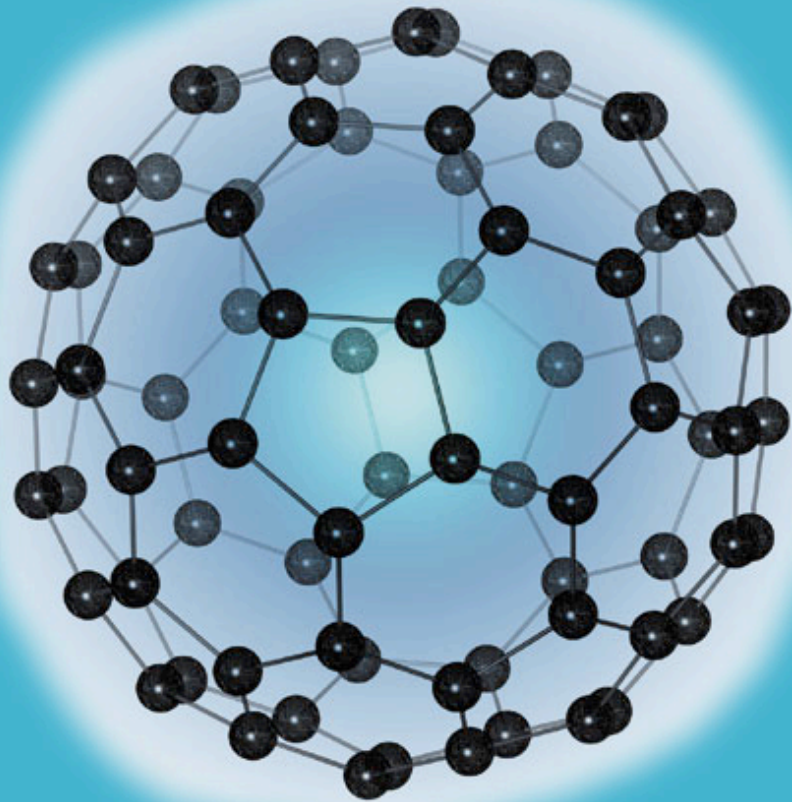


Emerging Contaminants: Emerging Questions



Sarah Gerould

US Geological Survey

Society of Environmental Toxicology and
Chemistry

Renewable Natural Resources Foundation
December 1-2, 2005

Emerging Contaminants

are:

New substances, chemicals or metabolites, or microorganisms
or

Older chemicals

- newly expanded distribution or altered releases, or
- newly found in the environment and not commonly monitored
- newly recognized or poorly known effects

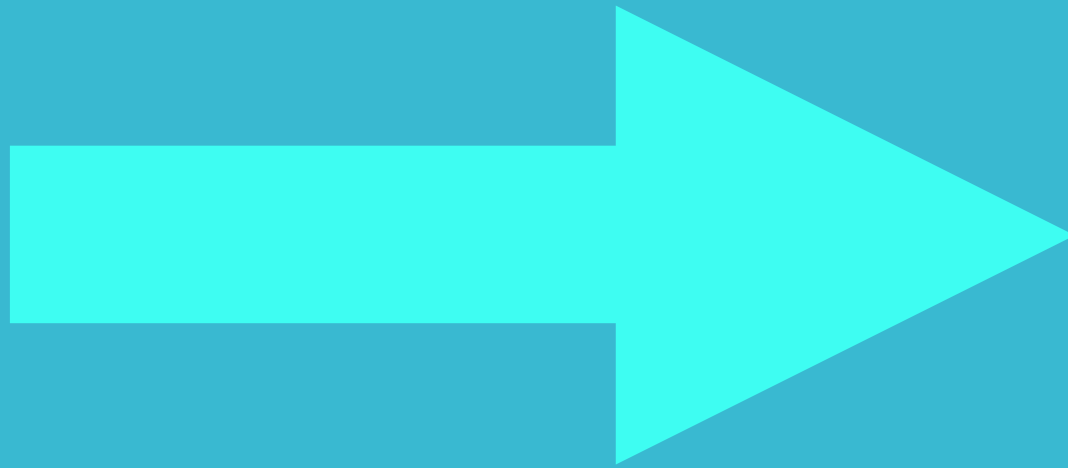
Emerging Contaminants

New substances, chemicals or its metabolites, or
microorganisms

or

Older chemicals with newly expanded
distribution or altered releases, or newly found
in the environment and not commonly
monitored **OR** with newly recognized or poorly
known effects

***“A deleterious substance with less than
a one-inch stack of reprints” - M. Mac***



- Fate
- Prevalence
- Effects
- Regulatory approaches
- Examples

Environmental Fate

- Treatment
- Solubility in water vs lipid
- Sorption: biota and sediment
- Volatilization into air
- Metabolites
- Photolysis
- Persistence

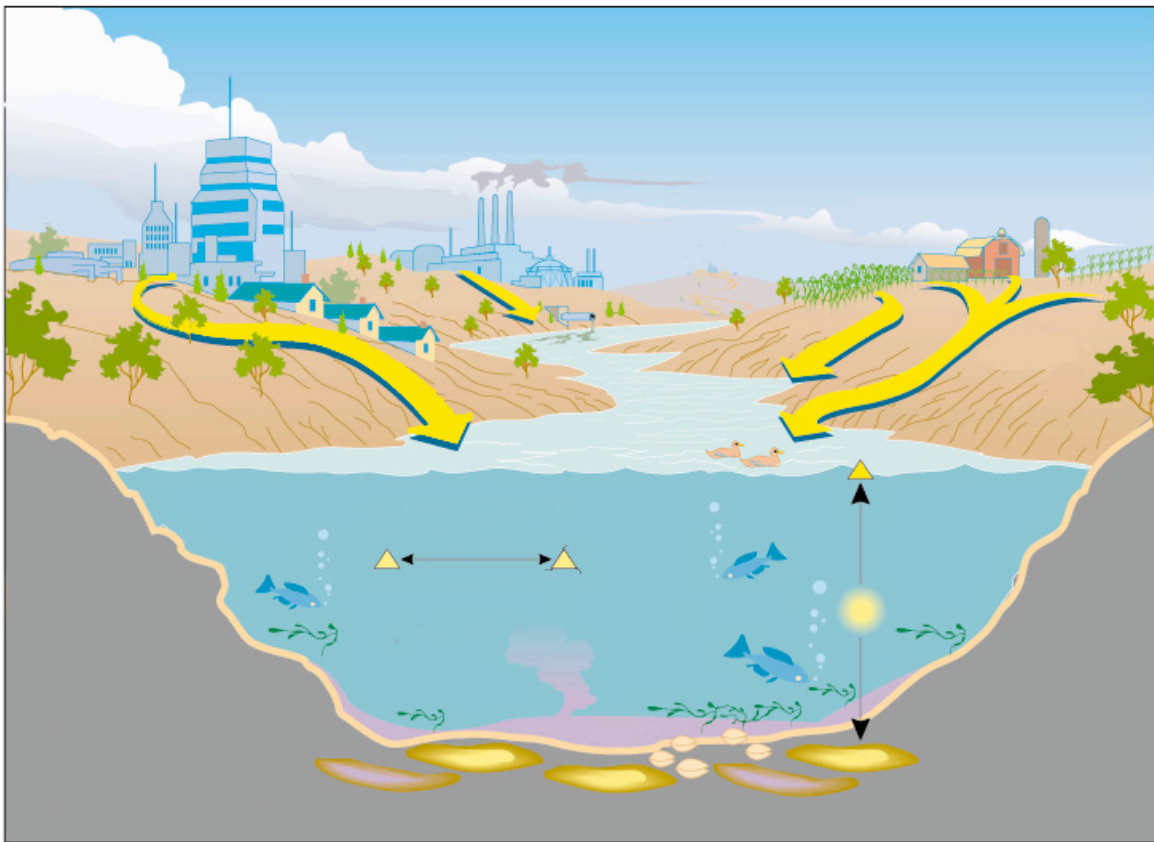


Image: USGS

Waste Treatment: Cure or Panacea?

Drug

Contraceptives

Antibiotics

Antiepileptics

Blood Lipid
regulators

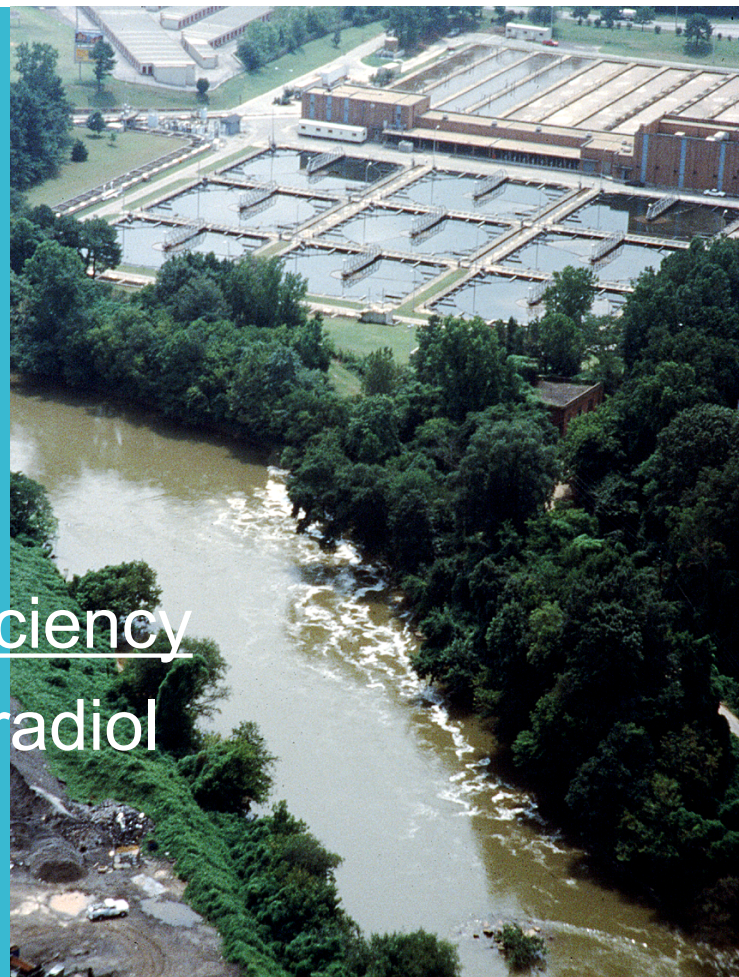
Removal Efficiency

0-85% of estradiol

“significant”

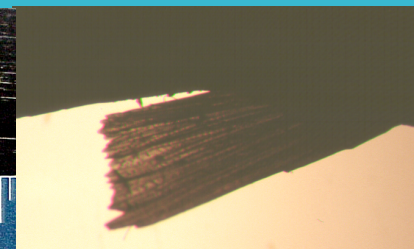
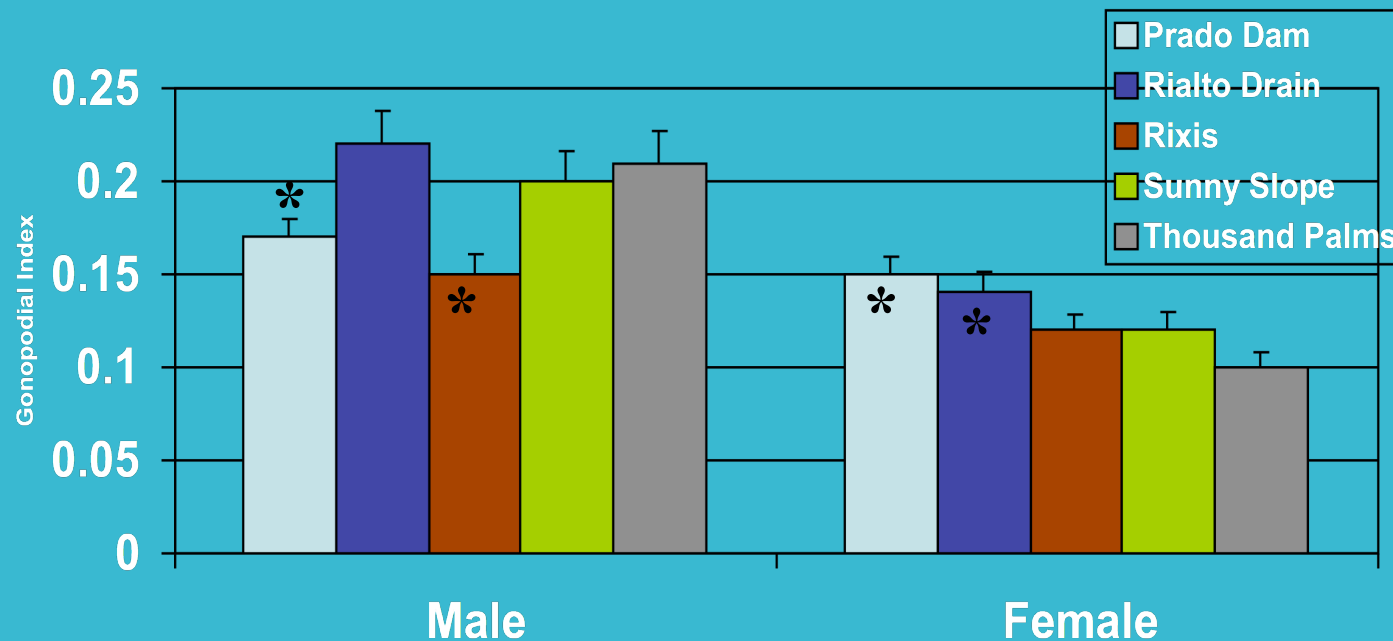
none

metabolites only



Reviewed in Heberer (2002) *Toxicology Letters* 131:5-17

Gonadopodial Index

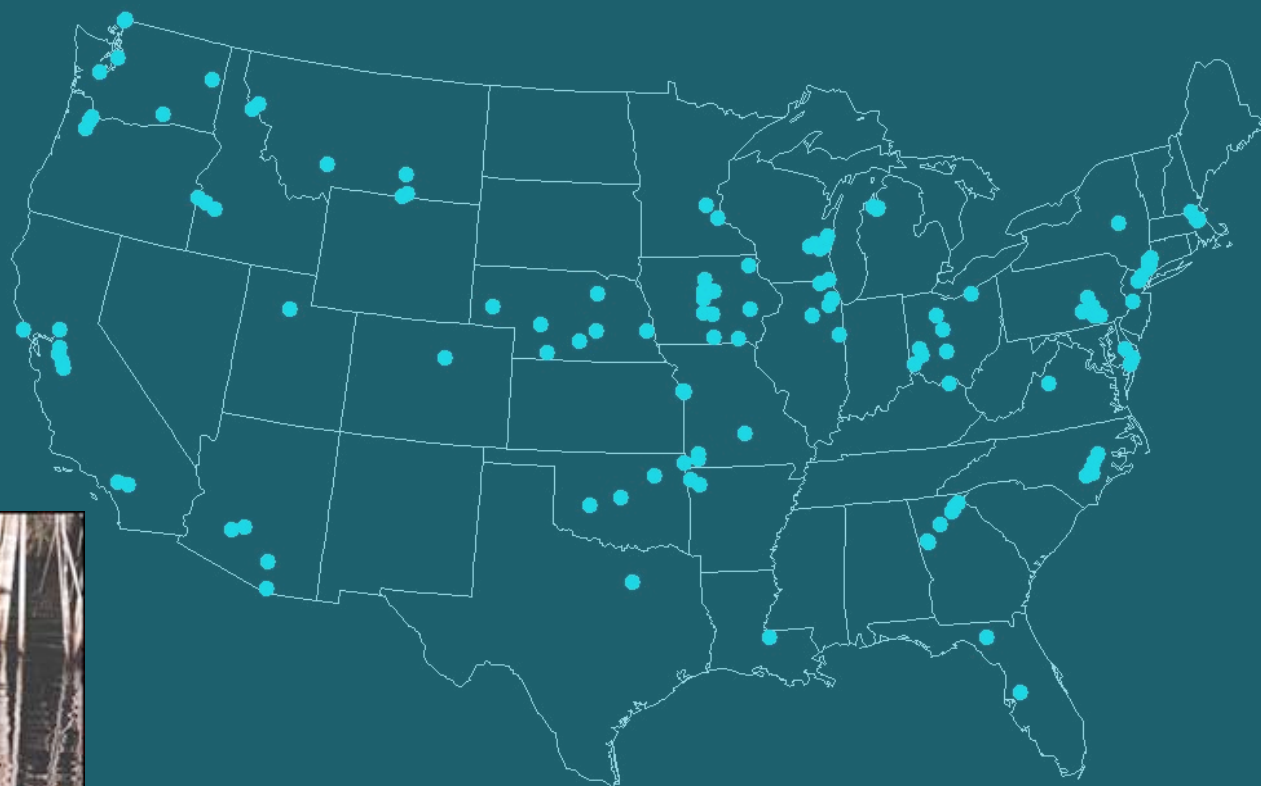


gonopodium anal fin

anal fin

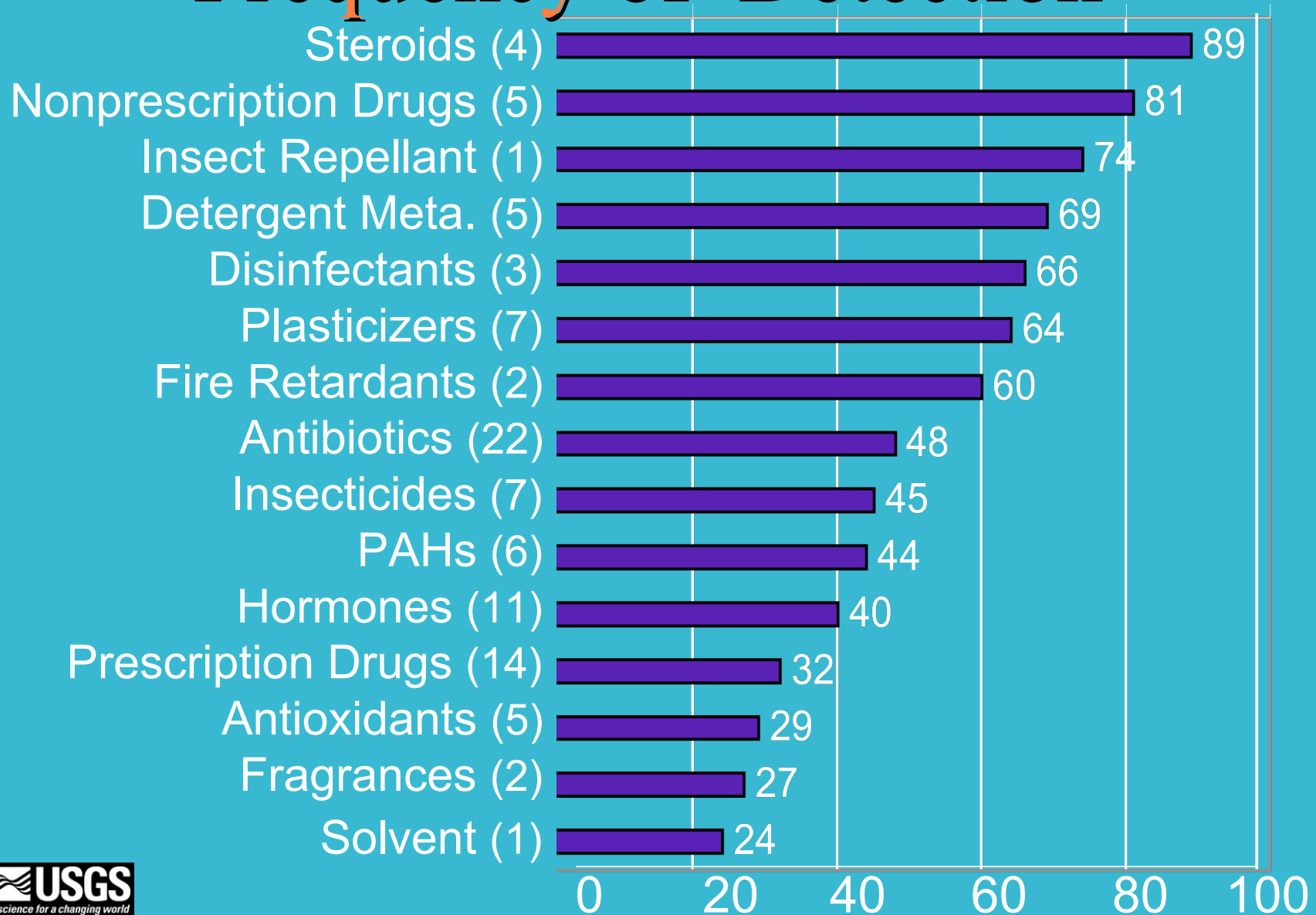
Gross et al: Gonadopodial Index (anal fin ray 4/6 ratio) for male and female gambusia at each site. NOTE: the decreased anal fin length for males and increased fin length for females at specific sites relative to the reference site (Thousand Palms).

National Picture:



- **Kolpin et al, 2002.** Pharmaceuticals, hormones and other organic wastewater contaminants in streams 1999- 2000: A National Reconnaissance. ES&T 36:1202-1211.
- 139 streams in 30 states: minimally Developed, Animal Production, Mixed Land Use, Urbanized

Frequency of Detection



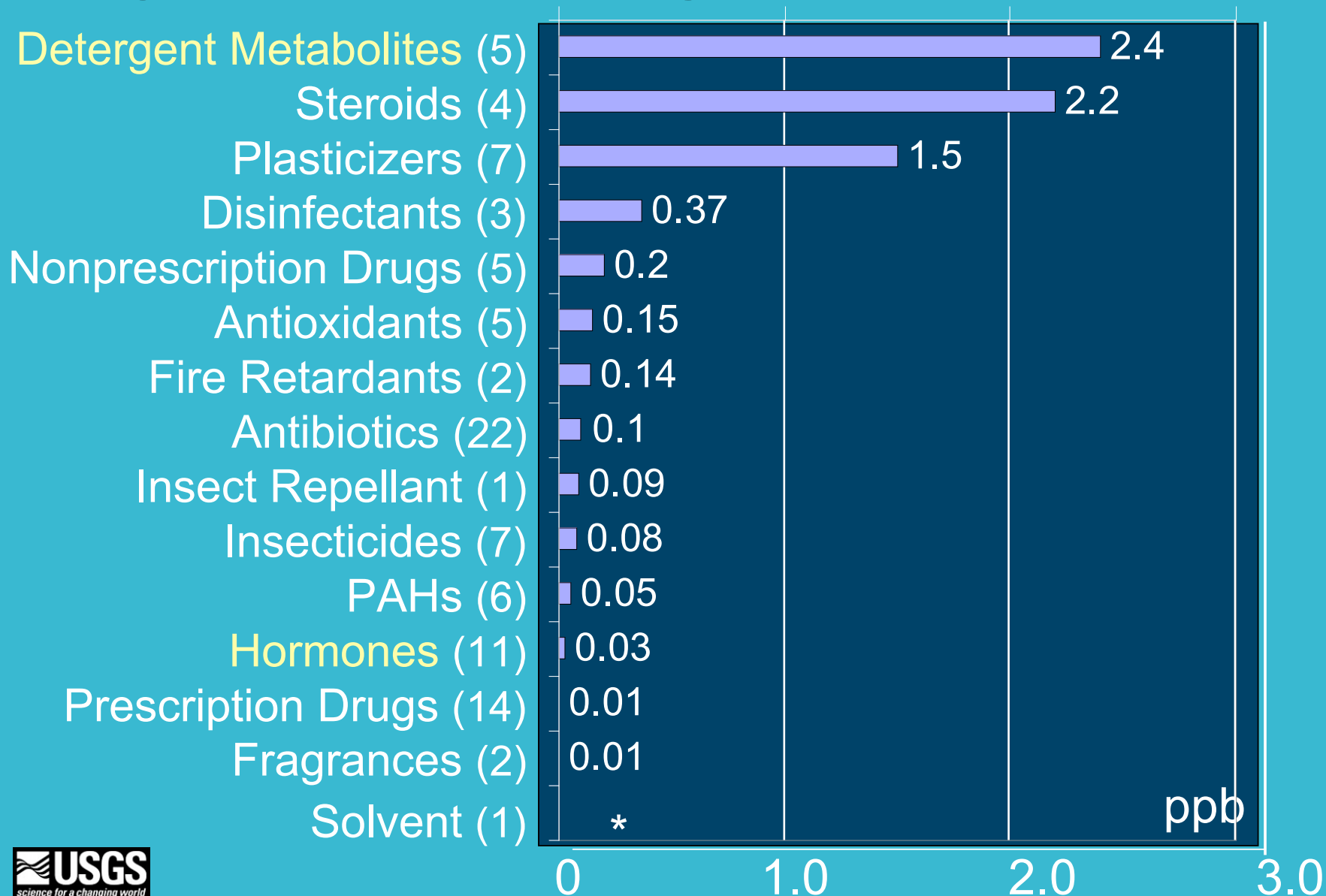
USGS National Reconnaissance

- Streams (2002)
- Ground Water
- Sources of Drinking Water
- Streambed Sediment
- Endocrine Disruption in Fish

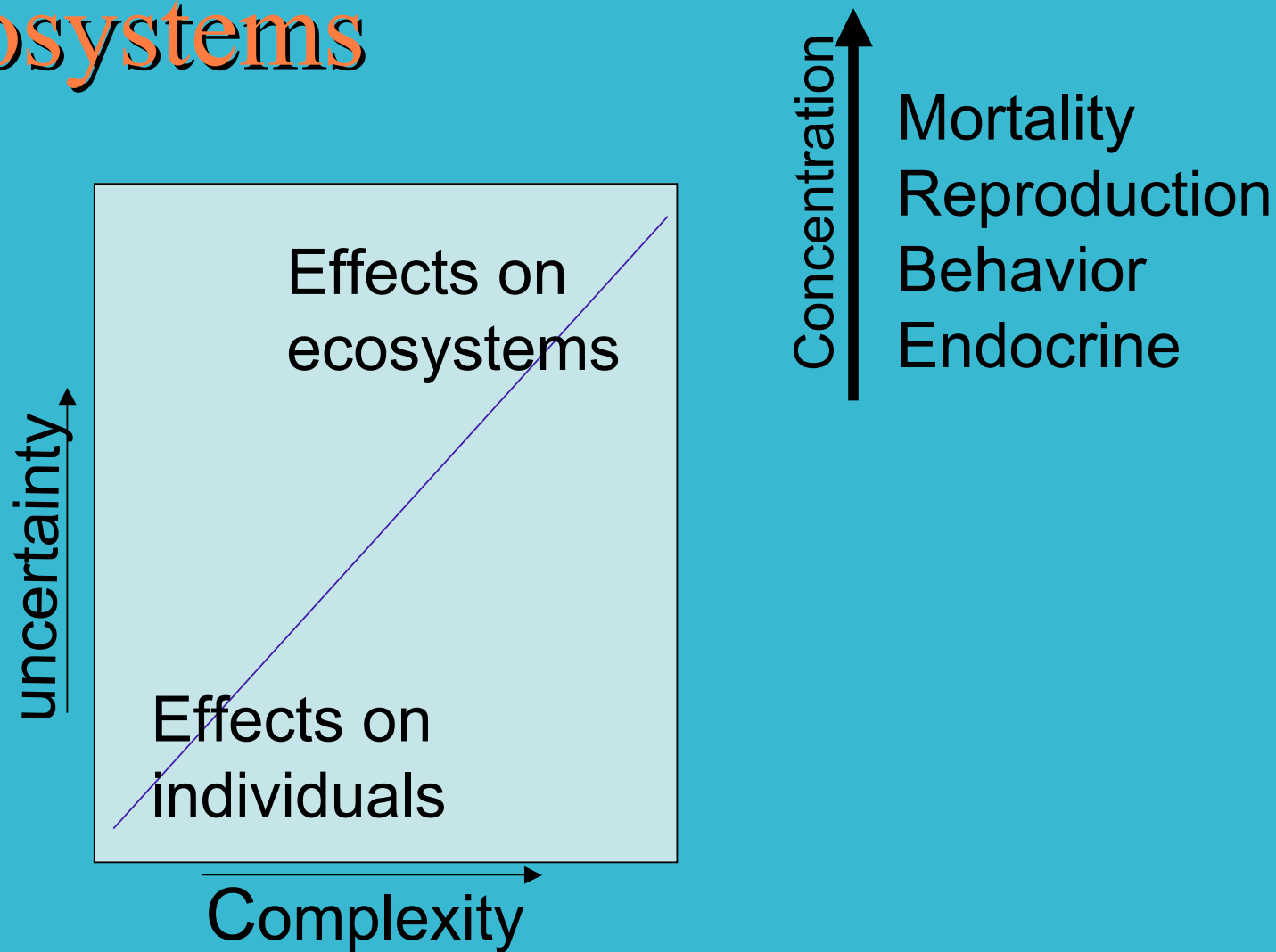
Detection in Water vs Sediment at 44 stream sites

	<u>Stream Water</u>	<u>Bed Sediment</u>
Cotinine	81.8%	34.1%
Carbamazepine	59.1	72.7
Caffeine	54.5	29.5
Acetaminophen	36.4	25.0
Dehydronifedipine	36.4	63.6
Sulfamethoxazole	36.4	6.8
Codeine	34.1	6.8
Diphenhydramine	27.3	68.2
Trimethoprim	22.7	27.3
Diltiazem	20.4	43.2
Cimetidine	13.6	34.1
Fluoxetine	4.5	63.6
Thiabendazole	2.2	43.2

75th Percentile Concentrations



Effects: Individuals vs Ecosystems



Effects: Where's the Proof?

Using multiple lines of evidence

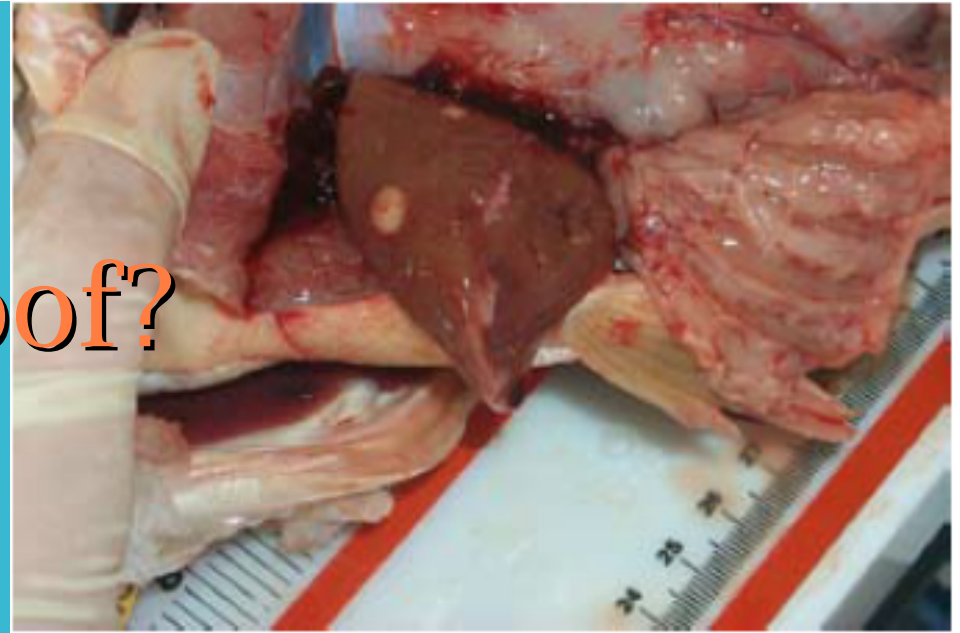


Photo: USGS

- Are exposures to the contaminant in the field high enough to theoretically cause the injury based on laboratory tests?
- Were effects found in the field?
- Are the effects consistent with those in controlled laboratory studies?

Regulation

CAA
CWA
SDWA
CERCLA
FIFRA
TSCA
FQPA
FFDCA



Regulations Based on:

- List of contaminants (e.g., 198 Clean Air Act chemicals list, TSCA list) **vs** Categories of chemicals
- Premarket approval **vs** Premanufacture notification **vs** Voluntary schemes
- Who has the burden of proof (TSCA **vs** FIFRA)
- Best available technology **vs** regulated use
- Precautionary principle
- Cost benefit ratios
- Assessment of risk (FIFRA, CWA, NEPA, TSCA, FFDCA)

Regulatory Strategies using Assessments

- Quantitative structure activity models (QSAR) (industrial chemicals)
- Tiered testing (pesticides)
- Determination of no significant impact (Vet drugs)
- Water Quality Criteria and Standards (water pollutants)
- Assessment of cumulative load (Permitting discharges into waterbodies - TMDL)
- Remediation cleanup levels (Hazardous waste sites)

New Materials

- Biotech - genetically modified organisms
- Nanotech

Nanoparticles

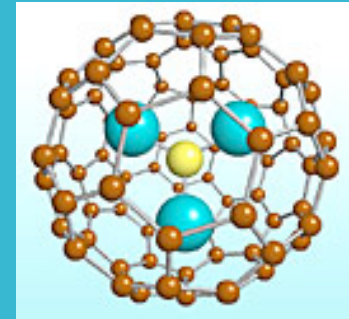
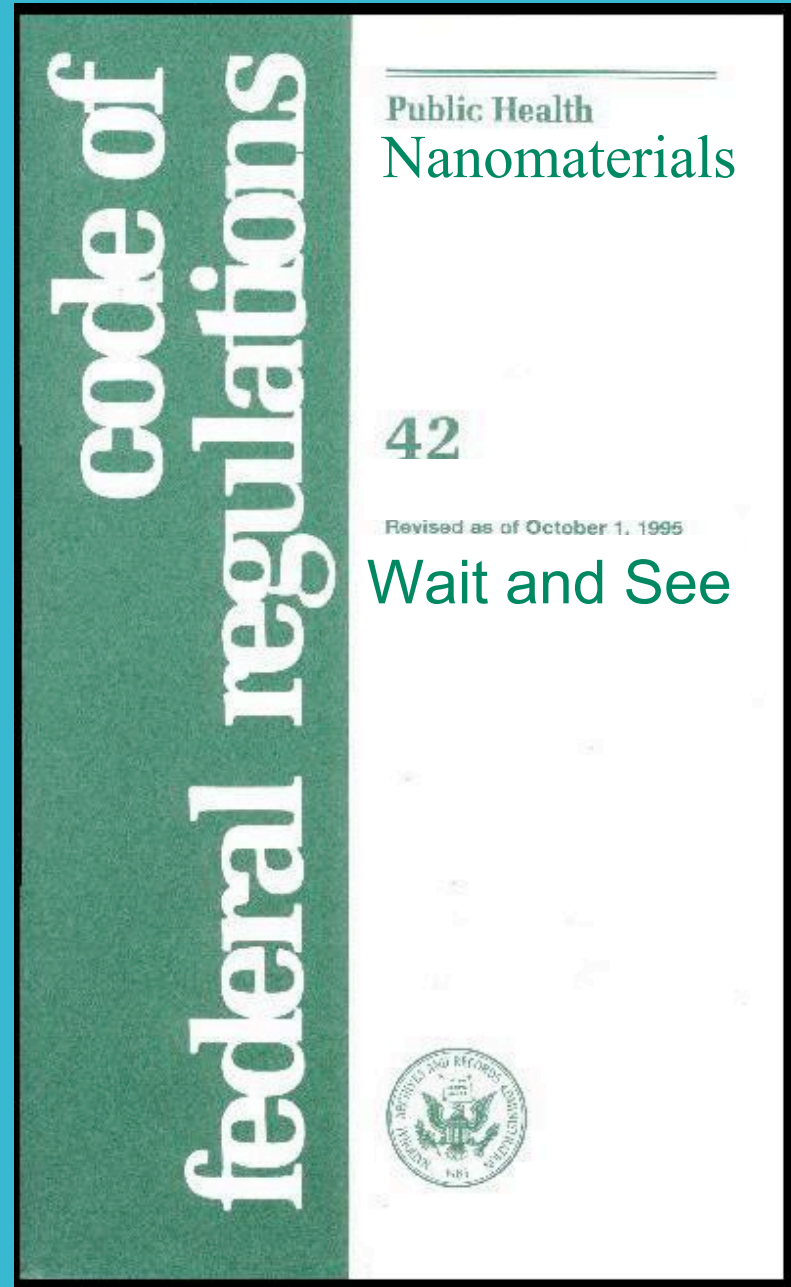


Image credit: Courtesy
LUNA Innovations

- Nanotechnology is used in ~ 700 consumer products (detergents, sunscreens, building materials, electronics and medical applications)
- Fullerenes- Brain damage, altered behavior of genes in liver cells of bass. (Oberdorster) spherical, nano-sized carbon molecules
- Size and shape matter

Nanomaterials Regulation



Pharmaceuticals and Personal Care Products

- Biologically active
- Endocrine disruption
- Removal from the waste stream
- Persistence?



Photo: EPA

Pesticides

- FIFRA: Screens for persistence, toxicity to nontarget species, bioaccumulation
- Selectivity in application or toxicity?
- Usage critically important

Industrial/Household Chemicals

- **Perfluoro compounds** - coatings
e.g., teflon
- **Perchlorate** - rocket fuel
- **MTBE** gasoline additive
- **Polybrominated diphenyl ethers** and
other flame retardants



Photo: EPA

Discussion Groups

Research

Monitoring

Regulation

Education

Research Discussion Group

- How can we improve our ability to see ahead?

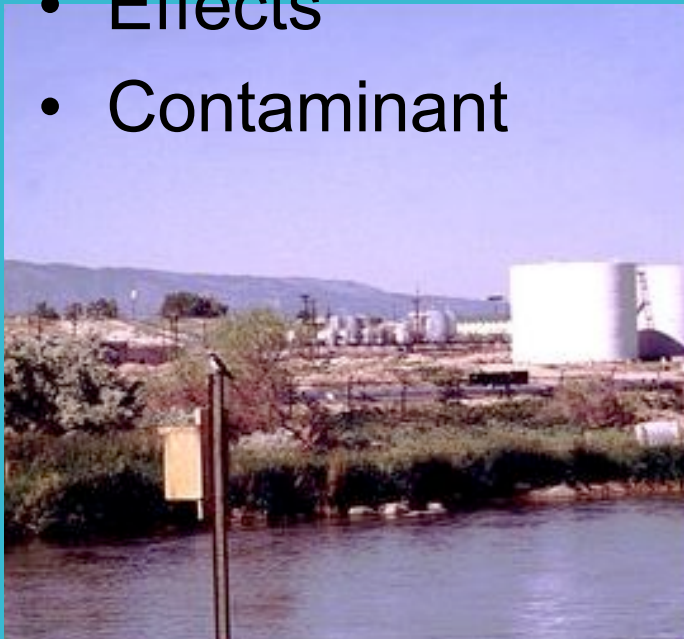


Photo: USGS

What is the potential for serious environmental losses?

Monitoring Discussion Group

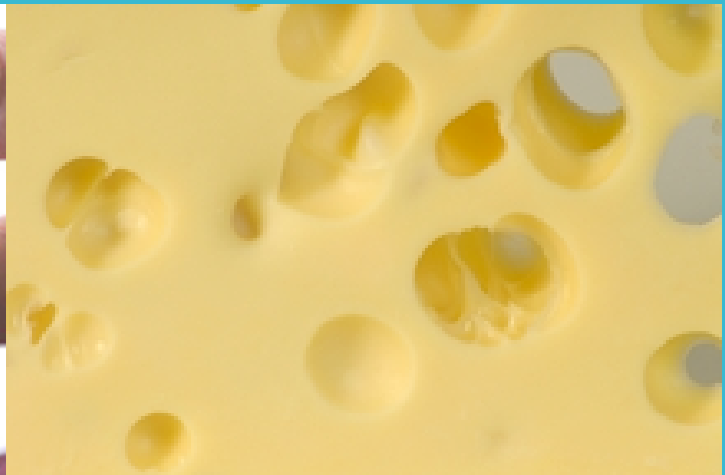
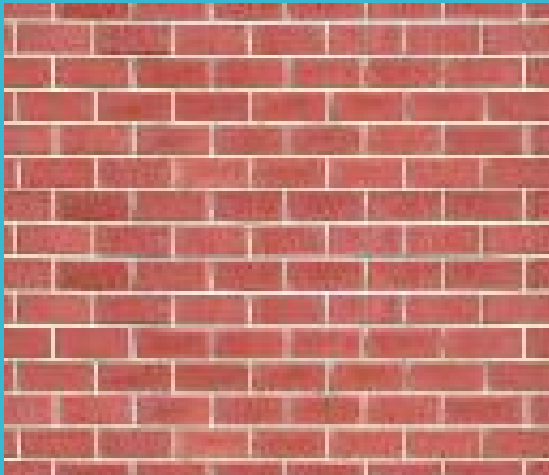
- Location
- Media
- Effects
- Contaminant



What monitoring
will identify the
next emerging
chemical issue?

Regulation Discussion Group

Is regulation adequate to
protect the environment?



Education Discussion Group

How can we better inform
ourselves, our students,
policymakers, and the public?
What issues are ripe for
communication?