



CECs: Contaminants, Sources, Significance

ILMA 2012

DeKalb, Illinois

Dana Kolpin

Toxic Substances Hydrology Program

1 March , 2012

U.S Department of the Interior

U.S. Geological Survey

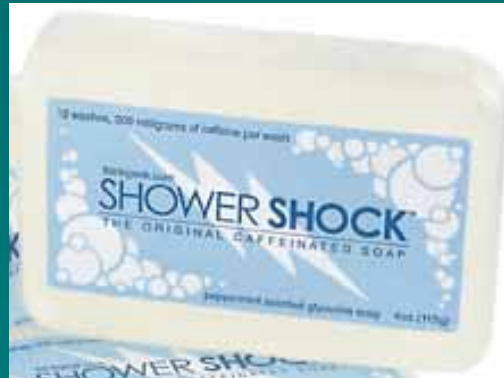


CECs

“umbrella term”

- Pharmaceuticals
- Fungicides
- Mycotoxins
- Fragrances
- Detergents
- Plastics
- PFOS / PFOA
- Pathogens
- Hormones
- Fire retardants
- Disinfectants
- Fumigants
- Plant/animal sterols
- Phytoestrogens
- Algal toxins
- Nanomaterials

Not your father's caffeine....



REVOLUTIONARY SLIMMING TIGHTS
SLIM YOURSELF IN EXPRESSO TIME!*

skinkiss

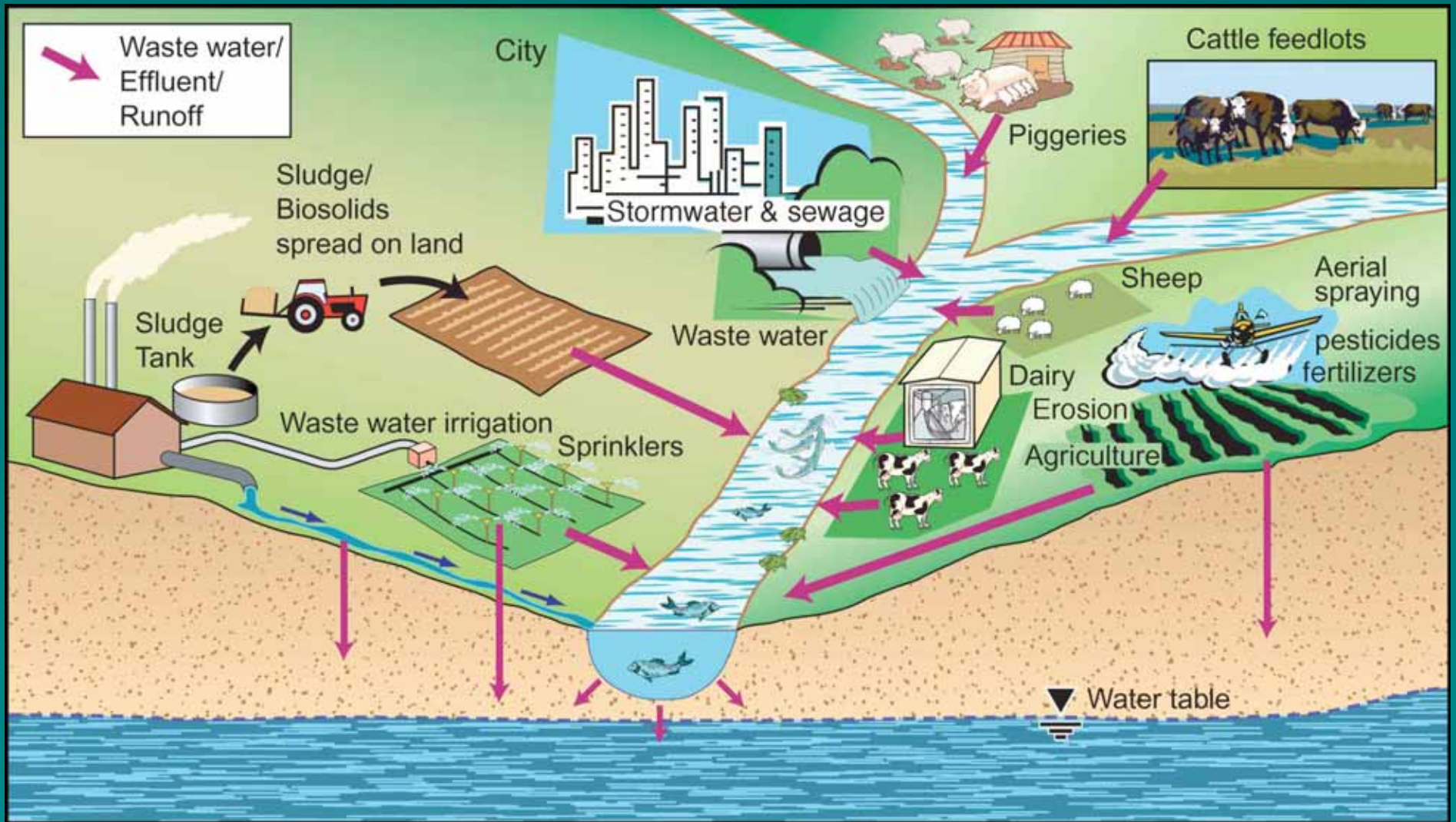
Contains 3 pairs



Caffeine Slimming Tights skinkiss

*Contains caffeine microcapsules

Environmental Pathways for CECs



CSIRO Land and Water (2012)

Fundamental Research Questions

- *Are CECs entering our environment?*
- *What are the sources (signatures)?*
- *What happens to them in the environment?*
- *Do they have adverse ecological health effects?*
- *Do unintended exposures pose a human health risk?*
- *How can we minimize their entry to the environment or remove them?*

Are CECs entering our environment?

- Present in ground water and streams at sub-ppb conc.'s.
- Entering via human & animal waste pathways.
- Present as complex mixtures.

(Kolpin, et al., 2002; Barnes et al., 2008; Focazio et al., 2008)



2160 citations

Recent Examples...

- Antivirals
- Vet growth promoters
- Antidepressants
- Mycotoxins
- Cytotoxic drugs
- Benzotriazoles
- Artificial sweeteners
- Phytoestrogens
- Cocaine

What are the potential sources?

Human

- Wastewater treatment plants
- Land application
- Combined sewer overflows
- Onsite septic systems
- Industrial/commercial discharge
- Landfills
- Water reuse



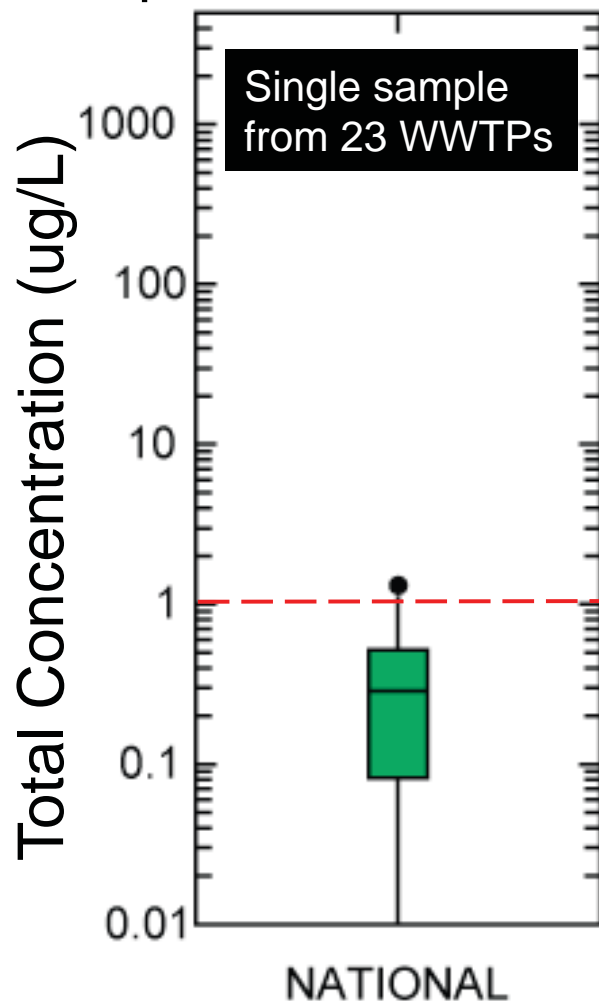
Animal

- Waste lagoons, etc.
- Land application
- Processing plants
- Aquaculture



National WWTP Network

Phillips et al., 2010



Measured pharms

metaxalone

oxycodone

methadone

butalbital

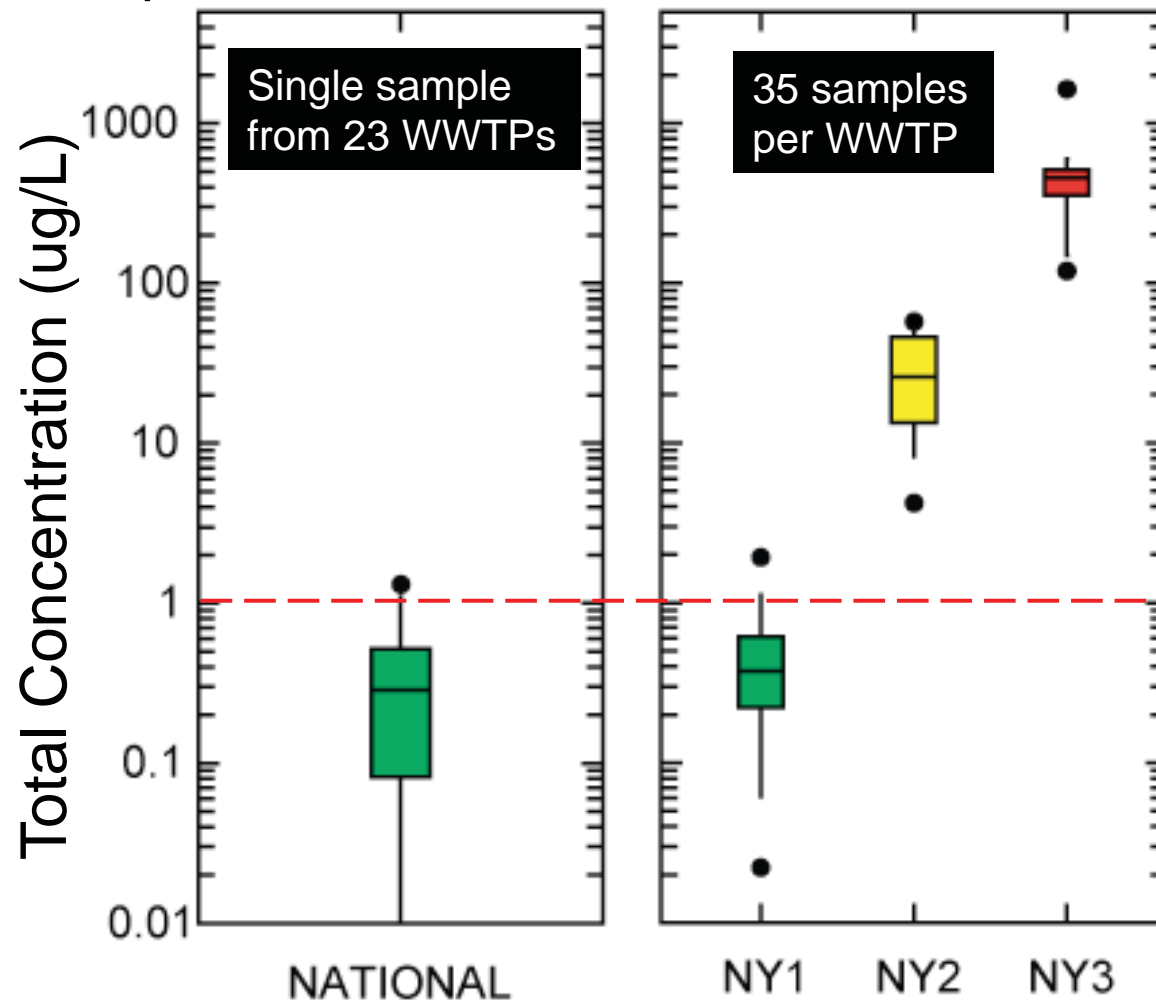
phendimetrazine

carisoprodol

diazepam

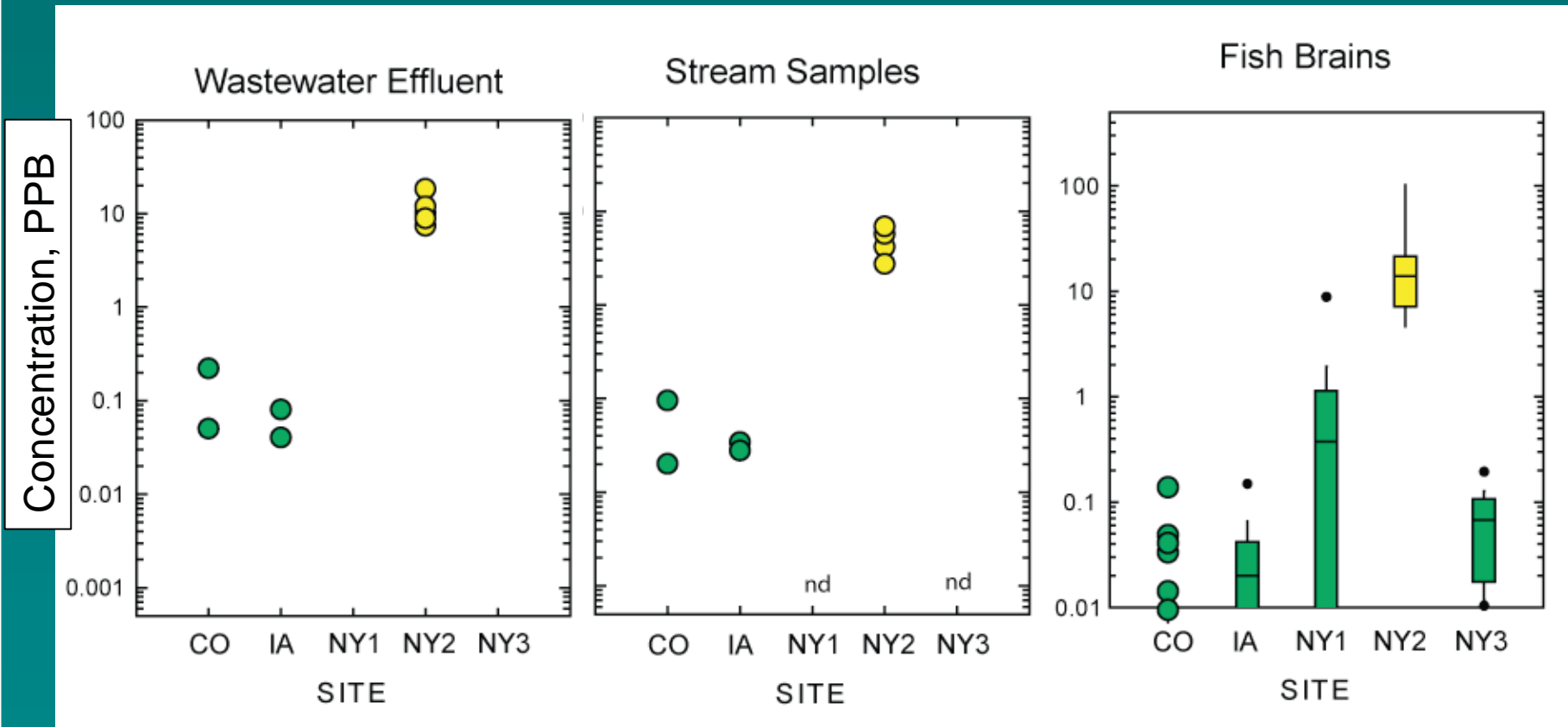
WWTPs – Pharm. Manufacturing Facilities

Phillips et al., 2010



Max Conc. (ug/L)
3800 metaxalone
1700 oxycodone
>400 methadone
160 butalbital
>40 phendimet.
>40 carisoprodol
4 diazepam

Bupropion Env'l Exposure @ PMF



Uptake into Plant and Animal Tissue



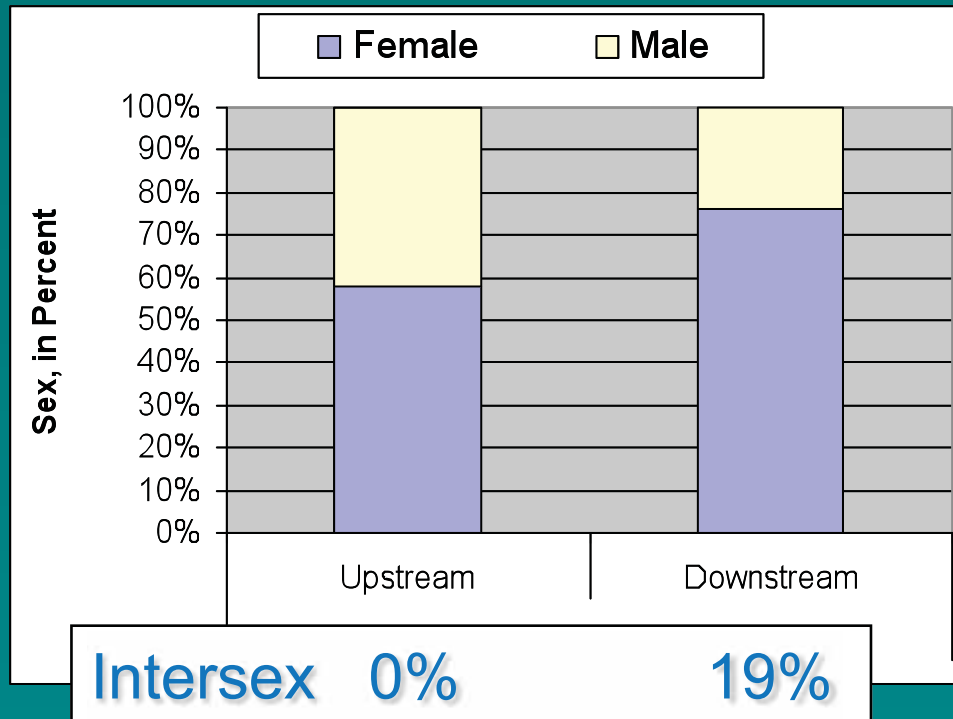
- Trimethoprim: in carrots & lettuce; *Boxall et al., 2006*
- Sulfamethazine: in corn, lettuce, potatoes; *Dolliver, et al., 2007*
- Triclosan & Trimethoprim: in earthworms; *Kinney et al., 2008*
- Diclofenac: in mussels; *Ericson et al., 2010*
- BPA: in fish; *Mita et al., 2011*
- Antidepressants: in fish; *Schultz et al., 2010*
- Triclosan: in dolphins; *Fair et al., 2009*

Mounting Evidence for Ecological Effects

- **Trenblone:** Irreversible fish masculinization
Morthorst et al., 2010
- **Sulfamethoxazole:** Affected denitrification rates in bacteria; *Underwood et al., 2011*
- **Triclosan:** Inhibited soil microbial respiration at doses $> 10\text{mg/kg}$, *Butler et al., 2010*
- **Progesterin:** Disruption of oviduct and ovary development in frogs; *Kvarnryd et al., 2011*

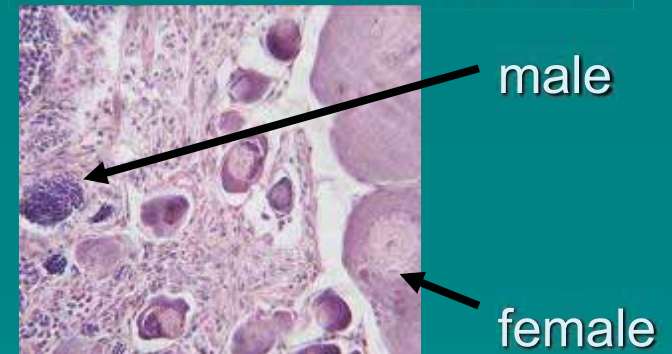
Evidence of Endocrine Effects in WWTP Impacted Stream (Boulder Creek)

White sucker



Intersex

Blood Vitellogenin
Cellular Abnormalities

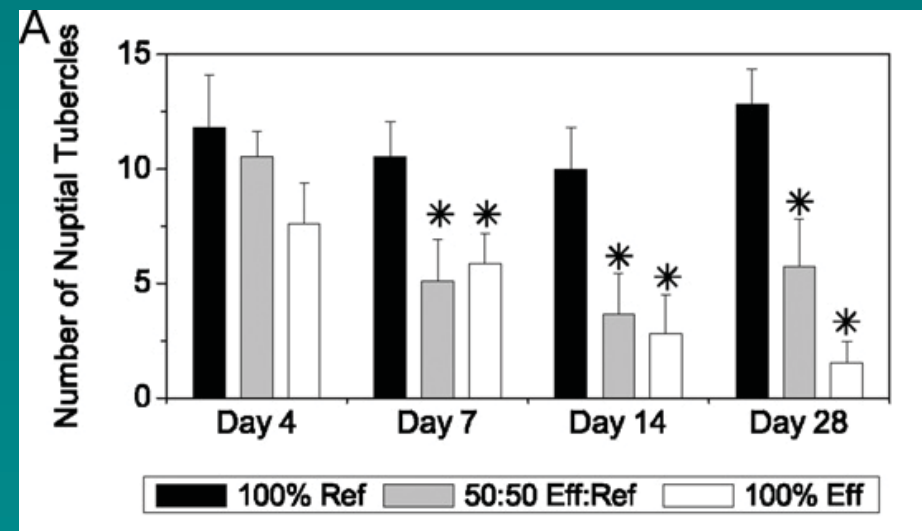
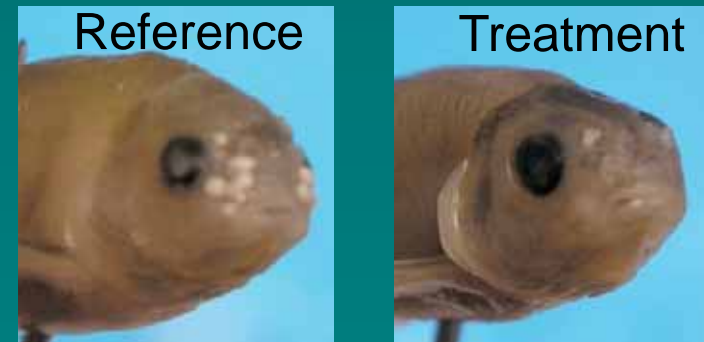


Vajda et al., 2008

Boulder WWTP Effluent Estrogenic (trickling filter treatment process)



Onsite stream waters with controlled photo-period and water temp.



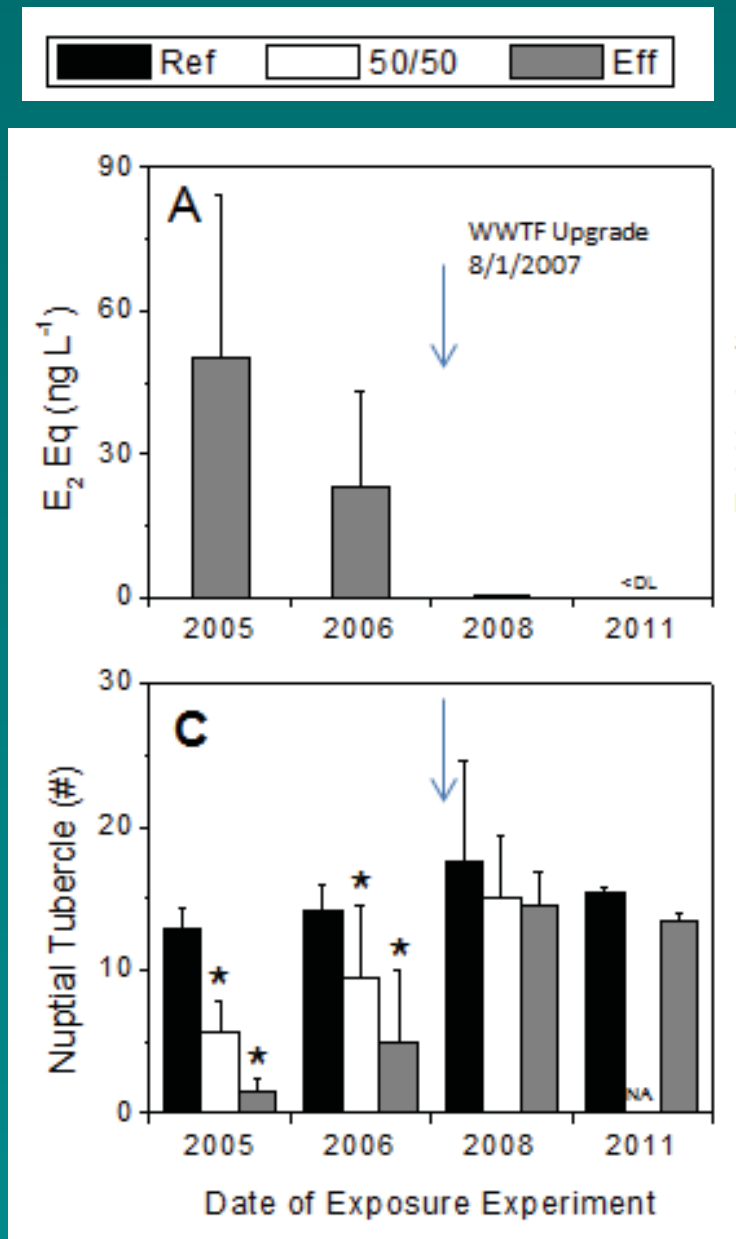
Vajda et al., 2011

Boulder WWTP Post-Upgrade Results

Switch from trickling filter to an activated sludge process:

- Improved the removal efficiencies of many CECs
- Decreased the estrogenicity of discharged effluent
- Reduced endocrine disruption relative to pre-upgrade conditions

Repeat field survey of fish populations and endocrine disruption in white suckers (Oct. 2011)



Barber et al., 2012, ES&T

Human Health Effects?

- Less is known related to human health effects
 - difficulty in conducting epidemiological studies
- Concern of fetal exposure
 - classic example: diethylstilbestrol
- Animals as sentinels
- View that adverse effects from pharms in drinking water are not expected (Bruce et al., 2010; WHO, 2011)
- **Epigenetics** (early exposure → late effects)
- **Transgenerational transmission** (chemical exposure now could impact future generations)

Questions?



toxics.usgs.gov/regional/emc