

Fate of Emerging Contaminants along the Lower Santa Cruz River, Arizona

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Acknowledgment

- Water Sustainability Program at The University of Arizona
- Pima County Regional Wastewater Reclamation Department
- Robert Speir, Jason Grodman, and Mike Silva (PCRWRD)

Today's questions:

1. What are emerging Contaminants (ECs) and why do we care about them?
2. What happens to ECs in the lower Santa Cruz River?
3. Are ECs present in ground water along the lower Santa Cruz River?

What are emerging contaminants?

Emerging contaminants include (but are not limited to):

- pharmaceuticals & personal care products (**PPCPs**)
- endocrine disrupting compounds (**EDCs**)

Measured in water sources throughout the US

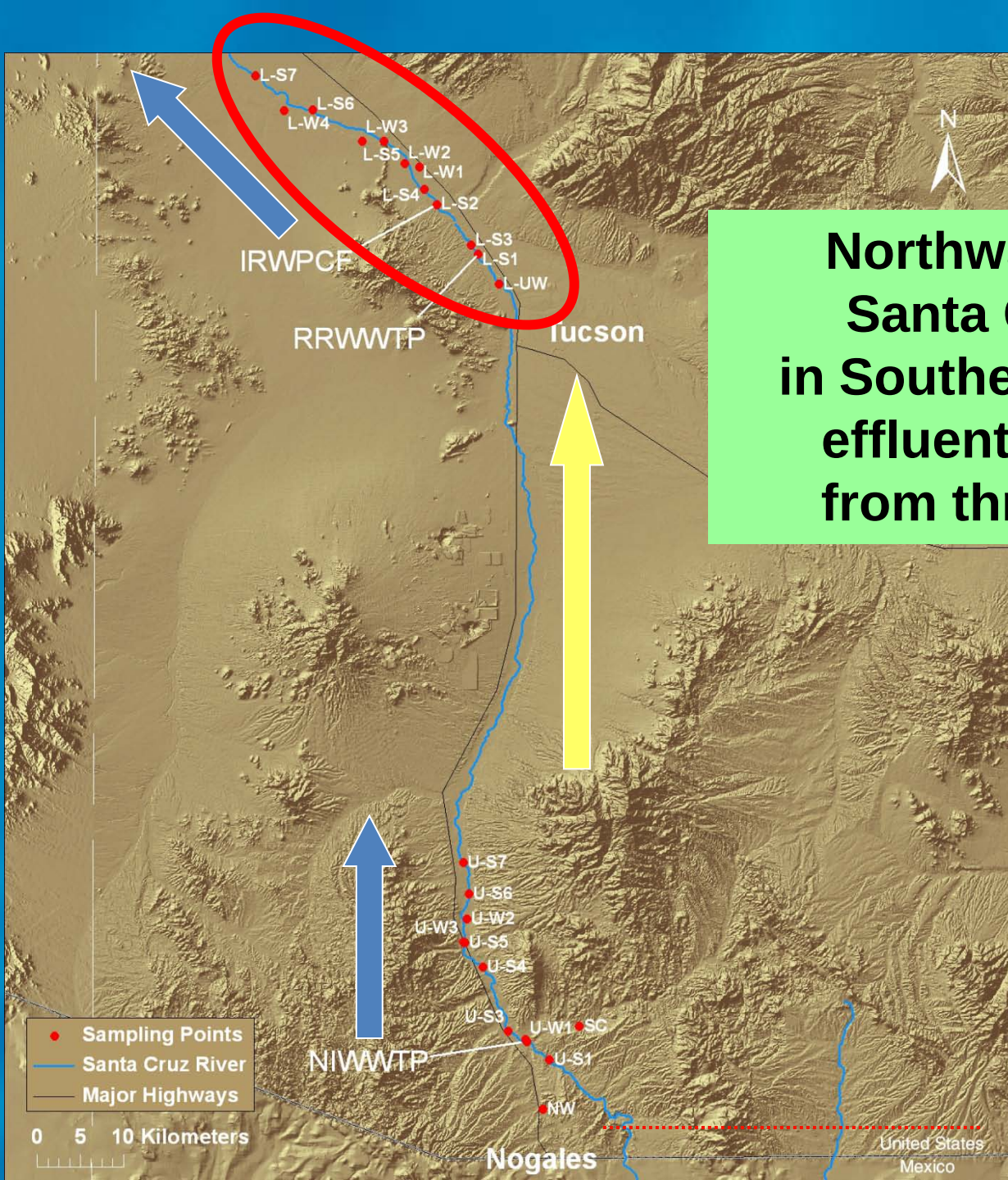
(Kolpin, et al. **2002**. Pharmaceuticals, hormones, and other organic wastewater contaminants in U.S. streams, 1999-2000: A national reconnaissance. *Environ. Sci. Technol.* 36, 1202-1211).



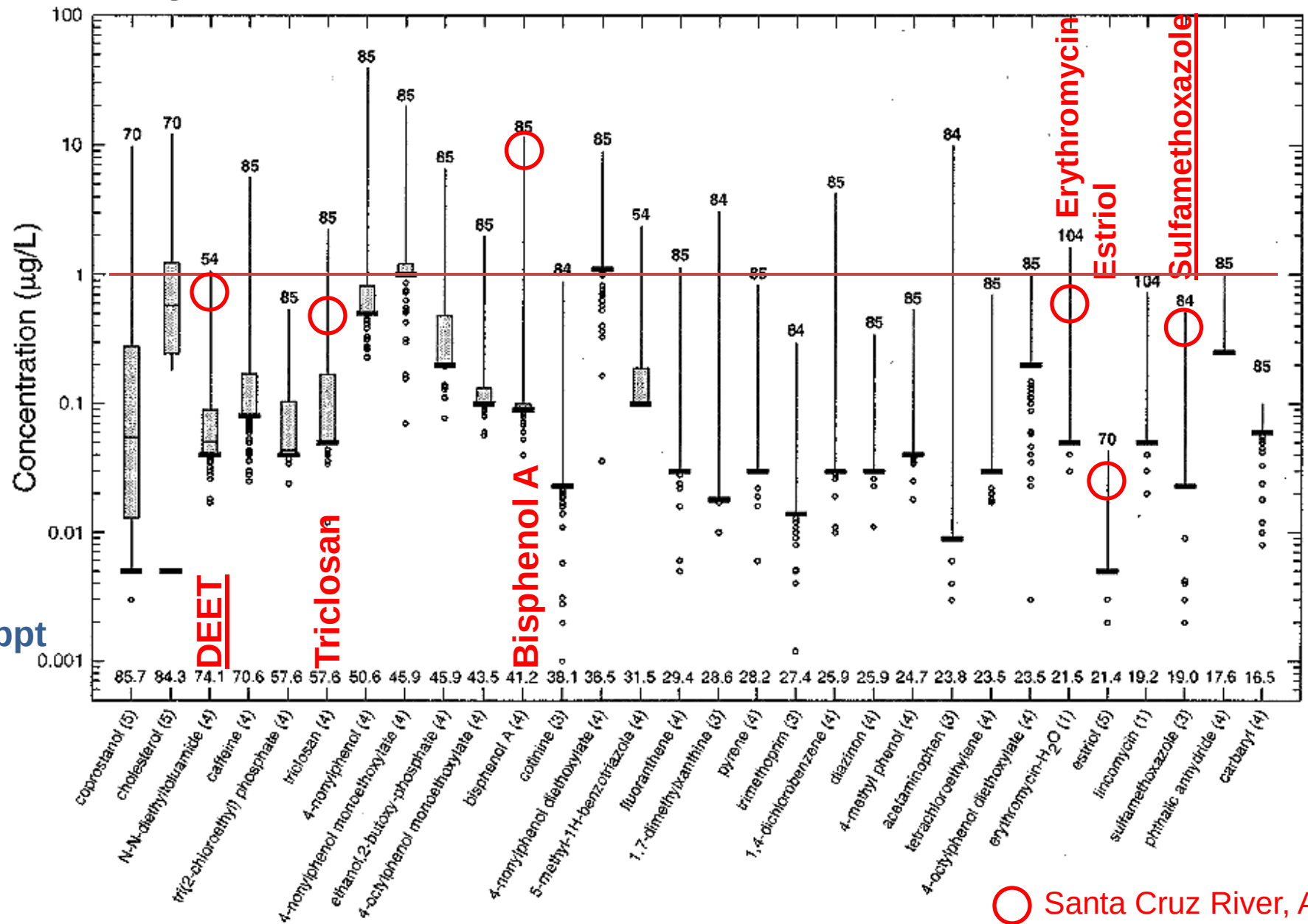
PPCPs and **EDCs** in streams - attributed to widespread domestic use of these compounds, followed by **wastewater treatment** that is only partially effective in their removal, prior to discharge into receiving waters.

In Arizona effluent discharge constitutes a significant fraction of surface water flux (e.g. Santa Cruz River)

**Northward flowing
Santa Cruz River
in Southern Arizona is
effluent dependent
from three WWTPs**

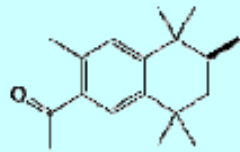


Measured concentrations for 30 most frequently detected organic wastewater contaminants (Kolpin, et al. 2002)

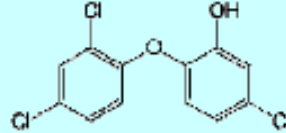


Examples of types of ECs found in wastewater

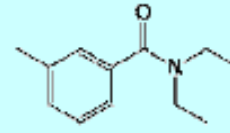
Personal Care Products



AHTN
Fragrance

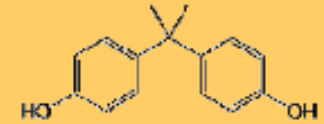


triclosan
Antibacterial

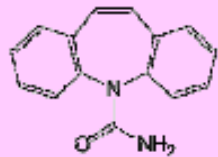


DEET
Insecticide

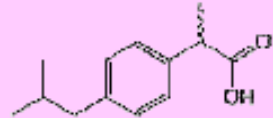
Industrial products



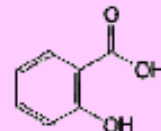
bisphenol A
Plastic / epoxy



carbamazepine
Anti-epileptic

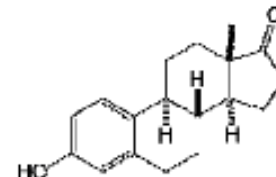


ibuprofen

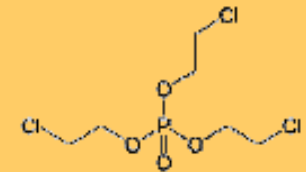


salicylic acid

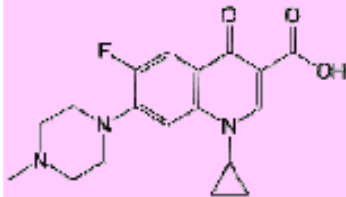
Analgesics



estrone
Estrogen

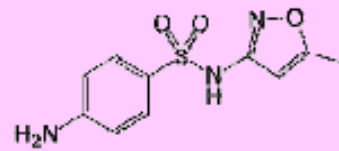


TCEP
Flame retardant



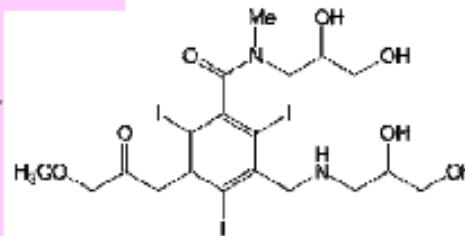
ciprofloxacin

Antibiotics



sulfamethoxazole

Pharmaceuticals



Iopromide
Contrast agent



PFOS
Perfluorinated
surfactant

Trace organic compounds measured in this study

Log K_{ow} : a measure of how hydrophilic ("water-loving") or how hydrophobic ("water-fearing") a chemical substance is

Compound	Use	Log K_{ow}
Iopromide	X-ray contrast agent	-2.30
PFOS (Scotchgard)	Surfactant	-1.08
Sucralose	Artificial sweetener	-1.00
PFOA	Surfactant	-0.90
Primidone	Anti-convulsant	0.11
Sulfamethoxazole	Antibiotic	0.48
Trimethoprim	Antibiotic	0.91
TCEP	Flame retardant	1.63
Fluoxetine (Prozac)	Anti-depressant	1.80
DEET	Mosquito repellent	2.18
Carbamazepine	Anti-convulsant	2.45
Tonalide (synthetic musk)	Fragrance	5.90

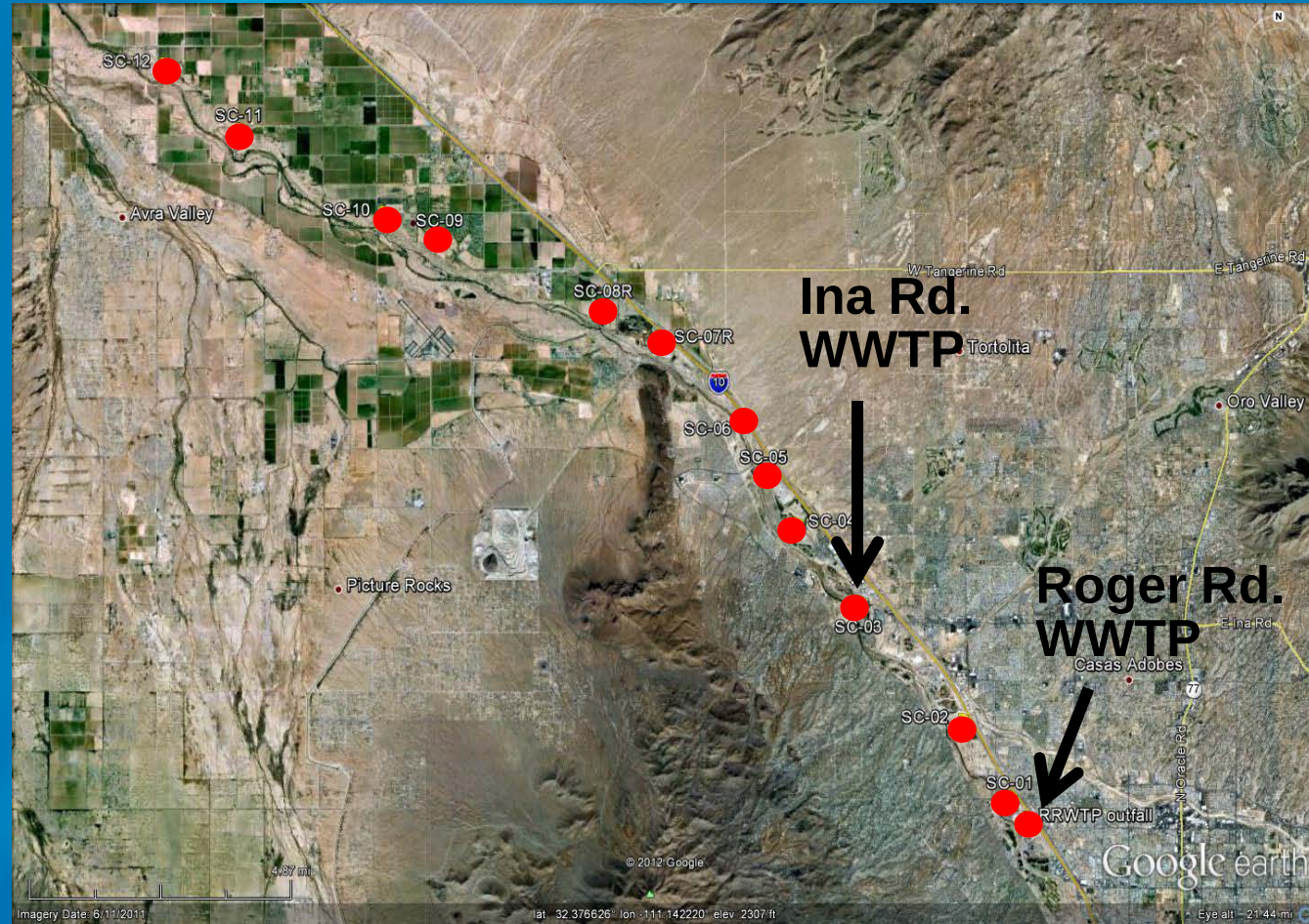
most hydrophilic
(water-loving)

(water-fearing)
most hydrophobic

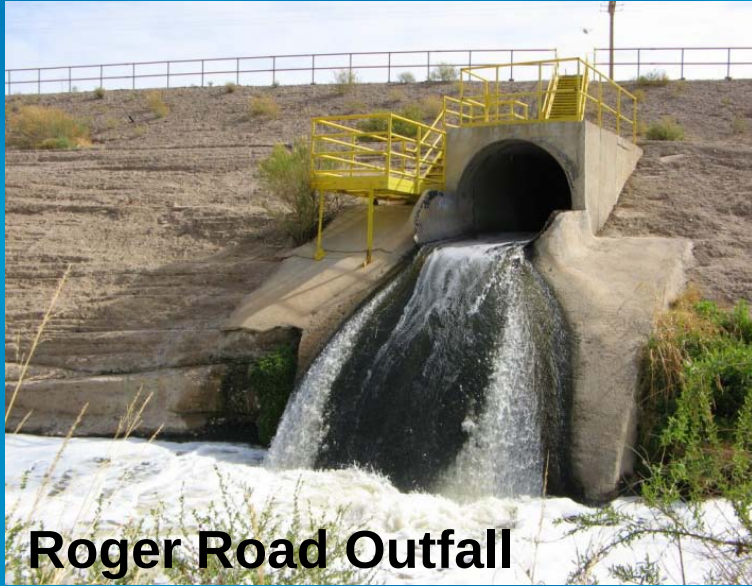
(None of these compounds are currently regulated in USA)

Study Reach of the Lower Santa Cruz River

- 13 sampling locations
- Roger Rd WWTP to Trico Rd.
- About 22 miles
- Sampling:
 - River
 - Ground water (SC monitor wells)
 - Performed twice in spring 2011



Sampling the Lower Santa Cruz River



Sampling the SC Monitor Wells



- 12 monitor wells
- Sampling performed twice during spring 2011

Laboratory methods

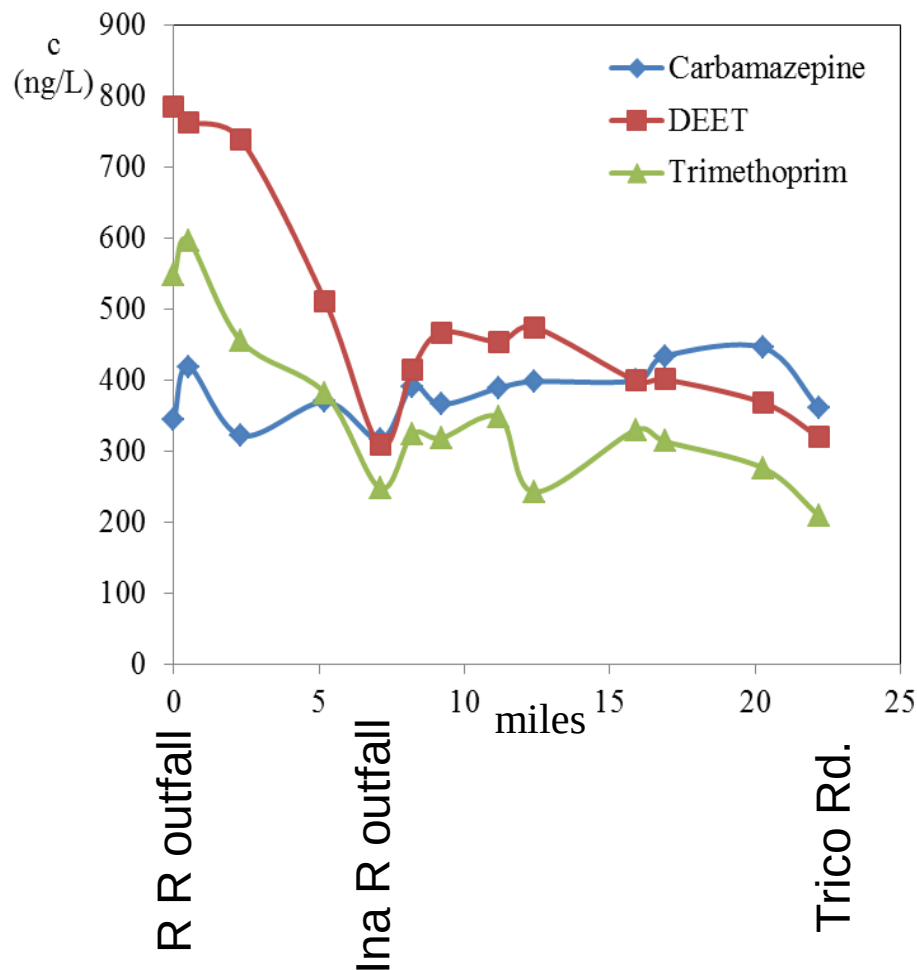


Solid phase extraction
(Dionex Autotrace)



Compound detection
(Agilent 6460 LC-MS/MS)
Liquid chromatography
combined with tandem mass
spectroscopy

Fate of ECs during river transport (along 22 mile reach of lower SCR)



- All 12 ECs were detected in the SCR
- Conc. range: 10 to 3,000+ ng/L
- Compounds that were reduced:
 - DEET
 - Fluoxetine (Prozac)
 - Trimethoprim
 - Tonalide
 - Iopromide
- Compounds that were not reduced:
 - Sucralose
 - Sulfamethoxazole
 - Primidone
 - Carbamazepine
 - TCEP
 - PFOS
 - PFOA
- Possible removal mechanism(s)
 - Biodegradation
 - Photo-oxidation
 - Sorption to particulates/sediments

Results: percolation to ground water

Sufficient evidence
for attenuation:

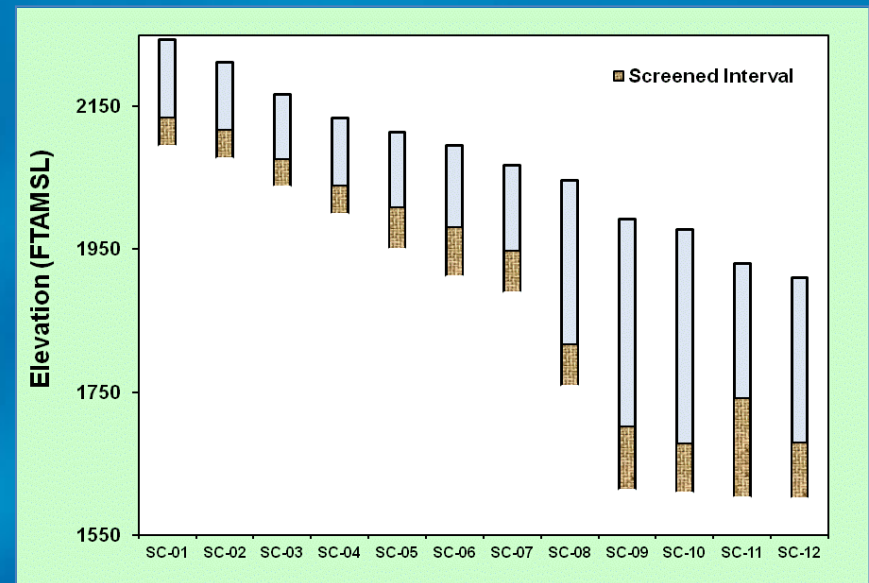
- DEET (<MRL)
- TCEP (<MRL)
- Fluoxetine (<MRL)
- Trimethoprim (<MRL)
- Iopromide
- Tonalide

No evidence for attenuation:

- Sulfamethoxazole
- Primidone
- Carbamazepine
- Sucralose
- PFOS
- PFOA

Possible attenuation mechanisms:

- Biodegradation
- Sorption
- dilution



ECs of highest concern

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

EC of highest concern in this study:

PFOS—detected at 50 to 200 ng/L in ground water
(State of California action level = 200 ng/L)

What next?

- What are the removal mechanism(s) during percolation?
- New 2012 USGS(104b) project:
 - Examine solid phase (riverbed sediments) and look for possible accumulation

Questions?

