Investigation of Natural Levels of Total Dissolved Solids Impact on Benthic Macroinvertebrate Communities in the South Coast Region




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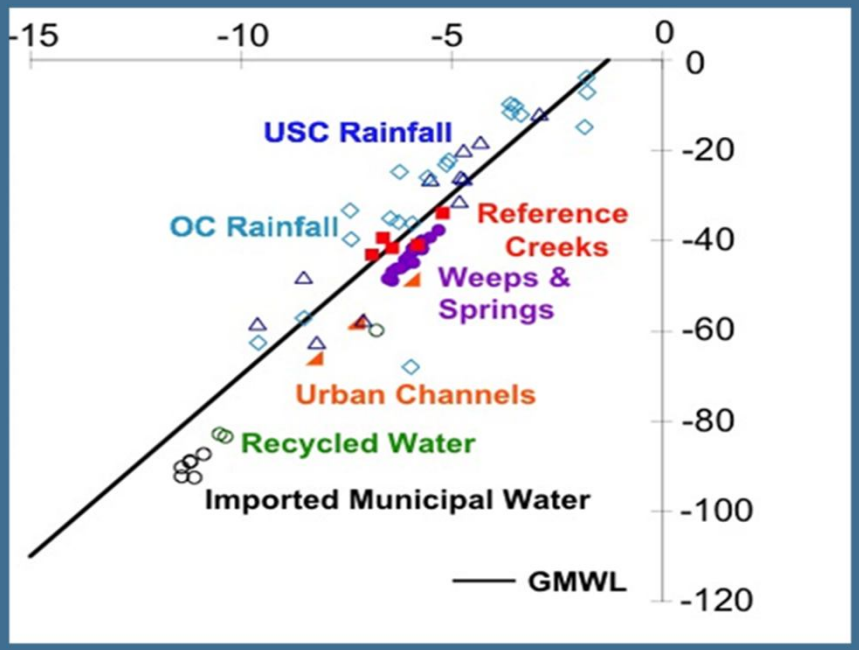
Project Purpose

- Investigate the influence of groundwater on surface water TDS concentrations in San Diego Region
- Investigate the influence of natural TDS concentrations and related ions (e.g., calcium, sodium, chloride, sulfate, etc.) on local macroinvertebrates
- Difficult to tease apart impacts in an urban influenced region with multiple ubiquitous stressors
- Some local streams contain naturally elevated TDS
- Field Study
  - Macroinvertebrates collected from “reference” streams across a broad range of TDS concentrations
  - Look at changes in the community
- Mesocosm Laboratory Study

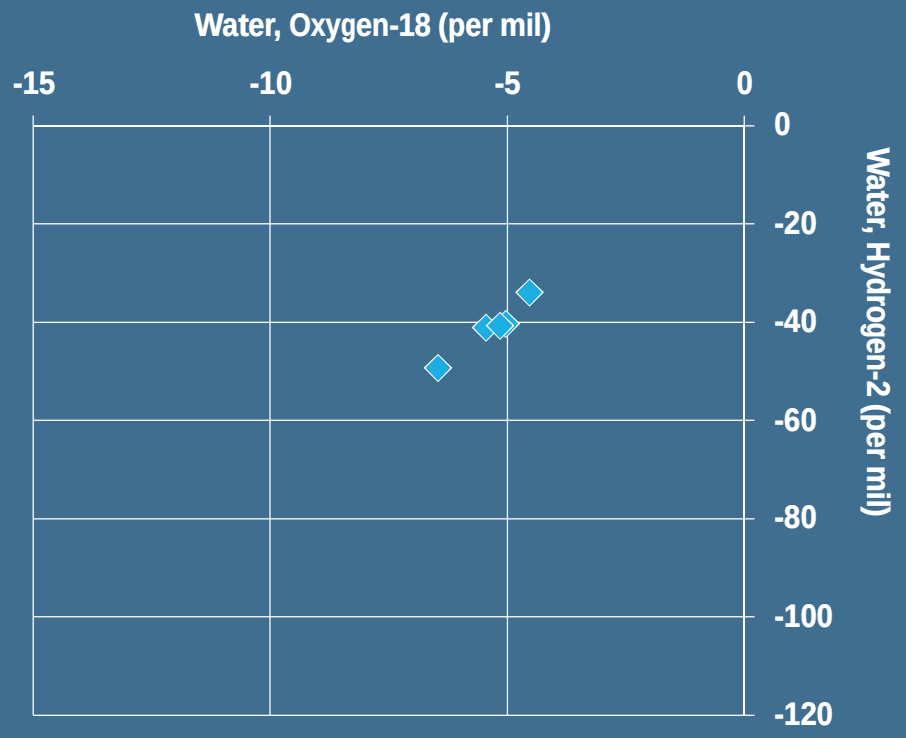
Tools to Quantify Natural vs. Anthropogenic Water Sources in San Diego Region streams

USC Stable Isotope Results from Various Water Sources



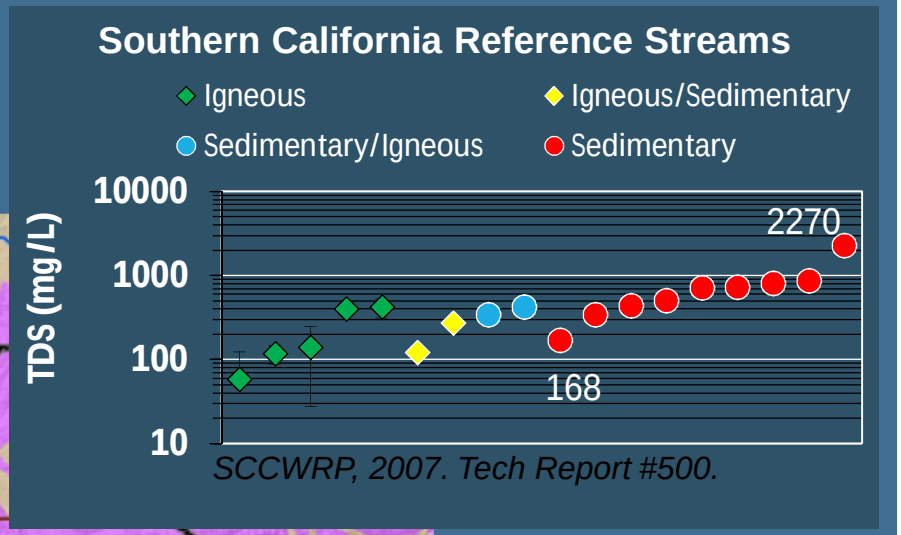
Data Source: Bardsley, Von Bitner et. al. 2015

USGS Stable Isotopes Results from San Diego River and Los Penasquitos Creek

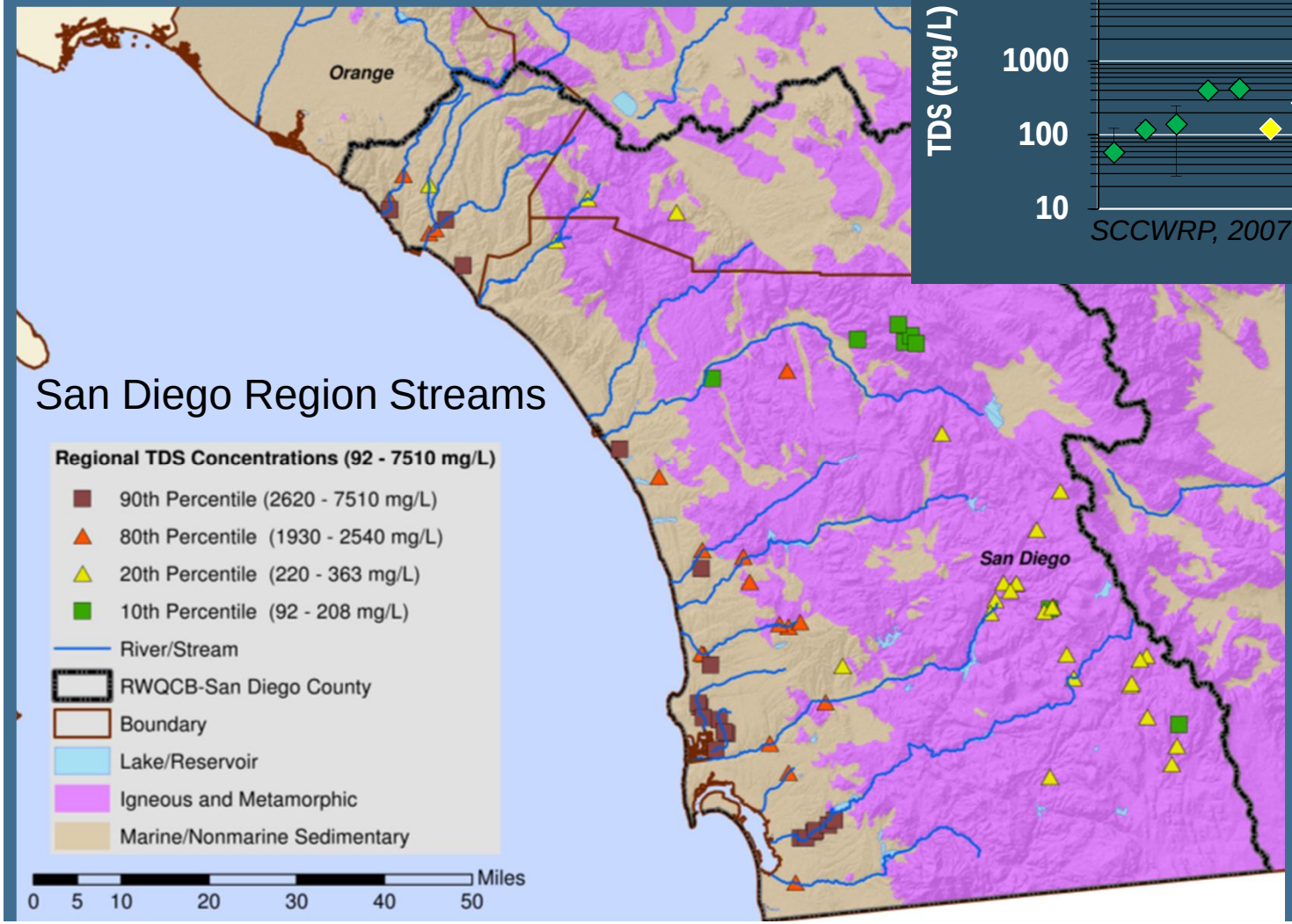


Data Source: USGS Water Data for the Nation

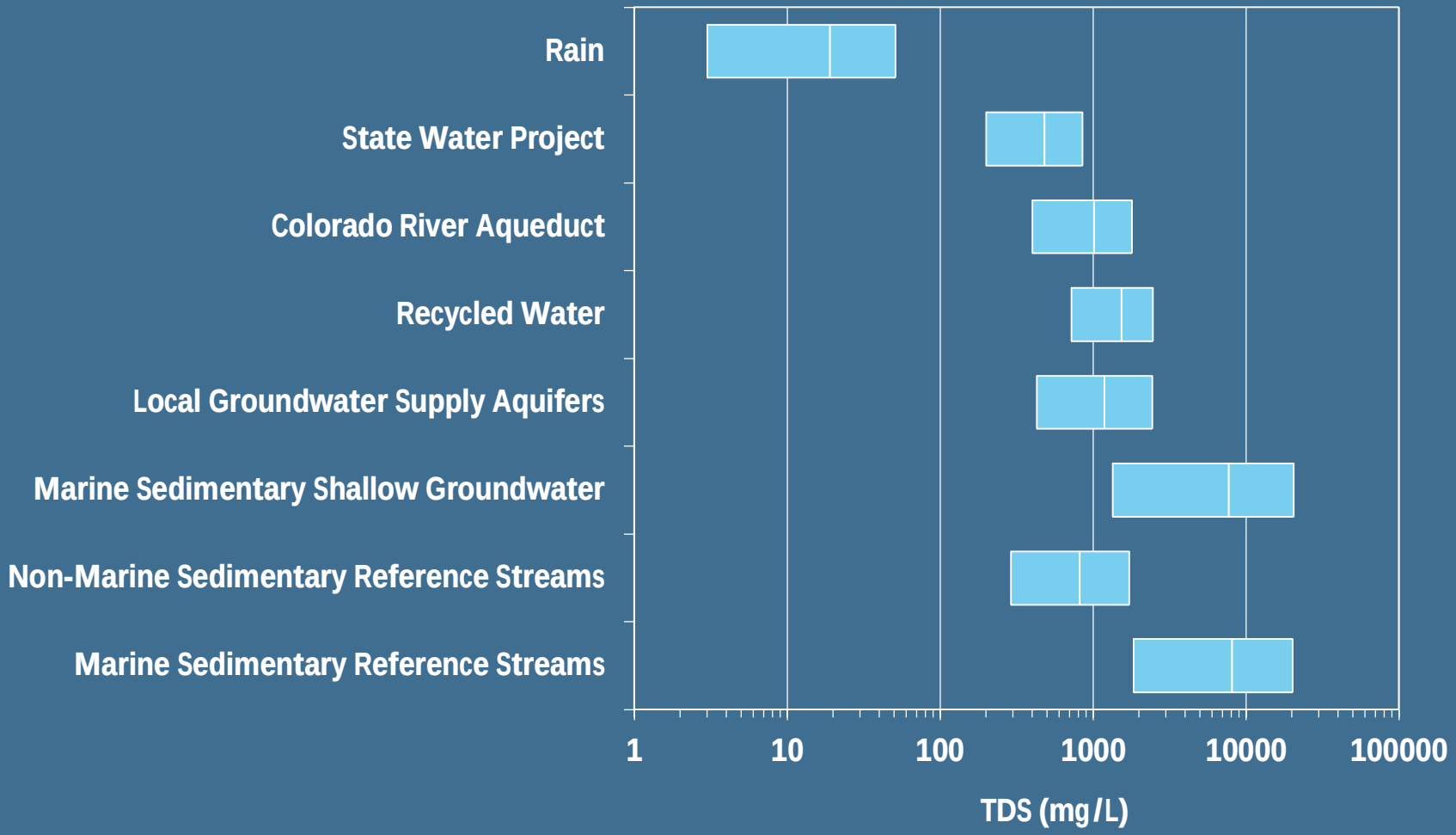
Watershed Geology Governs Urban and Reference Stream TDS Concentrations



SCCWRP, 2007. Tech Report #500.



Marine Sedimentary Geology Shallow Groundwater is the Most Significant Source of TDS



Elevated TDS Concentrations Were Documented 140 Years Ago

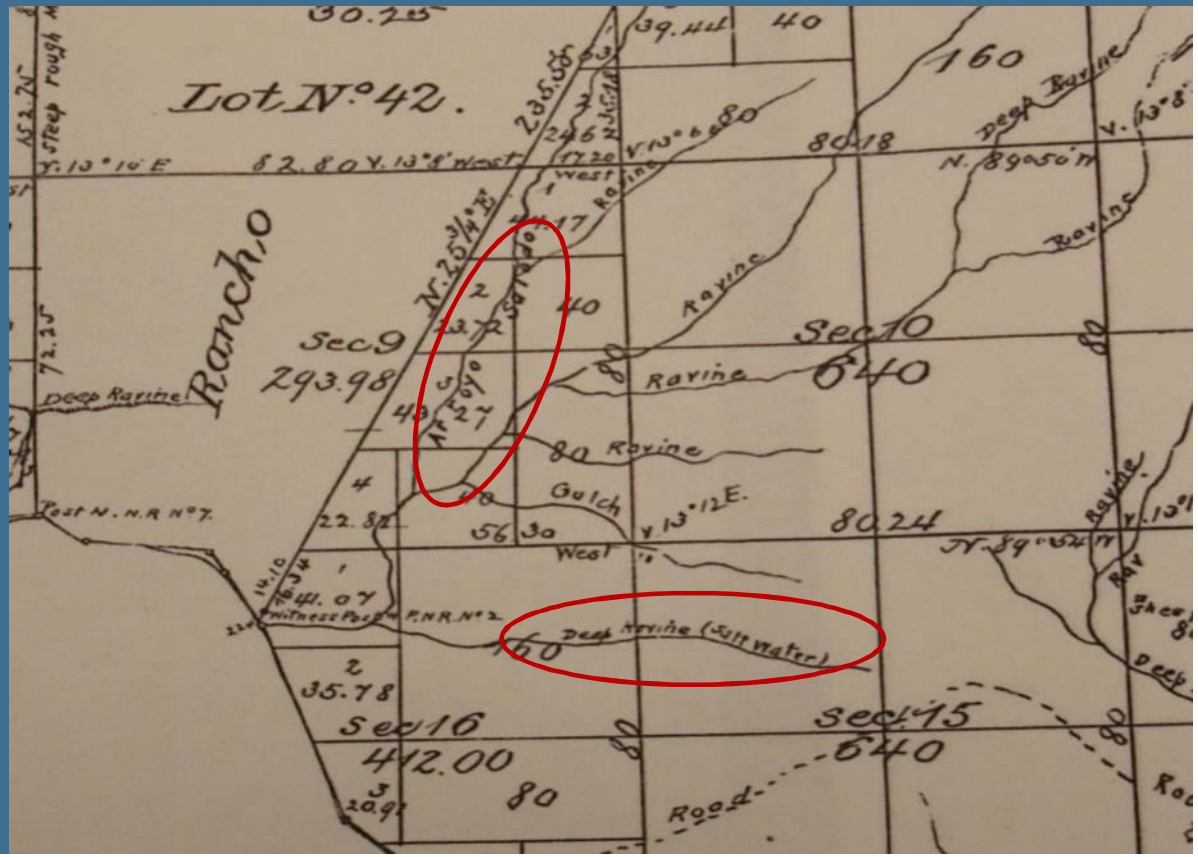
USGS Water Supply Papers vol. 446, 1919.

Soledad Canyon.

"*...Well K 18, which is 1 mile above Sorento or 3 miles above the marsh, yields water which is said to be saline and of very poor quality. This well is 12.4 feet deep and 3 feet square, and its water level is 9.5 feet below the surface…*

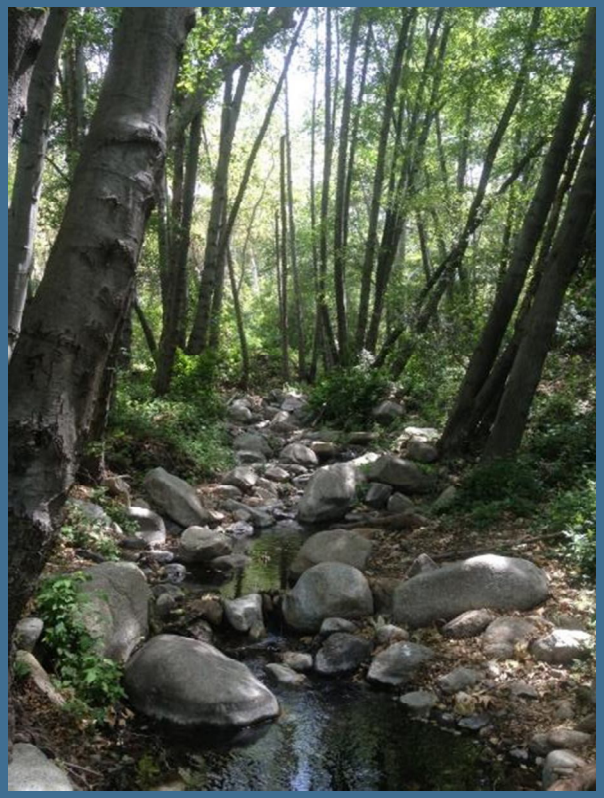
Dana Point, California, 1878. Egan Map Series. UC Archives. Salt Creek Watershed

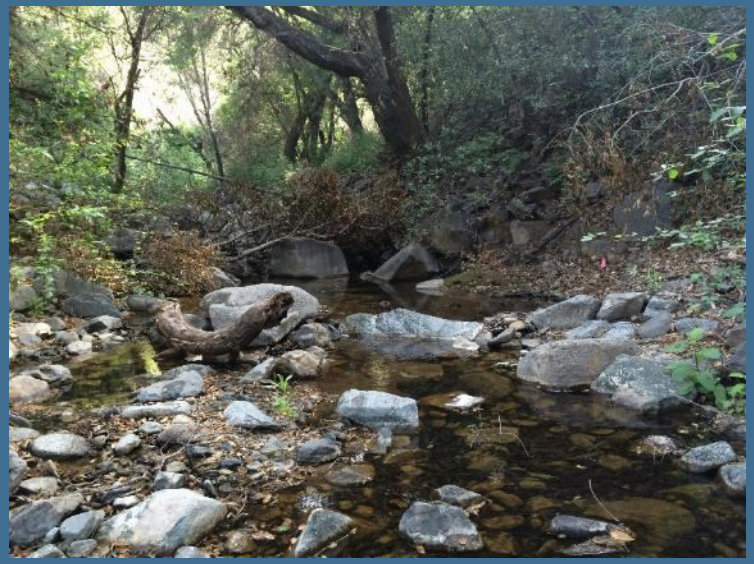
"Arroyo Salado" translates as "Salt Creek" and a second deep ravine is listed as containing "salt water".

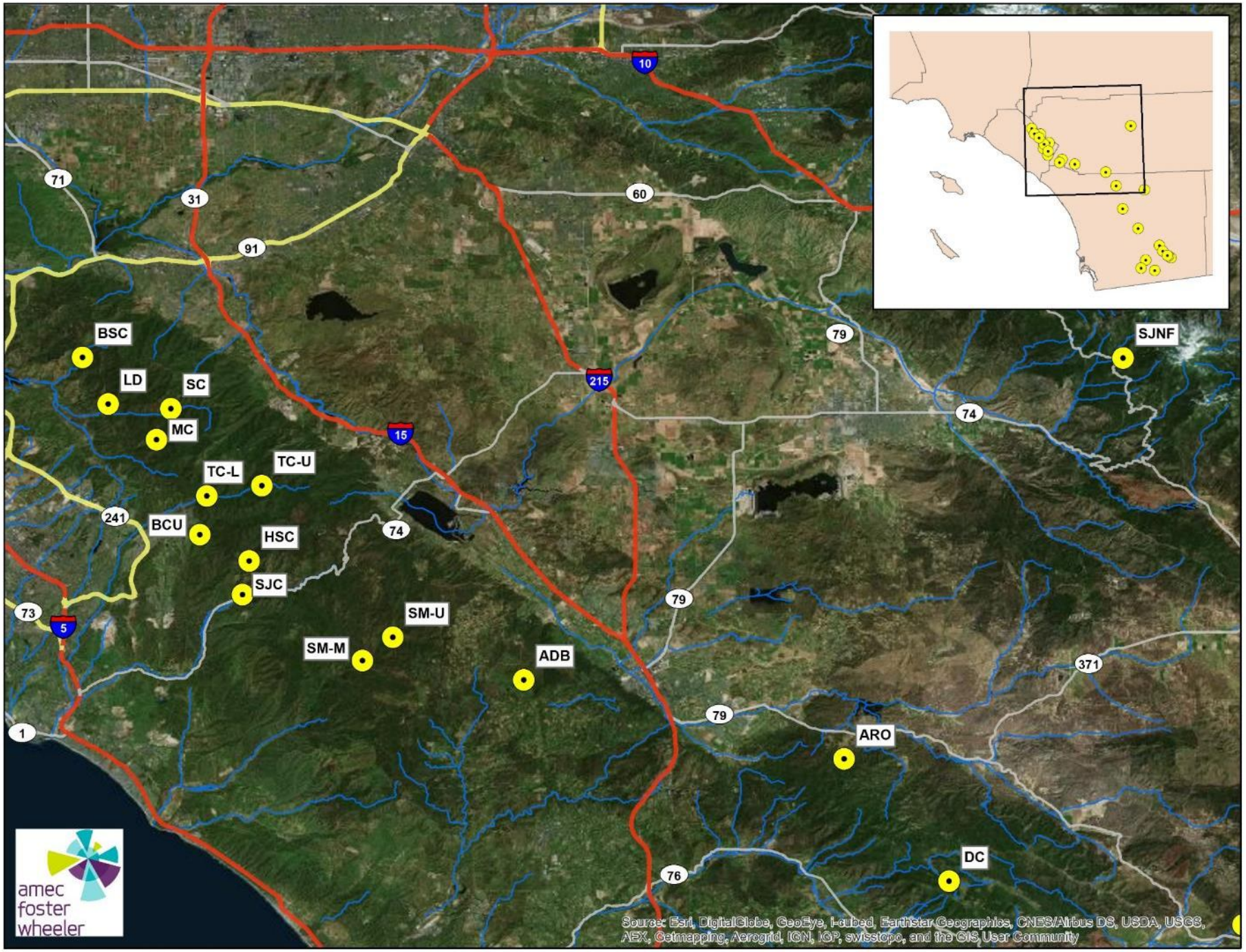


Influence on BMI Methods – Field Study

- Macroinvertebrates and physical habitat data collected at 29 “reference” streams
- San Diego County, Southern Orange County, and West Riverside County
- Field in situ conductivity, pH, temp, turbidity
- TDS and associated ions



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DC
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71
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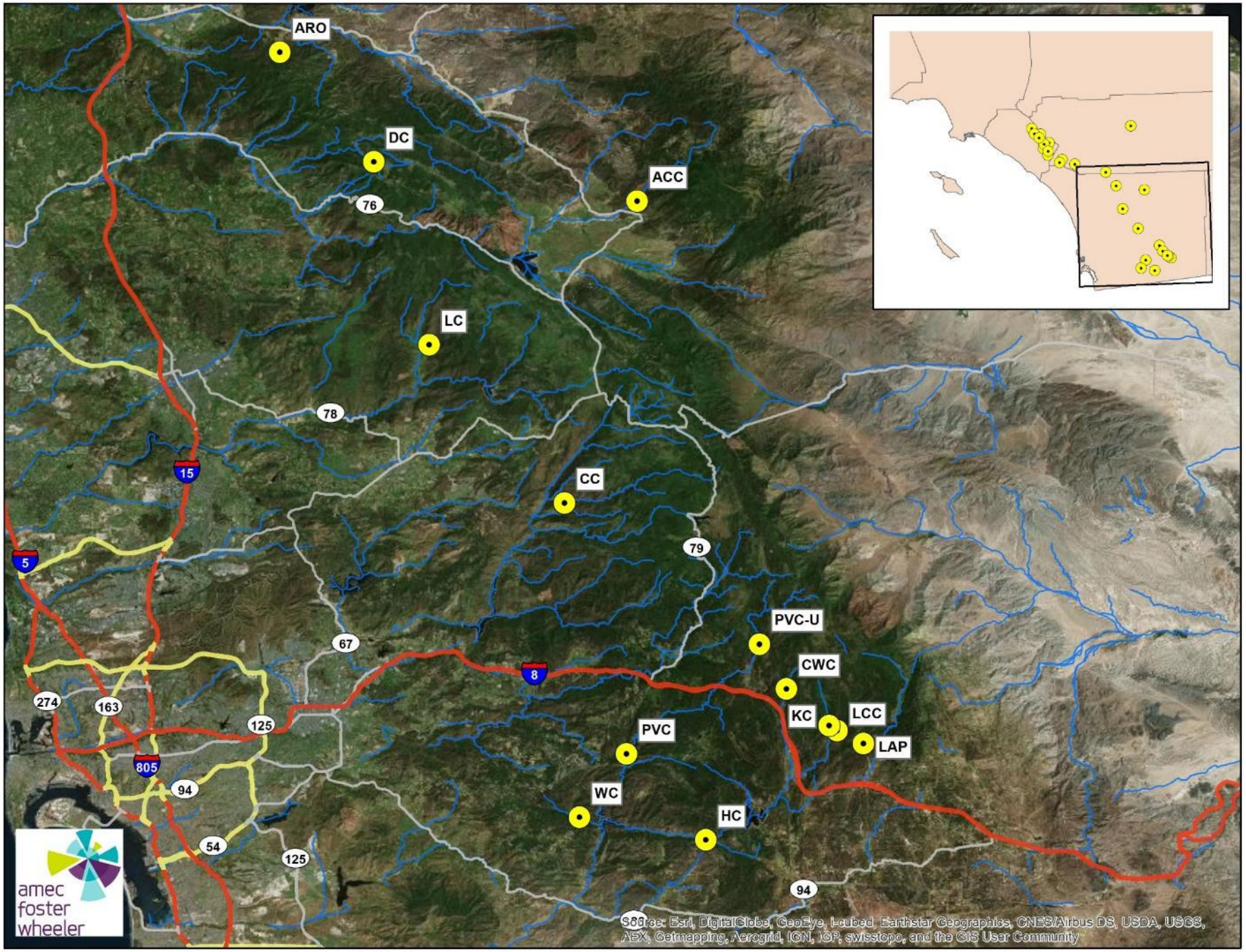
amec
foster
wheeler
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community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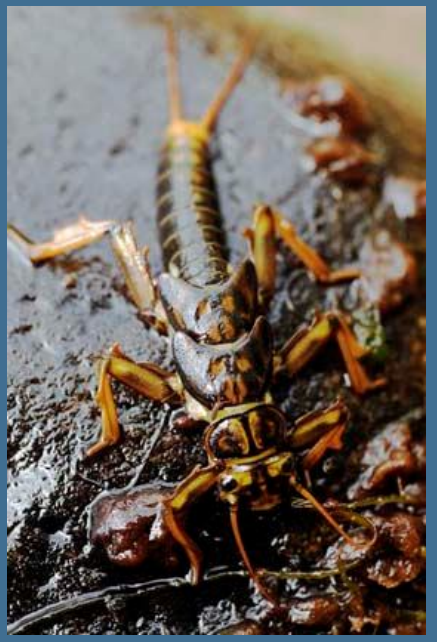
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
amec
foster
wheeler

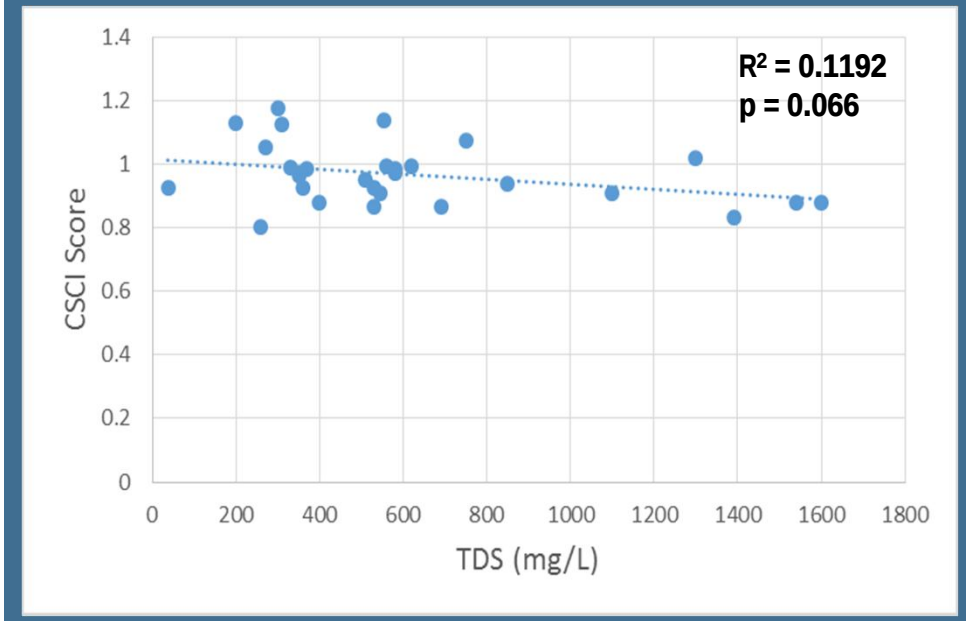
Macroinvertebrate and TDS Results

- Taxa richness 33 to 73
- Many sensitive taxa
  - EPT taxa richness range: 4 to 20
  - % EPT taxa range: 6 to 36%
  - Mean HBI range: 4.35 to 6.78
  - % Highly sensitive (TV 0): up to 7.3%
- Overall Community
  - Mean CSCI Score: 0.97 (0.80-1.18)
  - Mean SoCal IBI Score: 56.4 (28-86)
- TDS Range 56 – 1600 mg/L

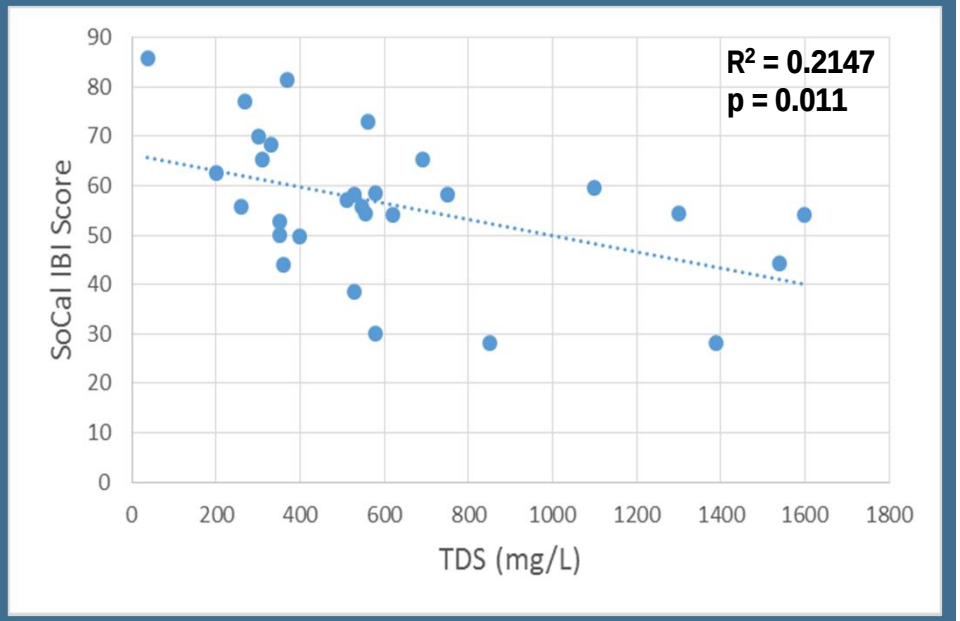


Relationship TDS with MMIs

CSCI

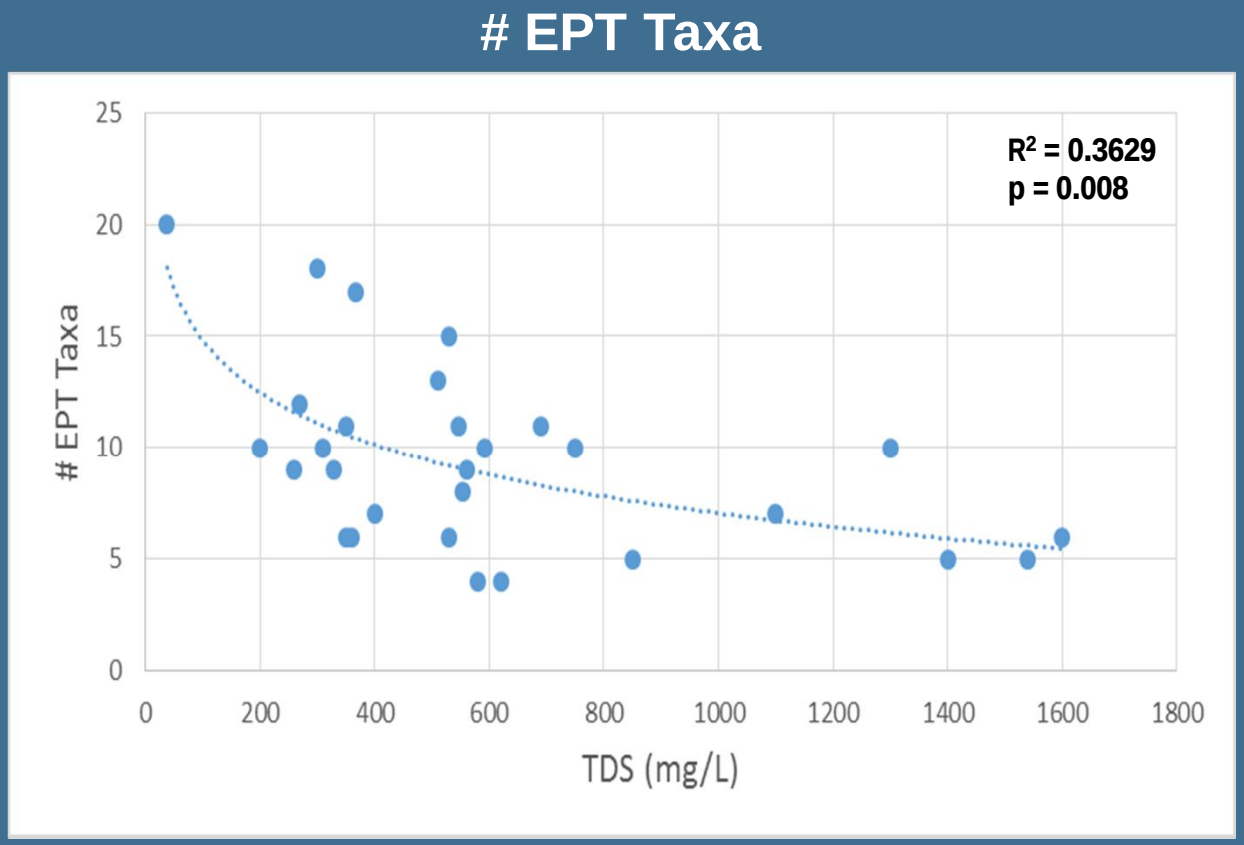


SoCal IBI



- CSCI maybe slight downward trend, but just above significance
- SoCal IBI distinct downward trend and significant
- Exhibits utility of the new CSCI

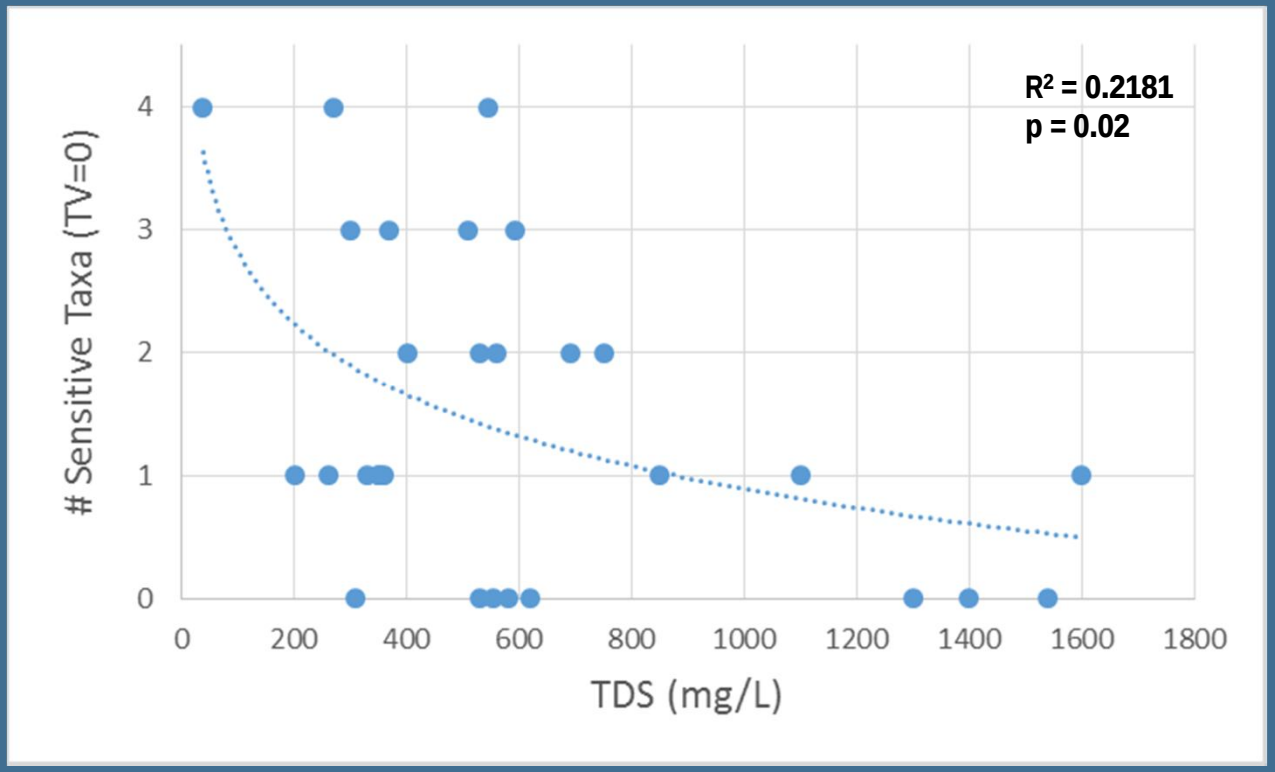
Relationship TDS with Submetrics



- But TDS does exhibit clear trends with submetrics

Relationship TDS with Submetrics

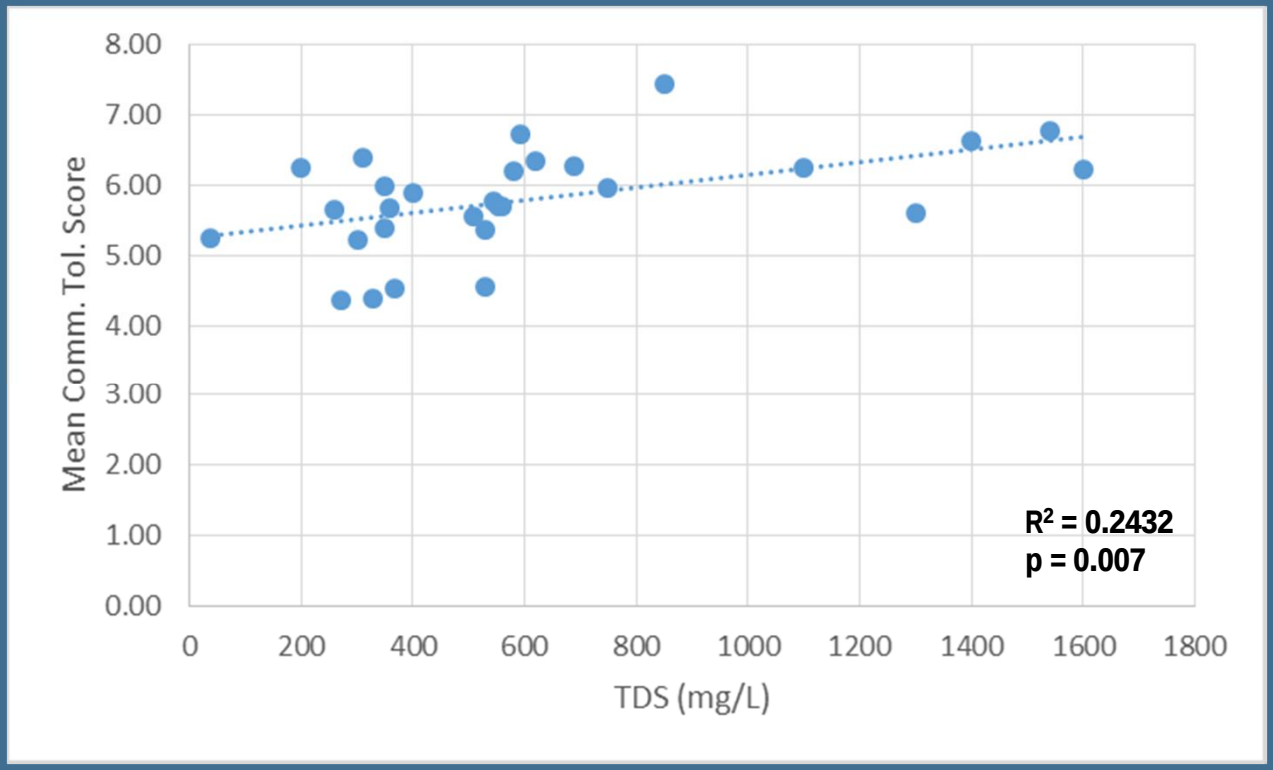
 # Highly Sensitive Taxa (TV=0)



- But TDS does exhibit clear trends with submetrics

Relationship TDS with Submetrics

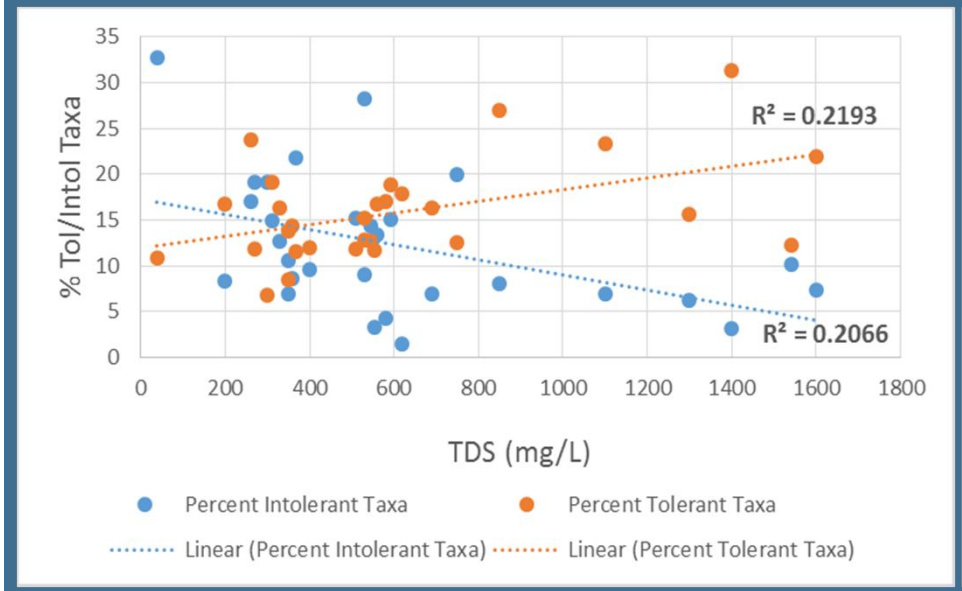
Mean Community Tolerance Value (MCTV)



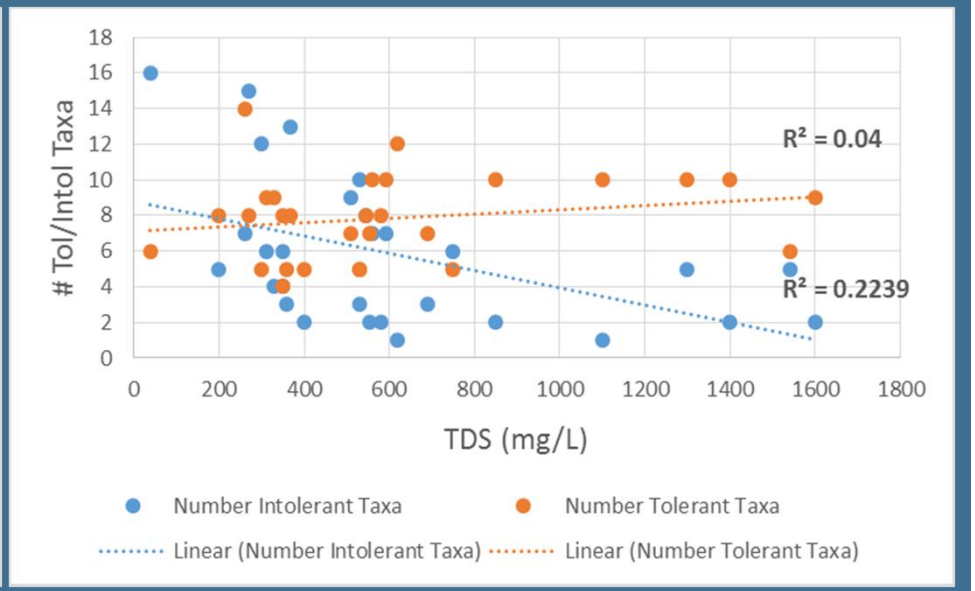
- But TDS does exhibit clear trends with submetrics

Relationship TDS with Submetrics

% Tol / Intol Taxa

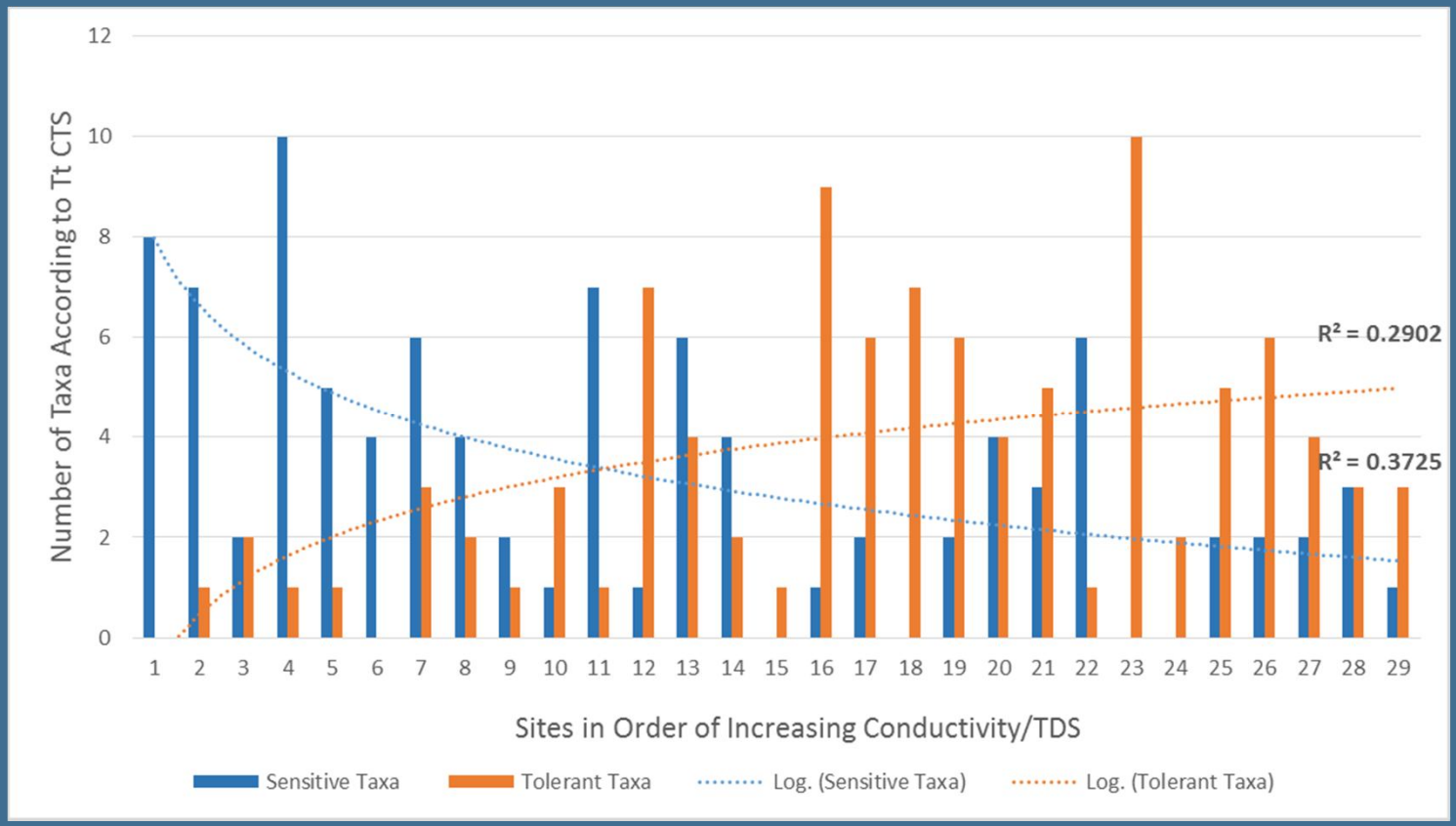


Tol / Intol Taxa



- Trends at both ends of the Tolerance Value spectrum
- Might expect ↑ in % Tol Taxa as % Intol ↓, but also true for # Taxa

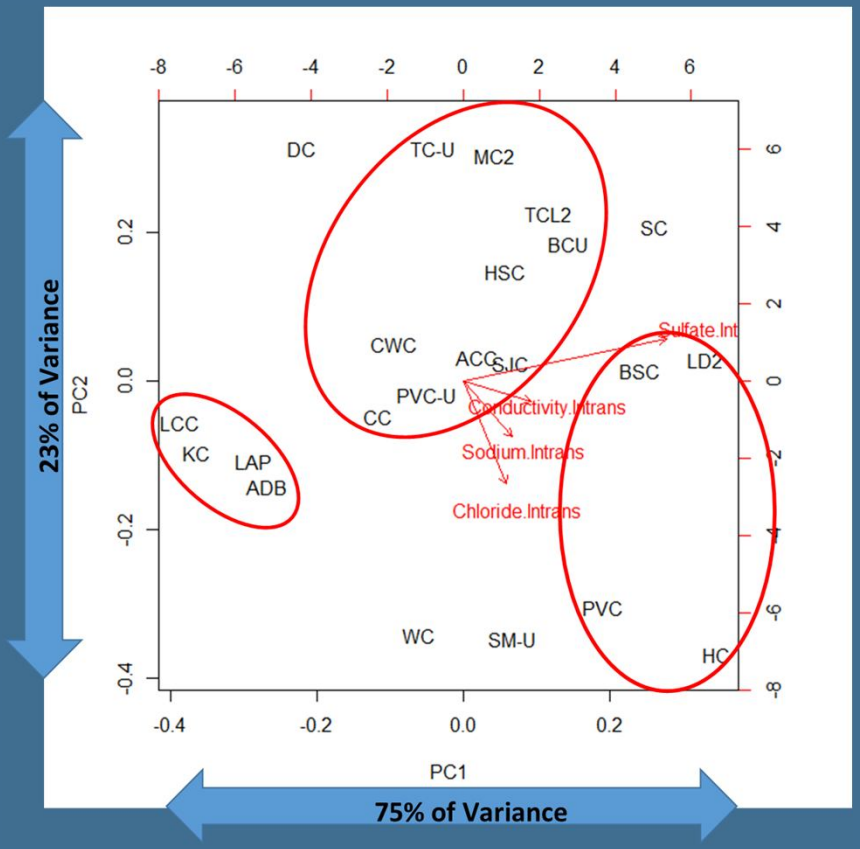
Conductivity Tolerance Scores (CTS) – Tetra Tech (2014)



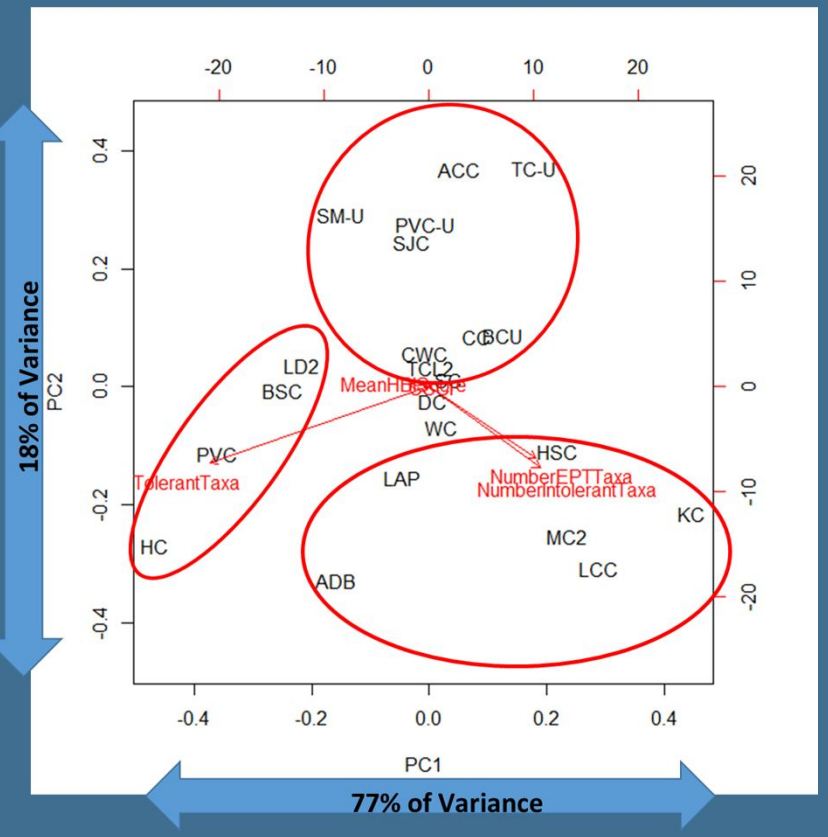
- Clear trend in # Tol/Intol taxa with Conductivity Tolerance Score

PCA Analyses

Water Chemistry

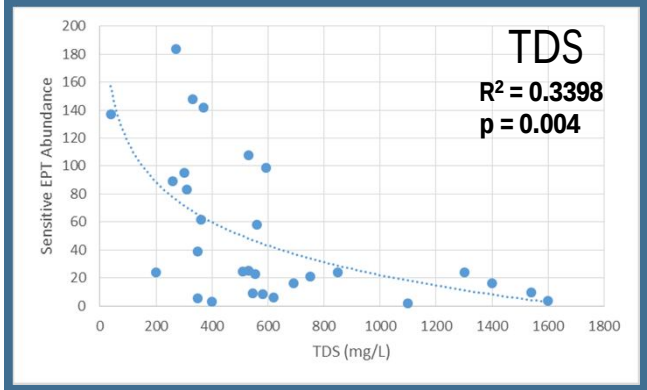


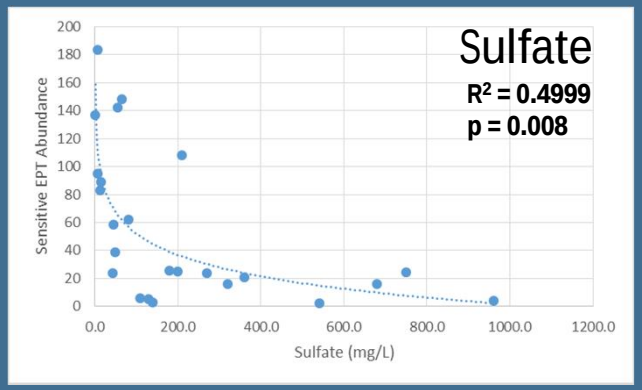
Biological Metrics

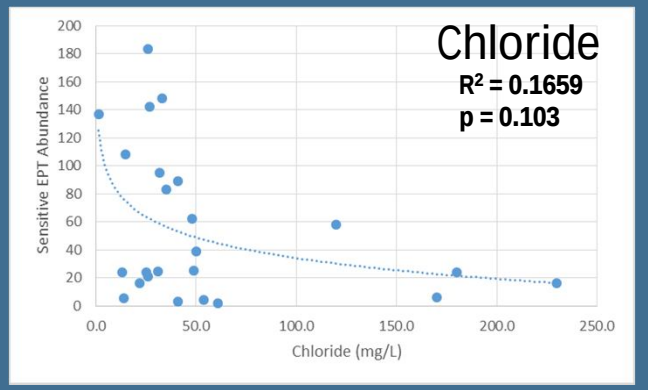


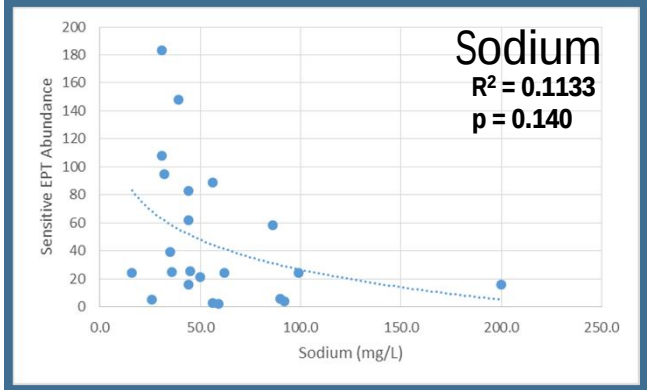
- Sulfate driver of water chemistry variance
- % Tolerant and # Intolerant/EPT drivers of biology variance
- Some similarity in site clustering based on chemistry and biology

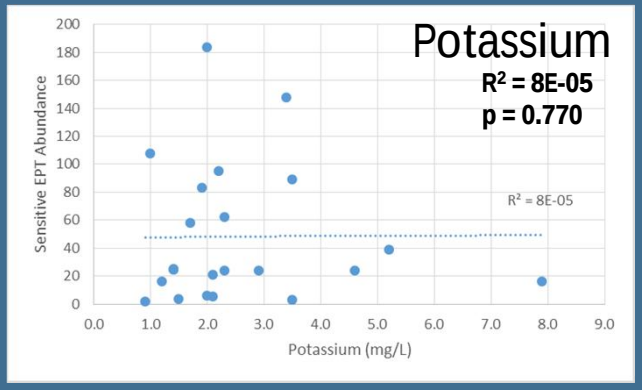
Further Examination Ions and Sensitive EPT

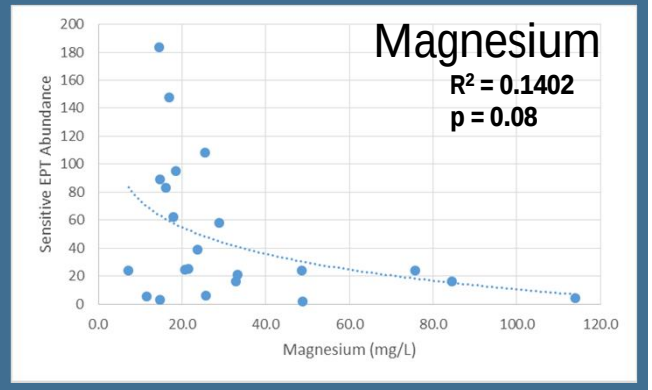












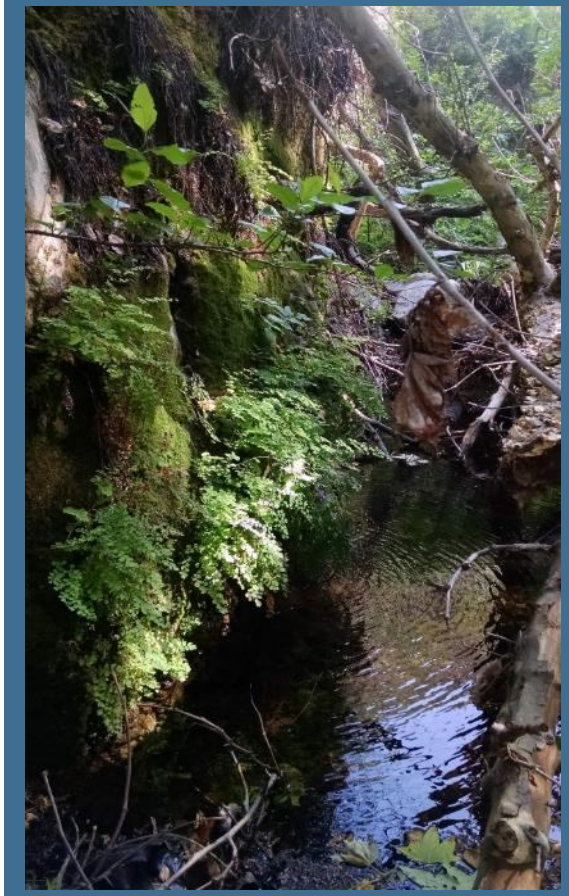
Conclusions

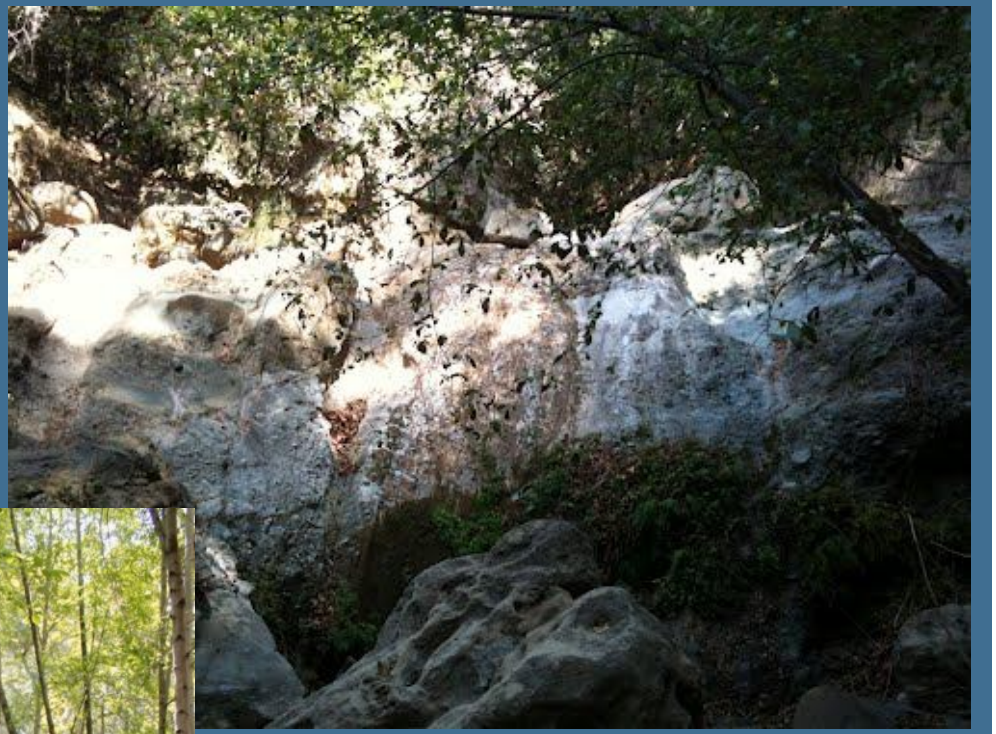
- Watershed geology governs urban and reference groundwater and stream TDS concentrations
- Marine sedimentary geology groundwater that appears to be influencing TDS in South Coast streams
- Natural levels of TDS and associated ions can influence the BMI community
- High natural TDS concentrations, do not appear to limit CSCI condition scores. Potentially SoCal IBI scores.
- Close and significant relationships with various submetrics
- Sulfate, and potentially chloride, may be the drivers of TDS effects observed.

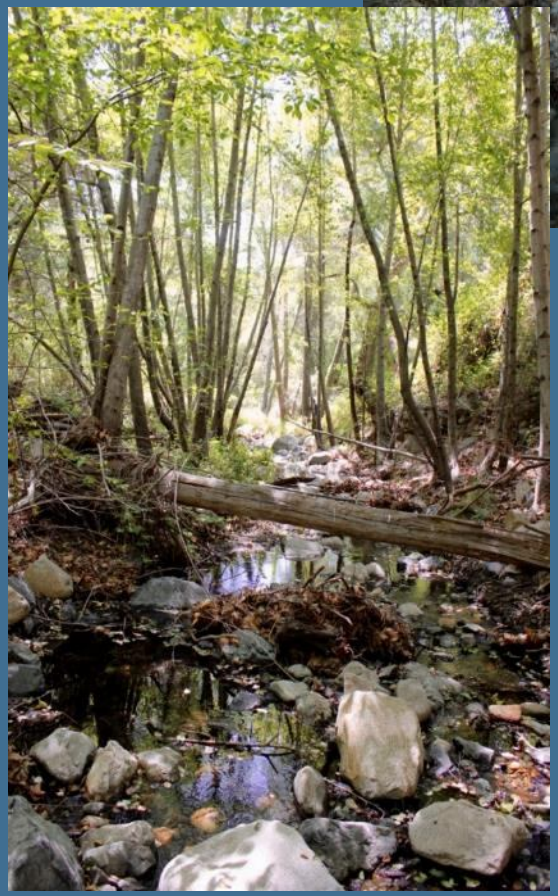
Conclusions

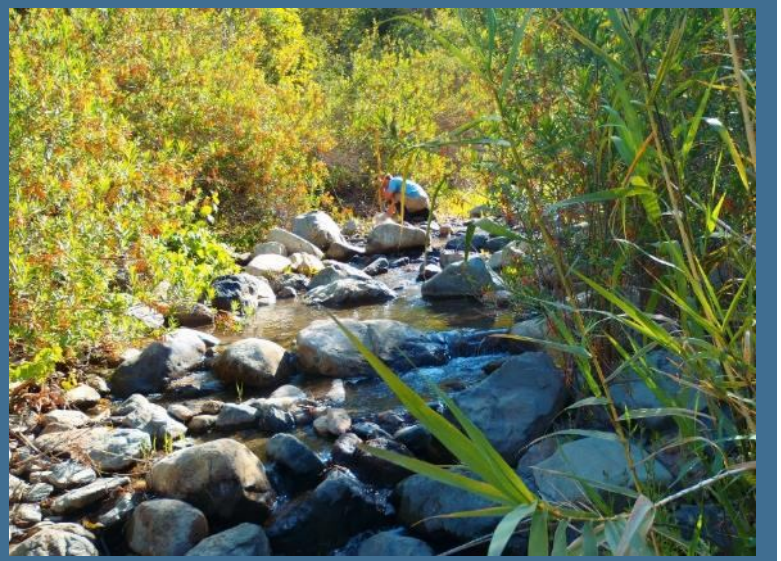
- SMC 5-year report (2015) ranked TDS as its highest priority stressor, affecting 76% of stream-miles region-wide
  - Sulfate also ranked as very high priority stressor due its high relative risk and widespread extent of influence
- Background TDS and ion concentrations should be taken into consideration when assessing BMI impairment
- Important diagnostic implications when conducting Causal Assessments and restoration.
- Presence absence of taxa could help diagnose. Sensitive to TDS, but tolerant of other stressors

Questions?









EXTRA SLIDES

Methods – Lab Study

- Macroinvertebrates collected via colonization baskets
- Collected after 4 week incubation
- Brought back to lab and introduced to one of four TDS treatments (300, 450, 600, 950 mg/L TDS)
- 4 week mesocosm exposure period
  - Emergence documented daily
  - Continuous temp loggers
  - Conductivity measured daily
  - TDS and associated ions measured weekly
- All replicates terminated and sent for taxonomic ID

Lab Macroinvertebrate Results

- Taxa Richness 35 to 47 across treatments
- Sensitive Taxa generally lower
  - EPT taxa richness range: 5 to 7
  - % EPT taxa range: 5.2 to 6.4%
  - Mean HBI range: 7.10 to 7.56
- Low to moderate diversity
  - Shannon diversity range: 1.22 to 2.13

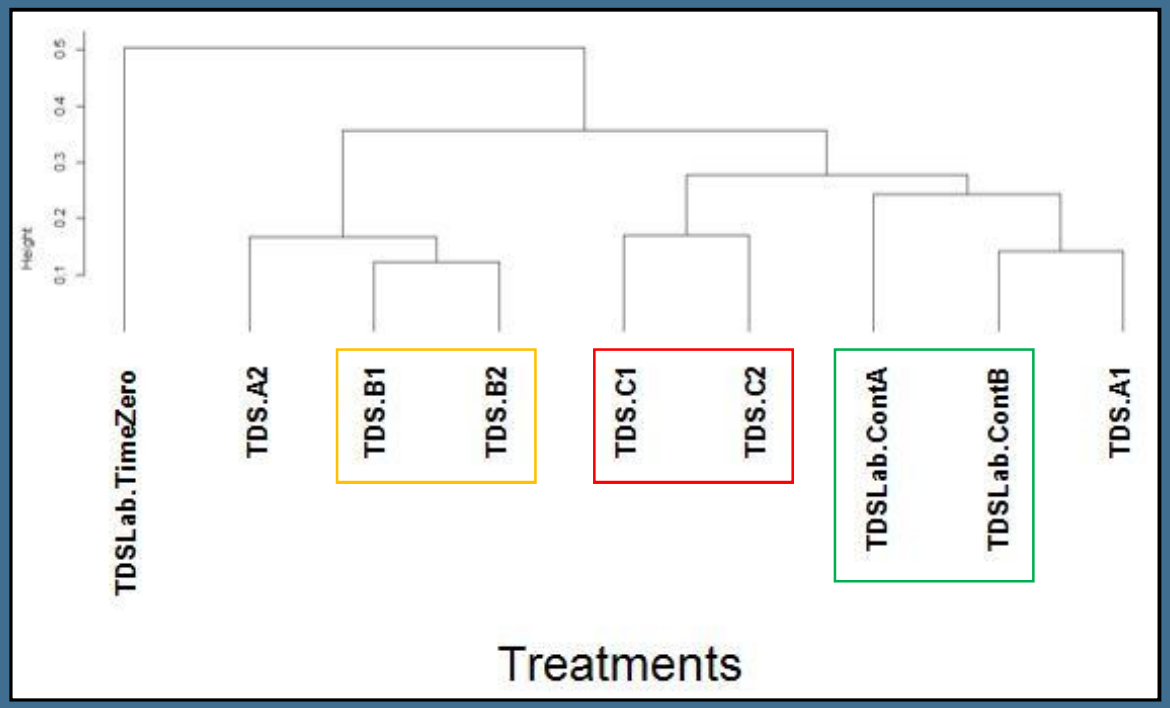
Lab Emergence of BMI

Stonefly Nymph Exoskeletons Post-Emergence

- High emergence within first 1.5 weeks
- Temperature spikes likely responsible for some of this
- No clear trend with TDS with sensitive taxa
- Highest emergence of midges and black flies in highest TDS treatment

Mesocosm Study Treatment Results

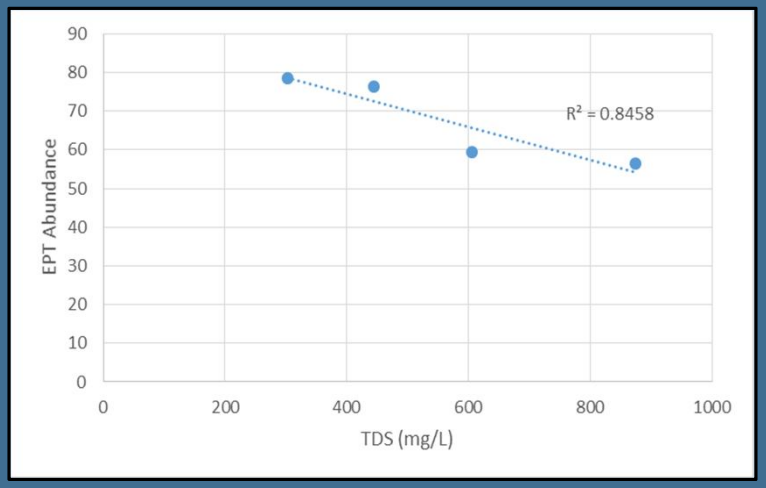
Dendrogram of Taxonomic Similarity



- Dendrogram shows similarity in taxa based on treatment TDS conc.
- Not a clean progression, but shows TDS does shape community

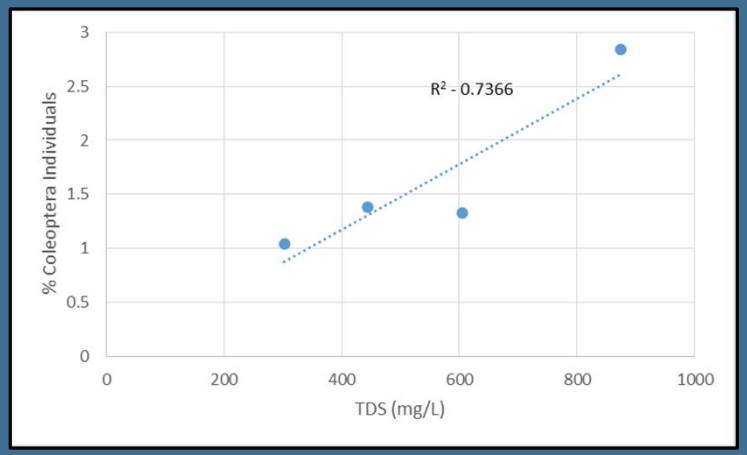
Mesocosm Submetrics with TDS

EPT Abundance



Coleopterans (beetles)

Lab Study



- No relationship with SoCal IBI, but submetrics

Field Study