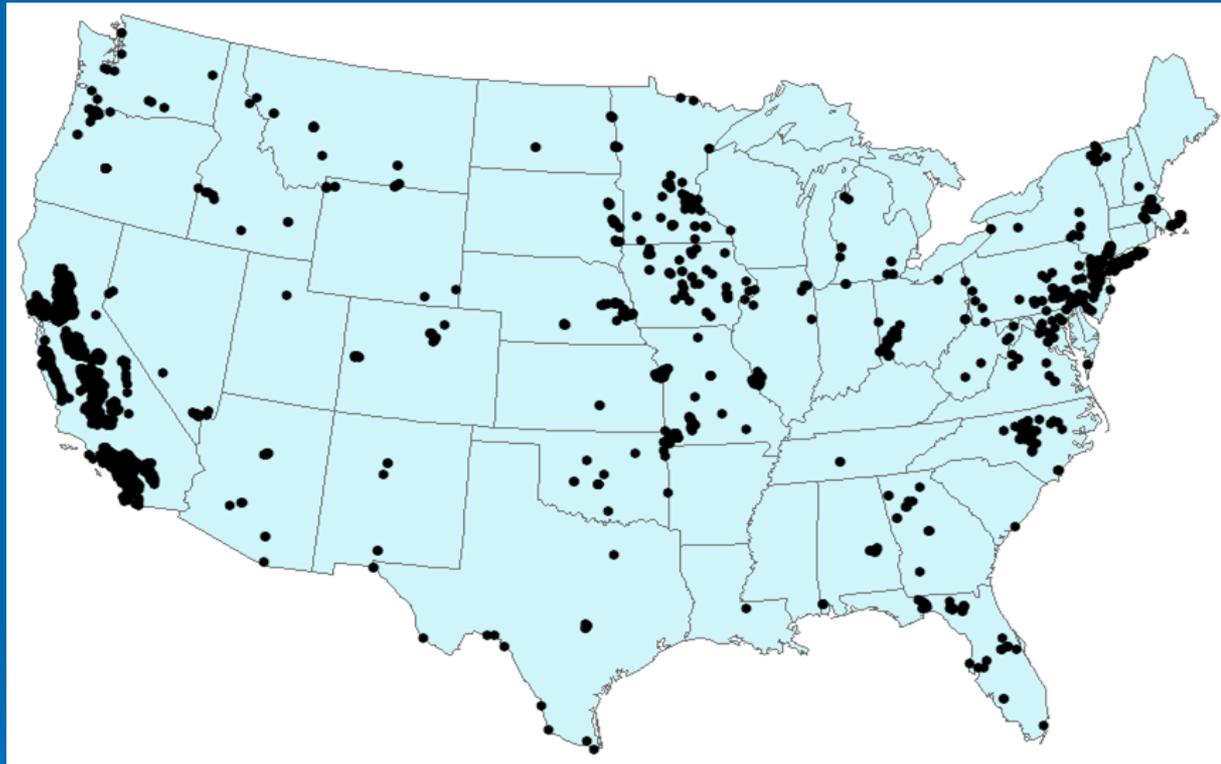


Emerging Contaminants in the Environment Research by the U.S. Geological Survey



American Water Works Association Research Symposium:
Emerging Organic Contaminants
Austin, Texas. February 12, 2009 (Darwin's Birthday!)

Mike Focazio
USGS

Source-to-Receptor Research

<http://toxics.usgs.gov/regional/emc/>

Sources & Pathways



Environmental Occurrence



Transport and Fate



Receptors
(Eco exposure and effects)

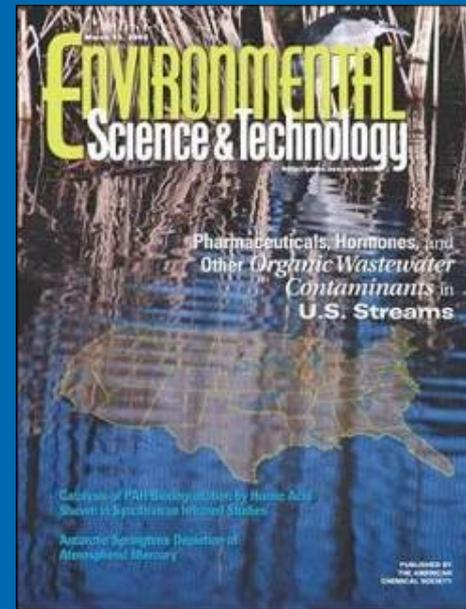


Methods Development



Occurrence Databases

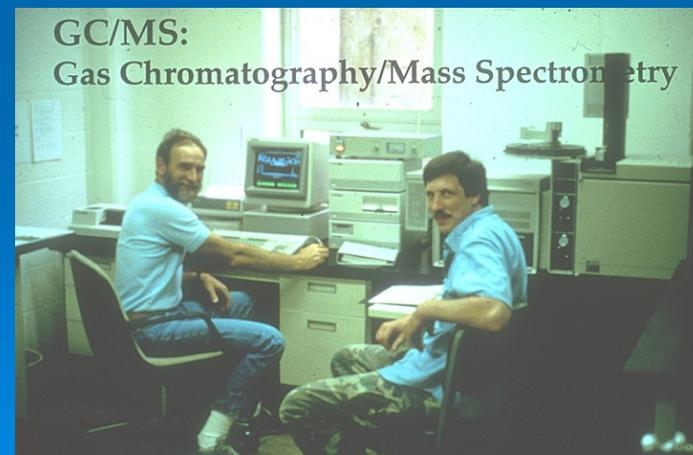
Complex mixtures
in streams, ground water,
sources of drinking water
(ppt-ppb)



Kolpin, et al., 2002



Barnes et al., 2008; Focazio et al., 2008, others...



Environmentally Relevant Databases and Interpretations...

1. U.S. Environmental Protection Agency Contaminant Candidate List

2. Aquatic Toxicology:

Antidepressants at environmentally relevant concentrations affect predator avoidance behavior of larval fathead minnow (*Pimephales promelas*)

McGee et al. 2009.

Predator avoidance performance of larval fathead minnows (*Pimephales promelas*) following short-term exposure to estrogenic mixtures.

McGee et al., 2008

Impairment of the reproductive potential of male fathead minnows by environmentally relevant exposures to 4-nonylphenol.

Schoenfuss et al., 2008

Larval exposure to environmentally relevant mixtures of alkylphenoethoxylates reduces reproductive competence in male fathead minnows.

Bistodeau et al., 2006



Accurate Source Identification and Quantification

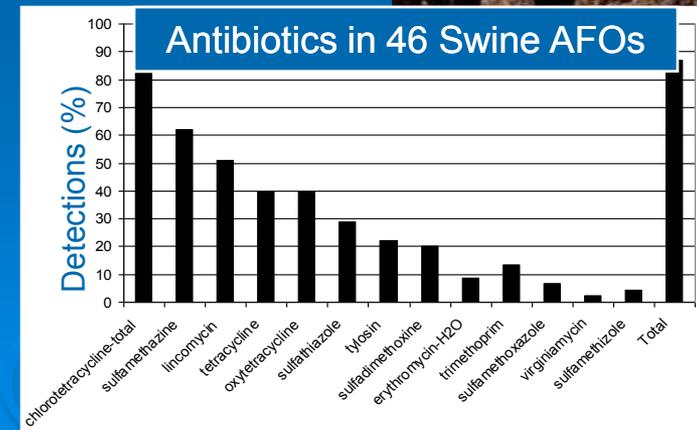
Human

- 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



Meyer et al., 2003

Source Pathways to the Environment

Soils amended with biosolids and manures



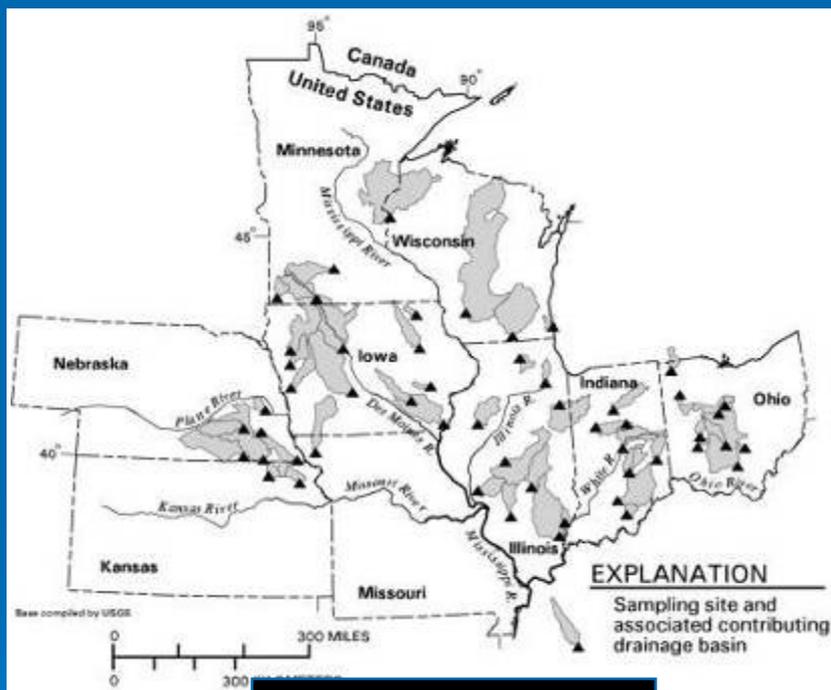
Biosolids from 9 locations across the US

Concentration (ng/kg)

	<u>Range</u>	<u>Median</u>
Carbamazepine	15-1,200	68
Diphenhydramine	32-22,000	340
Fluoxetine	100-4,700	370
Triclosan	1,170-32,900	10,200

Source Pathways to the Environment

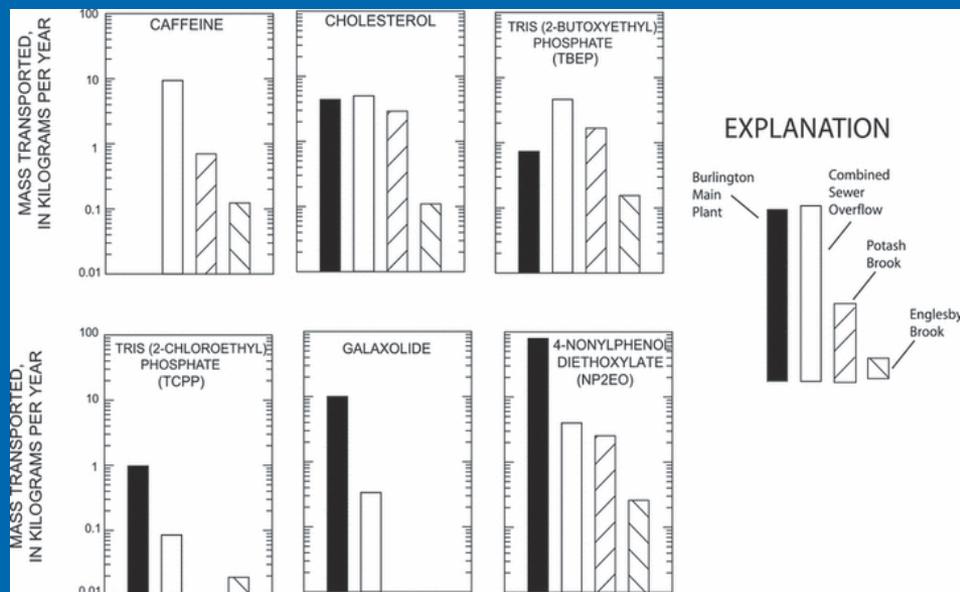
Hydrologic Events



Spring Flush

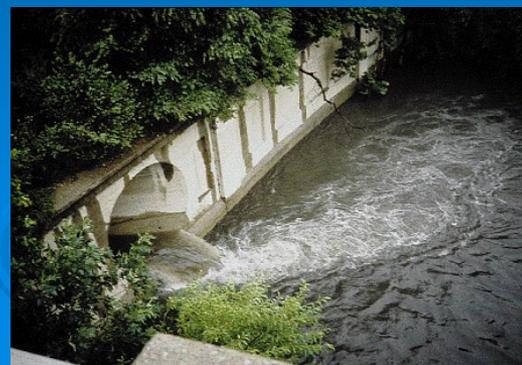
21 herbicides, 27 degradates, 36 antibiotics
in 51 Midwest Streams

Scribner et al., 2003



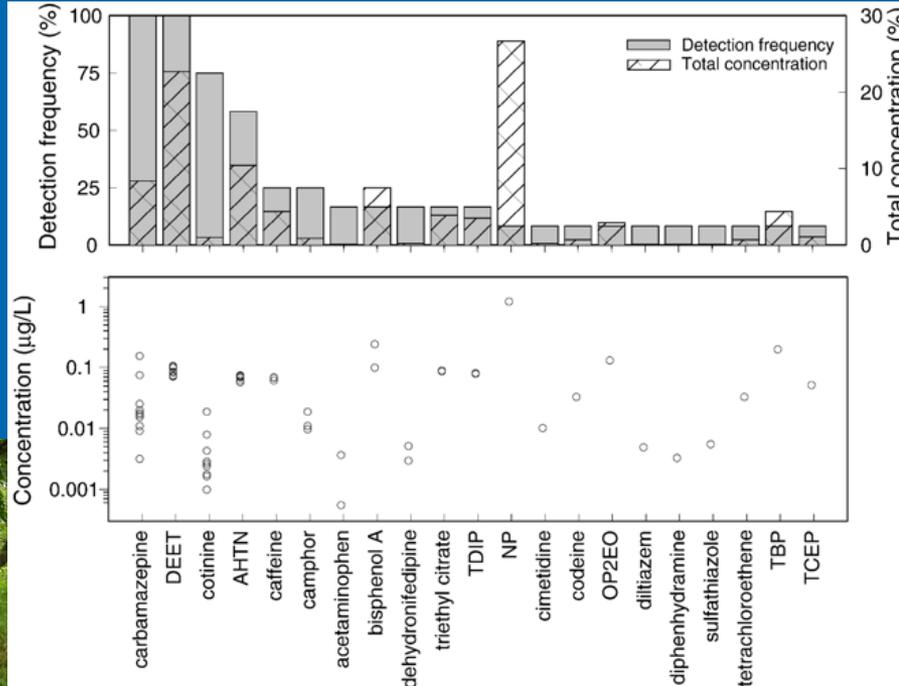
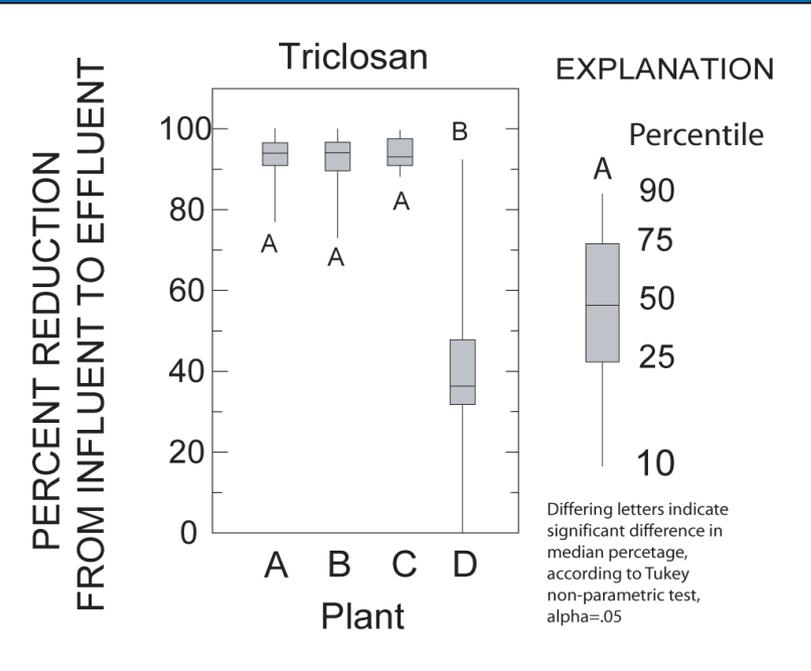
Combined Sewer Overflows

Phillips and Chalmers, 2009



Reducing Ecological and Human Exposure

Wastewater treatment, drinking water treatment, natural assimilative capacities of watersheds and aquifers...



Waste Water

Phillips et al., 2008

Drinking Water

Stackelberg et al., 2007

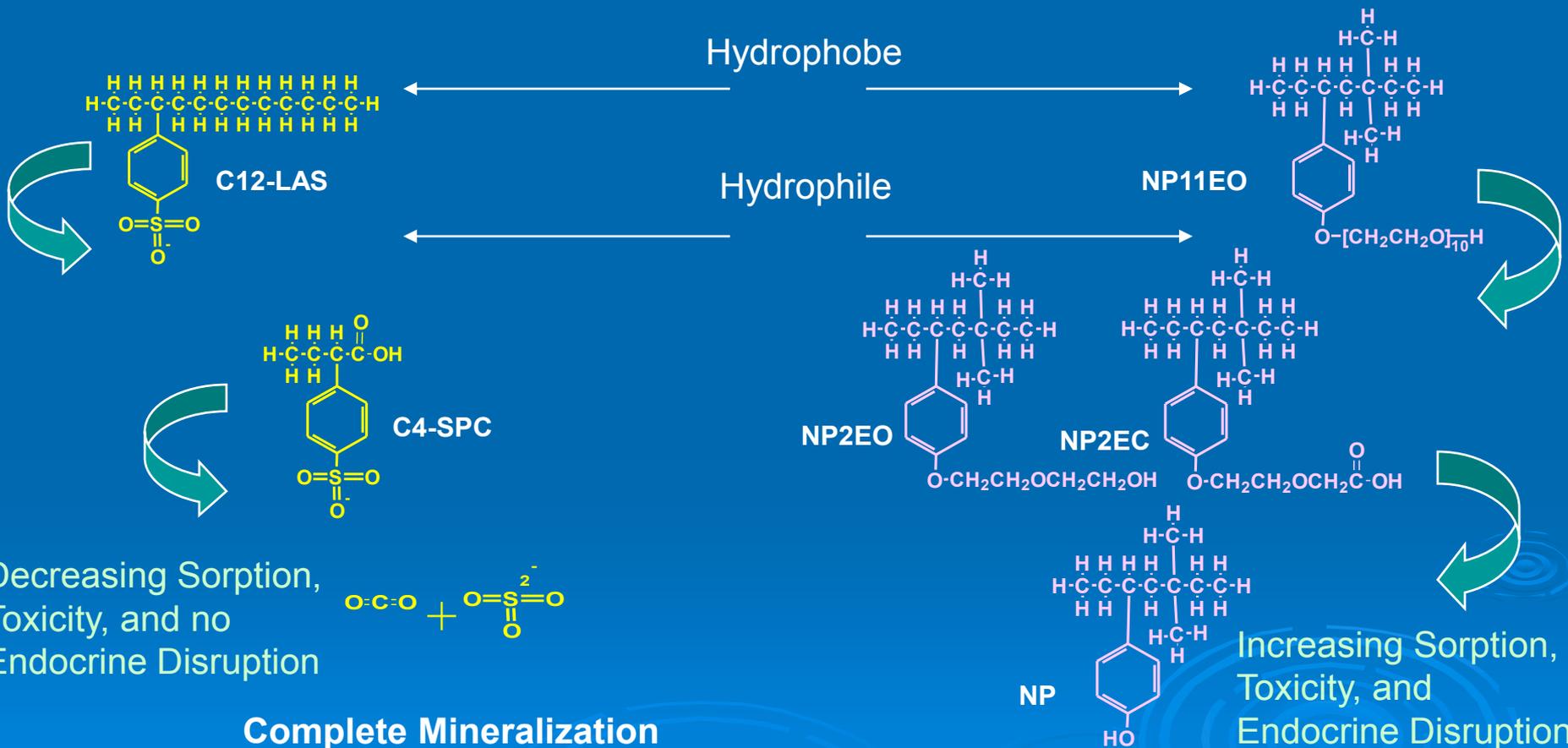


Reducing Ecological and Human Exposure

Understanding the Assimilative Capacities of Watersheds and Aquifers

Anionic
Linearalkylbenzenesulfonate (LAS)

Nonionic
Alkylphenolethoxylates (APEO)



1991 LAS use = 390 million kg (Modler et al. 1993)

1988 APEO use = 200 million kg (Talmidge 1994)

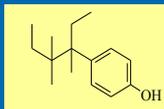


USEPA 2005, Aquatic life ambient water quality criteria - Nonylphenol FINAL. EPA822R05005.

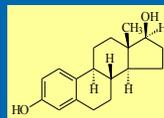
Reducing Ecological and Human Exposure

Understanding the Assimilative Capacities of Aquifers

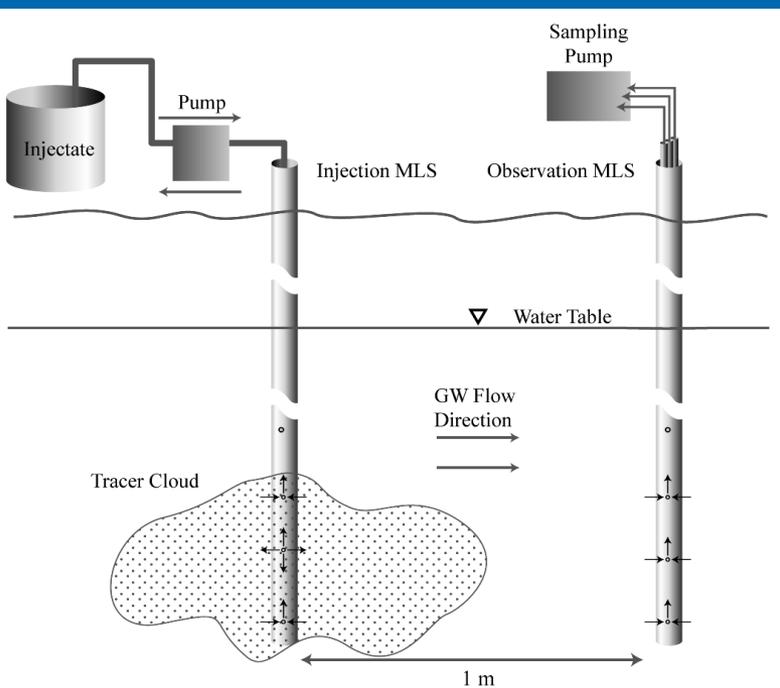
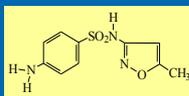
Nonylphenol



Estradiol

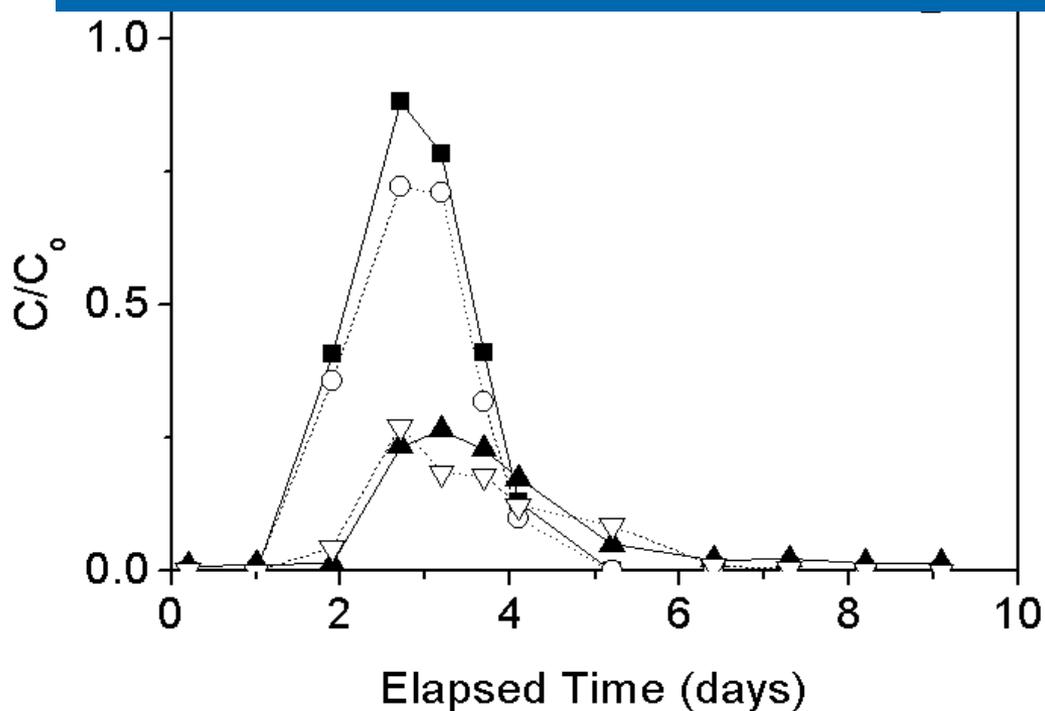


Sulfamethoxazole



Uncol
ction MLS

Contaminated Zone



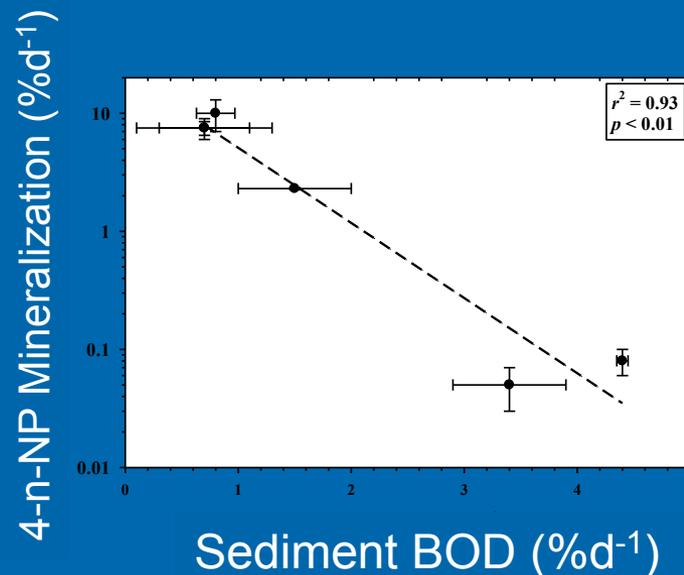
Reducing Ecological and Human Exposure

Understanding the Assimilative Capacities of Watersheds

4-Nonylphenol Biodegradation:

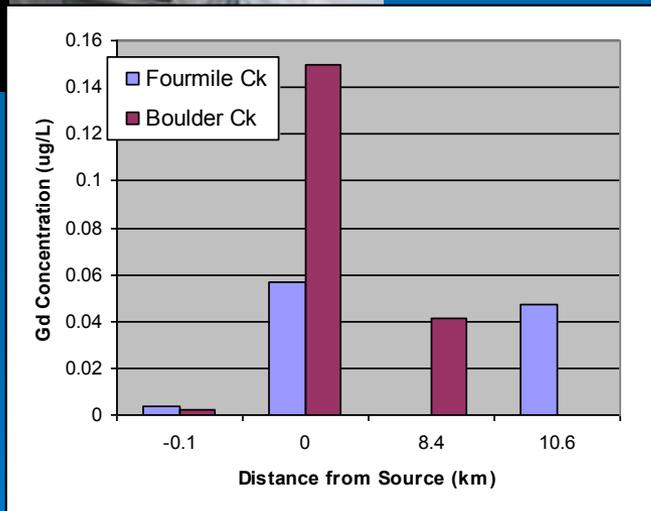
Natural and engineered conditions that maintain high dissolved oxygen in stream-sediment pore water favor biodegradation

Natural and engineered conditions that contribute to sediment anoxia (e.g. high BOD in effluent) inhibit biodegradation



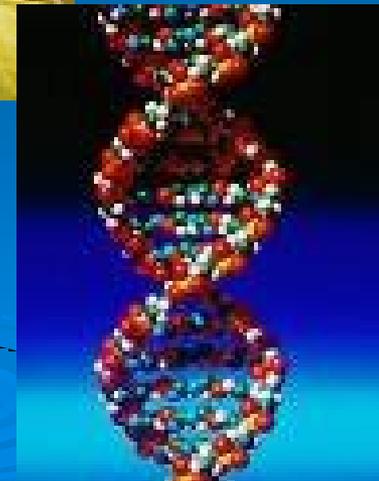
Waste Water Indicators and Tracers

MRI Contrast Agent



Comparing Wastewater Chemicals, Indicator Bacteria Concentrations, and Bacterial Pathogen Genes as Fecal Pollution Indicators

-Haack et al., 2008



Verplanck et al., 2005

Complex Mixtures and Potential Ecological Effects

Sensitive Ecosystems Receiving Wastewater Effluent

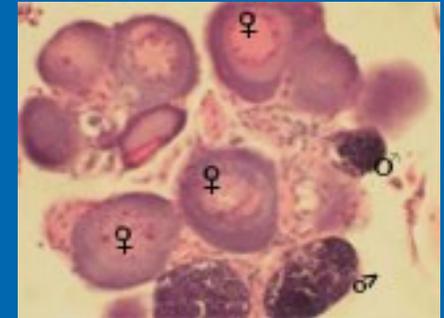


Colorado

Iowa

Minnesota

Virginia/Maryland/Washington DC



Blazer et al., 2007

Biological: fish tissue, histopathology, intersex, microbiological, gene transfer and expression, etc.

Water chemistry: water column, passive samplers, fate/transport/exposure, assimilative capacity, etc.

Complex Mixtures and Potential Ecological Effects

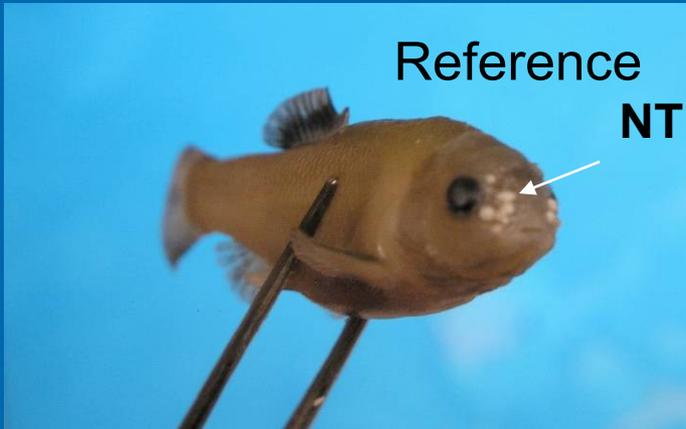
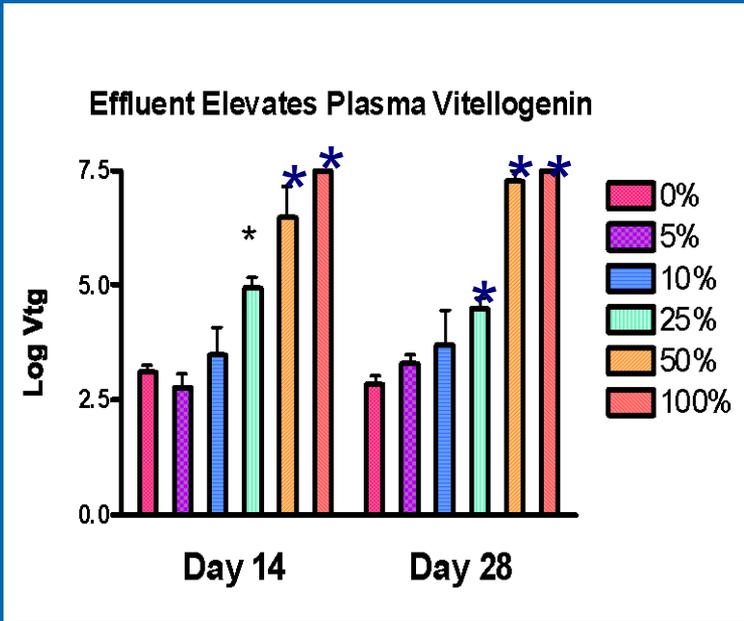


On Site - uses actual stream waters and(or) wastewater effluent with controlled photo-period and temperature.



Complex Mixtures and Potential Ecological Effects

Endocrine Disruption: Elevated Plasma Vitellogenin, Nuptial Tubercle Expression, Intersex



New Research for 2009 and Beyond

Source —————> Receptor

Method Development: Hormone metabolites, phytoestrogens, pesticide adjuvants, algal toxins, pharmaceutical degradates, nanoparticles...

Occurrence: Large datasets – 10 years of emerging contaminant data, national-scale source-water assessments, drinking water...

Sources and Pathways: Animal Feeding Operations...

Fate and Transport: Natural Assimilative Capacities of Watersheds and Aquifers - National Parks and elsewhere...

Effects: Endocrine disruption, antibiotic resistance, other modes of action...

New Research for 2009 and Beyond

Complex Mixtures and Potential Ecological Effects



Other Modes of Action

Are estrogenic chemicals related to immune suppression?....

Impacts of antibiotics, resistance genes, and other contaminants on indigenous microbiology...



New Research for 2009



Relative source contributions from swine, cattle, poultry AFOs. Fate and transport. Ecological effects.

Analyte List

Antibiotics

and Metabolites

Biogenic/Synthetic Hormones

and Metabolites

Phytoestrogens

Microbial Contaminants and Associated Genetic Material

Inorganics and other Indicators

Type of Operation or Contributing Process

Confined

Pastured

Meat/Dairy/Eggs

Manure Management

Therapeutic/prophylactic uses of pharmaceuticals

Feed



Thank you

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mfocazio@usgs.gov

<http://toxics.usgs.gov>

