



# *Contaminants of Emerging Concern in Human and Animal Wastewaters*

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# Emerging Contaminants?

API's

EDC's

HAA's

MP's

PPCP's

- Human Drugs
- Vet. Drugs
- Antibiotics
- Hormones
- Steroids
- Detergents
- Plastics

- Antioxidants
- Fire retardants
- Disinfectants
- Fumigants
- Fragrances
- Insecticides/ Repellants

OWC's

PhAC's

*New and understudied contaminants!*

CEC's

# How do we decide which chemicals to look for?

- Quantities produced/used.
- Pathways for chemical release.
- Anticipated environ'tal behavior.
- Health significance.
- Potential as indicators/tracers.
- Ability to measure.
- Stakeholder priorities.



# Human Waste Pathways

- WWTF
- CSOs
- ISDS
- Industrial Disch.
- Landfills
- Water Reuse.



# Animal Waste Pathways

## Animal Agriculture

- Waste lagoons
- Land application
- Processing
- Aquaculture



# The Important Questions

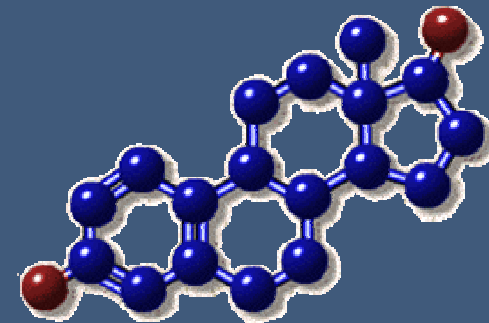
- What compounds enter the environment
- What are the sources?
- At what levels are they found?
- In what mixtures?
- In what media (water, sediment, tissue)?
- Do they persist and accumulate?
- Do they transform and to what?
- Do they pose an ecological health risk?
- Do they pose a human health risk?
- Are our stewardship activities sufficient?

# USGS Priorities

- I. Methods Development.
- II. Occurrence and Source Pathways.
- III. Transport & Fate.
- IV. Ecological Effects.



# I. Methods Development



## 158 Compounds in Water

- 45 Antibiotics
- 20 Human Drugs
- 14 Hormones and Steroids
- 79 Household and Industrial Compounds

## 83 Compounds in Sediment

- 3 Antibiotics
- 19 Human Drugs
- 61 Household and Industrial Compounds



# New Methods Priorities

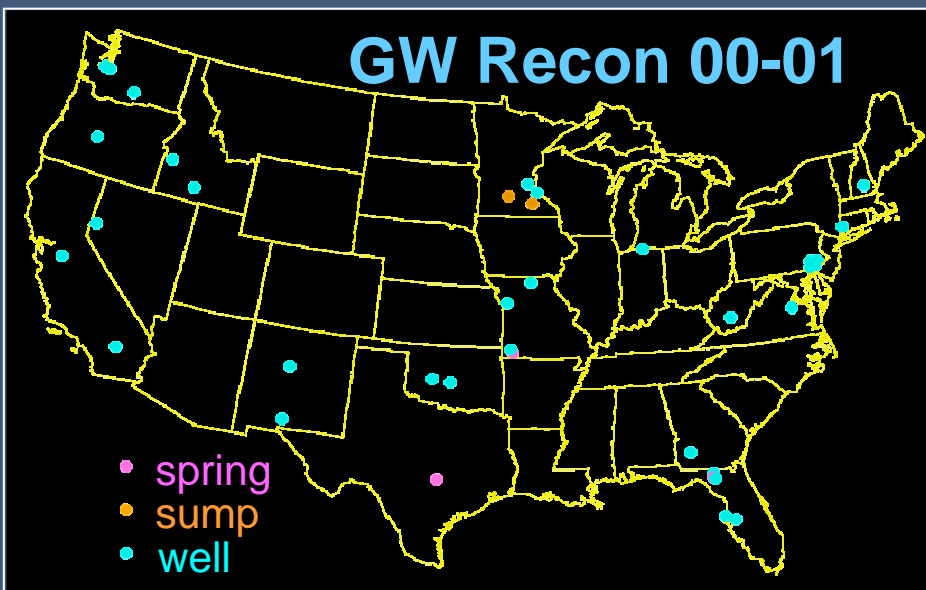
- SSRI's
- Fluorochemicals
- Hormones
- Antibiotics
- Statins
- Benzodiazepenes
- Cox II inhibitors
- Algal Toxins
- Additional Environmental Media
- Lower Reporting Levels

## II. Occurrence & Source Pathways

### What have we learned?

- 1) Present at low concentrations in water.
- 2) Present as mixtures (up to 38 in 1 sample).
- 3) A wide range of compounds and classes reflect a range of human activities & inputs.
- 4) The compounds and concentrations detected depend on the media sampled.

GW Recon 00-01



Stream Recon 99-00



# Source Characterization Studies

Human: septic tanks, municipal biosolids, municipal effluents, municipal holding ponds, hospital waste.

Animal Agric: poultry, swine, dairy, beef cow operations, food processing plants, aquaculture.

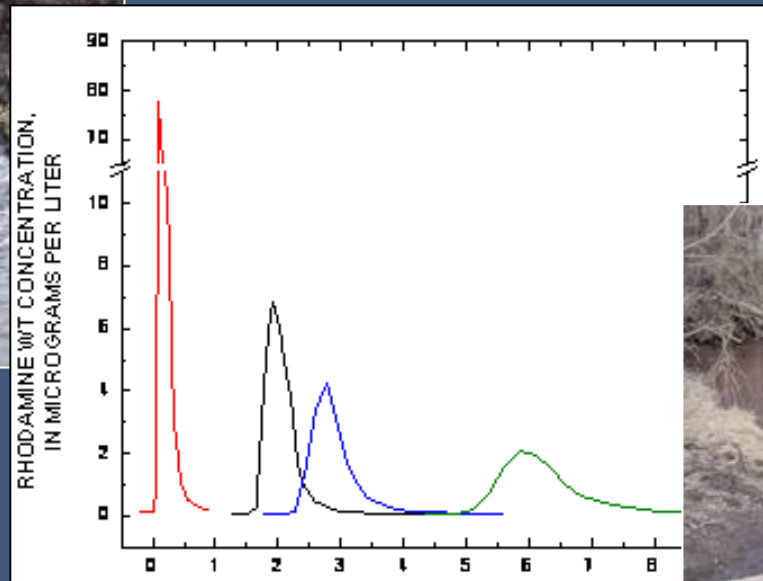


# III. Transport & Fate

- Transport processes
- Environmental media
- Degradation byproducts
- Persistence



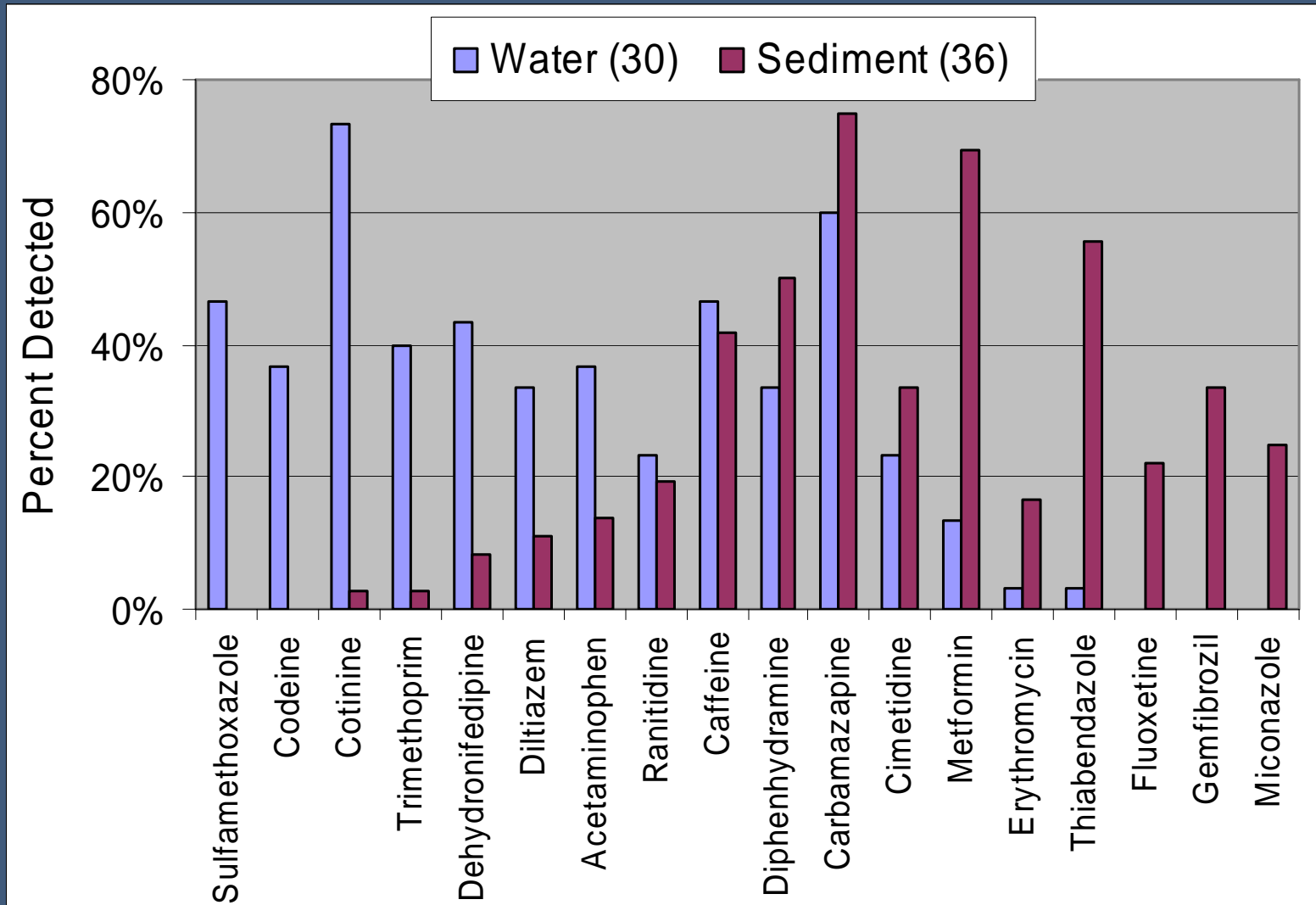
Tracer  
Tests



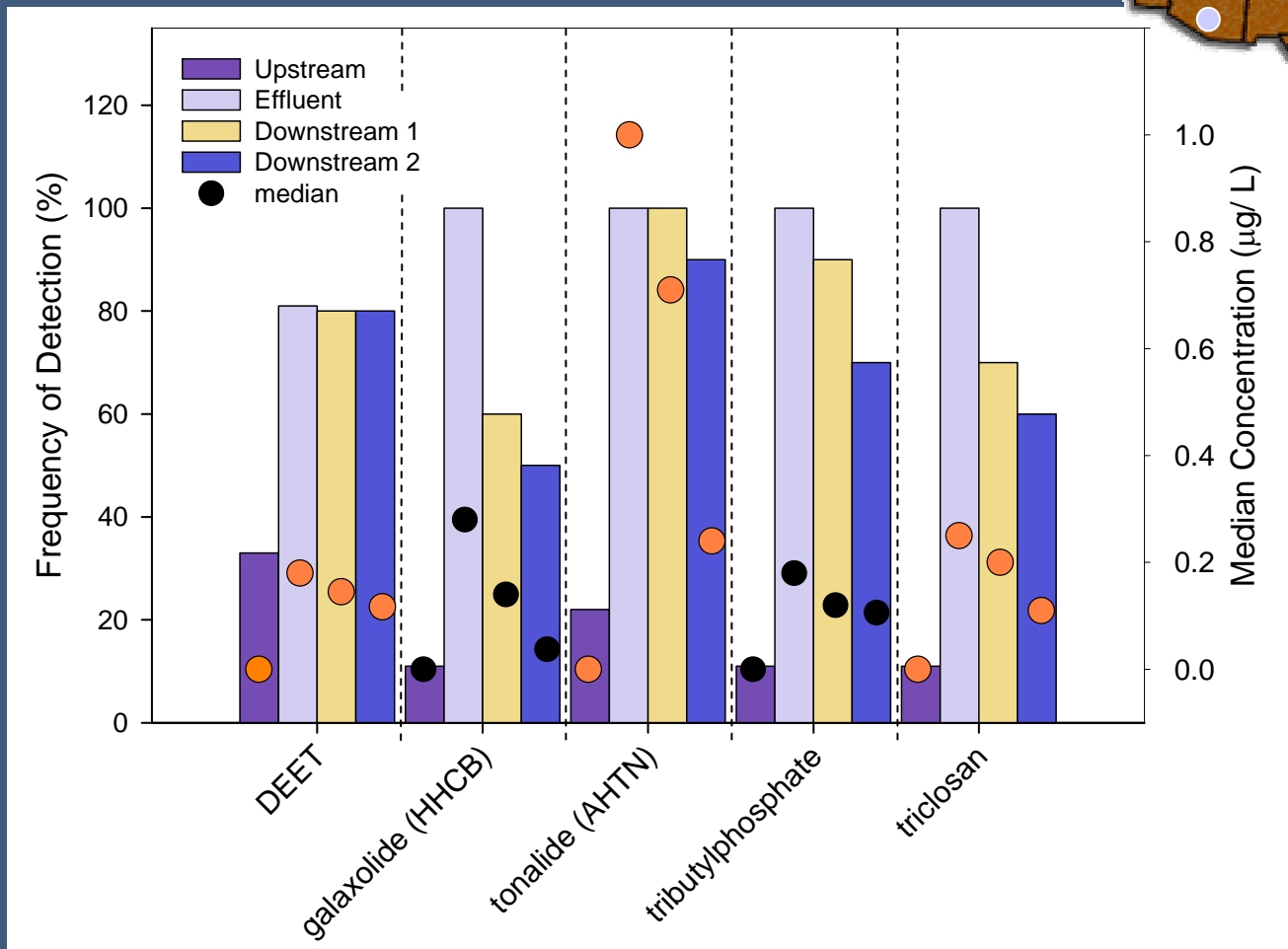
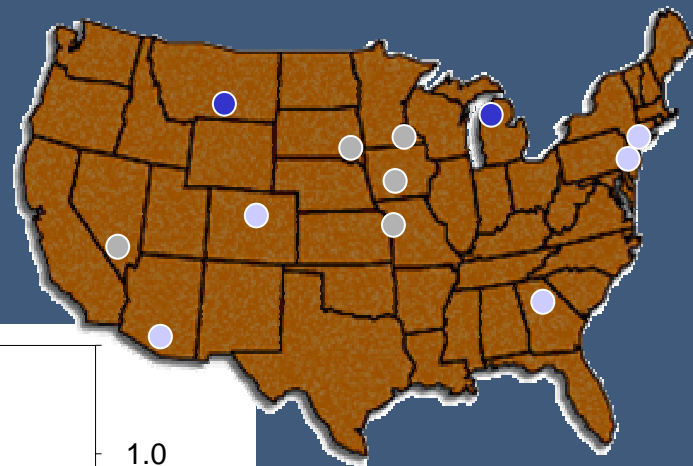
Fourmile Creek, IA



# Are they in the water or sediments?

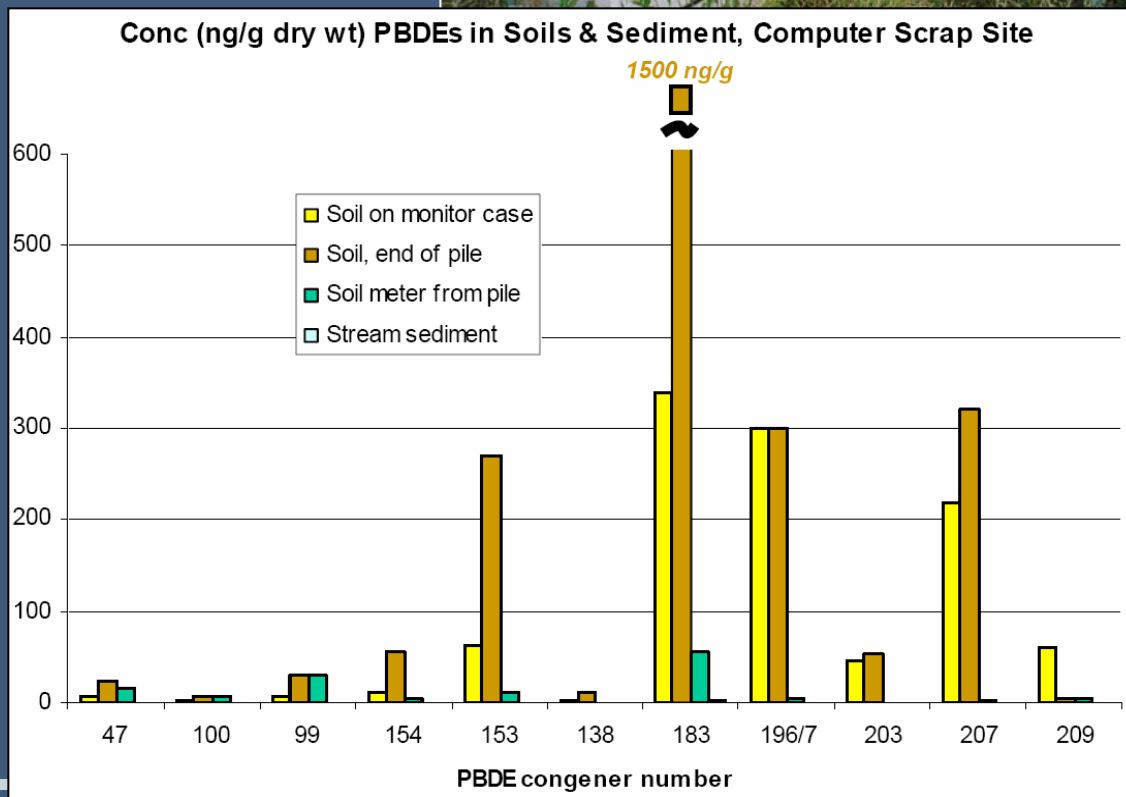
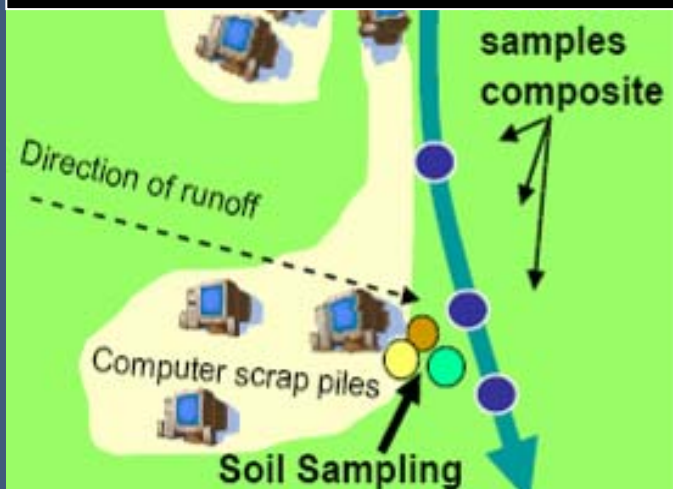


# WWTP Study: 10 Plants, US/DS



# PBDE's in Soil near Weathered Outdoor Computer Scrap

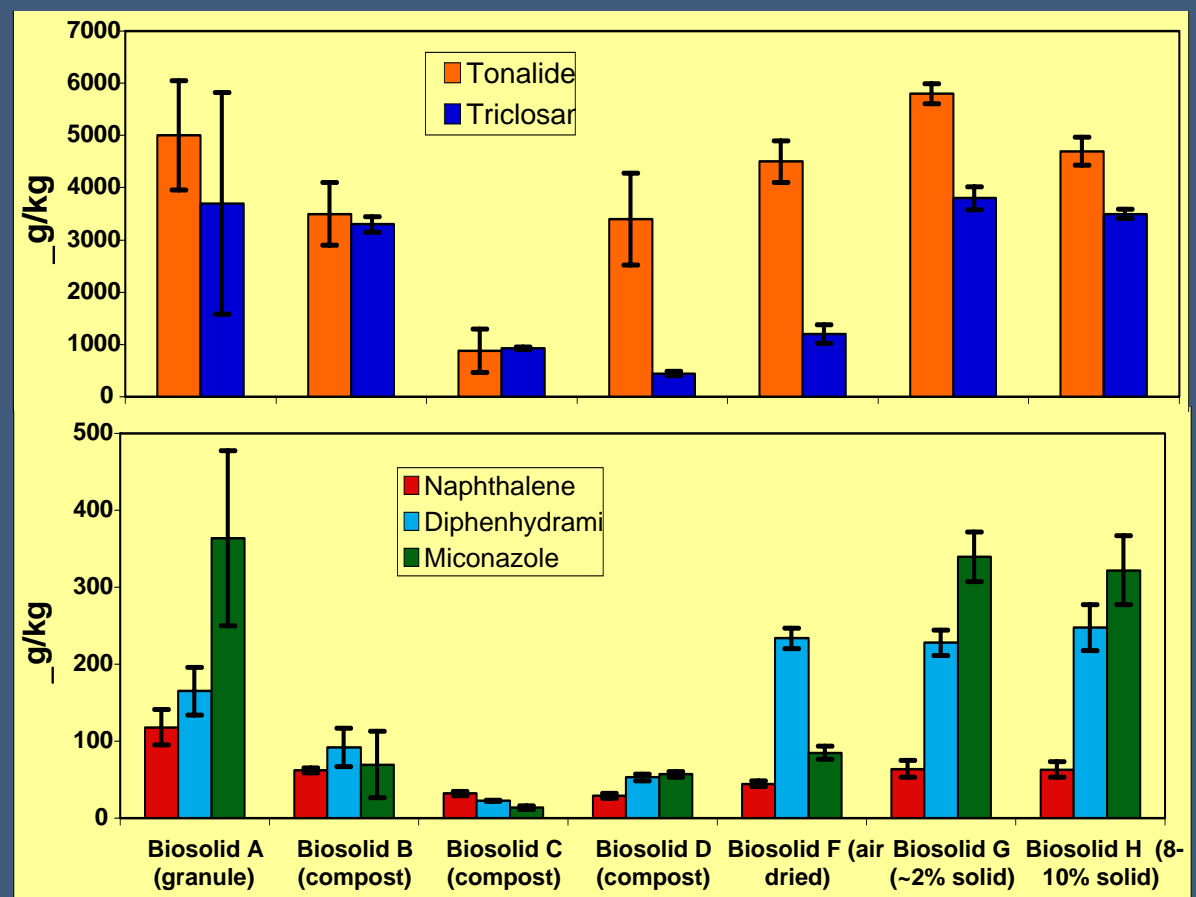
- PBDEs in soil is varied as high as 1500 ppb (PBDE 183)
- limited movement to the stream.



# Biosolids

~ 6.9 million dry tons of biosolids produced in 1998 (USEPA)

50% of all biosolids are recycled and land applied

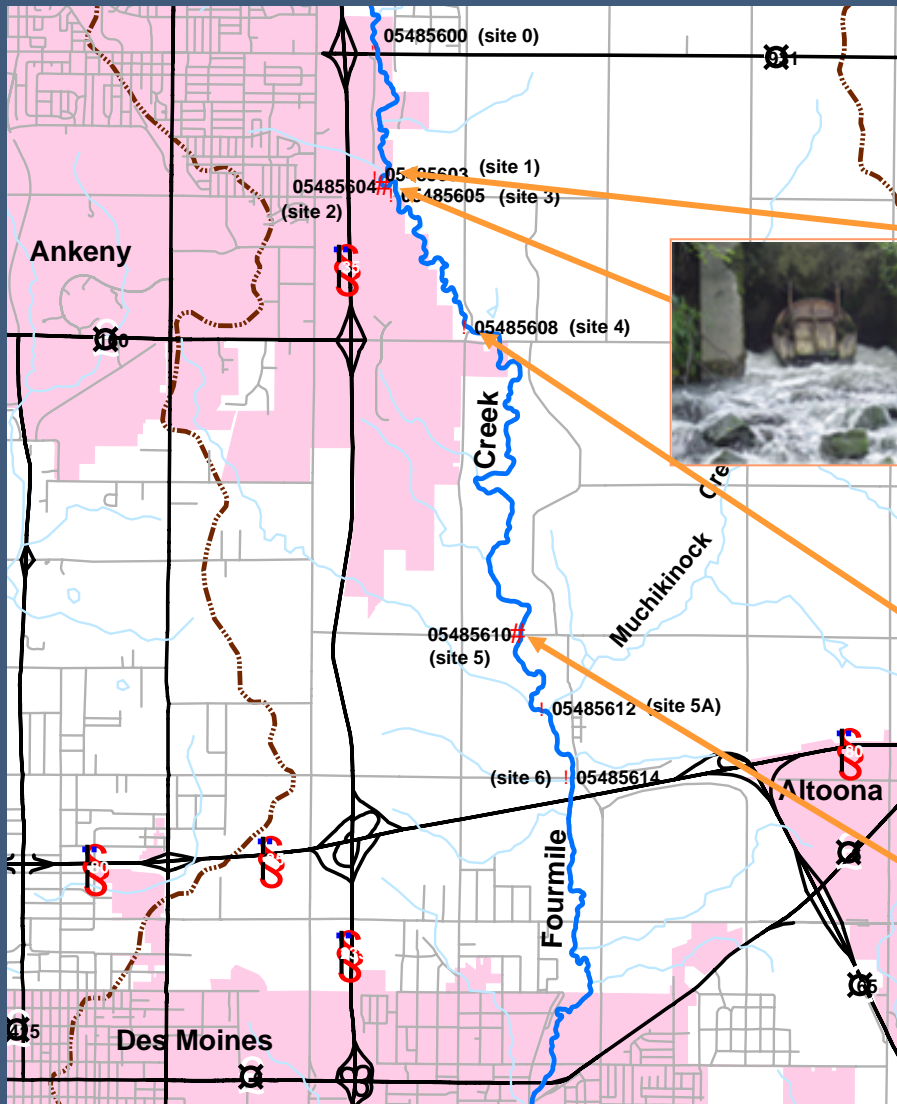


## Results of sampling 9 WWTP biosolids enroute to land application

- Each sample had between 34 and 45 of 87 ECs tested
- diethylhexyl phthalate (plasticizer) – up to 20,000 mg/kg
- 1,7-dimethylxanthine (caffeine metabolite) – up to 6,200 mg/kg



# Tonalide (musk) in Fourmile Creek, IA



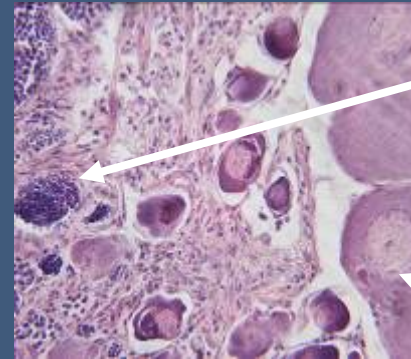
Site #	Water ( $\mu\text{g/L}$ )	Sediment ( $\mu\text{g/kg}$ )
1 (-0.1 km)	0.021	<25
2 (0 km)	3.1	2000
4 (2.9 km)	0.7	580
5 (8.4 km)	0.4	200

# IV. Health Effects

## Intersex

- Endocrine Disruption
- Antibiotic Resistance
- Chemical Mixtures
- Pathogens
- Other Ecological Effects

### Cellular Abnormalities



male

female

### External Deformities



# WWTP Effluent and Endocrine Disruption

## THE SUNDAY DENVER POST

DENVERPOST.COM | THE DENVER POST | Rocky Mountain News | \$1.00

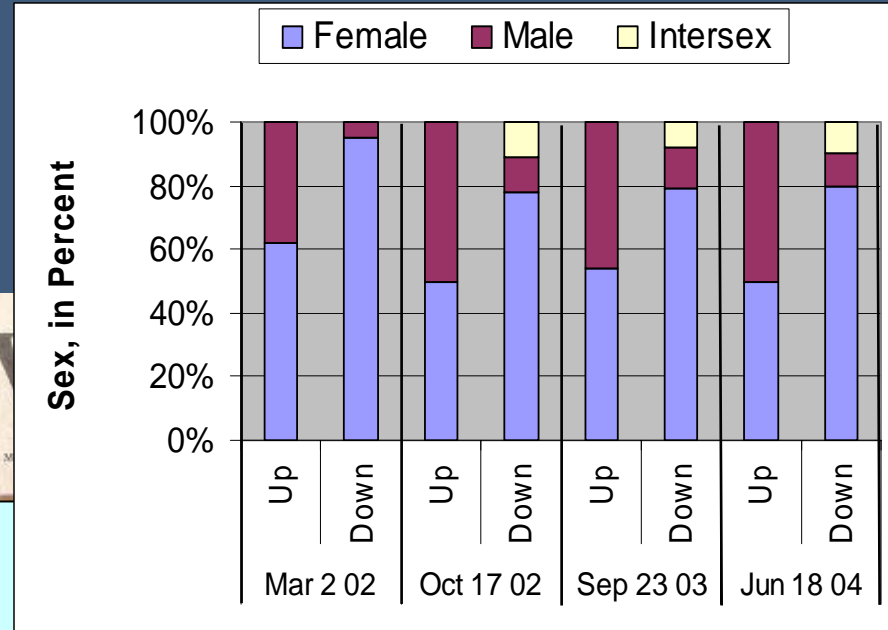
### Mutant fish prompt concern

Study focuses on sewage plants

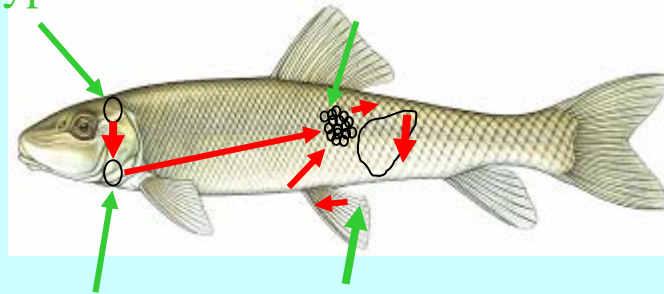
CU researchers are trying to determine if chemicals in area wastewater are causing deformities.

By Theo Stein and Miles Moffett  
Denver Post Staff Writers

When Colorado biologist John Woodling and a team of researchers pulled fish from the South Platte River and Boulder Creek two years ago, they found deformities they'd never



Hypothalamus Gonads



Pituitary

Liver

White sucker

(*Catostomus commersoni*)

# Antibiotic Resistance

- Resistance develops in organisms.
- Environmental Transfer of Genetic Determinants.
- Development of Multiple Resistance.
- Resistance from non antibiotics.
- Is resistance facilitated by chronic low-level exposure?



Direct use in orchards.



Animal waste lagoons



Aquaculture

# Studies finding potential effects of selected compounds

- Carbmazepine: Effect thru sediment exposure of benthic insect (Oetkin, et al., 2005).
- Antibiotics: Affecting soil microbial activity and bacterial denitrification (Costanzo et al., 2005; Thiele-Bruhn and Beck, 2005).
- Diclofenac: consumption of diclofenac-treated meat caused renal failure in vultures (Nature, 2004)

# Studies finding potential effects of selected compounds

- Ciprofloxacin, triclosan, Tergitol NP 10: shifts in community structure of suspended and attached algae (Wilson et al., 2003) .
- SSRIs: Found in fish tissue (Brooks et al., 2005); delayed development in fish and delayed metamorphosis in frogs (Black et al., 2006).
- Drug Mixtures: Effects at Env. Levels on Human Embryonic Cells 13 drugs in environmental mixtures and concentrations (Pomati et al., 2006).

# Interagency Coordination

## CENR, Toxics & Risk Subcommittee,

- Pharm.'s in the Environment Work Group
- Endocrine Disruptors Work Group

## Activities

- Coordination and collaboration of Fed.'s.
- Research Strategies.
- USGS Gathering input on Methods Development (Contaminant) Priorities.

# Acknowledgements

Team Leader: Dana Kolpin, Iowa City IA  
([dwkolpin@usgs.gov](mailto:dwkolpin@usgs.gov))

The USGS Toxics Program:  
[toxics.usgs.gov](http://toxics.usgs.gov)

Emerging Water Quality Issues:  
[toxics.usgs.gov/regional/emc.html](http://toxics.usgs.gov/regional/emc.html)

Bibliography with over 125 publications