPACTS

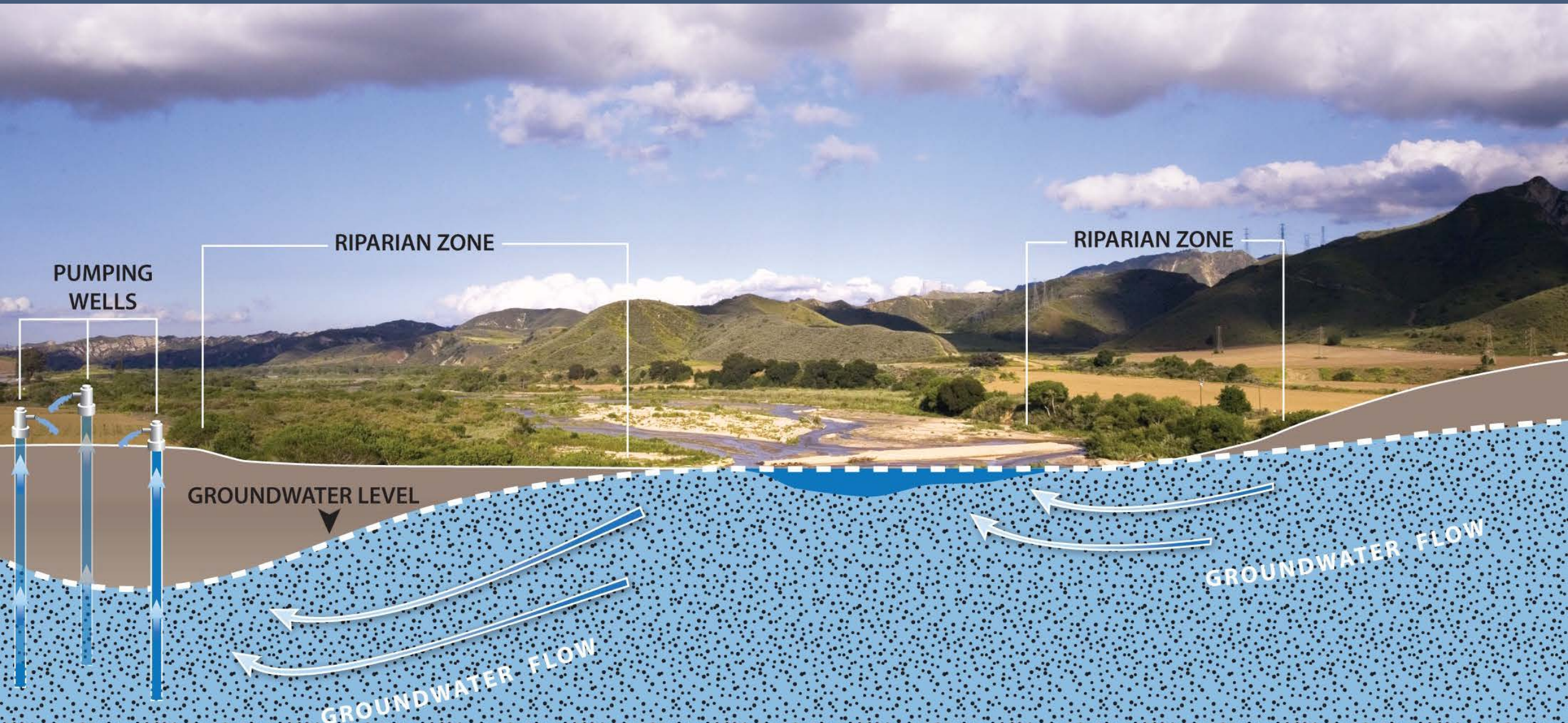
Ecosystem collapse

MORE — GROUNDWATER AVAILABILITY — LESS

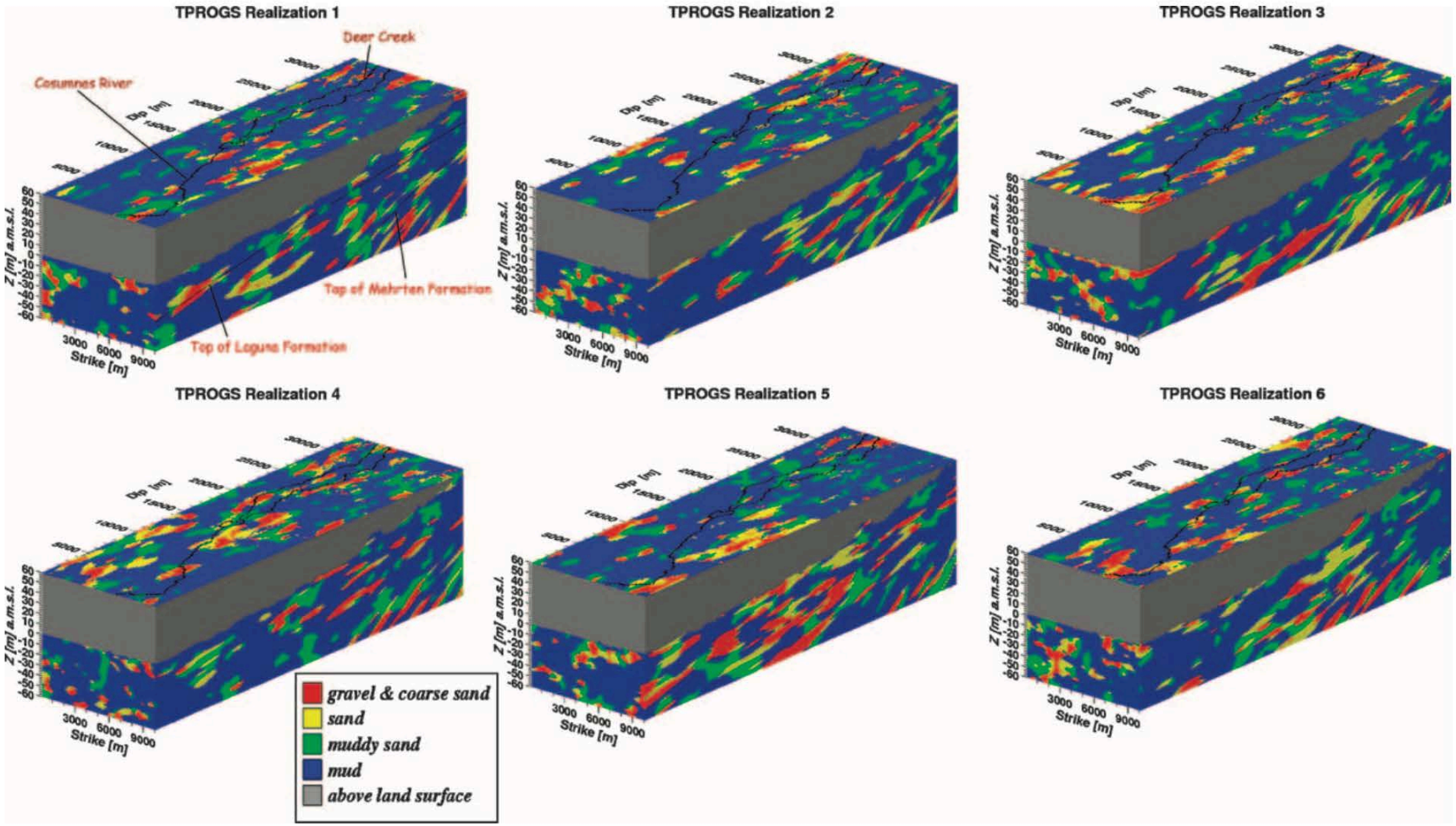
3 Questions

1. How do we quantify potential effects on GDEs?

2. How do groundwater levels vary in the GDE?

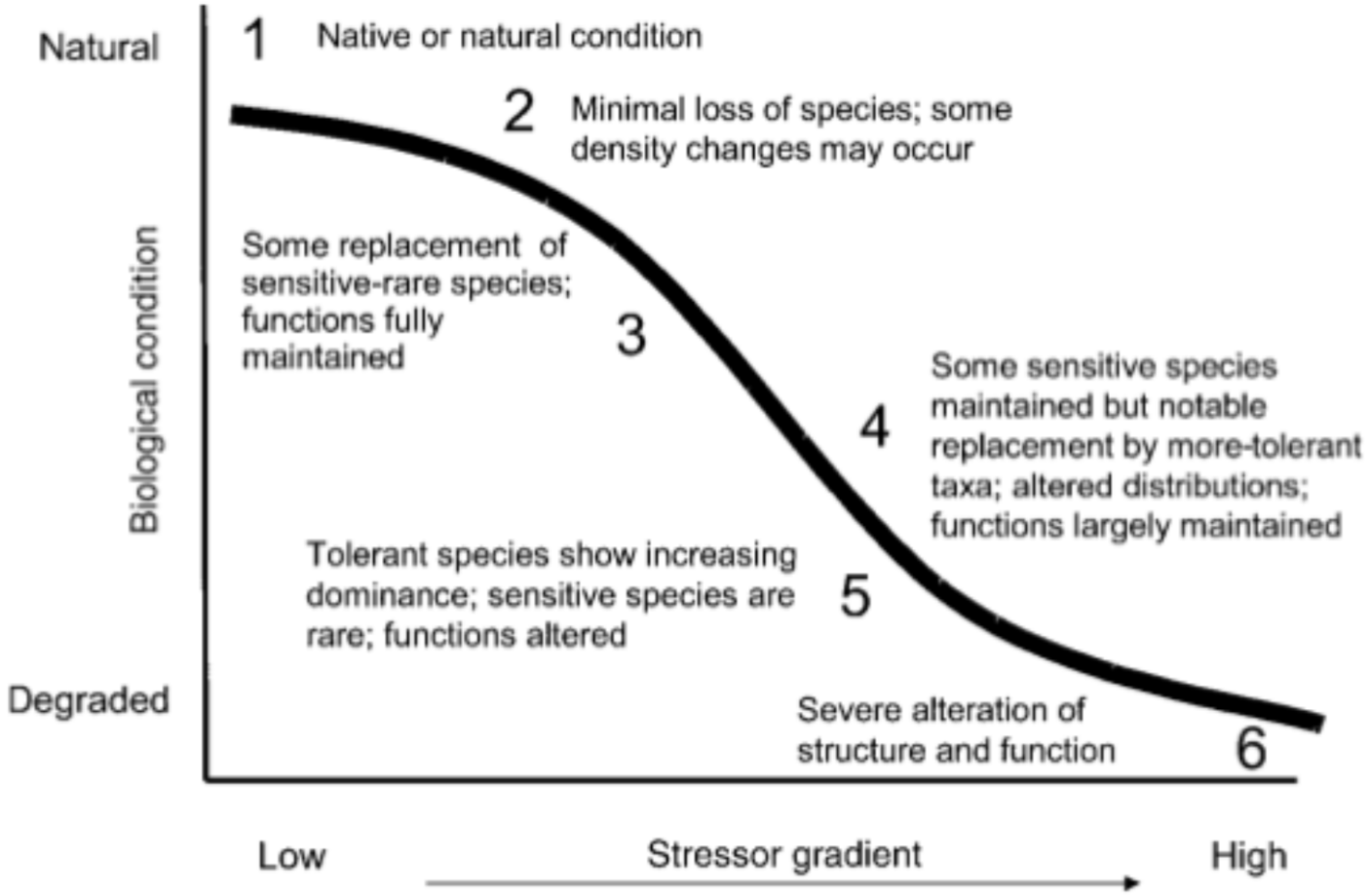


HETEROGENEOUS SUBSURFACE CONDITIONS



Fleckenstein et al. (2006)

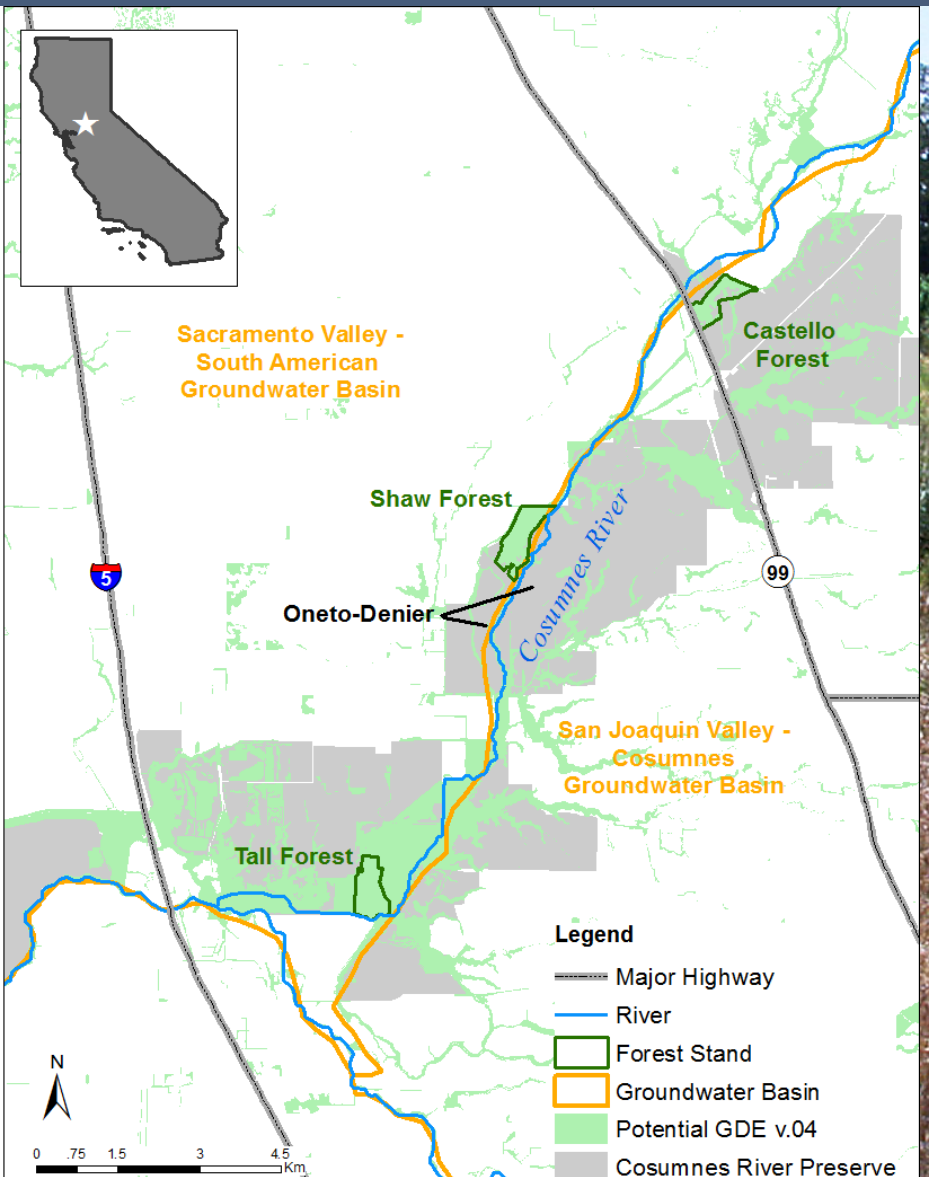
3. Is there a cause-and-effect relationship? Is groundwater impacting the GDE? Are there thresholds?



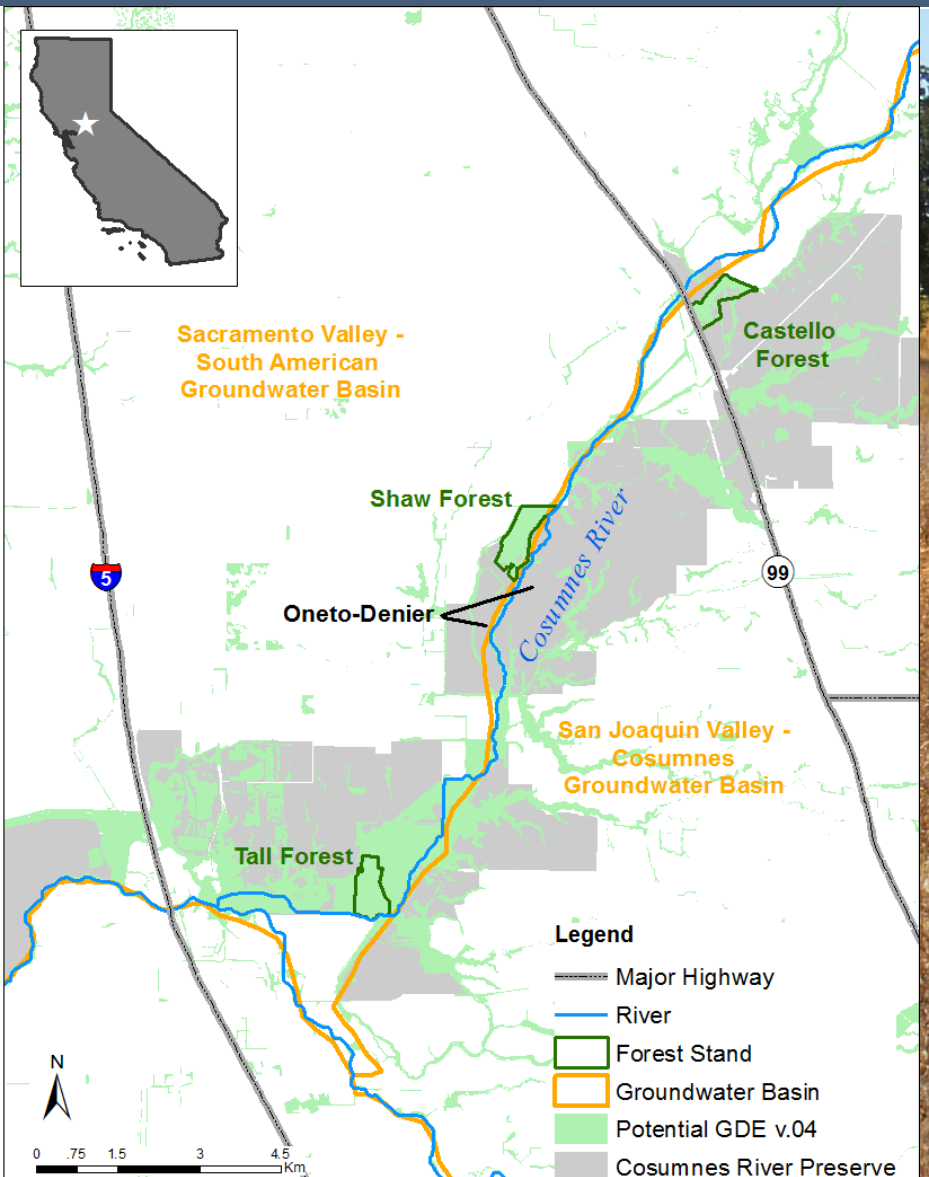
Davies & Jackson (2006)

What potential effects do groundwater levels have on GDEs?

STUDY SITE: Cosumnes River Preserve



STUDY SITE: Cosumnes River Preserve



Geophysics: Electrical Resistivity Tomography

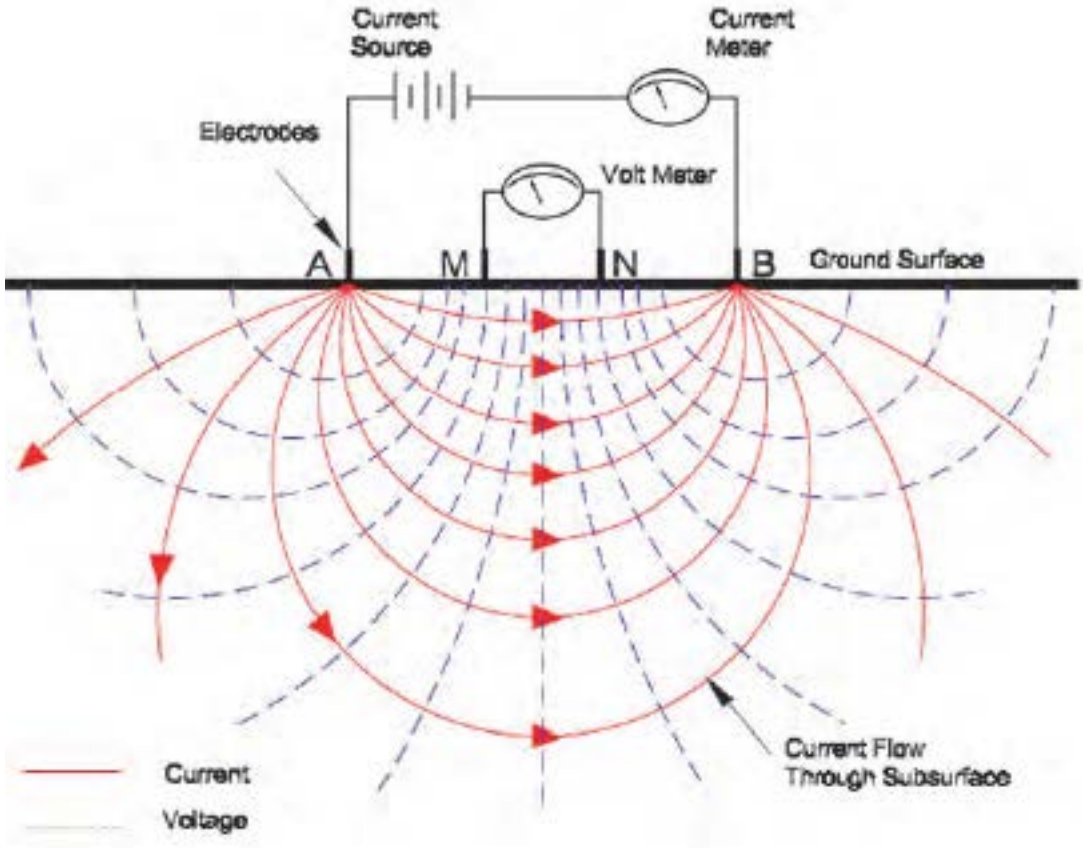
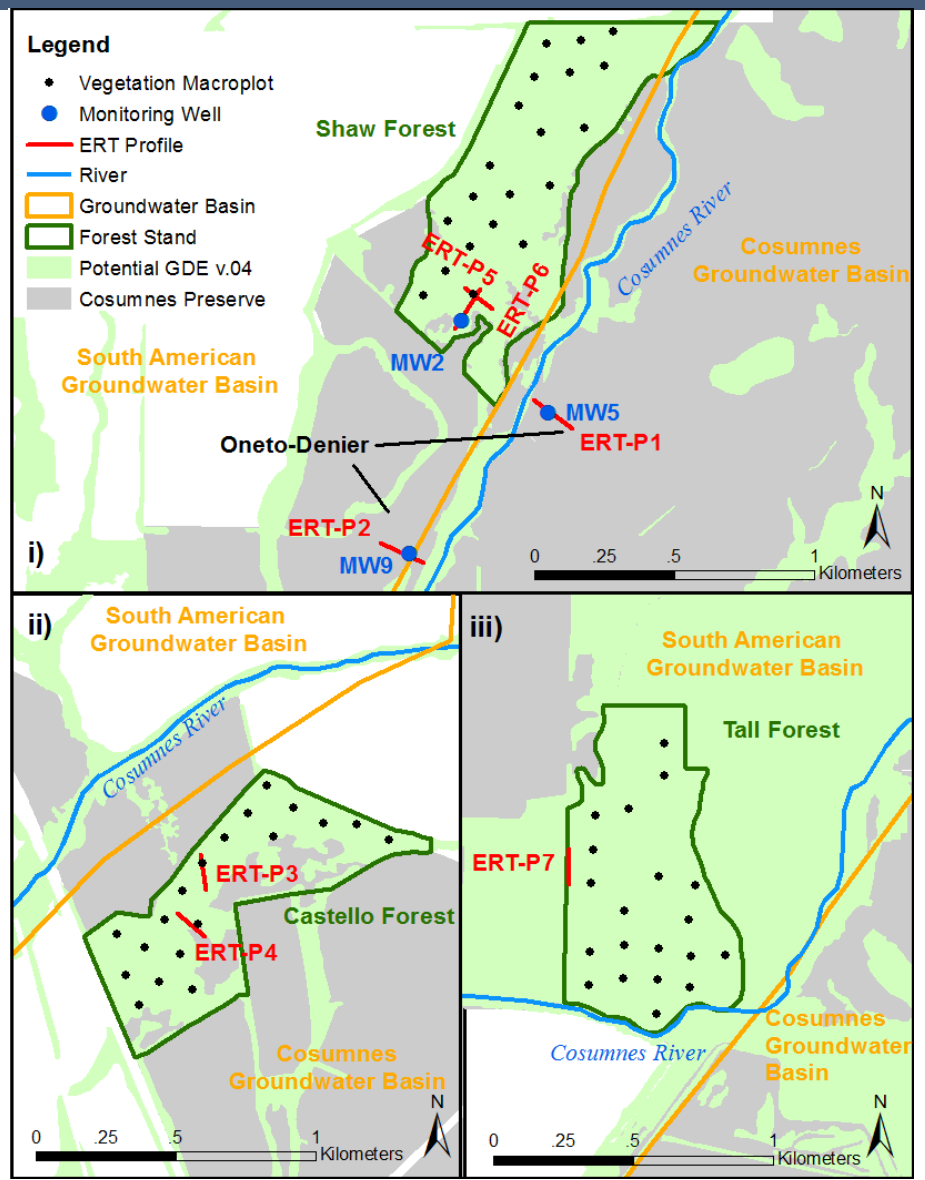


Figure 5
Basic concept of electrical resistivity subsurface measurement (adopted from Sharma, 1997)

STUDY DESIGN



7 Electrical Resistivity Profiles

3 Monitoring Wells (2012-2016 data)

56 Vegetation Macroplots

1. How do we quantify potential effects?

HEALTH INDICATORS

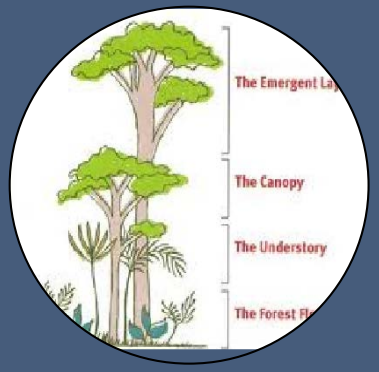
Growth

Survivorship

Diversity

Ecosystem Function

Ecosystem Structure



Regeneration

10 Simple Measurements

- Number of Native Species
- Number of Introduced Species
- Number of Total Species

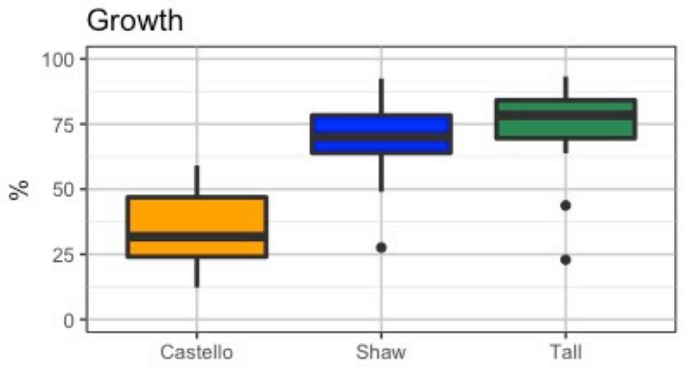
- Native Plant Cover
- Introduced Cover

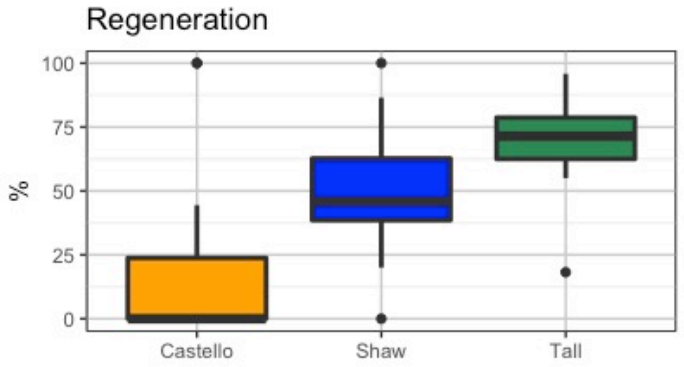
- Total Cover (Spherical Densiometer)

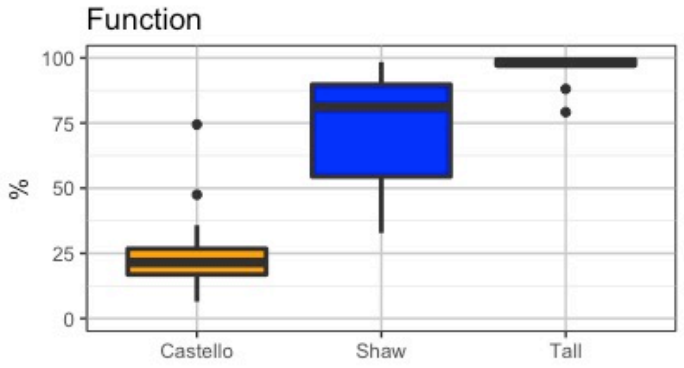
- Number of Saplings
- Number of Young Trees
- Number of Mature Trees

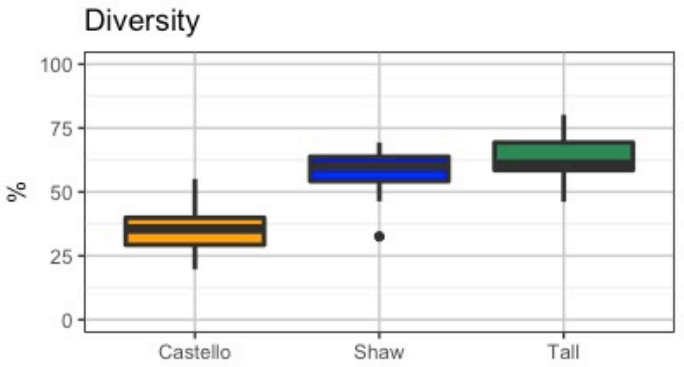
- Number of Strata

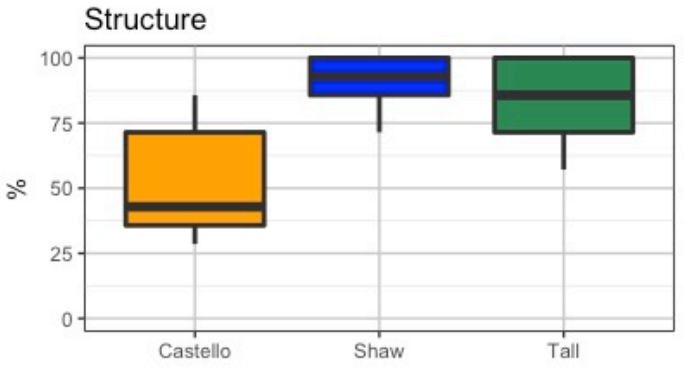
GDE HEALTH

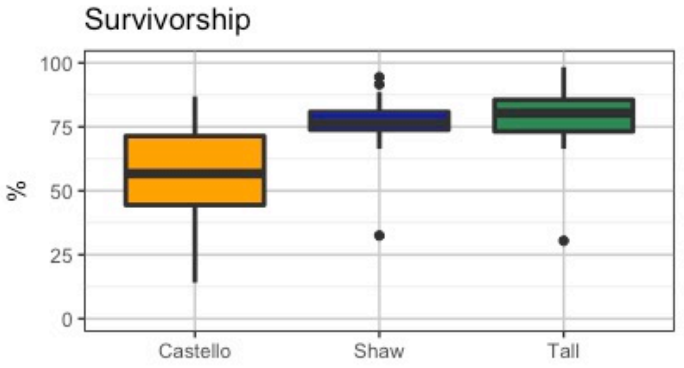

Growth
100
75
50
25
0
%
Castello
Shaw
Tall

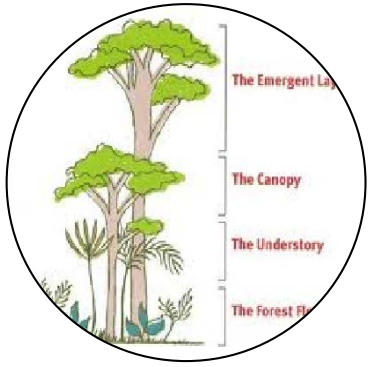

Regeneration
100
75
50
25
0
%
Castello
Shaw
Tall


Function
100
75
50
25
0
%
Castello
Shaw
Tall


Diversity
100
75
50
25
0
%
Castello
Shaw
Tall

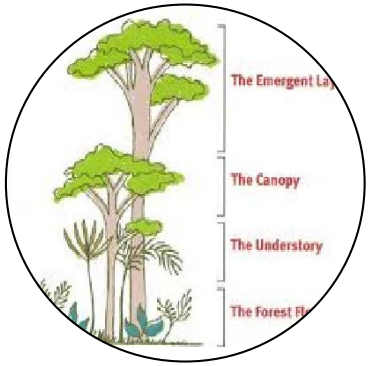

Structure
100
75
50
25
0
%
Castello
Shaw
Tall


Survivorship
100
75
50
25
0
%
Castello
Shaw
Tall


The Canopy
The Understory

GDE HEALTH




Castello Forest statistically different from Shaw Forest and Tall Forest

	Growth	Diversity	Regeneration	Ecosystem Structure	Ecosystem Function	Survivorship
Castello : Shaw	$p < 0.05$	$p < 0.05$	$p < 0.05$	$p < 0.05$	$p < 0.05$	$p < 0.05$
Castello : Tall	$p < 0.05$	$p < 0.05$	$p < 0.05$	$p < 0.05$	$p < 0.05$	$p < 0.05$
Shaw : Tall	$p = 0.68$	$p = 0.26$	$p < 0.05$	$p = 0.22$	$p < 0.05$	$p = 0.87$

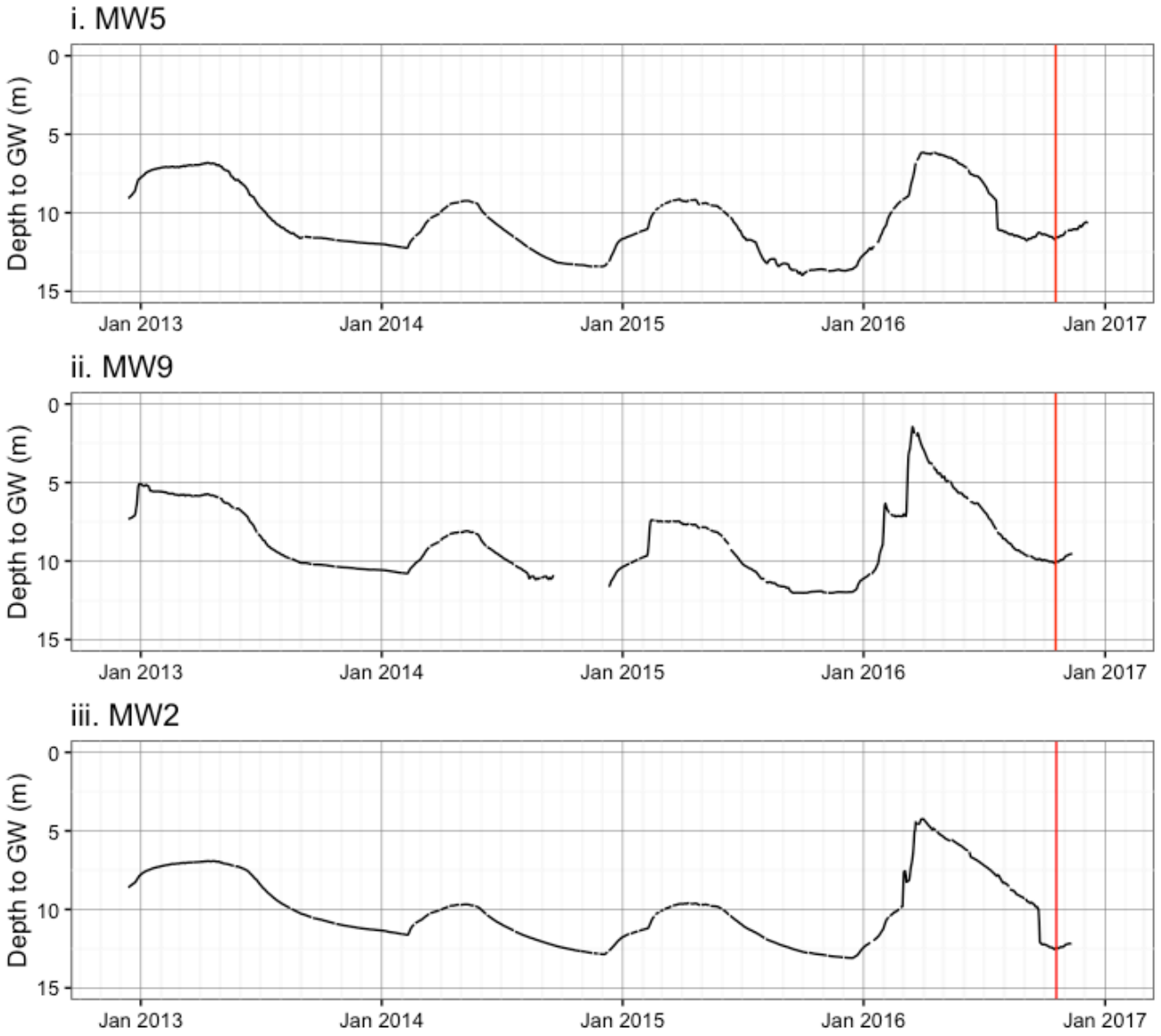
Shaw Forest and Tall Forest statistically similar, except for Regeneration and Ecosystem Function

GDE HEALTH

Less **‘Healthy’** **More**

2. How do groundwater levels vary in the GDE?

GROUNDWATER LEVELS



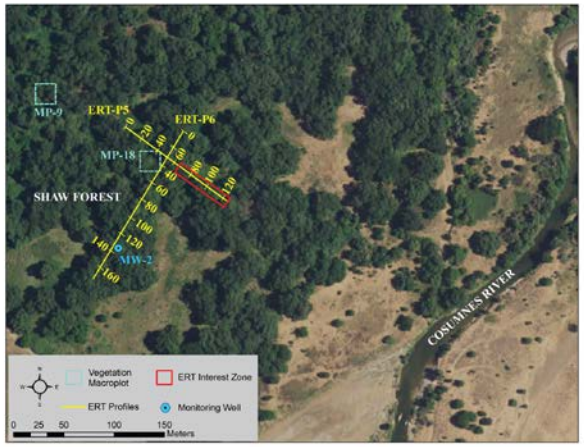
Groundwater Levels at Shaw Forest fluctuate between

4 to 13 meters

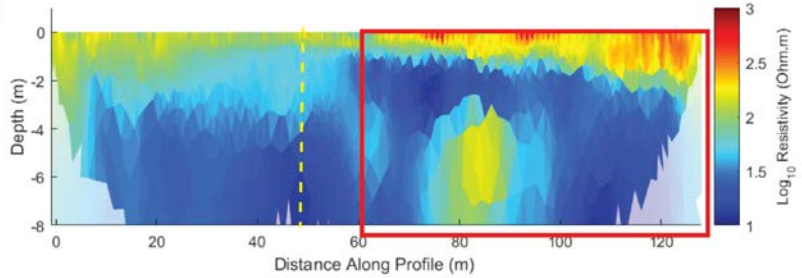
below land surface

SHAW FOREST

i)



ii)



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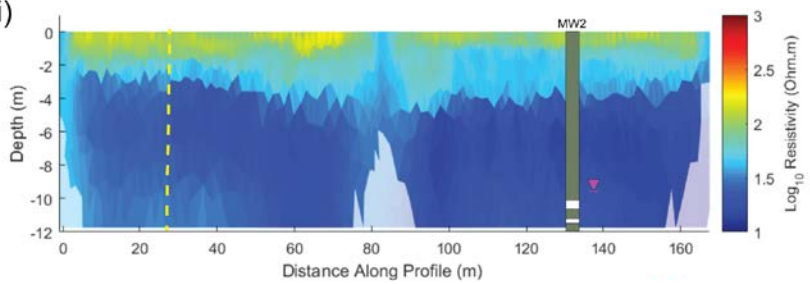
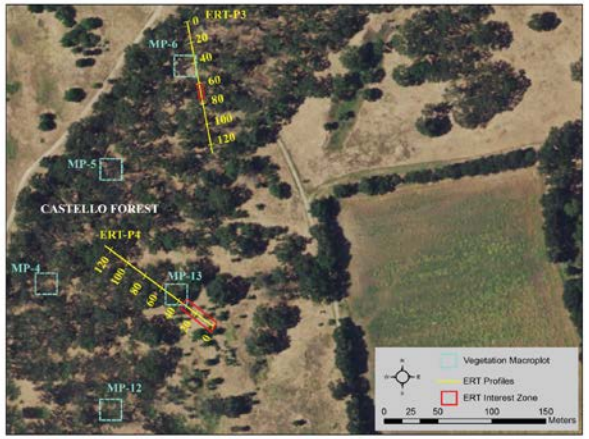


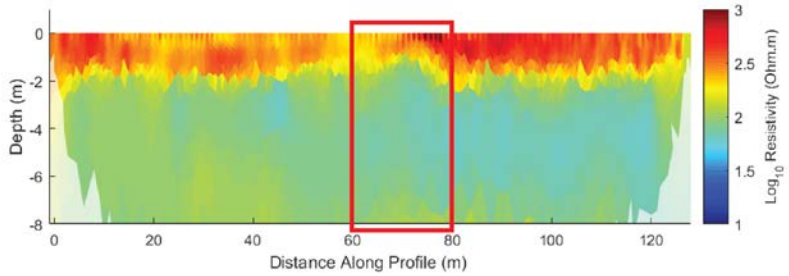
Water Table
Sand
Clay/Silt

CASTELLO FOREST

i)



ii)



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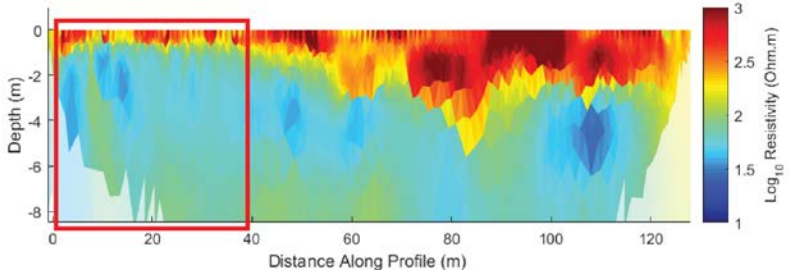
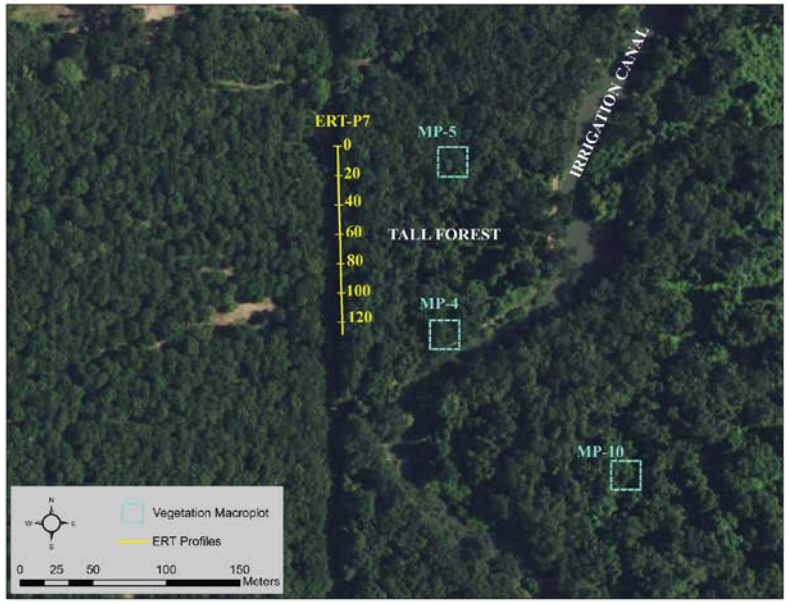


TALL FOREST

i)



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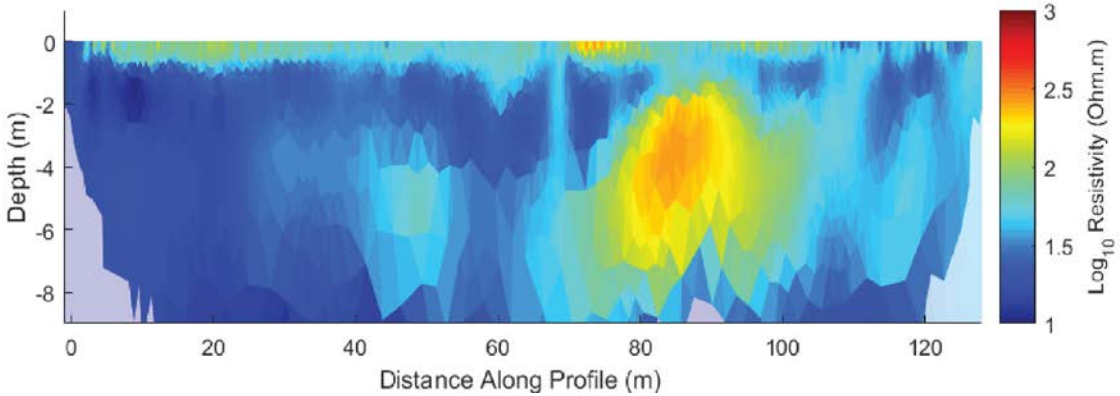
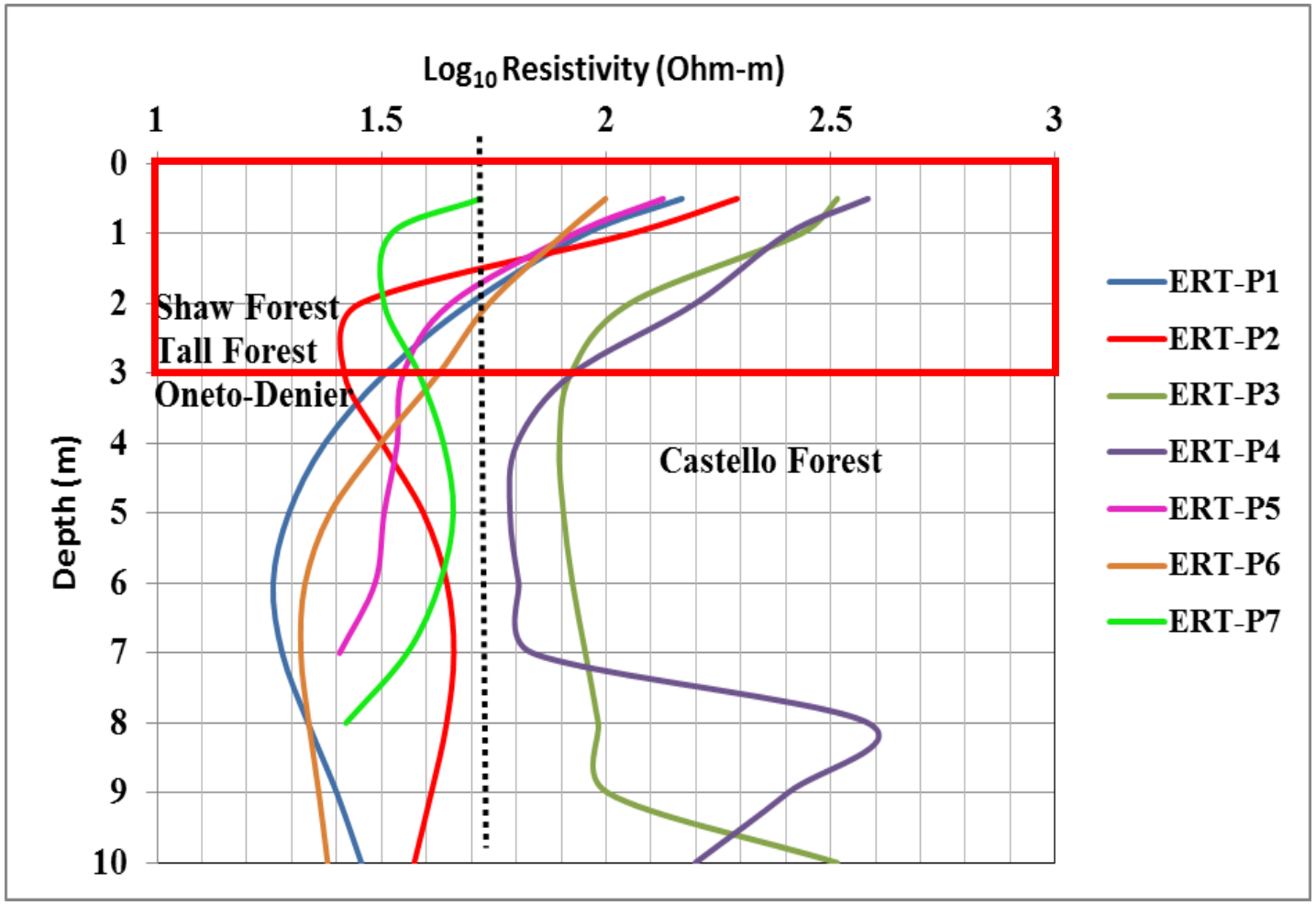


FOREST COMPARISON



Resistivity
in shallow depths

Tall < Shaw <Castello

3. What are the cause-and-effect relationships? Is groundwater impacting the GDE? Are there thresholds?

BIOLOGIC & HYDROLOGIC DATA

Growth

Diversity

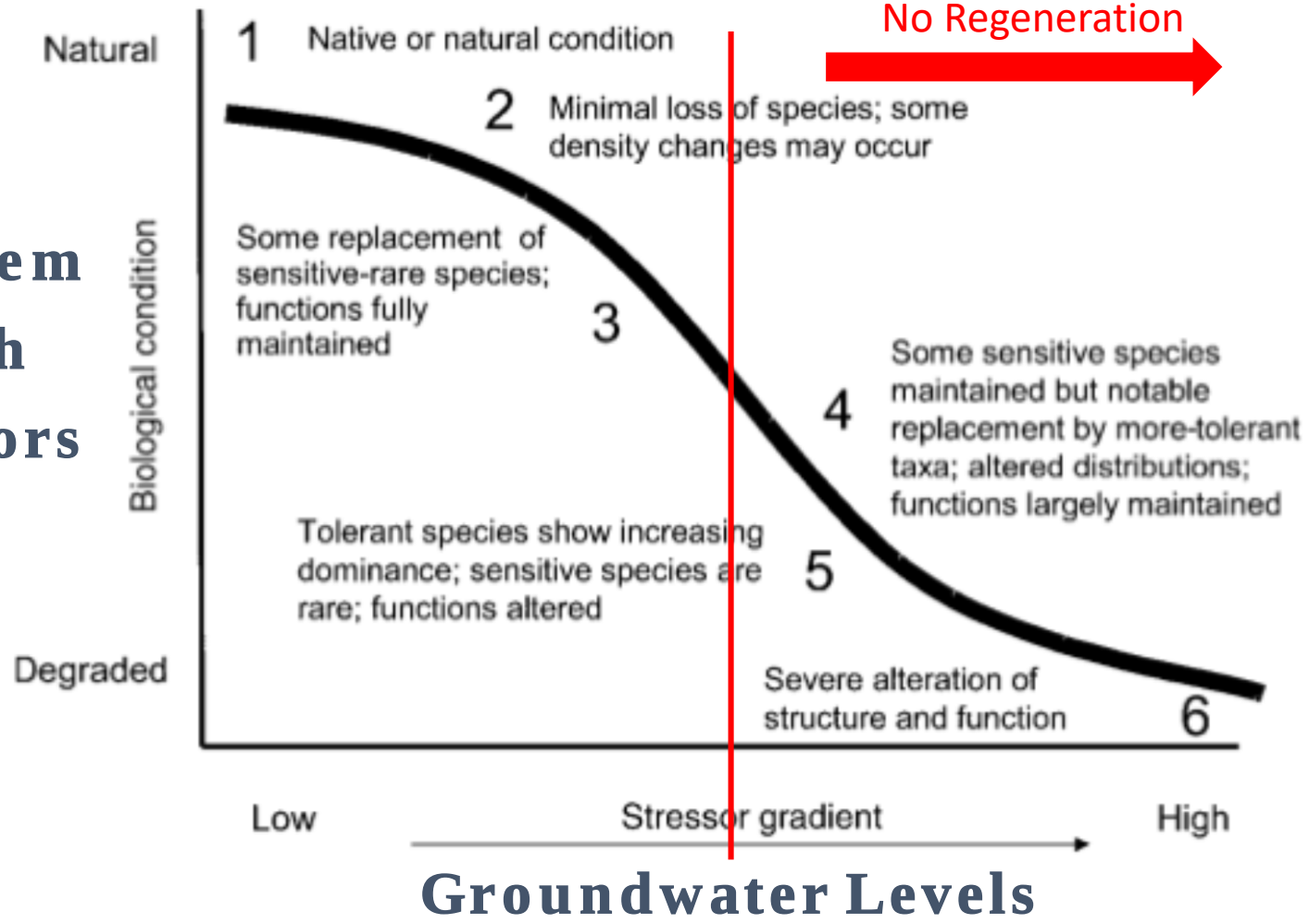
Regeneration

Structure

Function

Survivorship

Ecosystem Health Indicators



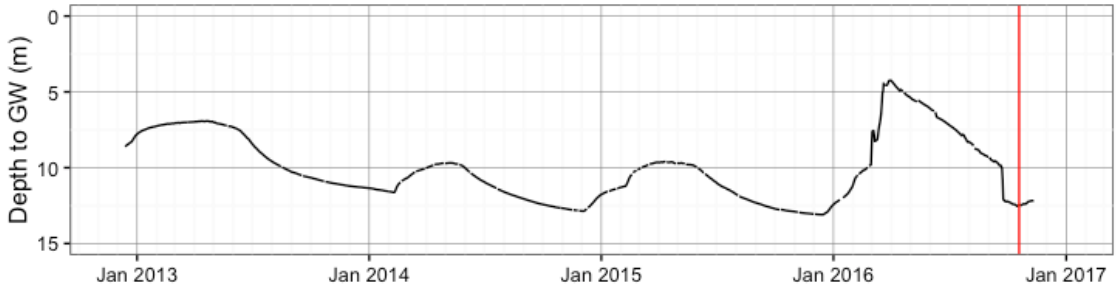
Groundwater Levels

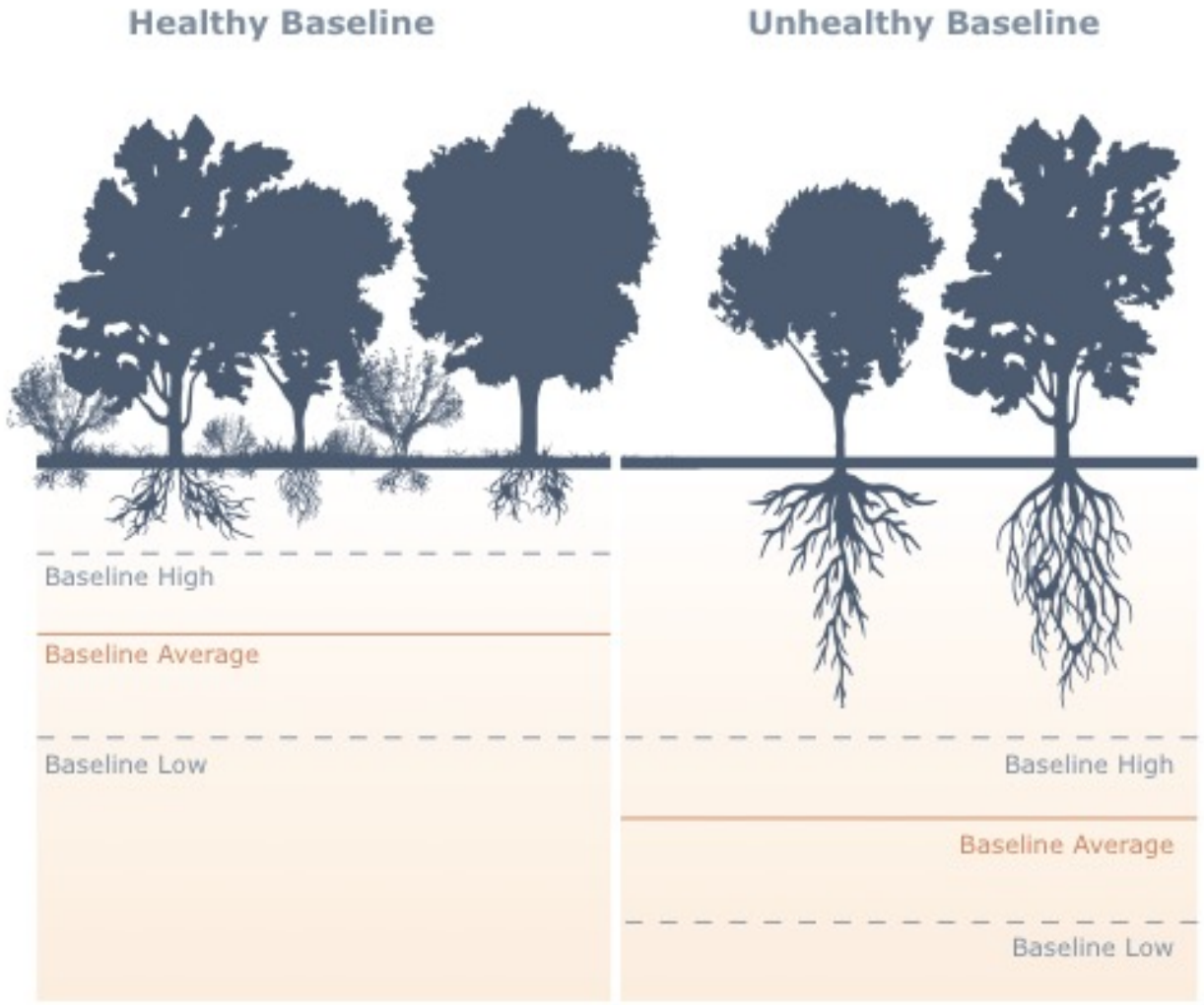
Davies & Jackson (2006)

CAUSE AND EFFECT

Other things to consider:

- Pre-existing laws protecting ecologic assets
- Other beneficial uses and users of groundwater
- Ecologic Assets and Stakeholder values





CONCLUSIONS

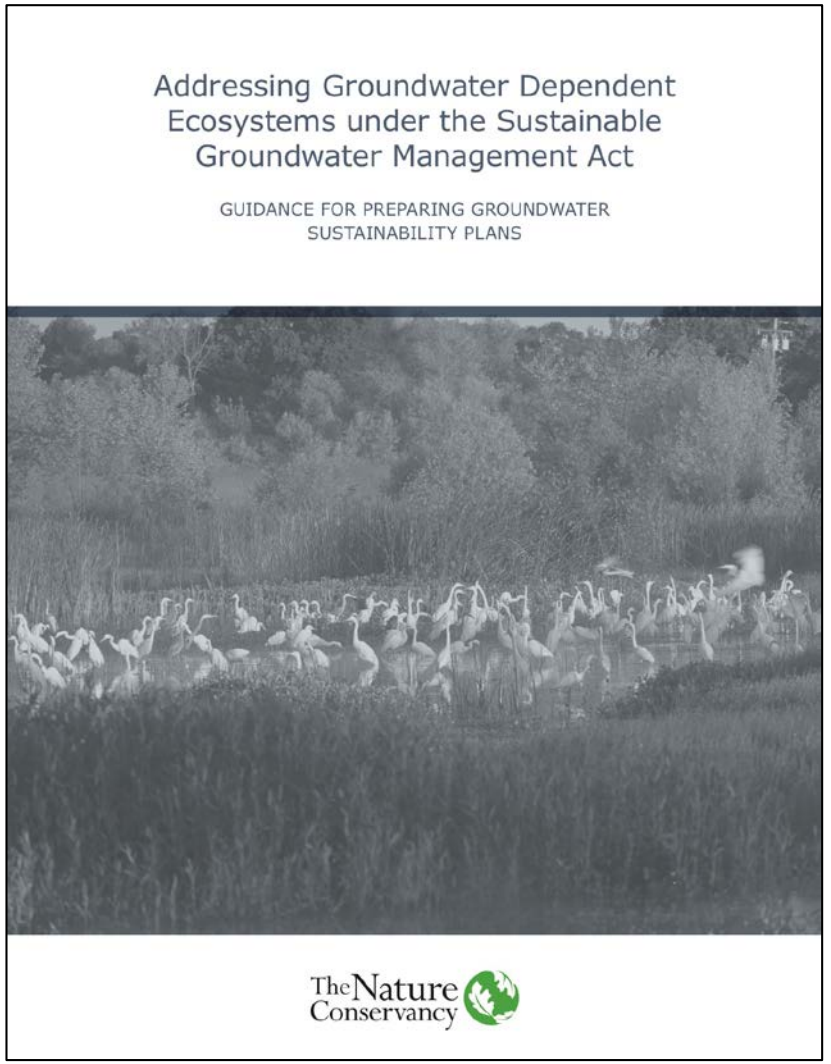
- Hydrologic and biologic data are both necessary for assessing whether groundwater conditions may have potential effects on GDEs
- Geophysics can help characterize subsurface conditions in heterogeneous environments
- Correlation does not equal causation
- Adaptive management of GDEs is necessary

COMING SOON!

Workshop Oct 19th

Monitoring GDEs under SGMA and Beyond

http://ripariansummit.ucdavis.edu



THANK YOU!

Craig Ulrich **Sara Sweet** **Jeanette Howard**

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Victor Oelschlaegel
Jane Thompson
Dr. Graham Fogg
Stephen Maples
Alysa (Amy) Yoder

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