

**IS ARTIFICIAL  
RECHARGE OF  
TREATED EFFLUENT  
A SAFE LONG-TERM  
STRATEGY?**

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# I. THE PROBLEM

- EMERGING CHEMICALS
  - CATEGORIES
  - BODY BURDEN
  - WHY ARE THEY THERE?
  - RISK - BENEFIT

# ENDOCRINE DISRUPTOR CHEMICALS (EDCs)

DEFINITION: “Any compound or mixture that alters the function of the endocrine system that causes an adverse effect on an organism or its progeny.” World Health Org 2002

## CONCENTRATION?

# ENDOCRINE DISRUPTOR CHEMICALS (EDCs)

- HOW DO EDCs ACT?
- EXAMPLES



**Slide 6**

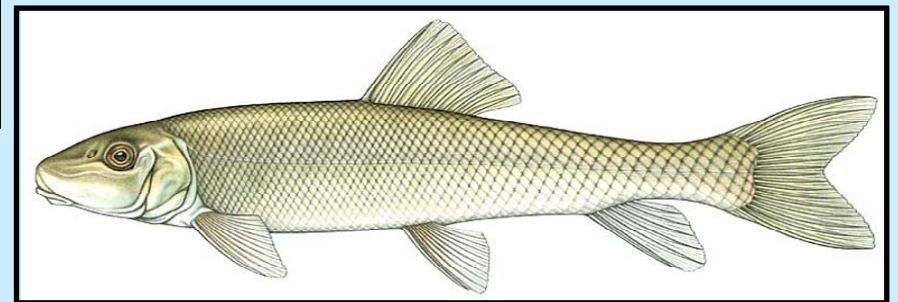
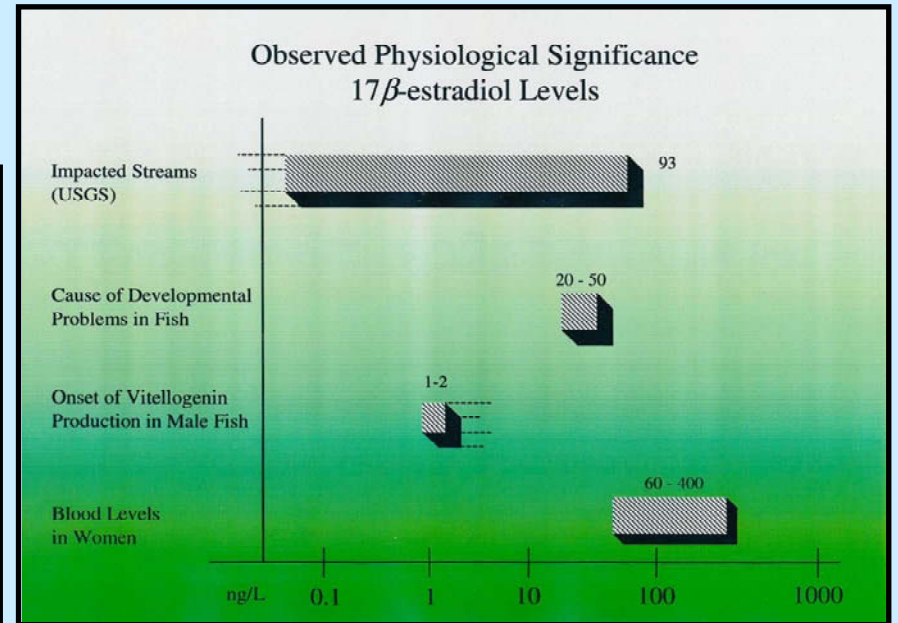
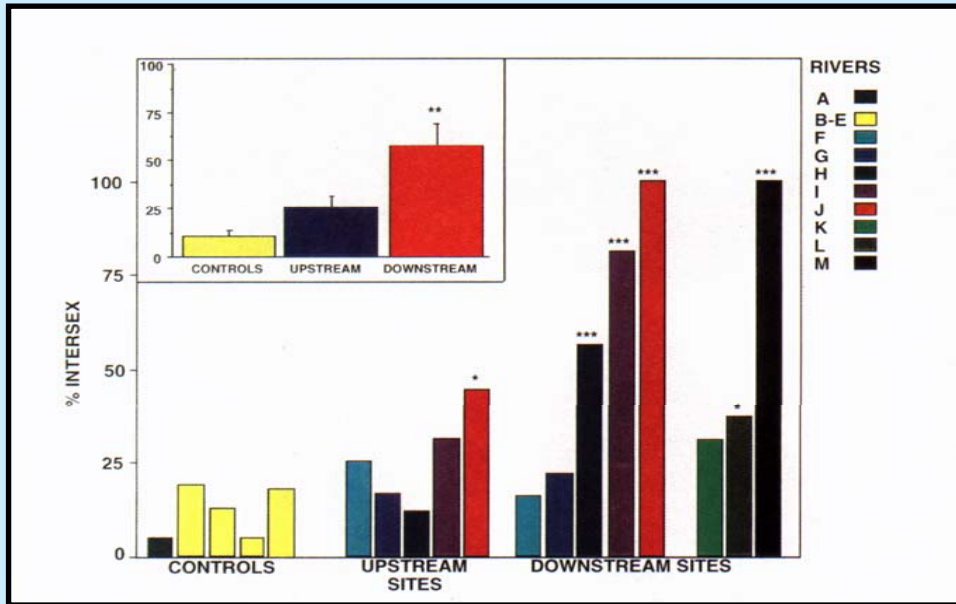
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frank, 12/18/2008

# Adverse Effects on Wildlife

## Feminization of Male Fish (from Jobling *et al.*, 1998)

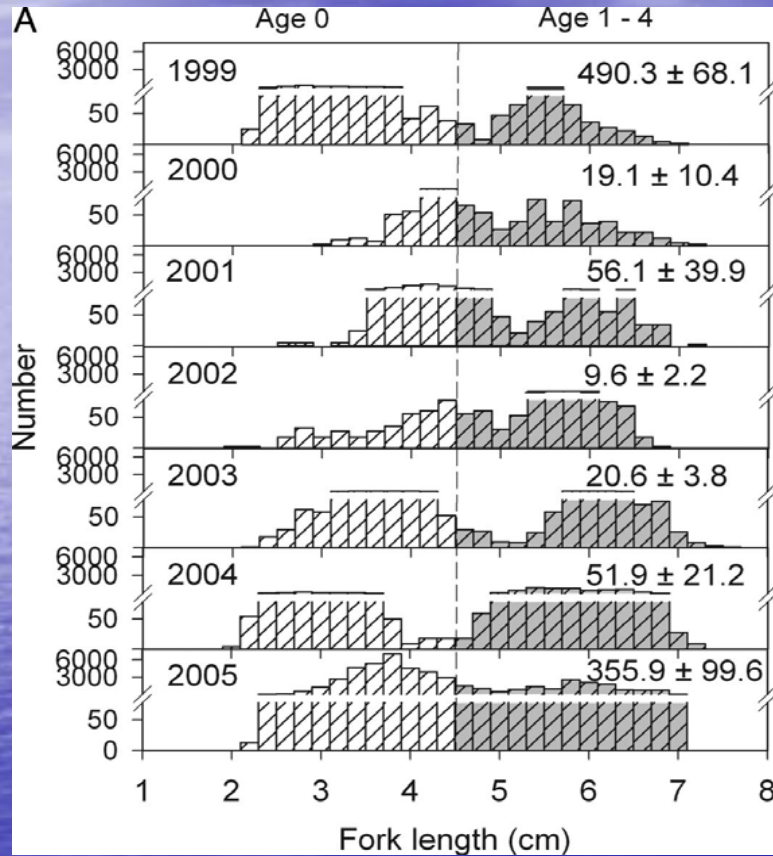


Kindly provided by Bob Arnold, UofA

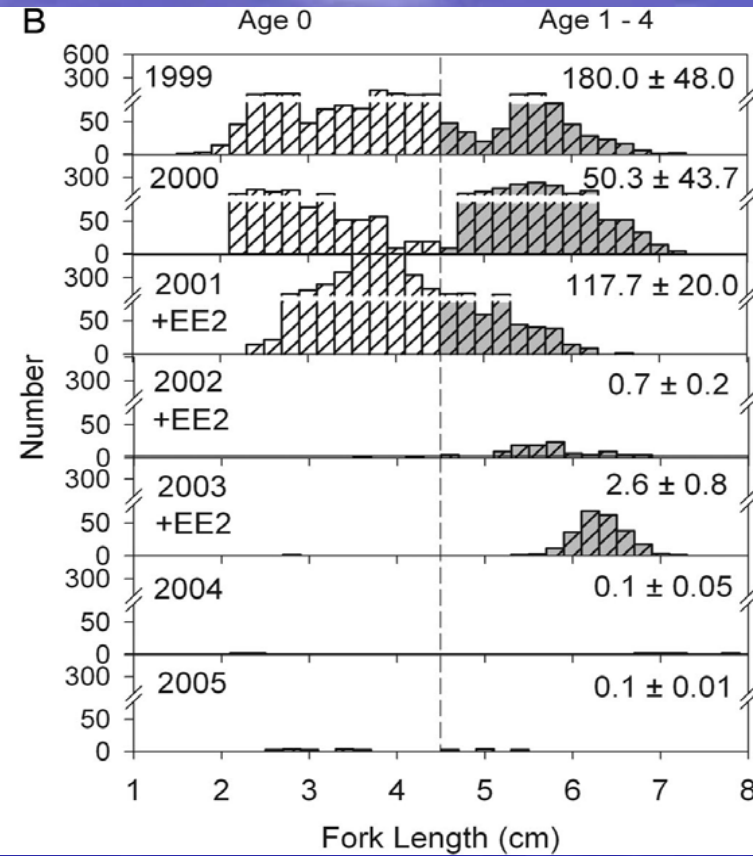
# Fathead Minnow Population Collapse

Experimental Lakes Area, NW Ontario, Canada

Kidd, KA et al., 2007



Lake 442 (A)-  
Unamended control



Lake 260 (B)-amended with  
5-6 ng/L EE2 (2001-2003)

Kindly provided by Bob  
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# HOW DO YOU MEASURE THEM?

- CHEMICALLY
- “YES” METHOD
- BIOLOGICAL SURVEYS, SENTINEL ORGANISMS
- HUMAN BIOMONITORING: BODY BURDEN

## II. WHAT IS BEING DONE?

- USEPA STRATEGY
  - CCL3 LIST – 104 SUSPECTS
  - INFORMATION GATHERING
  - STANDARDS
  - REGULATION
  - IMPLEMENTATION

# STATES - FISH CONSUMPTION ADVISORIES

- STATE FISH AND GAME DEPTS
  - MICHIGAN
  - ARIZONA

# MUNICIPALITIES

- ORANGE CO. WATER FACTORY 21
  - TOILET-TO-GW-TO-TAP
  - \$480 MILLION PLANT
  - EFFLUENT FILTERED, ROed, -  
STERILIZED AND RECHARGED
  - OPERATING COST \$39 MIL/Y or  
\$16/Y PER CUSTOMER

# MUNICIPALITIES Cont.

- NEW YORK CITY
  - USES AN AUTOMATED, ON-LINE CONTINUOUS 24/7 BIOMONITORING SYSTEM OF THEIR SOURCE-WATER RESERVOIRS

# WATER PROBLEMS IN THE ARID SOUTHWEST

- MOST RAPID GROWTH IN US
- LIMITED WATER RESOURCES REQUIRE RECLAMATION OF WW
- NO EFFLUENT DILUTION IN DRY STREAMBEDS
- RECHARGE SCHEMES ENDANGER GW
  - GROWTH DEPENDENT ON  
- RECHARGE

# CURRENT WWT SUMMARY

- E2 STUDIES DURING AND AFTER WWT
- BUT VAST NUMBER OF ECs AND EDCs ARE NOT DESTROYED BY WWT
  - HYDROPHILIC vs HYDROPHOBIC CPDs
- REMOVAL STRATEGIES
  - ‘POLLUTED’ WATER MOUNDS
  - PERCENT GW RECLAIMED

BOB ARNOLD STUDIES – SOME EDCs ARE REMOVED QUICKLY BY TOPSOIL.

# CURRENT WWT SUMMARY

- **FATE OF ESTROGENIC E2 COMPOUNDS**
  - **PRIMARY FOCUS OF MANY STUDIES**
  - **CONVENTIONAL BIOLOGICAL TREATMENT**
  
- **UP TO 90% E2 REDUCTION POSSIBLE**
  - **BIO DEGRADATION**
  - **SOME HYDROPHOBICS ADSORBED ON BIOMASS**
  - **MANY HYDROPHILICS LEFT IN EFFLUENT**

# CURRENT WWT SUMMARY

- **TERTIARY TREATMENT OPTIONS**
  - **GRANULAR ACTIVATED CARBON FILTRATION**
  - **LIME COAGULATION + SAND FILTRATION**
  - **GOOD FOR HYDROPHOBIC EC'S + EDC'S**
  - **INEFFECTIVE FOR HYDROPHILICS**

# CURRENT WWT SUMMARY

- **OXIDATION OF EC AND EDC COMPOUNDS**
  - **CHLORINATION - PRODUCES THM'S**
  - **OZONATION**
  - **HYDROGEN PEROXIDE**
  - **ULTRAVIOLET 254 WAVELENGTH**
  - **PEROXIDE + UV-254**

# SOIL RECHARGE OF EFFLUENT

- **U. OF A. STUDIES – BOB ARNOLD**
  - **SOILS USED IN RECHARGE BASINS 9 YEARS**
  - **REDUCTIONS UP TO 90%+ IN TOP 2 FEET**
  - **MECHANISM FOR REMOVAL IS A COMBINATION OF BIODEGRADATION AND ADSORPTION**

# REUSE OF RECHARGE

- WELLS PUMPING FROM MOUNDS
  - MAY BE ESSENTIALLY ALL RECHARGE
  - NEED TO PREDICT FUTURE RECOVERED WATER QUALITY

**THE VERDE NEAR PAULDEN**



# HEADWATERS OF THE VERDE

- WHAT IS THE EC STATUS?
- WHAT IS THE BIOLOGICAL STATUS?
- MIMBY

# III. WHAT HAS TO BE DONE?

- Determine EDC baseline in GW
- Develop more sophisticated  
Biological Monitoring Systems
- Find a cheap, effective Body  
Burden test.

# III. WHAT HAS TO BE DONE? Cont.

- Reduce EC input
- Remove septic tanks
- Fix sewer-line leaks
- Go to tertiary treatment
- Raise taxes?

# PROTECT THE SOURCE WATER?

- COST-BENEFIT
- FOOD, AIR (WORKPLACE, HOMES, CARS), WATER
- WWT

# SUMMARY

- ECs ARE A POTENTIAL THREAT TO OUR LIVES
- EDCs POSE THE GREATEST THREAT
- NEED TO EVALUATE THE THREAT
- ARID LAND PROBLEM
- COST VS BENEFIT
- COULD THE BENEFIT BE AN ETHICAL ONE?

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