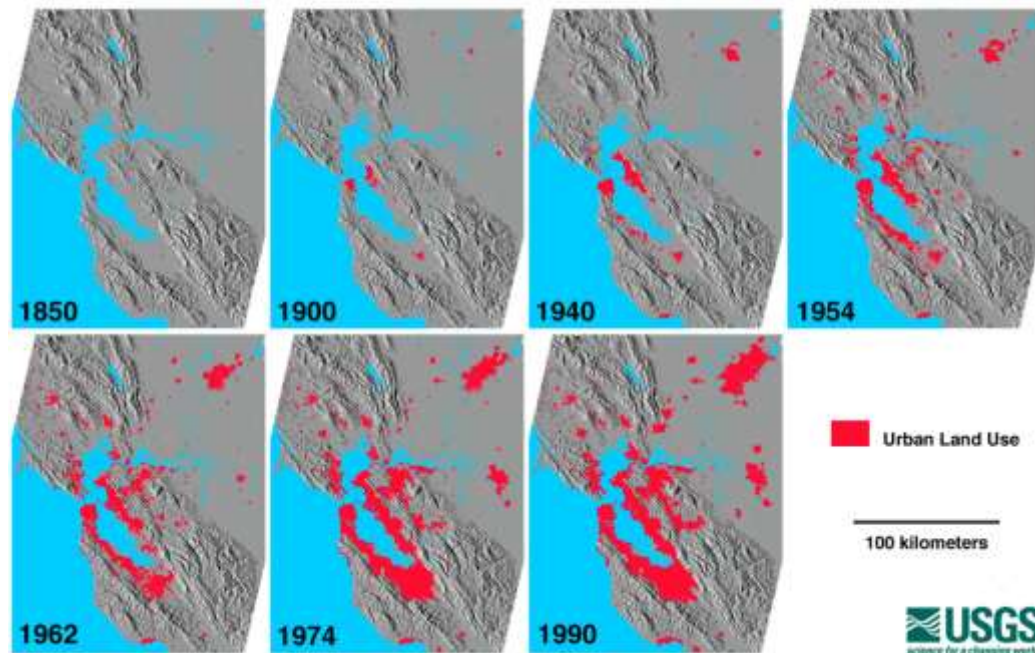




Management Implications for Small Urban Reservoirs Based on a Multi-Year Study of Three Alameda County Watershed-Reservoir Pairs

Kristina Faul (Mills College) and Laura Rademacher (University of the Pacific)
Celine Barrera and Maria-Elena Ramos (Mills College)

Motivation: Small urban watersheds are important but understudied

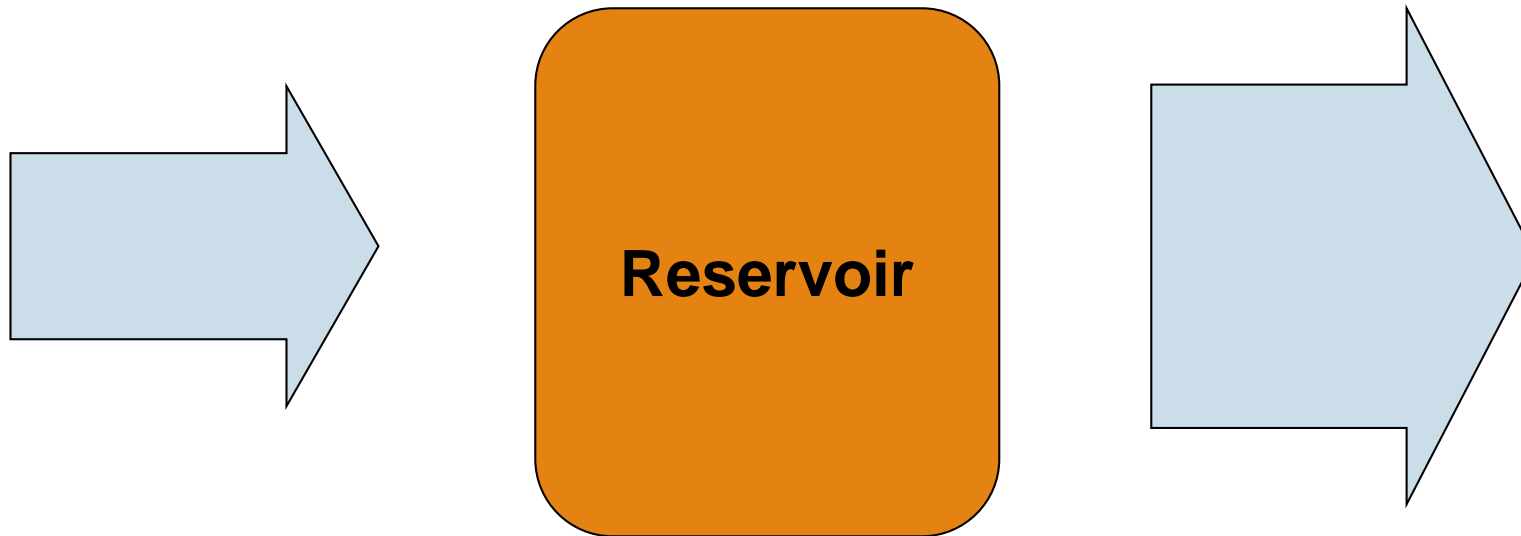


Motivation: Ideal for undergraduate research!



Goals of our study: To determine....

(1) whether small, urban reservoirs serve as sources (or sinks) for carbon, nutrients, and metals to the Bay



Goals of our study: To determine....

(2) whether perennial reservoirs are more efficient sinks for carbon, nutrients, and metals than ephemeral reservoirs;



Perennial reservoir—always full

vs



Ephemeral reservoir—full/empty seasonally





Goals of our study:

To determine....

(3) the recent history of environmental impacts on East Bay watersheds from sediment records from small, urban reservoirs.

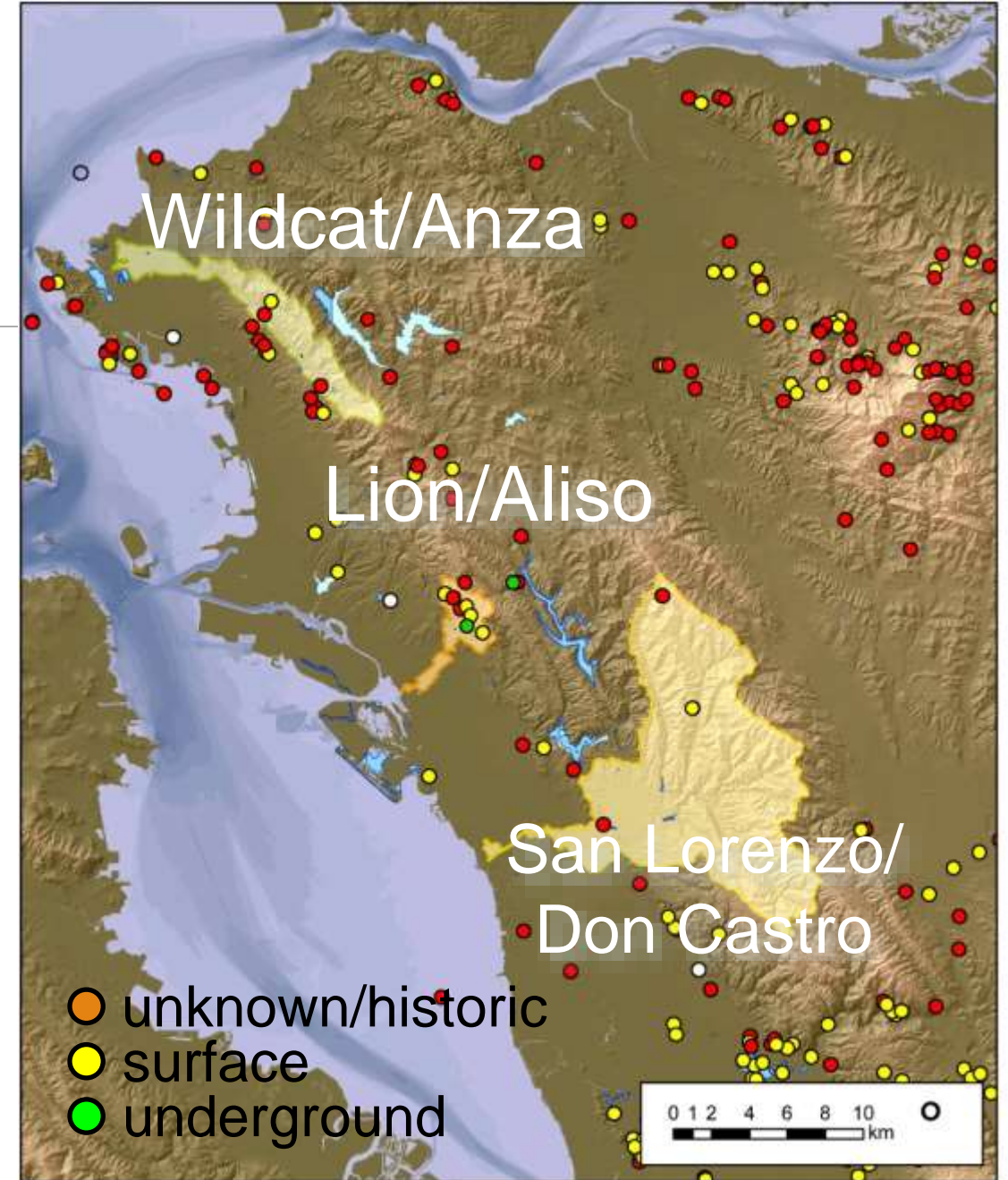
Our three study East Bay watersheds

- Wildcat/Anza:
 - “Control”
- San Lorenzo/Don Castro:
 - Urbanization
- Lion/Aliso:
 - Urbanization
 - Mining



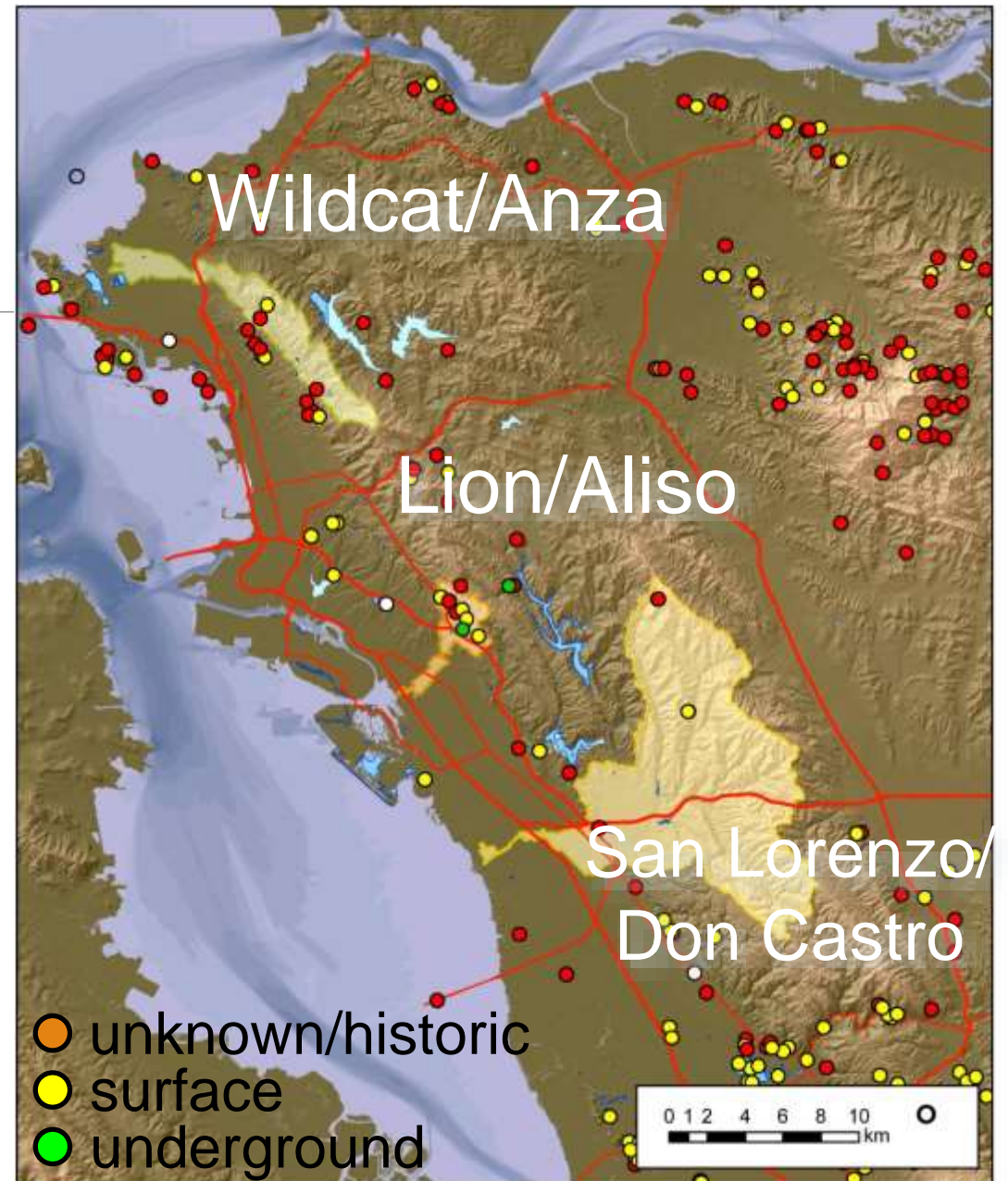
Our three study watersheds

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Our three study watersheds

- Wildcat/Anza:
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- San Lorenzo/Don Castro:
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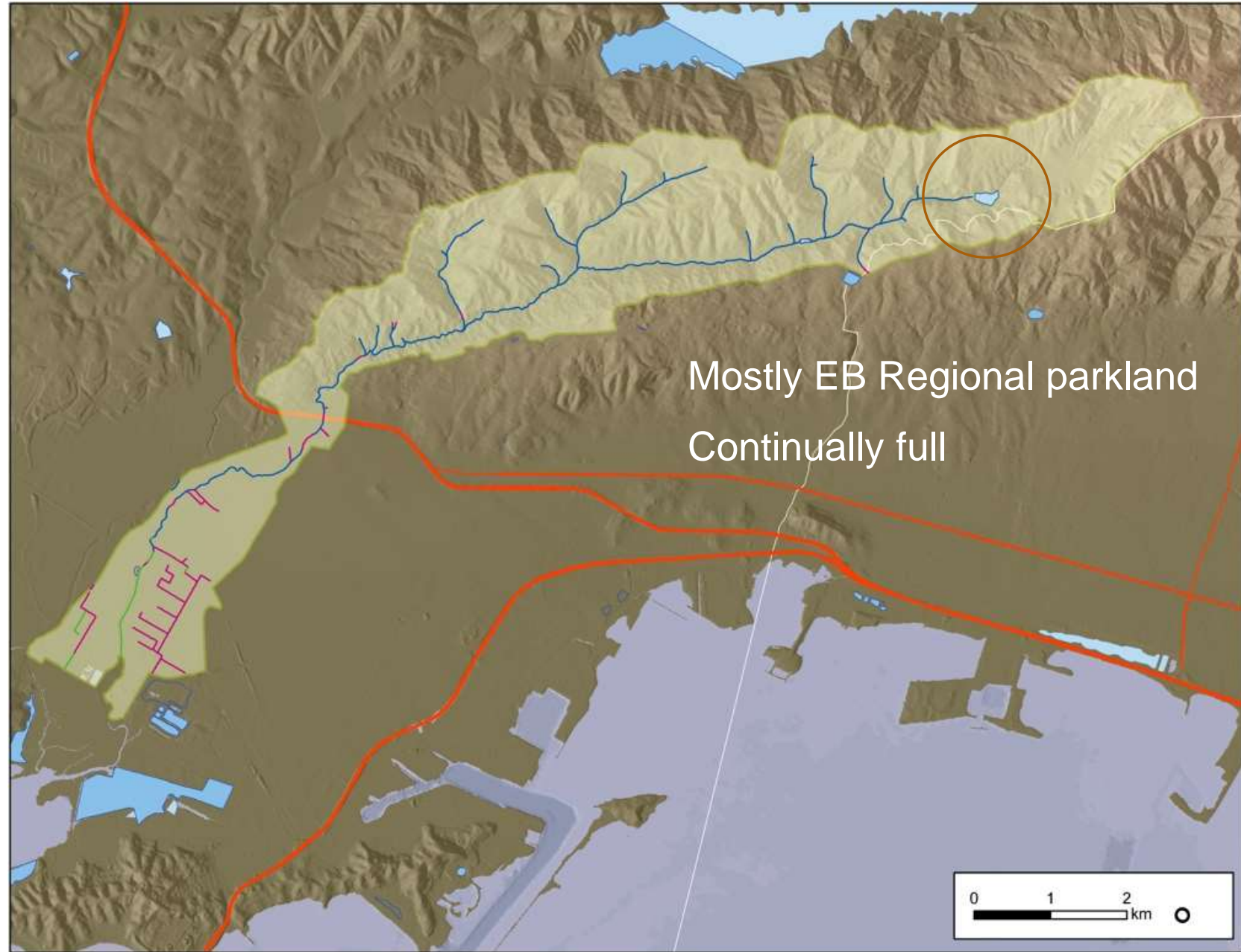
Lake Anza/Dammed Wildcat Creek

Current uses are recreation, swimming, fishing (not stocked)

Dam built in 1938 for recreational purposes

Wildcat Creek Watershed & Lake Anza

- Watershed 4.0 km²
- Lake surface area 40,000 m²
- Average depth 1 to 2 m
- Perennial





Don Castro Reservoir/Dammed San Lorenzo Creek

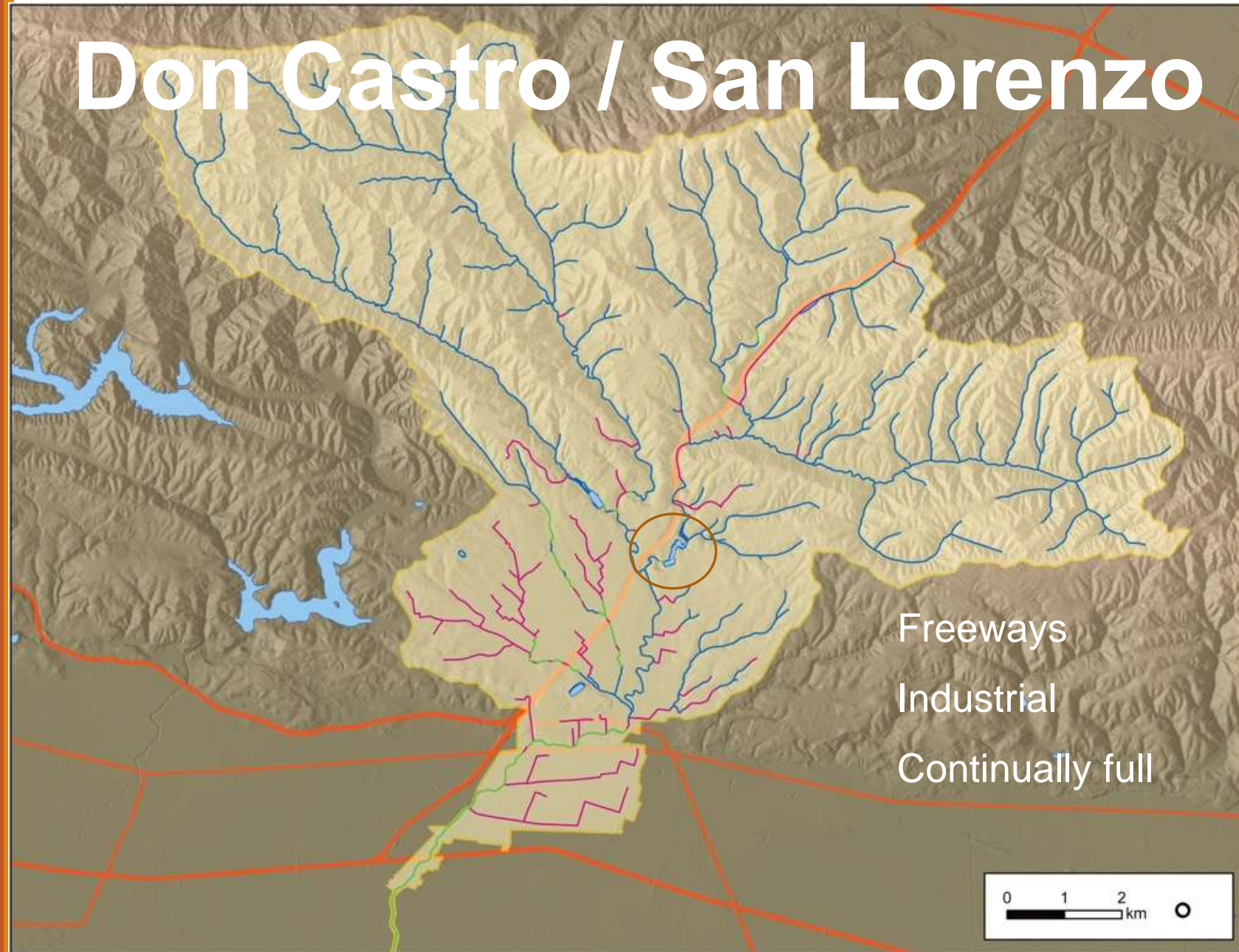
Current uses: recreation, fishing (stocked)

Dam built in 1964 for flood control

Don Castro / San Lorenzo

San Lorenzo Creek Watershed & Don Castro Reservoir

- Watershed 51 km²
- Surface Area 87,000 m²
- Average depth 1 m
- Perennial





Summer

Winter

Lake Aliso/Dammed Lion Creek

Current uses: campus irrigation, flood control

Full in summer/empty in winter

Lion Creek Watershed & Lake Aliso

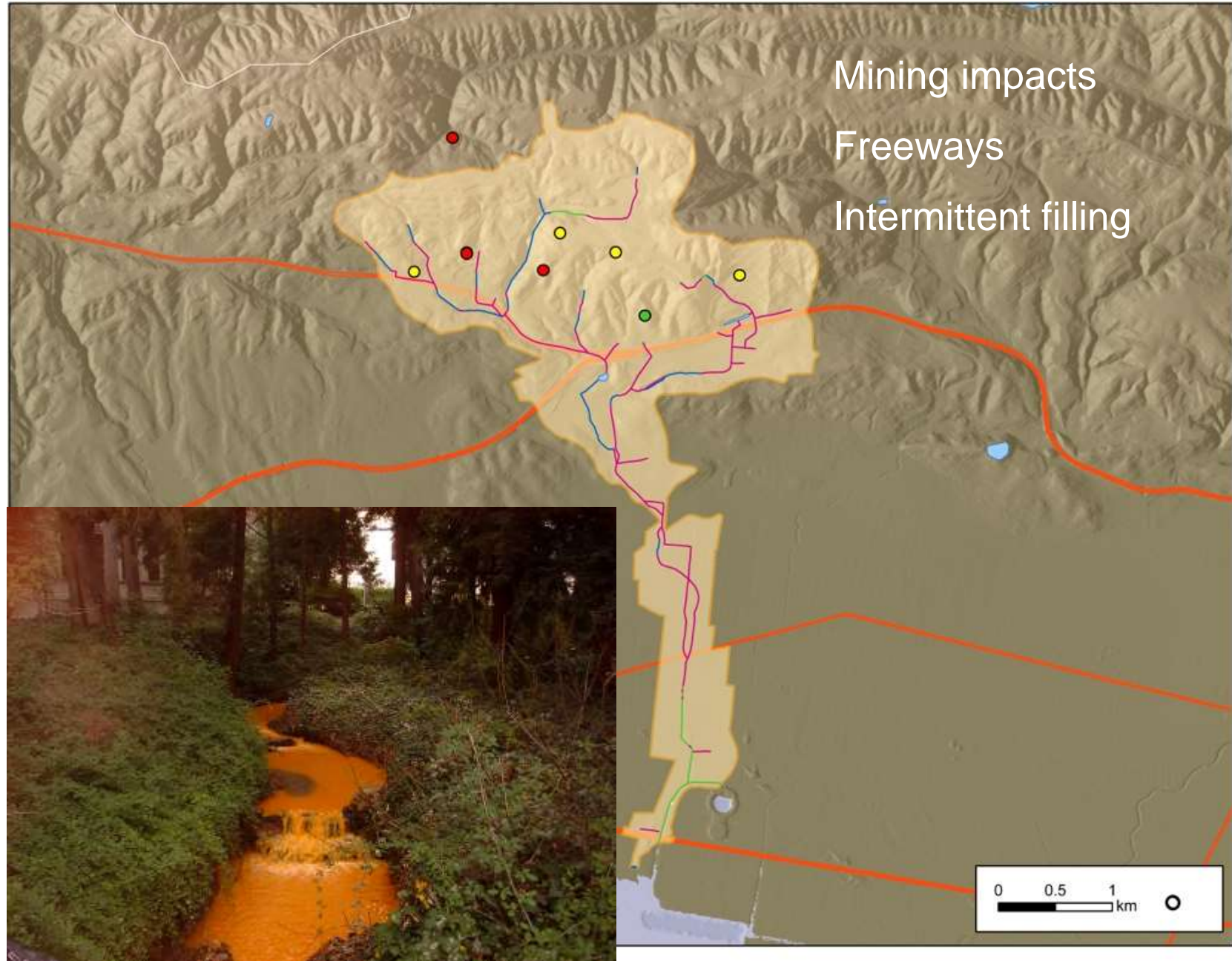
Watershed = 4.4 m³

Surface Area = 7,400 m²

Percent Current Volume of Capacity = 50%

Downstream of a former sulfur mine

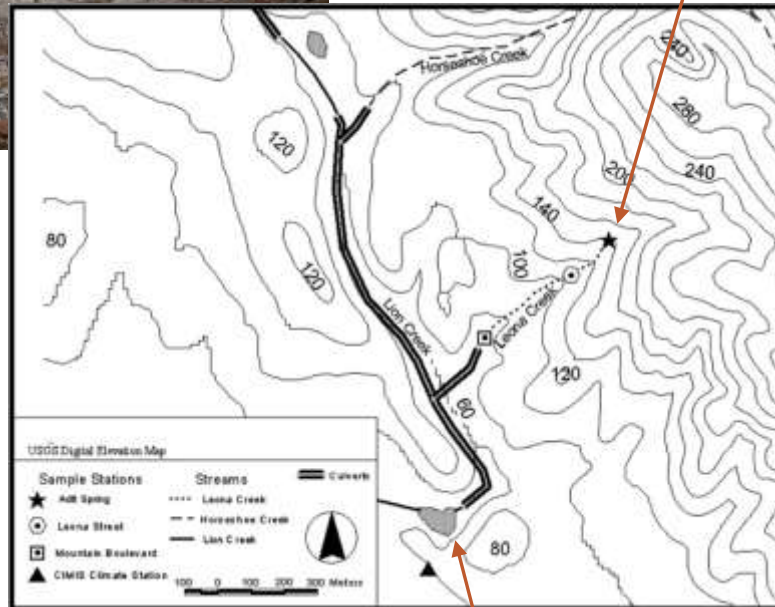
Managed by Mills College: ephemeral



Leona Heights Sulfur Mine: See Laura Rademacher's Poster!

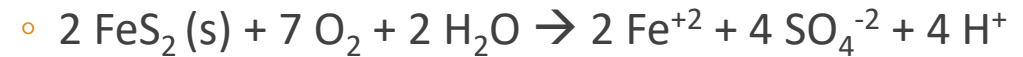


Mine Site

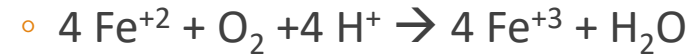


Lake Aliso

Oxidation of Sulfur in Pyrite to Sulfate:



Oxidation of Fe^{+2} to Fe^{+3} :



Precipitation of iron hydroxide:

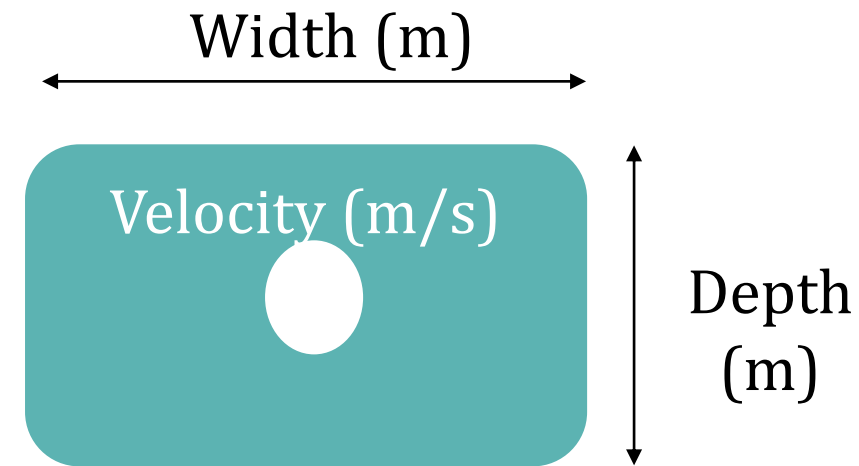


Field Methods: In situ data collection

- Bimonthly at inlet, outlet, reservoir:
 - Temperature
 - Dissolved Oxygen
 - Conductivity
 - pH
 - Alkalinity
 - Total Dissolved Solids



Field Methods: Water Discharge at Inlet & Outlet



$$\begin{aligned}\text{Discharge} &= W * D * \text{Velocity} \\ &= \text{m}^3/\text{s}\end{aligned}$$



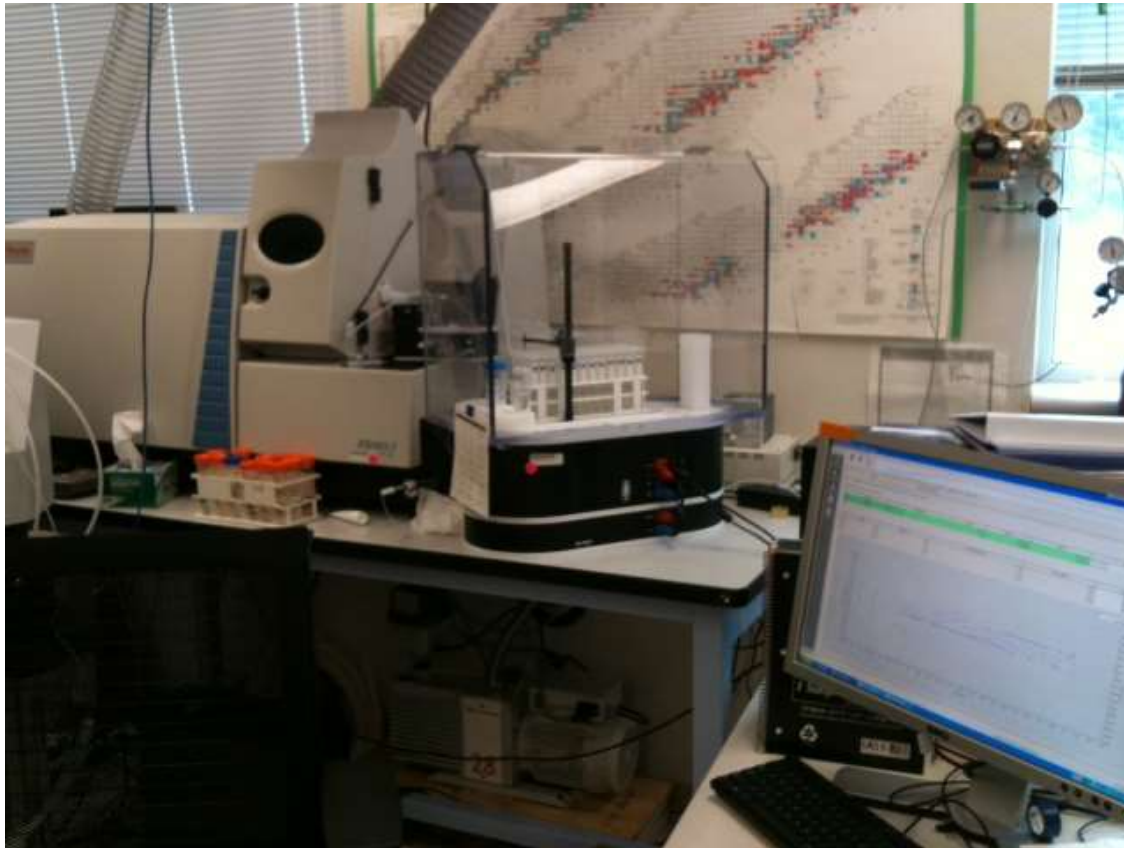
Field Methods: Water Sample Collection

- Bimonthly at inlet, outlet, in reservoir:
 - Cations
 - Anions
 - Trace metals
 - Total Inorganic Carbon/Total Organic Carbon



Lab Methods: ICP-MS for Trace Metals

Fe, Mn, Ni, As, Pb, Cu, Zn



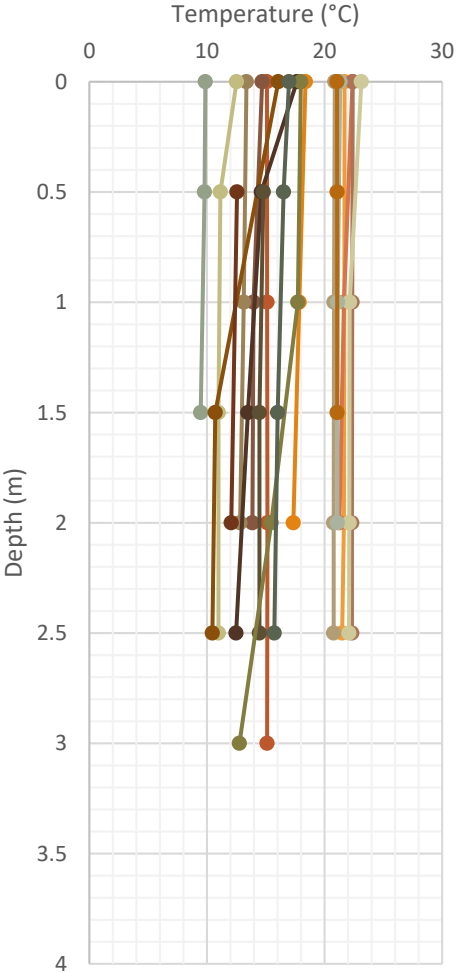
In Situ Data & Water Samples Collected

Water-shed	2010	2011	2012	2013	2014	2015	2016	2017	2018
Anza/ Wildcat				✓	✓	✓	✓		
Don Castro/ San Lorenzo				✓	✓	✓	✓		
Aliso/ Lion	✓	✓	✓	✓	✓	✓	✓	✓	✓

← California Drought 2012-2016 →

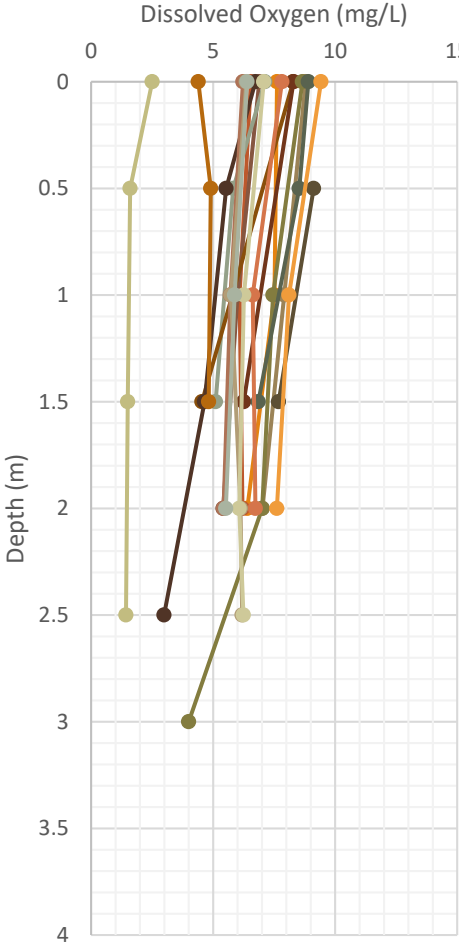
Results: Lake Anza Depth Profiles WY14 & WY16

WY 14

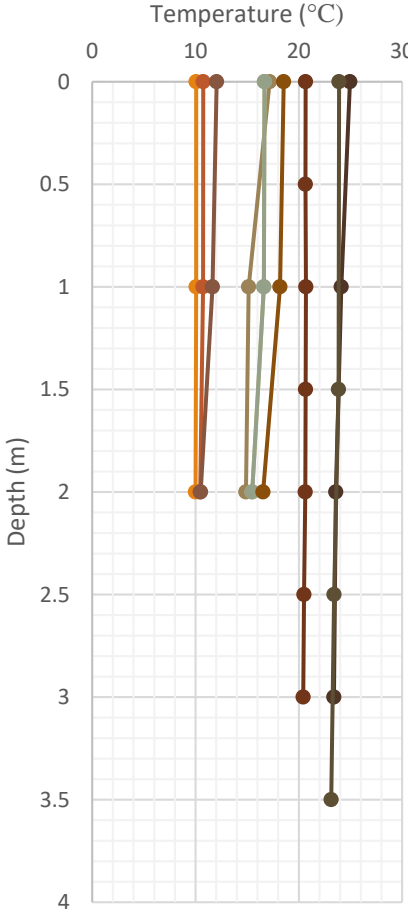


- 10/6/13
- 10/27/13
- 11/3/13
- 11/17/13
- 12/1/13
- 2/2/14
- 2/16/14
- 3/2/14
- 3/16/14
- 3/30/14
- 4/13/14
- 4/27/14
- 6/11/14
- 6/23/14
- 7/7/14
- 7/21/14
- 8/4/14
- 9/7/14
- 9/21/14

WY14

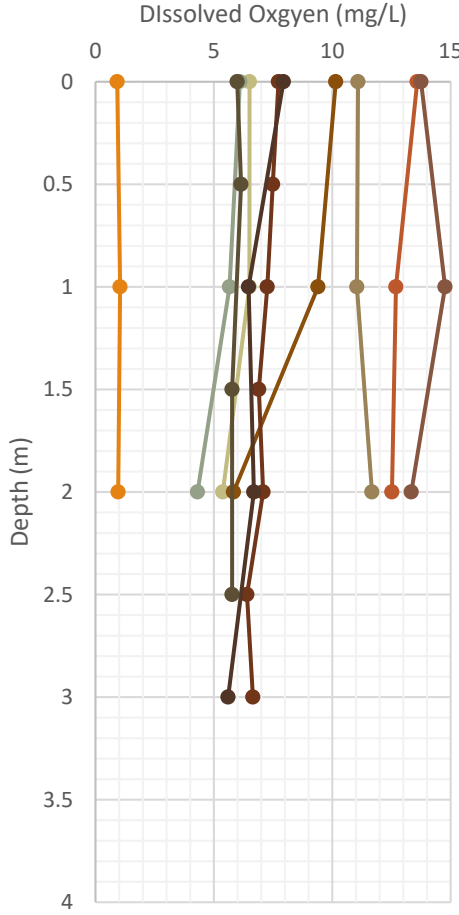


WY16



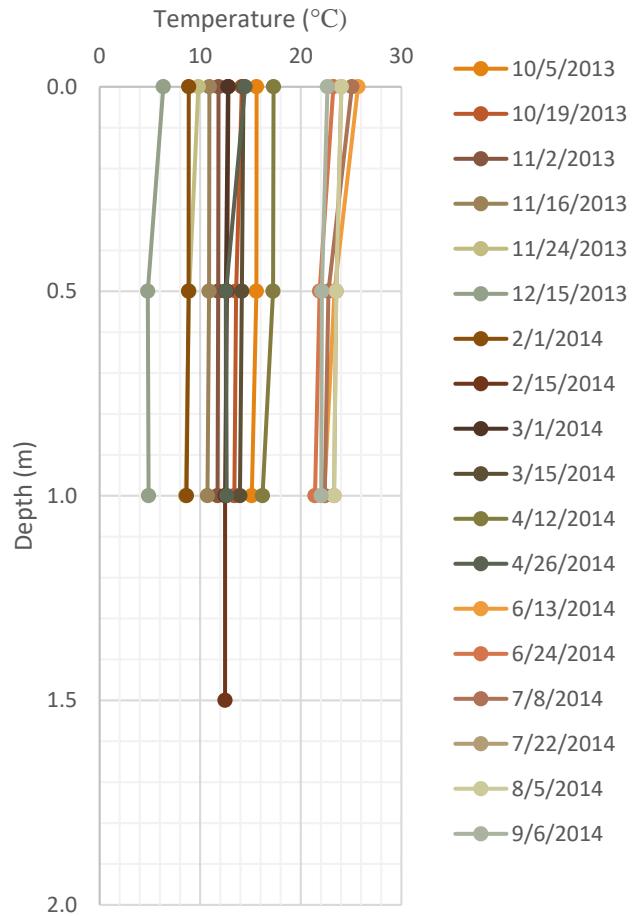
- 12/5/15
- 1/31/16
- 2/13/16
- 4/2/16
- 4/9/16
- 4/23/16
- 5/1/16
- 6/15/16
- 7/1/16
- 7/28/16

WY16

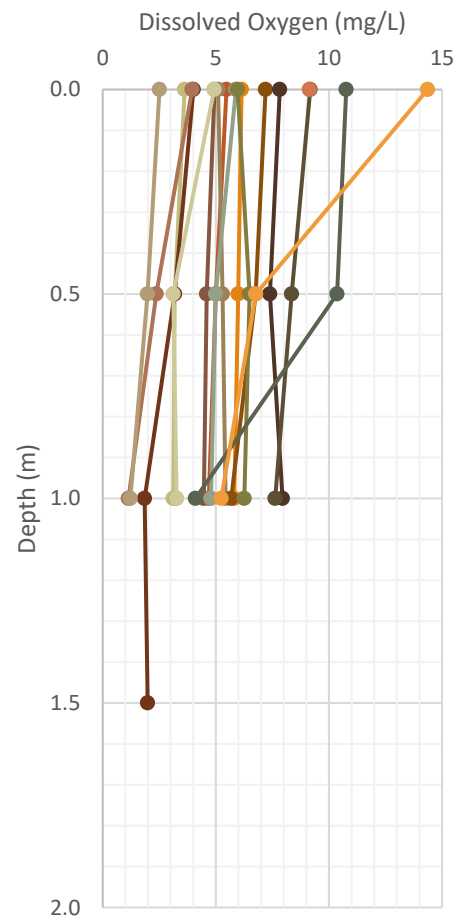


Results: Don Castro Depth Profiles WY14 & 16

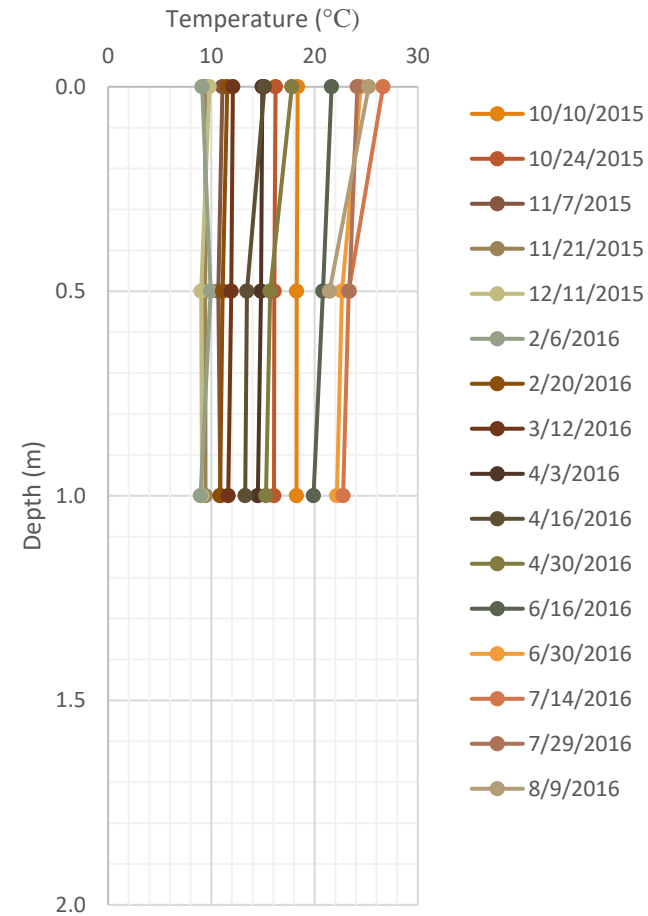
WY14



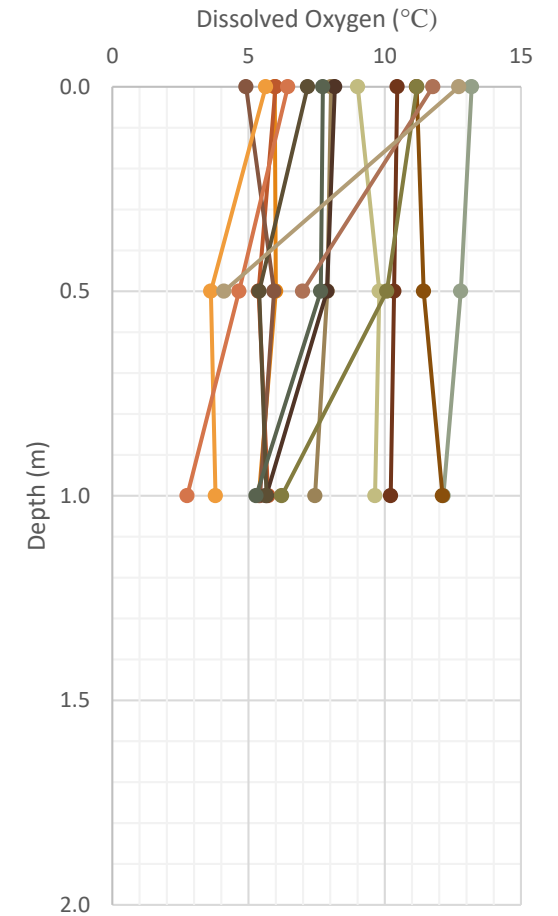
WY14



WY16

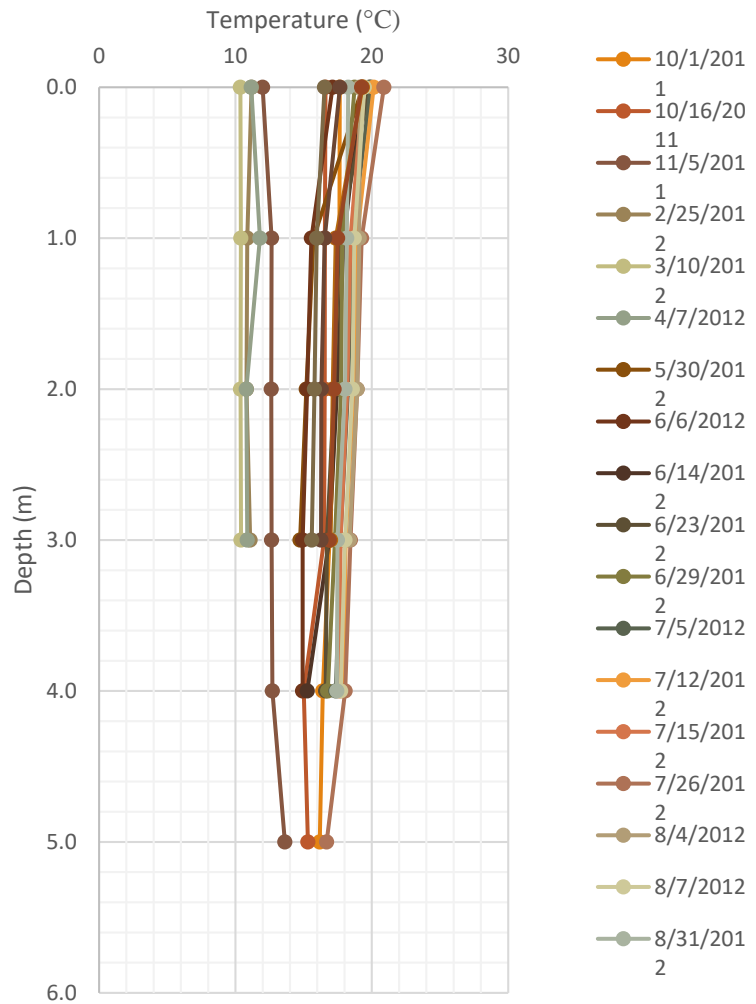


WY16

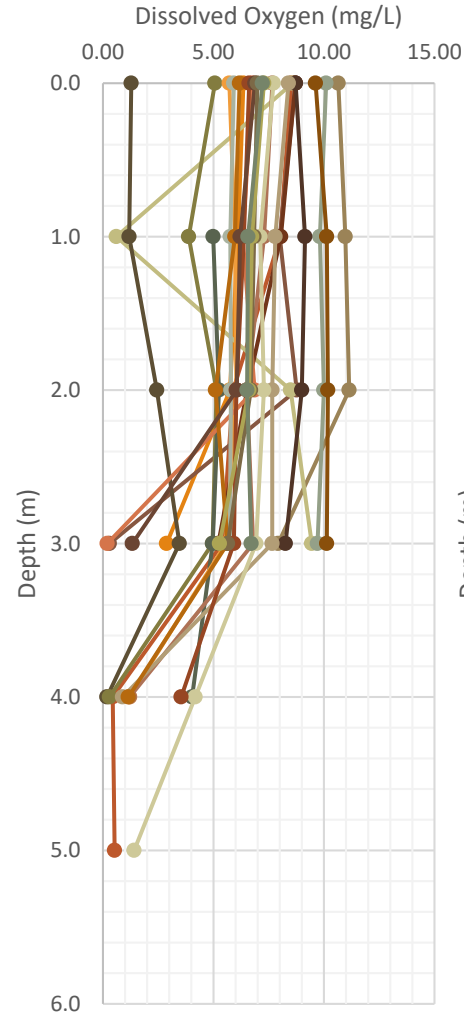


Results: Lake Aliso Depth Profiles WY14 & 16

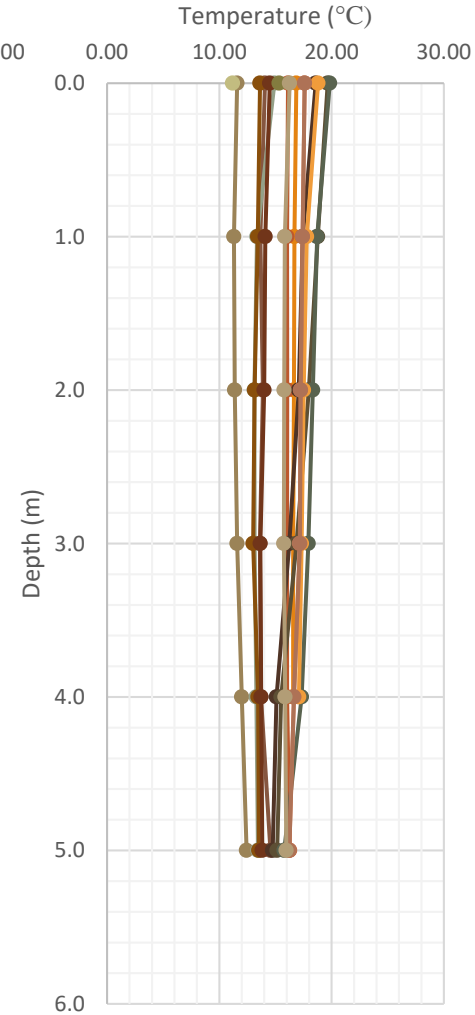
WY12



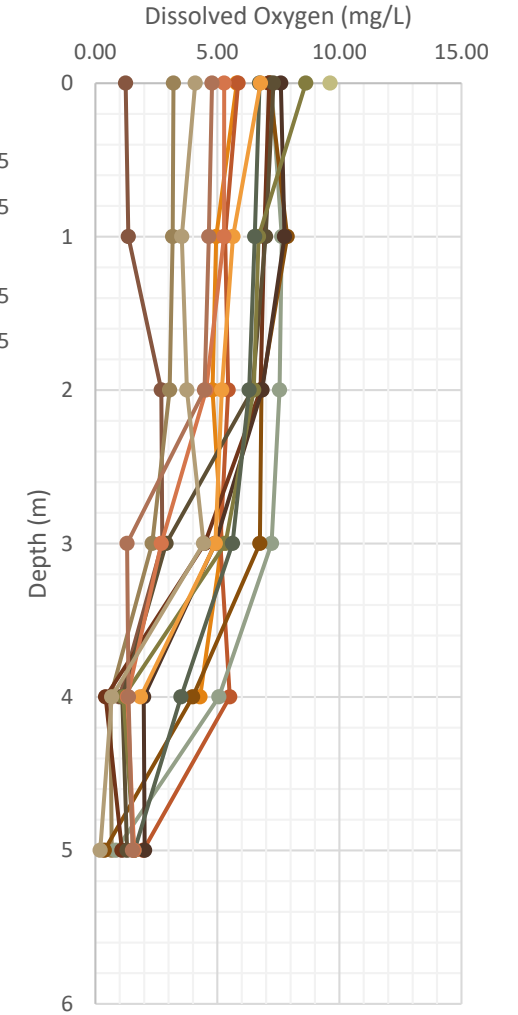
WY12



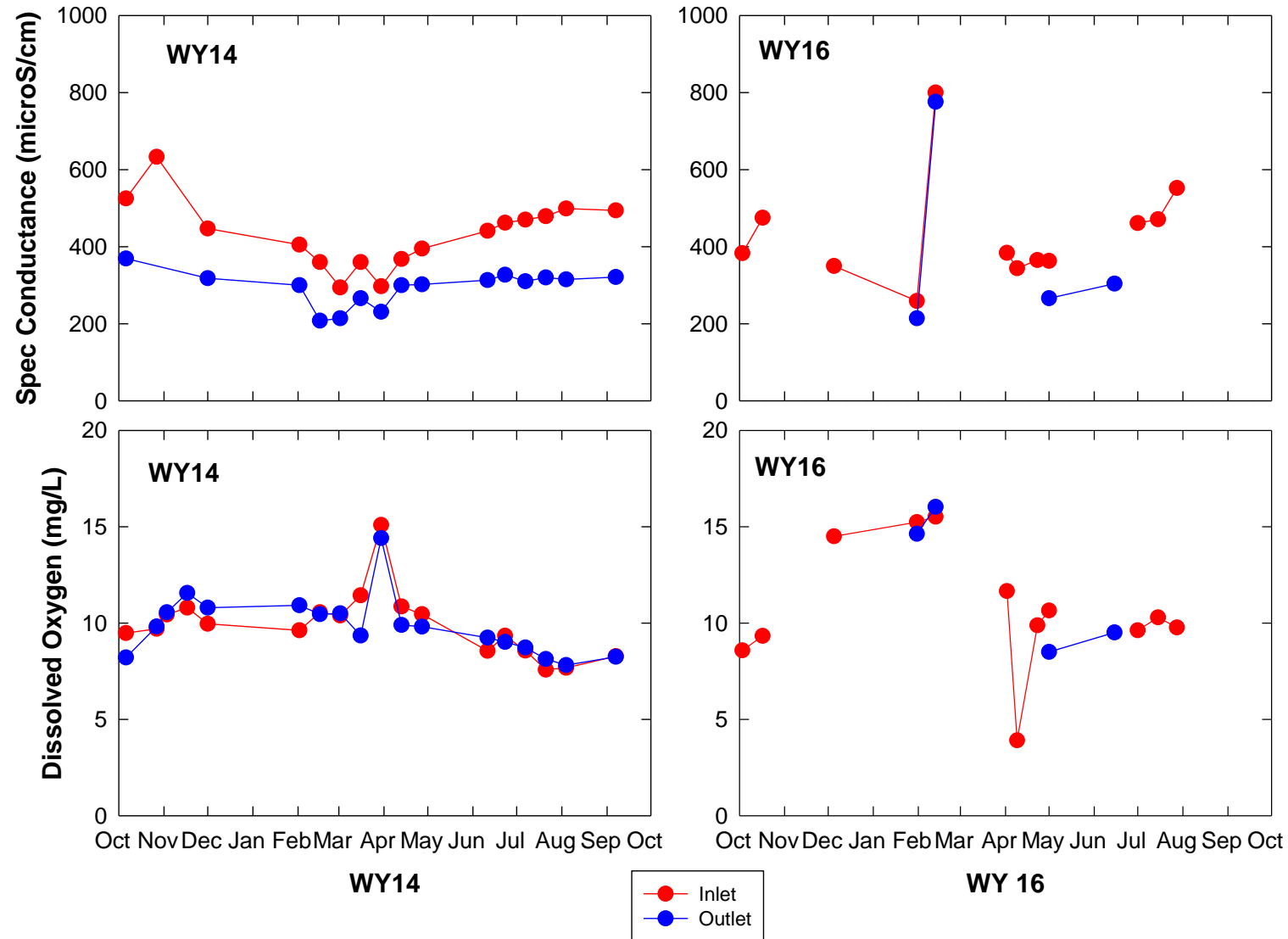
WY16



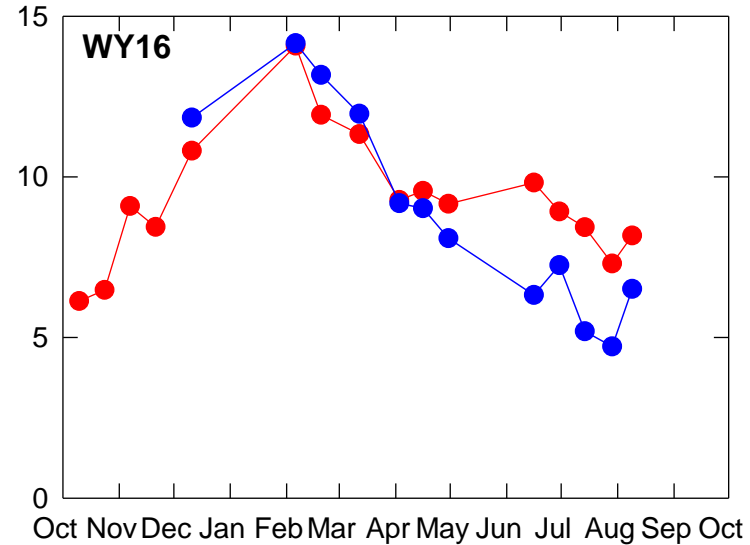
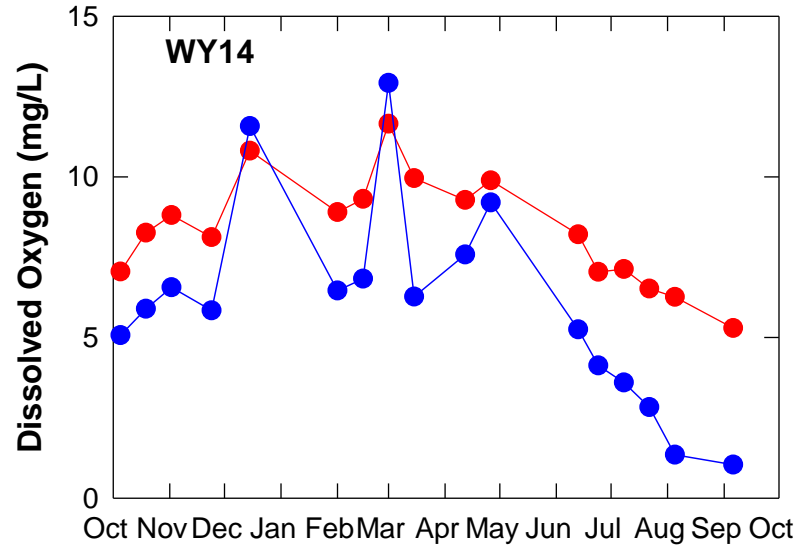
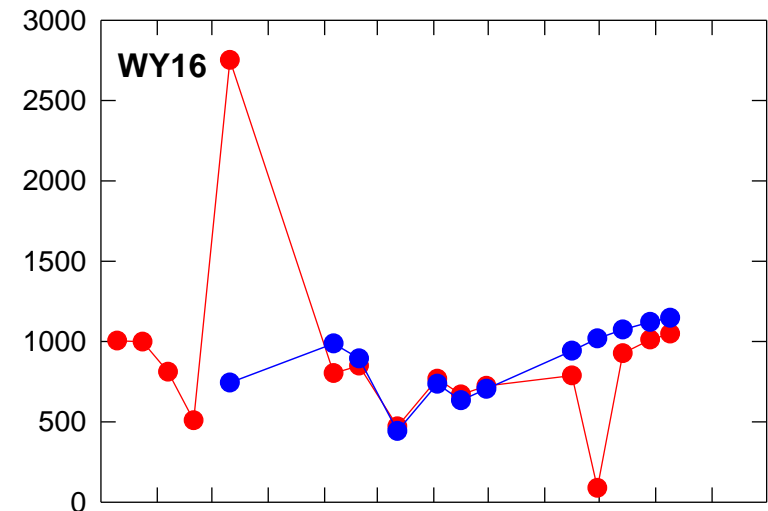
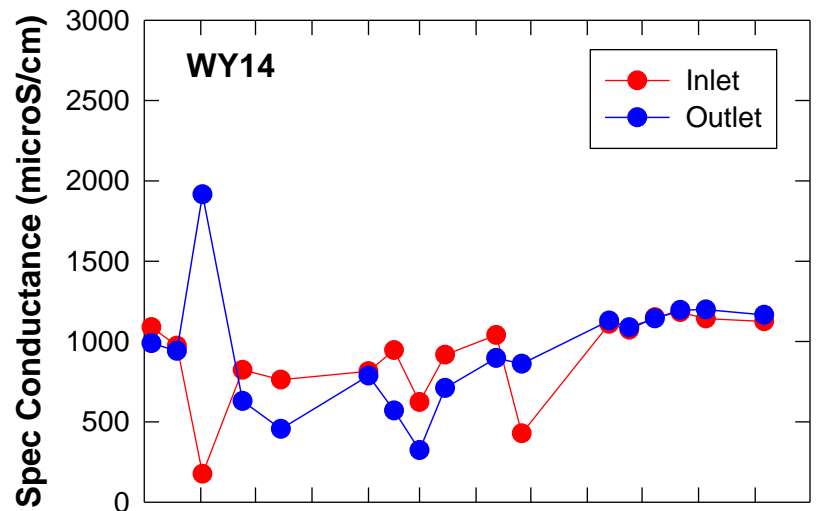
WY16



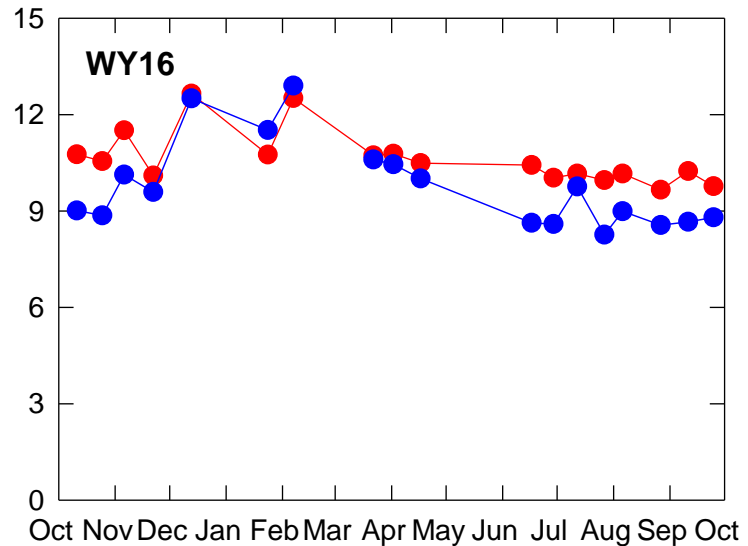
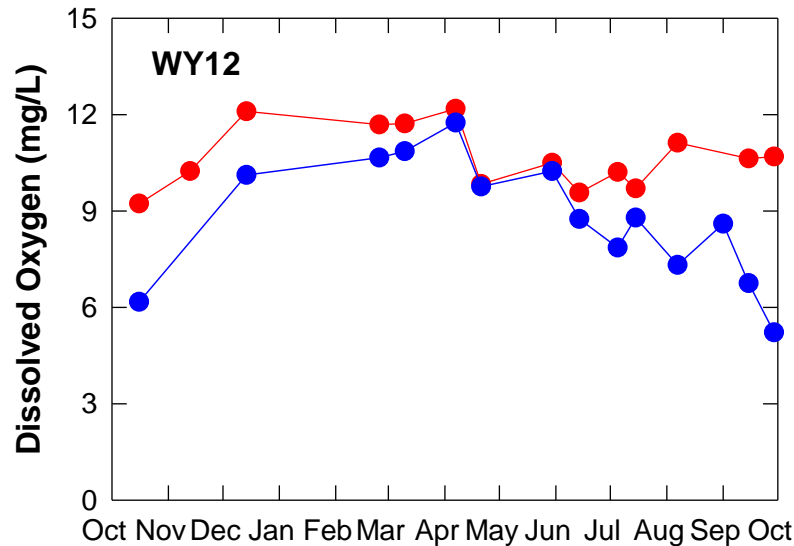
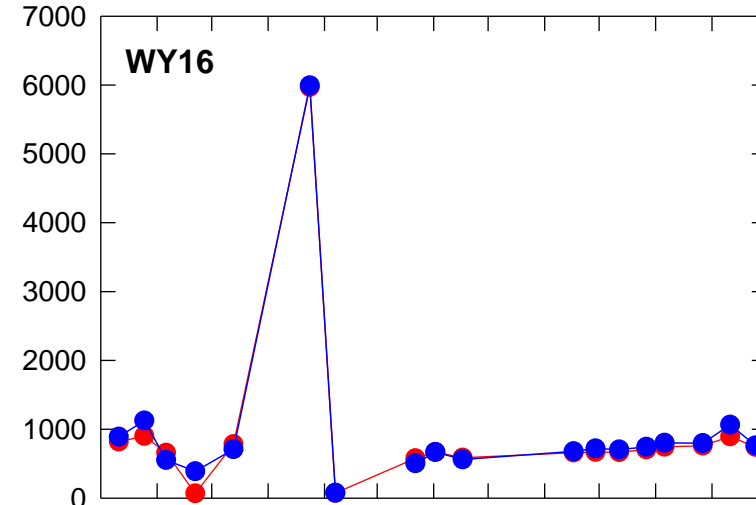
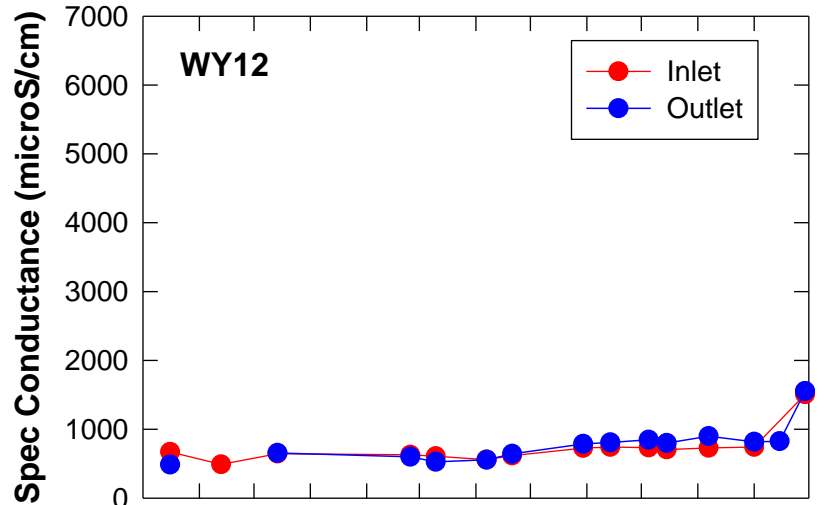
Results: Lake Anza Inlet/Outlet WY 14 & 16



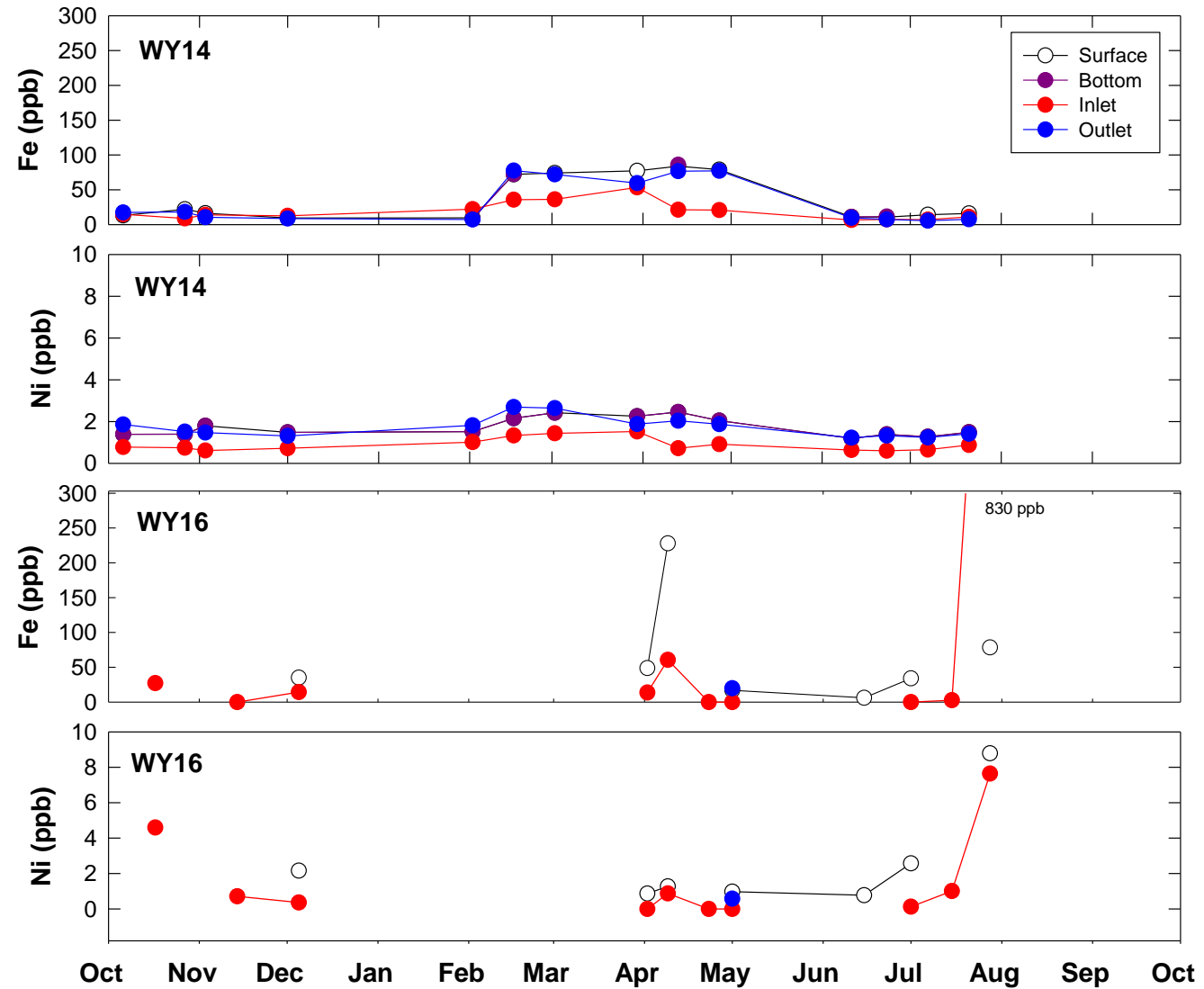
Results: Don Castro Inlet & Outlet WY14 & 16



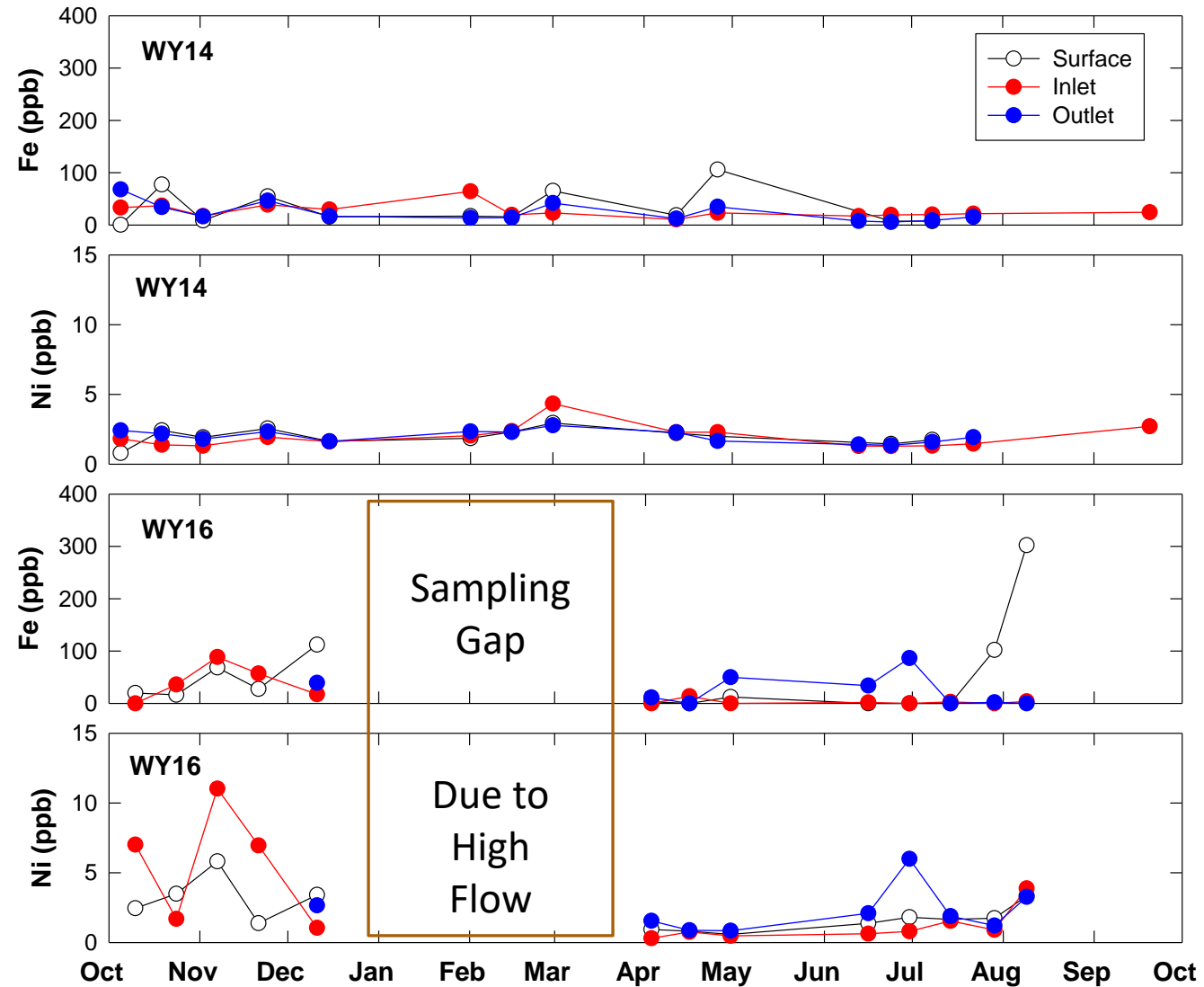
Results: Aliso Inlet & Outlet WY12 & 16



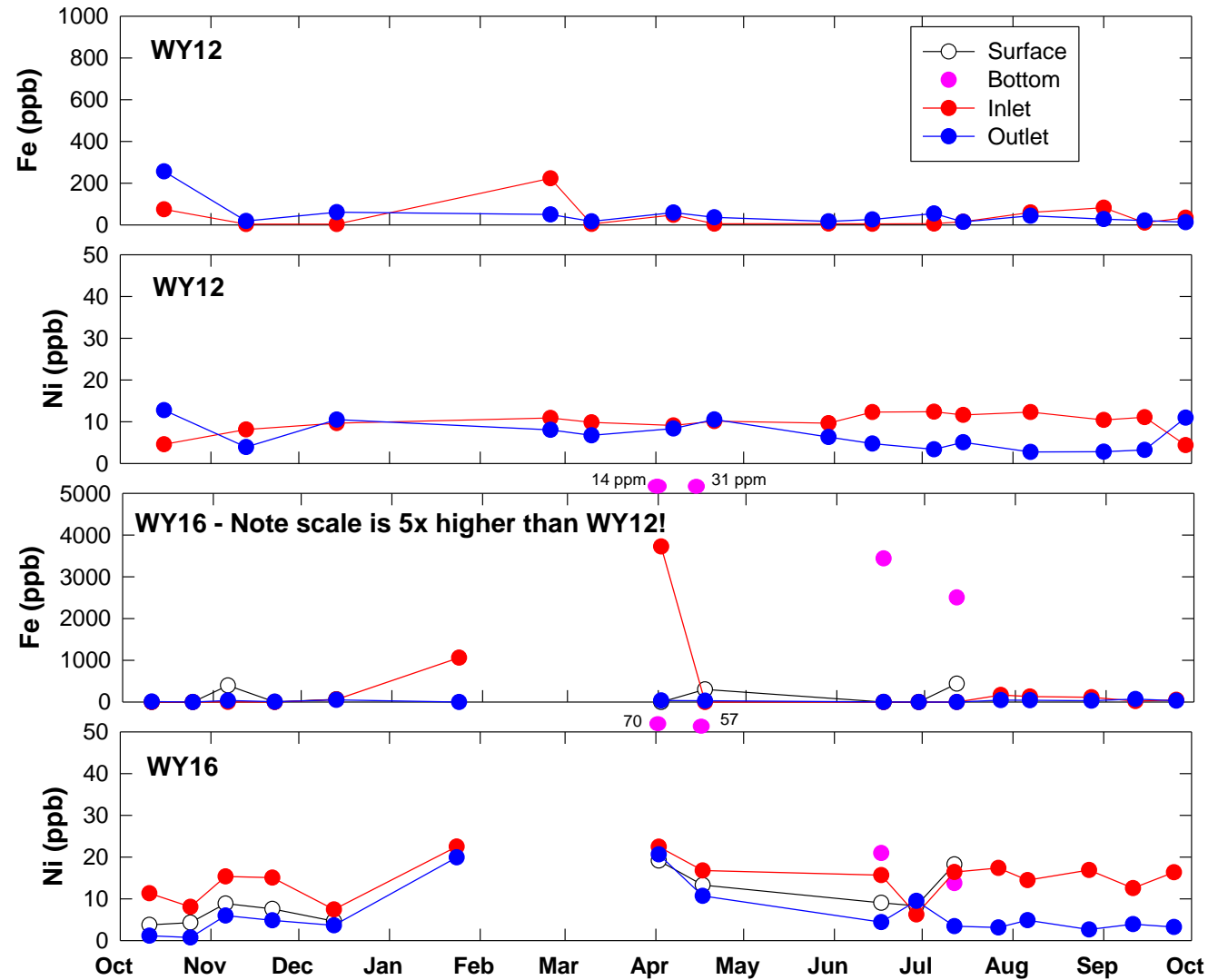
Results: Lake Anza/Wildcat Metals WY14 & 16



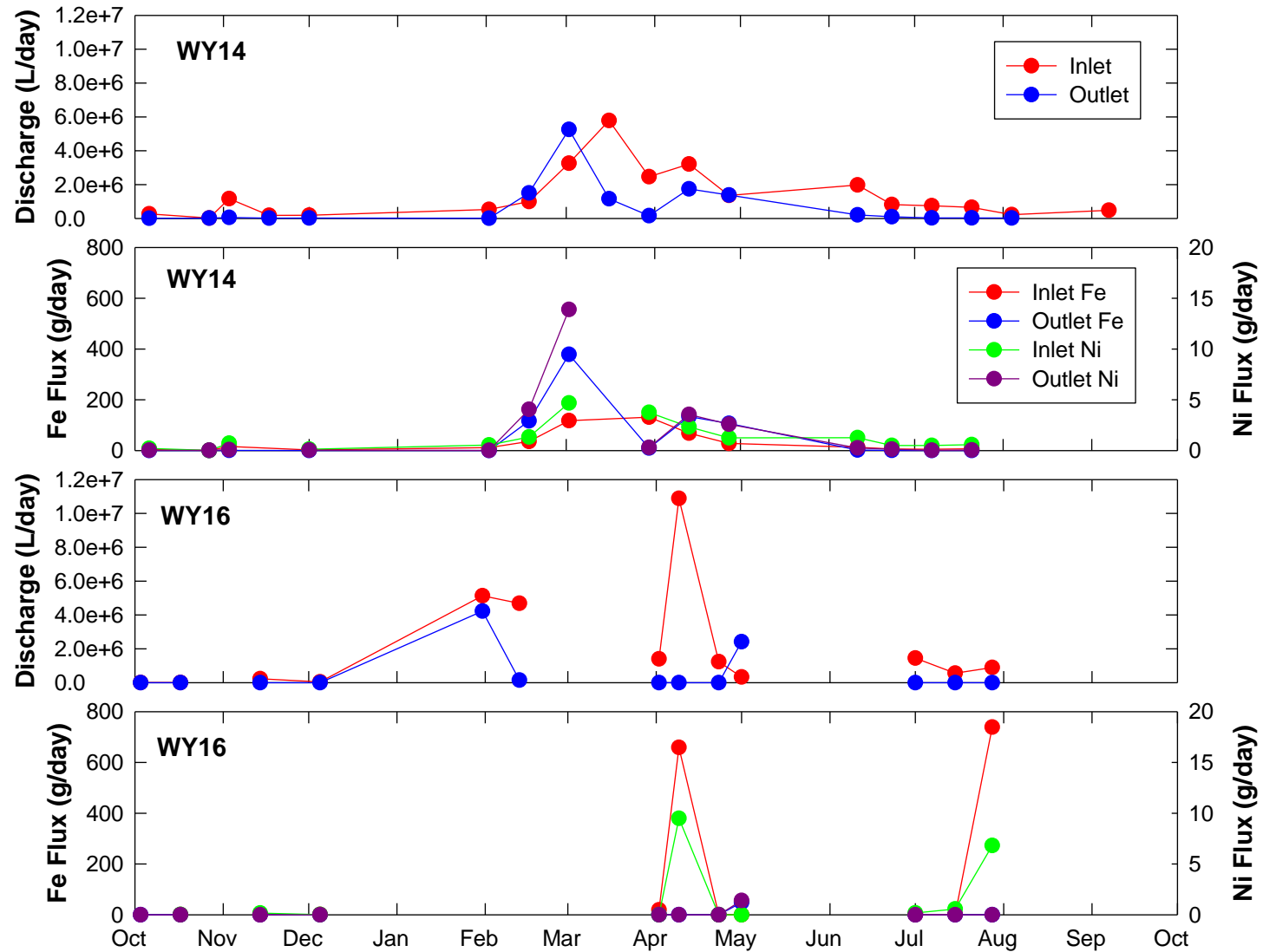
Results: Don Castro/San Lorenzo Metals WY14 & 16



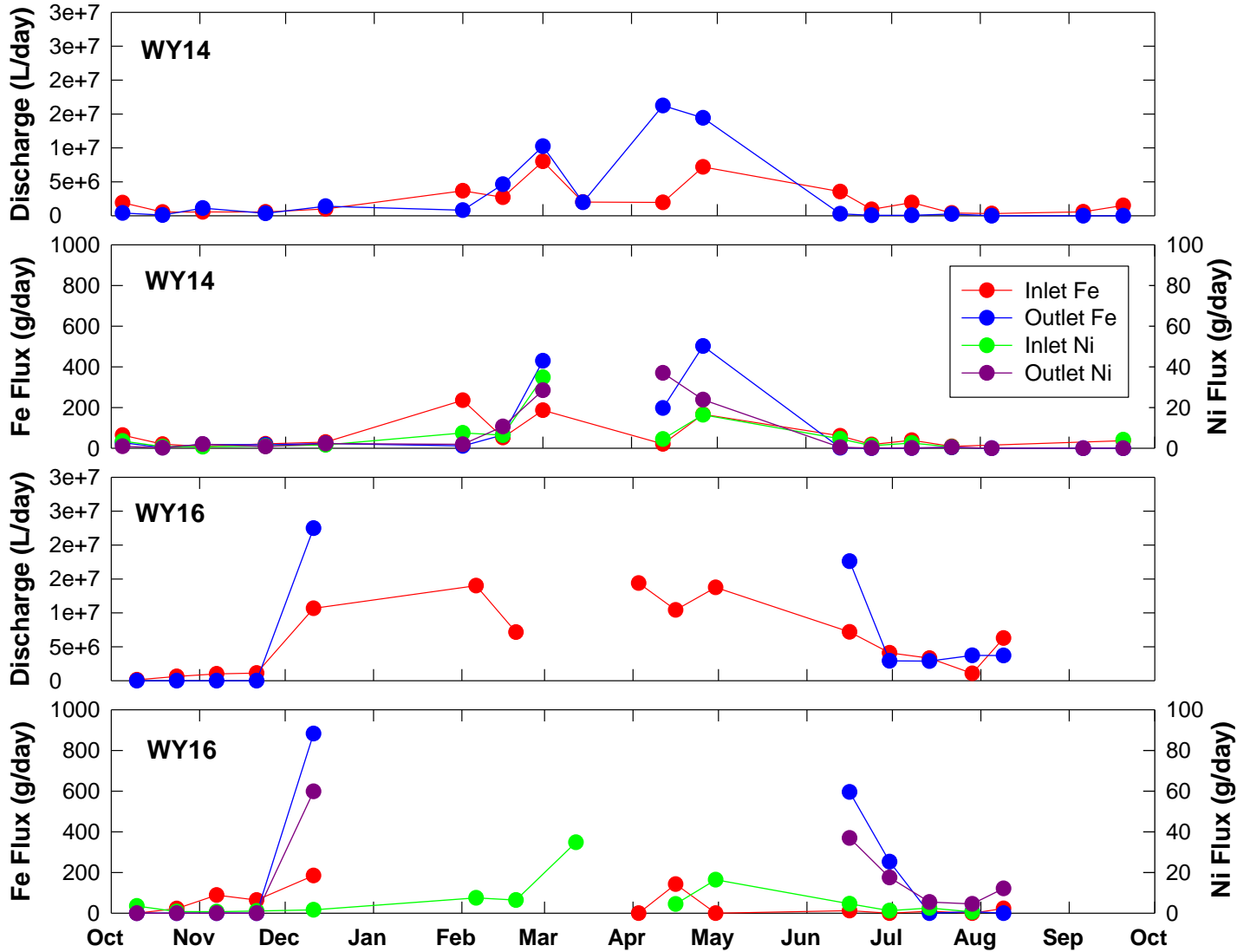
Results: Lake Aliso/Lion Creek Metals WY12 & 16



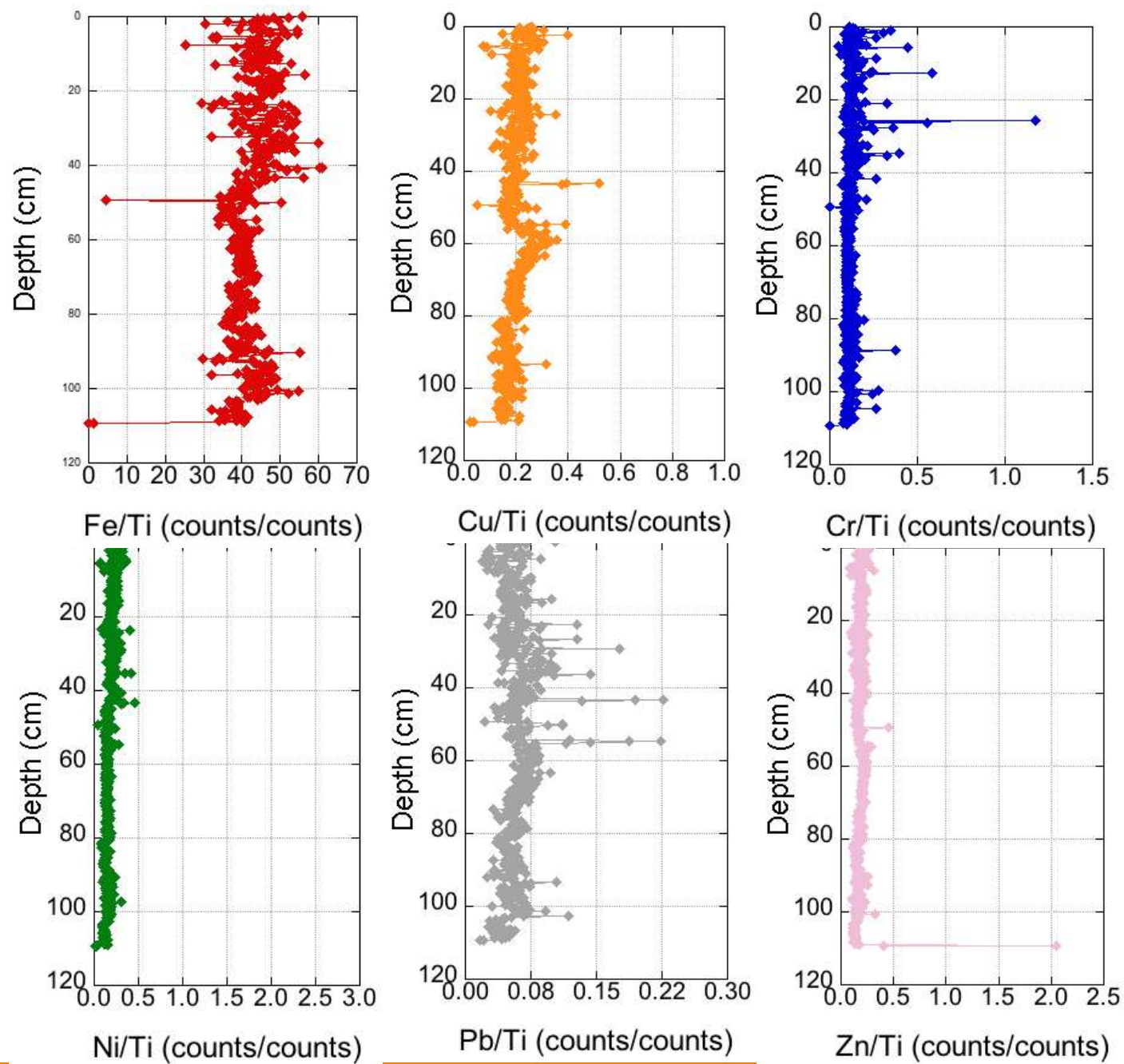
Lake Anza Discharge & Metal Flux WY14 & 16



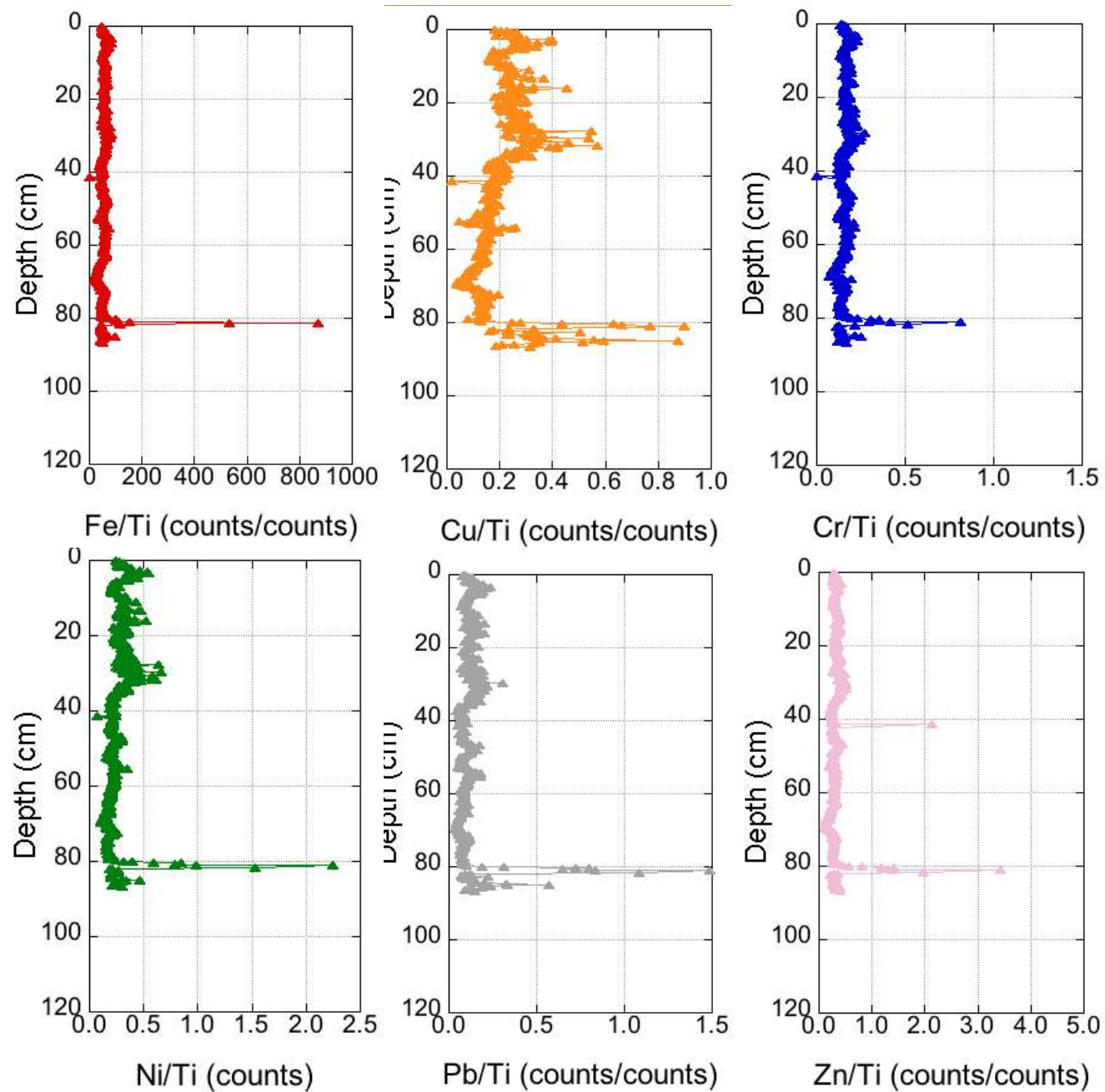
Don Castro Discharge and Metal Flux: WY14 & 16



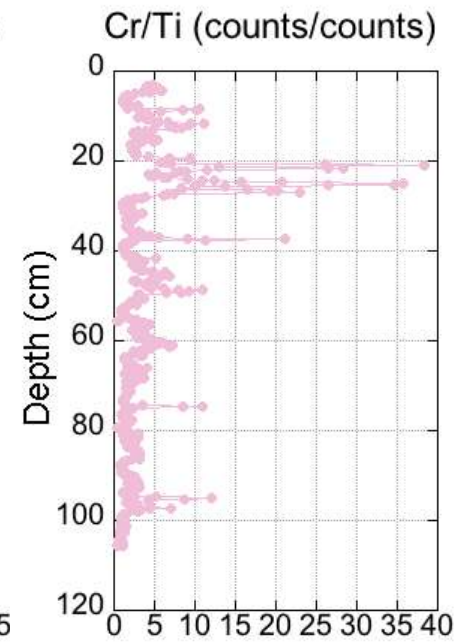
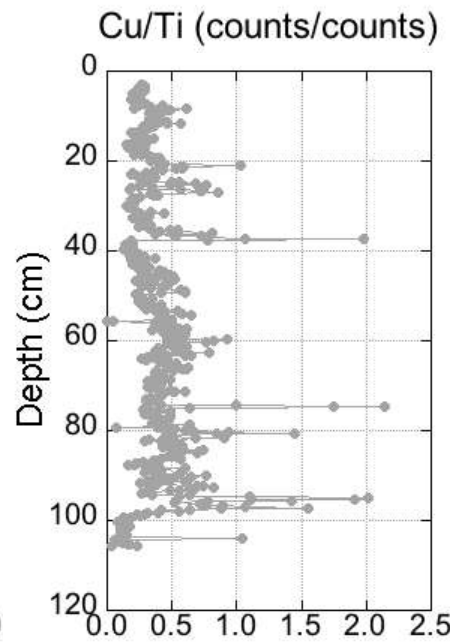
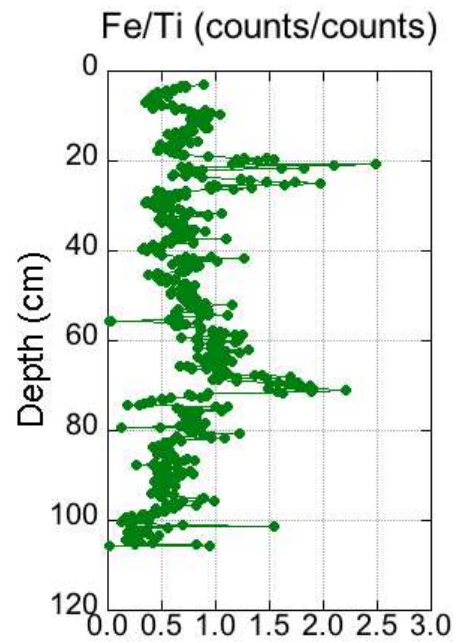
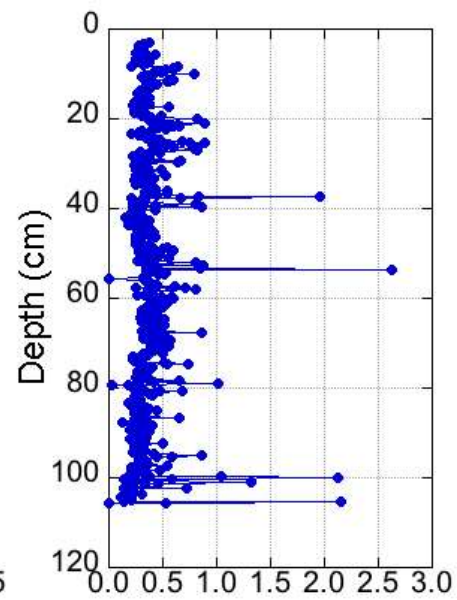
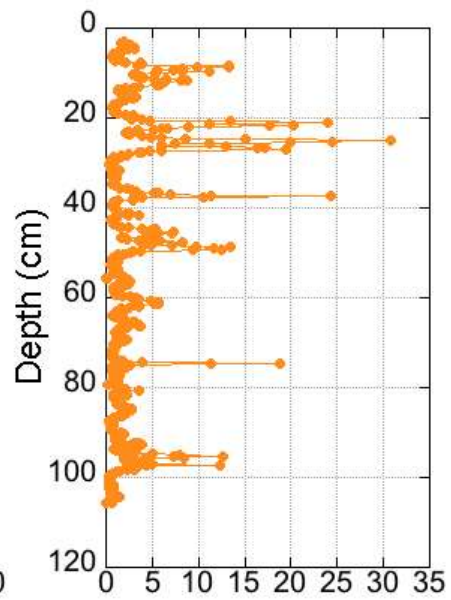
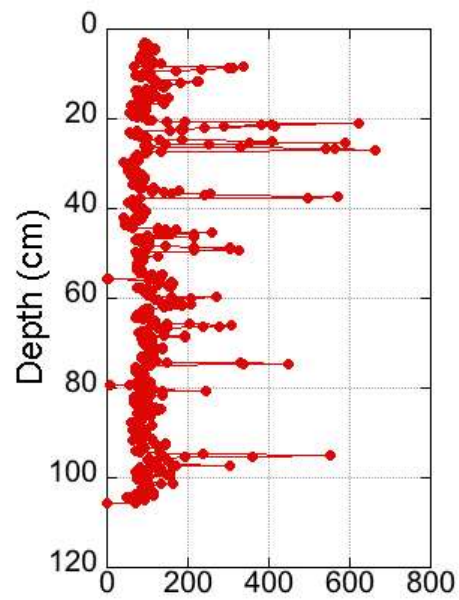
Results: Lake Anza Sediment Cores



Results: Don Castro Sediment Cores



Results: Lake Aliso Sediment Cores



Ni/Ti (counts/counts)

Pb/Ti (counts/counts)

Zn/Ti (counts/counts)

Conclusions: Summary of Findings So Far...

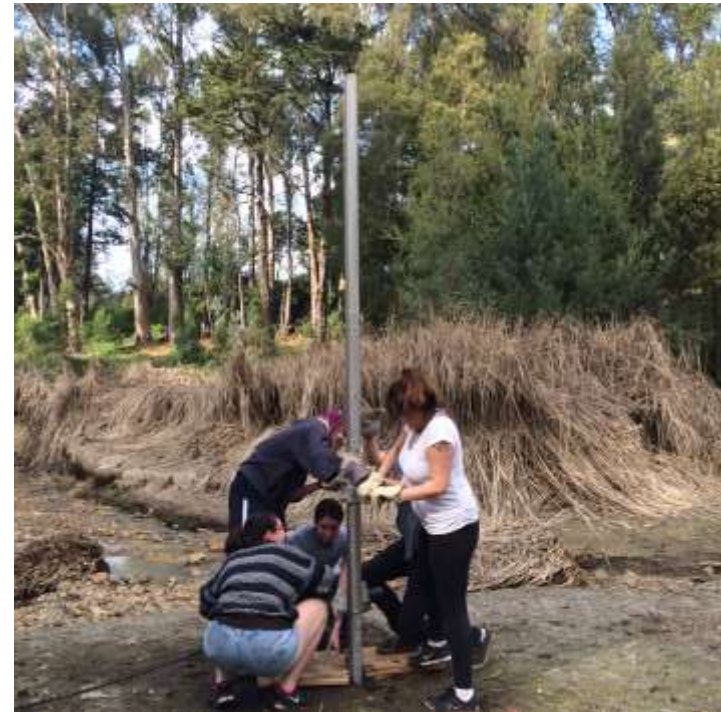
Reservoir	Management Style	Stratification/ Dissolved Oxygen	Source or Sink?	Sediment Metal Content
Anza	Perennial	Seasonally somewhat stratified/ Higher DO	Fe & Ni Source in WY14 (drought) Fe & Ni Sink in WY16 (end drought)	Relatively low/ consistent
Don Castro	Perennial	Not stratified/ Lower DO	Fe & Ni Source in WY14 & WY16	Increasing towards present
Aliso	Ephemeral	Seasonally well stratified/ Lower DO	Fe Source in WY14 (drought) Fe & Ni Sink in WY16 (end drought)	Relatively high/ variable

What might account for the difference in metal behavior between Anza and Aliso?

ANZA



ALISO



Acknowledgments

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At Pacific: G. Alldredge, K. Gomez, D. Schilling, R. Ward, J. Yun,
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H. Glicker, R. Jensen, L. Kong, S. Kreutzer, R. Sandoval, N.
Labarca, C. Le, N. Lemon, P. Miranda, M. Murphy, J. Moore, M.
Nutt, M. Page, A. Parmidge, E. Rigby, J. Rodriguez, A. Savage, A.
Scholtz, K. Singh, C. Soares, R. Stewart-Laws, C. Stitt, O. Sun, L.
Tice, A. Timm, C. Wu, L. Zentner

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