Bioassessment of the San Joaquin River: Implications for Chinook Salmon Habitat Restoration

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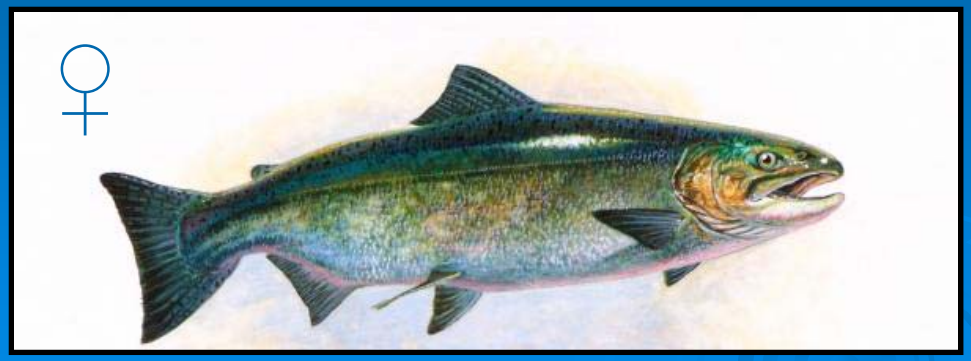
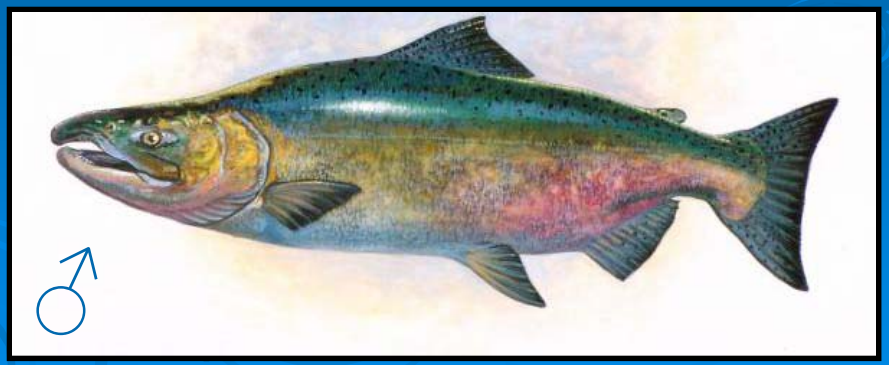
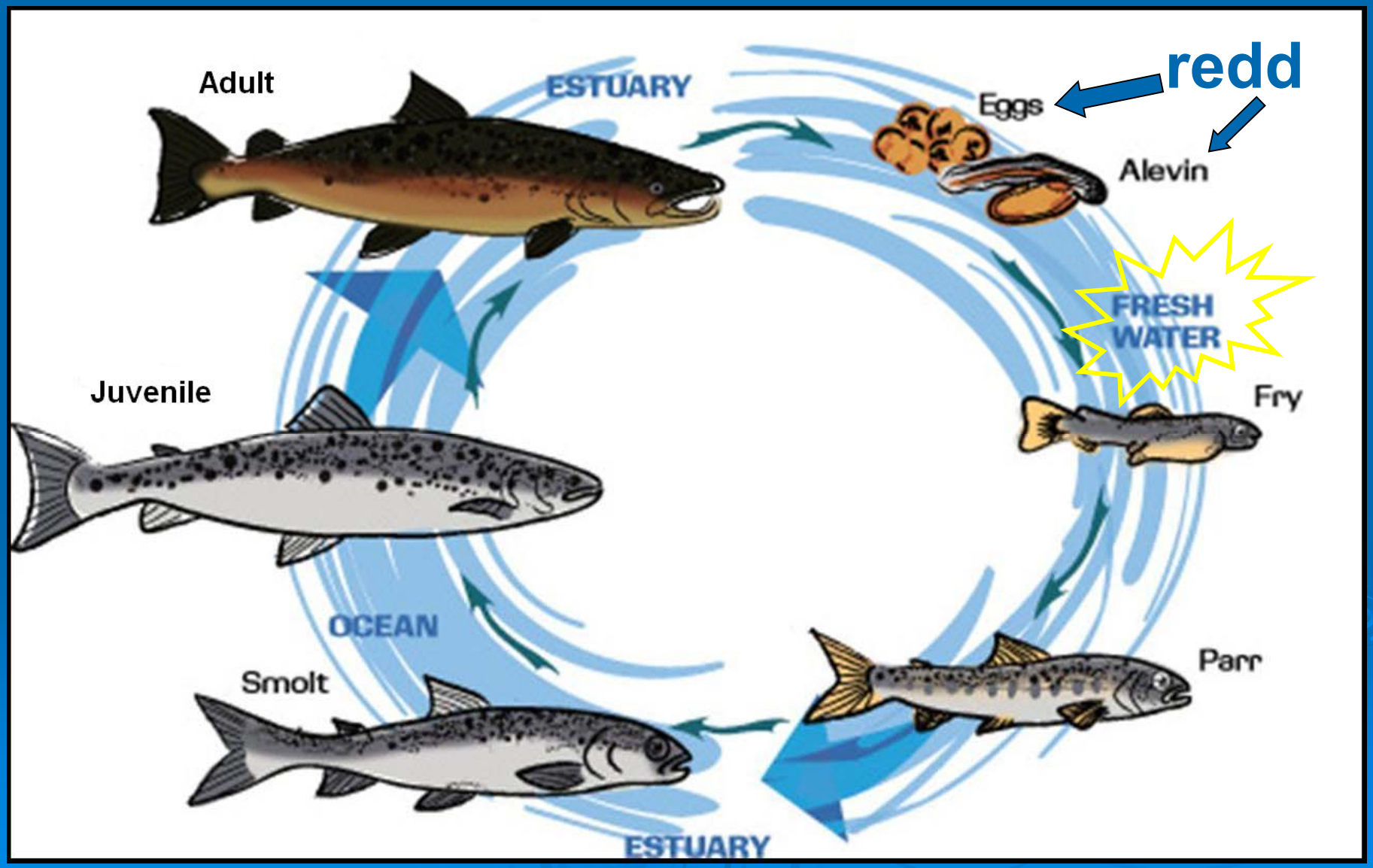
Chinook Salmon

- *Oncorhynchus tshawytscha*
- Anadromous
- California's Central Valley runs
  - Fall/late fall = species of concern
  - Winter = endangered
  - Spring = threatened

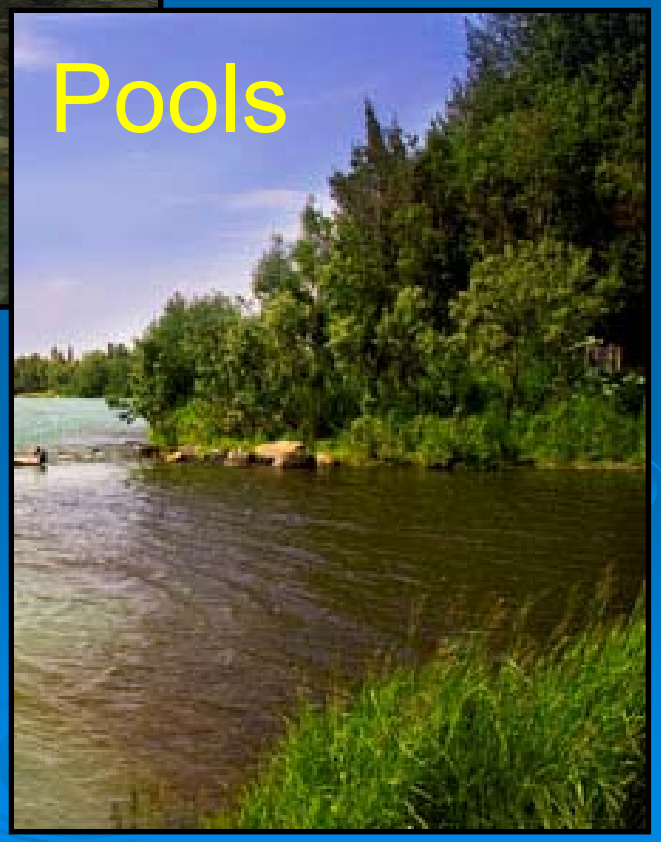




Chinook Salmon Lifecycle



Chinook Salmon Freshwater Habitat



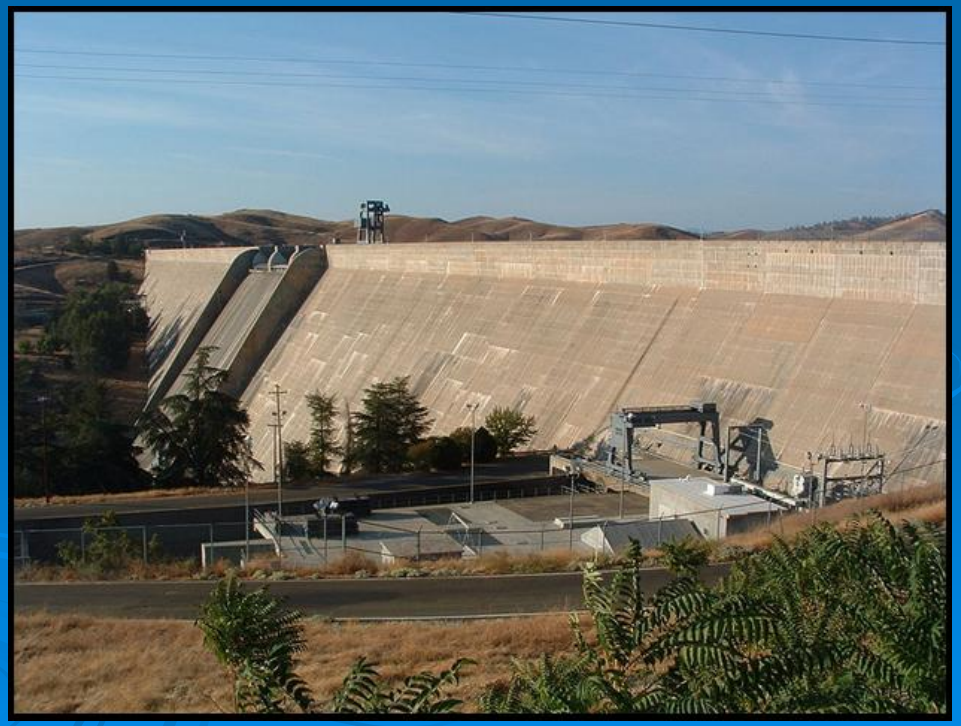
Chinook Salmon Freshwater Habitat


Family Chironomidae

- Benthic macroinvertebrates
  - Fry and parr food source
  - Indicators of freshwater habitat conditions

San Joaquin River

- Historically abundant population of Chinook
- Mostly nonexistent today between:
  - Hills Ferry barrier (Merced River)
  - Friant Dam
- Degraded habitat
- Over 60 miles of insufficient flows



Restoration Settlement Act of 2009

- San Joaquin River Restoration Program
  - Increase Friant Dam flow releases
  - Reintroduce spring-run Chinook salmon
- Bioassessment of 2010-2012 habitat conditions
- SWAMP bioassessment

San Joaquin River Restoration Area

Reach Number	Begins at	Ends at	Length (miles)
1	Friant Dam	Gravelly Ford	39
2	Gravelly Ford	Mendota Dam	24
3	Mendota Dam	Sack Dam	23
4	Sack Dam	Eastside Bypass	46
5	Eastside Bypass	Merced River	18

Eastside Bypass

Sack Dam

Mendota Dam

Gravelly Ford

Friant Dam

Map credit: A. León

San Joaquin River Reach 1

- Reference site
- Sites with good biological condition
  - 2010 preliminary bioassessment analysis
  - Central Valley index of biotic integrity
- Minimally disturbed conditions

Research Objectives

- 2010 and 2011 SWAMP bioassessment
- **Abundance** and **diversity** of benthic macroinvertebrates
  - San Joaquin River Reach 2 – 5
  - Which differed from Reach 1?
  - Which should be restored?

Research Objectives

- 2010 and 2011 SWAMP bioassessment
- Physical habitat variables
  - Which require restoration for salmon?

Method: SWAMP Bioassessment

Results: Benthic Macroinvertebrates (BMIs)

Caddisfly – *Mysticides habitus*

Mayfly – *Callibaetis habitus*

Number of BMI Samples Collected

Year	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Total
2010	11	10	6	2	5	34
2011	10	8	9	5	1	33

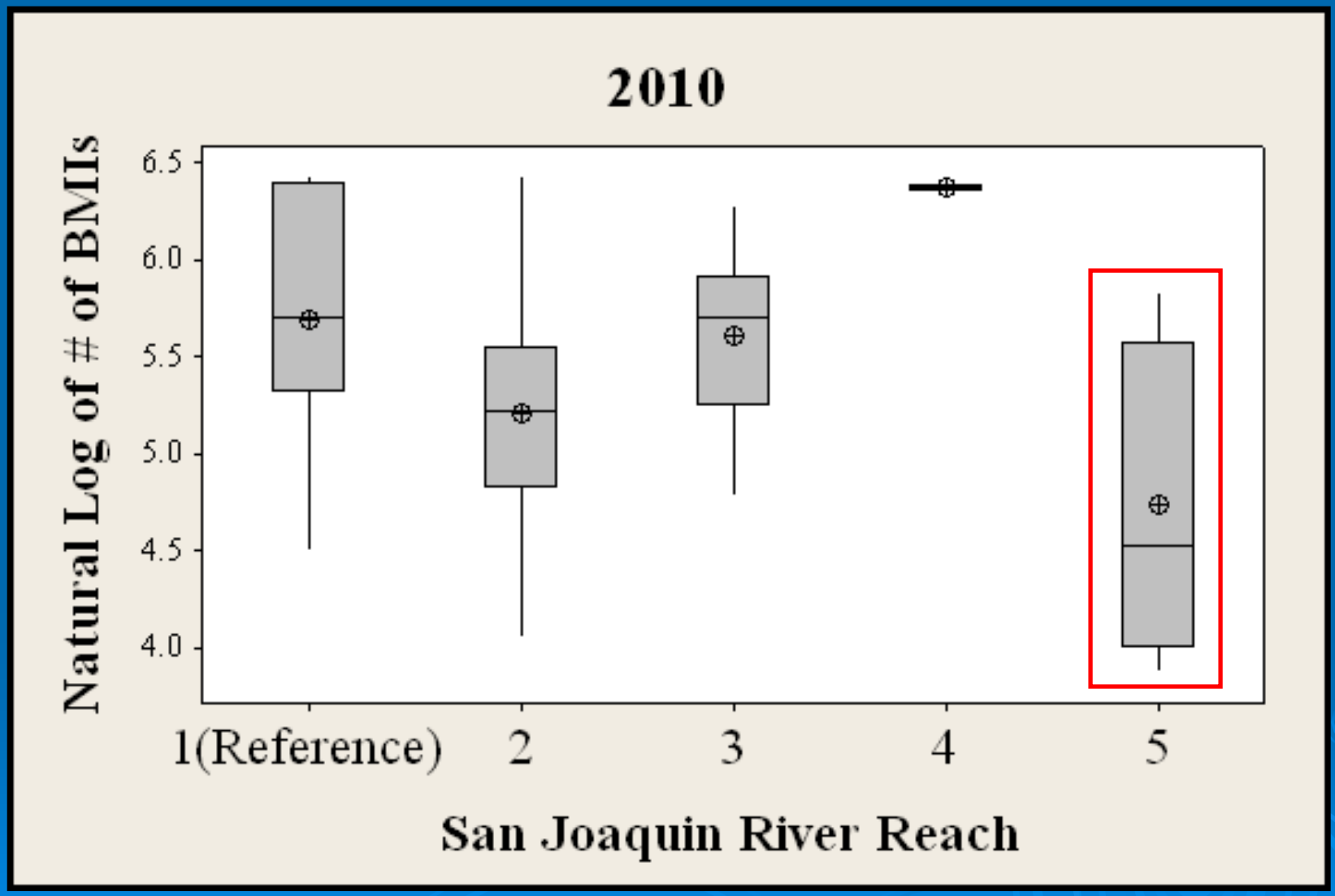
Summary of BMI Results

	2010	2011
Total Number of Samples Collected	34	33
Total Number of BMIs	9,722	6,711
Minimum Number	48	11
Maximum Number	622	595
Mean	285.9	203.4
Standard Error	31.3	33.9

Research Objectives

- **Abundance** and diversity of benthic macroinvertebrates
  - San Joaquin River Reach 2 – 5
  - Which differed from Reach 1?
  - Which should be restored?

BMI Abundance: One-way ANOVA

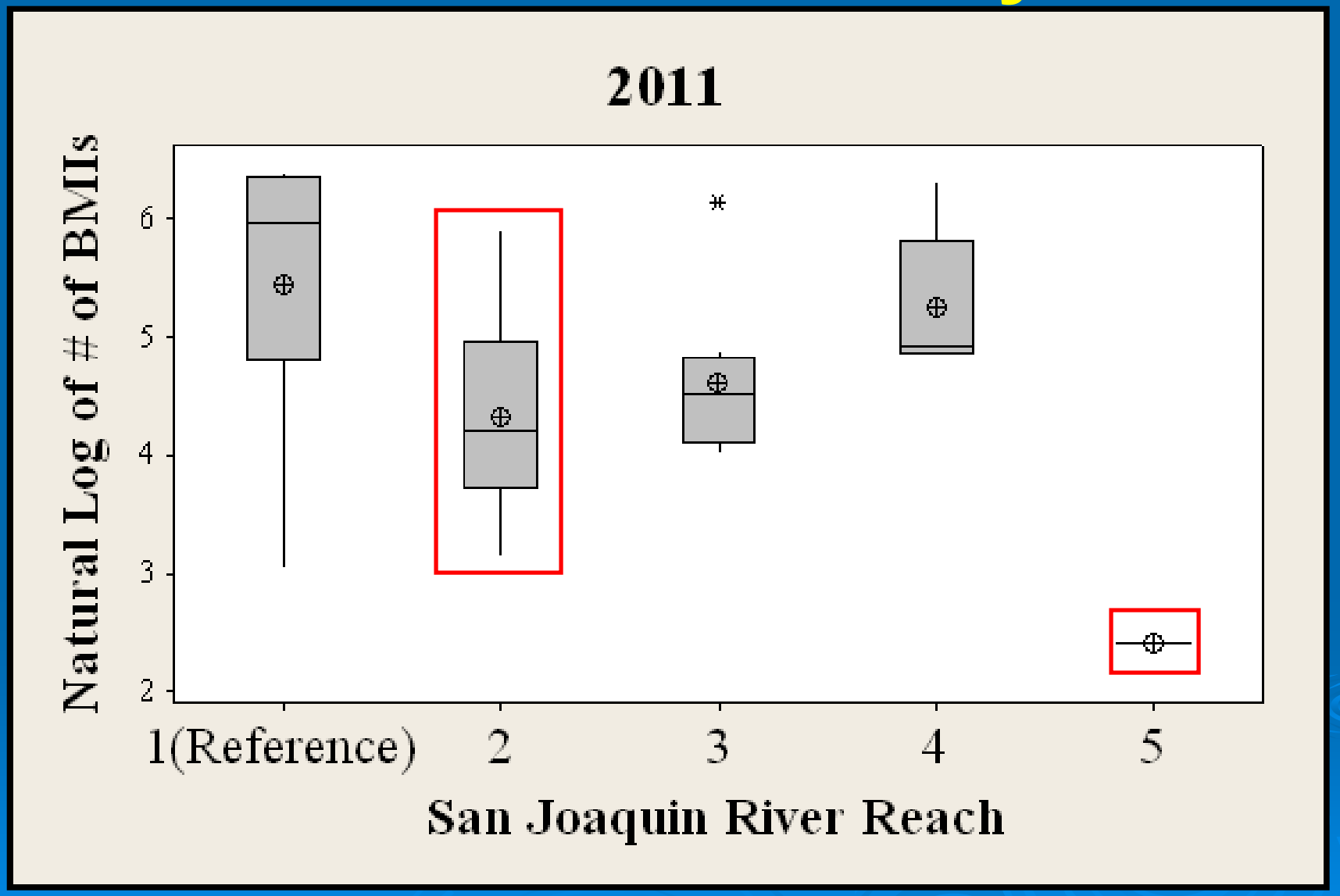


- 95% confidence interval
- p-value = 0.016

BMI Abundance: Dunnett's Test

- 2010
  - Reach 5 was different from 1
  - Reach 2, 3, 4 were similar to 1

BMI Abundance: One-way ANOVA



- 95% confidence interval
- p-value = 0.010

BMI Abundance: Dunnett's Test

- 2011
  - Reach 2, 5 were different from 1
  - Reach 3, 4 were similar to 1

San Joaquin River Restoration Area

Reach Number	Begins at	Ends at	Length (miles)
1	Friant Dam	Gravelly Ford	39
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Eastside Bypass

Sack Dam

Mendota Dam

Gravelly Ford

Friant Dam

Map credit: A. León

BMI Abundance

- Which reaches should be restored?
  - Reach 2
    - Historically dry most of the year
    - Sandy substrate
    - Limited water conveyance

BMI Abundance

- Which reaches should be restored?

- Reach 5
  - Flows from adjacent waterways
  - Agricultural areas
  - Poor water quality

Research Objectives

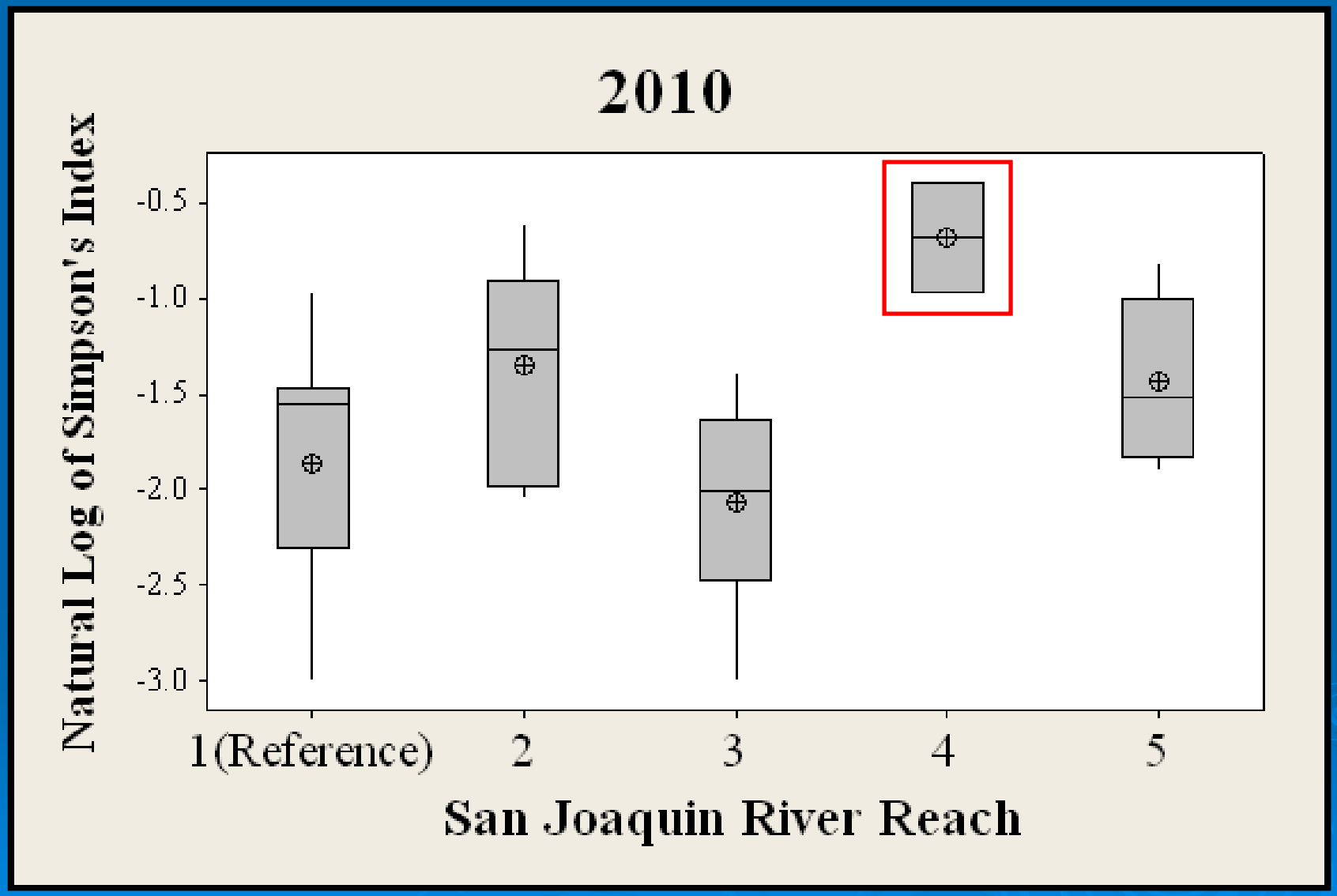
- Abundance and **diversity** of benthic macroinvertebrates
  - San Joaquin River Reach 2 – 5
  - Which differed from Reach 1?
  - Which should be restored?

Simpson's Index of Diversity

$$1 - D = 1 - \sum_{n-1}^{i} \frac{n_i (n_i - 1)}{N (N - 1)}$$

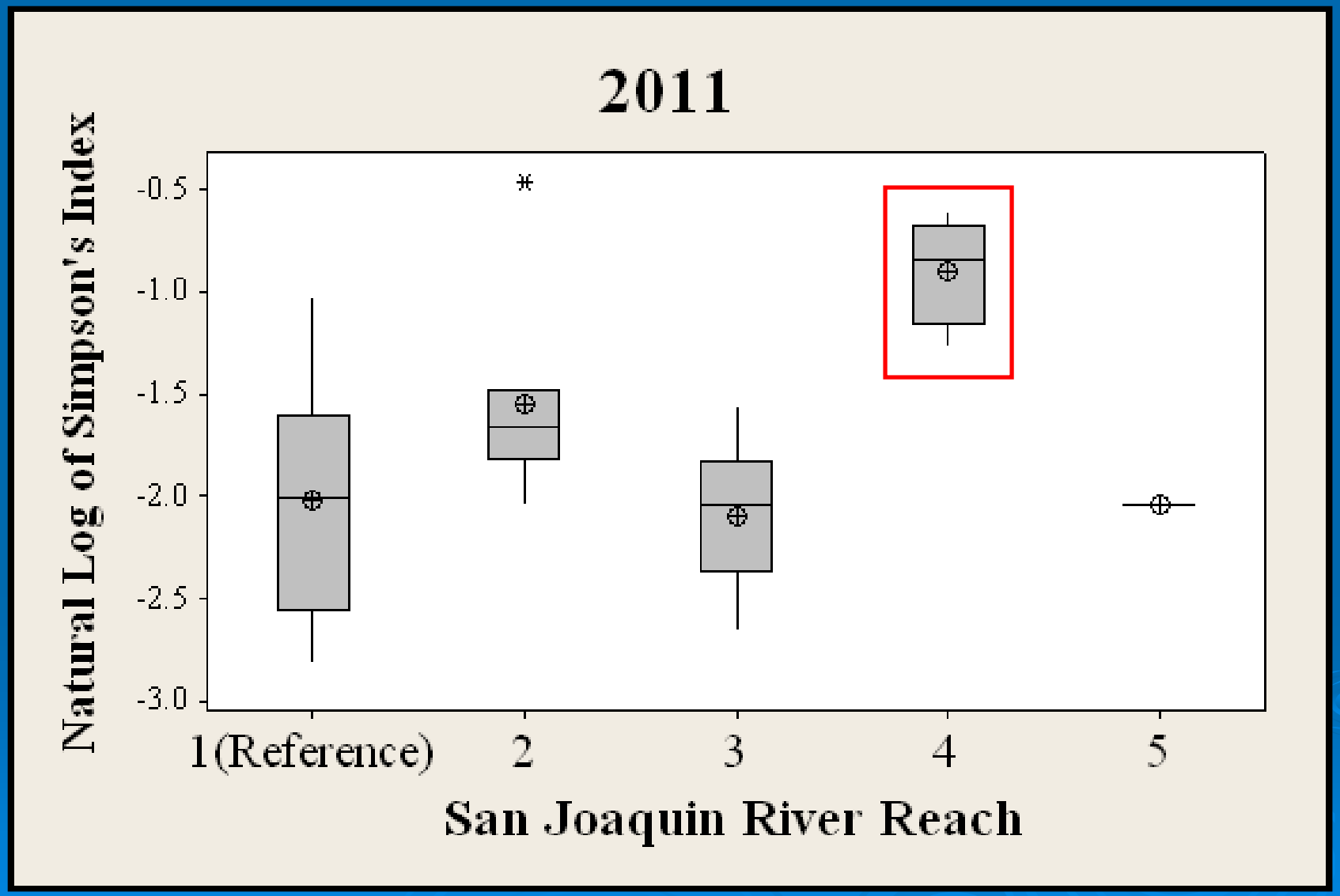
- N = total # per sampling reach
- n = total # per species
- Ranges from zero to one
- Higher index = higher diversity

Simpson's Index: One-way ANOVA



- 95% confidence interval
- p-value = 0.002

Simpson's Index: One-way ANOVA



- 95% confidence interval
- p-value = 0.000

Results: Physical Habitat Variables

Physical Habitat Variables: PCA

	PC 1 (20.4%)	PC 2 (15.6%)
Depth	**0.332**	0.008
% Gravel	0.099	**0.393**
Riparian Vegetation Complexity	**0.395**	0.057
Instream Habitat Complexity	**0.328**	0.023
% Fast Water Habitat	-0.064	**0.506**

PC 1: Physical Habitat Complexity

- Addition of:
  - Boulders
  - Woody debris
  - Artificial structures
  - Riparian canopy vegetation
- Dam!

PC 2: Physical Habitat for Redds

- Addition of gravel
- Alter streambed topography:
  - Boulders
  - Woody debris
  - Artificial structures
- Creates upwelling and downwelling

Acknowledgments

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Questions?