

Estrogenic Activity and Emerging Contaminants in the Lower Santa Cruz River, Arizona

**David Quanrud, Bingfeng Dong, Long Cheng,
Alandra Kahl, Hao Vo, Stephanie Ruehl, Andrew Keller,
Shane Snyder, Robert Arnold, Eduardo Saez**

The University of Arizona

Friends of the Santa Cruz River Researchers Day 2013

Tucson, Arizona

15 April 2013

Acknowledgment

- National Institutes for Water Resources
- Technology and Research Initiative Fund (State of Arizona)

Today's questions:

1. What is estrogenic activity?
2. What happens to estrogenic activity in the lower Santa Cruz River?
3. Are estrogenic trace contaminants accumulating in riverbed sediments?

What is an endocrine disrupting compound?

“An endocrine disruptor is an exogenous substance or mixture that alters function(s) of the endocrine system and consequently causes adverse health effects in an intact organism, or its progeny....”

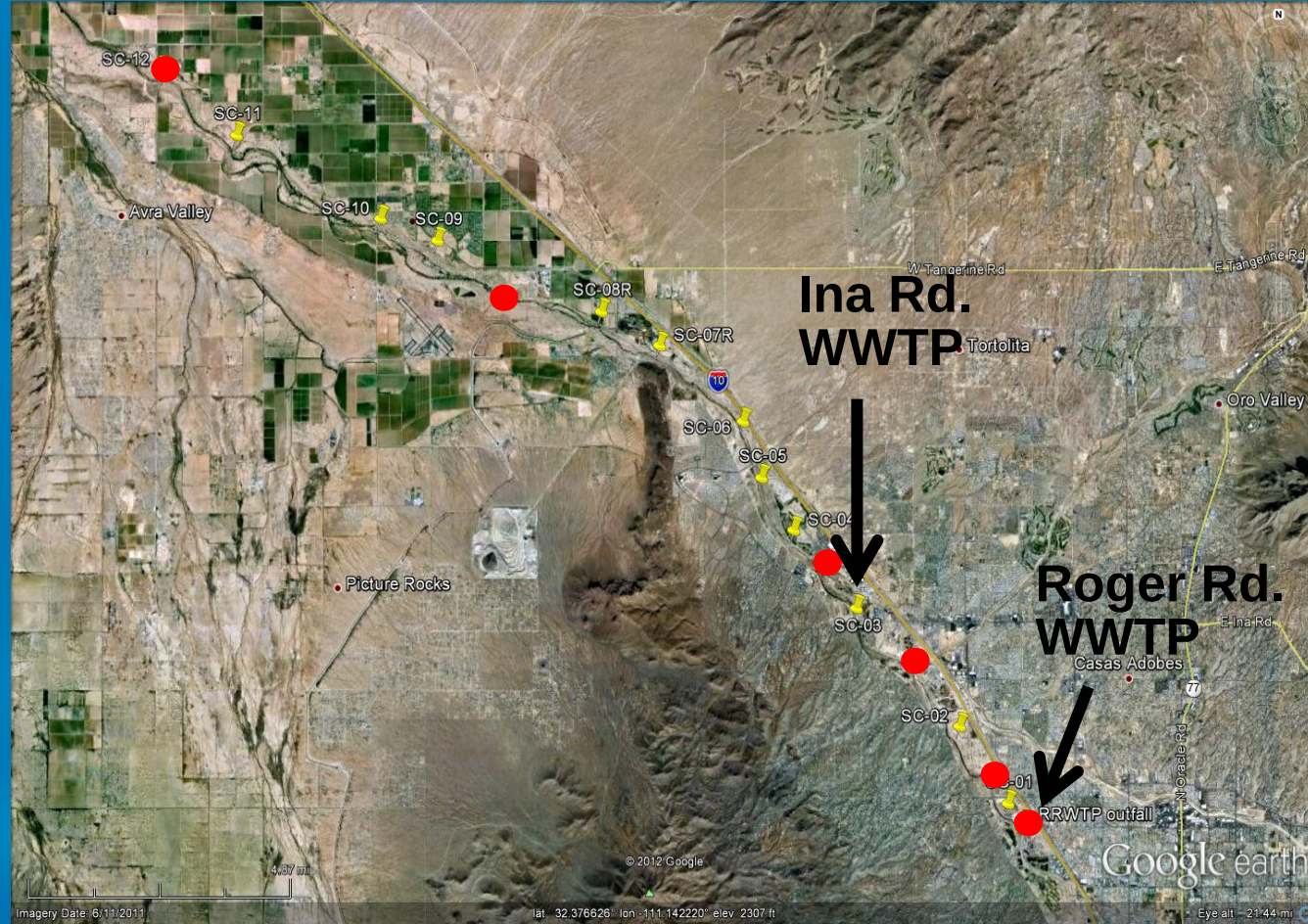
From: *“Global Assessment of the State-of-the-Science of Endocrine Disruptors.”* International Programme on Chemical Safety, World Health Organization (2002)

Examples of known EDCs in wastewater

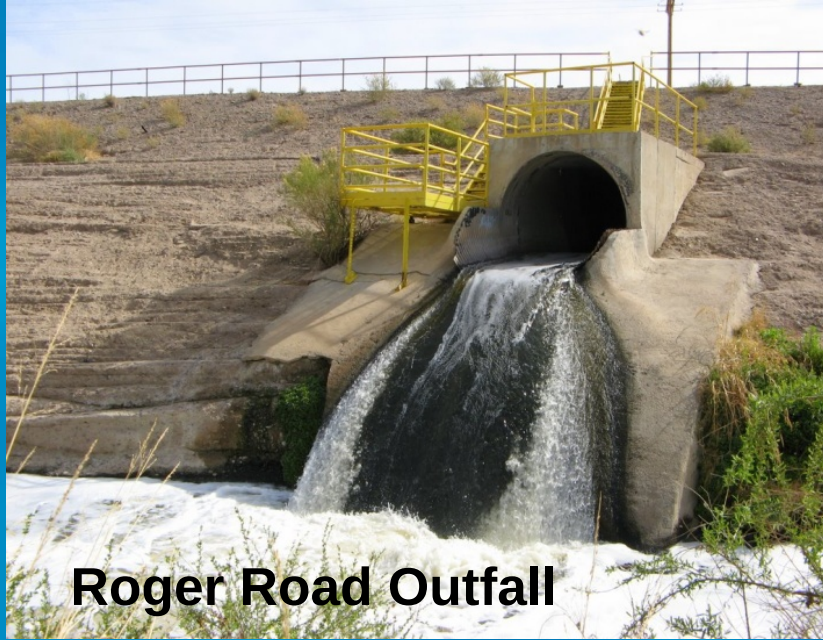
- Natural hormones (*estrogens*)
 - Estradiol
 - Estrone
 - Estriol
- Synthetic compounds
 - Ethinyl estradiol (birth control pill)
 - Alkylphenols, e.g. nonylphenol (surfactant byproduct)
 - Bisphenol A (e.g. polycarbonate plastic)
 - PBDEs (flame retardant; partially phased out)

Study Reach of the Lower Santa Cruz River

- 6 sampling sites:
Roger Rd. WWTP
to Trico Rd. (23 mi)
- Sampling:
 - Liquid phase
 - Suspended solids (turbidity)
 - Riverbed sediments



Sampling the Lower Santa Cruz River



Riverbed sediment sampling



- 6 sampling sites: Roger Rd. WWTP down to Trico Rd. (~23 mi)

Question:

How can we measure estrogenic compounds in environmental samples?

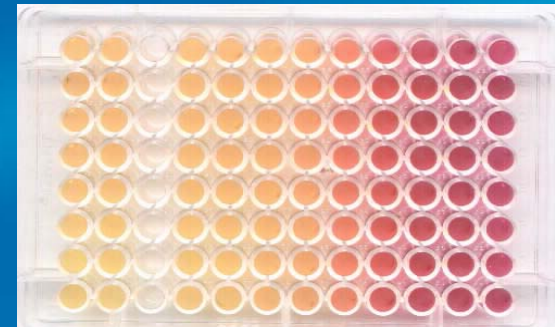
- Individual chemical measurements

- GC MS/MS
- LC MS/MS

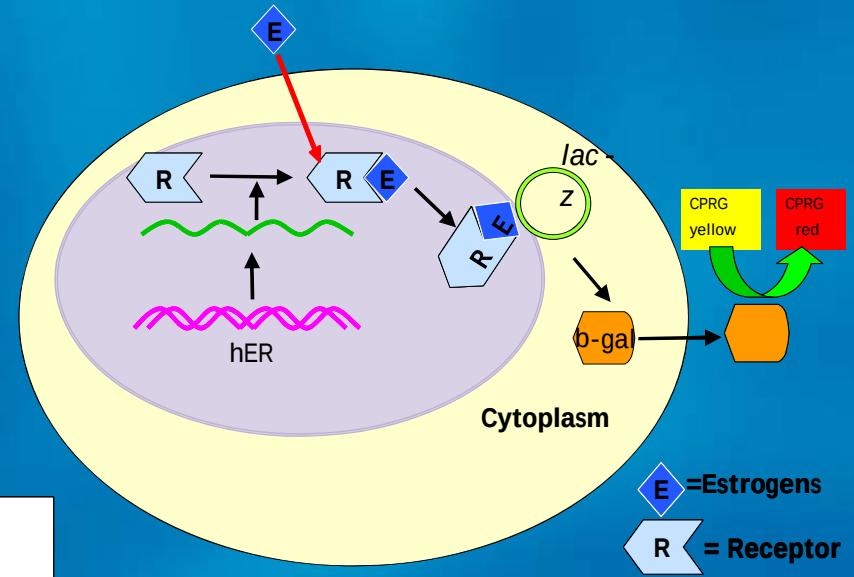
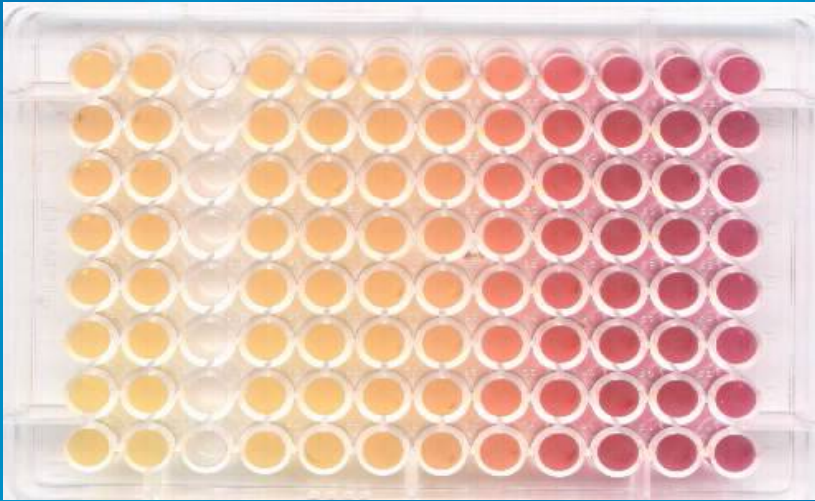


- Collective measurement using bioassays

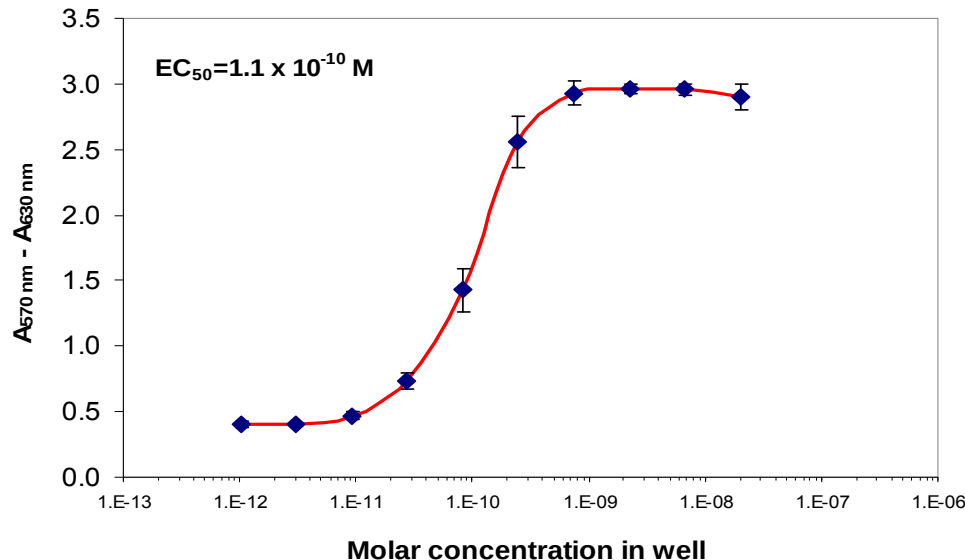
Total estrogenic activity



Yeast estrogen screen (YES) bioassay

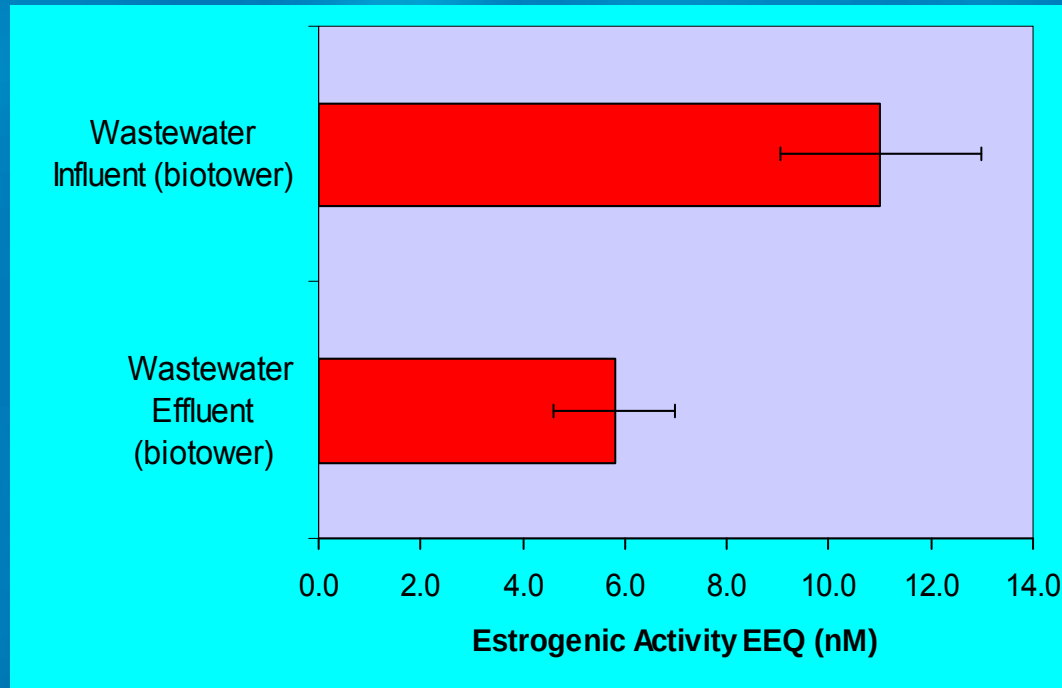


17- α Ethinylestradiol



- *In vitro* reporter gene bioassay
- Utilizes human estrogen receptor
- → Total estrogenic activity expressed as equivalent concentration of EE2, based on comparison to standard curve

Fate of Estrogenic Activity: Secondary Wastewater Treatment



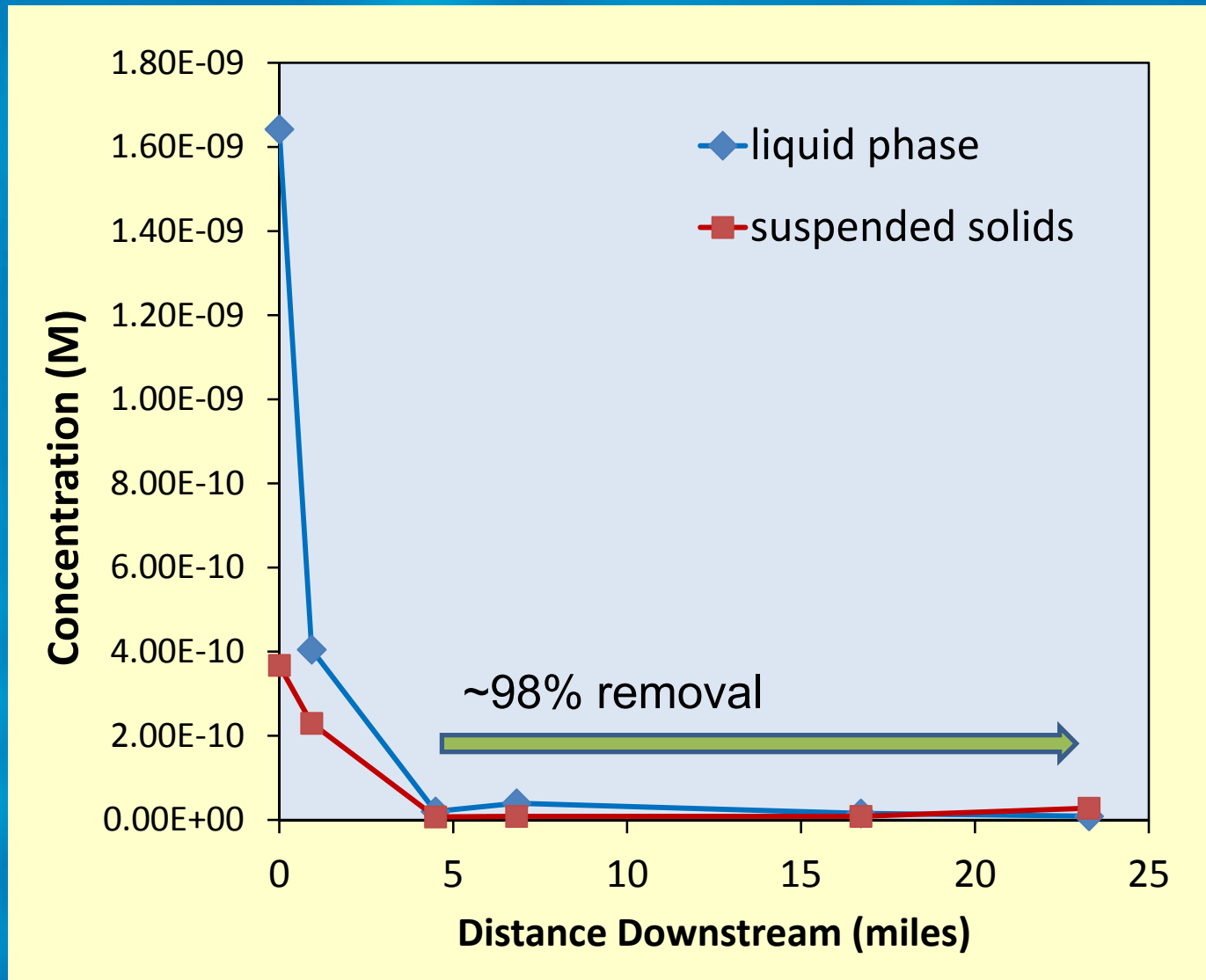
Where did it go?

Two possibilities:

- compound destruction (biodegradation)
- mass transfer (adsorption to the solid phase)

Most estrogenic compounds
are hydrophobic

Estrogenic Activity (YES Bioassay)

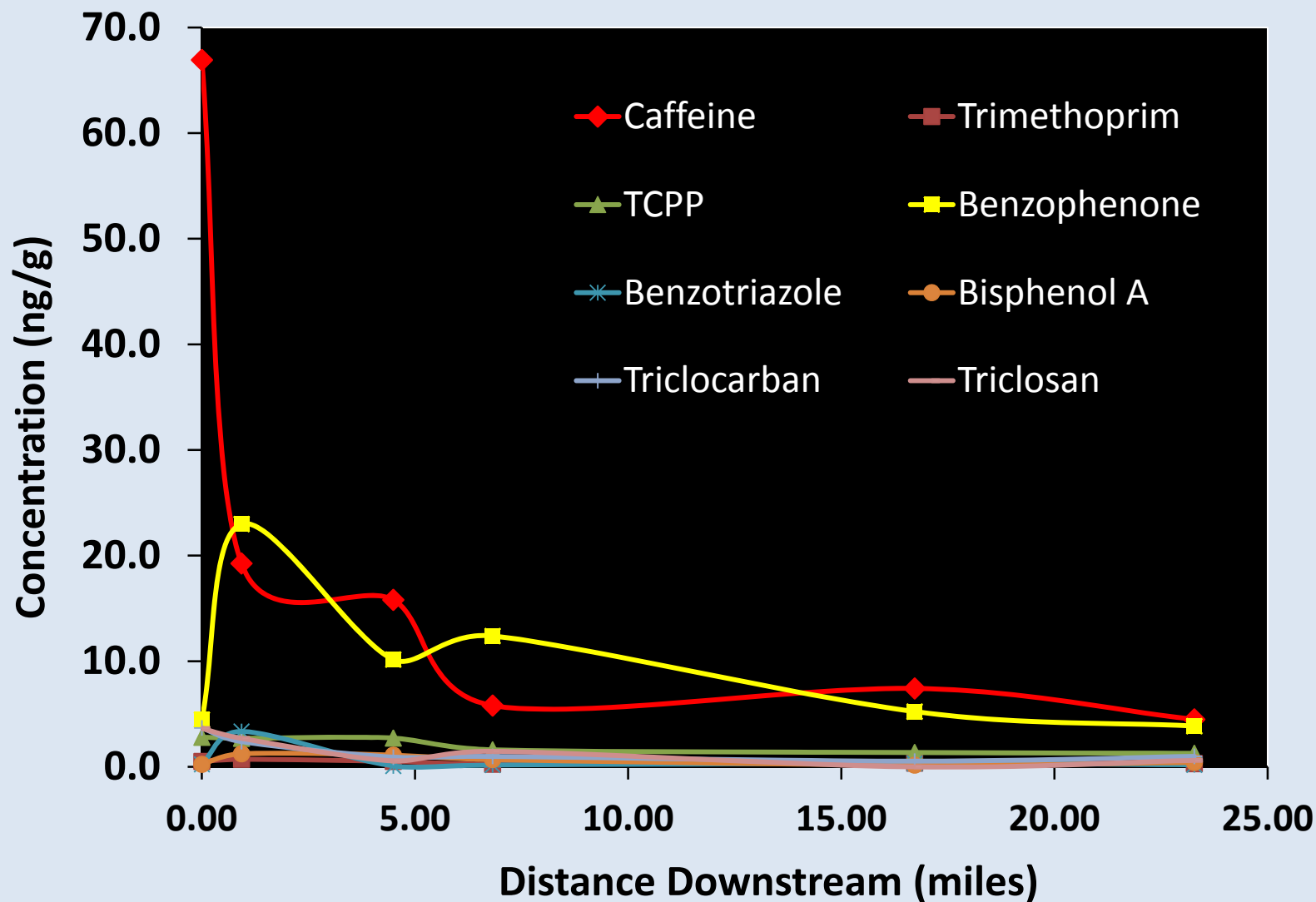


SCR Sediments: Trace Organics

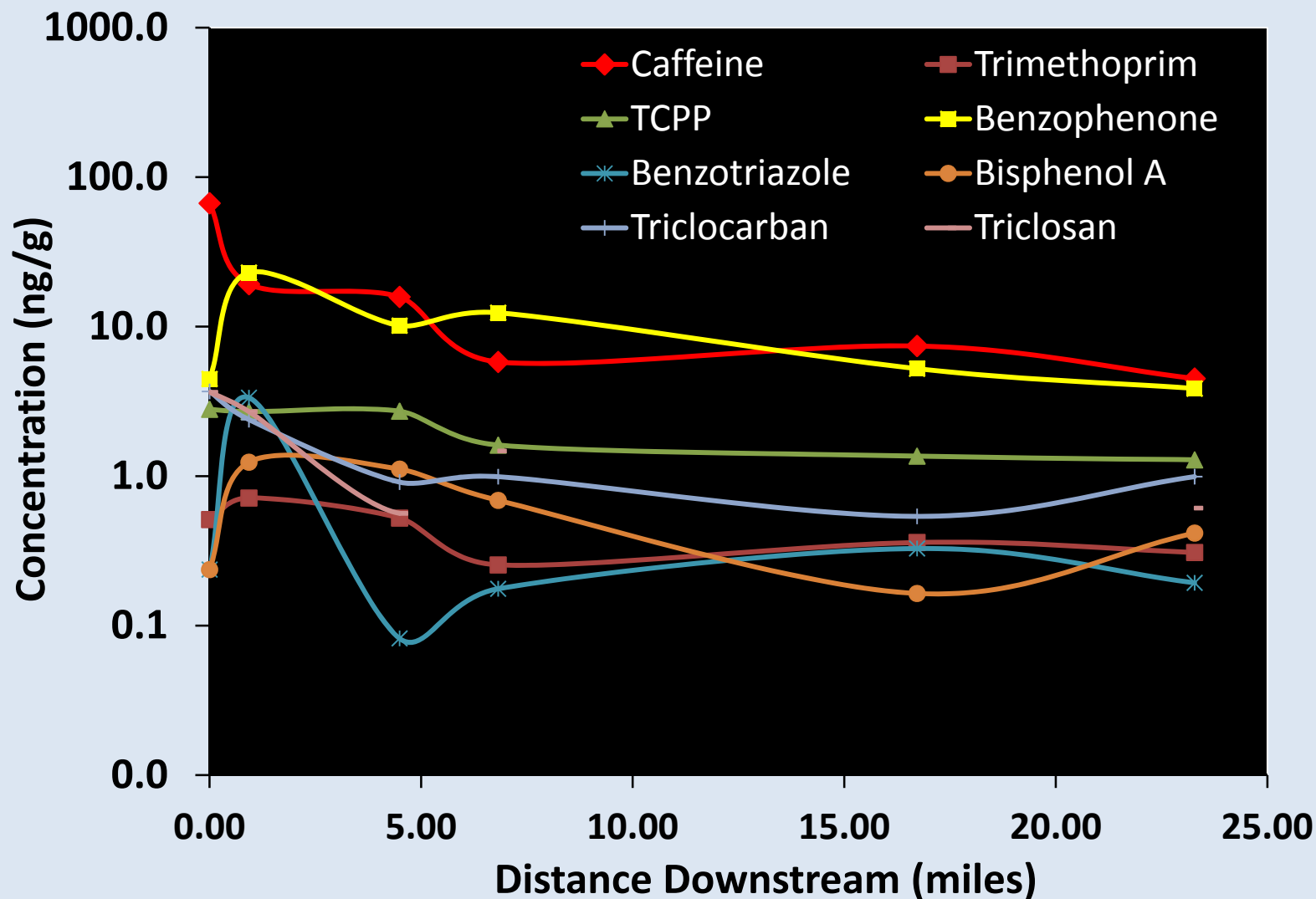
- Sediments collected from six locations, down to Trico Rd
- Sediments tested for 36 CECs
- Blue = not detected (20)
- Yellow = detected at Roger Rd. (16)
- Red = detected at majority of sites (8)
- Asterisk = Endocrine disrupting compound (10/20)

Atenolol	PFBS
Atrazine	PFDA*
Benzophenone*	PFDoA*
Benzotriazole (BTA)*	PFHxDA
Bisphenol A (BPA)*	PFOA
Caffeine	PFOS*
Carbamezapine	Prednisone
DEET	Primidone
Dexamethasone	Propylparaben*
Diclofenac	Simazine
Diphenylhydramine	Sucralose
Ditiazem	Sulfamethoxazole
Fluoxetine	TCEP
Gemfibrozil	TCPP*
Ibuprofen	Testosterone
Meprobamate	Triclocarban (TCC)*
Naproxene	Triclosan*
Norgestrel	Trimethoprim (TMP)

Trace Organics on sediments



Trace Organics on sediments



CECs of highest potential concern in sediments

- Long half lives (persistent)
- High $\log K_{ow}$ values (bioaccumulative in some biota)
- High toxicity (to some species)

Benzophenone (UV blocker)

Questions?



quanrud@email.arizona.edu