

*Pharmaceuticals and other Emerging
Environmental Contaminants: Sources,
Occurrence, and Health Implications*

APHA Conference on Water and Public Health
Philadelphia, Pennsylvania
November 7-10, 2009

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2

Presenter Disclosures

Herbert T. Buxton

No Relationships to Disclose



3

Chemicals of Emerging Environmental Concern: *Emerging Contaminants*

Not Just Pharmaceuticals!

Chemicals that:

- *co-occur* in the environment, &
- *interact* in their effect on organisms.



4

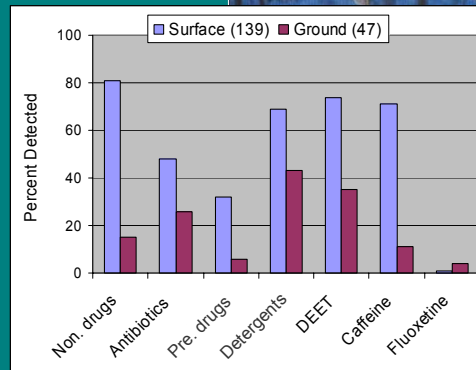
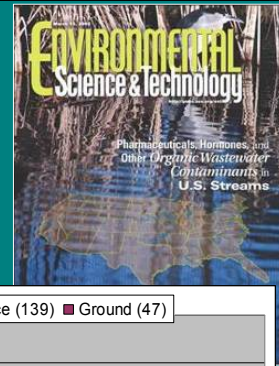
Emerging Contaminants

- Human & Veterinary Pharmaceuticals
- Detergents
- Antioxidants
- Fire retardants
- Disinfectants
- Fumigants
- Fragrances
- Pesticides/
Repellants
- Industrial Chem's, HPVs
- Some Metals
- Biogenic Hormones
- Phytoestrogens
- Natural antimicrobials
- Natural pesticides
- *Degradates/
Metabolites*



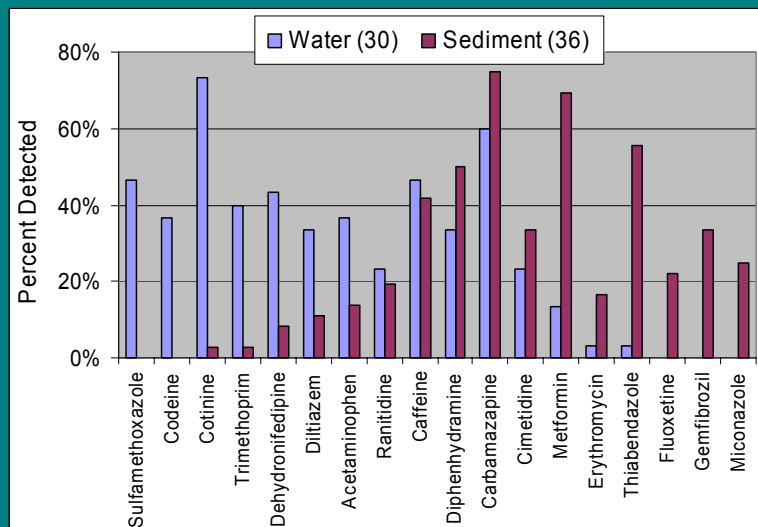
National Surveys of "Susceptible" Waters

- High density of population and animal production.
- Present in water at sub-ppb concentrations
- Present in complex mixtures.
- Greater levels in streams than wells



Kolpin, et al., 2002; Barnes et al., 2008

Don't just look in stream waters!



Furlong, et al., 2003

7

Measurement Capabilities

- Clofibric Acid (Buser 1998)
- 32 drugs in German WWTPs (*Ternes 1998*)
- 45 drugs in US Rivers (Kolpin et al. 2002)

- amphetamines
- antibiotics
- antidepressants (SSRIs)
- antiphlogistics
- antivirals
- barbiturates
- beta-blockers

- Ca channel blocker
- contraceptives
- cytostatics
- fibrates
- glucocorticoids
- muscle relaxants
- opioids



8

Human Source Pathways

- WW Treatment Plants
- Domestic Septic Systems
- Land Application
- Industrial/Commercial Discharges
- Landfills
- Water Reuse



Animal Source Pathways

- Grazing
- AFOs/CAFOs
- Waste lagoons
- Land application
- Processing
- Aquaculture
- Pets

Manure (kg/day)	
Human	1.5
Cow	30
Hog	4
Sheep	1.5
Chicken	0.14














Hydrologic Events

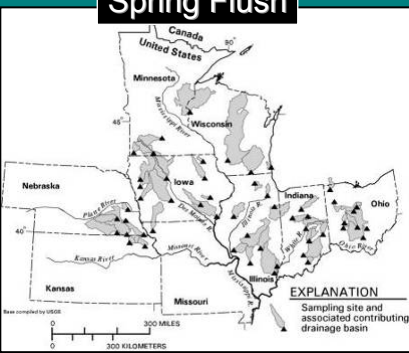

10



Cedar Rapids, IA

Midwest Floods, Spring '08


Spring Flush



EXPLANATION
Sampling site and associated contributing drainage basin

36 antibiotics, 21 herbicides, 27 degradates, in 51 Midwest Streams

Scribner et al., 2003



EC Uptake in Organisms



Plant Tissue

- *Oxytetracycline* in alfalfa (Kong et al., 2007).
- *Oxytetracycline*, *flumequine* & *oxolinic acid* in bryophytes (Delepee et al., 2004).
- *Trimethoprim* in carrots & lettuce (Boxall et al., 2006).
- *Sulfamethazine* in corn, lettuce, potatoes (Dolliver, et al., 2007).

Animal Tissue

- *Fluoxetine* in bluegill, catfish, carp, crappie (Brooks et al., 2005).
- *Gemfibrozil* in goldfish (Mimeault et al., 2005).
- *Triclosan* & *Methyl-triclosan* in carp (Leiker et al., 2008).
- *Trimethoprim* & *Triclosan* in earthworms (Kinney et al., 2008).



Ecological Effects

12

- Antibiotics: Reduced soil microbial activity at env. concentrations (Costanzo et al., 2005; Thiele-Bruhn and Beck, 2005).
- Diclofenac (NSAID): Consumption of diclofenac-treated meat caused renal failure in *vultures* (Oaks et al., 2004).
- Ciprofloxacin, triclosan, Tergitol NP 10: shifts in algal community structure (Wilson et al., 2003).
- Drug Mixtures 13: Inhibited growth of human embryonic cells at environmental levels (Pomati et al., 2006, 2008).
- Fluoxetine: Affected reproduction in freshwater molluscs -- water-sediment exchange (Sanchez-Arguello et al., 2009).
- Antidepressants: (environmental levels) Affected predator avoidance behavior of larval fathead minnow (McGee et al. 2009).
- 4-nonylphenol: (environmental exposures) Impaired reproductive potential of male fathead minnows. (Schoenfuss et al., 2008).
- Alkylphenoethoxylates: (environmental mixtures) Reduced reproductive competence in male fathead minnows (Bistodeau et al., 2006).
- Sewage Sludge: Affected bone homeostasis in sheep (Lind et al., 2009).



Modes of Action with Chemical Interactions

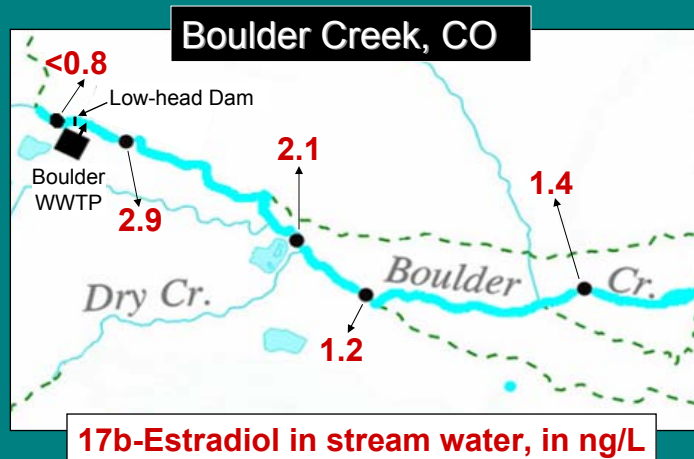
13

- Endocrine Disruption (biogenic hormones, synthetic hormones, hormone mimics & blockers)
- Antimicrobial Resistance (synthetic antimicrobials, natural antimicrobials, metals, pesticides?)

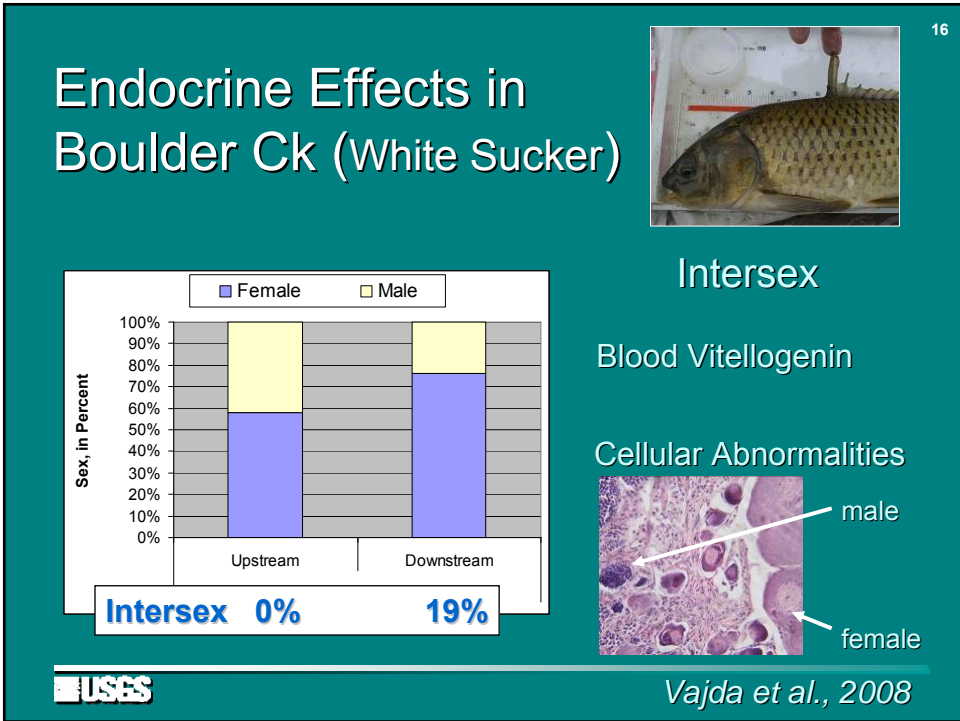
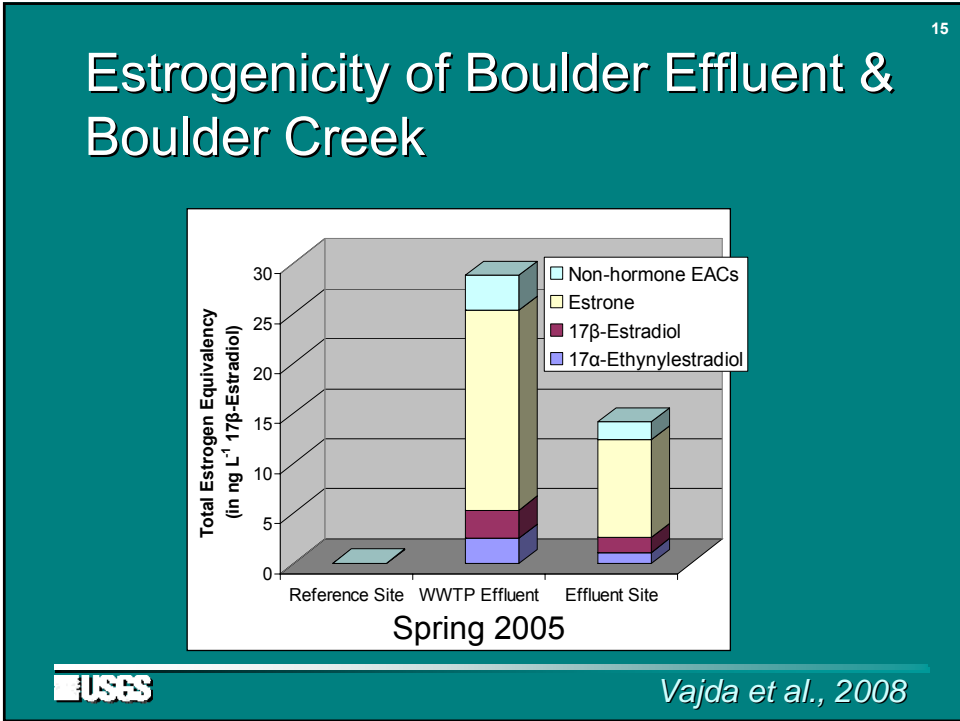


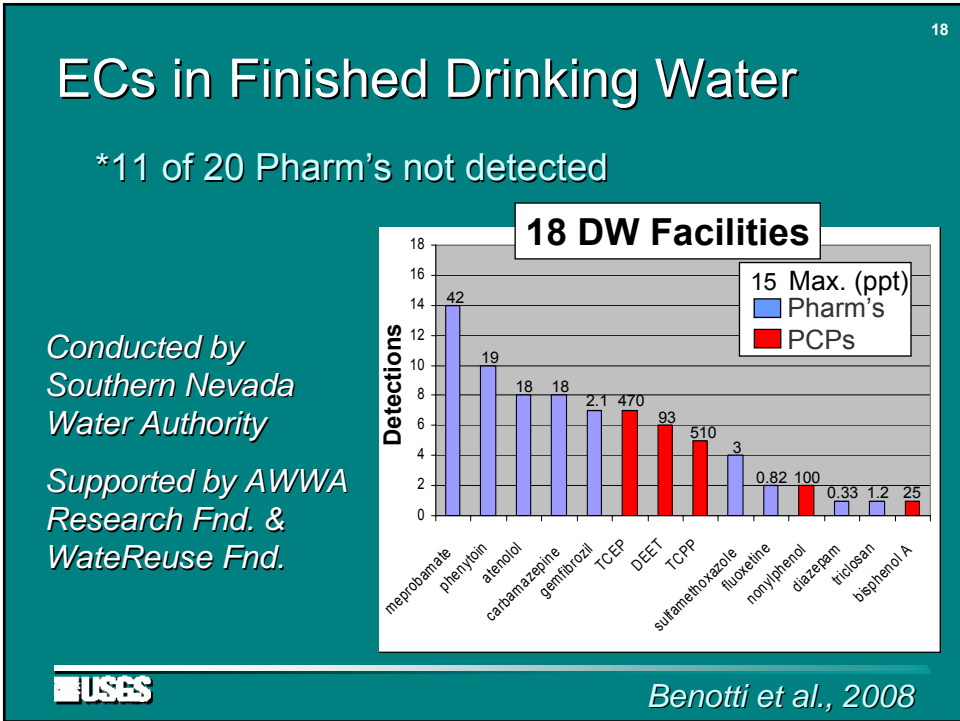
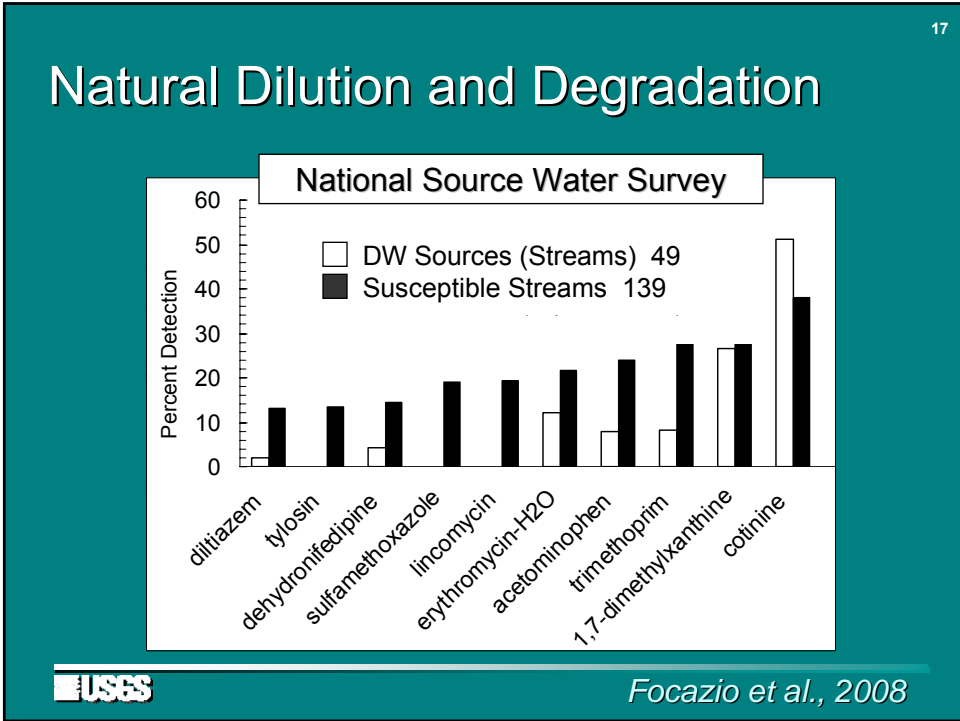
Endocrine Disruption: A Case Study

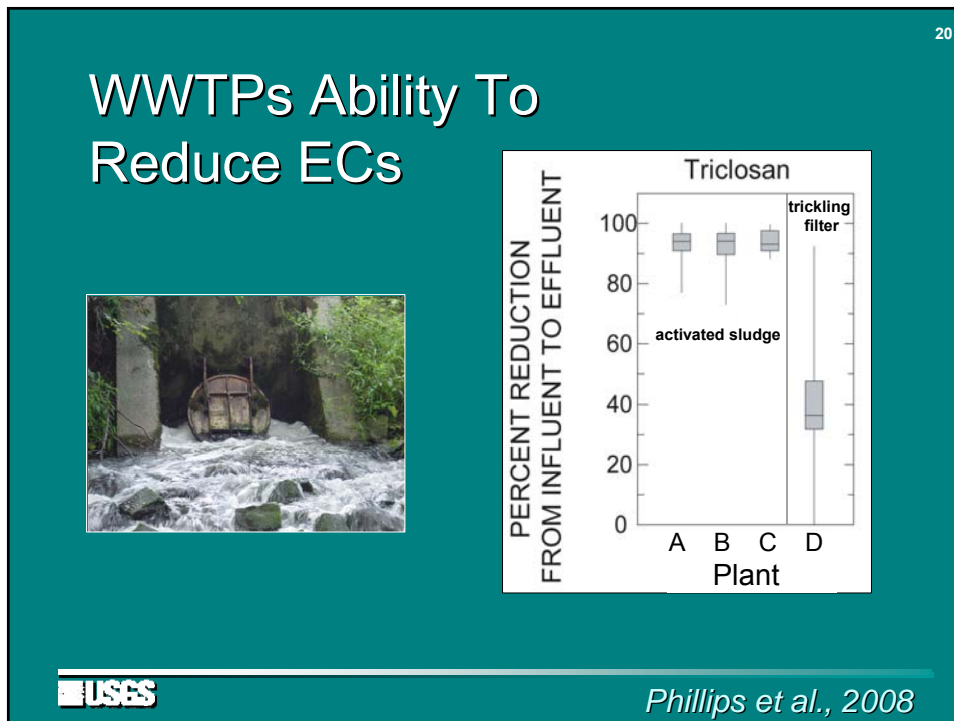
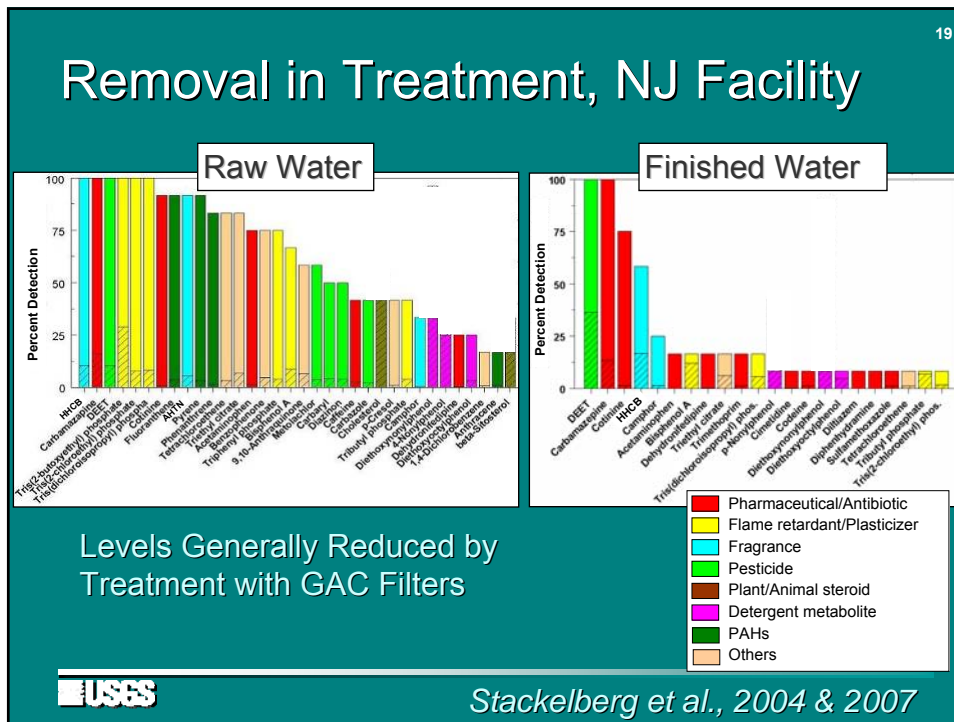
14



Vajda et al., 2008







21

Human Health Risk?

- Chronic low-level exposure.
- Chemical mixtures.
- Non-target Organisms
- Sensitive subpopulations.
- Can we prioritize chemicals systematically for effects studies?



22

Thank you!

*And thanks to the many
researchers who provided the
information presented.*

*For more info on USGS EC research:
<http://toxics.usgs.gov>*

