

# Validating the California Rapid Assessment Method for Depressional, Slope, and Vernal Pool Wetlands

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# What is Validation?

- Validation is defined as:  
“the process of documenting relationships between CRAM results and independent measures of condition in order to establish CRAM’s defensibility as a meaningful and repeatable measure of wetland condition” (Stein et al., 2009).

# Ten Steps to Validation

1. Begin with the existing Verification version of the module, and make any necessary updates to create a useable Validation version,
2. Identify the gradient of stress
3. Identify appropriate detailed Level 3 data to validate the CRAM scores
4. Identify the metrics that will be calculated from the detailed data
5. Create conceptual modules that describe the expected relationship between the detailed data and CRAM scores
6. Select field site locations that have the selected existing data, or collect the data themselves
7. Conduct new CRAM assessments
8. Develop correlations between the Level 3 data and CRAM scores
9. Consider any necessary modifications to the module to better capture the full range of condition
10. Report the findings to the Level 2 and the CWMW for discussion

# Depressional CRAM Validation Sites

Depressional Validation



Google earth

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Image Landsat / Copernicus  
Data SIO, NOAA, U.S. Navy, MGA, GEBCO

# Diverse Depressional Wetlands



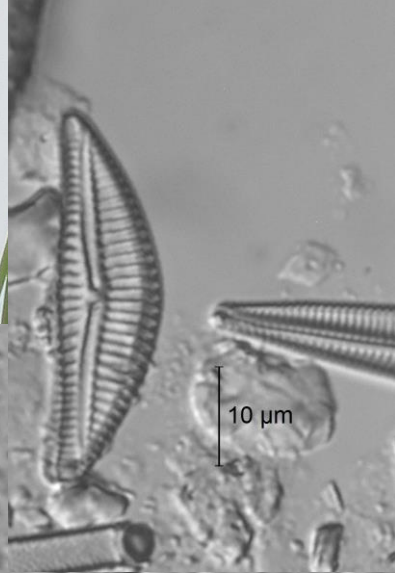
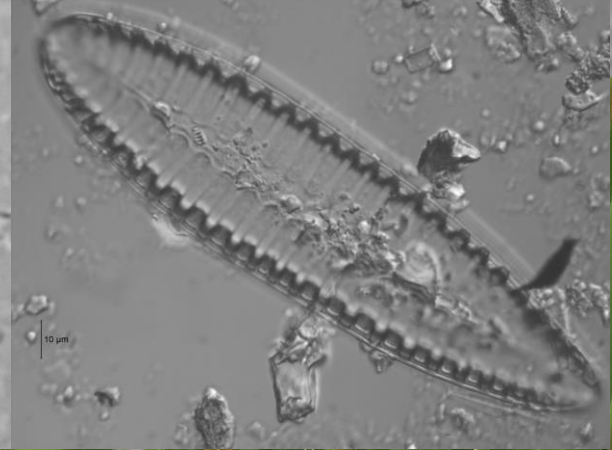
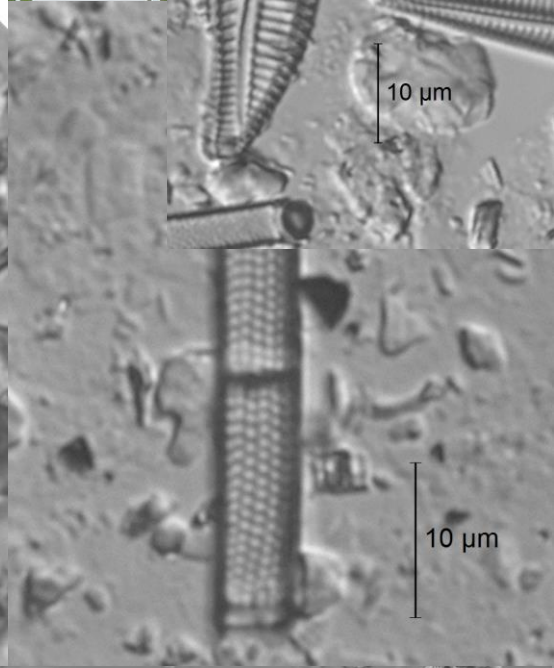
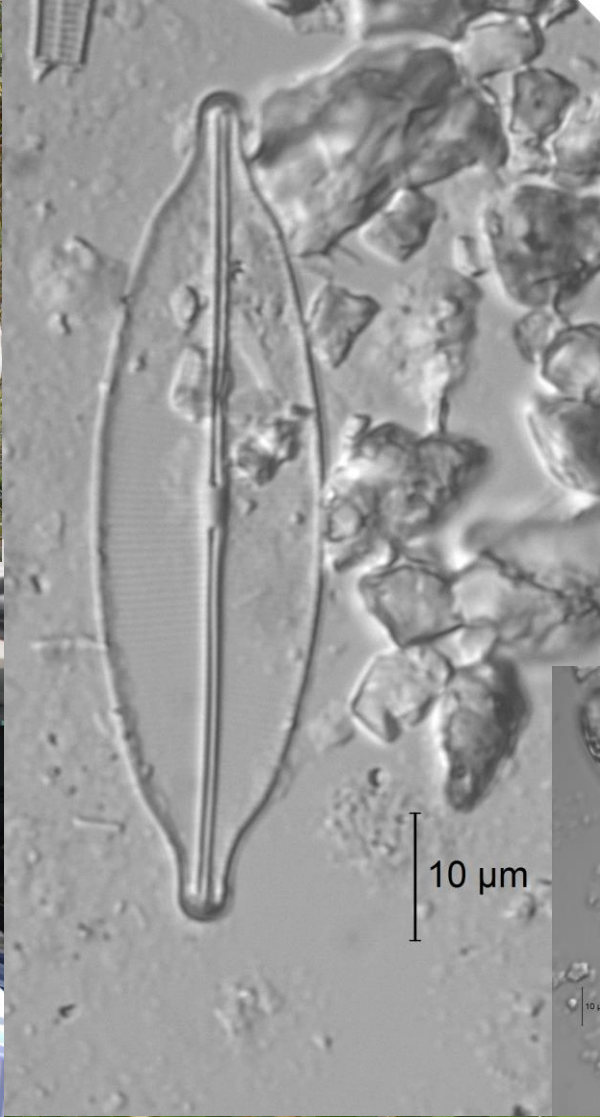
# Depressional CRAM Validation Data

- Level 3 data
  - Algae IBI
  - Invertebrate IBI
  - Water Quality
- Collect new data and leverage existing data
  - So Cal existing dataset (15 sites)
  - Bay Area existing dataset (15 sites)
  - New data in Northern California (15 sites)
  - Total of 45 sites

# Depressional IBI for Macroinvertebrates and Algae



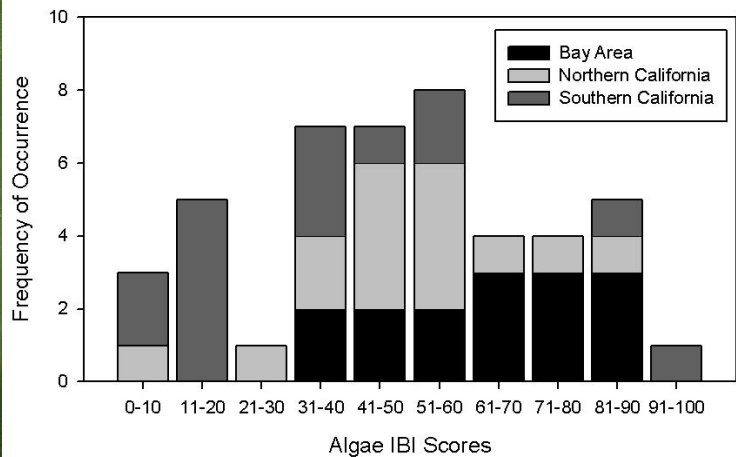
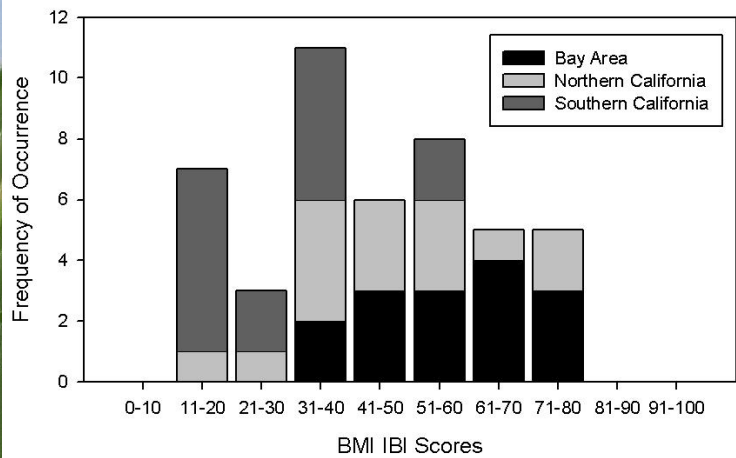
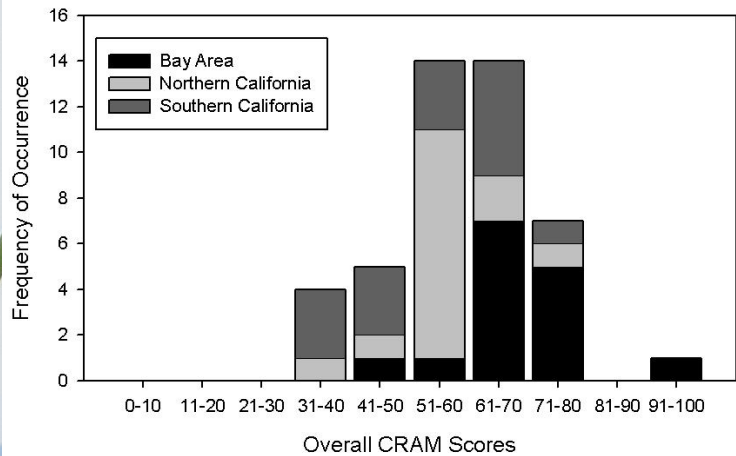
# Diatom Algae

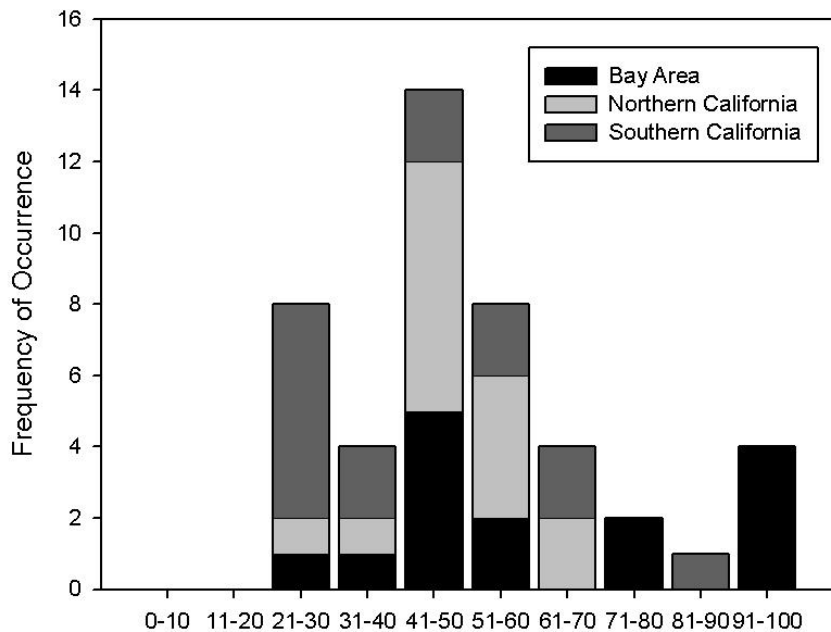




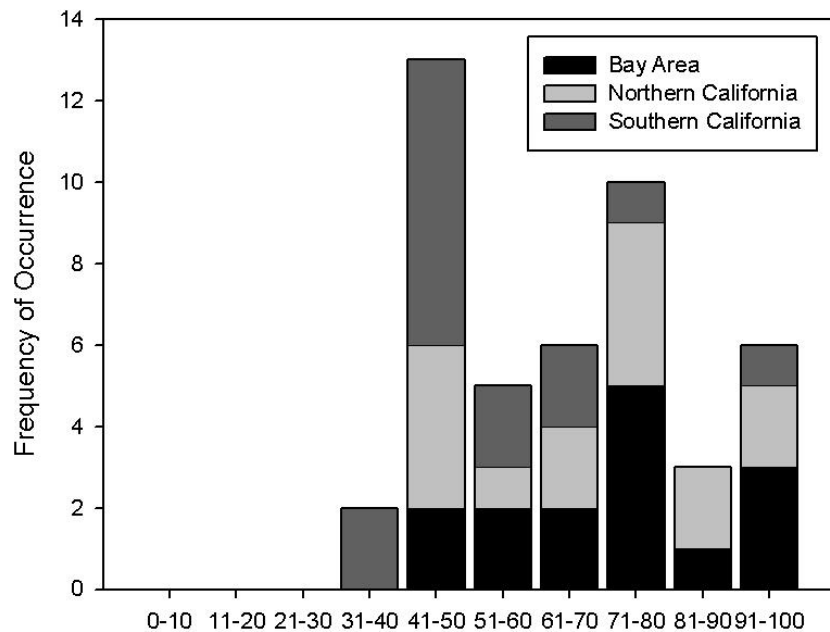
# Benthic Macroinvertebrates



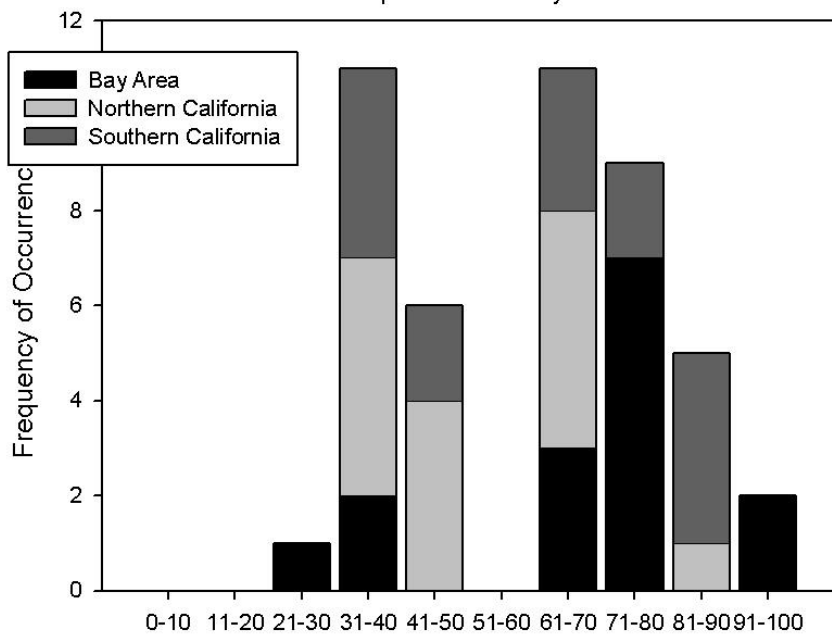




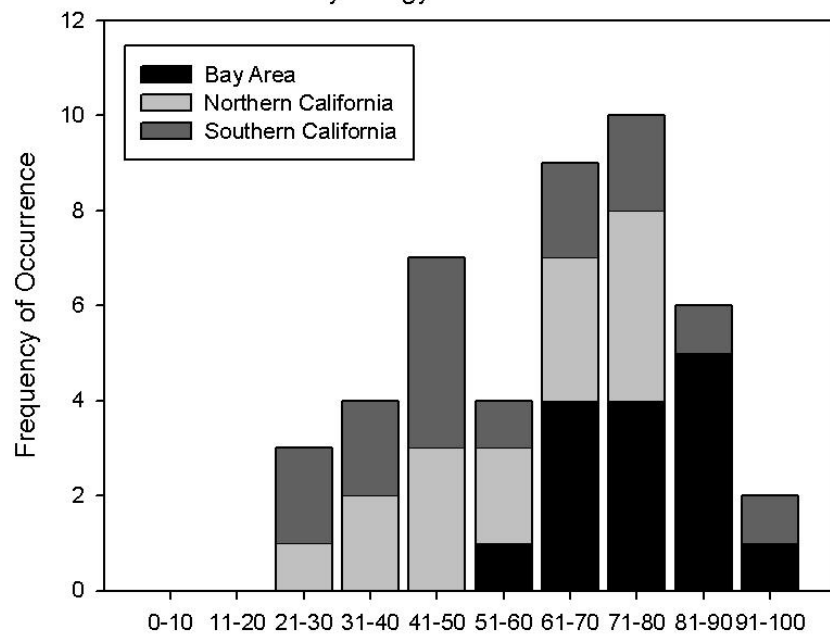
Buffer & Landscape Connectivity CRAM Scores



Hydrology CRAM Scores



Physical Structure CRAM Scores



Biological Structure CRAM Scores

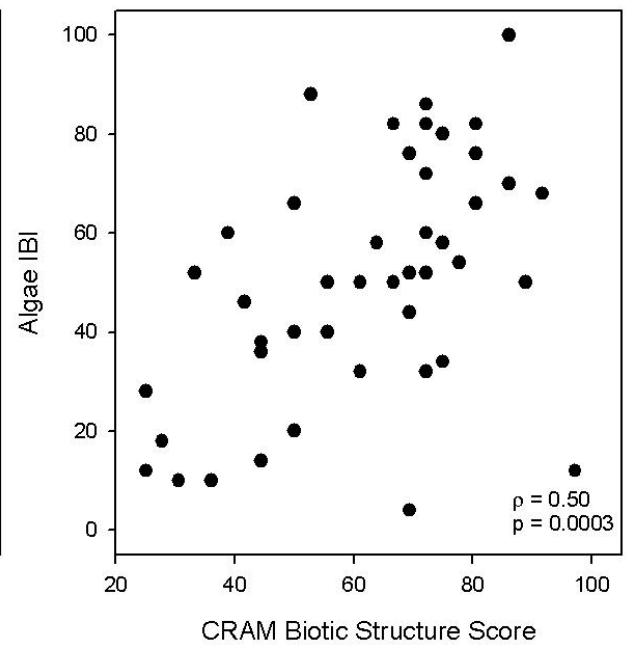
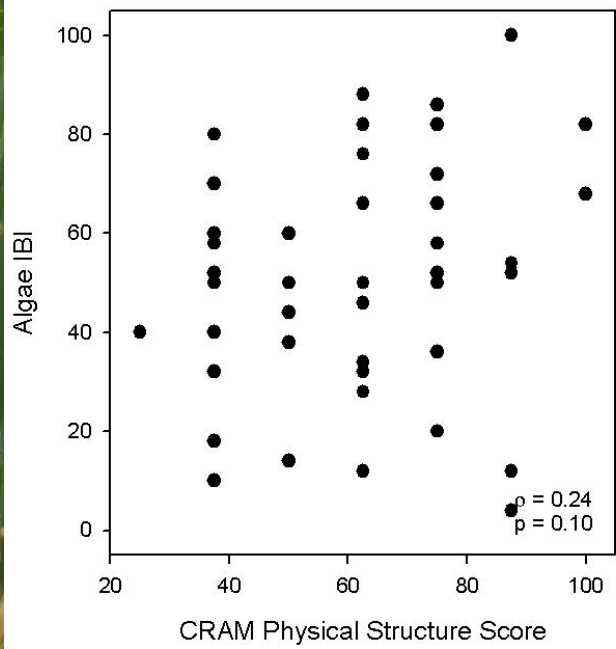
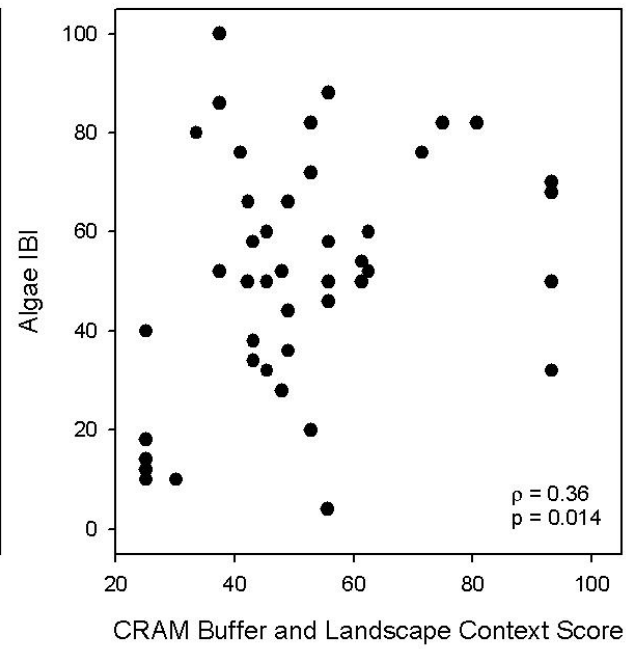
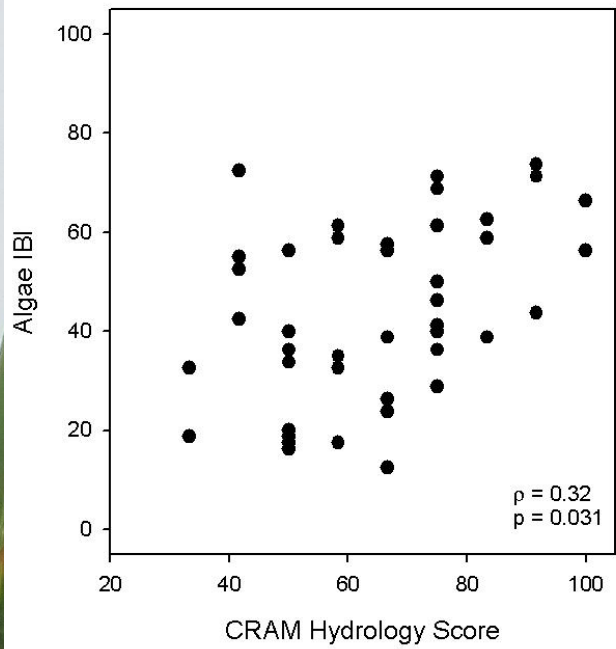


# Correlation Table

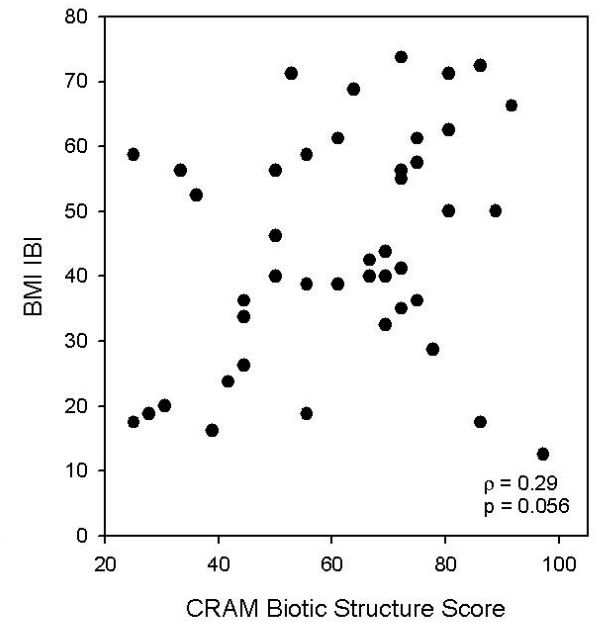
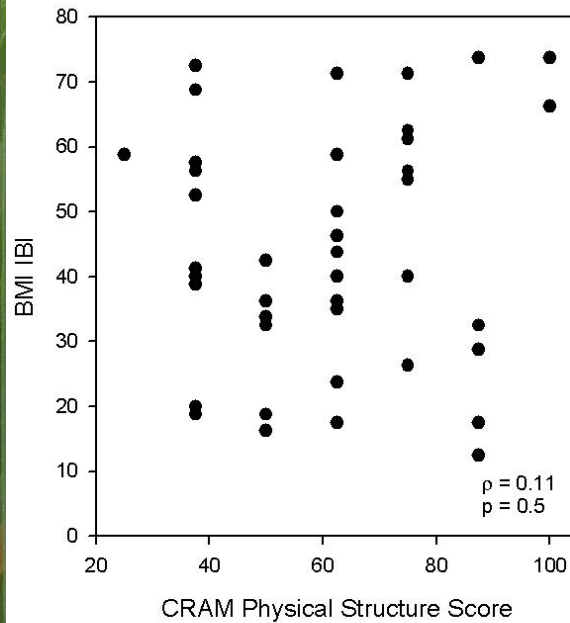
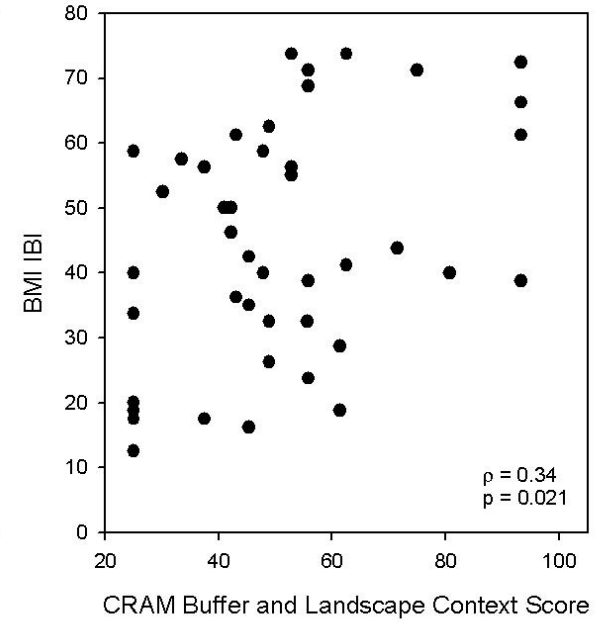
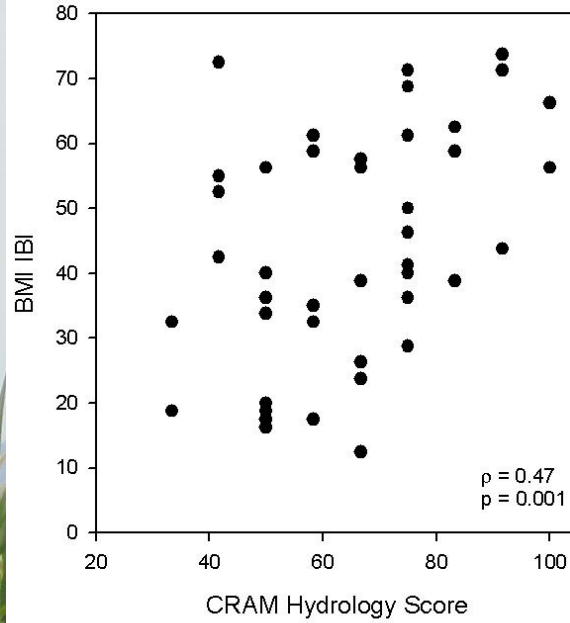
	Overall CRAM	CRAM Buffer & Landscape Connectivity	CRAM Hydrology	CRAM Biotic Structure	CRAM Physical Structure
BMI IBI	$\rho = 0.42$ <b>p = 0.004</b>	$\rho = 0.34$ <b>p = 0.02</b>	$\rho = 0.47$ <b>p = 0.001</b>	$\rho = 0.29$ p = 0.06	$\rho = 0.11$ p = 0.50
IBI D18	$\rho = 0.49$ <b>p = 0.0005</b>	$\rho = 0.36$ <b>p = 0.01</b>	$\rho = 0.32$ <b>p = 0.03</b>	$\rho = 0.50$ <b>p = 0.0003</b>	$\rho = 0.24$ p = 0.10
Turbidity (NTU)	$\rho = -0.19$ p = 0.28	$\rho = -0.04$ p = 0.83	$\rho = -0.05$ p = 0.80	$\rho = -0.30$ p = 0.08	$\rho = -0.15$ p = 0.38
Water Temp (°C)	$\rho = 0.23$ p = 0.21	$\rho = 0.05$ p = 0.81	$\rho = 0.13$ p = 0.51	$\rho = 0.03$ p = 0.88	$\rho = 0.37$ <b>p = 0.04</b>
pH	$\rho = -0.28$ p = 0.06	$\rho = -0.20$ p = 0.06	$\rho = -0.21$ p = 0.19	$\rho = -0.42$ <b>p = 0.003</b>	$\rho = -0.16$ p = 0.30
Specific Conductance ( $\mu\text{S}/\text{cm}$ )	$\rho = -0.38$ <b>p = 0.01</b>	$\rho = -0.36$ <b>p = 0.01</b>	$\rho = -0.33$ <b>p = 0.03</b>	$\rho = -0.39$ <b>p = 0.007</b>	$\rho = -0.09$ p = 0.56
Salinity (ppt)	$\rho = -0.47$ <b>p = 0.003</b>	$\rho = -0.41$ <b>p = 0.01</b>	$\rho = -0.41$ <b>p = 0.01</b>	$\rho = -0.35$ <b>p = 0.04</b>	$\rho = -0.19$ p = 0.26
DO (mg/L)	$\rho = -0.07$ p = 0.67	$\rho = -0.13$ p = 0.41	$\rho = -0.06$ p = 0.68	$\rho = -0.13$ p = 0.41	$\rho = 0.01$ p = 0.96
Alkalinity ( $\text{CaCO}_3$ average)	$\rho = -0.32$ <b>p = 0.03</b>	$\rho = -0.34$ <b>p = 0.02</b>	$\rho = -0.34$ <b>p = 0.02</b>	$\rho = -0.25$ p = 0.10	$\rho = -0.07$ p = 0.65



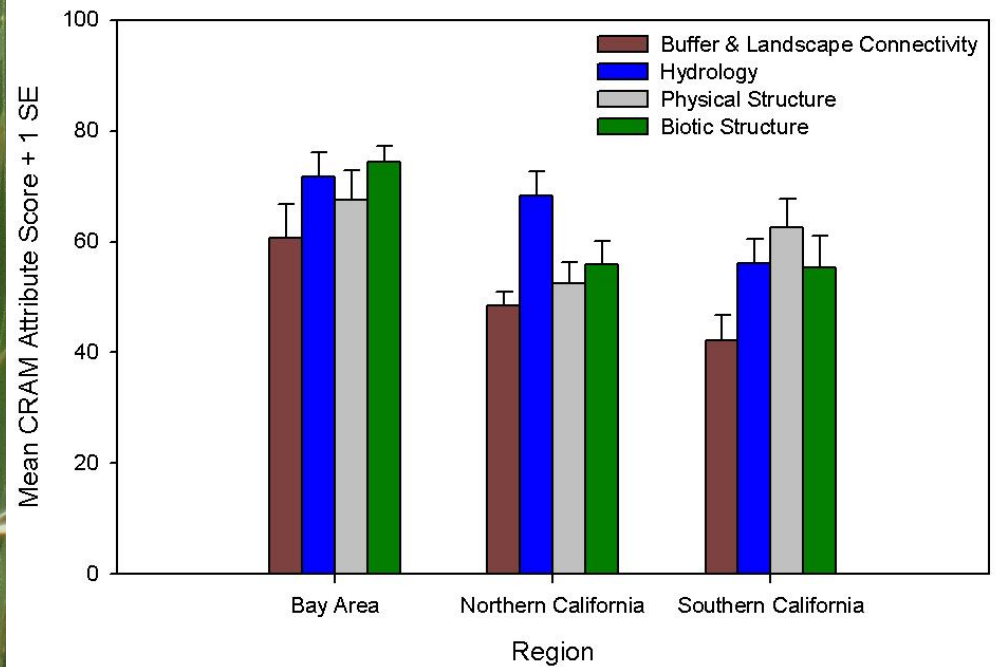
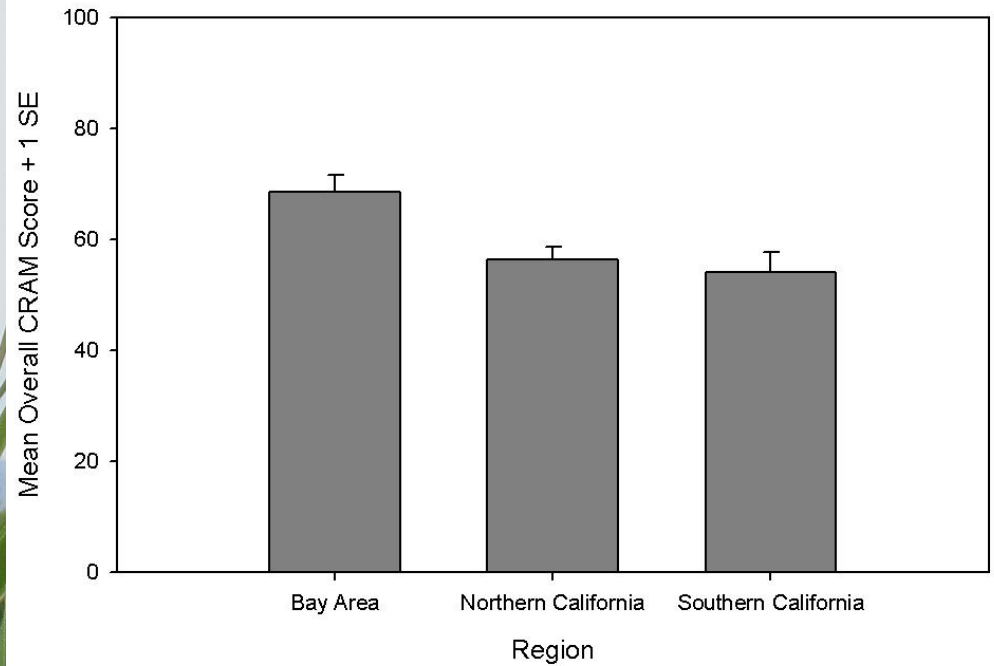
# CRAM Attributes vs. Algae IBI



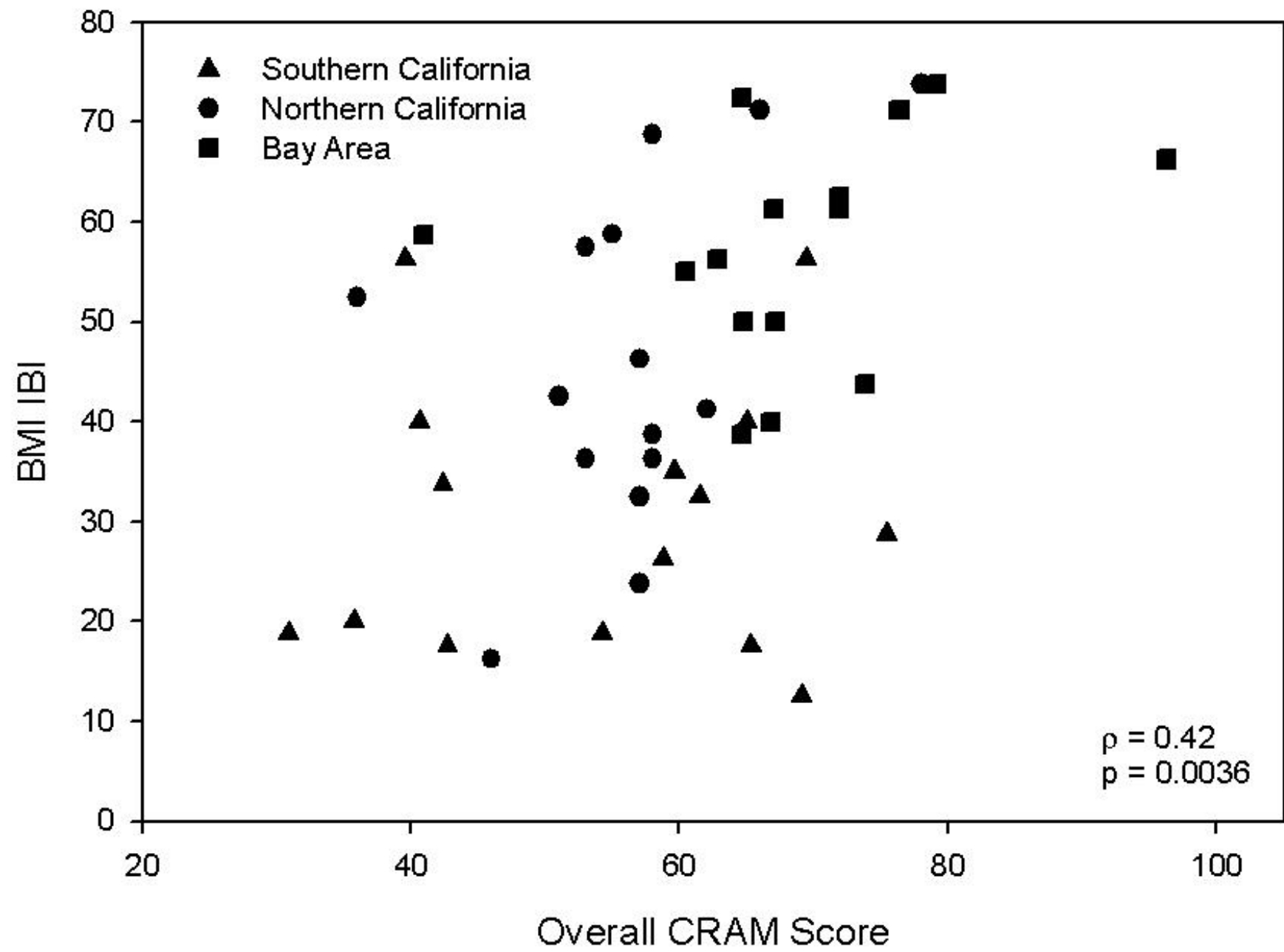
# CRAM Attributes vs. Invertebrate IBI



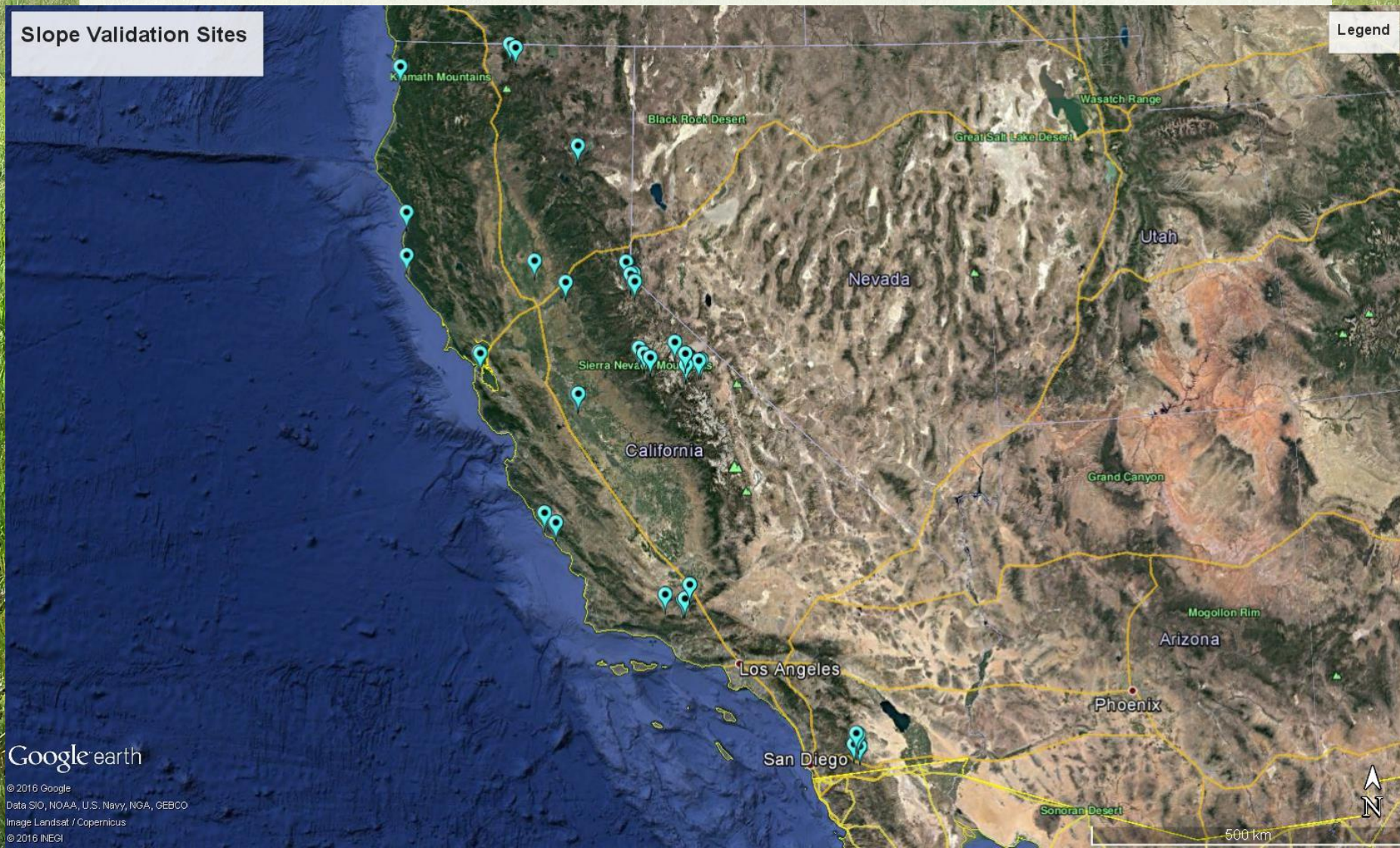
# Regional Patterns







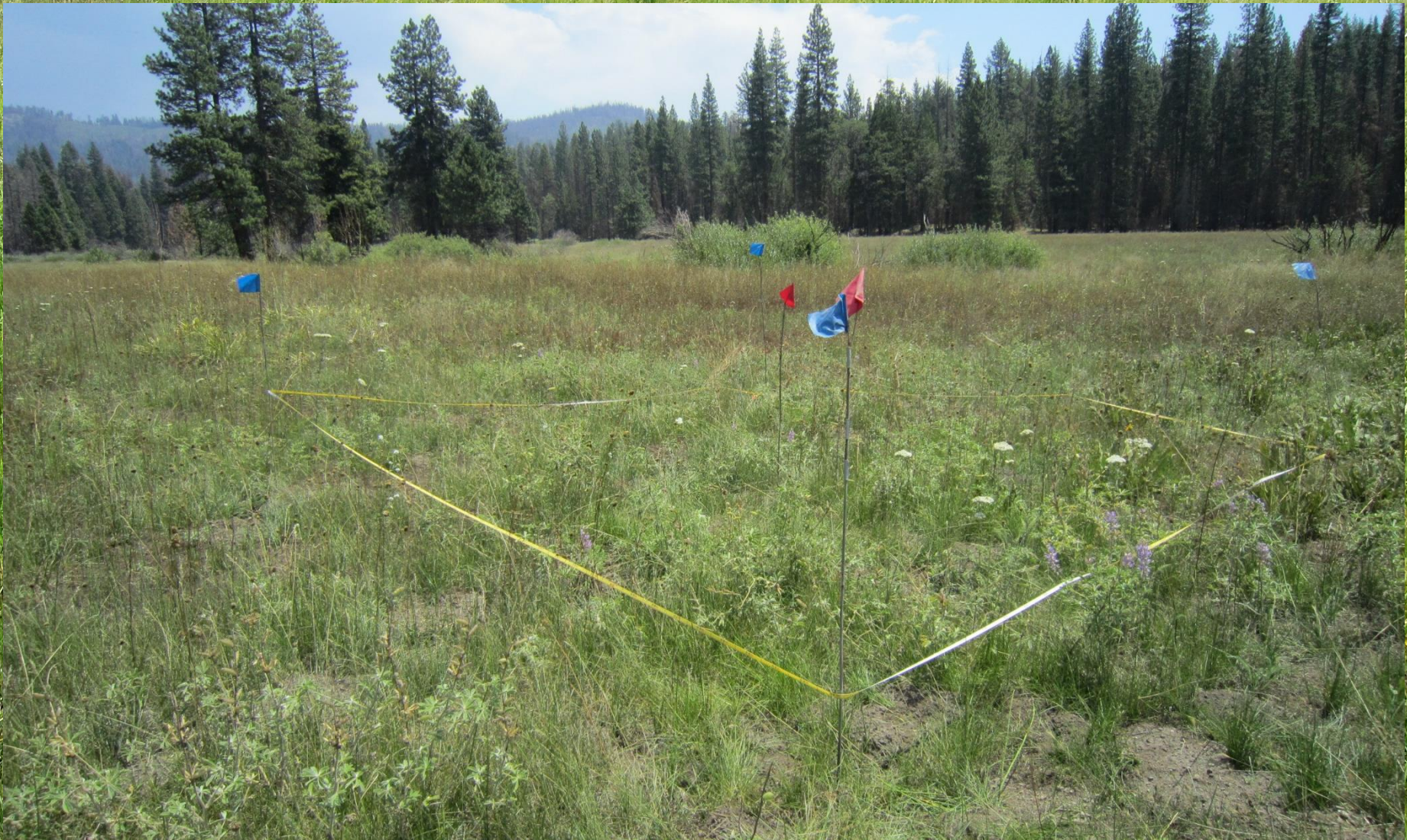
# Slope Module Validation Sites



# Slope Module Validation Data

- US Forest Service- network of vegetation monitoring sites in meadows on National Forest lands. Monitoring occurred in 2015.
- National Park Service- similar network of vegetation monitoring sites in meadows on National Park lands. Monitoring occurred in 2015 (Drosera in 2009).
- This data covers a wide condition gradient, is standardized, indicates the condition of the wetland, and was collected in a similar time frame as the CRAM assessments.
- However, this dataset was limited geographically
  - Statewide, but only on National Forest or National Park lands
  - No coastal or Central Valley sites

CRAM team collected data following the NPS protocols at 19 sites, to increase the geographic scope (climatic and topographic gradient) of sites.



# Slope Module Validation

- 15 channeled wet meadows
- 16 non-channeled wet meadows
- 5 forested slopes
- 4 seeps/springs (all found through previous knowledge)
- Important to understand the population of sites
  - Overall fair to good condition
  - The majority (35) on publicly-owned lands
  - Difficult to gain access to poor condition privately-held wetlands

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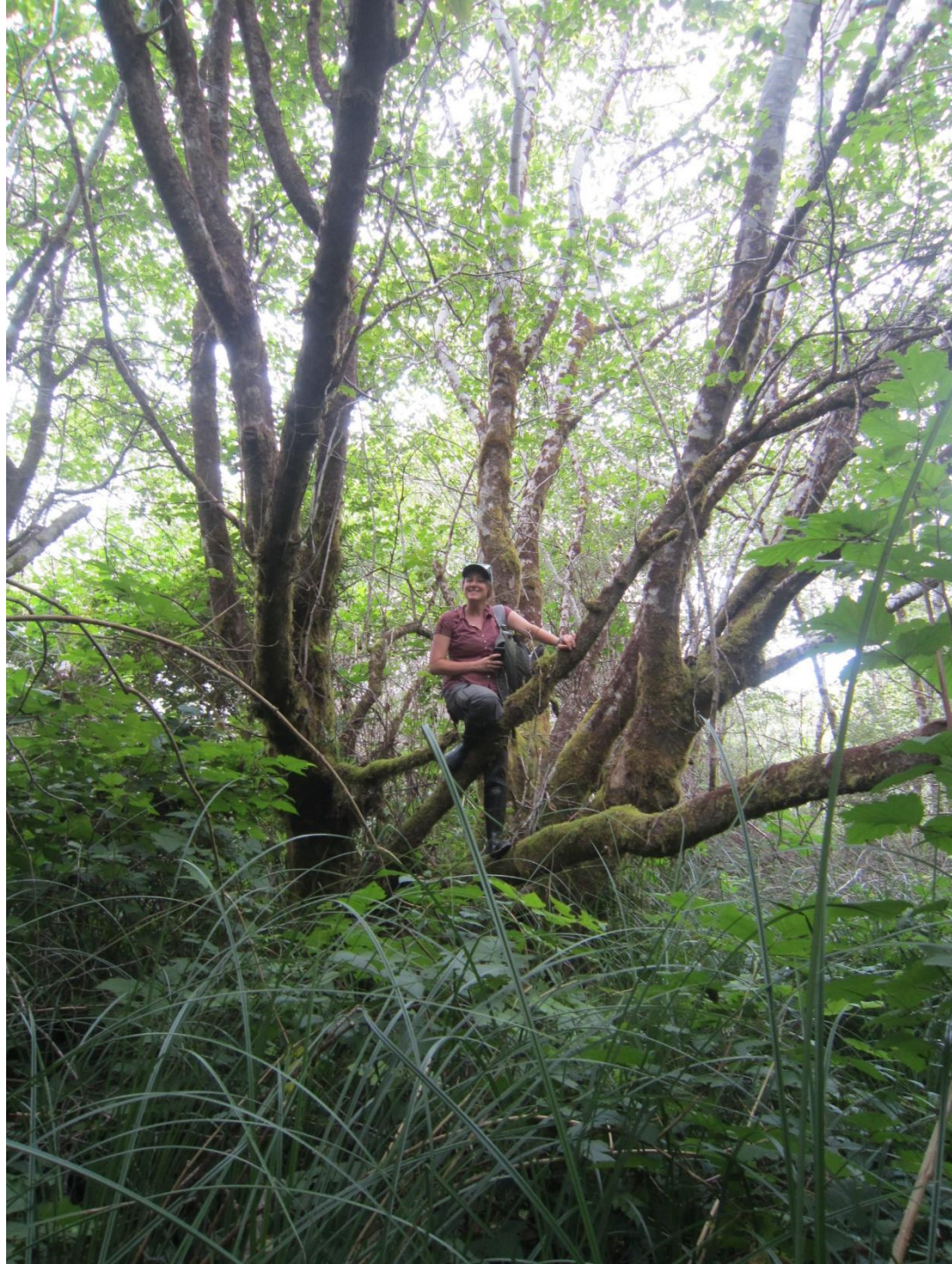


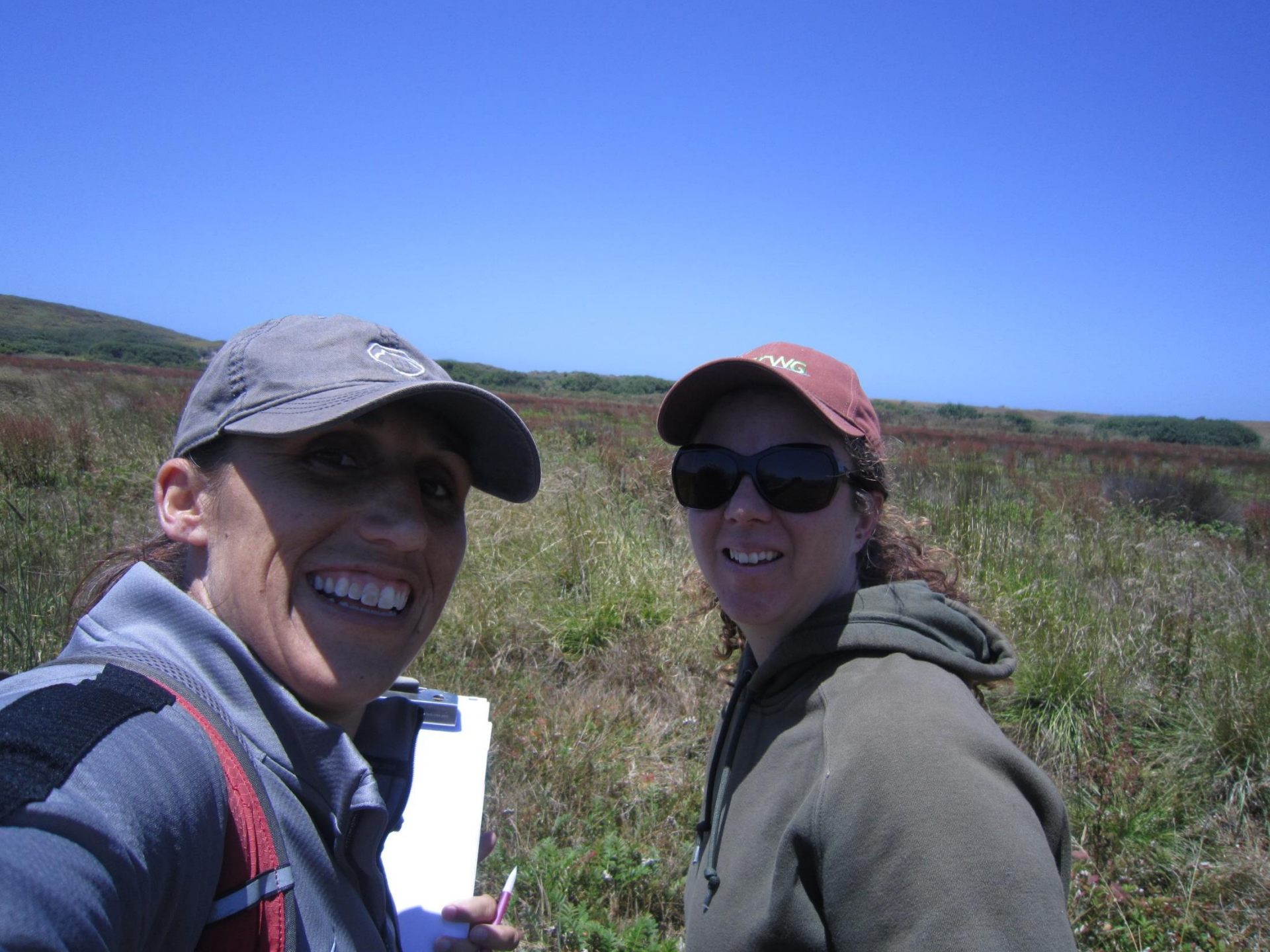












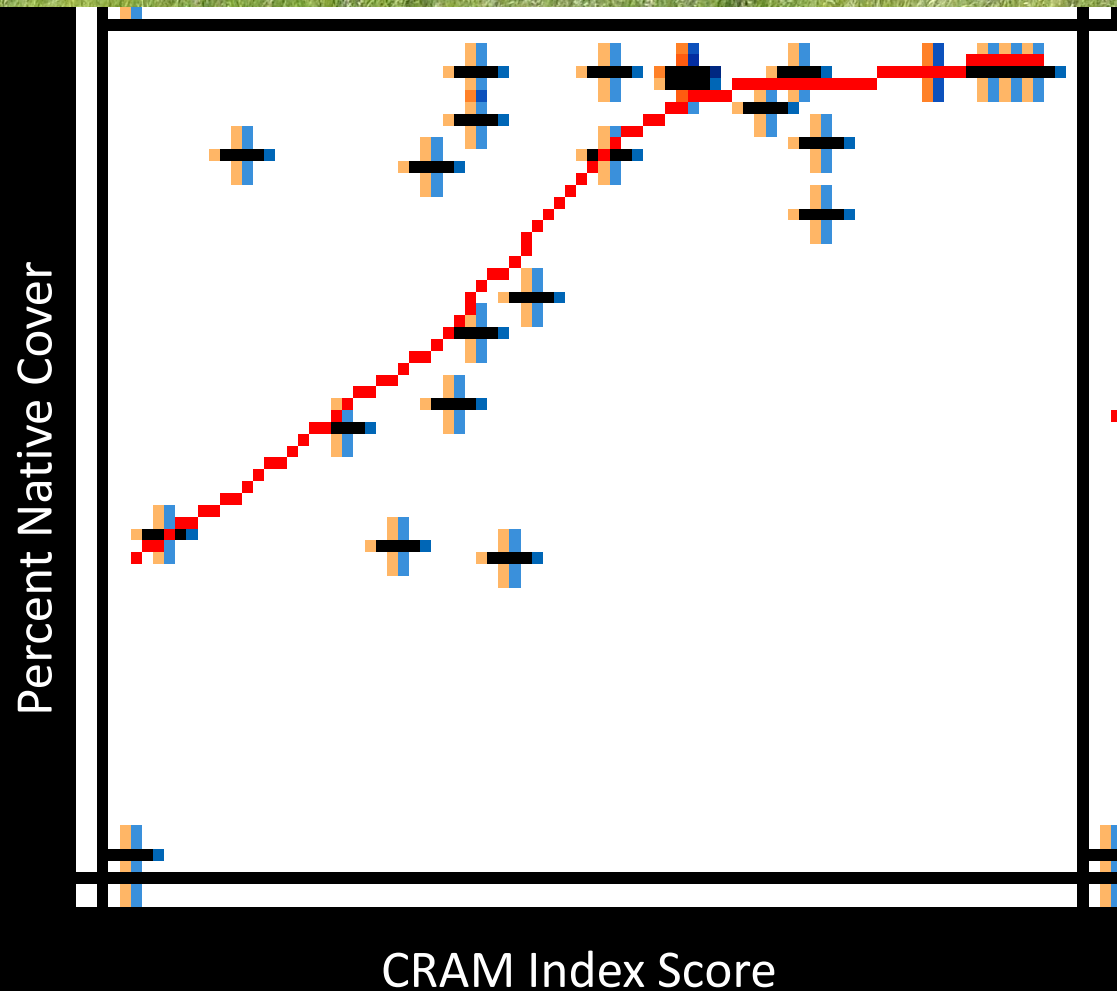


# Percent Native Cover

- Results:

A positive relationship, showing increasing CRAM score with increasing percentage of native cover

Spearman's  $\rho = 0.76$ ,  $P = <0.0001$



# Percent Early-, Mid-, and Late-Successional Plants

- Conceptual model:
  - Describes the species of plants that come in after a disturbance.
  - Early-successional come in first, immediately after the disturbance.
  - Late successional come in last, a long time after the disturbance.



# Percent Early-, Mid-, and Late-Successional Plants

- Results:

A negative relationship with Early-successional

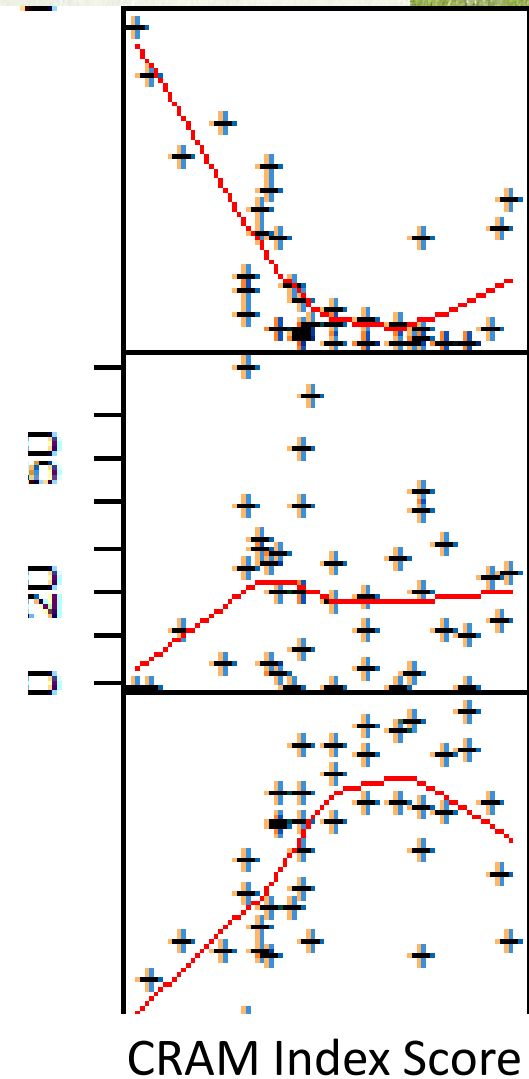
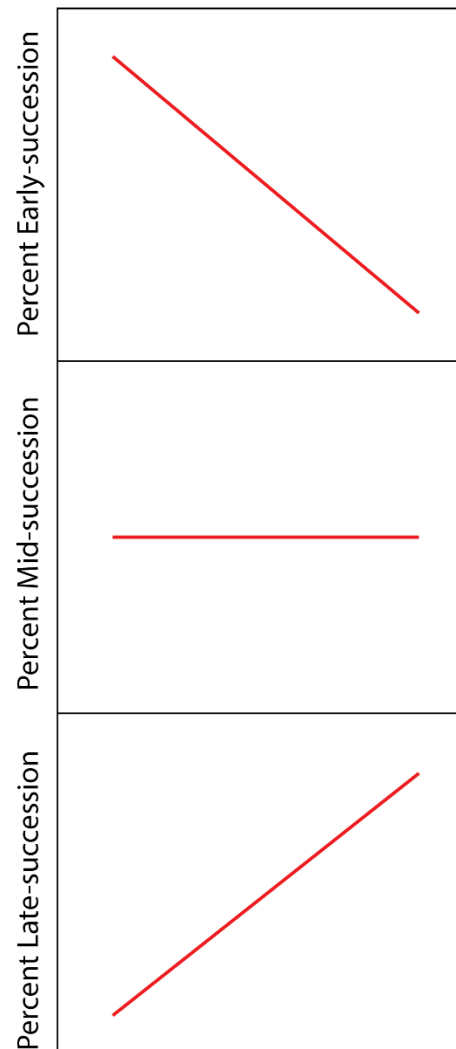
Spearman's  $\rho = -0.59$ ,  $P = <0.0001$

No relationship with Mid-successional

Spearman's  $\rho = -0.02$ ,  $P = 0.894$

A positive relationship with Late-successional

Spearman's  $\rho = 0.57$ ,  $P = 0.0001$





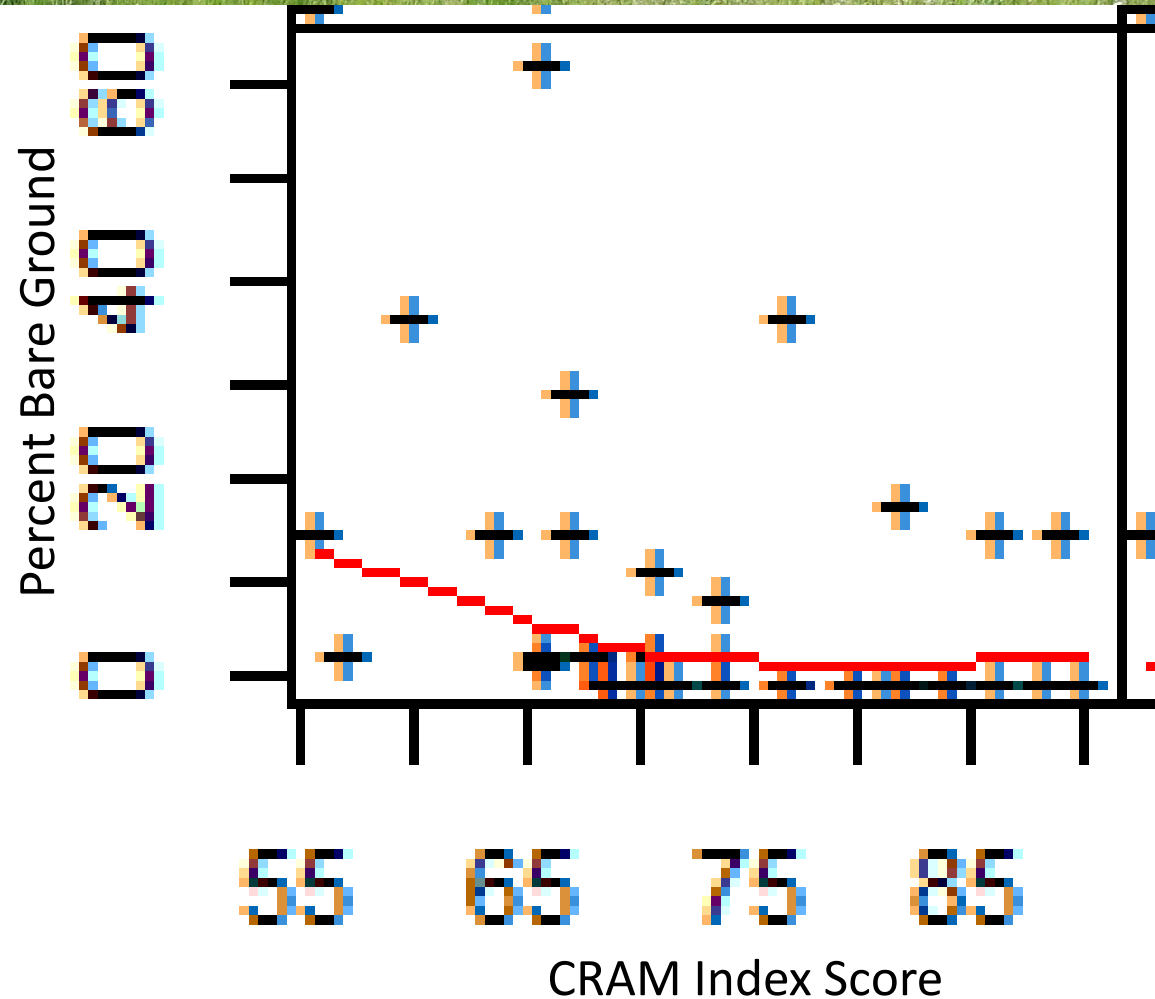
# Percent Bare Ground

- Results:

A moderate negative relationship, showing decreasing CRAM score with increasing percentage of non-native cover

Spearman's  $\rho = -0.47$ ,  $P = <0.002$

Variety of percentage of bare ground in poor condition sites, likely with many other factors affecting condition in addition to bare ground





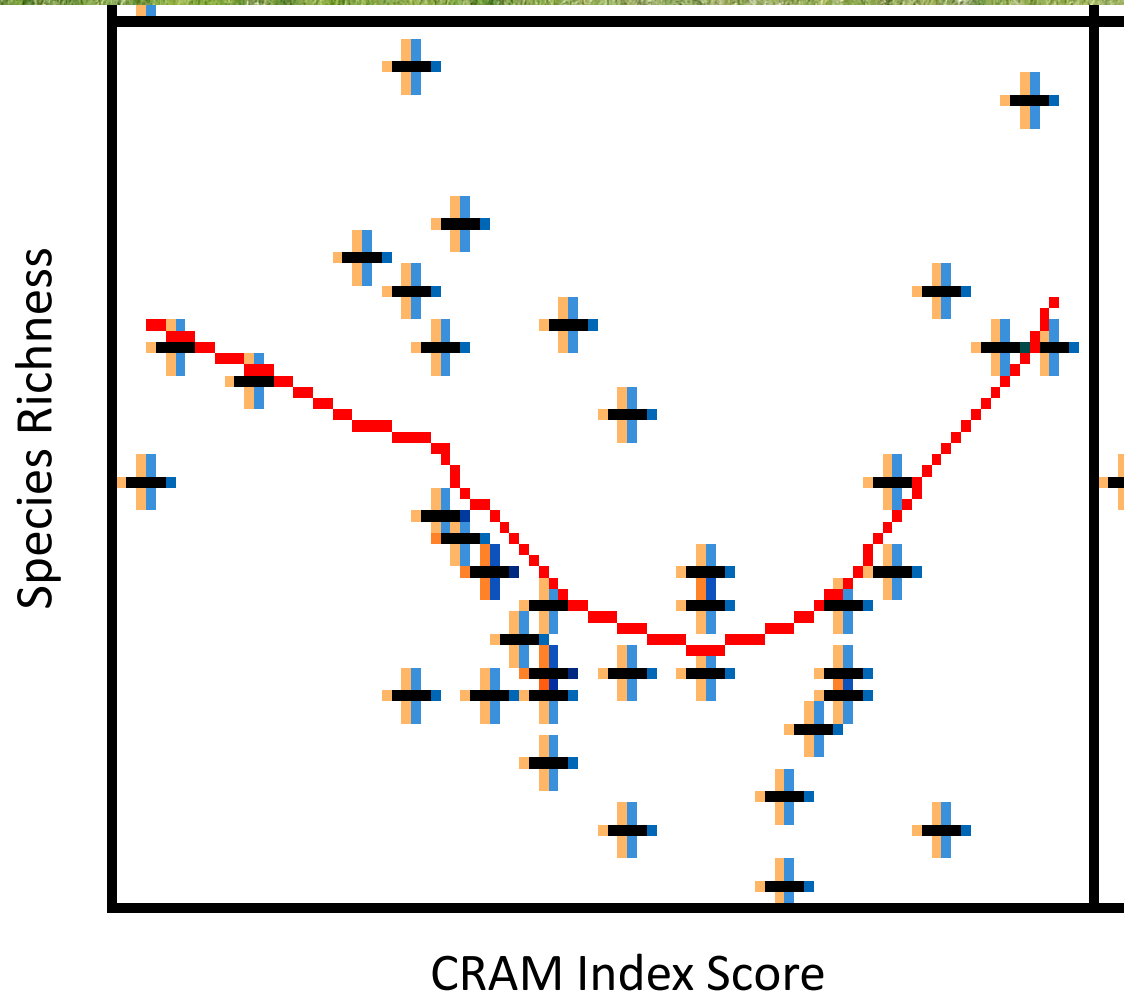
# Species Richness

- Results:

Index scores were not well correlated with Richness.

Spearman's  $\rho = -0.23$ ,  
 $P = <0.154$

Low condition sites are high disturbance and high richness.



# Ratliff Vegetation Score

- Looks at species composition and ecological position to indicate vegetative condition.
- Uses species composition method to look at percent of decreaser, increaser, and invader species.
- Decreaser = would decrease in cover due to overgrazing (they are sensitive)
- Increaser = would expand and increase due to overgrazing (they are hardy)
- Invader = were not present before the disturbance, since colonized and invaded the area
- Higher scores = better condition = higher percentage of decreaser and increaser species compared to total number of species

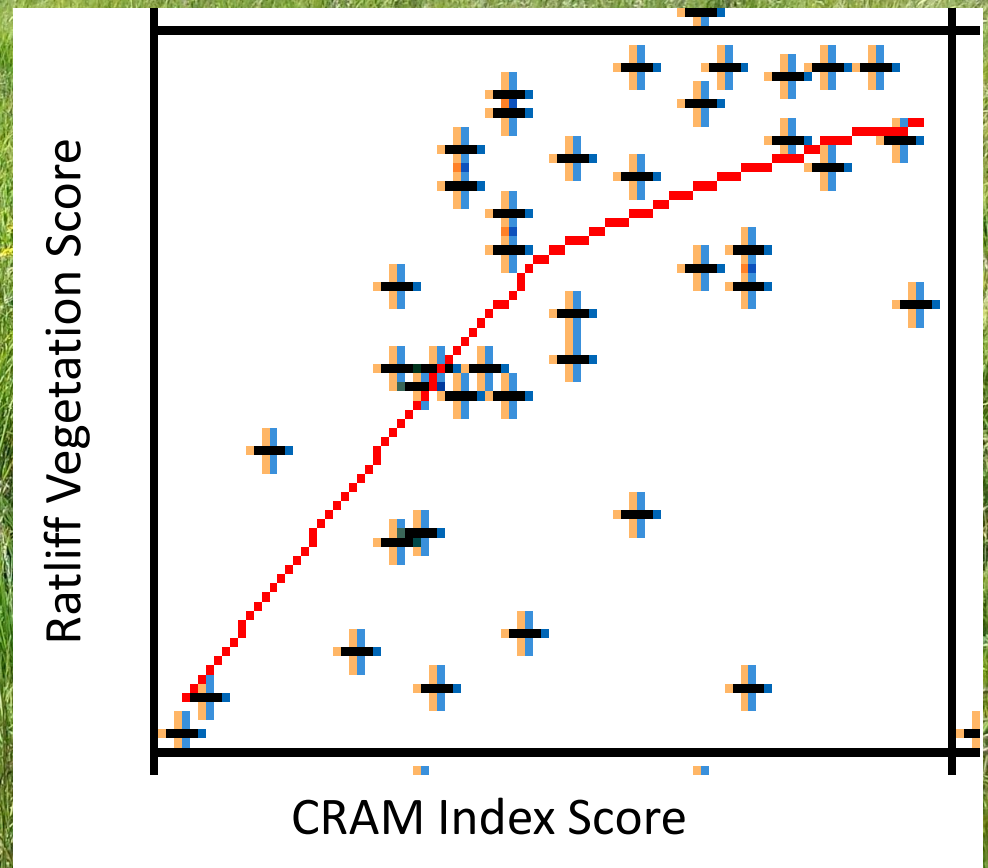
# Ratliff Vegetation Score

- Results:

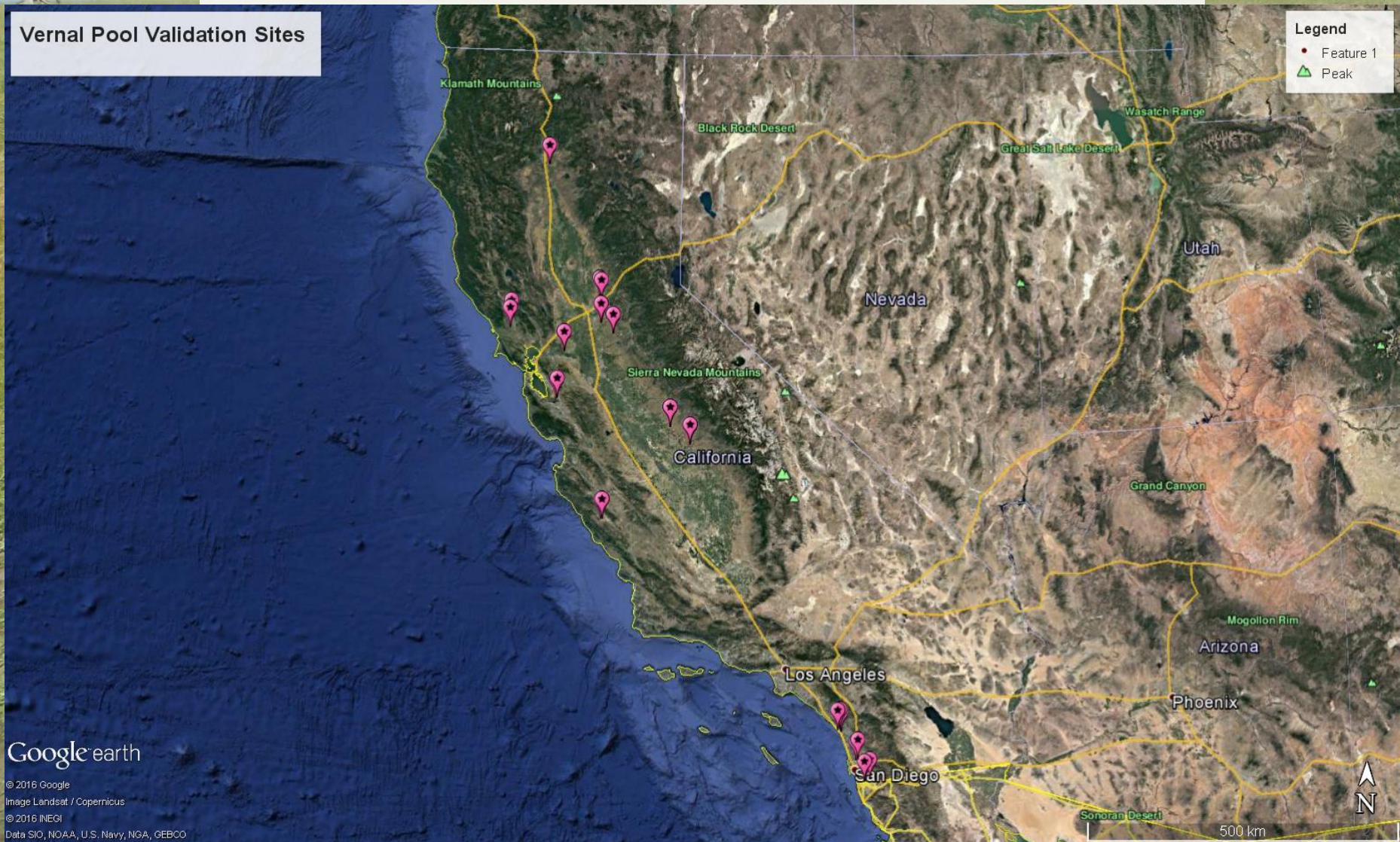
Index scores correlated well with Ratliff scores.

Spearman's  $\rho = 0.62$ ,  $P = <0.0001$

Sites with low Ratliff scores have many invasive species, often occurring in stressed and disturbed sites, which will be evident in many other CRAM metrics



# Vernal Pool Validation Sites



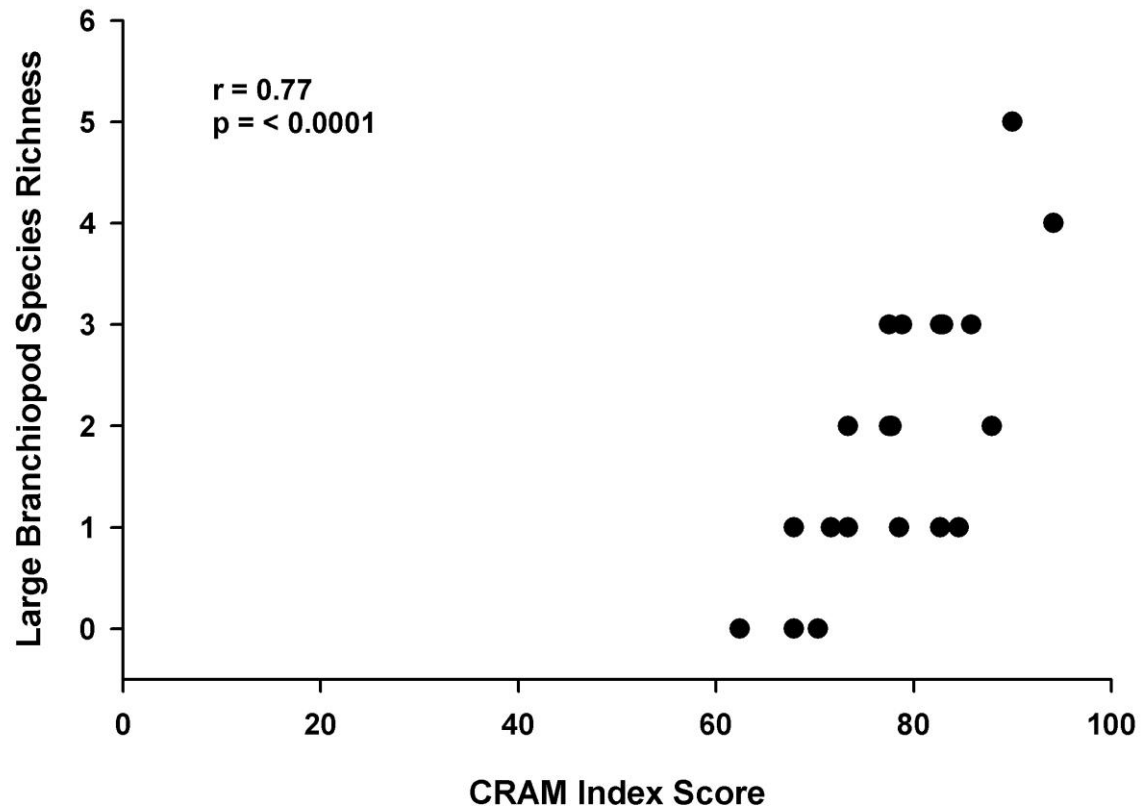
# Level 3 Data

- Vegetation data
  - Species Richness
  - Percent Native Cover
  - Shannon Diversity Index
  - Shannon Evenness Index
- Invertebrate data
  - Large Branchiopod Species Richness
  - Species Richness of All Invertebrates



Photo by Ken-ichi Ueda  
<https://creativecommons.org/licenses/by-nc/2.0/legalcode>

# Significant Correlation!

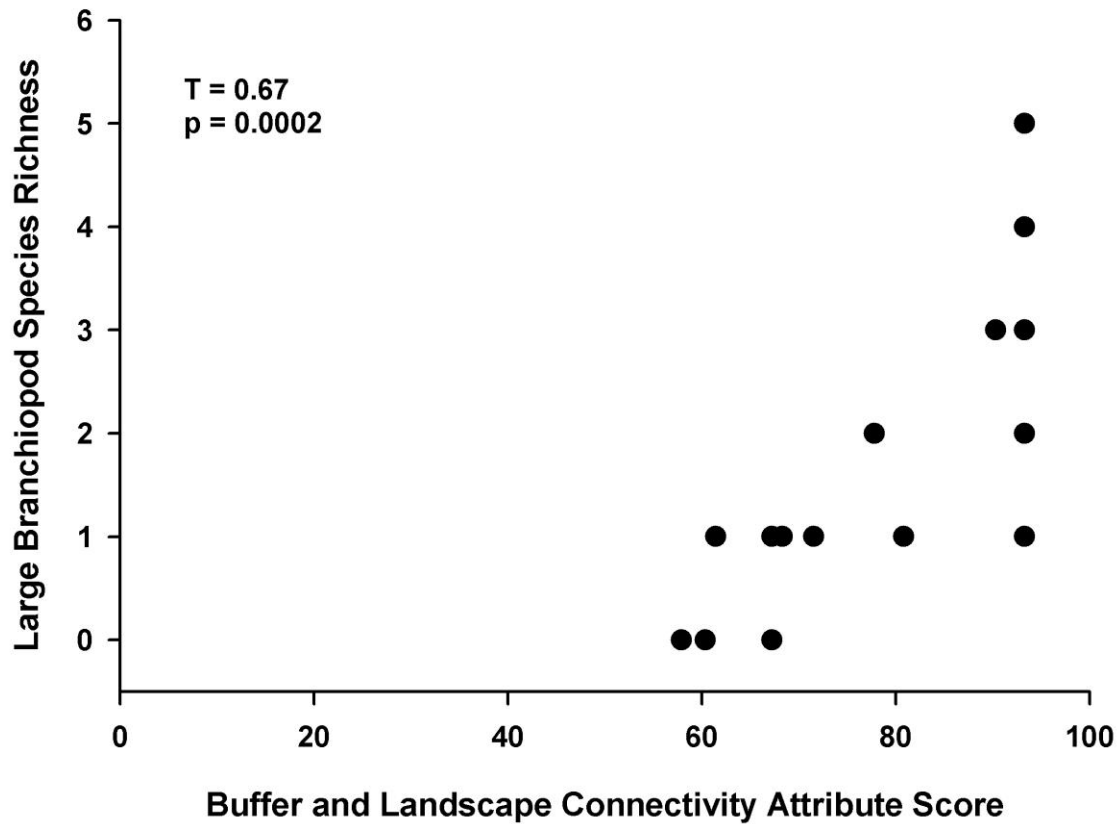




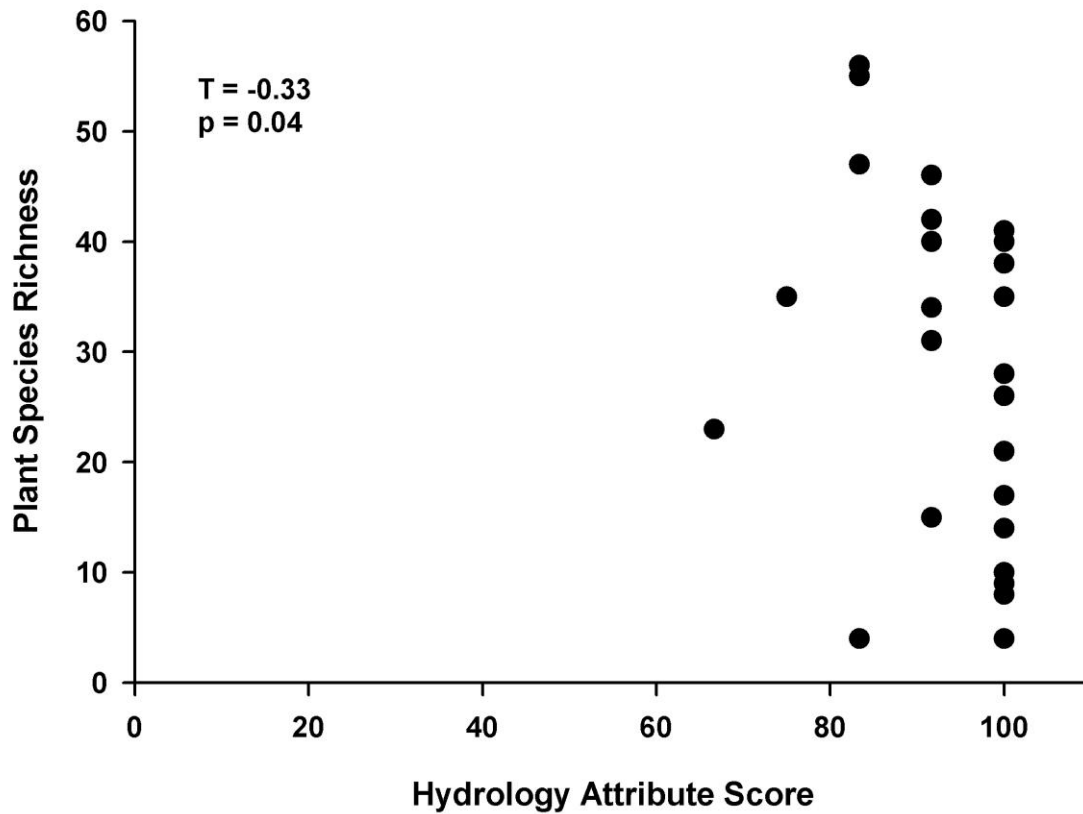
# Correlation Table

	Log transformed Invert Sp Rich	Large Branchiopods	Plant Species Richness	Endemic Plant Species Richness	Native % Cover	Non-native % Cover	Shannon Diversity Index	Shannon Evenness Index
CRAM Score	0.23	0.77	0.21	0.32	0.33	-0.16	0.34	0.43
p-value	0.35	<b>&lt;0.0001</b>	0.31	0.11	0.15	0.50	0.17	0.07
n	19	21	26	26	20	20	18	18
Physical Structure	0.18	0.52	0.14	0.17	0.12	-0.1	0.55	0.23
p-value	0.47	<b>0.02</b>	0.48	0.40	0.63	0.70	<b>0.02</b>	0.36
n	19	21	26	26	20	20	18	18
Biotic Structure	0.23	0.63	0.42	0.52	0.34	-0.09	0.58	0.56
p-value	0.35	<b>0.002</b>	<b>0.03</b>	<b>0.006</b>	0.14	0.70	<b>0.01</b>	<b>0.01</b>
n	19	21	26	26	20	20	18	18

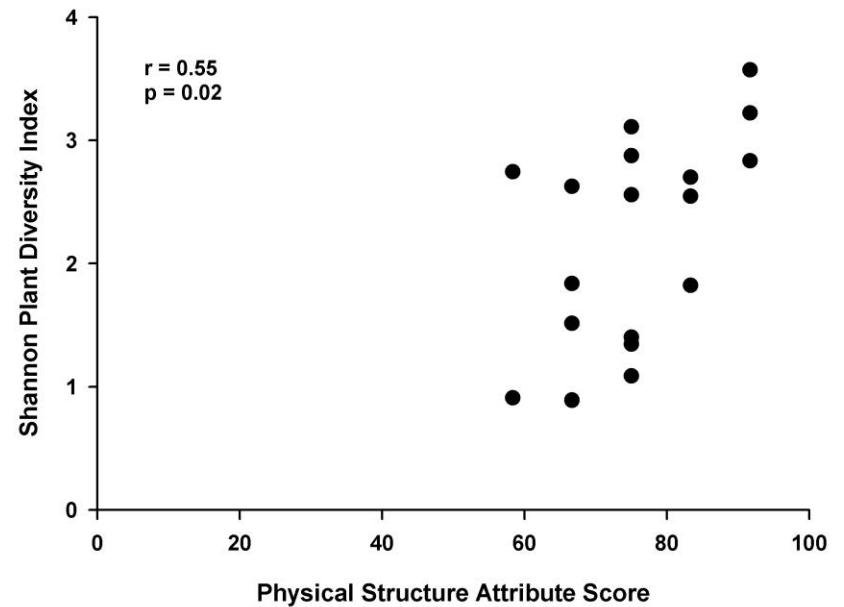
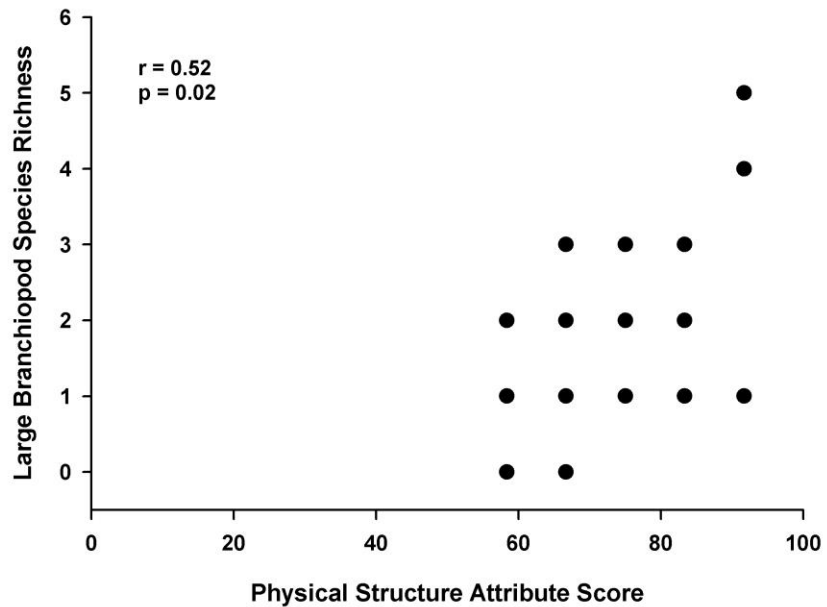
# Buffer and Landscape Context



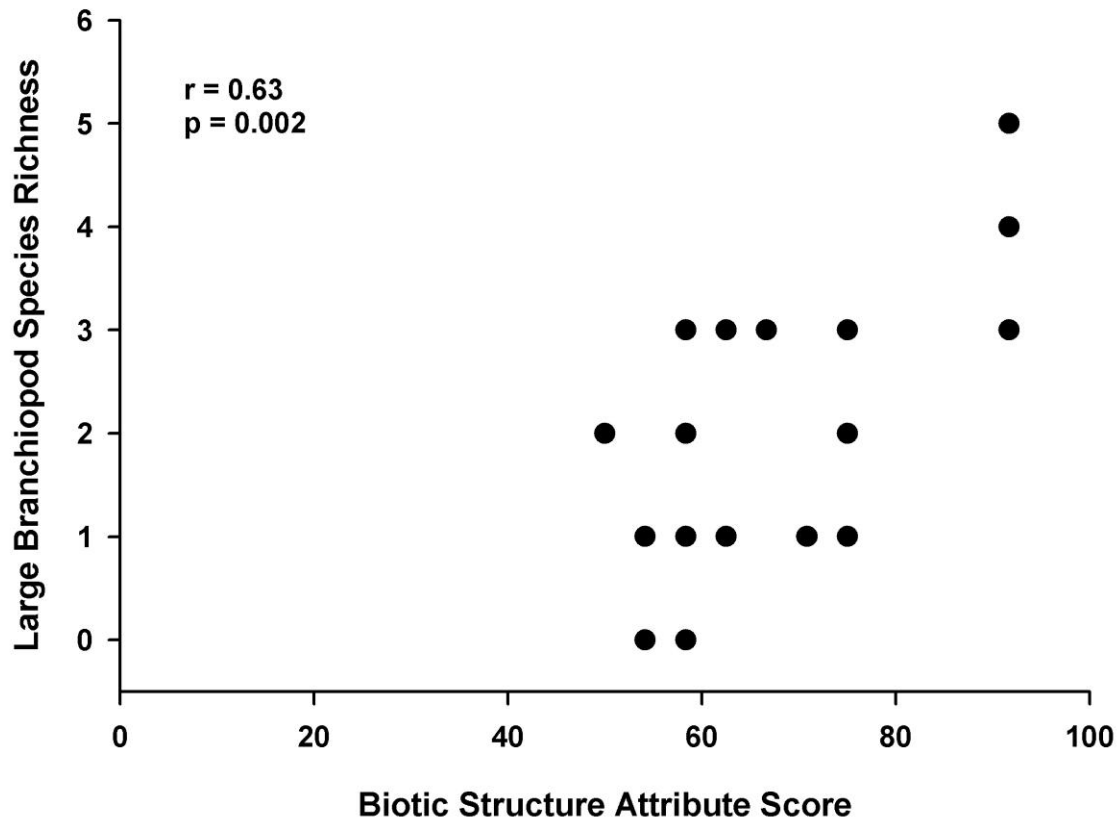
# Hydrology – unexpected negative correlation – artifact of skewness



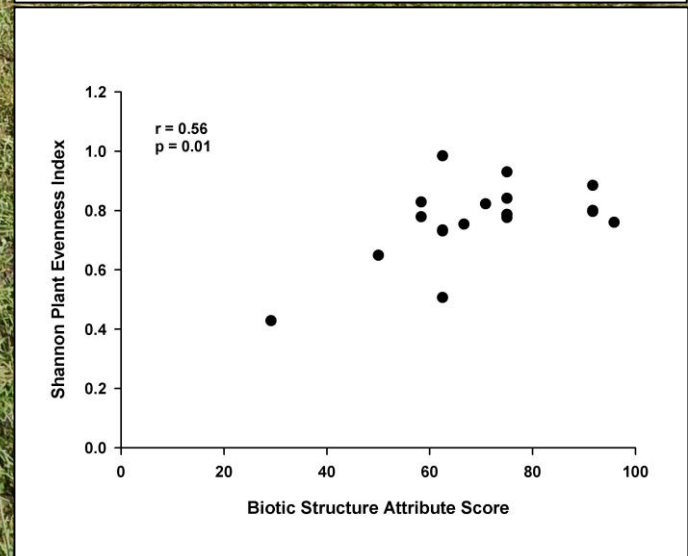
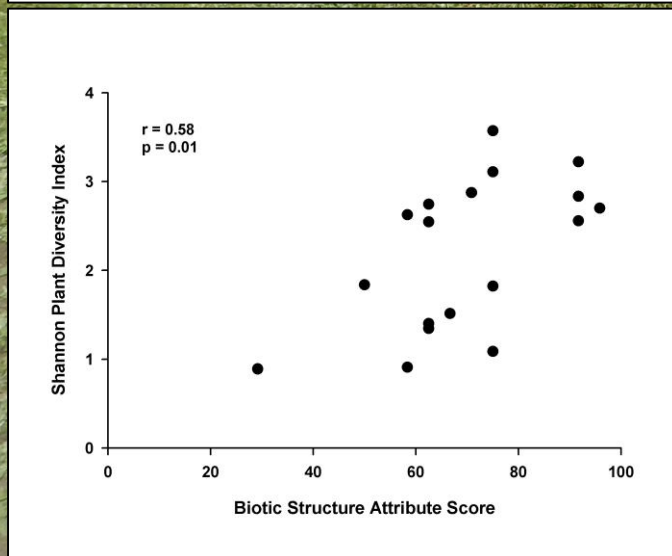
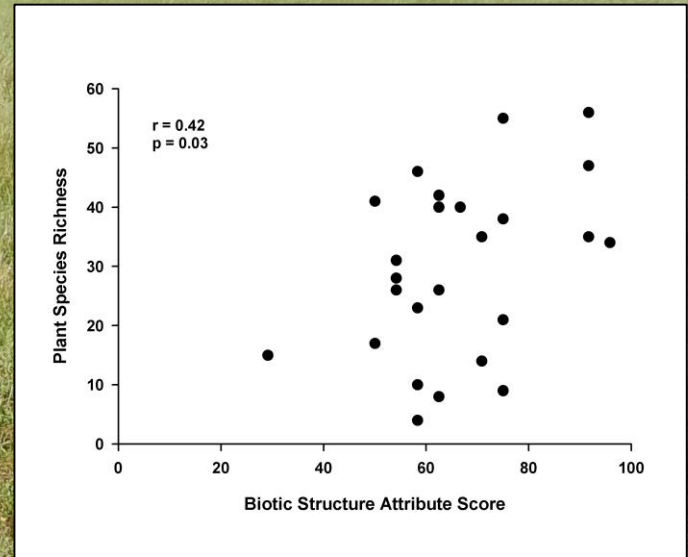
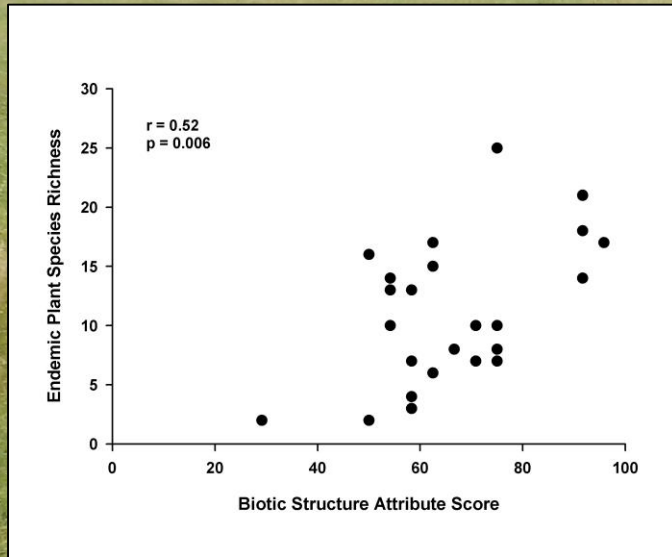
# Physical Structure

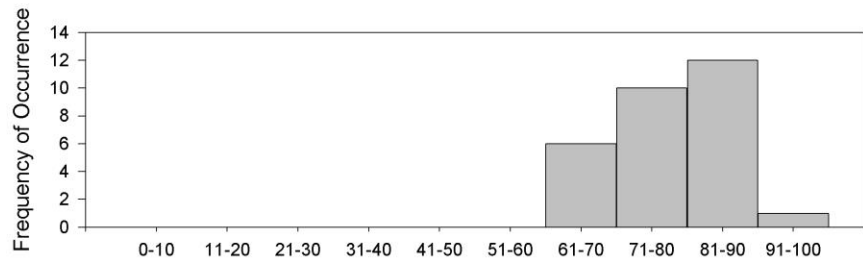


# Biotic structure

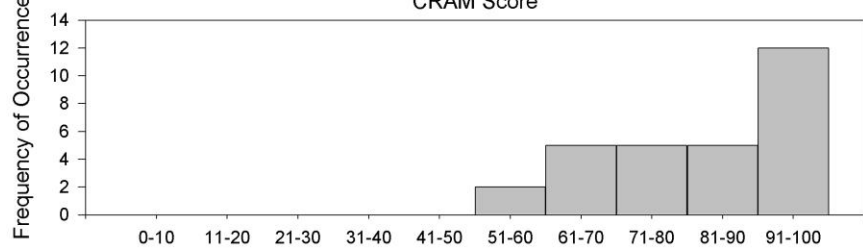


# Biotic Structure continued

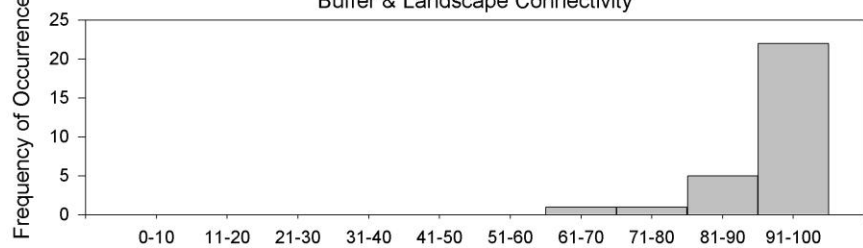




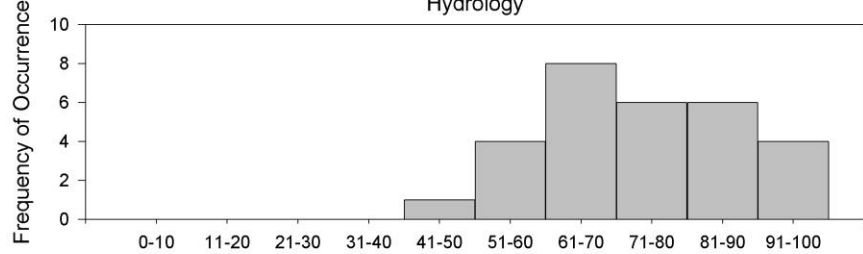
CRAM Score



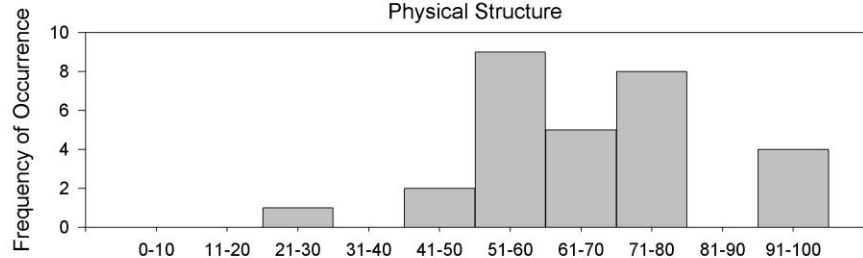
Buffer & Landscape Connectivity



Hydrology



Physical Structure



Biotic Structure



# Partners and Collaborators: Depressional

- Partners and contractors: San Francisco Estuary Institute, San Francisco Bay Regional Water Quality Control Board, Southern California Coastal Water Research Project, Aquatic Bioassessment Laboratory, and EcoAnalyst
- Collaborators: USFS, USFWS, NPS, CDFW, SWRCB, City of Arcata, City of Roseville, City of Watsonville, California Tahoe Conservancy, The Nature Conservancy, Sacramento Audubon Society, Pacific Gas and Electric, Lake Tahoe Golf Course, Fall River Mills Golf Course, other private landowners





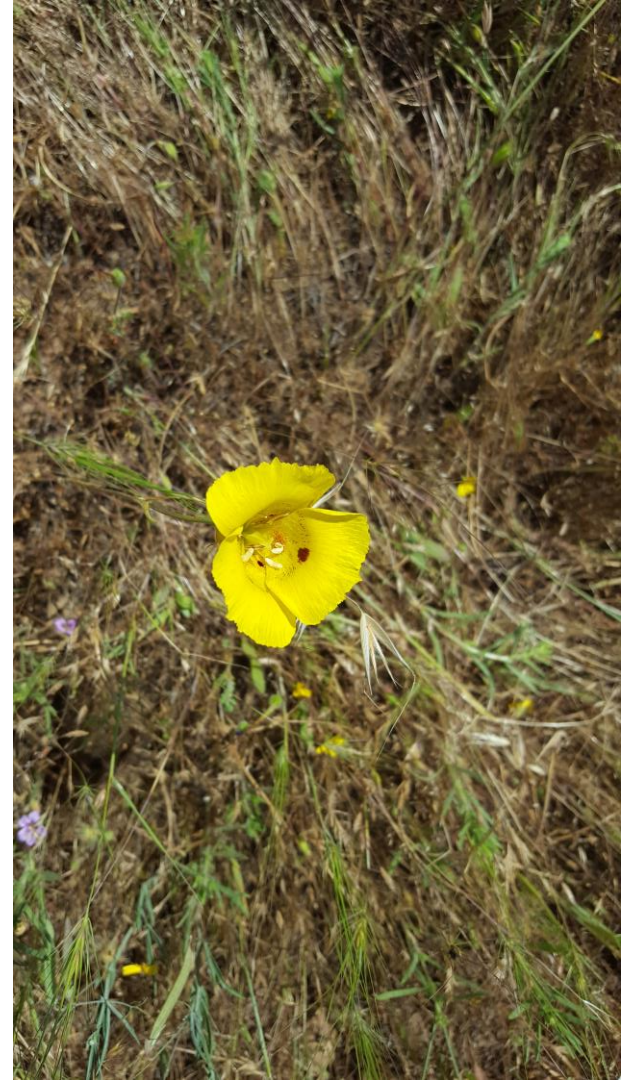
# Partners and Collaborators: Slope

- Partners and contractors: San Francisco Estuary Institute (Sarah Pearce), ICF International (Lindsay Teunis), AECOM (Debra Sykes)
- Collaborators: USFS, USFWS, NPS, CDFW, CA State Parks, San Francisco Dept. of Parks and Rec., American Rivers, Sacramento Audubon, other private landowners



# Partners and Collaborators: Vernal Pools

- Partners and contractors:  
Vollmar Natural Lands Consulting (John Vollmar and Jake Schweitzer), ICF International (Lindsay Teunis), ECORP (Debra Sykes)
- Collaborators: USFWS, U.S. Dept. of the Army, U.S. Marine Corps, CDFW, CalTrans, City of Roseville, Larry Stromberg, private landowners



Thank you

