University of Arizona

Application of Chemical and Biological Techniques to Characterize the Organic Matter within Environmental Buffers Receiving Wastewater Effluent

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Water Background

97% Seawater (non-drinkable)

2.5% Frozen freshwater

0.5% Freshwater available

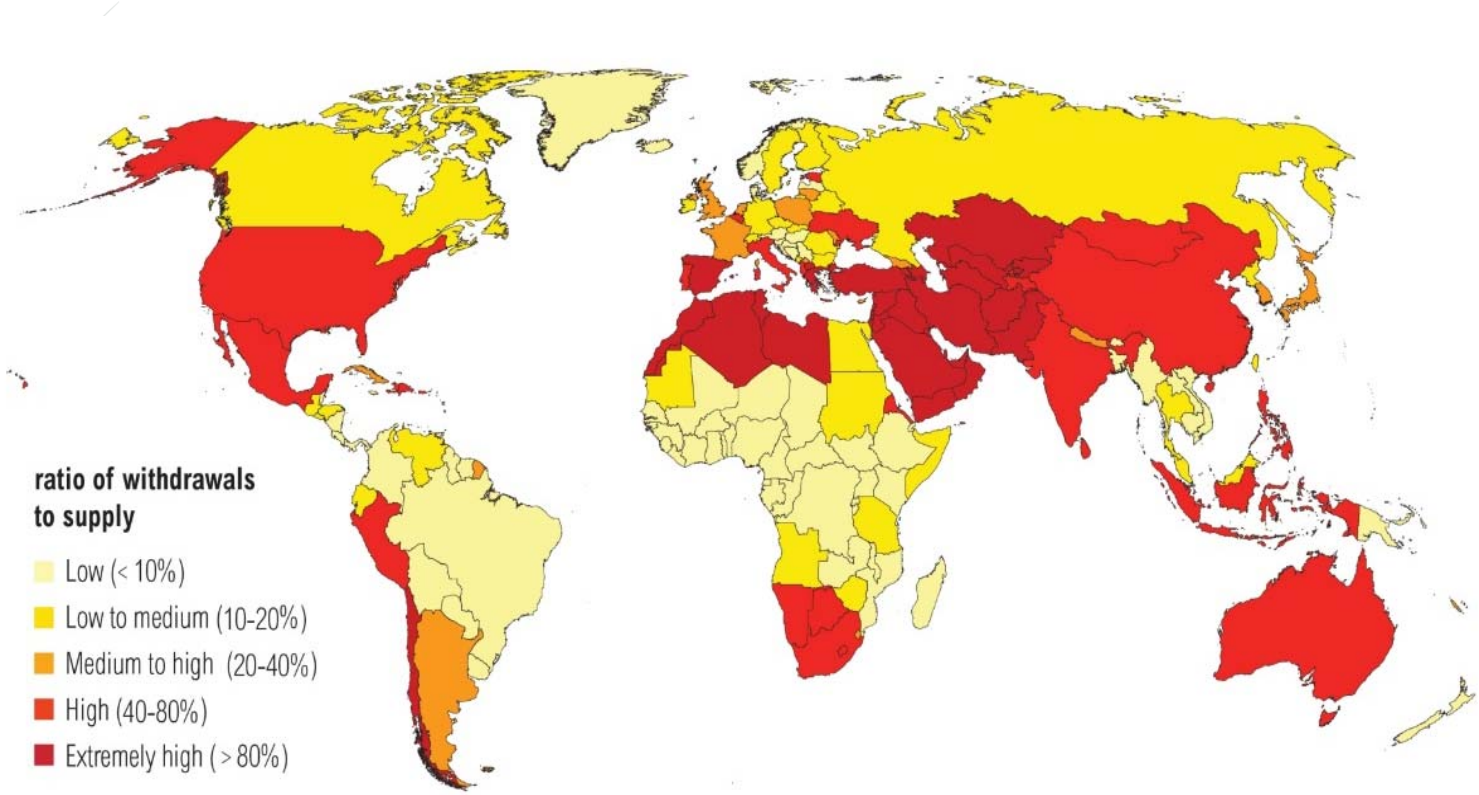
Water Scarcity

California Drought

Lake Oroville

Folsom Lake

Water Stress by Country: 2040



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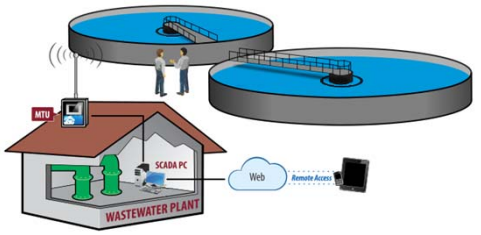
Water Reuse Alternatives

- Estimates of the cost of developing extra water capacity in dollars per acre-foot of water.

Indirect Potable Reuse (IPR)

Consumer



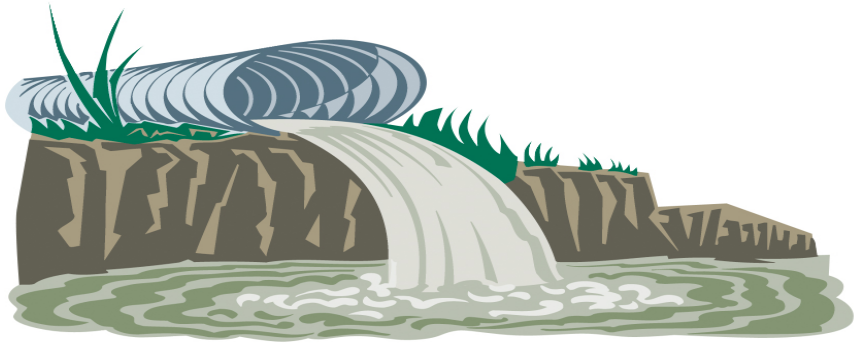
Conventional
Wastewater Treatment

Discharge

Drinking Water
Treatment

Objective

- Objective: To characterize the organic matter within secondary effluent produced in Tucson, AZ.
- Purpose: To investigate how different types of environmental buffers can alter the composition of organic matter within the water.



Sites

Sweetwater Wetlands

Santa Cruz River

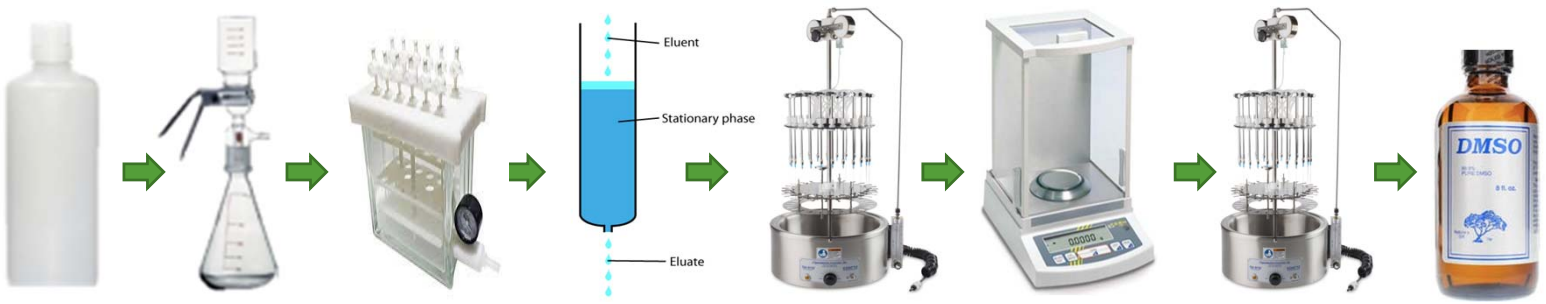
Sample Collection

Sweetwater Wetlands

Santa Cruz River

Sample Preparation

- Method: Mehinto et al. 2015; Jia et al. 2016

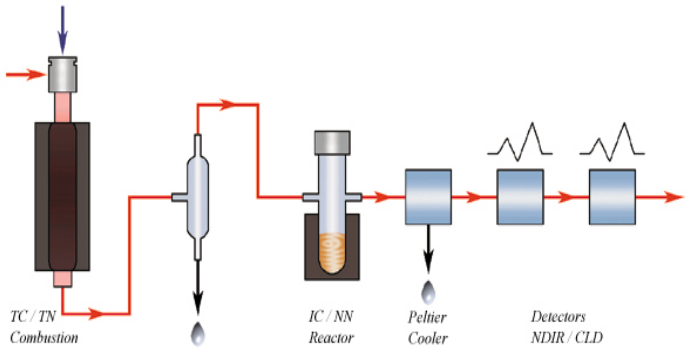


Bulk
Targeted

Bioassays

Bulk Organic Parameters – Dissolved Organic Carbon (DOC)

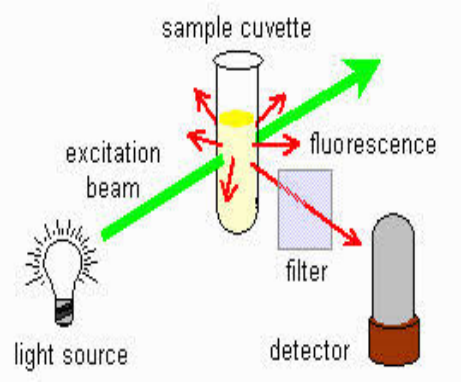
- Shimadzu-TOC analyzer
- Method: Standard Methods 5310 B



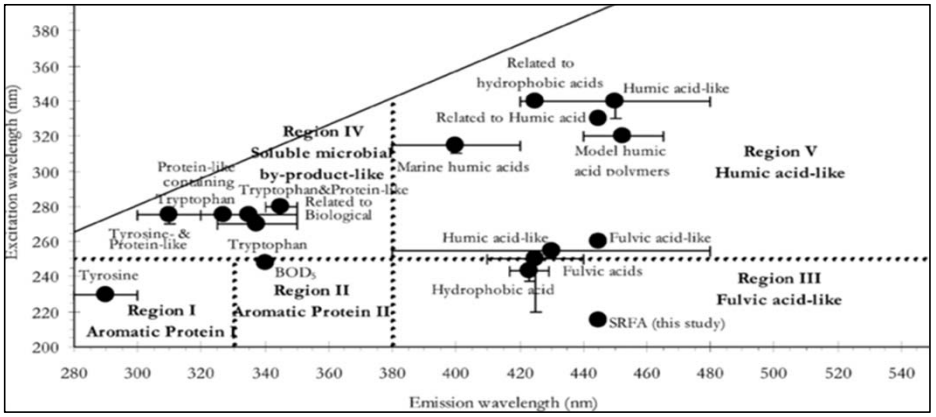
Bulk Organic Parameters - Fluorescence

- Aqualog Horiba fluorometer
- Method: Minkyu et al., 2017

Total Fluorescence (TF)

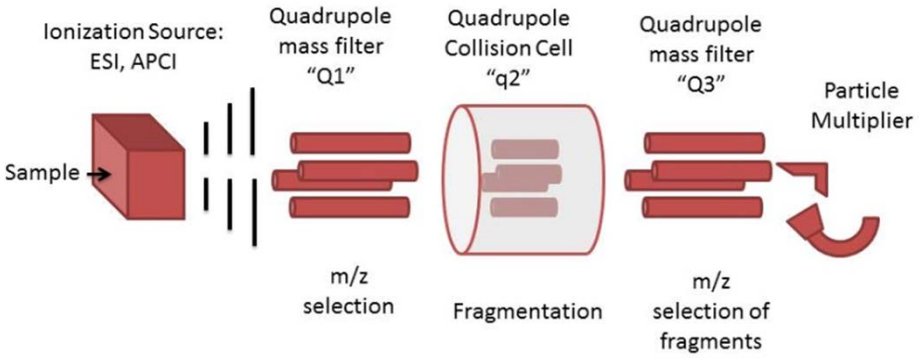


Excitation Emission Matrix (EEM)



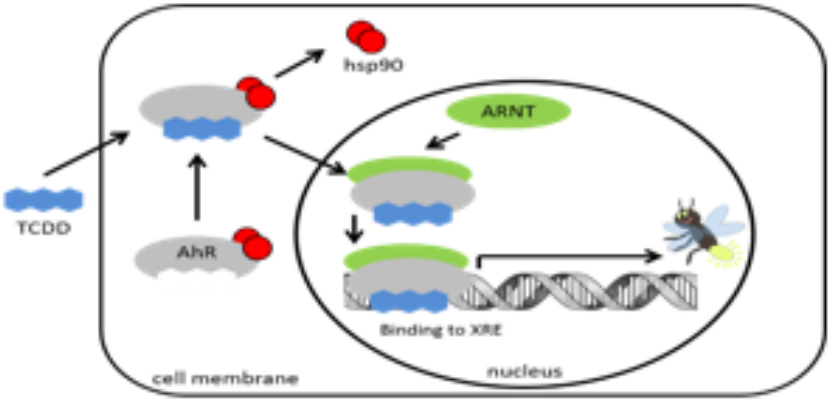
Targeted Analysis

- An Agilent Liquid Chromatographer triple quadruple mass spectrometer (LC-QQQ 6490) was applied.
- Quantification of the occurrence of 45 different contaminants of emerging concern (CECs)
  - including pharmaceuticals, iodinated x-ray contract media, personal care products, household/commercial compounds

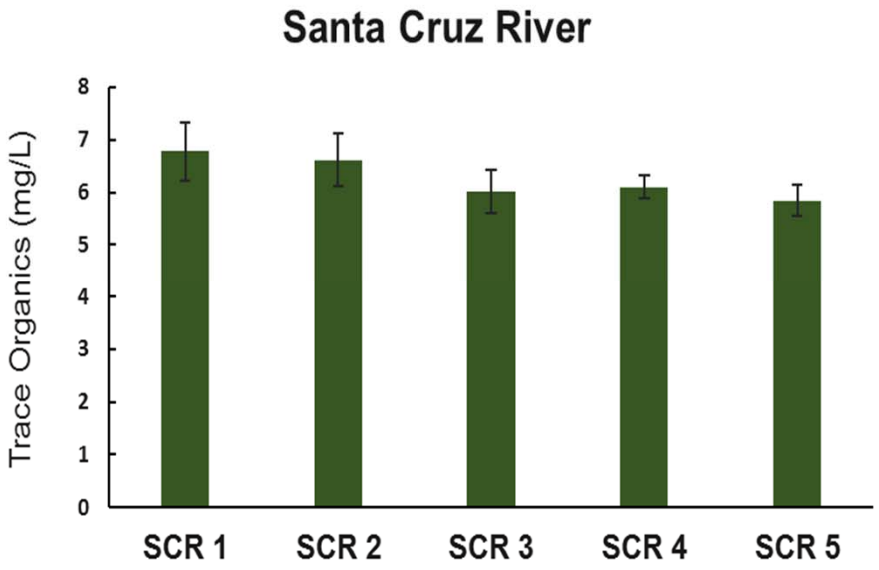


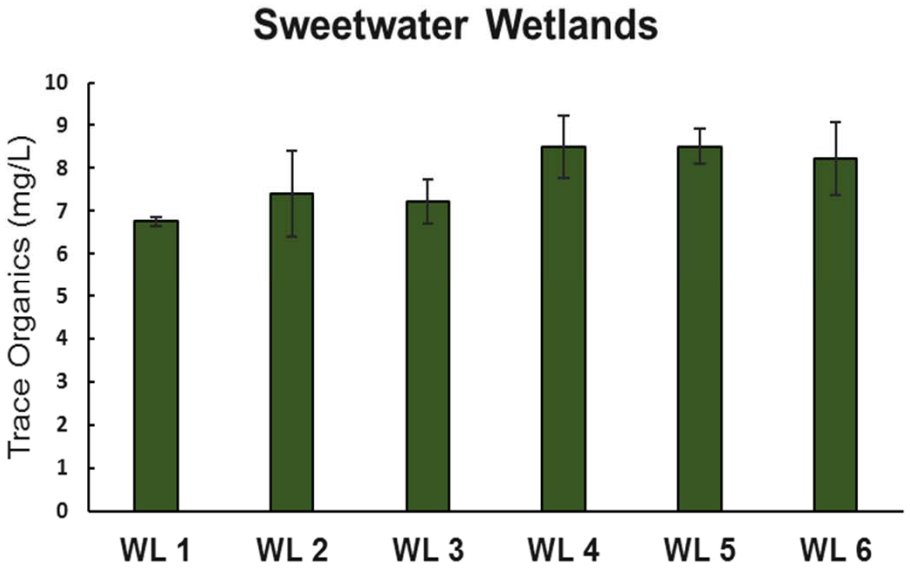
Bioassay

- Glucocorticoid Receptor
- Estrogen Receptor
- Aryl Hydrocarbon Receptor

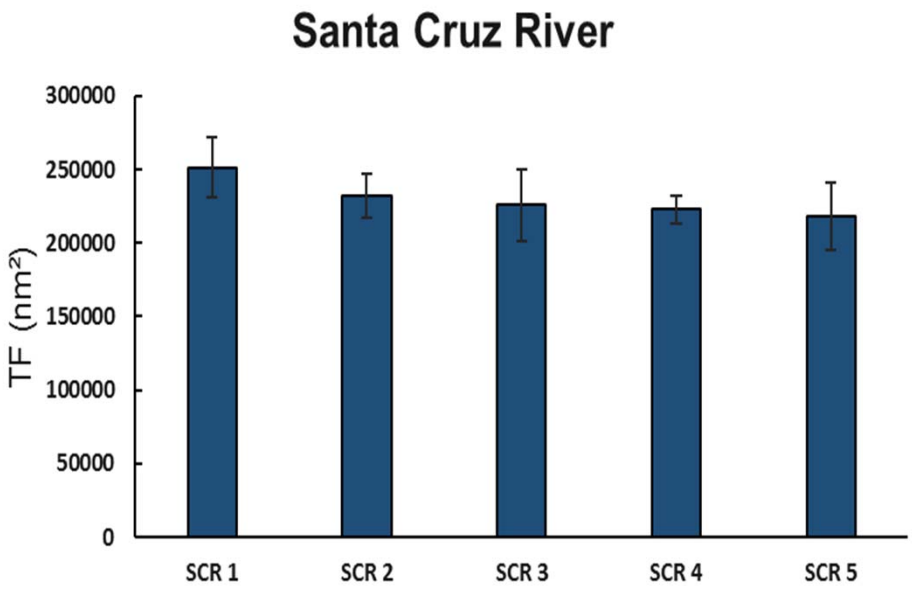


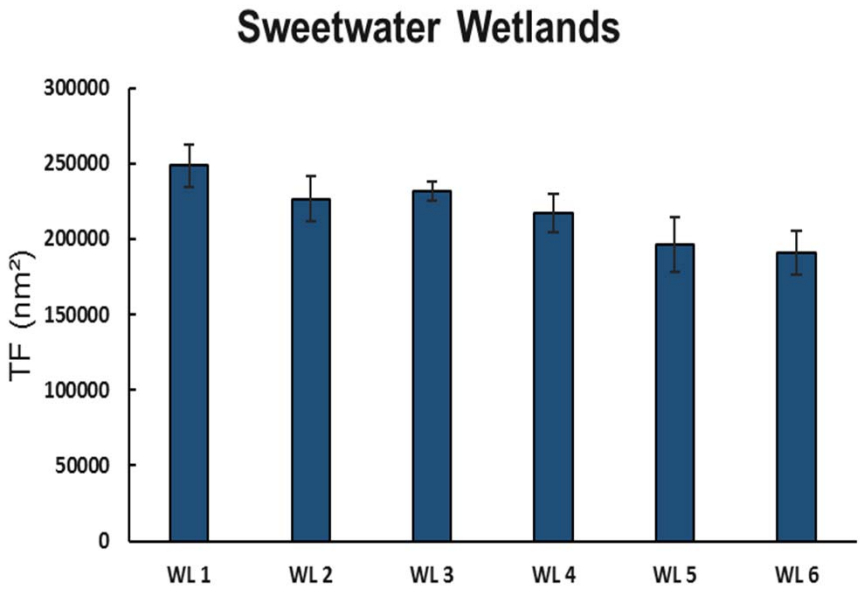
Dissolved Organic Carbon (DOC)



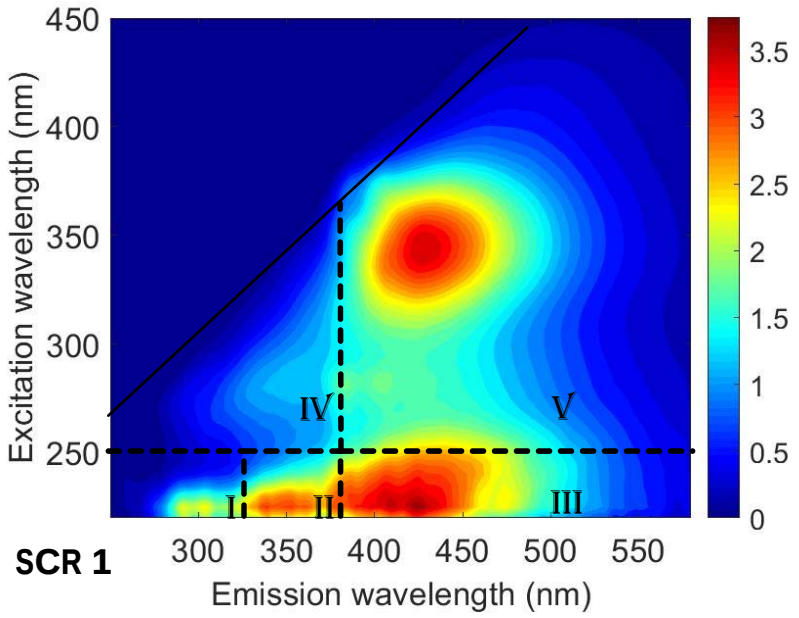


Total Fluorescence (TF)

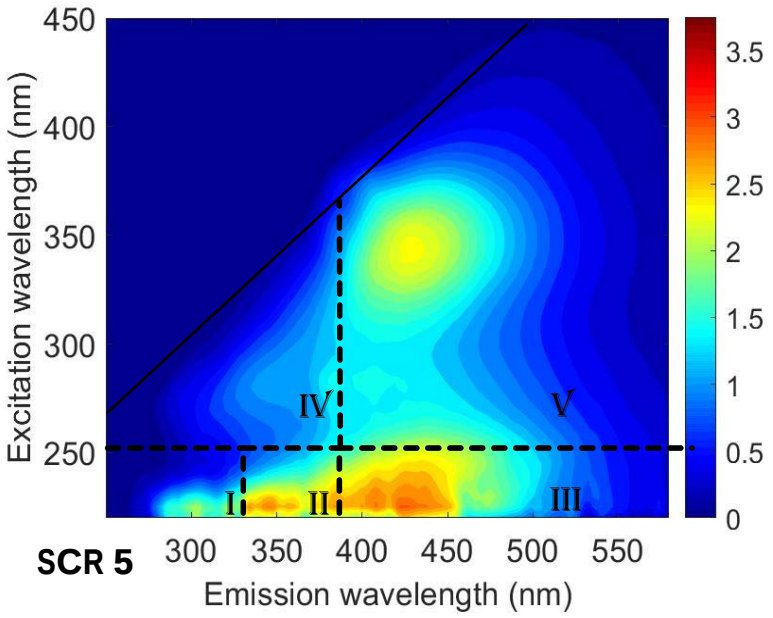




Excitation Emission Matrix (EEM) – SCR

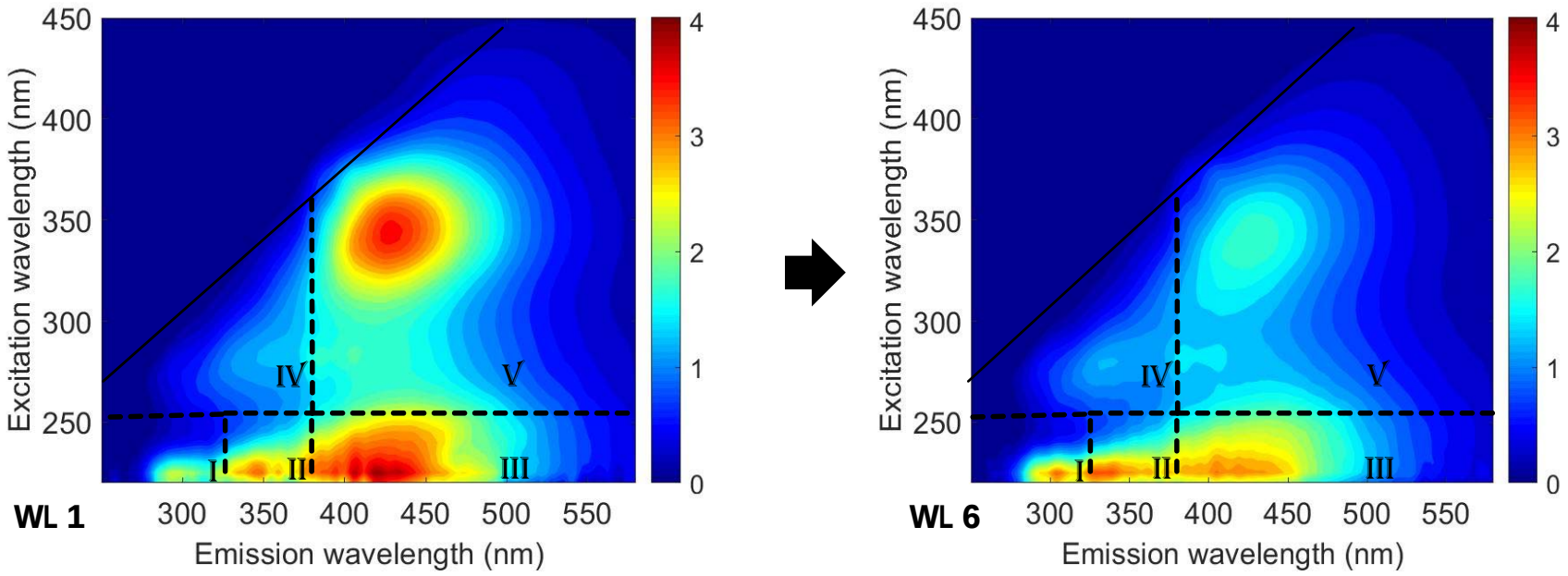


SCR 1

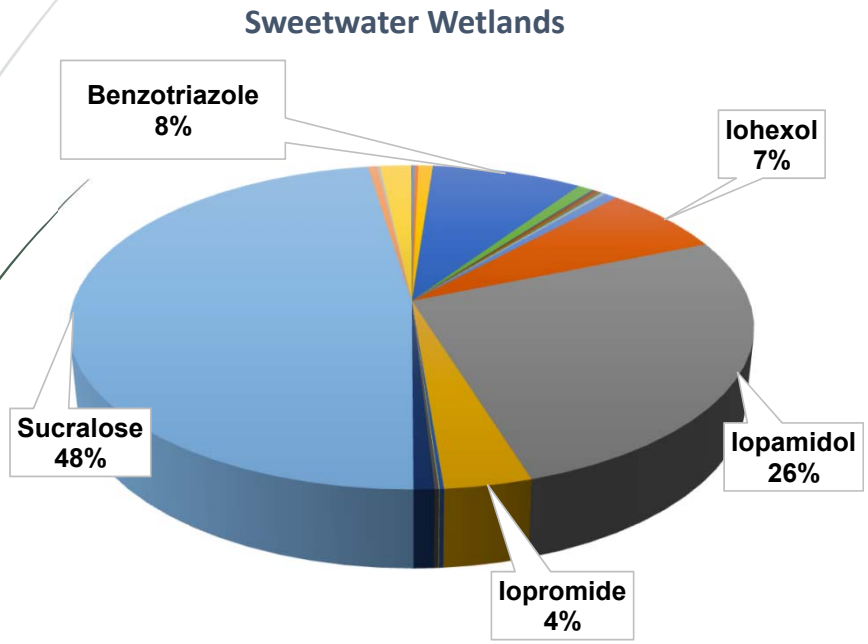


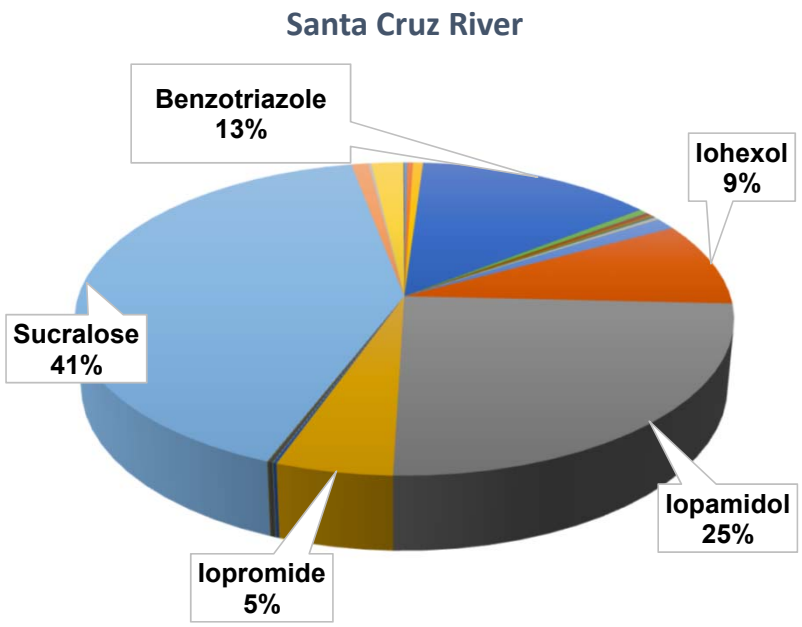
SCR 5

Excitation Emission Matrix (EEM) - WL

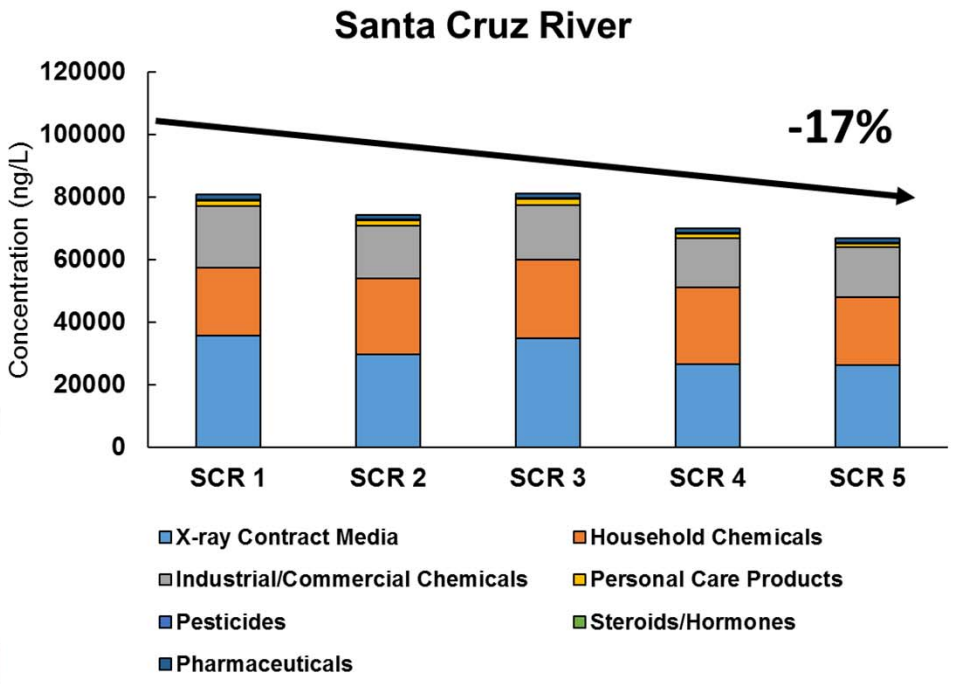


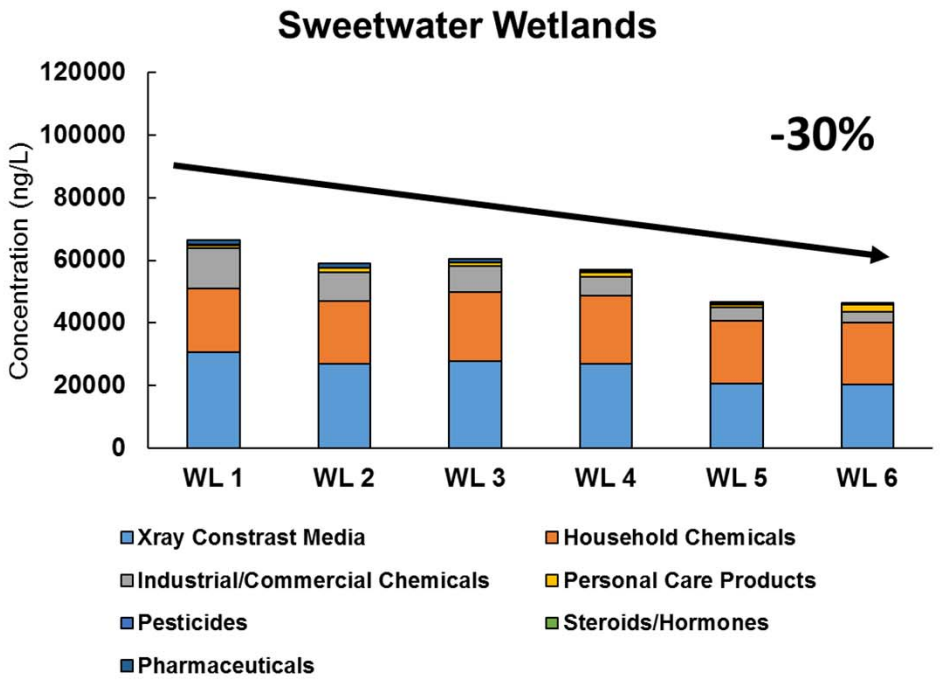
Most Prevalent Compounds



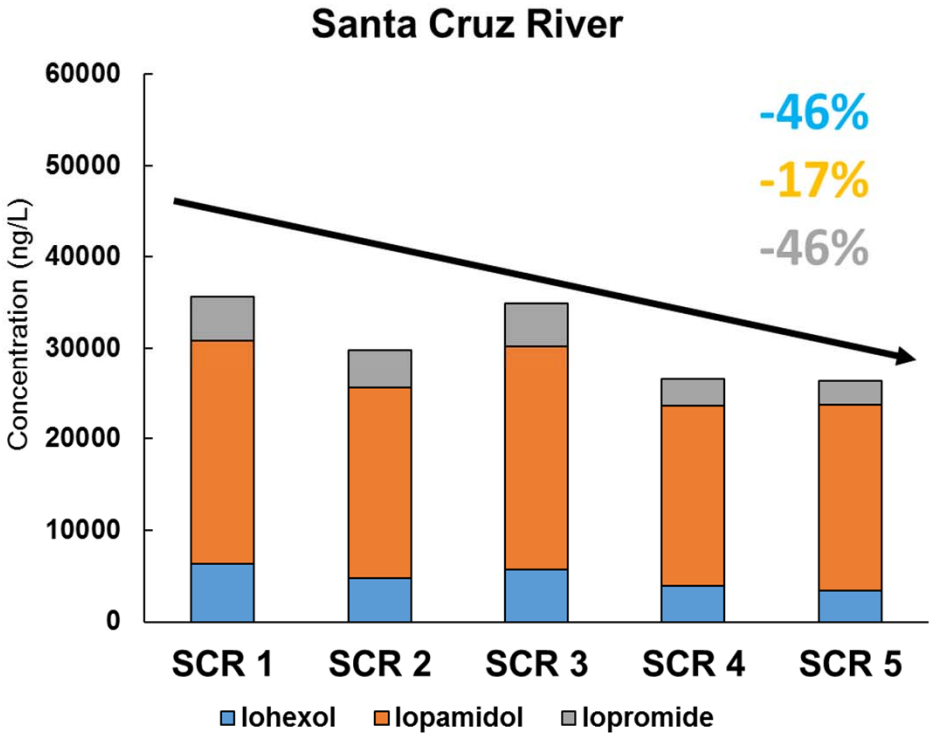


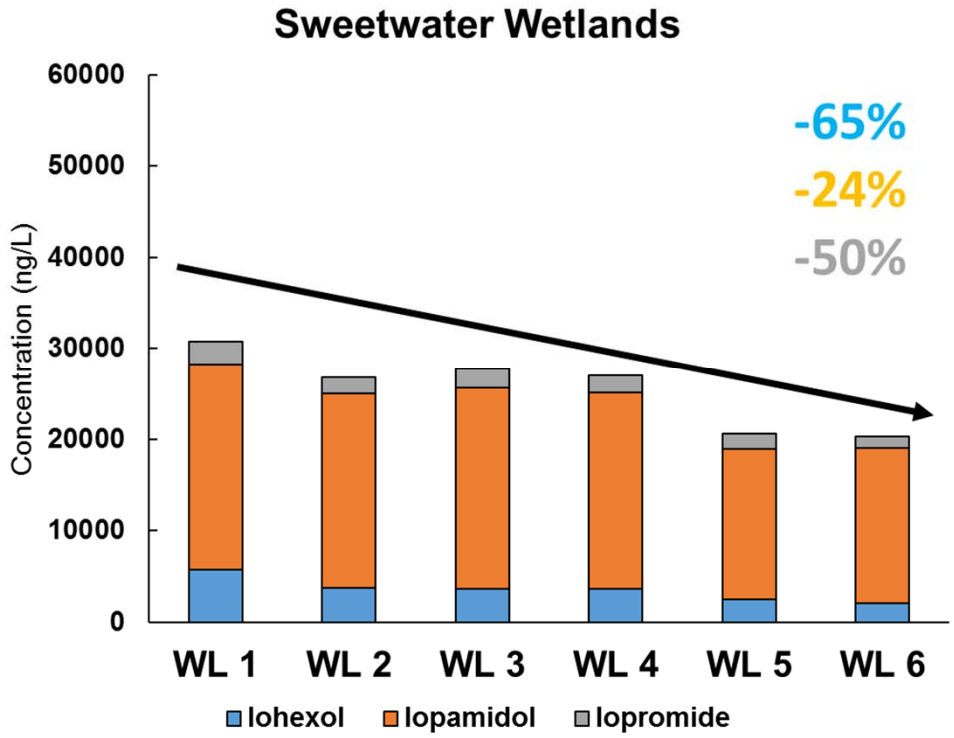
Targeted Analysis



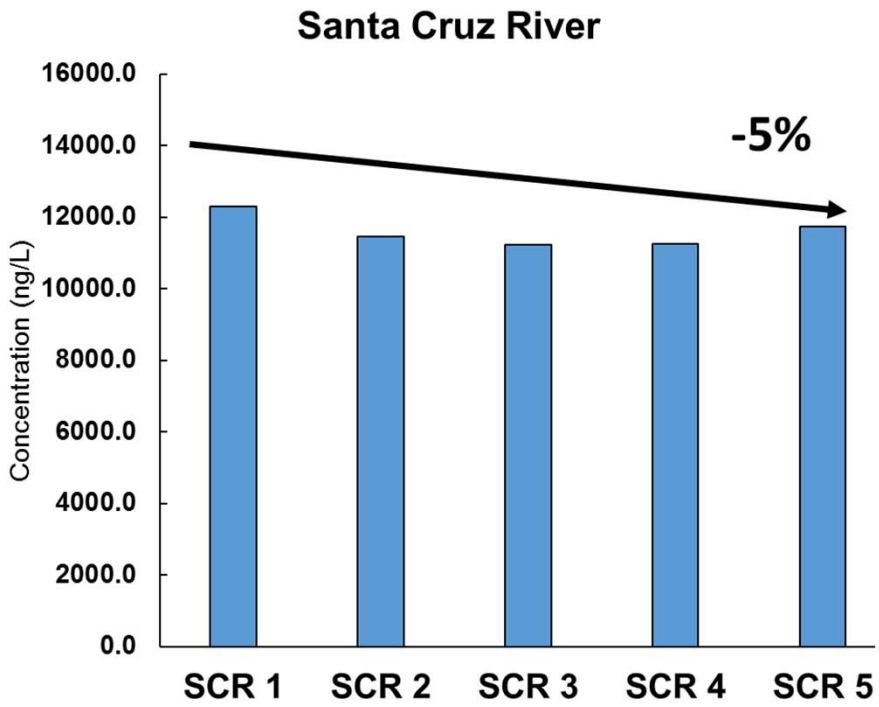


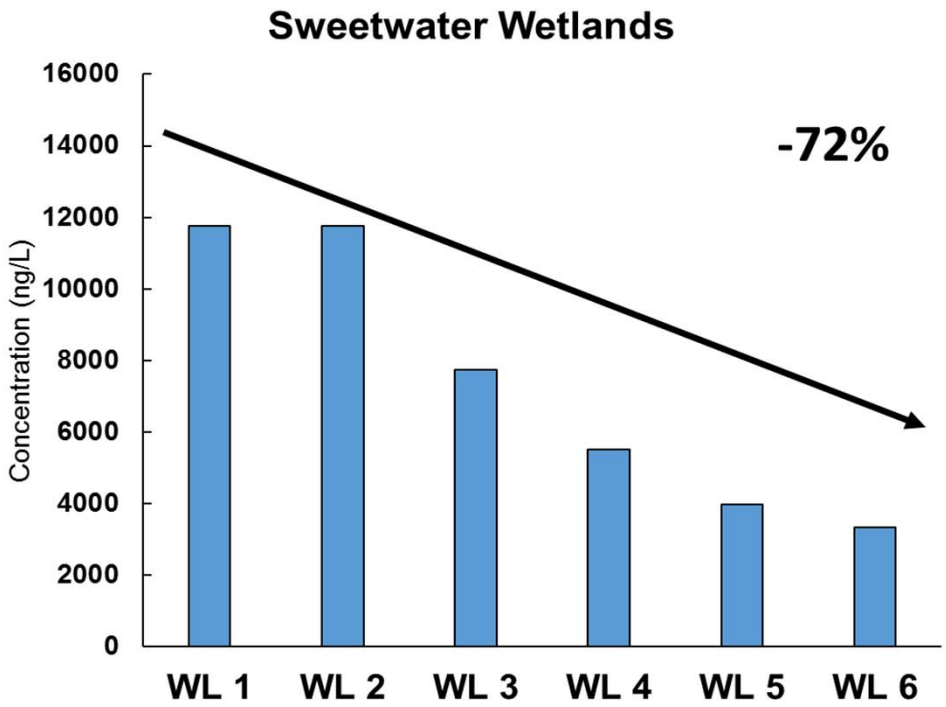
Targeted Analysis – X-ray Contract Media



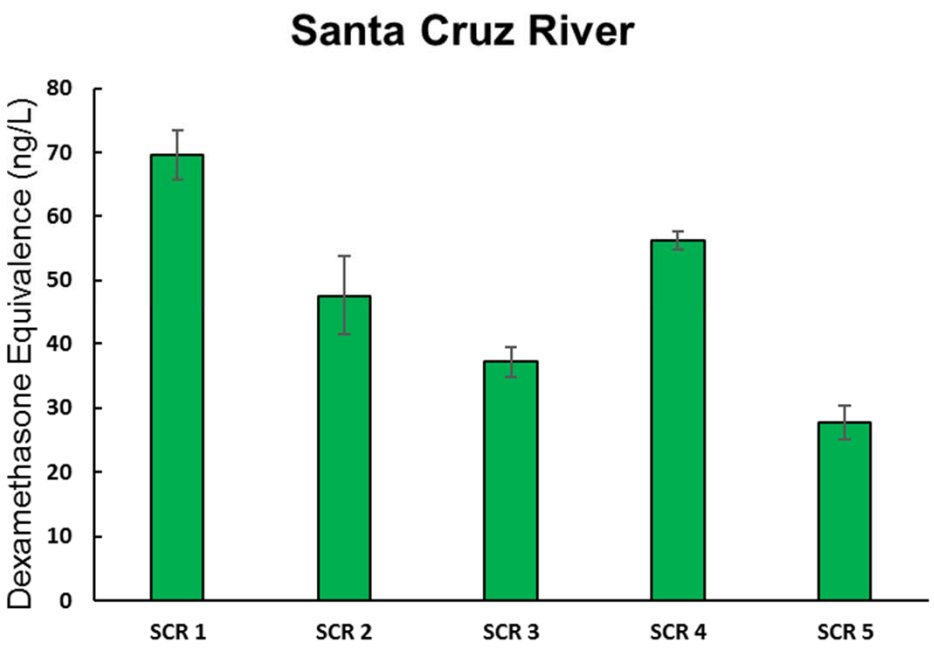


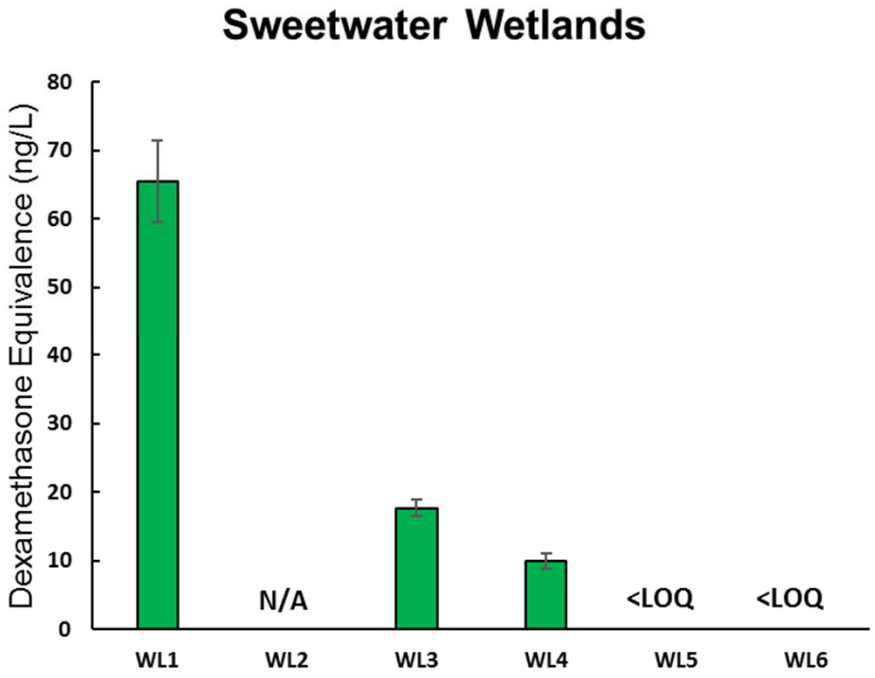
Targeted Analysis - Benzotriazole





Bioassays


Santa Cruz River
Dexamethasone Equivalence (ng/L)
0
10
20
30
40
50
60
70
80
SCR 1
SCR 2
SCR 3
SCR 4
SCR 5


Sweetwater Wetlands
Dexamethasone Equivalence (ng/L)
0
10
20
30
40
50
60
70
80
N/A
<LOQ
<LOQ
WL1
WL2
WL3
WL4
WL5
WL6

Conclusion

- DOC slightly decreases along the Santa Cruz River and slightly increases in the wetlands
- Fluorophore concentration decreases along river and wetlands
- The concentration of humic and fulvic acids decreases in both the Sweetwater Wetlands and Santa Cruz River
- Out of the compounds analyzed, the most prevalent CECs in both the river and wetlands inlets are: Sucralose, Iopamidol, Benzotriazole, Iohexol, and Iopromide.
- Each compounds responds differently. However, in an overall perspective the wetlands showed a greater removal of the CECs analyzed than the Santa Cruz River
- Concentration of compounds that react with glucocorticoid receptor decreases to a greater extend in the wetland than the river.
- Further research:
  - Bank Filtration
  - Seasonal Variance

Acknowledgments

- I would like to thank Agilent Technologies and BioDetection Systems (BDS) for the financial, instrumental, and technical support. This project was funded by National Institute of Environmental Health Sciences, Grant #1-R25-ES025494