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*by Jacki Lopez**

Introduction[1]

The National Institute of Environmental Health Sciences ("NIEHS") defines endocrine disruptors as "chemicals that may interfere with the body's endocrine system and produce adverse developmental, reproductive, neurological, and immune effects in both humans and wildlife."[2] It notes that a wide variety of substances, including pharmaceuticals, dioxins, polychlorinated biphenyls ("PCBs"), dichlorodiphenyltrichloroethane ("DDT") and other pesticides, and plasticizers such as bisphenol A (commonly known as "BpA") can cause endocrine disruption.[3]

Endocrine disruptors, also known as endocrine-disrupting chemicals ("EDCs"), exist throughout our environment and work in a variety of nefarious ways. They can mimic naturally occurring hormones like estrogens and androgens, thereby causing overstimulation of the endocrine system.[4] EDCs can bind to receptors within cells and block endogenous hormones from binding, causing interference with the production or control of natural hormones and their receptors.[5] The latest scientific knowledge indicates that EDCs persist throughout the environment, including in our nation's waters, and are having profound effects on fish, wildlife, and humans.[6]

Yet, the U.S. federal government has done very little to protect human health or the environment from these harms. A patchwork of regulatory mechanisms exist—through the Federal Food, Drug, and Cosmetic Act; Safe Drinking Water Act; Toxic Substances Control Act; Resource Conservation and Recovery Act; Consumer Product Safety Improvement Act; and the Clean Water Act. However, as currently implemented, these mechanisms at best provide a regulatory net full of holes whereby EDCs enter and pervade our environment and have astonishing effects. Perhaps the most promising of all existing frameworks is the Clean Water Act ("Act"), which if implemented fully could both limit human exposure to waterborne EDC pollution, as well as protect aquatic environments and species from EDC harm.

Clean Water Act

The Act's Role in Regulating Endocrine-Disrupting Chemicals

The Act aims "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."[7] The "national goal" of the Act is to guarantee "water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation."[8] Toward these objectives, the Act provides a variety of tools to control water pollution from all sources. Foremost, the Act requires that states adopt water quality standards based on the National Recommended Water Quality Criteria ("Criteria").[9]

The Act requires the EPA to establish the Criteria,[10] publish information on the protection of water quality,[11] and guide states in their adoption and periodic review of water quality standards.[12] The Criteria and information required by section 304 of the Act are significant because they establish a baseline for nationwide implementation of the Act. State water quality standards include designated uses, water quality criteria sufficient to protect the designated uses, and an anti-degradation policy.[13] Guided by EPA's Criteria and information, states must either adopt the Criteria in their water quality standards or provide a science-based explanation for their alternate criteria.[14] Each state is also required to "identify those waters within its boundaries for which the effluent limitations . . . are not stringent enough to implement any water quality standard applicable to such waters."[15] States must identify any water body failing to meet any numeric criteria, narrative criteria, water body use, or anti-degradation requirements, and the Act requires states to establish total maximum daily loads ("TMDLs") for pollutants "at a level necessary to implement the applicable water quality standards."[16] Therefore, water quality standards provide a mechanism for states to regulate all sources of pollution that are degrading water quality.

Section 304 of the Act mandates that the EPA revise the Criteria "from time to time" to reflect the "latest scientific knowledge."[17] As the basis for state water quality standards and pollution controls, it is crucial that the Criteria reflect the latest science. The duty to review and consider the latest scientific knowledge, among other factors, is a non-discretionary duty.[18]

The EPA's Criteria are at the heart of protecting water quality across the nation. In effect, the Criteria are the floor for water quality standards (with states left free to establish a higher ceiling), and, when federal criteria do not exist, water quality throughout the nation suffers. Despite the statutory mandate to establish Criteria for EDCs, the EPA has failed to update and revise its Criteria to establish limitations for EDCs sufficient to protect against endocrine disruption.

* *Ms. Lopez is a staff attorney at the Center for Biological Diversity who, in January 2010, petitioned the EPA asking it to update and revise its National Recommended Water Quality Criteria to reflect the latest scientific knowledge that endocrine-disrupting chemical pollution is harming aquatic life and water quality. This article is based in part on Ms. Lopez's work on the submitted petition.*

The Latest Scientific Information on Endocrine-Disrupting Chemicals

Researchers have recently discovered that a number of contaminants can have the potential for deleterious effects on aquatic ecosystems.[19] These contaminants include pesticides, pharmaceuticals and personal care products ("PPCPs"), and other compounds that can evoke hormonal responses in fish and wildlife.[20] EDCs can interfere with the synthesis, secretion, transport, binding, or elimination of natural hormones in the body.[21] They can compromise normal reproduction, development, growth, and homeostasis.[22] EDCs have become ubiquitous in our nation's water bodies, entering them largely through runoff and treated wastewater discharges.[23]

EDCs find their way into our environment through a surprising array of unchecked mechanisms. Ingested drugs, for example, are excreted in varying metabolized amounts (primarily in urine and feces) and end up in municipal sewage treatment plants where they then enter our waterways as treated wastewater effluent.[24] EDCs leach from municipal landfills and can be found in the runoff from concentrated animal feeding operations and medicated pet excreta. EDCs also come from aquaculture, spray-drift from agriculture,[25] and the direct discharge of raw sewage.

An EPA internal planning document recognizes that EDCs discharged from wastewater treatment plants are contaminants of emerging concern with potentially widespread environmental effects.[26] Municipal wastewater contains a multitude of EDCs, many of which derive from the domestic application of active ingredients found in PPCPs.[27] PPCPs are constantly entering rivers and groundwater via treated municipal wastewater. Betablockers, antibiotics, antiphlogistics, estrogens, antiepileptics, and contrast agents have been detected in many of our nation's waters.[28] These EDCs are affecting the biological, chemical, and physical integrity of our water, including having profound effects on the flora and fauna that rely on clean U.S. waters.[29]

In 2008, the Associated Press reported the detection of pharmaceutical residues in the drinking water of twenty-four major metropolitan areas, serving forty-one million people.[30] The pharmaceuticals detected included antibiotics, anticonvulsants, and mood stabilizers.[31] Supporting these findings, the United States Geological Survey ("USGS") reports that a sample of 139 streams in thirty states, eighty percent of the sampled sites contained organic wastewater contaminants and pharmaceuticals—including antibiotics, hypertension- and cholesterol-lowering drugs, antidepressants, analgesics, steroids, caffeine, and reproductive hormones.[32]

Many pesticides are also EDCs. According to a recent USGS report, "[T]he most widespread potential impact of pesticides on water quality is adverse effects on aquatic life and fish-eating wildlife, particularly in streams draining watersheds with substantial agricultural and urban areas."[33] All of the pesticides surveyed in the study are known endocrine disruptors and enter our nation's water bodies through runoff and spray-drift.[34]

The latest scientific knowledge indicates that EDCs persist throughout the environment, including in our nation's waters, and are having profound effects on fish, wildlife, and humans.

EDCs Are Likely Harming Endangered and Threatened Species

The Endangered Species Act ("ESA") prohibits the "take" of endangered species.[35] The ESA defines "take" as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" endangered species.[36] The U.S. Fish and Wildlife Service has further defined "harm" to include "significant habitat modification or degradation" that "actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering."[37] EDCs enter our waterways pursuant to the authority delegated to the EPA under the Clean Water Act. There is evidence that EDCs are significantly degrading habitat, including federally designated critical habitat, and are likely injuring fish and wildlife by disrupting behavior patterns such as breeding ability.[38] Therefore, EPA has a heightened duty under the ESA to establish and enforce Criteria for EDCs to prevent harm to endangered species.

A litany of studies confirms that EDCs are presently harming fish and wildlife throughout the nation.[39] A 2009 study by Jenkins, et al., investigated the impacts of effluents from wastewater treatment plants using the western mosquitofish as a surrogate fish model.[40] They detected fifteen organic wastewater compounds and EDCs, and samples from the point sources of the wastewater effluent showed the compounds with the highest influence on sex steroid hormone activities, compared to other sample sites.[41] In samples closest to the wastewater treatment plants' effluent discharges, male mosquitofish showed the most impairment of endocrine and reproductive function, as evidenced by changes in sex steroid hormone levels, secondary sex characteristics, organosomatic indices, and sperm quality parameters.[42] The study concluded that exposure to EDCs and consequent impairment showed the most significant effects at the wastewater treatment point sources, with gradually lesser effects further away from the point sources.[43]

EDCs May Be Harming the Razorback Sucker

The endangered razorback sucker is found in Las Vegas Bay and Lake Mead and has federally designated critical habitat throughout these water bodies.[44] Razorback suckers are long-lived fish that can grow up to three feet long. Habitat loss and competition with other fish species threatens the species' survival.[45] Blackbird Point at Las Vegas Bay—known spawning habitat for the razorback sucker—is fed by treated wastewater effluent from four wastewater treatment plants upstream.[46] Researchers have found distinct differences between razorback suckers from Las Vegas Bay and razorback suckers from other locations.[47] One study found significantly higher concentrations of estradiol ("E2"), lower concentrations of 11-ketotestosterone ("11KT"), and a higher ratio of E2 to 11KT in male razorback suckers from Las Vegas Bay than those from Echo Bay.[48] DDT residues accounted for more than half the detected OC concentrations in the fish, and PCBs accounted for a third of the total detected OC concentrations.[49] The USGS is currently doing much to study the effects of EDCs in Lake Mead and their effects on the razorback sucker.[50]

EDCs May Be Harming the Desert Pupfish

California's Salton Trough's only endemic species, the endangered desert pupfish, is listed as endangered because of habitat alteration and the effects of water contamination.[51] The species is threatened by contamination from EDCs born from pesticides and effluent.[52] Pesticides suspected of endocrine disruption are used at high rates throughout the adjacent Imperial Valley.[53] Fish and bed sediment in the Imperial Valley have higher concentrations of hydrophonic pesticides, and some believe that exposure to the pesticides chlorpyrifos, diazinon, and malathion used in the Imperial Valley, is contributing to endocrine disruption.[54] After similar exposure to these pesticides, western mosquitofish exhibited endocrine disruption in the form of lower levels of the sex hormone 17 beta-estradiol in females, skewed ratios of estrogen to testosterone in males, altered secondary sex characteristics in males, reduced gonopodium size, and significantly lower sperm counts and proportions of mature sperm.[55] In addition to pesticides, Imperial Valley irrigation water comes from the lower Colorado River, a water source that causes concern due to potential EDC effects.

EDCs May Be Harming the Santa Ana Sucker

Effluents from wastewater treatment plants and urban runoff impact the Santa Ana River. The Santa Ana River basin is one of the only river basins supporting native populations of the endangered Santa Ana sucker. Thirty EDCs have been detected in water from the Santa Ana River, and sex steroid hormone levels, secondary sex characteristics, organosomatic indices, and sperm quality parameters indicate endocrine and reproductive disruption.[56] In studies of the western mosquitofish in these waters, mean E2 values were well above the 1.0 male ratio and were closer to the female value.[57] The study found a strong negative correlation between levels of the plasticizer di(2-ethylhexyl) phthalate ("DEHP") and testosterone levels in males.[58] These endocrine and reproductive effects are likely also negatively impacting the Santa Ana sucker.

EDCs Likely Harm Humans

One critical concern and obstacle to identifying EDC exposure and harm in humans is that there can be a significant lag time, possibly decades, between exposure and the manifestation of a clinical disorder. Another difficulty is the timing of exposure as there may be developmental periods having increased susceptibility to EDCs. Even so, multiple studies already show that EDCs are affecting human health.

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A multi-state epidemiologic study found that women exposed to the plasticizer DEHP had a two day longer gestation length and higher odds for caesarian section delivery.[59] These findings suggest that DEHP may interfere with the hormonally controlled signaling that initiates birth.[60] Another study found that women with detectable levels of DDT and 1-chloro-2-[2,2-dichloro-1-(4-chlorophenyl)ethenyl]benzene ("DDE") higher than typical of U.S. women had menstrual cycles approximately four days shorter and decreased progesterone metabolite levels.[61]

An EPA-funded study discovered that breast-fed girls exposed to high levels of polybrominated biphenyl ("PBB") *in utero* had an earlier age of menarche than breast-fed girls exposed to lower levels of PBB *in utero*.[62] It also found that women with high exposures to PBB in serum had shorter menstrual cycles and longer bleed lengths than women whose exposure levels were undetectable in serum.[63] Another study identified a link between persistent pesticides in human breast milk and cryptorchidism (undescended testicles) in male offspring.[64]

Another EPA-funded report found that exposure to fungicides and herbicides is associated with a 1.5- or two-fold risk of endometriosis in women eighteen to forty-nine years of age.[65] An epidemiological study discovered a positive association

between diabetes and elevated serum PCBs, DDE, and hexachlorobenzene ("HCB") in Native Americans.[66] There is overwhelming evidence of unnecessary human exposure to EDCs and of resulting harmful effects.

EPA Has a Duty to Establish Criteria for Endocrine-Disrupting Pollutants

With regard to what the EPA coins "Contaminants of Emerging Concern" ("CECs") (largely referring to EDCs), "[w]idespread uses, some indication of chemical persistence, effects found in natural systems, and public concerns have made clear the need for EPA to develop criteria that can be used to help assess and manage potential risk of some CECs in the aquatic environment."[67]

Currently, Criteria for aquatic life are based on criterion maximum concentration ("CMC") to protect against acute effects and criterion continuous concentration ("CCC") to protect against chronic effects.[68] CMC is derived from forty-eight to ninety-six hour tests for lethality or immobilization while CCC is from longer-term tests measuring survival, growth, or reproduction.[69] Criteria for human health are designed to protect against long term human health effects based on a lifetime of exposure, and exposure to a pollutant is interpreted as through ingestion of water and contaminated fish and shellfish.[70]

There is overwhelming evidence of unnecessary human exposure to EDCs and of resulting harmful effects.

However, EDCs defy the typical "dose makes the poison" paradigm of toxicology.[71] The EPA Guidelines, "anticipat[ing] that rote application of the basic procedures may not yield the most appropriate criteria," provide flexibility in moving away from normal procedures whenever:[72]

> Sound scientific evidence indicates that a national criterion produced using these Guidelines would probably be substantially overprotective or underprotective of aquatic organisms and their uses on a national basis
>
> -or-
>
> On the basis of all available pertinent laboratory and field information, determine if the criterion is consistent with sound scientific evidence. If it is not, another criterion, either higher or lower, should be derived using appropriate modifications of these Guidelines.[73]

In reviewing the latest scientific knowledge and promulgating the new water quality standards, EPA must incorporate EDC-relevant knowledge. For example, EDCs differ from traditional pollutants in that (1) the timing of exposure is highly critical to the outcome of the exposure (with fetal or early post-natal exposure being the most detrimental due to potential permanent effects); (2) EDCs act at environmentally relevant doses with complex dose-response curves; and (3) the effects of EDCs may not be limited to the exposed individual but can be transmitted to subsequent generations via the germ line.[74] The standard procedures for deriving CMC and CCCs use only toxicity tests meeting certain requirements, but the Guidelines mandate that the collation and examination of other data should be considered.[75]

The case of tributyltin should serve as an example for the EPA in establishing and revising its Criteria for other EDC pollutants. The final acute value using standard derivation procedures for tributyltin was .0658 µg/L even though concentrations linked to imposex and immuno-suppresion in snail and bivalves was in the range of 0.0093-0.334 µg/L.[76] The EPA rightly took this new scientific knowledge into account and lowered the CCC for tributyltin to .0074 µg/L.[77]

The EPA has established Criteria for some known EDCs. Some EDCs, such as PCB, have Human Health Criteria calculations, however, they are not on the matrix because of their endocrine-disrupting potential but because of their carcinogenic potential.[78] New scientific information indicates these EDCs are having substantial effects on fish and wildlife at levels previously deemed acceptable by the EPA. The EPA recognizes that frequency alone is not enough to establish Criteria and that Criteria development "needs to focus efforts on chemicals that demonstrate a reasonable potential to adversely affect aquatic life."[79] It also acknowledges that "there may be chemicals for which regulatory guidance is needed, but for which toxicological data are insufficient to meet the minimum standards of the Guidelines" and that in those cases, "there may still be a need for alternate approaches to derive interim regulatory guidance values on which to base decisions that must be made before sufficient information for a complete water quality criterion can be gathered."[80]

Conclusion

The EPA has a mandatory duty to establish Criteria protective of our nation's waters. Currently, the EDCs entering and persisting in these water bodies are having profound effects on wildlife, fish, and humans. Although the EPA has established Criteria for some of the EDCs, the limits were not designed to protect against EDC harm. Section 304(a) of the Act requires the EPA to develop and publish and "from time to time thereafter revise" Criteria and information.[81] New information that controverts previously held beliefs about water quality and pollutants triggers the EPA's duty to review and revise the Criteria. Therefore, the EPA must revise the Criteria and information to reflect the latest science on EDCs.

Endnotes: Endocrine-Disrupting Chemical Pollution

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[1] Petition for Water Quality Criteria for Endocrine Disrupting Chemicals Before the EPA, Center for Biological Diversity (Jan. 10, 2010), *available at* http://www.biologicaldiversity.org/campaigns/pesticides_reduction/endocrine_disruptors/pdfs/EPA_304_EDC_petition.pdf.

[2] Nat'l Inst. of Envl. Health Sciences ("NIEHS"), Environmental Agents: Endocrine Disruptors, http://www.niehs.nih.gov/health/topics/agents/endocrine/ (last visited Apr. 12, 2010).

[3] *Id.* (providing studies, reports, and general information).

[4] *See* NIEHS, ENDOCRINE DISRUPTORS 1 (2007) http://www.niehs.nih.gov/health/docs/endocrine-disruptors.pdf (providing an overview of how endocrine disrupters function) (last visited Apr. 20, 2010).

[5] *See id.*

[6] *See id.*

[7] 33 U.S.C. § 1251(a) (2006).

[8] 33 U.S.C. § 1251(a)(2).

[9] 33 U.S.C. §§ 1313-1314.

[10] 33 U.S.C. § 1314(a)(1).

[11] 33 U.S.C. § 1314(a)(2).

[12] 33 U.S.C. § 1313(a)(3).

[13] Water Quality Standards, 40 C.F.R. § 131.6 (2010).

[14] 40 C.F.R. § 131.11(b).

[15] 33 U.S.C. § 1313(d)(1)(A).

[16] 33 U.S.C. § 1313(d)(1)(C).

[17] 33 U.S.C. § 1314(a)(1).

[18] *See* Our Children's Earth Found. v. EPA, 506 F.3d 781, 785 (9th Cir. 2007) (holding that the EPA does not have discretion to ignore the technology-based criteria).

[19] *See, e.g.,* Christian G. Daughton, *"Emerging" Chemicals as Pollutants in the Environment: a 21st Century Perspective*, 23 RENEWABLE RES. J. 6 (2005) (discussing the emergence of new chemical pollutants).

[20] *See generally Pharmaceuticals in the Nation's Water: Assessing Potential Risks and Actions to Address the Issue: Hearing Before the Subcomm. on Trans. Safety, Infrastructure Sec., & Water Quality of the S. Comm. on Env't & Pub. Works*, 111th Cong. (2008) (statement of J. Sass, Senior Scientist, Nat. Res. Def. Council) [hereinafter Sass Testimony] (providing general information on PPCPs); Daughton, *supra* note 19; Mark Alpert, *Fighting Toxins in the Home: Everyday Materials May Pose Health & Environmental Threats*, 298 SCI. AM. 46 (2008).

[21] *See* NIEHS Report, *supra* note 4, at 1-2 (describing some products and chemicals that contain EDCs).

[22] *See* Sass Testimony, *supra* note 20, at 8-9 (discussing health risks of low dose exposure to EDCs).

[23] *See id.,* at 2-4 (discussing the ways in which EDC's enter the environment).

[24] *See id.*

[25] "Spray-drift" describes the phenomenon of pesticides drifting beyond the area to which they were intended to be applied. *See* U.S. EPA, Pesticides: Topical & Chemical Fact Sheets: Pesticide Spray and Dust Drift, (Dec. 2009), http://www.epa.gov/pesticides/factsheets/spraydrift.htm (last visited Apr. 20, 2010).

[26] *See* OW/ORD Emerging Contaminants Workgroup, *Aquatic Life Criteria for Contaminants of Emerging Concern, Part I, General Challenges and Recommendations*, 2-4 (EPA, White Paper, June 3, 2008) (explaining why EPA is concerned with CECs), *available at* http://www.epa.gov/waterscience/criteria/library/sab-emergingconcerns.pdf [hereinafter EPA White Paper].

[27] *See* Sass Testimony, *supra* note 20, at 2-4 (discussing the source of PPCP's and the ways in which they enter the environment).

[28] *See, e.g., id.* (discussing the detection, *inter alia*, of antibiotics, anti-convulsants, mood stabilizing drugs, and pharmaceuticals and personal care products).

[29] *See, e.g.*, *id.*, at 2-5 (discussing health effects on animals and humans).

[30] Jeff Donn, Martha Mendoza & Justin Pritchard, *Pharmaceuticals Lurking in U.S. Drinking Water*, Associated Press, Mar. 10, 2008, http://www.msnbc.msn.com/id/23503485/ (last visited Apr. 20, 2010).

[31] *Id.*

[32] *See* JENNIFER A. JENKINS, ET AL., EFFECTS OF WASTEWATER DISCHARGES ON ENDOCRINE AND REPRODUCTIVE FUNCTION OF WESTERN MOSQUITOFISH (*GAMBUSIA* SPP.) AND IMPLICATIONS FOR THE THREATENED SANTA ANA SUCKER (*CATOSTOMUS SANTAANAE*), 2 (U.S. Dept. of Interior & U.S. Geological Survey Open-File Report 2009-1097) (rev. May 2009), *available at* http://pubs.usgs.gov/of/2009/1097/pdf/OF2009-1097.pdf.

[33] ROBERT J. GILLIOM, ET AL., THE QUALITY OF OUR NATION'S WATERS—PESTICIDES IN THE NATION'S STREAMS AND GROUND WATER 1992-2001, 9 (U.S. Geological Survey, Circular 1291, 2007), *available at* http://pubs.usgs.gov/circ/2005/1291/pdf/circ1291_front.pdf.

[34] *Id.*

[35] Endangered Species Act, 16 U.S.C. §§ 1531-1544 (2006).

[36] 16 U.S.C. § 1532(19).

[37] 50 C.F.R. §17.3.

[38] *See generally* Susan Jobling, *et al.*, *Wild Intersex Roach (*Rutilus rutilus*) Have Reduced Fertility*, 67 BIOLOGY OF REPROD. 515, 515 (2002) (finding that EDC-caused altering of sex characteristics leads to reduced reproductive ability).

[39] *See, e.g.,* J.M. Lazorchak & M.E. Smith, *National Screening Survey of EDCs in Municipal Wastewater Treatment Effluents*, EPA/600/R-04/171 (2004); Karl Fent, et al., *Review: Ecotoxicology of Human Pharmaceuticals*, 76 AQUATIC TOXICOLOGY 122 (2006).

[40] Jenkins *et al.*, *supra* note 32, at 2 (summarizing that the greatest exposure and effect of EDC's was found at wastewater effluent sources).

[41] Jenkins *et al*., *supra* note 32, at 39

[42] Jenkins *et al*., *supra* note 32, at 39.

[43] Jenkins *et al*., *supra* note 32, at 39.

[44] *See* Peter L. Turtle & Erik L. Orsak, Las Vegas Wash Water Quality and Implications to Fish and Wildlife 4-5 (U.S. Fish & Wildlife Serv., FFS No. 1F27 and 1F31, Nov. 1, 2002), *available at* http://www.fws.gov/pacific/ecoservices/envicon/pim/reports/LasVegas/LasVegasWash/Final_Las_Vegas_Wash_Study.pdf.

[45] *Id.* at 4.

[46] *Id.* at 28.

[47] *Id*. at 29.

[48] *Id.* at 32.

[49] *Id.* at 29.

[50] United States Geological Service, *Endocrine Disruption in Lake Mead*, http://nevada.usgs.gov/water/projects/mead_endocrine.htm (last visited May 3, 2010).

[51] Endangered and Threatened Wildlife and Plants; Determination of Endangered Status and Critical Habitat for the Desert Pupfish, 50 C.F.R. § 17 (1986).

[52] 50 C.F.R. § 17.

[53] *See* Jennifer A. Jenkins & Rassa O. Draugelis-Dale, Bioindicators from Mosquitofish (*Gambusia affinis*) Sampled from the Imperial Valley in Southern California, 1 (U.S. Geological Survey Open-File Report 2006-1307, 2006).

[54] *Id.*

[55] S.L. Goodbred, et al., Evidence of Endocrine Disruption in Western Mosquitofish (*Gambusia affinis*), 93 (Imperial Valley, California, U.S. Fish & Wildlife Serv., 2006).

[56] *See* Jenkins, *supra* note 33, at 20-21.

[57] *See id.* at 10.

[58] *Id.* at 38.

[59] Jennifer Adibi, et al., *Maternal Urinary Metabolites of Di-(2-Ethylhexyl) Phthalate in Relation to the Timing of Labor in a U.S. Multicenter Pregnancy Cohort Study*, 169 Am. J. Epidemiology, 1015, 1015 (2009).

[60] *See id.*

[61] Gayle C. Windham, et al., *Exposure to Organochlorine Compounds and Effects on Ovarian Function*, 16 Epidemiology182, 182 (2005).

[62] Heidi Blanck, et al., *Age at Menarche and Tanner Stage in Girls Exposed In Utero and Postnatally to Polybrominated Biphenyl*, 11 Epidemiology 641, 641 (2000).

[63] Michele Marcus, *The Michigan PBB Cohort 20 Years Later: Endocrine Disruption?* 1 (2000), *available at* http://www.epa.gov/ncer/science/endocrine/pdf/humanhealth/r825300_marcus_0415.pdf.

[64] Ida N. Damgaard, et al., *Persistent Pesticides in Human Breast Milk and Cryptorchidism*, 114 Envtl. Health Perspectives 1133, 1133 (2006).

[65] Victoria Holt, et al., Final Report: Persistent Organic Pollutants and Endometriosis Risk, (U.S. EPA 2007), *available at* http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/2361/report/F.

[66] Neculai Codru, et al., *Diabetes in Relation to Serum Levels of Polychlorinated Biphenyls and Chlorinated Pesticides in Adult Native Americans*, 115 Envtl. Health Perspectives 1442, 1442 (2007).

[67] EPA White Paper, *supra* note 26, at 2.

[68] EPA, Water Quality Standards Handbook 3-3 (2nd ed. 1994), *available at* http://www.epa.gov/waterscience/standards/handbook/handbookch3.pdf.

[69] *See id.*

[70] *Id.* at 3-4.

[71] *See* Emily Willingham, *Endocrine-Disrupting Compounds and Mixtures: Unexpected Dose-Response*, 46 *Archives of Envtl. Contamination & Toxicology* 265, 265 (2004) (finding that small doses can result in large changes when combined with other compounds).

[72] Charles E. Stephan, et al., Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses, 18 and 57 (U.S. EPA, 1985).

[73] *Id.*

[74] Andrea C. Gore, et al., *Endocrine Disruption for Endrocrinologists (and Others)*, 147 Endocrinology S1, S1 (2006).

[75] Stephan, *supra* note 72, at 54.

[76] *Notice of Availability of Final Aquatic Life Criteria Document for Tributyltin*, 69 Fed. Reg. 342, 343 (Jan. 5, 2004).

[77] *Id.*

[78] *See* Notice, *id*. (noting tributyltin's toxicity).

[79] EPA White Paper, *supra* note 27, at 3.

[80] Stephan, *supra* note 72, at 27.

[81] *See* 33 USC §§ 1314(a)(1)-(2) (mandating that the EPA periodically update its water quality criteria to "reflect the latest scientific knowledge").