Contaminants Associated with Stormwater and Combined Sewer Overflows: Potential Effects of Climate Change

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Constituents & Contaminants in Stormwater

- Pathogens
- Solids (TSS, detritus, soil/sediment particles, TDS, salinity)
- Nutrients (nitrogen, phosphorus)
- Metals and metalloids
- Dissolved natural organic matter (NOM)
- Synthetic organic chemicals (e.g., pesticides, industrial chemicals, petroleum-related chemicals, PPCPs)

Pathogens

- Parasites: Protozoans (*Giardia lamblia*, *Cryptosporidium parvum*), helminthes (parasitic worms)
- Bacteria: Coliform bacteria (including *E. coli*), *Salmonella*, *Burkholderia pseudomallei*
- Viruses: Norovirus and others
- Prions: infectious proteins

Solids

- Types of solids:
  - Suspended sediment
  - Dissolved solids
  - Settleable and non-settleable solids
  - Litter, debris, floatables, and coarse solids
- Various negative impacts
  - Physical problems affecting geomorphology and ecologic habitats
  - Potential to transport harmful chemicals into natural ecosystems

Suspended Solids

- Total suspended solids (TSS):
  - Hallmark water quality parameter for quantifying concentration of soilds in stormwater
  - Used in stormwater management as an indicator of receiving water responses to stormwater: scour and deposition potential, visibility impairment, benthic filter feeder clogging, organic solids sedimentation rates

(Continued)

Suspended Solids, Cont'd

- Suspended solids
  - Main vector of wet weather pollution in combined sewers
  - Associated with nutrients, toxins, heavy metals, other organic and inorganic materials

Inorganic Waterborne Constituents/Contaminants

- Examples:
  - Salinity
  - Acidity, e.g., acid precipitation
  - Nutrients, e.g., nitrogen compounds like ammonia, phosphorus, and sulfate
  - Ionic compounds, e.g., perchlorate
  - Metals and metalloids, e.g., lead, mercury, selenium

(Continued)

Inorganic Waterborne Constituents/Contaminants, Cont'd

- Many are present naturally in the environment but found at elevated levels in certain areas due to natural phenomena and/or human activities
  - Metals mobilized by mining
  - Elevated nutrients due to application of synthetic fertilizers to agricultural fields
  - Acid rain due to emissions of sulfur dioxide from fossil fuel combustion, industrial activities, volcanoes, wildfires

Nutrients

- Nitrogen and phosphorus are particularly problematic for aquatic environments
- Present naturally in the environment, but found at elevated levels in some water bodies due to human activities, e.g., application of fertilizer to agricultural fields
- Promote eutrophication of natural waters: overgrowth of aquatic plants, harmful algal blooms, anoxia, declines in wildlife and their habitat

Metals & Metalloids

- Naturally present in the environment
- Concentrations in water may be elevated due to natural phenomena (e.g., geologic activity) or human activities (e.g., mining, lead additives in gasoline)
- Toxicity depends on a number of modifying factors, particularly chemical speciation, water pH and hardness (for certain metals), and partitioning within organisms and in the environment

Organic Chemicals

- Dissolved natural organic matter (NOM)
- Biological toxins and other naturally occurring toxic organic chemicals (e.g., PAHs)
- Animal hormones
- Synthetic organic chemicals

Dissolved Natural Organic Matter (NOM)

- Organic matter originating from organisms present in natural waters
- Poorly characterized class of numerous natural constituents of water
  - Heterogeneous and complex
  - Includes high molecular weight organic molecules, comprised mainly by humic and fulvic acids and tannic acid
  - Wide range of molecular weights (200-20,000 amu), depending on polymerization

(Continued)

Dissolved Natural Organic Matter (NOM), Cont'd

- Difficult to break down due to presence of aromatic rings in many compounds
- Important in movement of nutrients and retention of water in the environment
- Presence in drinking water is undesirable
  - Direct problems: color and poor taste
  - Indirect problem: important precursors to certain disinfection byproducts (DBPs, some toxic, e.g., trihalomethanes) found in treated water

Synthetic Organic Chemicals (SOCs)

- Industrial chemicals
- Household chemicals
- Pesticides and herbicides
- Petroleum-related chemicals, e.g., VOCs like BTEX
- Combustion byproducts, e.g., PAHs
- Pharmaceuticals and personal care products (PPCPs)
- Breakdown products and metabolites of SOCs

Effects of Climate Change

- Decreased precipitation in some areas
- In other areas, greater frequency and intensity of wet weather events
  - Increased flooding, combined sewer overflows
  - Increased transport (volume, distance) of solids and associated contaminants
- Increased water temperature
  - Changes in contaminant cycling, availability
  - Changes in lake mixing, decreased DO

(Continued)

Effects of Climate Change, Cont'd

- Predicted increases in insect pests and invasive weed species will likely necessitate greater pesticide and herbicide use and runoff
- Increase in disease pathogens may boost need for monitoring, treatment
- Potential increase in wildfires will release toxic combustion byproducts and leave bare soils more vulnerable to erosion of solids by stormwater

(Continued)

Effects of Climate Change, Cont'd

- Climate change may alter toxicity modifying factors
  - Temperature: altered contaminant cycling in the environment, uptake and metabolism of contaminants
  - Water pH (e.g., acidification of oceans): altered speciation, and thus bioavailability, uptake, and cycling, of contaminants
  - Dissolved oxygen: direct effects of anoxia, changes in chemical oxidation and speciation

Contaminants of Emerging Concern (CECs)

- Pharmaceuticals
- Personal care products
- Other household products
- Endocrine disrupting chemicals
- Industrial chemicals
- Combustion byproducts
- Pesticides
- Novel disinfection byproducts

U.S. EPA Definition of an Endocrine Disrupting Chemical (EDC)

"An environmental endocrine disruptor is defined as an exogenous agent that interferes with the synthesis, secretion, transport, binding, action, or elimination of natural hormones in the body that are responsible for the maintenance of homeostasis, reproduction, development, and/or behavior."

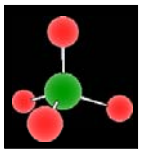
U.S. EPA. 1997. *Special Report on Environmental Endocrine Disruption: an Effects Assessment and Analysis*. EPA/630/R-96/012.

Natural Sources of EDCs

- Hormones excreted by humans, other animals
  - Municipal wastewater effluent, private septic tanks, biosolids
  - Concentrated animal feeding operations (CAFOs), dairies, fish hatcheries, land amended with animal manure
- Plants, fungi, and bacteria
  - Food plants (e.g., soy)
  - Fungal contaminants in food
  - Pulp and paper mill effluents

Natural Sources of EDCs, Cont'd

- Certain ions and metals
  - Perchlorate, thiocyanate, nitrate
  - Cadmium, mercury – mining, smelting, hazardous waste
- Combustion products
  - Examples: dioxins, polycyclic aromatic hydrocarbons (PAHs)
  - Sources: forest fires, volcanic activity



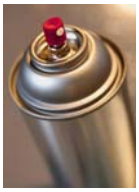
Anthropogenic Sources of EDCs

- Industrial chemicals and their degradation products or metabolites
  - Polychlorinated biphenyls (PCBs)
  - Nonylphenol
  - Bisphenol-A
- Petroleum products, incinerators, power plants, vehicle exhaust
  - PAHs
  - Dioxins

Anthropogenic Sources of EDCs, Cont'd

- Biocides
  - Antifoulants (tributyltin)
  - Insecticides (DDT*, chlordane)
  - Herbicides (atrazine)
- Pharmaceuticals
  - Oral contraceptives (ethynylestradiol)
  - Antidepressants (fluoxetine, or Prozac)

*DDT: dichlorodiphenyltrichlorethane



Pharmaceuticals

- Include prescription and over-the-counter drugs and both human and veterinary drugs
- Human drugs reach municipal wastewater treatment plants (WWTPs) after being excreted in urine or feces, washed from body surfaces, or disposed via sanitary sewer
- Veterinary drugs may not be treated before they reach the water cycle

Personal Care Products

- Often active ingredients or preservatives in cosmetics, toiletries, and food supplements
- Usually not intended for consumption but for application to the body
- Information about environmental fate or potential for effects is generally lacking; some can bioaccumulate
- Many are used and discharged to the environment in large quantities
- Often grouped with pharmaceuticals as "pharmaceuticals and personal care products" or PPCPs

Some Potential Sources of PPCPs to the Water Cycle

- Municipal wastewater effluents
- Hospital effluents
- Concentrated animal feeding operations (CAFOs), dairies, and aquaculture facilities
- Effluents from manufacturing facilities
- Landfill leachate
- Urban runoff containing pet wastes
- Runoff from land amended with biosolids, sewage sludge, or animal manure

2008 Associated Press Story

Health facilities flush estimated 250M pounds of drugs a year

By Jeff Donn, Martha Mendoza And Justin Pritchard, Associated Press

U.S. hospitals and long-term care facilities annually flush millions of pounds of unused pharmaceuticals down the drain, pumping contaminants into America's drinking water, according to an ongoing Associated Press investigation.

These discarded medications are expired, spoiled, over-prescribed or unneeded. Some are simply unused because patients refuse to take them, can't tolerate them or die with nearly full 90-day supplies of multiple prescriptions on their nightstands.

http://www.usatoday.com/news/health/2008-09-14-drugs-flush-water_N.htm

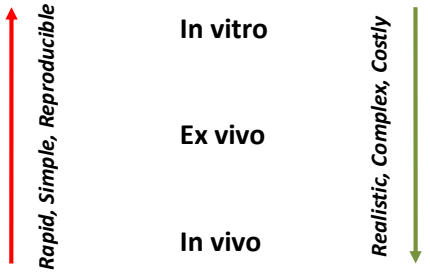
EDCs and PPCPs in Municipal Wastewater

- Municipal wastewater effluent contains a mixture of many natural and synthetic EDCs and PPCPs
- Those that are lipophilic (e.g., high log K_{OW} [octanol-water partition coefficient]) are likely to be removed with sludge, but concentrations remaining in wastewater may be significant to aquatic organisms due to bioconcentration or bioaccumulation

Selecting Target Contaminants for Monitoring, Treatment

- Toxicity (ecotoxicology, human health)
- Environmental fate and fate in water treatment processes of interest (physicochemical properties, monitoring data)
- Local sources may suggest specific target chemicals
- Health-based target concentrations
- Analytical feasibility

Comparison of Bioassay Types



E-Screen Versus Fish Bioassays

- Both can respond to estrogens but can also be affected by other chemical and non-chemical factors
- Responses may not be comparable due to differences in uptake, pharmacokinetics, and metabolic capabilities
- E-screen cannot account for interaction among tissues
- Different uses and purposes

Health Effects of Pharmaceuticals in the Water Cycle

- Many major modes of action, varies by drug class
- Pharmaceuticals tested for toxicity during clinical trials, drug development, and registration (some data are available)
- Effects of subtherapeutic doses, long-term exposure, and/or exposure of non-target, potentially sensitive subpopulations (e.g., fetus, aquatic organisms) may be unknown

EDCs and PPCPs in Wastewater: Effects on Aquatic Life

- A large and growing body of evidence indicates that contaminants in municipal and industrial effluents can cause endocrine disruption in fish
- Effects of EDCs reported in fish around the world include: vitellogenin induction, changes in secondary sex characteristics and sexual behavior, intersex, reduced gonad size, shift in sex ratio, and reduced fertility and fecundity (reproduction)
- Ethynylestradiol, estradiol, and estrone – among the most potent EDCs to fish – generally are not reported to bioconcentrate or bioaccumulate

EDCs and PPCPs in Wastewater: Effects on Aquatic Life, Cont'd

- Other less potent EDCs have also been implicated in effects on fish; although they are much less potent, they may exert an effect due to much greater concentrations and/or potential to bioconcentrate or bioaccumulate
- EDCs in sediments have been implicated in effects on bottom-feeding fish and marine flatfish
- Less is known about the potential toxicity of PPCPs to aquatic organisms – mostly acute toxicity information; some bioconcentrate or bioaccumulate (e.g., fragrance musks)

Toxicologic Relevance for Aquatic Life

- Wastewater and reuse water can cause significant exposure of aquatic biota to EDCs and PPCPs
  - Greater exposure relative to humans: longer duration, point of greatest concentration, more routes of exposure (e.g., food web, sediment), critical periods of development
  - Species-specific sensitivity
- Research into this issue is ongoing
  - Development of standardized bioassays and assessment endpoints
  - Assessment of potential for population level effects

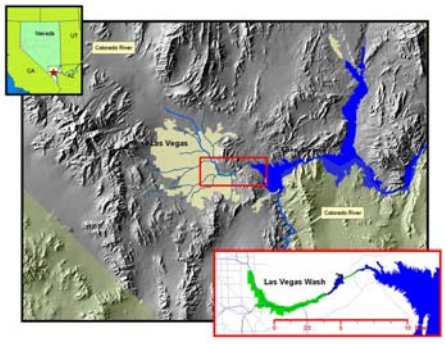
Regulations in the U.S.

- Concentrations of EDCs are not regulated in wastewater on the basis of endocrine effects
- Pesticide use may be restricted based on potential for endocrine effects
- FDA requires ecological risk assessments for pharmaceutical active ingredients with expected introduction concentration (EIC) to the aquatic environment ≥ 1 ppb
- Levels of PPCPs in wastewater are not otherwise regulated

Las Vegas – 1985

Return flow credit established: water returned to the Colorado River earns credit to withdraw equivalent amount for use as drinking water

Lake Mead and the Las Vegas Bay



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U.S. Department of the Interior—U.S. Geological Survey

SYNTHETIC ORGANIC COMPOUNDS AND CARP ENDOCRINOLOGY AND HISTOLOGY IN LAS VEGAS WASH AND LAS VEGAS AND CALLVILLE BAYS OF LAKE MEAD, NEVADA, 1992 AND 1995

Water-Resources Investigations Report 96-4266

Nevada Basin and Range Study Unit
National Water-Quality Assessment Program

By Hugh E. Bevans[1], Steven L. Goodbred[2], John F. Miesner[3], Sharon A. Watkins[1], Timothy S. Gross[4], Nancy D. Denslow[4], and Trenton Schoeb[4]

ABSTRACT

The Nevada Basin and Range study unit of the National Water-Quality Assessment Program, U.S. Geological Survey, in cooperation with the National Park Service, National Biological Service, and U.S. Fish and Wildlife Service, investigated the occurrence of organochlorines and semivolatile industrial compounds in the water column, bottom sediment, and carp (*Cyprinus carpio*) tissue at five sites in Las Vegas Wash and Lake Mead. Endocrine systems of carp were assessed by analyzing concentrations of female and male sex-steroid hormones, 17β-estradiol and 11-ketotestosterone, and vitellogenin (an estrogen-controlled egg protein) in blood-plasma samples. The histology of carp gonads, hepatopancreas, kidney, gill, and lower intestine were analyzed for effects that can result from endocrine disruption or exposure to toxicants.

Organochlorines (pesticides and industrial compounds) and semivolatile industrial compounds were detected in semipermeable membrane devices and bottom-sediment samples; only organochlorines were detected in carp-tissue samples. Concentrations of organochlorines were higher in Las Vegas Wash and Bay than in Callville Bay (the reference site) for the three media that were sampled. Results of a carp-tissue bioassay indicated the presence of dioxins or furans with low toxic-equivalent factors relative to 2,3,7,8-tetrachlorodibenzo-*p*-dioxin in Las Vegas Wash and Las Vegas and Callville Bays. Patterns of necrosis observed in hepatopancreas and kidney samples from carp are consistent with long-term subchronic exposure to toxicants. Polycyclic aromatic hydrocarbons, phthalates, and phenols also were detected at higher concentrations in bottom-sediment samples from Las Vegas Bay than in a comparable sample from Callville Bay. Polycyclic aromatic hydrocarbons were detected in samples from semipermeable membrane devices from all sites.

Endocrine disruption in carp from Las Vegas Wash and Bay, as compared to Callville Bay, is evidenced by high concentrations of 11-ketotestosterone levels in blood-plasma samples of female carp in Las Vegas Wash, low concentrations in male carp from Las Vegas Bay, and low 17β-estradiol concentrations in male carp from Las Vegas Bay. The most compelling evidence of endocrine disruption is the presence of vitellogenin in blood-plasma samples of male carp from Las Vegas Wash and Bay and elevated concentrations in female carp from Las Vegas Bay.

Many of the organochlorines and semivolatile industrial compounds detected in semipermeable membrane devices, bottom sediment, and carp tissue from Las Vegas Wash and Bay have been linked to endocrine disruption in fish by previous investigations of other areas. The endocrine disruption observed in carp from Las Vegas Wash and Bay could be due to the presence of these compounds.

Aerial view of lower Las Vegas Wash and Las Vegas Bay of Lake Mead. View to the northwest, Oct. 12, 1995. Photograph by A.S. VanDenburgh.

1999 *Environ. Sci. Tech.* 33(16): 2814-2829

Analytical Methods for Detection of Selected Estrogenic Compounds in Aqueous Mixtures

SHANE A. SNYDER,*,† TIMOTHY J. KEITH,† DAVID A. VERBRUGGE,† ERIN M. SNYDER,† TIMOTHY S. GROSS,‡ KURUNTHACHALAM KANNAN,† AND JOHN P. GIESY†

National Food Safety and Toxicology Center, Department of Zoology, and Institute of Environmental Toxicology, Michigan State University, East Lansing, Michigan 48824-1311, and

can operate through a number of both direct and indirect mechanisms of action, of particular concern are those compounds that mimic endogenious estrogens. The Safe Drinking Water Act Amendments of 1995 (Bill No. S.1316) and the Food Quality Protection Act of 1996 (Bill No. P.L. 104-170), which mandate comprehensive screening for estrogenic and anti-estrogenic chemicals, are examples of the increasing public concern regarding endocrine disruption. While it is known that many natural and synthetic chemicals are estrogenic, it is unclear whether the concentrations of estrogenic agents present in the environment are sufficient to cause adverse physiological effects. One aspect of conducting human or wildlife risk assessments is an exposure assessment. This suggests the need for assays and techniques to monitor the quantity and effects of endocrine

TABLE 3. Concentrations of Selected Xenoestrogens in Water Samples (Corrected for Recovery)

location	date	NP (ng/L)	OP (ng/L)	NPE (ng/L)	E2 (pg/L)	EE2 (pg/L)
			Lake Mead			
LV Wash[a]	4/30/97	1140 ± 28	43 ± 9	9990 ± 230	2670 ± 152	490 ± 68
LV Bay	4/30/97[a]	750 ± 34	27 ± 7	4850 ± 122	2210 ± 175	520 ± 117
	9/5/97	160	nd[c]	3130	188	253
LV Marina	9/5/97	nd	nd	nd	270	nd
Saddle Island[a]	4/30/97	nd	nd	nd	nd	nd
Callville Bay	9/5/97	nd	nd	nd	nd	nd

2001 *Environ. Sci. Tech.* 35(18): 3620-2625

Identification and Quantification of Estrogen Receptor Agonists in Wastewater Effluents

SHANE A. SNYDER,*
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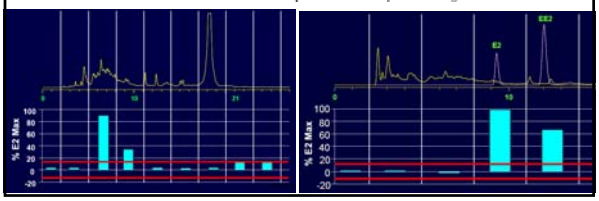
2). "Endocrine disrupting" compounds have been defined as exogenous agents that interfere with the "synthesis, secretion, transport, binding, action, or elimination of natural hormones in the body that are responsible for the maintenance of homeostasis, reproduction, development and/or behavior" (*3*). It has been hypothesized that such compounds may elicit a variety of adverse effects in both humans and wildlife, including promotion of hormone dependent cancers, reproductive tract disorders, and reduction in reproductive fitness (*1, 4*–*10*). Much of the concern has focused on compounds that are estrogen receptor (ER) agonists. These compounds have been variously referred to as "estrogenic", "estrogen like", "environmental estrogens", or "xenoestrogens". ER agonists and antagonists have the ability to mimic or block the functions of endogenous estrogen. Effects consistent with exposure to ER agonists have been observed



LAS VEGAS SUN

MONDAY, OCTOBER 16, 2000

Traces of drugs found in LV Wash

Effects on area's water supply unknown

By Mary Manning
LAS VEGAS SUN

Pill-popping, sun screen-smearing people living in and visiting Southern Nevada are leaving traces of drugs, detergents and DDT in the Las Vegas Wash.

The good news is that the contaminant levels discovered in the wash and the Las Vegas Bay are so low they might not disrupt human health. But scientists are still concerned over what they don't know about the new discovery — how it might affect the environment and water supplies.

The Las Vegas Wash runs into Lake Mead, where Southern Nevada draws most of its drinking water.

Scientists had found pesticides and detergents in the wash before, but this is the first time the presence of prescription and nonprescription drugs — as well as one pesticide previously only suspected, lindane — has been confirmed.

The Southern Nevada Water Authority first guessed drugs may be finding their way into the Las Vegas Valley's wastewater after German and British studies found evidence of prescription and over-the-counter drugs in the water supplies of their countries.

But now research by University of Michigan toxicologist Shane Snyder, hired by the water authority to test

See Drugs, A4

CONTAMINANTS

Toxicology studies of the Las Vegas Wash and the Las Vegas Bay have revealed traces of:

- Pesticides such as DDT and lindane
- Boat fuel compounds
- Oral contraceptives
- Seizure drugs such as Dilantin
- Pain medication such as hydrocodone and codeine
- Valium
- Robitussin
- Blood thinner such as Trental

Environ. Sci. Technol. 2004, 38, 6385–6395

Reproductive Responses of Common Carp (*Cyprinus carpio*) Exposed in Cages to Influent of the Las Vegas Wash in Lake Mead, Nevada, from Late Winter to Early Spring

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in LW influent. Male carp caged at LW had slightly greater concentrations of plasma VTG than those at other sites, and a modest elevation in plasma E2 was observed in male carp at LX and LW, but causes other than contaminant exposure cannot be ruled out. Water temperature differences among sites complicated interpretation of the results. Variation in some end points among carp at two different reference sites supports the use of multiple reference sites in field studies of the effects of endocrine-disrupting chemicals.

Introduction

Lake Mead is a large reservoir formed by impoundment of the Colorado River behind the Hoover Dam. The reservoir serves as a source of domestic and agricultural water for more than 22 million users (*1*) and is a popular recreation area. The Las Vegas Wash (LW) delivers tertiary-treated municipal wastewater effluent (87−88%), nonpotable shallow groundwater (6%), and urban runoff (6%) from the urbanized Las Vegas Valley (*1*, *2*) to the Boulder Basin of Lake Mead via the Las Vegas Bay (LX) (Figure 1). LW serves as the sole drainage of the Las Vegas Valley hydrographic basin and contributes approximately 1.5% of the flow into Lake Mead, while the Colorado River provides approximately 97% of the flow, and the Virgin and Muddy Rivers contribute an additional 1.5%.

In 1996, the U. S. Geological Survey (USGS) reported that endocrine disruption was occurring in feral adult male and female common carp (*Cyprinus carpio*) collected in the

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October 20, 2006

LAS VEGAS SUN

Chemicals cause changes in fish and raise concerns for humans

By Launce Rake <lrake@lasvegassun.com>
Las Vegas Sun

There's something wrong with the fish.

It's been confounding scientists for years: Male fish are developing female sexual characteristics in Lake Mead and other freshwater sources around the country.

On Thursday, the U.S. Geological Survey released a four-page summary of more than a decade of studies linking wastewater chemicals to those changes.

Mutated fish swimming in tainted water

Pharmaceuticals in drinking water supplies hurting surrounding wildlife

By Jeff Donn, Martha Mendoza and Justin Pritchard

The Associated Press
updated 10:03 a.m. PT,Mon., March. 10, 2008

LAKE MEAD, Nev. - Editor's note: Second of a three-part series.

On this brisk, glittering morning, a flat-bottomed boat glides across the massive reservoir that provides Las Vegas its drinking water. An ominous rumble growls beneath the craft as its two long, electrified claws extend into the depths.

Moments later, dozens of stunned fish float to the surface.

Federal scientists scoop them up and transfer them

water. There is more and more evidence that some animals that live in or drink from streams and lakes are seriously affected.

Severe reproductive problems

Pharmaceuticals in the water are being blamed for severe reproductive problems in many types of fish: The endangered razorback sucker and male fathead minnow have been found with lower sperm counts and damaged sperm; some walleyes and male carp have become what are called feminized fish, producing egg yolk proteins typically made only by females.

Meanwhile, female fish have developed male genital organs. Also, there are skewed sex ratios in some aquatic populations, and sexually abnormal bass that produce cells for both sperm and eggs.

http://www.msnbc.msn.com/id/23504633/

Reproductive and Endocrine Biomarkers in Largemouth Bass (*Micropterus salmoides*) and Common Carp (*Cyprinus carpio*) from United States Waters

Steven L. Goodbred[1], Stephen B. Smith[2], Patricia S. Greene[3], Richard H. Rauschenberger[4], and Timothy M. Bartish[5]

Goodbred, S.L., S.B. Smith, P.S. Greene, R.H. Rauschenberger, and T.M. Bartish. 2007. *United States Geological Survey. Data Series 2006-227. Reston, Virginia: U.S. Geological Survey. http://fisc.er.usgs.gov/endocrine_biomarkers/index.html*

Fishing Dock at Lake Mead

Public Communication Strategies

News Article in *Phoenix New Times*

Trouble in the Sack

Rand Carlson

August 9, 2001

Nevada's wastewater is causing sex problems in fish.

But will Arizona get screwed by the solution?

Credit: Phoenix New Times LLC

Winter 2003 *On Tap* Cover Story

They're in the Water...

They Make Fish Change Sex...

Endocrine Disruptors

- What are they doing to you?

National Drinking Water Clearinghouse; www.ndwc.wvu.edu; hotline number: (800) 624-8301

washingtonpost.com

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Male Bass Across Region Found to Be Bearing Eggs

Pollution Concerns Arise In Drinking-Water Source

By David A. Fahrenthold
Washington Post Staff Writer
Wednesday, September 6, 2006; A01

Abnormally developed fish, possessing both male and female characteristics, have been discovered in the Potomac River in the District and in tributaries across the region, federal scientists say -- raising alarms that the river is tainted by pollution that drives hormone systems haywire.

The fish, smallmouth and largemouth bass, are naturally males but for some reason are developing immature eggs inside their sex organs. Their discovery at such widely spread sites, including one just upstream from the Woodrow Wilson Bridge, seems to show that the Potomac's problem with "intersex" fish extends far beyond the West Virginia stream where they were first found in 2003.

http://www.washingtonpost.com/wp-dyn/content/article/2006/09/05/AR2006090501384_pf.html

Toxicologic Relevance for Humans

- Wastewater and reuse water are not expected to cause significant exposure of humans to EDCs or PPCPs
  - Limited human contact
  - Trace concentrations
  - Other sources and routes predominate
- Research into this issue is ongoing
  - Development of analytical techniques
  - Monitoring studies
  - Comparative exposure assessments
  - Toxicity studies

Human Health Effects of EDCs in Wastewater

"...no studies to date have effectively linked low concentrations of EDCs in wastewater to adverse health effects in humans..."

"Large studies have not indicated any association with a list of effects that have sometimes been attributed to environmental exposure to EDCs: low sperm counts, premature puberty in girls, testicular cancer in young men, and breast cancer in some women."

Anderson, P. D. 2005. *Technical Brief: Endocrine Disrupting Compounds and Implications for Wastewater Treatment.* Alexandria, Virginia: WERF.

Epidemiologic Studies on the Health Effects of Reuse Water

Studies to evaluate the health effects of using treated wastewater for groundwater recharge in Los Angeles County showed that, after almost 30 years of recharge, there is no association between exposure to reclaimed water and cancer rates, mortality, infectious disease, or adverse birth outcomes (prenatal development, infant mortality, birth defects).

U.S. EPA. (2004). *Guidelines for Water Reuse*. EPA/625/R-04/108. Washington, DC: U.S. Environmental Protection Agency (U.S. EPA).

Public Communication of Monitoring Results

- Understand what different results may mean and identify potential action plans before work begins
- Control release of data until results have passed internal review; avoid releasing preliminary data, but be prepared to discuss at any time
- Release data to stakeholders and partners first
- Consider publishing results in a peer-reviewed journal
- Establish or maintain good rapport with local media representatives

Public Communication of Monitoring Results, Cont'd

- Ensure that all questions are routed to one or more people who are thoroughly familiar with the subject and work
- Set up a website to release information and updates
- If work is a proactive effort not required for permitting, emphasize this point
- After results are finalized and ready for release, openness, honesty, and empathy are crucial

Public Communication of Monitoring Results, Cont'd

- Present results in terms easily understood by a lay person
- Put results into perspective
  - Comparative exposure
  - Cost/benefit
- Ensure the public and media that water purveyors and regulators care about these issues
  - Demonstrate expertise and discuss what is known and what is not known currently
  - Explain what is being done on international, national, state, and local levels