Disruption

New Pollutants in the Potomac and Beyond

The Marvin Center
The George Washington University, Washington, DC
June 3, 2011

potomac conservancy

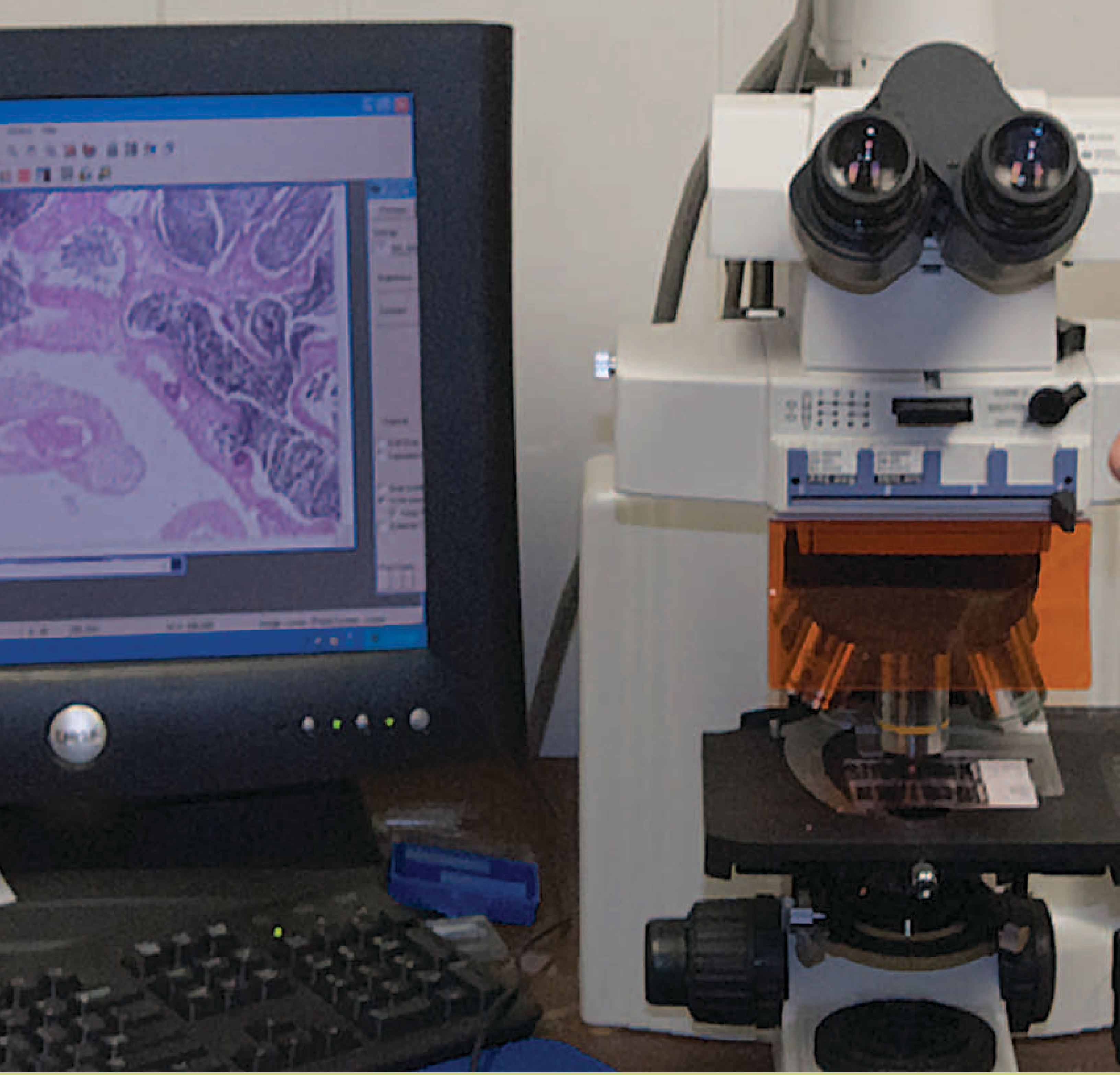


TABLE OF CONTENTS

ACKNOWLEDGEMENTS

CURRENTLY, MORE THAN 80% of the male small-mouth bass in the Potomac River and its tributaries have been found to be bearing immature eggs. One of the potential causes of this "intersex" fish phenomenon is endocrine disrupting compounds (EDCs) found in local waterways. These contaminants, found in everyday products such as medicines, cosmetics, and agricultural chemicals, interfere with normal biological processes by disrupting the hormonal (endocrine) systems that control growth, reproduction, and other development in all vertebrate species, including fish and humans.

Potomac Conservancy believes that these intersex fish, warn of serious problems with the ecological health of our rivers and streams. People in the metropolitan Washington, D.C. area should be particularly concerned because, at this time there is no dedicated treatment method to remove these compounds from our drinking water — almost 90% of which is drawn from the Potomac River for D.C. region residents.

With the discovery of intersex fish in local rivers, the Potomac region found itself at the forefront of one of the major environmental problems of our day. With its mix of urban and rural pollution, the Potomac River is a crucible for emerging contaminants such as endocrine disrupting compounds.

In response to this growing concern, Potomac Conservancy has worked to motivate Congress to appropriate sufficient funds to determine causes and pinpoint solutions. In this day-long forum, experts from different disciplines came together to discuss the latest findings and recommend next steps to limit endocrine disrupting compounds from entering our water.

We thank all of the forum participants: presenters and audiences. This event would not have occurred without support from the Palmer Foundation, The Munson Foundation and The Keith Campbell Foundation for the Environment.

the Palmer foundation

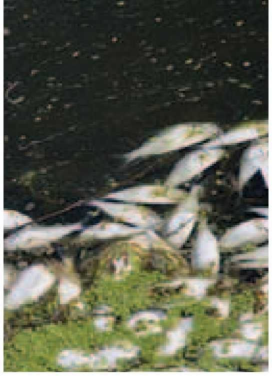
The Munson Foundation

The Campbell Foundation

ABOUT POTOMAC CONSERVANCY Potomac Conservancy safeguards the lands and waters of the Potomac River and its tributaries and connects people to this national treasure.

As the Voice of the Nation's River, the Conservancy's primary focus is to restore water quality by advocating sound policy and promoting thoughtful land management. The Conservancy protects and restores Potomac landscapes by enhancing a network of rivers, forests, and natural areas. Because healthy lands and rivers reflect the quality of life in our communities, the Conservancy promotes enjoyment of the river in ways that foster a conservation ethic.

Learn more about the Potomac Conservancy's programs and their vision for the Potomac River's future at www.potomac.org.



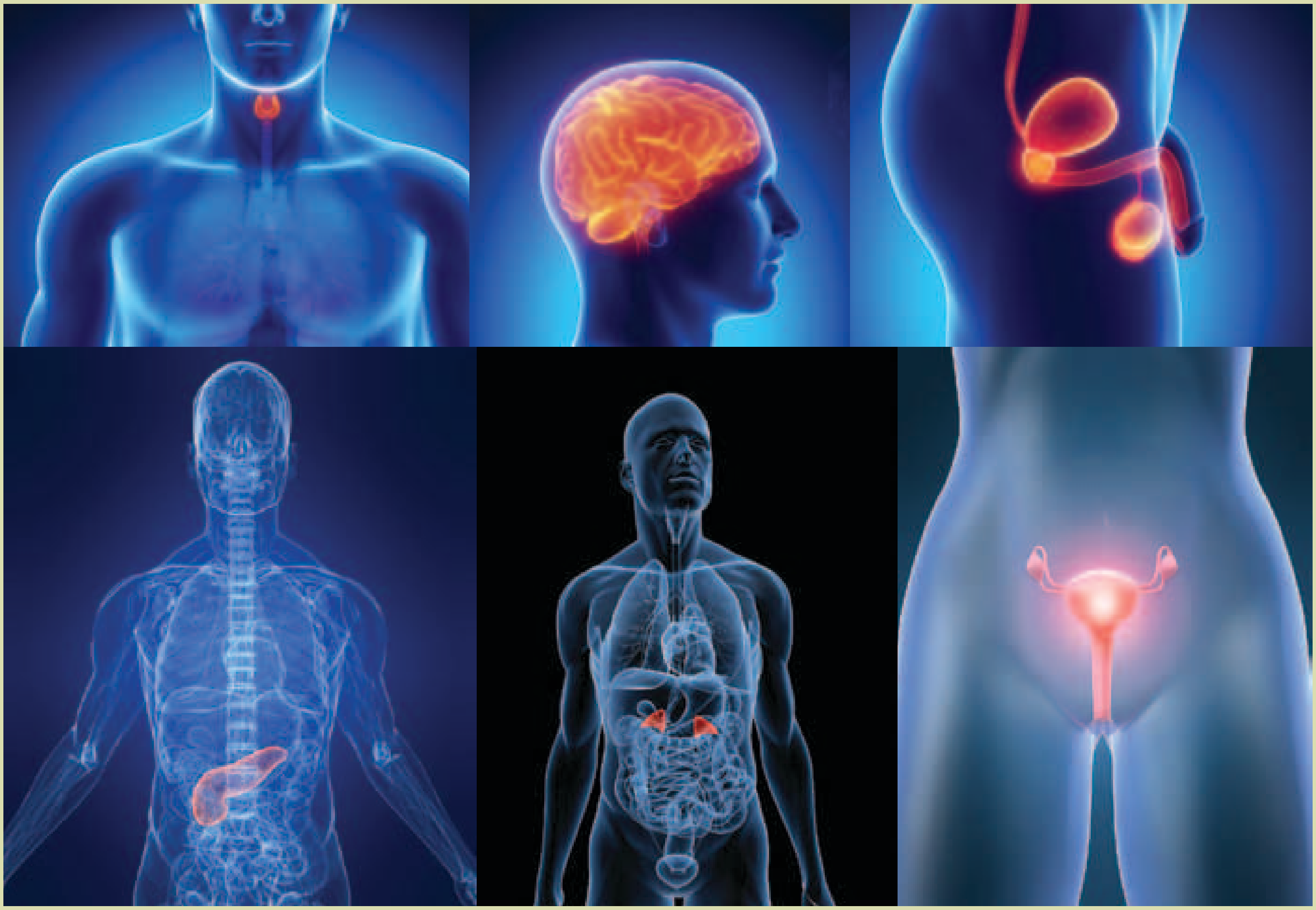
EXECUTIVE SUMMARY

ENDOCRINE DISRUPTING COMPOUNDS (EDCs) are emerging environmental contaminants with the potential to disrupt the health and development of humans and wildlife. More than 15 years' worth of research has traced the connections between EDC exposure and human and animal health and development problems. Ongoing research suggests that EDCs may be particularly harmful because of their ubiquity—they are found in thousands of commonly used products from pharmaceuticals to plastics; because they can produce toxic effects at low doses; and because they can hijack human development through genetic changes that have stealthy and often long-lasting impacts on human health.

Evaluating the risks posed by EDCs requires identification of individual EDCs, mostly in waterways; quantifying their toxicity individually and in concert with other chemical compounds; and determining which regions along a waterway may be most contaminated with EDCs. Several studies focus on wastewater treatment plants and agricultural runoff as sources of EDCs, with natural and synthetic hormones (usually estrogen or estrogen-like compounds), pesticides, and detergent ingredients among the most prevalent and high-risk contaminants.

The 2002–2003 fish kills in the South Branch of the Potomac River brought the issue of EDC exposure and its potential health impacts to the attention of the general public, with the discovery of intersex fish at several locations along the Potomac and tributaries. The scientific community has been engaged in research to discover the cause of the phenomena. Wastewater treatment plants and drinking water utilities, among other organizations, have been involved in efforts to identify EDCs at their sites and to develop plans for monitoring and reducing EDC contamination.

There are no overarching regulations or monitoring schemes for EDCs at the federal level, although the U.S Environmental Protection Agency is pursuing several avenues to test the toxicity of EDCs through amendments to the Safe Drinking Water Act and other major federal environmental legislation. Green chemistry alternatives to EDCs and industry incentives to reduce EDC release are also suggested remedies for EDC pollution.



MAJOR ORGANS OF THE ENDOCRINE SYSTEM The endocrine system, consisting of a network of glands, hormones, and the tissues targeted by hormones, controls some of the most critical activities of life. In plastics, medicines, perfumes, and pesticides, EDCs have emerged as environmental contaminants with the potential to disrupt the health and development of humans and wildlife.

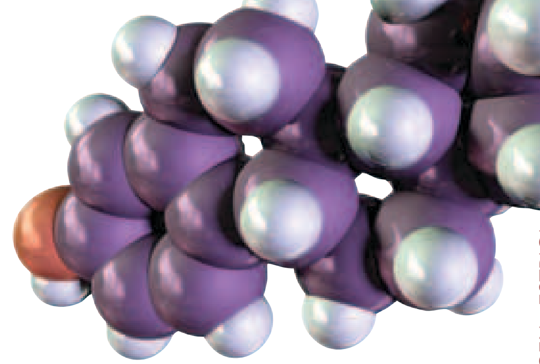
WHAT ARE ENDOCRINE DISRUPTORS?

PERVASIVE, PERSISTENT, AND UNHEALTHY In plastics, medicines, perfumes, and pesticides, endocrine disrupting compounds (EDCs) have emerged as environmental contaminants with the potential to disrupt the health of humans and wildlife. The endocrine system, consisting of a network of glands, hormones, and the tissues, controls some of the most critical activities of life. Hormones deliver specialized chemical messages throughout the body and throughout the lifespan to control growth, metabolism, and reproduction.

ADRENAL GLANDS	Secrete hormones that influence the body's metabolism, blood chemicals, and body characteristics; involved in nervous system response and defense against stress
HYPOTHALAMUS	Activates and controls the part of the nervous system that controls involuntary body functions and the hormonal system; helps regulate sleep and appetite
OVARIES AND TESTICLES	Secrete hormones that influence female and male characteristics
PANCREAS	Secretes a hormone (insulin) that controls the use of glucose by the body
PARATHYROID GLANDS	Secrete a hormone that maintains the calcium level in the blood
PINEAL BODY	Involved with daily biological cycles
PITUITARY GLAND	Produces a number of different hormones that influence various other endocrine glands
THYMUS GLAND	Plays a role in the body's immune system
THYROID GLAND	Produces hormones that stimulate body heat production, bone growth, and metabolism

Source: Atlas of the Human Body, American Medical Association's Current Procedural Terminology, Revised 1998 Edition. (http://www.ama-assn.org/ama/pub/physician-resources/patient-education-materials/atlas-of-human-body/endocrine-system.page?)

ENDOCRINE DISRUPTING COMPOUNDS HAVE BEEN DETECTED IN OUR WATERWAYS. More than 15 years' worth of research has traced possible links between EDCs and a host of diseases, including, asthma, learning disabilities, autoimmune diseases, hormone-related cancers, obesity, diabetes, and infertility.



ESTROGEN - ESTRIOL

The World Health Organization defines an EDC as a substance created outside the body that alters endocrine functioning in a way that causes adverse health effects in a person or that person's children[1]. The U.S. Environmental Protection Agency (EPA) uses a similar definition[2] in its Endocrine Disrupting Chemicals Risk Management Research program, focusing on the adverse health effects of chemicals that interact with the endocrine system. As Dr. Christopher Weis (National Institute of Environmental Health Sciences) noted, these effects can include changes in body growth and development, impaired physical or mental functions, and increased susceptibility to infection or disease. Within the range of EDCs, some chemicals may mimic the activity of the body's naturally produced hormones such as estrogen, while others may boost or lower the activity of naturally produced hormones.

More than 15 years' worth of research has traced possible links between EDCs and a host of diseases, Dr. Pete Myers (Environmental Health News) said, including learning disabilities, autoimmune diseases, hormone-related cancers, obesity, diabetes, and infertility. Weis suggests that the health impacts of EDCs could be considered in several categories. EDC exposure could trigger disease in individuals who would otherwise never have the illness, or the exposure could increase an individual's risk of developing a low-prevalence disease, or cause the person to develop disease at an earlier than usual age.

DEVELOPMENTAL DISEASES

REPRODUCTIVE/ENDOCRINE	• Breast/Prostate Cancer • Endometriosis • Polcystic Ovary Syndrome • Puberty • Fertility • Diabetes/Metabolic Syndrome • Obesity
BRAIN/NERVOUS SYSTEM	• Alzheimer's Disease • Parkinson's Disease • ADHA/Learning Disabilities
PULMOCARDIOVASCULAR	• Atherosclerosis • Asthma • Chronic Obstructive Pulmonary Disease • Heart Disease/Hypertension
IMMUNE/AUTOIMMUNE	• Systemic/Tissue-specific Autoimmune Disease • Immunosuppression
Source: Weis presentation, slide 22 . http://www.potomac.org/site/wp-content/uploads/pdfs/Weis.pdf.	

[1] http://www.who.int/ipcs/publications/new_issues/endocrine_disruptors/en/
[2] http://www.epa.gov/scipoly/oscpendo/pubs/edspoverview/index.htm

HOUSEHOLD PRODUCTSTHAT CONTAIN ENDOCRINE DISRUPTORS

ANTIINFLAMATORY/ANALGESICS	• Ibuprofin/Naproxen, Aspirin
ANTIEPILEPTICS	
PSYCHIATRICS/ANTIDEPRESSANTS	• Diazepam
CANCER THERAPEUTICS	
LIPID REGULATORS	• Artovstatin
STERIODS	• 17 α ethinylestradiol • 17 β estradiol • Estrone
PESTICIDES	• Organophosphate • Carbamates • Pyrethroids • Organochlorine
BETA BLOCKERS	• Metoprolol • Atenolol
ANTIBIOTICS AND ANTIMICROBIALS	• Sulphonamides • Tetracyclines • Triciosan
STIMULANTS	• Caffeine
DIURETICS	
PERSONAL CARE PRODUCTS	• Insect Repellants • Antioxidants • Preservatives • Soaps • Sunscreens • Fragrances/Cosmetics • Toothpaste
Source: Weis presentation, slide 7. http://www.potomac.org/site/wp-content/uploads/pdfs/Weis.pdf.	

PERVASIVE, PERSISTENT, AND UNHEALTHY Environmental contaminants may interact with EDCs to produce toxic effects, and still others may interact with natural endocrine regulators to damage health.

ENDOCRINE DISRUPTORS AND THE ENVIRONMENT The EPA's registry of commercially used chemicals contains nearly 80,000 chemicals. Myers noted that the agency must review the nearly 12,000 new chemicals added every day to the American Chemical Society's Chemical Abstracts Service registry[3]. Weis and Dr. Elaine Francis (EPA) offered extensive lists of common commercial and consumer sources of chemicals that may be detected as environmental contaminants, including caffeine; antioxidant vitamins; steroids, ibuprofen, and other anti-inflammatory medicines; common antibiotics such as tetracyclines (used in humans and farm animals); and antimicrobial products containing triclosan; pesticides; herbicides; personal care products and fragrances from soaps to sunscreens, fabric and plastic treatments. EPA also reviews pharmaceuticals including cholesterol control drugs such as statins, beta blocker drugs for heart disease, and estradiol, progesterone, tamoxifen, and other reproductive hormones used in birth control, hormone replacement therapies, and cancer treatment.

Several of these contaminants have been identified as EDCs, some may interact with EDCs to produce toxic effects, and still others may interact with natural endocrine regulators to damage health, Weis and Francis noted.

EDCs have been detected in our waterways, agricultural fields, and farm animals, and wildlife. Francis detailed a variety of pathways that EDCs take to become environmental contaminants (see below). Medicines and their containers, improperly disposed, may find their way into municipal wastewater systems. Pesticide runoff, and the dispersal of manure and slurry of concentrated agricultural operations (CAFOs) of cattle, pigs, chickens, and aquaculture operations are other common sources of EDCs.

Weis, Francis, and Dr. Luke Iwanowicz (US Geological Survey) noted that some EDCs such as pharmaceutical estrogens can come from a variety of sources, and are often difficult to distinguish from plant and animal estrogens that occur naturally. Iwanowicz also suggested that EDCs are not recognized or regulated routinely as contaminants at their source, but are instead detected as a potential health problem after being released into the environment.

EDCs vary in how long they linger as environmental contaminants, and Dr. Jerry Diamond (Tetra Tech, Inc.) said the "half-life" of EDCs (how long it takes half of a sample to disappear or lose its potency) is under intensive study.

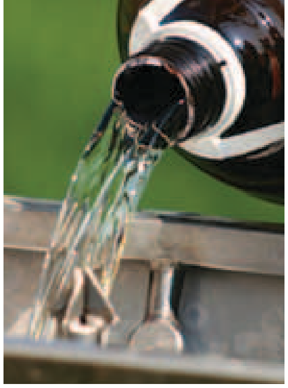
[3] http://www.sciencemag.org/content/331/6021/1136.1.full.pdf

CHEMICALS TO MONITOR

4-N-NONYLPHENOL	MUSK KETONE
4-NONYLPHENOL	PARA-NONYLPHENOL
BIS(2-ETHYLHEXYL)ADIPATE	PBDE-209
BIS(2-ETHYLHEXYL)PHTHATATE	PENTACLOROPHENOL
CAMPESTEROL	STIGMASTANOL
CHOLESTEROL	STIGMASTEROL
DESMOSTEROL	TAMOXIFEN
DI-N-OCTYL PHTHALATE	TONALIDE
EPICOPROSTANOL	B-SITOSTEROL
GALAXOLIDE	HEXABROMOCY
MESTRANOL	

Source: Diamond presentation, slide 13. http://www.potomac.org/site/wp-content/uploads/pdfs/Diamond.pdf.

EDC RISKS The pesticide atrazine has been shown to influence human birth weights and infant cognitive development at exposures of one part per billion. Exposure during development can cause molecular-level alterations that persist long after the exposure is gone.



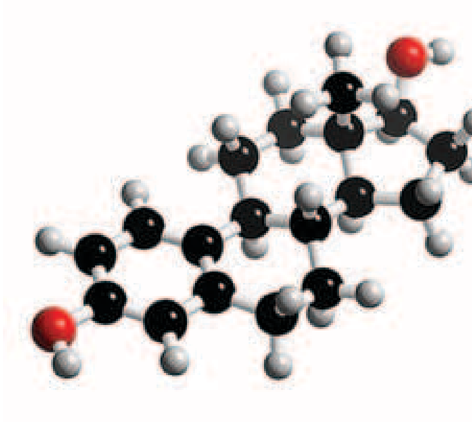
UNDERSTANDING EDC RISKS

Among the hundreds of potentially toxic chemical contaminants in our waterways, food supply, and wildlife, EDCs possess a trio of characteristics that make them especially damaging to human health:

ENDOCRINE DISRUPTORS ARE UBIQUITOUS Myers noted that thousands of chemicals are added to academic and commercial registries each day, and that hundreds of these chemicals are potential EDCs. Although most of these individual chemicals are understudied or even ignored in toxicity testing and regulation, even less is known about the combined effects of multiple EDCs. These chemical compounds may have an additive effect, where the biological effect of exposure to two or more compounds is greater or different in kind than the effects of each compound separately.

Combined effects are almost certain to happen in waterways and other points of environmental exposure, given the vast amounts of chemical contaminants deposited in these areas. As an example, Myers discussed a recent study[4] that found a doubling of the amount of estrogen in a combination of estradiol and 11 weak estrogens derived from pesticides. The increase was more than expected from estrogen measurements taken from each individual pesticide. Francis and Myers said most current assessments by regulatory agencies and others do not examine toxicity or health effects for multiple and combined EDCs.

As Diamond noted, EDC studies have taken several approaches to evaluating the level of risk posed by individual EDCs. These studies may take into account the EDC's prevalence in surface waters, its toxicity to amphibians and/or mammals, or its effect on endocrine activity. A study conducted by Diamond and colleagues evaluated risk for a number of wastewater pollutants, including EDCs. The researchers compiled a list of over 20 "chemicals to monitor" based on several methods of risk assessment.[5] EDCs derived from hormone treatments and detergents such as ethinylestradiol, nonylphenols, and tamoxifen were among the EDCs included in the list.



4 http://ehp03.niehs.nih.gov/article/fetchArticle.action?articleURI=info%3Adoi%2F10.1289%2Fehp.02110917
5 www.werf.org/diagnostictools

ENDOCRINE DISRUPTORS ARE HARMFUL IN SMALL DOSES OR NO DOSES Although it is well known that many chemicals are harmful in large doses (e.g., the dose makes the poison), Iwanowicz noted that many EDCs have been engineered to be biologically significant at the level of a few molecules. For instance, the pesticide atrazine has been shown to influence human birth weights[6] and infant cognitive development[7] at exposures of one part per billion.

Iwanowicz and Weis emphasized that small amounts of endocrine disruptors delivered at a developmentally critical period are multiplied in effect because their influence continues as tissues grow and change through the lifespan. A small dose delivered early in development can have the same magnitude effect as a larger dose delivered in adulthood.

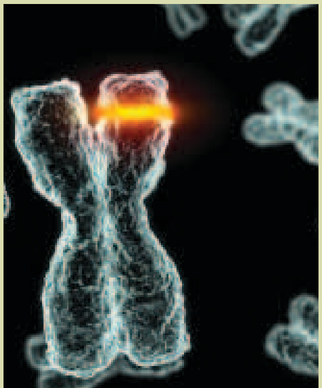
Researchers have also found that high-dose testing of EDCs cannot be used to predict low-dose effects; that is, higher doses do not necessarily have a greater effect than lower doses. This "non-monotonic" effect, Weis and Myers noted, has been observed in several experiments, most notably a 2009 study[8] involving mice exposed in the womb to the synthetic estrogen diethylstilbestrol (DES). At levels of one part per billion, the hormone caused severe obesity in the mice as adults. However, exposure at 1000 parts per billion produced slender adult mice.

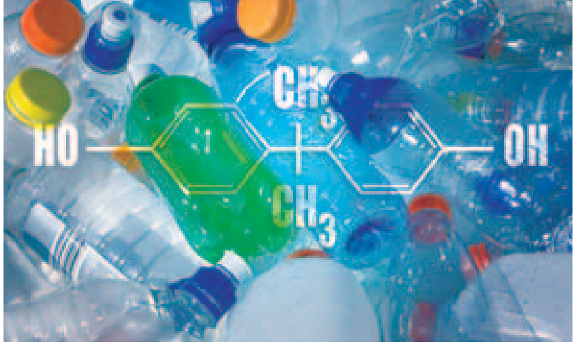
Because EDCs can have powerful effects at low levels, there appears to be no safe dose below a certain threshold level of exposure, Myers noted. Non-monotonic effects make it difficult to use traditional methods of toxicity testing, since traditional toxicology assumes that there is a threshold level of exposure below which there is no toxic effect, and that a pollutant is safe if no effect is found at high levels.

As another example of non-monotonic effects, Myers and Weis discussed the well-known "tamoxifen flare" phenomenon. Tamoxifen, an estrogen-blocking drug used to treat breast cancer, can in some cases lead to worse symptoms when small amounts are present in the body at the beginning of treatment. At low levels, tamoxifen stimulates rather than blocks the uptake of estrogen in breast tissue. A similar dosage effect may be at work with other EDCs, the speakers suggested.

ENDOCRINE DISRUPTORS HAVE LINGERING AND LATENT EFFECTS Several studies have shown that early exposure to EDCs can set in motion developmental changes that can have health effects over a lifetime. These developmental changes may visibly damage health over the entire lifespan, or may stay hidden until late life when they increase susceptibility to disease, Weis said.

Weis noted that early development—in the womb and in early childhood—is an especially sensitive time for EDC exposure. A number of factors contribute to this sensitivity: tissues are still forming and are susceptible to changes in growth; DNA repair mechanisms have not been perfected; the immune system is still naïve to many threats; and a high metabolic rate combined with poor metabolic processing in organs such as the liver make it difficult to dispose of environmental toxins. Exposure during development can cause molecular-level alterations that persist long after the exposure is gone.





Organs and body systems also develop at different rates—from 20 weeks for ear development to 10 years for a fully functioning immune system—which can extend the sensitive period for EDC exposure, Weis noted.

The effect of EDCs may also take some time to appear due to the phenomenon of bioaccumulation.[9] Animals such as fish may build up a store of chemical compounds, including EDCs, in their tissues over time, until concentrations of the compounds far exceed their usual levels in the environment. These compounds may trigger increased endocrine activity, or even become toxic, once they have accumulated at a certain level within the body.

Weis and Myers shared several notable natural and lab experiments tracing the latent effect of EDCs, including the DES mouse studies discussed above. Bisphenol A (BPA) is another common chemical component of plastics that has come under recent scrutiny as an EDC. In experiments[10] with mice exposed to a low dose of BPA in the womb, the bladder, kidneys and other vital organs failed in adulthood, Myers noted.

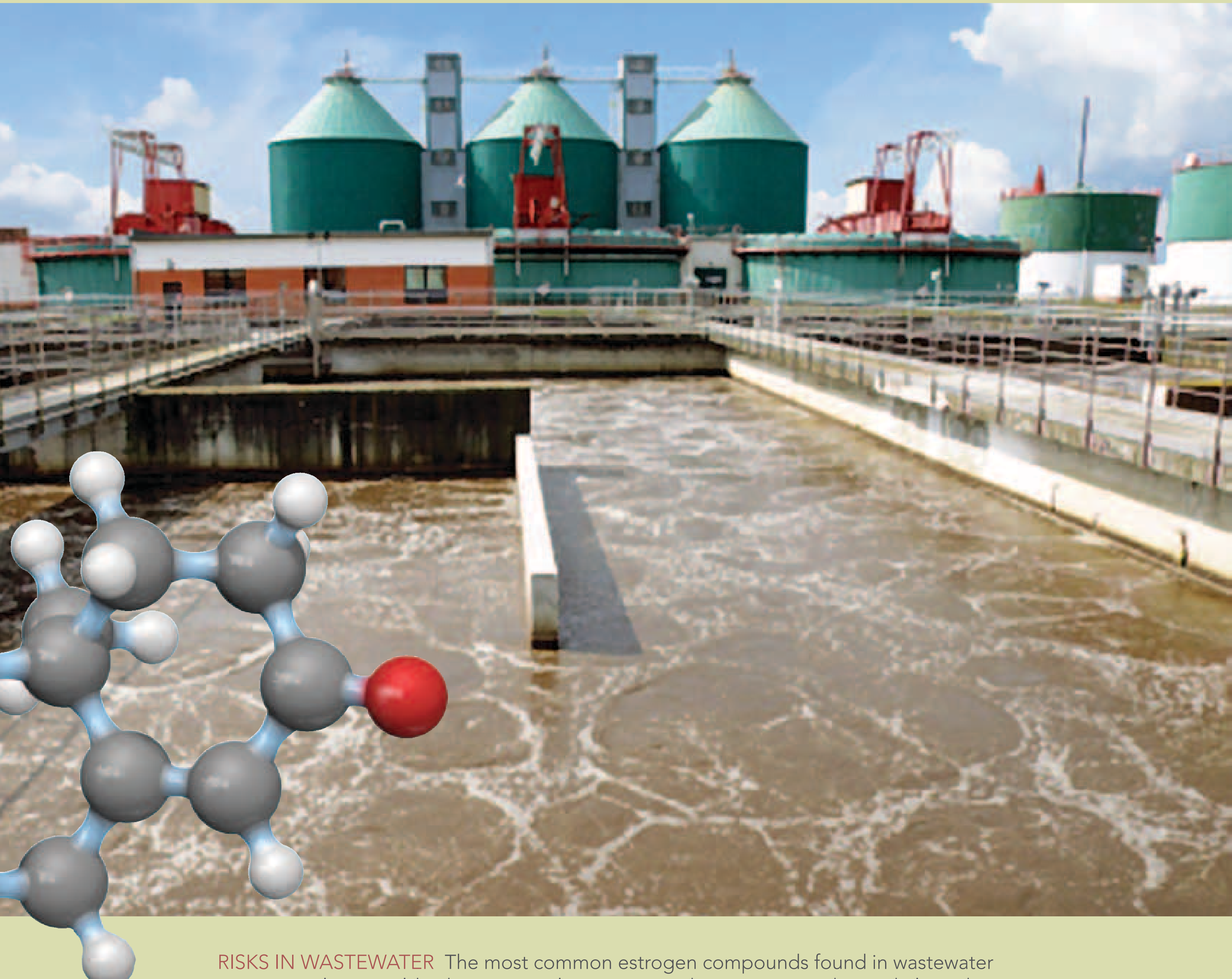
Developmental changes may even be passed on to the next generation, Weis suggested, citing a natural experiment in England after World War II. Poor nutrition among those who grew up in England during the war years had a profound effect on their children, with the offspring of World War II-era parents having a threefold increase in the rate of heart disease.

EDC exposure reaches across generations through epigenetics[11], the chemical modifications to DNA and the molecules associated with DNA that affect gene function. Endocrine disruption is a key mechanism in bringing about epigenetic changes.

Weis cited the DES experiments in mice as one example of epigenetic changes wrought by EDCs. In this case, the chemical was able to "hijack" the normal growth and development of cells to convert them into fat cells. Once these modifications have been made to the genome, they can be passed from generation to generation.

The speakers suggested that these three characteristics of EDCs make them especially challenging to assess with traditional measurements of toxicity. Myers said most standardized tests of EDC exposure and impact come from techniques and methods that are 20 to 30 years old, and he likened the task to making Hubble Telescope-scale discoveries with a pair of backyard binoculars.

[6] http://ehp03.niehs.nih.gov/article/fetchArticle.action?articleURI=info:doi/10.1289/ehp.09007840
[7] http://www.ncbi.nlm.nih.gov/pubmed/19433252
[8] http://www.ncbi.nlm.nih.gov/pubmed/19433252
[9] http://toxics.usgs.gov/definitions/bioaccumulation.html
[10] http://www.pnas.org/content/102/19/7014.full
[11] http://learn.genetics.utah.edu/content/epigenetics



RISKS IN WASTEWATER The most common estrogen compounds found in wastewater treatment plants worldwide are natural estrogens such as estrone and estradiol; synthetic estrogens such as ethinylestradiol; and the byproducts of alkylphenol ethoxylates, which come from common cleansers such as laundry detergents.

EVALUATING EDC RISKS

Humans and wildlife are exposed to EDCs primarily through natural waterways and their links to wastewater treatment, drinking water treatment, and agricultural runoff. Although EDCs have been detected in each of these main areas of concern, researchers are still in the early stages of identifying, prioritizing, and measuring the presence and effect of these chemicals.

EVALUATING RISKS IN WASTEWATER Many studies of environmental EDCs begin at wastewater treatment facilities, which already monitor a number of contaminants related to water input and output. Diamond said information from the EPA's Ecological Structure Activity Relationships (ECOSAR)[12], the PBT Profiler[13], and other databases can be used as a starting point for identifying contaminants with potential toxicity and endocrine effects. Diamond and colleagues examined studies from 700 water sites and compiled data on more than 500 chemicals of concern, eventually narrowing the list to high risk chemicals[14].

The risk-based approach used by Diamond and colleagues measured the highest detected levels of a compound and divided that level by the strongest measured effect of the compound, whether the effect was toxicity or increased endocrine activity. Diamond cautioned, however, that any list using these criteria would vary between sites, and should not be considered as the basis for monitoring requirements or regulation.

Using this approach, the researchers determined that natural hormones and steroids, along pharmaceuticals, appear to be the most common and highest—risk waterway contaminants. Surfactants (detergent additives) are also a high risk contaminant, especially since they are common and may transform into estrogen-like compounds.

Dr. Sudhir Murthy, Manager, Research & Laboratory, DC Water and Sewer Authority, agreed, noting that the most common estrogen compounds found in wastewater treatment plants worldwide are natural estrogens such as estrone and estradiol; synthetic estrogens such as ethinylestradiol; and the byproducts of alkylphenol ethoxylates, which come from common cleansers such as laundry detergents.

[12] http://www.epa.gov/oppt/newchems/tools/21ecosar.htm
[13] http://www.pbtprofiler.net
[14] werf.org/diagnostictools

EXAMPLES OF ENDOCRINE DISRUPTORS IN DRINKING WATER

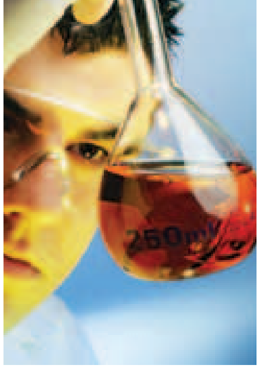
HERBICIDES	• Atrazine
FUNGICIDES	• Tri-butyl-tin • Vinclozolin
INSECTICIDES	• Chlordane • DDT and Metabolites • Methoxychlor • Parathion
INDUSTRIAL CHEMICALS	• Bisphenol-A • Dioxin (2,3,7,8-TCDD) • Nonylphenol • Octylphenol • PCBs • Phthalates

Source: Weis presentation, slide 9. http://www.potomac.org/site/wp-content/uploads/pdfs/Weis.pdf

Once the contaminants themselves have been identified and ranked in terms of their potential impact on environmental and human health, researchers must evaluate whether a geographical location along a waterway may be a high risk zone. As Diamond and Francis noted, sites where the incoming water contains high levels of hormones, steroids, or estrogen-like plasticizer chemicals could be considered high risk sites.

Wastewater treatment plants where nutrients are removed at lower rates than other plants, sites where wastewater is less diluted; or sites where organisms are unable to move freely away from sources of contamination, may all present a higher risk of EDC contamination.

Other factors contributing to an area's risk may include the surrounding region's input to wastewater systems. Areas near industries that use or produce large amounts of surfactants in a manufacturing process, for example, or CAFOs, should be monitored carefully for EDC impact.

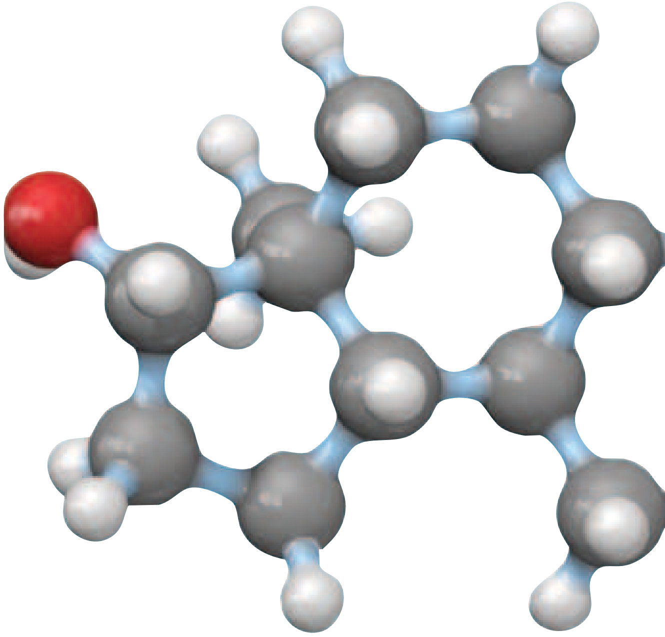


EVALUATING RISKS IN DRINKING WATER Researchers who evaluate EDC risk in drinking water use similar approaches to those used in wastewater management, Diamond and Tom Jacobus said. Endocrine disruptors that have been detected in both wastewater and drinking water are included in the chart on the left.

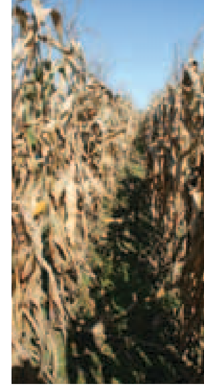
Jacobus noted that drinking water facilities must contend with a number of other potentially toxic contaminants beyond EDCs, including deicing salts, nanomaterials, hexavalent chromium, and iodine 131. Drinking water facilities also screen for microorganisms such as cryptosporidium parasites (which can cause gastrointestinal illness) and natural sediments such as iron that may affect the water's taste. Jacobus said drinking water facilities include compounds that cause a cloudy appearance or distasteful water alongside EDCs as contaminants of concern, although some of these compounds change the water's appearance or taste without any known toxic effect. These waters are still treated because these undesirable characteristics may cause the water to be rejected by the facilities' customers.

Diamond and Jacobus suggested that EDCs do not persist in the environment for long periods. Instead, they are replenished frequently in surface waters. To measure an EDCs risk in wastewater and drinking water, they suggested, researchers should look at the maximum concentration of an identified EDC, along with the known level of its most potent effect.

Diamond suggested that careful studies of key animals such as fish can be better indicators of EDC impact than studies that detect single chemical levels in the water itself. Animals can be effective tools for determining how much of an EDC is needed to have a measurable impact on health, or to show what happens when animals must cope with two or more contaminants at a time, he noted. Eventually, studies of individual animals should give way to evaluations conducted across entire animal populations. Diamond said these broader studies can help determine the impact of EDC contamination at the ecosystem level, and may help researchers learn more about the lingering, generational effects of EDCs.



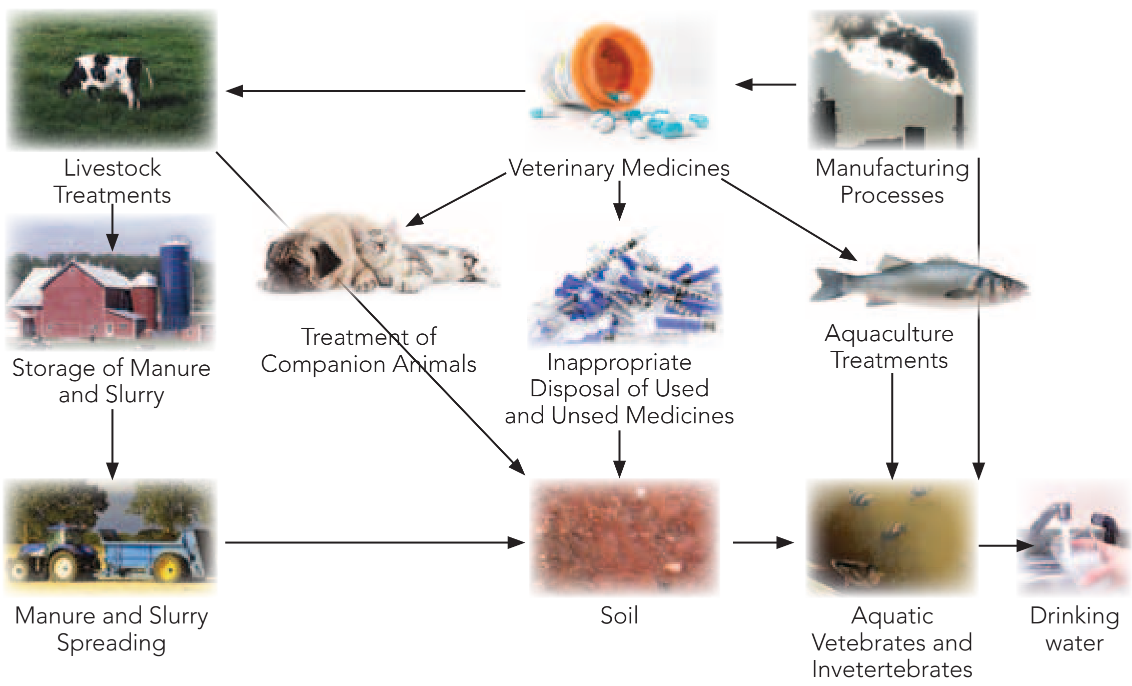
RISKS FROM AGRICULTURE Agricultural practices at the concentrated animal feeding operations, or CAFOs, including pharmaceutical treatment with antibiotics and natural and artificial hormones, are being scrutinized as a source of EDCs.



EVALUATING RISKS FROM AGRICULTURE Agricultural practices, including pharmaceutical treatment with antibiotics and natural and artificial hormones, are being scrutinized as a source of EDCs. Francis said the U.S Food and Drug Administration (FDA) recognizes 48 marketed animal drugs that include steroid hormones, mostly reproductive hormones such as estrogens and androgens. Francis also noted that these veterinary pharmaceutical treatments can make their way from animal operations to drinking water through a number of routes.

The EPA's Endocrine Disruptors Research Program[16] is focusing on CAFOs, as a significant source of EDC pollutants, Francis said in her talk. The EPA definition of a CAFO is a "large or medium animal feeding operation where the animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period."[16] A 2008 General Accounting Office study[17] found a 230% increase in the number of CAFOs in the United States between 1982 and 2002, representing a jump from 3,600 to nearly 20,000 operations.

SOURCES OF FATE OF VETERINARY DRUGS TO RECEIVING WATERS

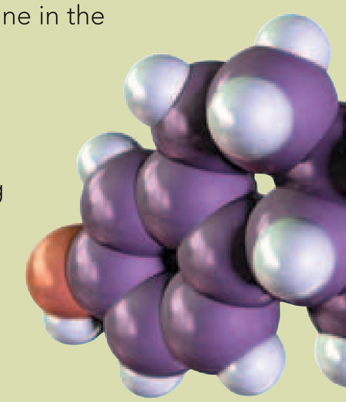


EPA
Office of Research and Development
Modified from Boxall et al., 2003, *Environmental Science and Technology*
(Source: Francis presentation, slide 6)

[15] http://www.epa.gov/endo
[16] http://cfpub.epa.gov/npdes/afo/cafofinalrule.cfm
[17] http://www.gao.gov/products/GAO-08-1177T
[18] http://www.accessdata.fda.gov/scripts/animaldrugsatfda

Through extramural grants made to researchers throughout the country, the EPA Endocrine Disruptors Research Program is working to increase its knowledge about the amount and fate of steroid hormones associated with animal waste, to determine the impact of hormones from CAFO waste on water and land, and to evaluate new or improved options for handling animal waste that reduce the flow of steroid hormones into natural habitats.

Francis detailed several of these studies in her talk. For instance, the EPA has studied the effects the male steroidal hormone trenbolone acetate, given to cattle to produce leaner meat, on laboratory populations of the fathead minnow[19]. Trenbolone exposures at levels similar to those found in a natural environment have a "masculinizing" effect on female fathead minnows, altering their appearance and decreasing their egg production. In the wild, the change in egg production could produce a measurable decline in the minnow population within 2-5 years.



In studies from Purdue University and others, Francis said, researchers have documented differences in watersheds near CAFOs, including less diverse fish communities, smaller than normal reproductive organs in creek chub fish, higher levels of testosterone in male snapping turtles, and more males than usual among fish embryos.

Beyond CAFOs, Weis noted that agricultural runoff of pesticides and herbicides, leaching from landfills, and urban runoff can also be sources of EDCs and other compounds of concern.

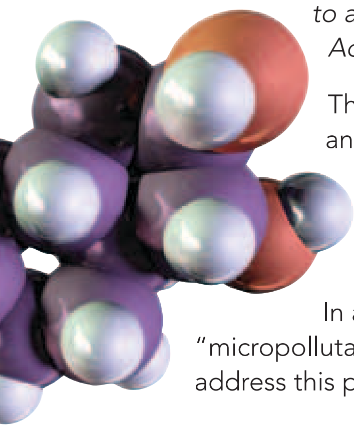
Atrazine in particular has a seasonal peak presence in the Potomac River watershed due to runoff, Iwanowicz said. The herbicide is sprayed on agricultural fields in the spring, but high levels of atrazine and its chemical byproducts appear in the watershed in the fall.

19 http://www.ncbi.nlm.nih.gov/pubmed/12785594
20 http://www.epa.gov/opp00001/regulating/laws/fqpa/backgrnd.htm
21 http://www.epa.gov/opp00001/regulating/laws/fqpa/backgrnd.htm
22 http://www.epa.gov/scipoly/oscpendo/pubs/edspoverview/primer.htm
23 http://www.fda.gov/regulatoryinformation/legislation/federalfooddrugandcosmeticactfdcact/default.htm
24 http://www.epa.gov/oecaagct/lfra.html
25 http://www.epa.gov/regulations/laws/cwa.html
26 http://www.epa.gov/regulations/laws/cwa.html
27 http://www.micropollutants.org/report.php
28 http://www.epa.gov/regulations/laws/rcra.html
29 http://www.epa.gov/regulations/laws/esa.html
30 http://thomas.loc.gov/cgi-bin/bdquery/z?d112:HR02521:|/home/LegislativeData.php
31 http://www.micropollutants.org/report.php

LEGAL REMEDIES AND REGULATION

Several federal acts give the EPA an obligation to measure and advise on EDC levels in the environment, Francis said. For instance, the 1996 Food Quality Protection Act[20] and the 1996 Amendments to the Safe Drinking Water Act[21] require EPA to:

"Develop a screening program, using appropriate validated test systems and other scientifically relevant information, to determine whether certain substances may have an effect in humans that is similar to an effect produced by a naturally occurring estrogen, or other such endocrine effect as the Administrator may designate." [22]



The Federal Food, Drug, and Cosmetics Act (FFDCA)[23], The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)[24], and the Clean Water Act (CWA)[25] give the EPA authority to require testing of all pesticides. The Toxic Substances Control Act (TSCA)[26] provides authority for EPA to require testing of TSCA chemicals, including some EDCs, provided certain hazard and/or exposure-based findings are made.

In a four-year EPA-funded project, Gabriel Eckstein and colleagues looked at the prevalence of "micropollutants" (such as EDCs) in American waterways, and the potential legal and policy remedies to address this pollution[27].

Eckstein concluded that many of these legal remedies are weak or difficult to apply to EDC pollution. Tort remedies and litigation, for example, do not usually result in larger policy changes to regulate or remove EDCs in the environment. Each chemical of concern must be litigated separately in an often expensive, time-consuming, and case-specific process. Moreover, there are significant evidentiary and procedural barriers to establishing the harm caused by an individual chemical in the face of the thousands of chemicals that Americans are exposed to on a regular basis.

In addition, major environmental legislation including the Clean Water Act, the Safe Drinking Water Act, the Resources and Conservation Recovery Act[28], and the Endangered Species Act[29] are a poor fit for micropollutant regulation, Eckstein explained. None of these laws were designed to deal specifically with these chemicals or products or the sheer numbers of manufactured EDCs introduced into our fresh water systems every year. , Notwithstanding, Congress has made efforts to formulate additional regulations, most recently, in July 2011, in the form of The Endocrine-Disrupting Chemicals Exposure Elimination Act of 2011.[30] Introduced in both the U.S. Senate and House of Representatives, the Act is intended to strengthen research into the prevalence and effects of EDCs, as well as clarify their regulation by law such as the Clean Water Act and Safe Drinking Water Act.

Nevertheless, in light of current legal barriers, Eckstein suggested that a more effective regulatory route for minimizing the threats of EDCs in our fresh water systems may come from actions taken before EDCs and other micropollutants enter the environment. These efforts would focus on removing or limiting EDCs at the source of production and disposal and might include: designing drugs and other products that minimize EDC content; educating physicians and patients to tailor doses of EDC-containing medication to maximize absorption and minimize excretion; developing programs for the proper disposal of pharmaceuticals and other EDC-containing products.[31]

ENDOCRINE DISRUPTORS IN FISH Scientists found a significant number of fish in the Potomac carried intersex characteristics. In the smallmouth bass, the male animals typically contained female reproductive tissue (developing egg cells) in male reproductive tissue.

ENDOCRINE DISRUPTORS IN THE POTOMAC BASIN

ENDOCRINE DISRUPTORS IN POTOMAC FISH

The potential impact of EDCs in the Potomac River watershed came to public attention during the 2002-2003 South Branch fish kill that affected predominantly smallmouth bass but also affected other species. The South Branch fish showed signs of severe immunosuppression, bearing sores and large loads of harmful bacteria that would otherwise have been contained by a healthy immune system. Scientists analyzing the kill's causes uncovered another startling phenomenon: a significant number of fish carried intersex characteristics. Intersex refers to animals that abnormally carry both female and male reproductive tissue. In the smallmouth bass, the male animals typically contained female reproductive tissue (developing egg cells) in male reproductive tissue[31].

The intersex features in the South Branch fish prompted an ongoing search for estrogen exposure and endocrine disrupting compounds in the Potomac waters. Iwanowicz presented the details of studies conducted in 2005-2006 along the Potomac watershed at wastewater treatment plants, considered a potential source of EDC contaminants. The studies[32, 33] determined chemical contaminant levels in the regions near the treatment plants and compared EDC exposure at these points with the prevalence of intersex fish.

The Potomac tributaries tested in collaboration with U.S. Fish and Wildlife Service included Conococheague (up and downstream), Monocacy (up and downstream), and the wastewater treatment plant at Blue Plains. The researchers found differences in how sensitive fish species were to EDC exposure, although they did not confirm differences in intersex prevalence above and below the treatment plants, Iwanowicz said.

The researchers did find a positive link between the prevalence and severity of intersex fish and the density of human population and agricultural land use in the region. The intersex condition was more common in areas with dense human settlement and intensive agriculture. Despite the thought that intersex fish would be more common around wastewater treatment plants, the bulk of the studies showed a stronger link between intersex condition and proximity of agricultural operations. Iwanowicz noted that intersex conditions among small and largemouth bass were most common in the Shenandoah and main stem of the Potomac, compared to the South Branch.

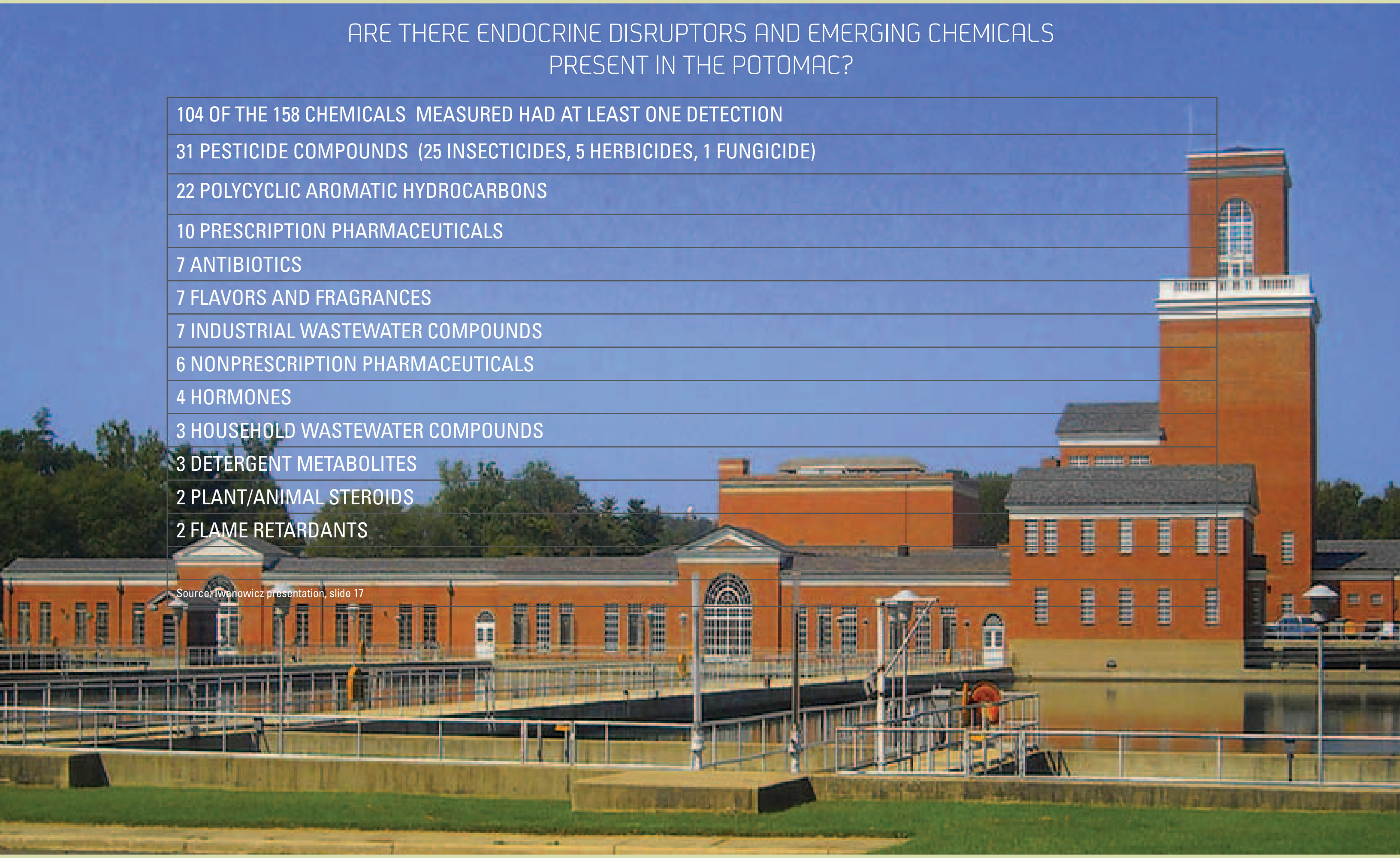
Iwanowicz also discussed data collected during 2007 regarding chemical contaminants, including the antibacterial triclosan, pesticides, and the plastic additives BPE and PCB (some of which have endocrine disrupting effects) from the Shenandoah River. The contaminants appear to concentrate more heavily in some fish tissues than others, the study concluded. For instance, the contaminants were found in high amounts in the ovary, but relatively small amounts in muscle tissue.

[31] http://antietamflyanglers.org/docs/jaahintersex.pdf
[32] http://onlinelibrary.wiley.com/doi/10.1897/08-433.1/full
[33] http://onlinelibrary.wiley.com/doi/10.1897/08-417.1/full
[34] Ciparis *et al.* (Submitted) *Science of the Total Environment*
[35] Blazer *et al.* (In press) *Environmental Monitoring and Assessment*

ENDOCRINE DISRUPTORS IN POTOMAC WATER

During the 2007 fish spawning study in the Potomac Basin, researchers looked at the prevalence of EDCs at sample sites on the Gauley River, South Branch of the Potomac, Shenandoah and Monocacy basins. The study detected hormones, including estradiol, estrone, and androstenedione. Other chemicals detected included pesticide and herbicide compounds (including atrazine), prescription medicines, antibiotics, fragrances, and detergent compounds, Iwanowicz said.

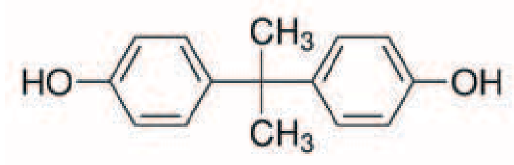
The discoveries of intersex fish in the Potomac watershed has led the Blue Plains wastewater treatment plant, which serves 2 million customers in the District of Columbia, Montgomery, Prince George, Fairfax, and Loudoun counties, to track estrogen as a potential wastewater contaminant. Murthy said the most common estrogen or estrogen-like compounds found in the Blue Plains influent wastewater include natural estrogens excreted by women, synthetic estrogens such as the chemicals found in birth control pills, and laundry detergent additives called akylphenol ethoxylates. These substances can be removed during wastewater treatment, and facilities designed for nitrogen and phosphorus removal are more effective in the removal of these compounds.



ARE THERE ENDOCRINE DISRUPTORS AND EMERGING CHEMICALS PRESENT IN THE POTOMAC?

104 OF THE 158 CHEMICALS MEASURED HAD AT LEAST ONE DETECTION
31 PESTICIDE COMPOUNDS (25 INSECTICIDES, 5 HERBICIDES, 1 FUNGICIDE)
22 POLYCYCLIC AROMATIC HYDROCARBONS
10 PRESCRIPTION PHARMACEUTICALS
7 ANTIBIOTICS
7 FLAVORS AND FRAGRANCES
7 INDUSTRIAL WASTEWATER COMPOUNDS
6 NONPRESCRIPTION PHARMACEUTICALS
4 HORMONES
3 HOUSEHOLD WASTEWATER COMPOUNDS
3 DETERGENT METABOLITES
2 PLANT/ANIMAL STEROIDS
2 FLAME RETARDANTS

Source: Iwanowicz presentation, slide 17



EDC MONITORING, REMOVAL, AND REGULATION IN THE POTOMAC

Although EDCs are still under study and consideration for regulation, some water managers in the Potomac Basin have chosen to evaluate the potential threat of EDCs prior to regulation. Jacobus, said public confidence in the region's water supply is a key driver behind Washington Aqueduct's decision to monitor EDCs. The facility supplies drinking water to one million people in the District of Columbia region through the Dalecarlia and McMillan treatment plants.

Washington Aqueduct's current EDC studies will affect future decisions on how and when to treat water to remove these contaminants, Jacobus said. For the moment, Washington Aqueduct treats water primarily through a multi-tier system that coagulates and filters particles and disinfects the water with chlorine. Washington Aqueduct is examining the treatment procedures that can remove contaminants such as EDCs, what sort of additional wastes might be produced by this treatment, and the cost-effectiveness of such treatment.

Jacobus said the Aqueduct's current water supply meets and exceeds federal requirements for water treatment, but that the Aqueduct is working to keep ahead of any new requirements in part through its participation with the Potomac Drinking Water Source Protection Partnership[36].

Murthy said the Blue Plains wastewater plant uses several processes to treat its water, from filtration of larger particles to biological and chemical degradation of nutrients such as nitrogen and phosphorus. He noted that 95-100% of estrogens that have been degraded can be removed by treatment[37], although the exact level of removal depends on the types of treatment used. The longer estrogen is given to degrade, he said, the more of it can be removed[38].

The European Union and Canada have restricted the use of alkylphenol ethoxylates, detergent ingredients that degrade into estrogen-mimicking compounds, Murthy said. The United States has no restrictions on the compounds, although the EPA is supporting their phase-out in industrial laundry detergents[39].

He noted that the Blue Plains plant has used yeast estrogen screens (YES) to test for estrogen and estrogen-like compounds across several stages of treatment. Using YES, he said, Blue Plains has found estrogens in the primary and secondary treatment stages, where particles are filtered and removed, but has not detected them with the screen at further stages of chemical and biological treatment.

Murthy, Myers, and Diamond also noted that treatment processes at Blue Plains and other facilities that are designed to remove nutrient contaminants (such as large amounts of phosphorus) are also very efficient at removing estrogens. They suggest that improvements to nutrient removal should bring benefits to EDC removal as well.

[36] http://www.potomacdwspp.org
[37] http://www.werf.org/AM/Template.cfm?Section=Search&Template=/CustomSource/Research/ResearchProfile.cfm&ReportId=01-HHE-20T&ID=01-HHE-20T
[38] http://www.ingentaconnect.com/content/wef/wer/2005/00000077/00000001/art00003
[36] http://www.potomacdwspp.org
[39] http://www.epa.gov/oppt/existingchemicals/pubs/actionplans/np-npe.html

THE POTOMAC'S FUTURE Green chemistry offers a preventive approach by removing EDCs from products before they have a chance to become waterway contaminants.

ENDOCRINE DISRUPTORS IN THE POTOMAC'S FUTURE

The risks posed by EDCs in the Potomac watershed have been difficult to quantify, in part because the waters can contain thousands of potential endocrine disruptors. Despite this uncertainty, Myers and others noted, science in the field of EDCs has reached the point where researchers can confirm that exposure to some EDCs can pose serious health risks.

A PRECAUTIONARY, PREVENTIVE OUTLOOK

Several speakers at the Disruption forum expressed hope that the EDC problem could be addressed in part by "green chemistry," or chemical processing that minimizes environmental toxins produced during manufacturing and in its final products[40]. In the case of EDCs, Myers said, green chemistry could aid in the design of pesticides and detergents that do not break down into estrogen-like compounds. The approach might also be used to design EDC molecules that degrade more rapidly in water, or are flushed quickly from the body before they can become bioaccumulative. Green chemistry might also facilitate the search for replacement molecules for EDCs, which can perform similar functions but do not have endocrine disrupting effects. In these ways, Myers explained, green chemistry offers a preventive approach by removing EDCs from products before they have a chance to become waterway contaminants.

Researchers in several fields of chemistry and materials science are already working with environmental health scientists to design new molecules that can be a healthier replacement for EDCs in products such as plastics and pharmaceuticals. Francis said the EPA supports these green chemistry efforts through the Presidential Green Chemistry Challenge award[41], and is preparing a new series of grants to encourage more academic scientists to pursue green chemistry projects.

Eckstein also encouraged solutions that would remove EDCs from products in favor of greener alternatives, especially since current law is not well suited to addressing micropollutants after they are released into the environment. In addition to crafting greener molecules, he said, researchers should also pursue smarter drug delivery systems that deliver targeted doses of medicines to people and livestock while minimizing the excretion of "leftover" EDCs. Eckstein also recommended that the pharmaceutical industry and others should promote proper disposal and recycling of products and containers that could release EDCs.

Green chemistry could also play a role in developing remediation strategies for wastewater and drinking water treatment, several speakers suggested. Murthy said new studies of the dynamics of biodegradation, where bacteria break down wastewater contaminants, could lead to the synthesis of "helper" molecules or different biodegradation containers to speed the process and remove higher levels of contaminants.

[41] http://www.epa.gov/oppt/existingchemicals/pubs/actionplans/np-npe.html
[42] http://www.epa.gov/gcc/pubs/pgcc/presgcc.html

Myers and Weis also noted that cutting-edge research that defines the biological impact of EDCs on human health, particularly their lingering effects due to epigenetic changes, offer an unusual hope for preventive treatment. Research is now showing that some diseases that were once thought to be irrevocably "in the genes" from birth may actually have their critical roots in early development. Weis said this change in thinking could alter the focus from curing diseases such as diabetes or certain cancers, to intervening during development to prevent the disease from the start.

SEARCHING FOR BETTER TOOLS

Murthy and others noted that technological advances, such as the YES assay to test for the presence of estrogens, have improved how EDCs are identified in the watershed and how their health impacts are measured in wild species. At the level of the wastewater treatment plant, new technology such as cold-weather efficient biodegradation tanks may aid in the design of treatment plants that encourage the degradation of estrogen and other compounds, Murthy and Diamond said.

Contamination by multiple and potentially interacting EDCs remains a problem for researchers looking for ways to measure and monitor EDCs at levels that affect health. Francis said the EPA's ToxCast™ tool[42] will be one way that scientists can screen hundreds of chemicals in the watershed at one time to test for toxicity. She noted ongoing EPA tests of the Polar Organic Chemical Integrative Sampler (POCIS), a collector that samples chemicals in water over time and will soon be used to study water intake and outflow at wastewater treatment plants. Francis also emphasized the importance of ongoing studies by EPA researchers and others to develop "mode of action" biological assays that can measure the impact of multiple EDC on hormone activity.

Phosphorus and other nutrient runoff from CAFOs and other agricultural lands are still a larger concern than EDCs for the Potomac watershed and the region's Chesapeake Bay, Diamond suggested. But Diamond and other speakers also noted that efforts at wastewater treatment plants and agricultural facilities to remove nutrient contaminants can also benefit EDC removal. For instance, Francis noted that a University of Maryland study of poultry manure, comparing till methods to reduce nitrogen and phosphorus runoff, also found that tilling methods could affect estrogen runoff as well.

REFINING REGULATIONS As the research on EDCs continues, the speakers agreed that federal regulations of the chemicals and penalties for pollution remain an emerging issue. Myers and Murthy suggested that economic incentives for developing green chemistry products would be more effective than pollution penalties for the short-term future. Murthy suggested that incentives such as extended periods of patent protection could be used to encourage more green chemistry research. Francis agreed that incentives for industry to take greater responsibility for the composition and disposal of products containing EDCs would be preferable to regulation at this time. To guide industry in this endeavor, she said, the EPA is developing its programs to look at the entire "life cycle" of a chemical, rather than its usual programs and regulations aimed at chemicals that have already entered the environment.

Francis discussed the progress of the EPA's Endocrine Disruptor Screening Program, which in 2009 began testing its first list of priority chemicals[43] for effects on endocrine functioning. The program has a two-tier approach: Tier 1 will test chemicals that have the potential to interact with the endocrine system; and Tier 2 will determine the endocrine-related effects caused by each chemical and obtain information about effects at various doses[44]. EPA is also drafting policies and procedures[45] for which chemicals must be tested under Tier 1, she said.

Speakers at the conference also shared some ideas about how individuals can minimize the release of EDCs into the Potomac and other waterways. Eating organic food, avoiding canned food and plastic products containing chemicals such as BPA, using fewer pesticides and herbicides, and buying personal care products without fragrances were some of the most popular suggestions from the panel. All too often, Murthy said, the "no litter" philosophy that keeps Americans from throwing trash on the ground is forgotten when it comes to pouring a medicine down the sink or rinsing a pesticide into the streets, where it can have a long lasting and significant effect on the health of our rivers.

Studies that examine the impact of EDCs on human health, and on the health of animals in our waterways, leave no doubt that the chemicals should be monitored as an emerging environmental threat. But the sheer numbers of EDCs, along with their lingering effects, pose special difficulties for researchers hoping to learn more about the compounds. Academic researchers, government agencies, industry, public utilities and consumers must work together toward a better understanding of where EDCs accumulate, which ones pose the greatest risk in our rivers, and how they can be removed from the environment.

[42] http://www.epa.gov/ncct/toxcast
[43] http://www.epa.gov/endo/pubs/prioritysetting/final_listfacts.htm
[44] http://www.epa.gov/endo
[45] http://www.epa.gov/endo/pubs/regaspects/index.htm

APPENDIX
Disruption: New Pollutants in the Potomac and Beyond

Continental Ballroom, The Marvin Center
The George Washington University, Washington, DC

June 3, 2011

Conference Agenda

8:30 Registration

9:00 Welcome/Opening Remarks — Hedrick Belin, President, Potomac Conservancy

9:10 Keynote Speaker — J. P. Myers, Ph.D., CEO and Chief Scientist, Environmental Health Sciences, Charlottesville, VA

9:30 The History of Endocrine Disrupting Compounds (EDCs) in the Potomac River & Effects on Aquatic Life — Luke Iwanowicz, Ph.D., Research Biologist, United States Geological Survey, Kearneysville, WV

10:00 The Effect of EDCs on Human Health and Development — Christopher P. Weis, Ph.D., DABT, Senior Toxicologist, National Institute for Environmental Health Science, Bethesda, MD

10:30 Identification and Risk Assessment of Commonly Observed EDCs in Surface Waters — Jerry Diamond, Ph.D., Principal Aquatic Ecologist and Director of Ecotoxicology, Tetra Tech, Inc., Owings Mills, MD

11:00 Washington Aqueduct's Future Treatment Alternatives Project — Tom Jacobus, General Manager, Washington Aqueduct, Washington, DC

11:30 Sources and Treatment of EDCs in Wastewater — Sudhir Murthy, Ph.D., Manager, Research & Laboratory, DC Water and Sewer Authority, Washington, DC
12:00 Lunch

12:30 EPA's Endocrine Disruptors Research Program— Elaine Francis, Ph.D., National Program Director, Pesticides & Toxics Research Program, Office of Research and Development, US Environmental Protection Agency, Washington, DC

1:00 Regulating PPCPs and EDCs in our Drinking Water: Traditional Mechanisms and Alternative Strategies — Gabriel E. Eckstein, Professor of Law, Texas Wesleyan University School of Law, Fort Worth, TX; Senior Fellow, Center for Water Law & Policy, Texas Tech University School of Law, Lubbock, TX

1:30 PANEL: Solutions for EDCs in the Potomac and Beyond — Moderator: Juliet Eilperin, Washington Post, Washington, DC

2:30 Closing remarks, Hedrick Belin

Potomac Conservancy thanks The Palmer Foundation, The Munson Foundation, and The Keith Campbell Foundation for the Environment for their generous support.

APPENDIX: Speaker Biographies

H. Hedrick Belin

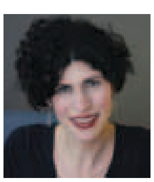
As president of Potomac Conservancy, Hedrick provides overall strategic direction to the Conservancy's land, policy, outreach and fundraising programs. He came to the Conservancy in 2007 with more than 15 years of nonprofit fundraising and leadership experience, most recently as Vice President of the Metropolitan Group, a strategic communication and resource development consulting firm. Before joining the Metropolitan Group, Hedrick worked for several conservation groups, including the National Park Foundation, Izaak Walton League of America, and the League of Conservation Voters. In addition to his extensive fundraising and management expertise, Hedrick has experience mobilizing grassroots advocates, formulating public policy, partnering with public agencies and developing conservation programs. Hedrick received his bachelor's degree in history from Yale University, and his master's in public administration from George Washington University.

Jerry Diamond, Ph.D.

Dr. Jerry Diamond is a principal aquatic ecologist and a director of ecotoxicology at Tetra Tech with more than 25 years of experience in aquatic toxicology, design and interpretation of ecological and water quality assessments, ecological risk assessments, beneficial use analyses, and water quality criteria and standards. He has developed and managed hundreds of projects involving toxicological responses of aquatic organisms and aquatic communities to a variety of chemicals and other stressors. He is an Editor of Aquatic Toxicology for the international journal Environmental Toxicology and Chemistry, and he has served on many peer review committees for other journals, EPA Office of Research and Development, NSF, and other granting institutions.

Gabriel Eckstein, Ph.D.

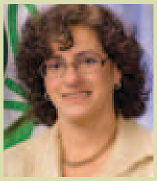
Professor Eckstein, of the Texas Wesleyan University School of Law, is a recognized expert in US and international water law and policy and has significant experience in U.S. and international environmental law and policy. He has lectured in numerous law and science conferences around the world, and served as an expert advisor and consultant on US and international environmental and water issues to various organizations, including the United Nations, US Agency for International Development, World Commission on Dams, Organization of American States, International Association of Hydrogeologists, and various local water entities in the United States. Professor Eckstein is also a Senior Fellow with the Texas Tech University Center for Water Law & Policy, where he has just concluded a four-year research effort investigating pharmaceuticals and other micropollutants in our nation's drinking water and the legal and regulatory responses to such contaminants. Professor Eckstein regularly teaches courses and seminars on U.S. and international water law, U.S. and international environmental law, U.S. property law, law and science, and related topics. Prior to joining academia, Professor Eckstein served as Senior Counsel for CropLife America, an agrichemical trade association, advising on matters of U.S. and international regulatory and environmental law and compliance issues related to agricultural chemicals and biotechnology, air and water pollution, endangered species, and intellectual property. Prior to that, he worked as a litigator in private practice on environmental, toxic tort, and asbestos cases.



Juliet Eilperin

Since April of 2004 Ms. Eilperin has covered the environment for the national desk of the Washington Post, reporting on science, policy and politics in areas including climate change, oceans, and air quality. In 2005, she taught political reporting as the McGraw Professor of Journalism at Princeton University. She joined the Post as its House of Representatives reporter in March 1998, covering the impeachment of Bill Clinton, lobbying, legislation, and four national congressional campaigns. Rowman & Littlefield has published her first book, "Fight Club Politics: How Partisanship is Poisoning the House of Representatives," and on June 14, Pantheon will publish her second book, "Demon Fish: Travels Through the Hidden World of Sharks." Ms. Eilperin graduated in 1992 magna cum laude from Princeton University.

APPENDIX: Speaker Biographies



Elaine Z. Francis, Ph.D.

Dr. Elaine Francis is the National Program Director for the U.S. Environmental Protection Agency's Pesticides and Toxics Research Program. She coordinates the development and implementation of multi-million dollar intramural and extramural research programs, working with scientists from across EPA, other federal agencies, governments of other countries, academia, and the regulated scientific community. The research programs she oversees include those on endocrine disruptors and the development of testing, risk assessment, and risk management approaches for pesticides and toxic substances. Elaine has been at EPA for over 30 years. She spent 1991 as a legislative fellow to Senator Joseph Lieberman of Connecticut working on pesticides, lead, and children's issues. Elaine received her Bachelor of Science in Biology from American University in Washington, DC. She received her doctorate in Anatomy from Thomas Jefferson University in Philadelphia, from which she received the Distinguished Alumni Award in 2001. Elaine is the recipient of numerous awards at EPA, including a gold, a silver, and twelve bronze medals.

Luke Iwanowicz, Ph.D.

Dr. Iwanowicz is a research biologist at the USGS, Leetown Science Center, National Fish Health Research Laboratory located in Leetown, WV. He is a multidisciplinary fish health scientist with expertise in the fields of virology, molecular biology, immunology, endocrine physiology, endocrine disruption, and environmental health monitoring. His current virological research projects include the application of molecular methods to identify putative viral agents associated with fish disease, and the identification of immune regulated genes involved in viral disease outbreaks. In addition to this work, he continues to engage in research studies regarding fish health and endocrine disruption associated issues in the Chesapeake Bay Drainage and the Great Lakes. He is an active member of the American Fisheries Society - Fish Health Section for which he currently serves as chair of the communications committee and webmaster of the section website. He is also an associate editor of the Journal of Aquatic Animal Health.

Tom Jacobus

Tom Jacobus is the general manager of Washington Aqueduct., the water utility operated by the U.S. Army Corps of Engineers that provides potable water to the District of Columbia and to Arlington County and the City of Falls Church service area in Northern Virginia. Tom Jacobus came to Washington Aqueduct in October 1994. Since then he has been part of the team that has streamlined and improved the capabilities of the workforce, executed major improvements to infrastructure, and continued to modify the water treatment process to meet increasingly stringent regulatory standards and customer expectations. Prior to assuming his duties at Washington Aqueduct, he served as an active duty Corps of Engineer military officer in a variety of assignments including Vietnam, Europe, and installations in the United States. He graduated from West Point and subsequently received masters degrees in nuclear engineering from Iowa State University and business administration from Long Island University. He is registered as a professional engineer in Virginia.

Sudhir Murthy, Ph.D.

Dr. Murthy is Manager, Research and Laboratory, and manages research, development and planning initiatives for the Department of Wastewater Treatment at the District of Columbia Water and Sewer Authority. Dr. Murthy has been associated with the Blue Plains plant on projects ranging from process design to process optimization for nitrogen and phosphorus removal, and solids processing and stabilization with many active projects and research investigations. Dr. Murthy is an International Water Association Fellow, a professional engineer as well as a licensed wastewater treatment plant operator. Dr. Murthy received his Ph.D. in Civil Engineering from Virginia Tech.

J. P. Myers, Ph.D.

Pete Myers is founder, CEO and Chief Scientist of Environmental Health Sciences. Along with co-authors Dr. Theo Colborn and Dianne Dumanoski, Myers wrote Our Stolen Future, a 1996 book that explores the scientific basis of concern for how contamination threatens fetal development. In 2003 he founded Environmental Health Sciences, which publishes EnvironmentalHealthNews.org and DailyClimate.org. Myers is now actively involved in primary research on the impacts of endocrine disruption on human health. He currently serves on the board of the John Heinz Center for Science, Economics and the Environment, and the Jenifer Altmann Foundation. In 2010 Myers was elected Adjunct Professor of Chemistry at Carnegie Mellon University. He holds a doctorate in the biological sciences from UC Berkeley and a BA from Reed College.

Christopher P. Weis, Ph.D., DABT

Dr. Weis joined the National Institute of Environmental Health Science in August 2010. He brings decades of practical experience working in the fields of rapid exposure and risk evaluation for environmental emergencies and environmental forensics. As the NIEHS toxicology liaison, Dr. Weis serves as a senior advisor to NIEHS/NTP Director Linda Birnbaum, Ph.D., and also represents the Institute and the NTP on national and international committees, subcommittees, task forces, and ad hoc working groups. Weis also serves as a liaison to external constituencies, stakeholders, and advocacy groups, as well as members of the NTP community. As part of his responsibilities, Dr. Weis was recently named to represent NIEHS as a co-chair on the Toxics and Risks Subcommittee of the White House National Science and Technology Council Committee on Environment, Natural Resources, and Sustainability. Prior to joining NIEHS in August 2010, Dr. Weis served as a senior toxicologist at the U.S. Environmental Protection Agency National Enforcement Investigations Center in Denver. Dr. Weis completed his Ph.D. in medical physiology and toxicology at Michigan State University in 1987, and was awarded two NIH postdoctoral fellowship positions at the University of Virginia School of Medicine, Department of Physiology and Biophysics.

Selected Resources

Disruption: New Pollutants in the Potomac and Beyond : Speaker Presentations http://www.potomac.org/site/EDC-Forum/index.php

Water Environment Research Foundation (WERF) Trace Organics Site
http://www.werf.org/AM/Template.cfm?Section=Trace_Organics

U.S. EPA Endocrine Disruptor Screening Program
http://www.epa.gov/endo/

Micropollutants Clearinghouse
http://www.micropollutants.org

Our Stolen Future
http://www.ourstolenfuture.org

potomac conservancy

8601 Georgia Avenue, Suite 612
Silver Spring, MD 20910
301.608.1188
301.608.1144 fax
www.potomac.org