

Causes and Consequences of Clogging in the Santa Cruz River

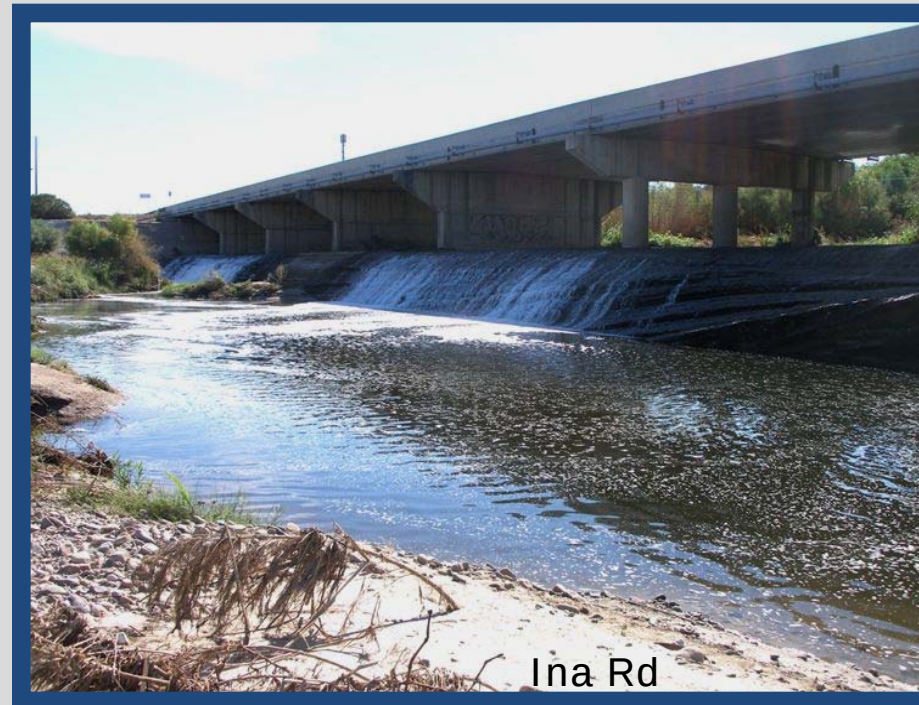
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March 29, 2011



Research Problem

- In waterways used for groundwater recharge or riparian ecosystem support, effluent-induced clogging and reduced infiltration may impair these ecosystem services
- The clogging process is not well studied in flowing streams - the mechanisms behind it need to be determined and understood before it can be managed.



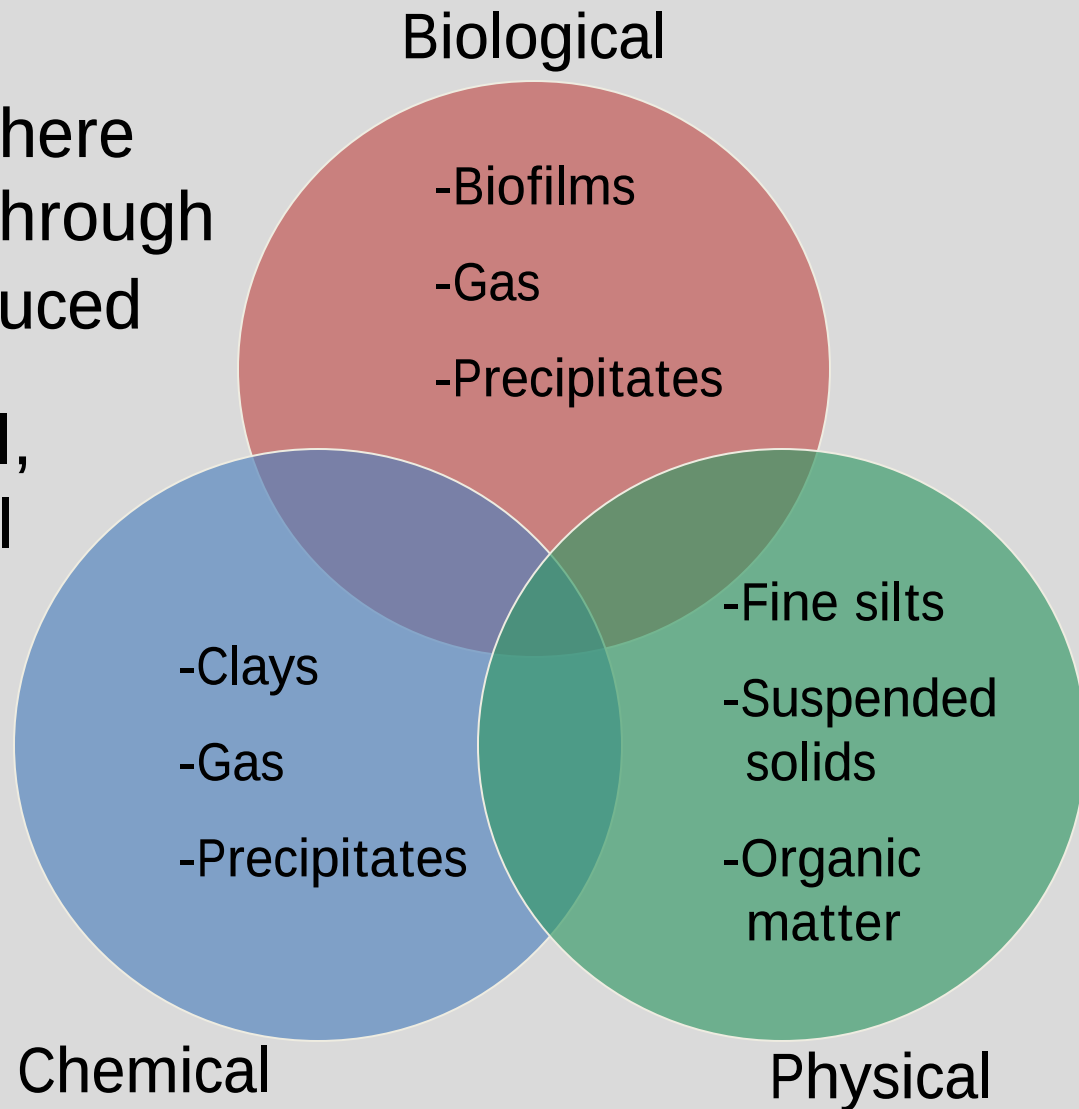
Riparian tree die-off along Santa Cruz River at Rio Rico, 2005



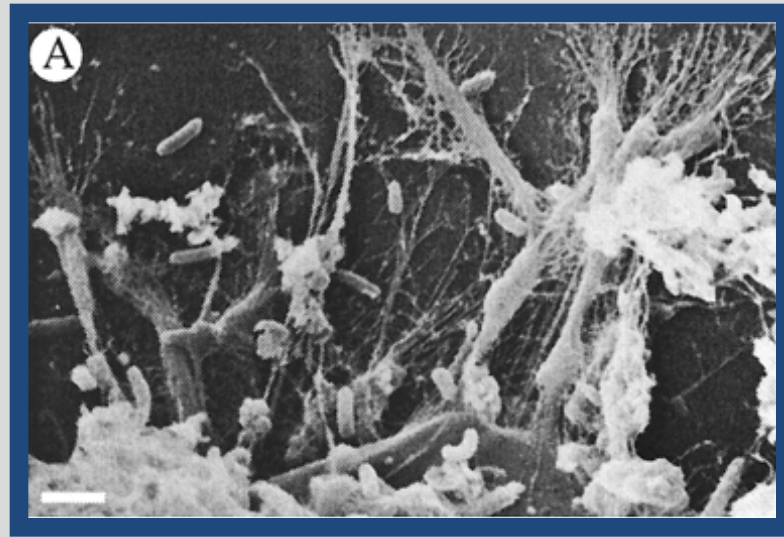
Aerial photo courtesy of Friends of the Santa Cruz River

Clogging

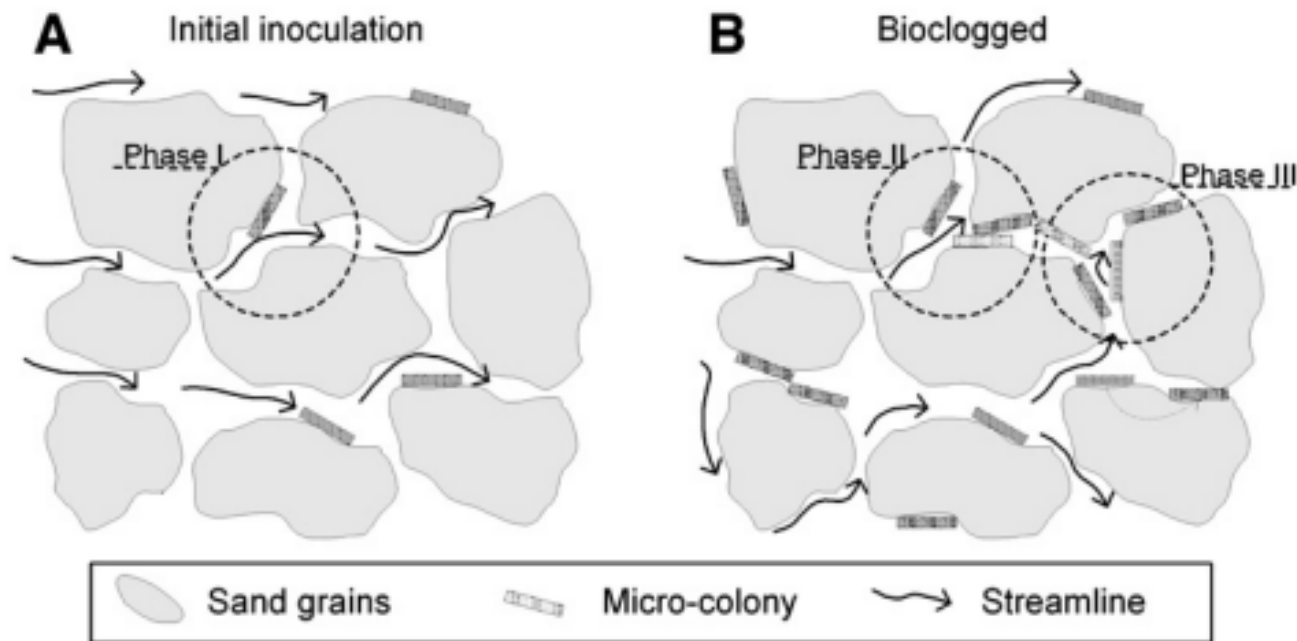
- Refers to a processes where the flow path of water through a porous medium is reduced
- Can be through Physical, Chemical, and Biological processes
- Time dependent

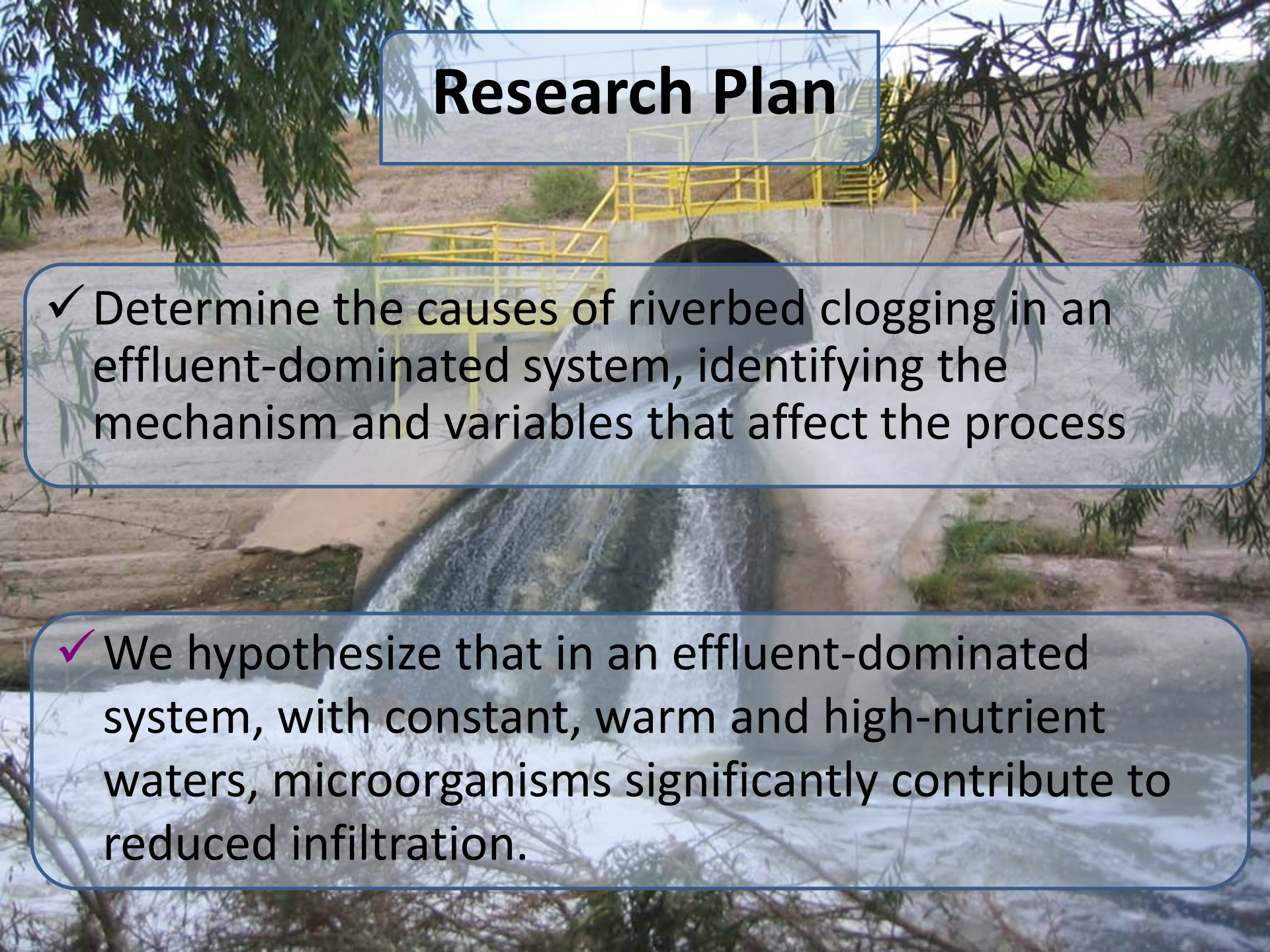


Focus on Bio-Clogging



SEM of bacteria attached to sand grains

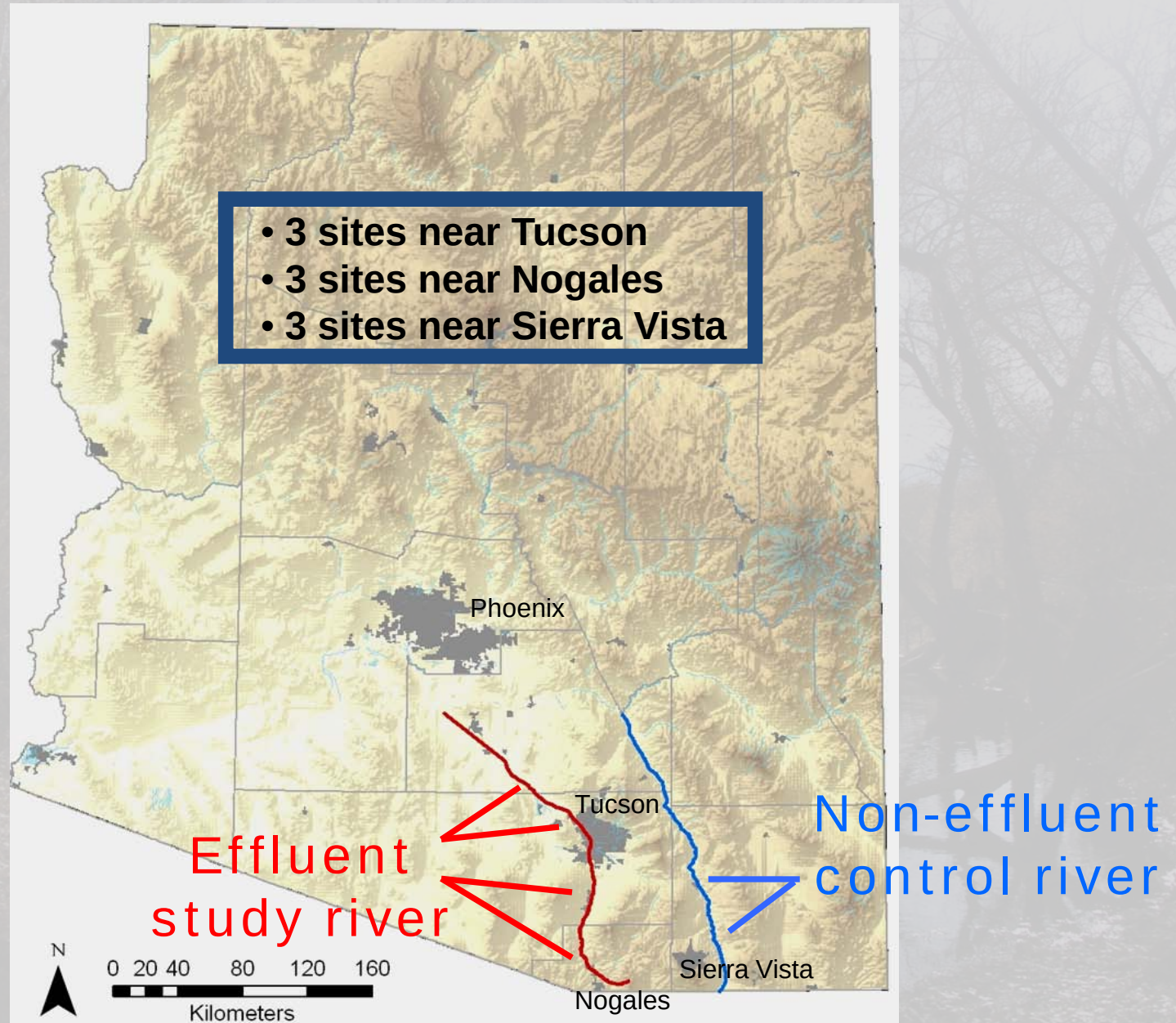




Research Plan

- ✓ Determine the causes of riverbed clogging in an effluent-dominated system, identifying the mechanism and variables that affect the process
- ✓ We hypothesize that in an effluent-dominated system, with constant, warm and high-nutrient waters, microorganisms significantly contribute to reduced infiltration.

Study Area

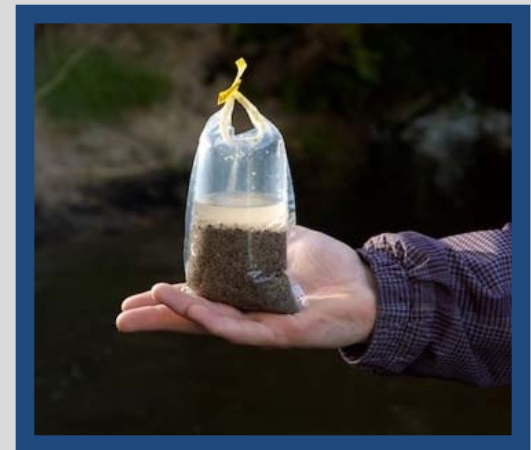


Experimental Design

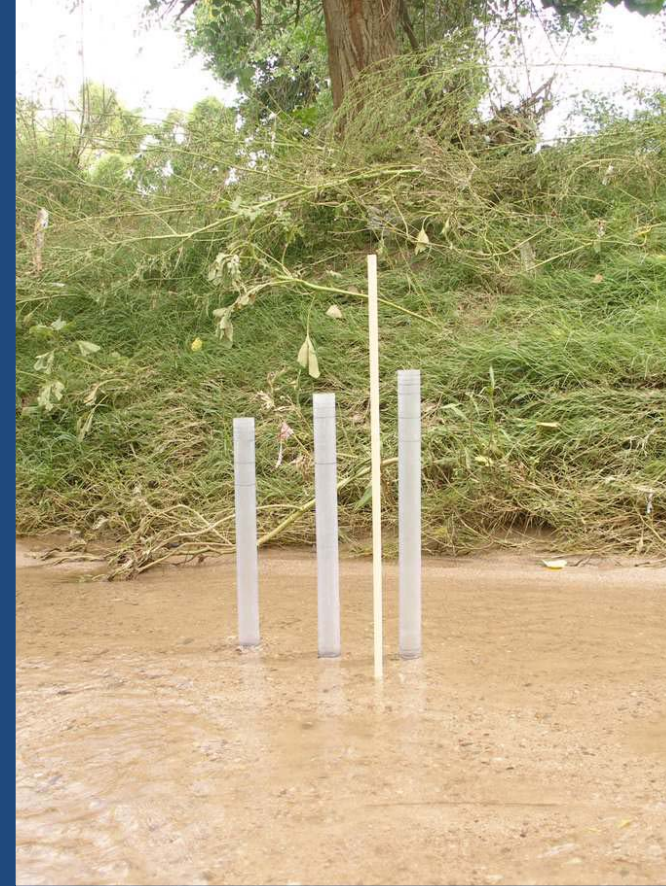
- Compare the microbiology, hydrology, and sediment traits of two effluent-dominated river reaches to one not greatly impacted by effluent.

Methods

- Surface and pore water samples analyzed for dissolved O_2 , temp, pH, NO_3/NO_2 , NH_4 , PO_4 , Organic Carbon (NPOC)
- Sediment samples analyzed for particle size composition and microbiology (plate counts, functional groups)



- Hydraulic conductivity measured using falling head test with piezometers; at pool, thalweg, and bank



- Field data collected April, August, October, November 2010

Observations



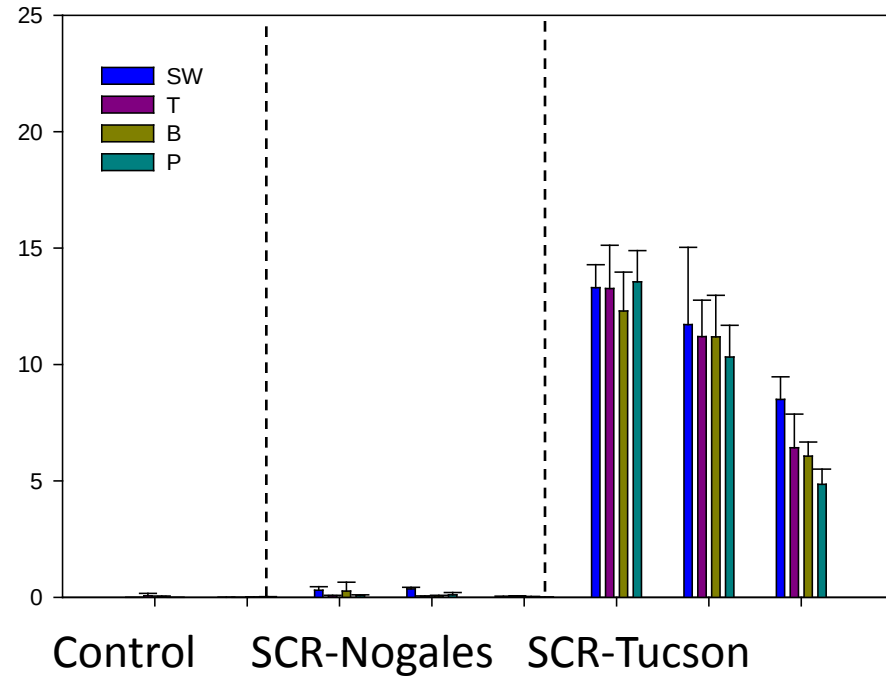
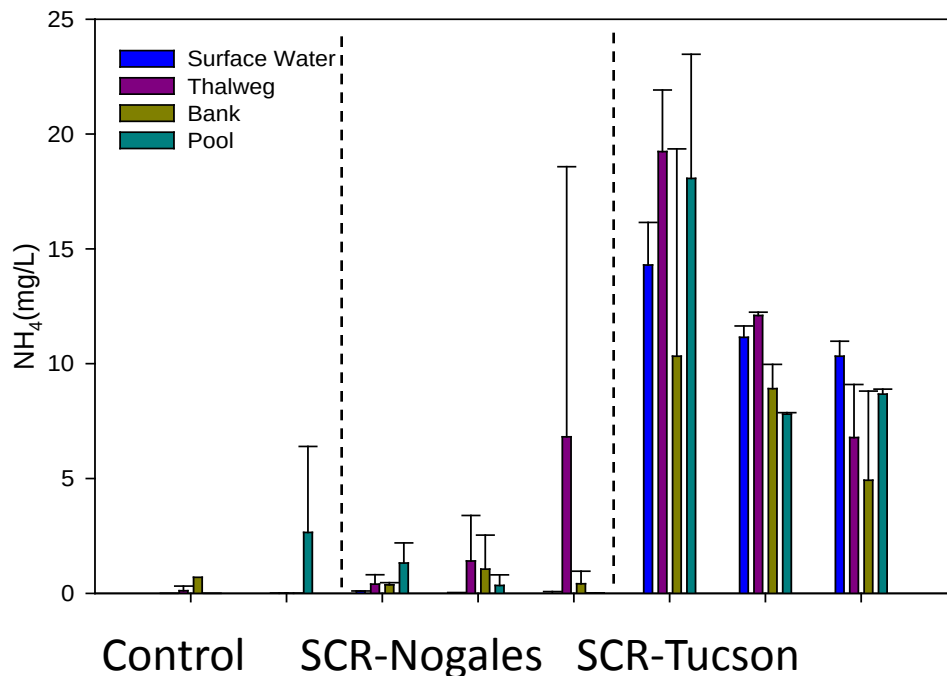
Results

Surface water quality varies among reaches and sites

Average Ammonia

April, 2010

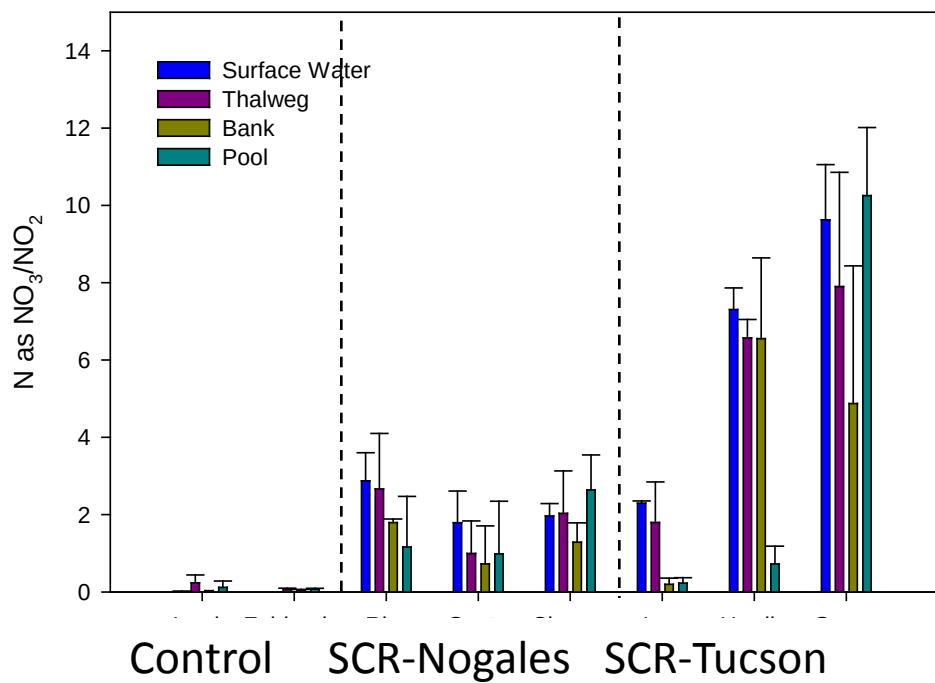
October, 2010



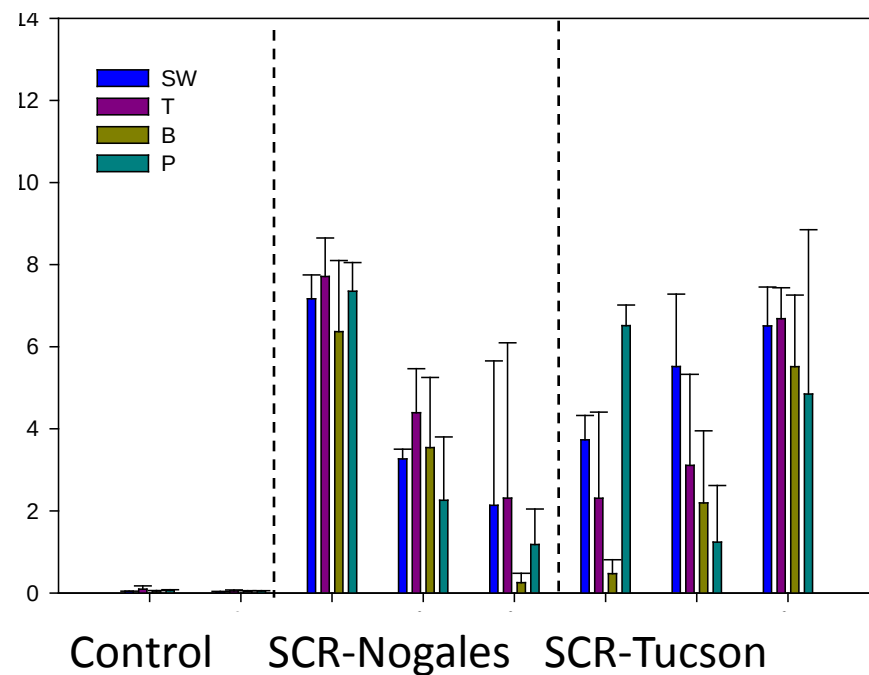
Results

Average Nitrate+Nitrite

April, 2010



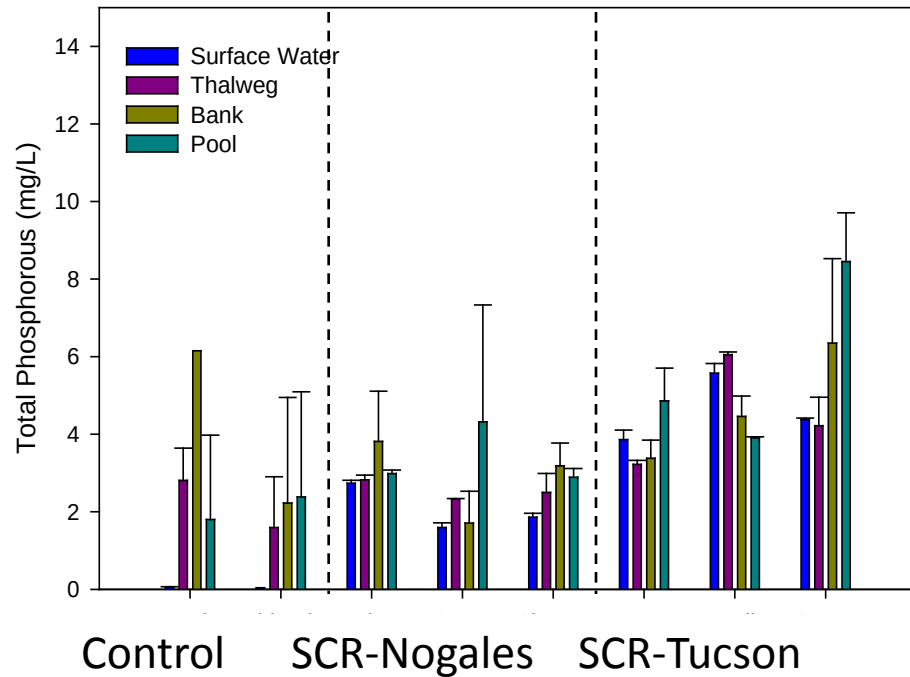
October, 2010



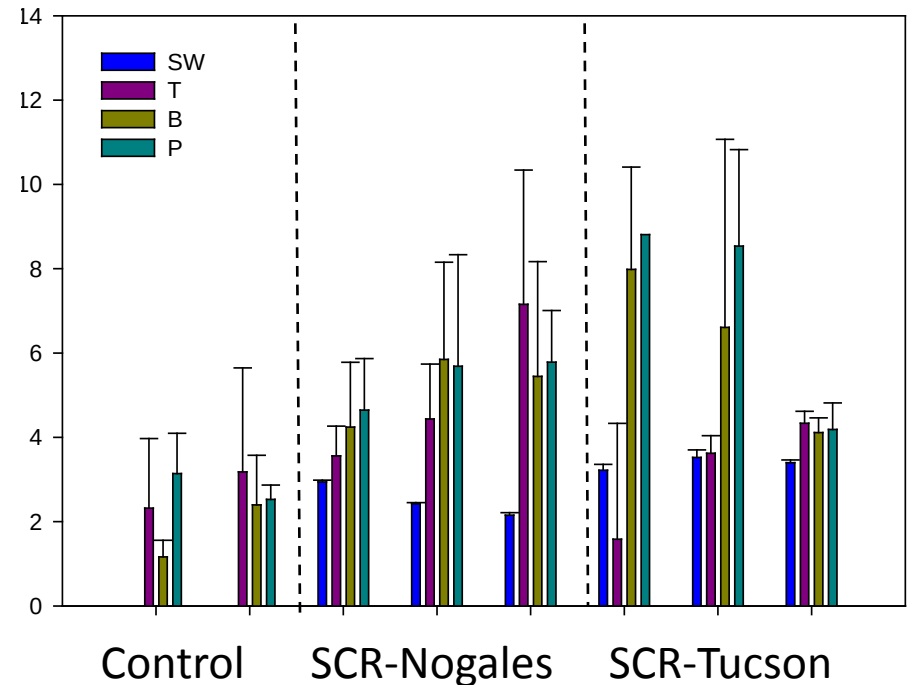
Results

Average Total Phosphorous

April, 2010



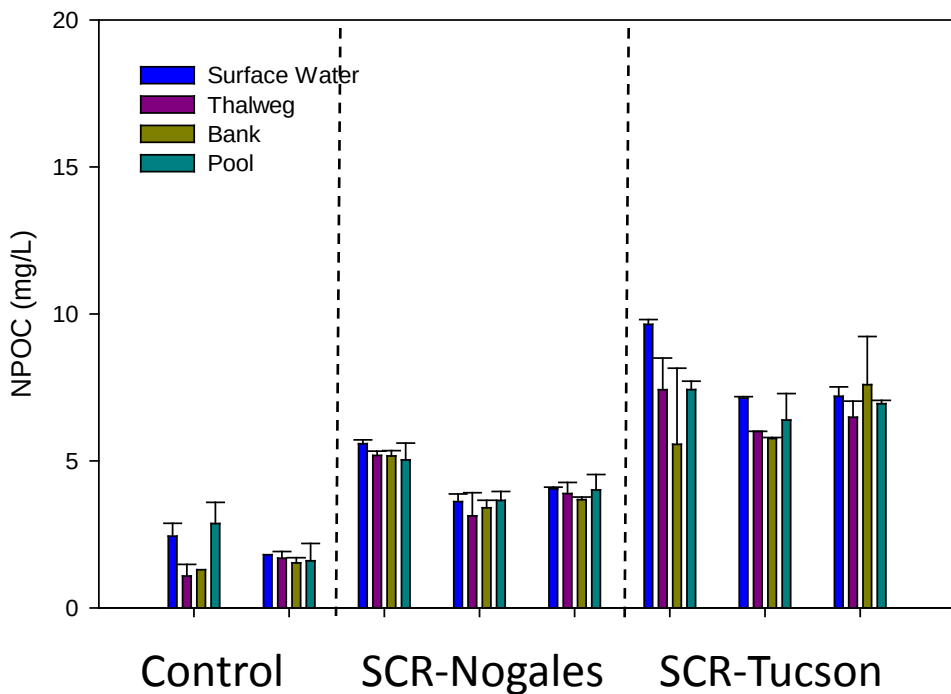
October, 2010



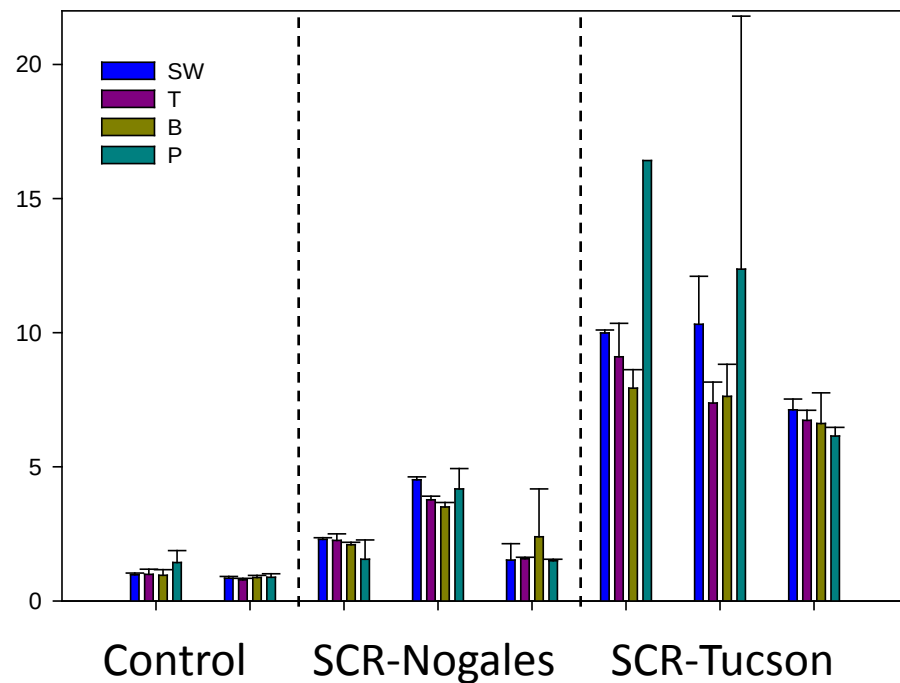
Results

Average Total Organic Carbon

April, 2010



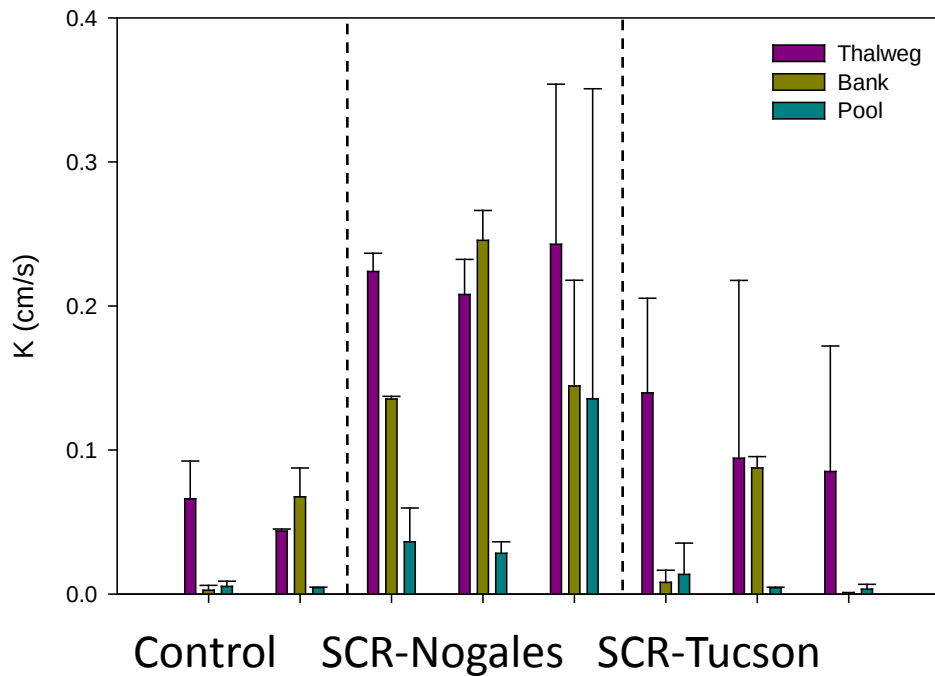
October, 2010



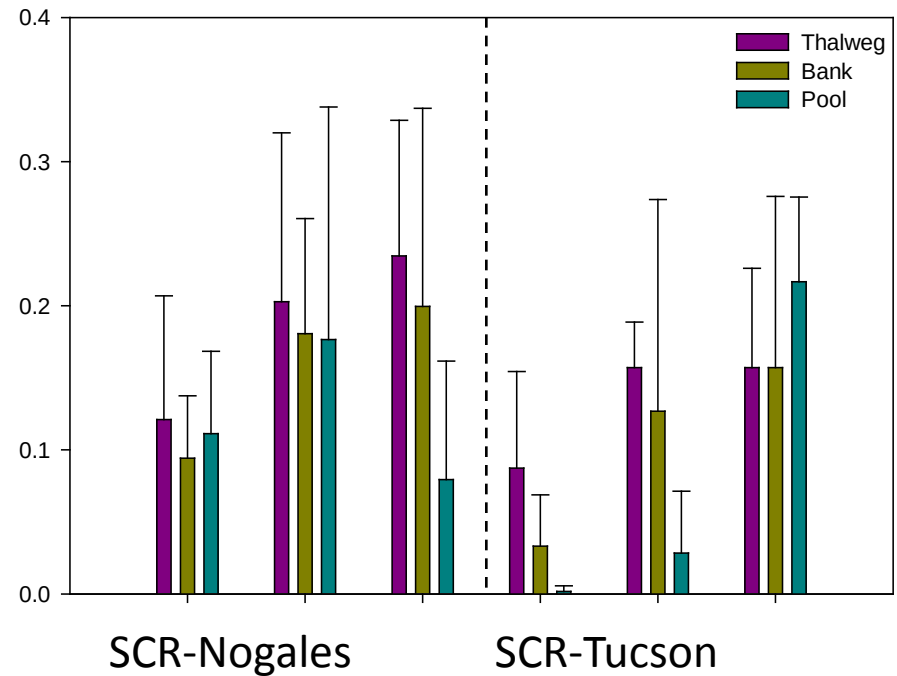
Hydraulic conductivity varies among river reaches, sites, and fluvial surfaces

Site-averaged Hydraulic Conductivity

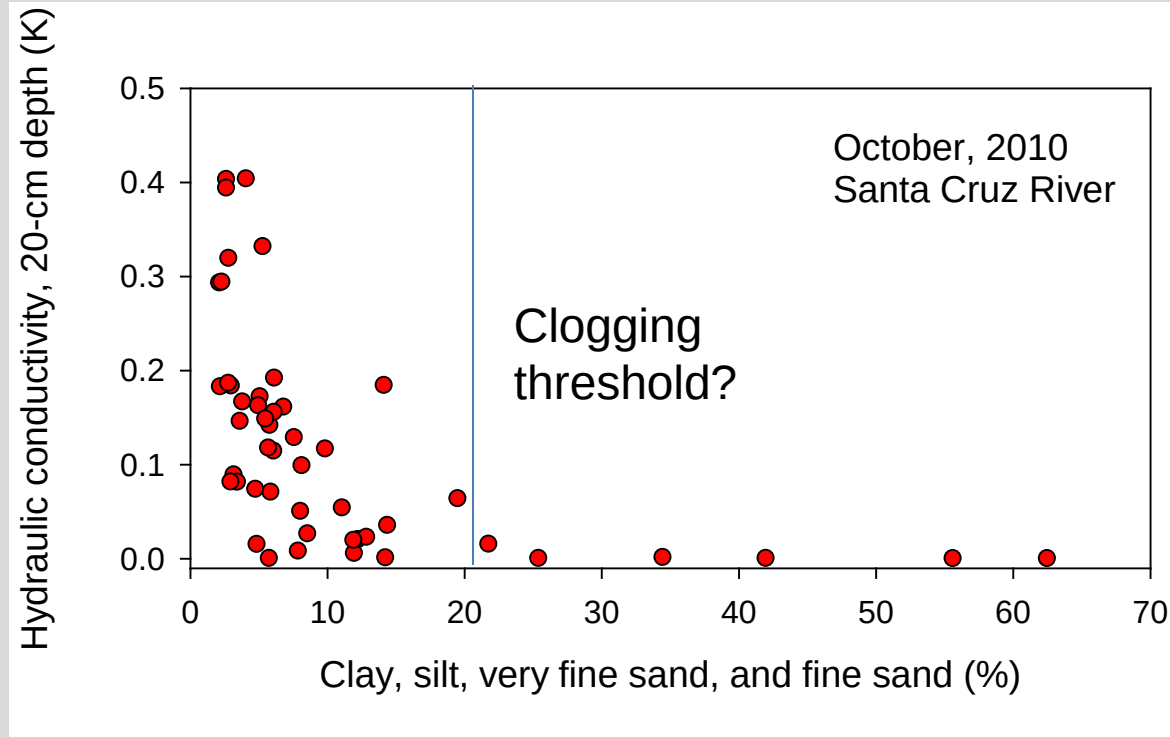
April 2010



October 2010



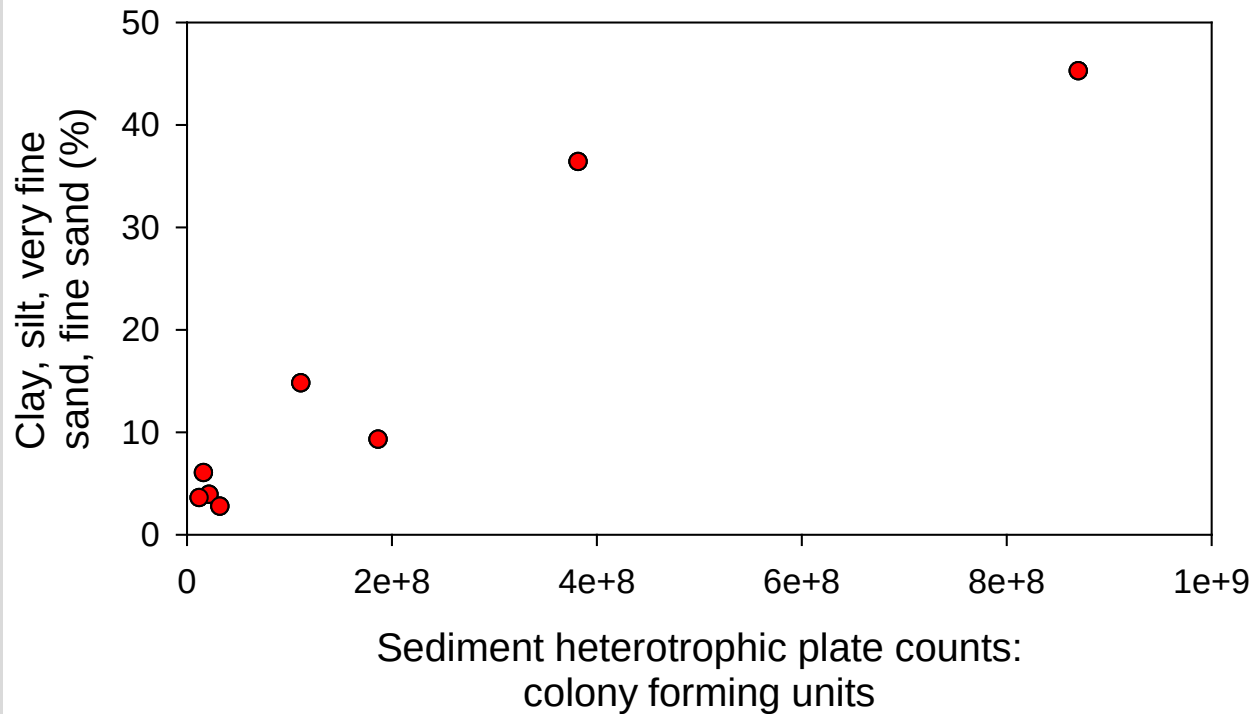
Sediment particle size is strongly related to hydraulic conductivity



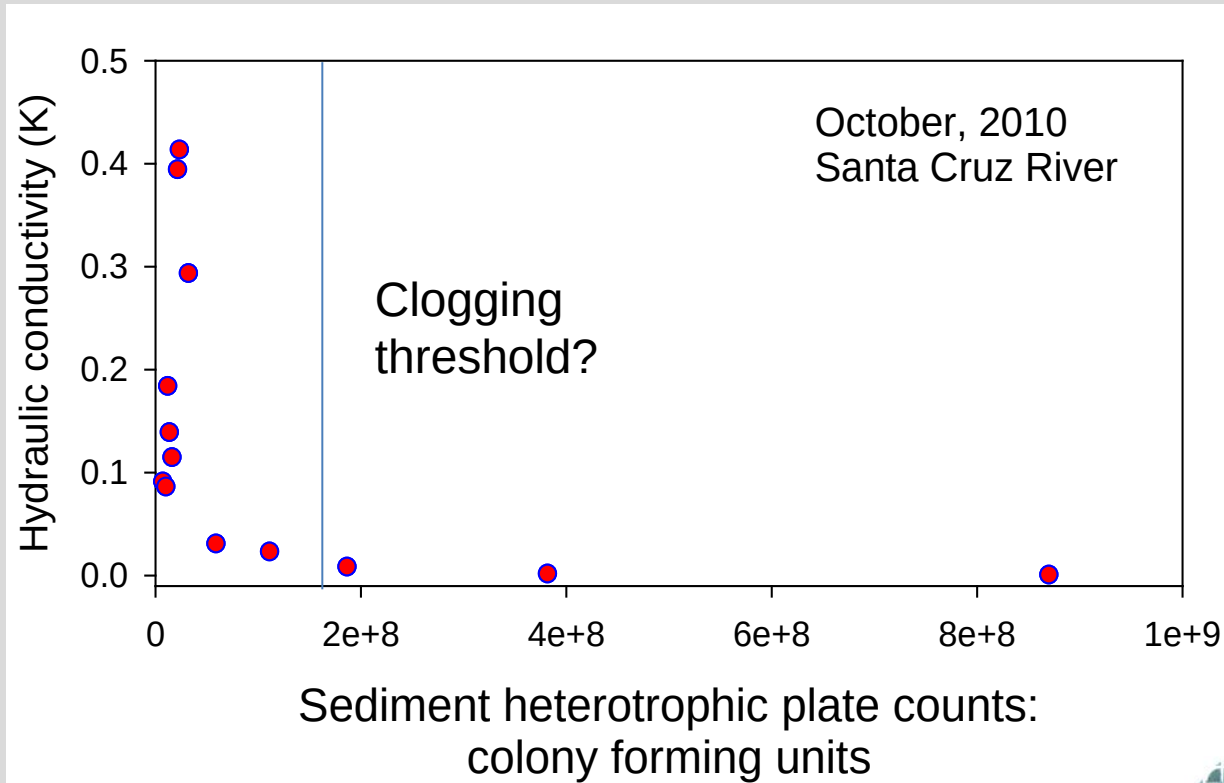
Pearson correlation between sediment class and K

	Clay	Silt	VF-Sand	F-Sand	M-Sand	C-Sand	VC-Sand	Gravel
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
r value	-0.46	-0.51	-0.53	-0.65	-0.35	0.34	0.35	0.22
p value	0.03	0.01	0.01	0.00	0.44	0.57	0.52	1.00

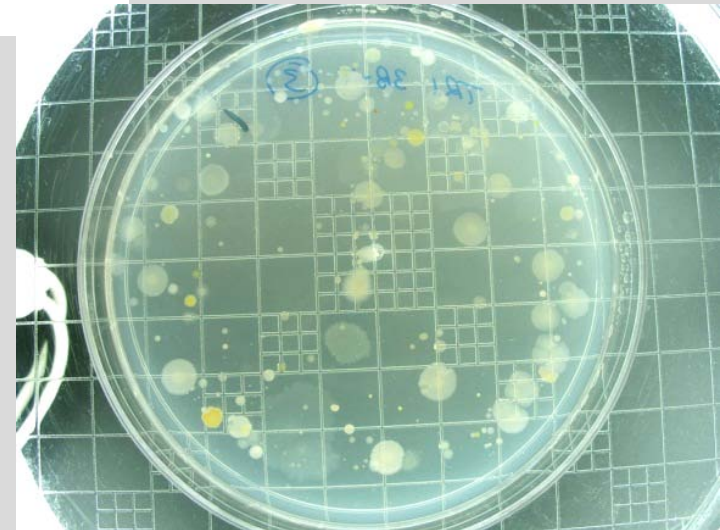
Bacterial abundance correlates strongly with fine-textured sediments



Bacterial abundance is related to hydraulic conductivity



- Numbers of CFUs also increase with certain water quality parameters (NH_4 , TP, NPOC)



Conclusions

- Hydraulic conductivity tends to be reduced in fine sediments, in both the control and effluent river
- Reduced hydraulic conductivity is also associated with higher bacterial numbers
- Bacteria are more abundant in fine sediments and in areas with higher levels of organic carbon and ammonia
- Additional analysis underway to tease apart connections between water quality, bacterial abundance, sediment texture, and hydraulic conductivity, and to identify thresholds for reduced conductivity

Future Work

Pre-monsoon trip planned to collect during a longer flood-free sequence

“Ecolog” plates to assess microbial community physiological profile

Participation in Enhanced Recharge Project, funded by ABOR

Additional Studies

- Laboratory manipulation of clogging conditions
- Sequencing of microbial DNA for functional groups

Acknowledgements

Funding source: Southwest Consortium for Environmental Research and Policy

Advisors and assistants: Dr. Julie Stromberg, Dr. Channah Rock and Kelley Riley for microbial methods, Dr. Tom Meixner for hydrological methods,

Meg White, Danika Setaro, Amanda Suchy, Lane Butler, Joe Monfeli, Michelle Perry, Tristan Dunton, Evan Balbona, Nick McLamb, Ray Leimkuehler, John Shasky, Kellie Elliott, and Chelsey Hull for field assistance