

Occurrence of PPCP/EDC in Arizona Waters and The Impact of Recreational Activities

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Objectives

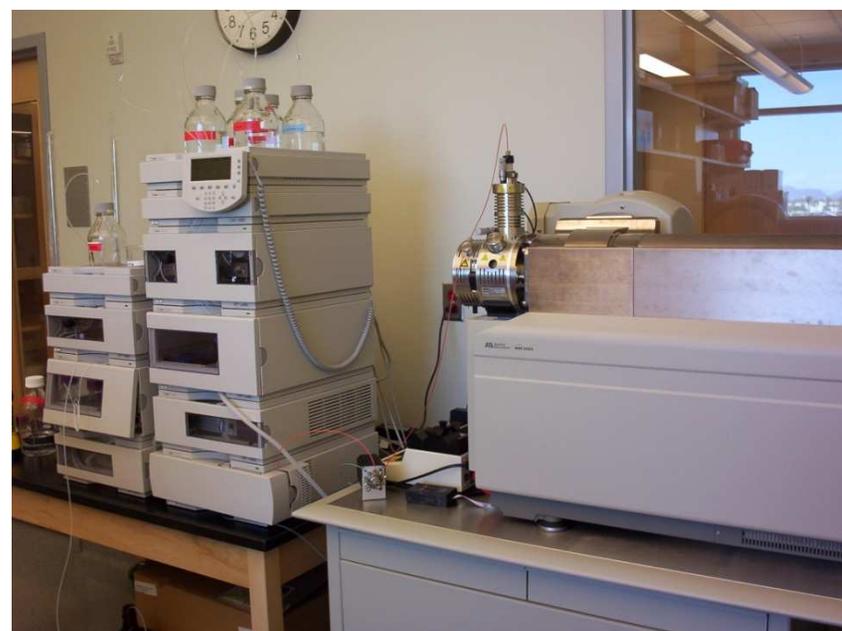
- **Investigate occurrence of trace organics in multiple Arizona Waters.**
- **Demonstrate the seasonal effect of trace organics occurred in surface waters.**
- **Demonstrate the impact of water recreational activities on trace organics occurred in downstream waters.**

Target compounds

Compounds name	Function	Ionization mode	Compounds name	Function	Ionization mode
Acetaminophen	NSAID	ESI +	Naproxen	NSAID	ESI -
Caffeine	stimulant	ESI +	Oxybenzone	Sunscreens	ESI +
Carbamazepine	anticonvulsant	ESI +	Pentoxifylline	antiplatelet drug	ESI +
Cotinine	metabolite of nicotine	ESI +	Primidone	Anticonvulsant	ESI +
DEET	insect repellent	ESI +	Sucralose	artificial sweetener	ESI -
Diazepam	anxiolytic	ESI +	Sulfamethoxazole	antibiotic	ESI +
Diclofenac	NSAID	ESI -	TBBA	flame retardant	ESI -
Dilantin	antiepileptic	ESI -	Triclosan	antibiotic	ESI -
Erythromycin	antibiotic	ESI +	Trimethoprim	antibiotic	ESI +
Fluoxetine	antidepressant	ESI +	Estradiol	sex hormone	APCI
Hydrocodone	narcotic analgesic	ESI +	Ethinyl Estradiol	estrogen	APCI
Ibuprofen	NSAID	ESI -	Progesterone	steroid hormone	APCI
Meprobamate	anxiolytic	ESI +	Testosterone	steroid hormone	APCI

Analytical Scheme

- Filtration using 0.75 μ m (GF/F) filter paper.
- Solid phase extraction (Oasis HLB) @ ASU
- Analysis at ADHS (LC/MS/MS)
- Isotope spiking for recovery correction
- Quality control – lab blank, field blank and duplication.



Arizona Potential EDC/PPCP Sources

- Colorado River
- Wastewater discharges into rivers and groundwater
- Leaking septic systems
- Houseboats & direct contact (recreation)



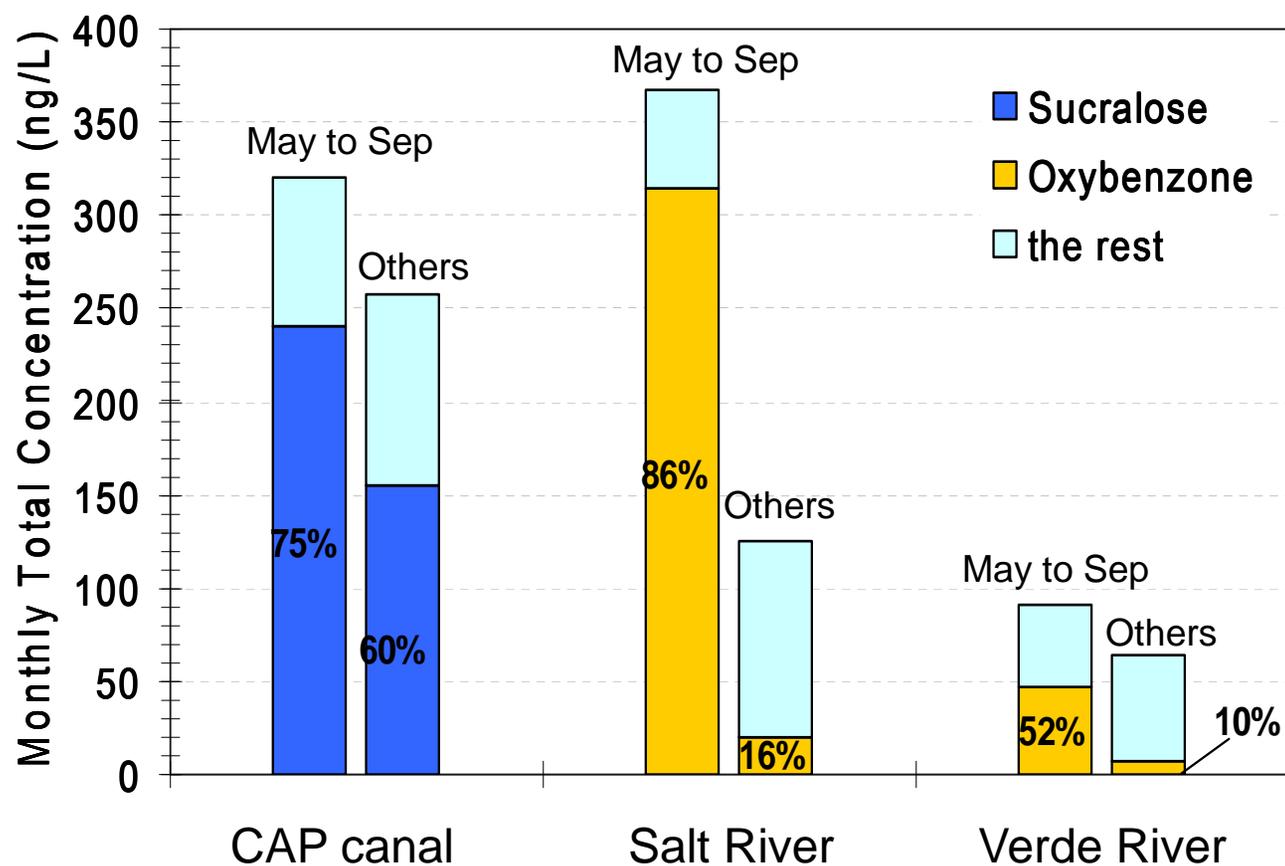
Overview of PPCP/EDC in AZ waters

Source	< 2 ng/L & ≤ Blank	2 to 10 ng/L	10 to 20 ng/L	20 ng/L to 1 ug/L	> 1 ug/L
Ground water at recharge site	Steroids and others	Acetaminophen, caffeine, DEET, erythromycin, meprobamate oxybenzone, pentoxifylline	None	Sulfamethoxazole, sucralose (in one site)	None
SRP waters (Verde River & Salt River)	Steroids and others	Sucralose, sulfamethoxazole, acetaminophen, cotinine, dilantin,	Caffeine, DEET	Oxybenzone	None
CAP Canal from Colorado River	Steroids and others	Sulfamethoxazole, oxybenzone, meprobamate, DEET, cotinine, dilantin, carbamazepine, acetaminophen, primidone, estradiol	Caffeine, triclosan	Sucralose	None
Activated sludge WWTP effluent with nitrification	Steroids and others	Acetaminophen, ibuprofen, diazepam, pentoxifylline	Cotinine	Caffeine, naproxen, oxybenzone, TBBA, carbamazepine, hydrocodone, meprobamate, sulfamethoxazole, DEET, erythromycin, trimethoprim, primidone, dilantin, triclosan, diclofenac, sucralose, fluoxetine	None
Raw wastewater	None	None	Diazepam, ethinyl estradiol, progesterone	Testosterone, hydrocodone, pentoxifylline, erythromycin, trimethoprim, primidone, fluoxetine carbamazepine, dilantin, diclofenac	Ibuprofen, naproxen, triclosan, sucralose, acetaminophen, caffeine, cotinine, oxybenzone, DEET, meprobamate, TBBA, sulfamethoxazole

Surface Waters

- **CAP Canal, Salt River, and Verde River**
 - ◆ **> 90% samples were measured with PPCP/EDC presented.**
 - ◆ **Progesterone was not detected in any of them.**
 - ◆ **Concentrations were low (less than 50 ng/L).**
 - ◆ **Oxybenzone and sucralose exceeded 300 ng/L during the period.**
 - ◆ **15/26 compounds were prevalent (>50% occurrences).**
 - ◆ **Caffeine, DEET, Sucralose and oxybenzone were detected in most samples (>90% occurrences)**

Seasonal effect on PPCP in surface waters



Water Treatment Plant

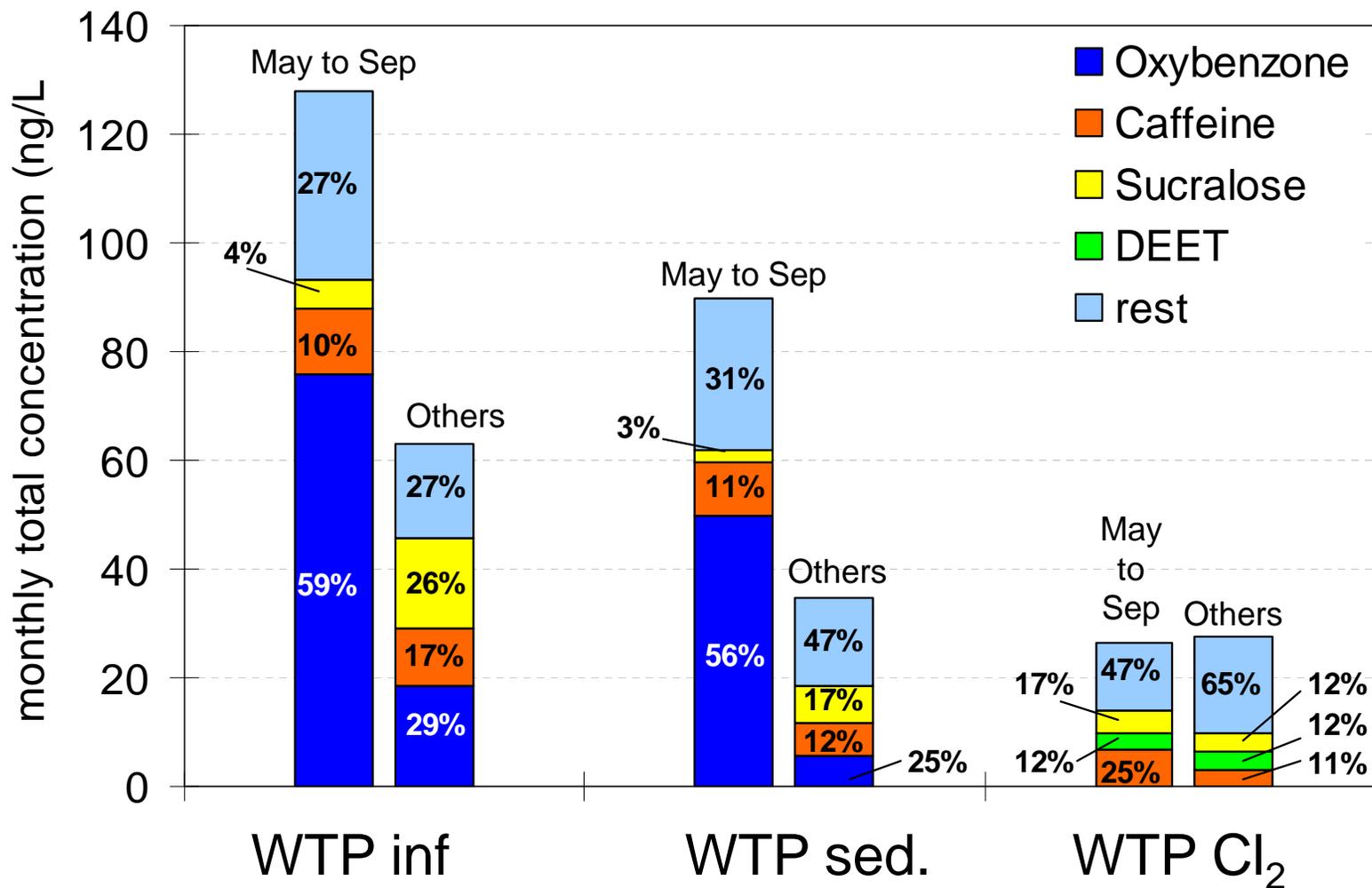
● WTP in Tempe

- ◆ Only Caffeine, DEET, Sucralose and oxybenzone were detected >10 ng/L in some WTP influent samples.
- ◆ 11/26 compounds remained in finished water (1~5 ng/L)
- ◆ Chlorination shows further oxidation on some compounds, especially oxybenzone.

Removal efficiency in WTP

(Unit: ng/L)	Raw Water	Sedimentation	Disinfection	% Removal
Oxybenzone	43	25	0	100%
Caffeine	10	7	5	52%
Sucralose	10	4	4	61%
DEET	6	3	3	46%
Acetaminophen	2	2	2	<1%
Erythromycin	1	1	1	<1%
Cotinine	1	1	1	<1%
Meprobamate	1	1	1	<1%
Pentoxifylline	1	1	1	<1%
Sulfamethoxazole	1	1	0	79%
TBBA	1	1	0	17%

Seasonal effect on PPCP/EDC in drinking water

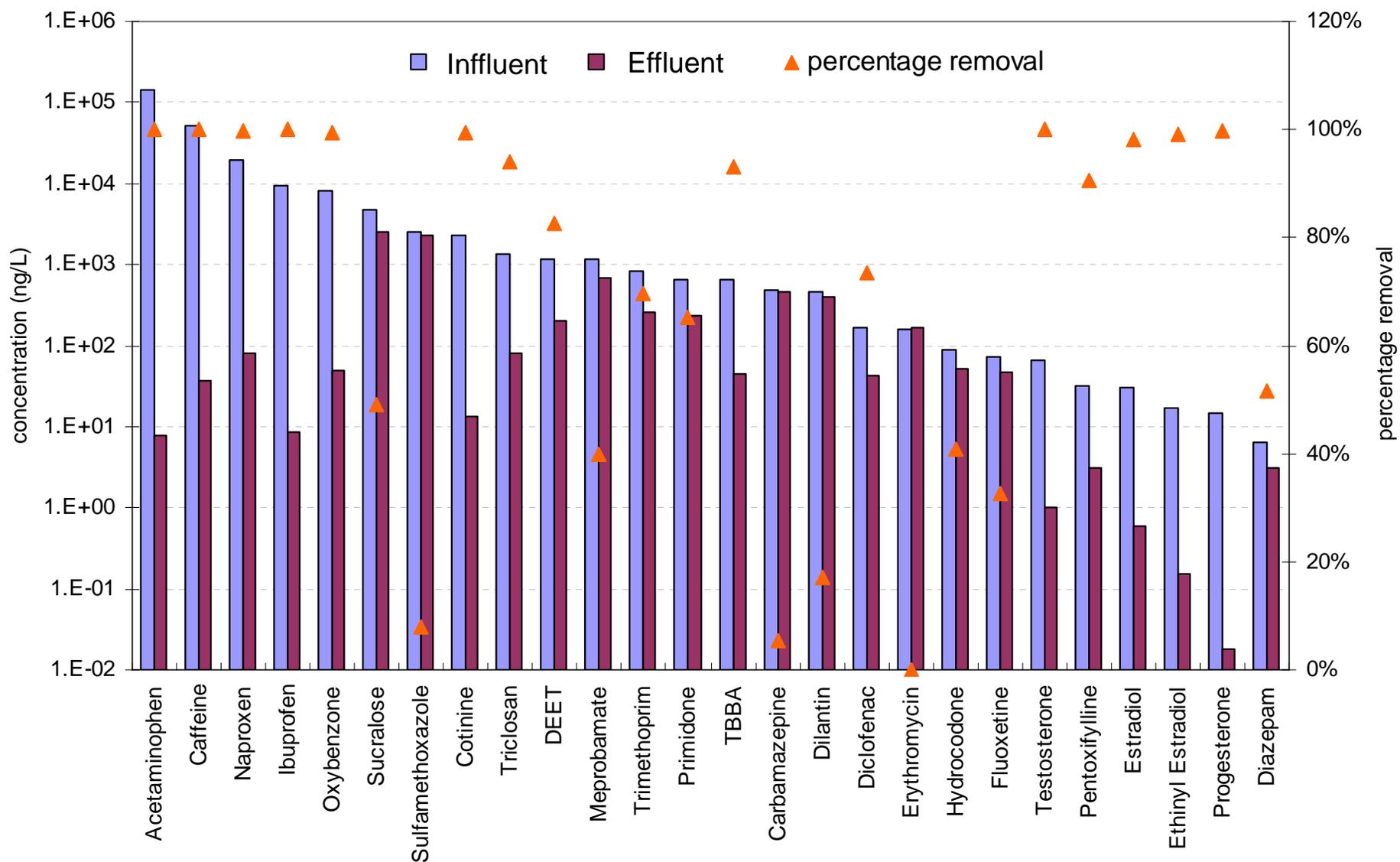


Wastewater Treatment Plant

● WWTP

- ◆ 12 out of 26 compounds were detected >1 $\mu\text{g/L}$; acetaminophen, caffeine, ibuprofen, and naproxen were >10 $\mu\text{g/L}$.
- ◆ Several compounds (caffeine, DEET, oxybenzone, ibuprofen, meprobamate, and triclosan) shows increasing trend in raw wastewater during summer.
- ◆ Removal efficiency of PPCP/EDC is not necessarily K_{ow} correlated in WWTP.

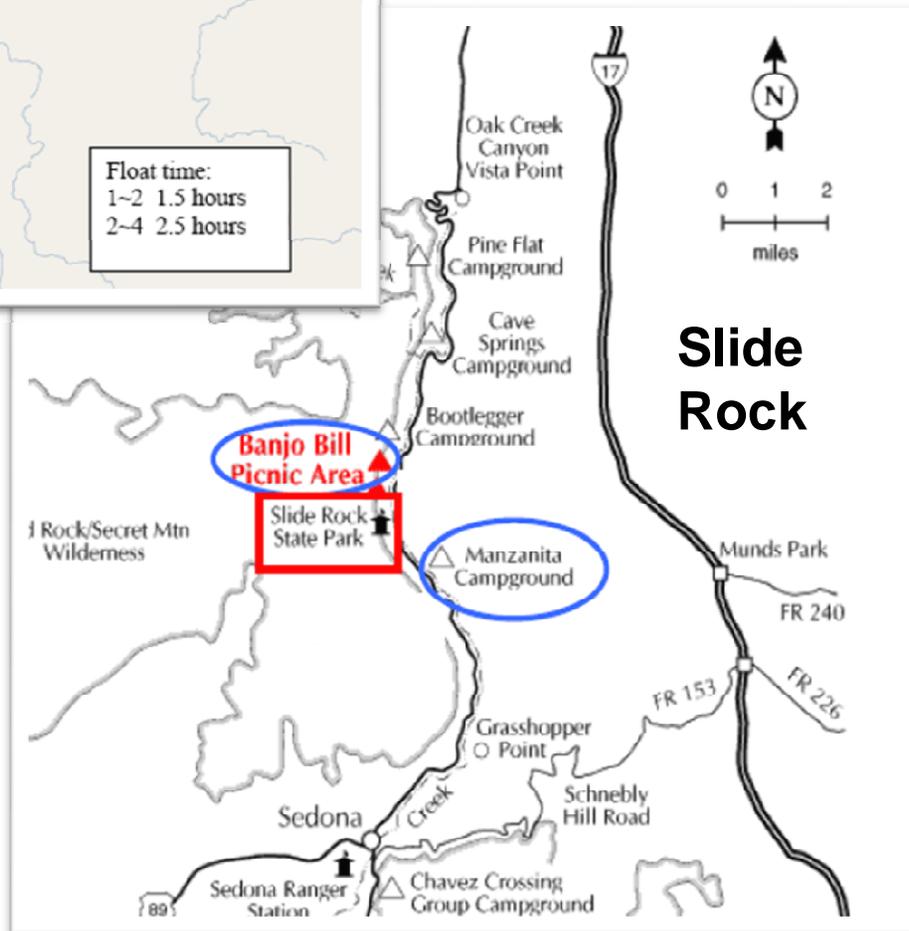
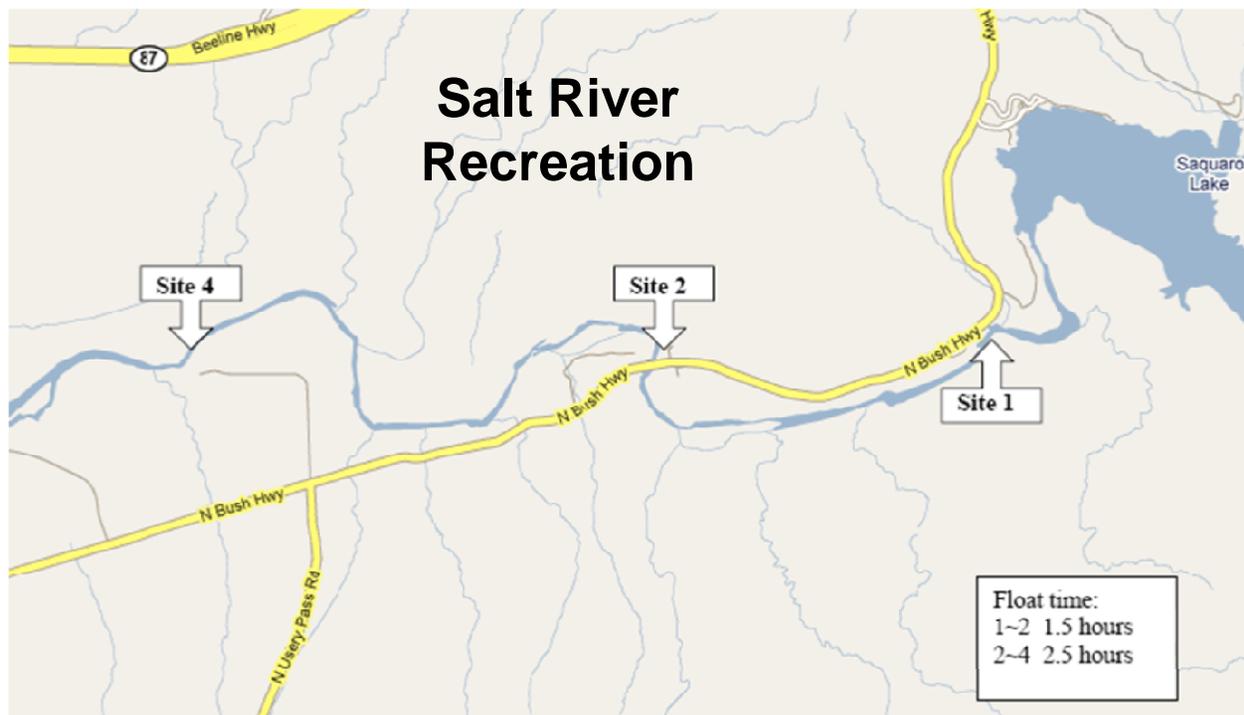
WWTP removal efficiency of PPCP/EDC



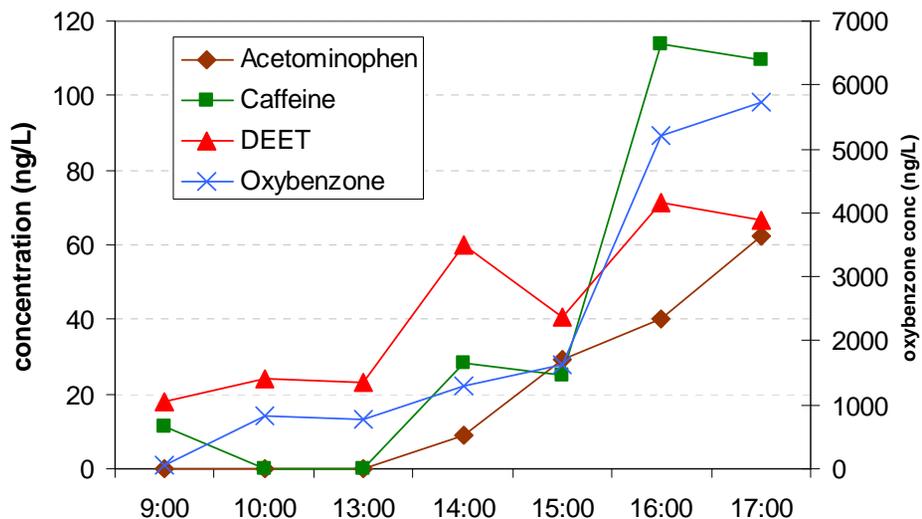
Water Recreation Area

- **Salt River and Slide Rock recreation area**
 - ◆ **Samples were collected hourly in one day during summer**
 - ◆ **Caffeine, DEET, and acetaminophen increased along time (up to 120 ng/L)**
 - ◆ **Oxybenzone was detected >1 µg/L**
 - ◆ **Most of the sources for these detected PPCPs are from skin-applied products (sunscreen, insect repellent) rather than oral-applied drugs.**

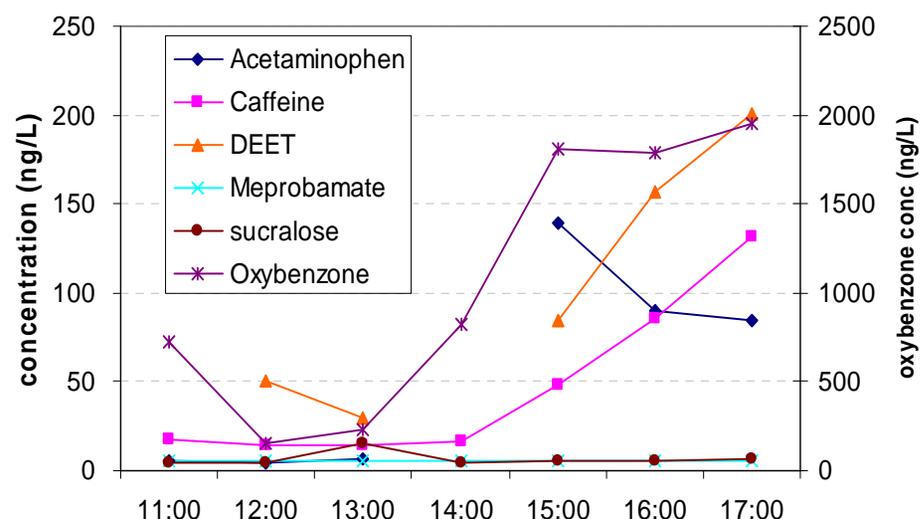
Salt River Recreation



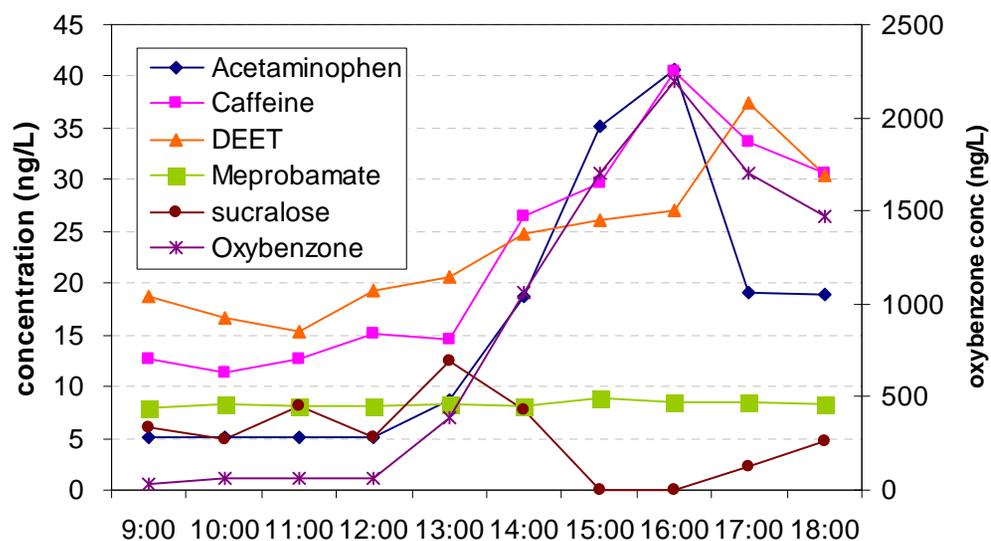
2008, Summer, Salt River



2009, Summer, Slide Rock

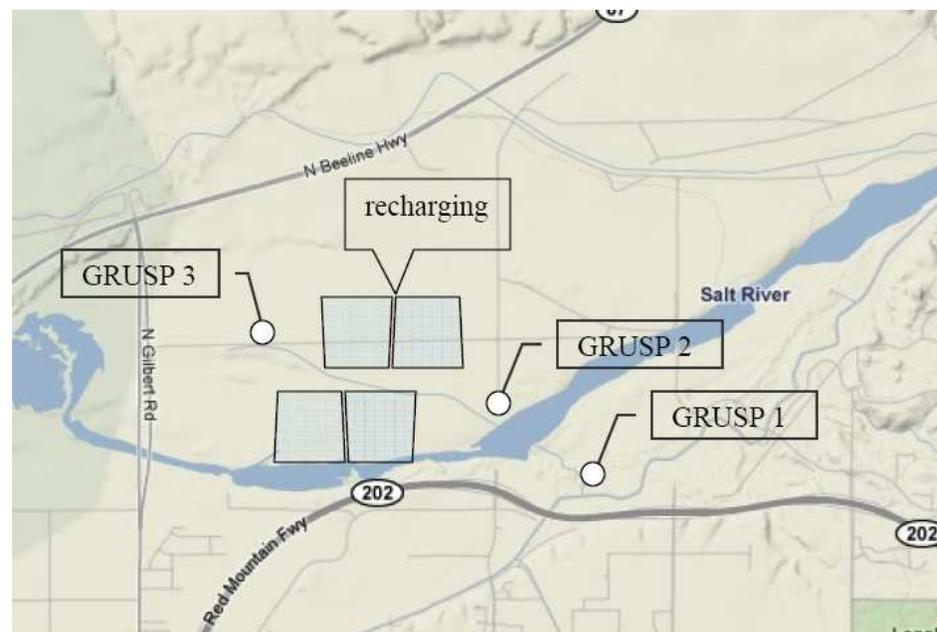


2009, Summer, Salt River



GRUSP Measuring Wells

- 13 out of 26 compounds were detected in three measuring wells.
- Most of the detected concentrations are low (< 5 ng/L)
- Acetaminophen, caffeine, DEET, Sulfamethoxazole, Sucralose, and Erythromycin were constantly present in ground water system.
- Sulfamethoxazole was detected up to 200 ng/L in MW#3.



PPCP/EDC occurrence in Phoenix water supply area

- **PPCP/EDC existing in surface water system might increase health risk for drinking water management.**
- **Water recreation and lakes from upstream could be important sources of these PPCP/EDC present in canal system of Phoenix area.**
- **Seasonal effect on different surface waters might influence raw water quality of WTP during source water switch by SRP.**
- **Tracking the occurrences and fate of these PPCP/EDC in drinking water system is important for water management of metropolitan Phoenix.**

Acknowledgement

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