

Submitted January 11, 2010

PETITION FOR WATER QUALITY CRITERIA FOR  
ENDOCRINE DISRUPTING CHEMICALS  
UNDER SECTION 304 OF THE CLEAN WATER ACT, 33 U.S.C. 1314

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BEFORE THE ENVIRONMENTAL PROTECTION AGENCY

## **Executive Summary**

The Center for Biological Diversity formally requests that the United States Environmental Protection Agency (“EPA”) publish water quality criteria and information taking into account overwhelming science about the effects of endocrine disrupting chemical (“EDC”) pollution.

Under the Clean Water Act, the EPA has a duty to periodically update water quality criteria to reflect the latest scientific knowledge. This Petition presents scientific information on endocrine disrupting chemical pollution in our nation’s waters and requests that the EPA promptly update water quality criteria reflecting this scientific information.

## **Administrator of the Environmental Protection Agency**

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## **Right to Petition**

Under the Administrative Procedures Act (“APA”), all citizens have the right to petition for the “issuance, amendment, or repeal” of an agency rule.<sup>1</sup> A “rule” is the “whole or a part of an agency statement of general or particular applicability and future effect designed to implement, interpret, or prescribe law or policy.”<sup>2</sup> In the present case, the EPA has not promulgated a final rule containing criteria relevant to the endocrine disrupting properties of the pollutants described in this Petition. Therefore, the Petitioner has the right to petition for the promulgation of such a rule. Further, the EPA is required to respond to this Petition: “Prompt notice shall be given of the denial in whole or in part of a written application, petition, or other request of an interested person made in connection with any agency proceeding.”<sup>3</sup>

Moreover, public participation in the development of water quality standards is to be provided for and encouraged by the EPA Administrator.<sup>4</sup> Under the Clean Water Act, any person may petition the Administrator to add any pollutant to the list of pollutants.<sup>5</sup> The

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<sup>1</sup> 5 USC §553(e).

<sup>2</sup> 5 USC §551(4).

<sup>3</sup> 5 USC §555(e).

<sup>4</sup> 33 USC §1251(e).

<sup>5</sup> 33 USC §1311(g)(4).

petition must contain sufficient information to allow the Administrator to make a determination.<sup>6</sup> The Clean Water Act requires that the Administrator rely on the latest scientific knowledge in developing water quality standards and publishing information on pollutants.

The petitioned action is for a non-discretionary action under the Clean Water Act. The subject of this Petition, setting guidelines under section 304, is a non-discretionary duty because the current guidelines do not reflect the latest scientific knowledge and fail to protect the beneficial uses of our nation's water, including our drinking water and water vital to sustaining fish and wildlife, as required by the Clean Water Act. The EPA is required to respond to the Petitioner, and this Petition is enforceable under the citizen suit provision of the Clean Water Act.<sup>7</sup> The federal district courts of the United States have jurisdiction over a claim that the Administrator of the EPA has failed to perform a non-discretionary duty,<sup>8</sup> and the APA provides judicial review of a final agency action.<sup>9</sup> The scope of review by the courts is determined by section 706 of the APA,<sup>10</sup> and it permits courts to compel agency action unlawfully withheld or unreasonably delayed.<sup>11</sup>

### **Petitioner**

The Center for Biological Diversity is a nonprofit environmental organization dedicated to the protection of imperiled species and their habitats through science, education, policy, and environmental law. The Center has over 240,000 members and on-line activists. The Center submits this Petition on its own behalf and on the behalf of its members and staff.

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<sup>6</sup> 33 USC §1311(g)(4)(B)(i).

<sup>7</sup> 33 USC §1365.

<sup>8</sup> 33 USC §1365(a)(2).

<sup>9</sup> 5 USC §704.

<sup>10</sup> 5 USC §706.

<sup>11</sup> *Id.*

## I. Introduction

The National Institute of Environmental Health Sciences 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.”<sup>12</sup> It notes that a wide variety of substances, including pharmaceuticals, dioxins, polychlorinated biphenyls, DDT and other pesticides, and plasticizers such as bisphenol can cause endocrine disruption.

Endocrine disruptors pervade our environment and work in a variety of nefarious ways. They can mimic naturally occurring hormones like estrogens and androgens, thereby causing overstimulation. They can bind to receptors within cells and block endogenous hormones from binding. They can also interfere with the way natural hormones and their receptors are made or controlled.<sup>13</sup> The latest scientific knowledge indicates that EDCs persist throughout our nation’s waters and are having profound effects on fish, wildlife, and humans.

The Center for Biological Diversity formally requests that the EPA initiate a rulemaking pursuant to the Clean Water Act to address threats posed by endocrine disrupting chemical pollution. This Petition for rulemaking specifically requests the EPA:

- (1) Establish national water quality criteria for the EDCs described in this Petition to reflect the latest scientific knowledge about their impacts; and**
- (2) Publish information pursuant to section 304(a)(2) to provide guidance on EDC pollution.**

As the nation’s premier mechanism for protecting water quality, the Clean Water Act was designed to eliminate all pollutants from our waterways. Under the Clean Water Act, the EPA is required to promulgate rules necessary “to restore and maintain the chemical, physical, and biological integrity of the nation’s waters.”<sup>14</sup> One of the methods to address national water quality concerns is through national water quality criteria created pursuant to section 304 of the Clean Water Act.<sup>15</sup>

The Clean Water Act requires the EPA to periodically update its rules to reflect the latest scientific knowledge. Section 304 mandates that the EPA promulgate and revise national water quality criteria “from time to time” to reflect the “latest scientific knowledge.” The national water quality criteria are the basis for state water quality standards and pollution controls; thus, it is crucial that they reflect the latest science. EPA currently regulates some of the EDCs addressed in this Petition, but not at levels designed to protect against endocrine disruption. The latest scientific knowledge suggests that infinitesimally small

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<sup>12</sup> National Institute of Environmental Health Sciences, available at <http://www.niehs.nih.gov/health/topics/agents/endocrine/>.

<sup>13</sup> See NIEHS Endocrine Disruptor Fact Sheet, available at <http://www.niehs.nih.gov/health/docs/endocrine-disruptors.pdf>.

<sup>14</sup> 33 USC §1251(a).

<sup>15</sup> 33 USC §1314(a)(1).

levels of exposure, in fact any level of exposure at all – may cause endocrine or reproductive abnormalities.<sup>16</sup> Therefore, current regulatory levels are insufficient to protect against water quality impairment from EDC harm.

## II. Clean Water Act

The objective of the Clean Water Act is “to restore and maintain the chemical, physical, and biological integrity of the nation’s water.”<sup>17</sup> According to the Supreme Court “the Act does not stop at controlling the ‘addition of pollutants,’ but deals with ‘pollution’ generally... which Congress defined to mean ‘the manmade or man-induced alteration of the chemical, physical, biological, and radiological integrity of water.’”<sup>18</sup> The national goal of the Clean Water Act is to guarantee “water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation.”<sup>19</sup>

Toward these goals of eliminating water pollution and maintaining the water quality of the nation’s waters, the Clean Water Act provides a variety of tools to control water pollution from all sources. Foremost, the Clean Water Act requires that states adopt water quality standards.<sup>20</sup> Water quality standards include designated uses, water quality criteria sufficient to protect the designated uses, and an antidegradation policy.<sup>21</sup> States are required to periodically review and, if necessary, revise their water quality standards.<sup>22</sup>

State water quality standards are the foundation of the Clean Water Act and are at the heart of pollution control. For example, section 402 requires polluters to obtain permits and adhere to effluent limitations and technology controls necessary to meet water quality standards.<sup>23</sup> Section 303 requires states to identify impaired waterbodies – those failing to meet water quality standards – and establish limits on pollutants causing the impairment.<sup>24</sup> Finally, section 401 requires applicants for any federal permit or license to obtain state certification that permitted activity will comply with state water quality standards.<sup>25</sup>

Although the implementation of the Clean Water Act is generally delegated to the states, Congress charged the EPA with the national implementation of the Clean Water Act. To accomplish this task, the EPA has broad authority to execute the mandates of the Clean Water Act: “The Administrator is authorized to prescribe such regulations as are

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<sup>16</sup> Sheehan, D.M., E.J. Willingham, J.M. Bergeron, C.T. Osborn, D. Crews, 1999, No threshold dose for estradiol-induced sex reversal of turtle embryos: how little is too much? *Environ Health Perspect* 107:155-159.

<sup>17</sup> 33 USC §1251(a).

<sup>18</sup> *S.D. Warren v. Maine Bd. Of Env't'l Protection*, 126 S.Ct. 1843 (2006).

<sup>19</sup> 33 USC §1251(a)(2).

<sup>20</sup> 33 USC §1313.

<sup>21</sup> 40 CFR §131.6.

<sup>22</sup> 33 USC §1313(c).

<sup>23</sup> 33 USC §§1342, 1311.

<sup>24</sup> 33 USC §1313(d).

<sup>25</sup> 33 USC §1314.

necessary to carry out his functions.”<sup>26</sup> Relevant here, the Clean Water Act requires the EPA to establish national water quality criteria,<sup>27</sup> publish information on the protection of water quality,<sup>28</sup> and guide states in their adoption and periodic review of water quality standards.<sup>29</sup>

### **National Water Criteria**

Under section 304, Congress mandated that the EPA “shall” develop and publish and “from time to time thereafter revise” water quality criteria “accurately reflecting the latest scientific knowledge.”<sup>30</sup>

- (A) on the kind and extent of all identifiable effects on health and welfare including, but not limited to, plankton, fish, shellfish, wildlife, plant life, shorelines, beaches, esthetics, and recreation which may be expected from the presence of pollutants in any body of water, including ground water;
- (B) on the concentration and dispersal of pollutants, or their byproducts, through biological, physical, and chemical processes; and
- (C) on the effects of pollutants on biological community diversity, productivity, and stability, including information on the factors affecting rates of eutrophication and rates of organic and inorganic sedimentation for varying types of receiving waters.

“[W]hen a statute uses the word ‘shall,’ Congress has imposed a mandatory duty upon the subject of the command.”<sup>31</sup> The duty to review and consider required factors, such as the latest scientific knowledge, is a non-discretionary duty.<sup>32</sup> In addition to imposing the mandatory duty to revise existing water quality criteria, the Clean Water Act allows any interested person to petition the Administrator to list additional pollutants, whereby the Administrator would be required to establish new water quality criteria. In considering a petition to revise or establish water quality criteria, the EPA must rely only on the latest scientific knowledge.

### **Water Quality Protection Information**

Section 304(a)(2) requires that the EPA “shall” develop and publish “and from time to time thereafter revise” information on four topics necessary to the protection of water quality:<sup>33</sup>

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<sup>26</sup> 33 USC §1361(a).

<sup>27</sup> 33 USC §1313(a)(1).

<sup>28</sup> 33 USC §1313(a)(2).

<sup>29</sup> 33 USC §1313(a)(3).

<sup>30</sup> 33 USC §1314(a)(1).

<sup>31</sup> *Forest Guardians v. Babbitt*, 174 F.3d 1178, 1187 (10<sup>th</sup> Cir. 1998).

<sup>32</sup> *See Our Children’s Earth v. EPA*, 506 F.3d 781 (9<sup>th</sup> Cir. 2007).

<sup>33</sup> 33 USC §1314(a)(2).

- (A) on the factors necessary to restore and maintain the chemical, physical, and biological integrity of all navigable waters, ground waters, waters of the contiguous zone, and oceans;
- (B) on the factors necessary for the protection and propagation of shellfish, fish, and wildlife for classes and categories of receiving waters to allow recreational activities in and on the water;
- (C) on the measurement and classification of water quality; and
- (D) for the purpose of section 1313 of this title, on the identification of pollutants suitable for maximum daily load measurement correlated with the achievement of water quality objectives.

The publication of this information is critical because it provides states with the necessary information to evaluate the needs of the waters in their jurisdiction, which may require modification of state water quality standards or pollution control requirements.

### **The Role of Criteria and Information in Protecting Water Quality**

The national water quality criteria and information required by section 304 are significant because they establish a baseline for nationwide implementation of the Clean Water Act. Guided by EPA's criteria and information, states must either adopt the national recommended water quality criteria in their water quality standards or provide a science-based explanation for their alternate criteria.<sup>34</sup> The EPA oversees state water quality standards and must either approve a state's standards or promulgate standards for that state guided by the national recommended water quality criteria.<sup>35</sup>

In establishing criteria, states should:

- (1) Establish numerical values based on:
  - (i) 304(a) Guidance; or
  - (ii) 304(a) Guidance modified to reflect site-specific conditions; or
  - (iii) Other scientifically defensible methods; and
- (2) Establish narrative criteria or criteria based upon biomonitoring methods where numerical criteria cannot be established or to supplement numerical criteria.

State water quality standards impact virtually all aspects of pollution control. For point source pollution, states use the standards to set effluent limits and technology standards for water pollution. The Clean Water Act requires compliance with such measures by requiring a permit for the discharge of any pollutant from a point source.<sup>36</sup> For control of both point source and non-point source pollution, water quality standards are also determinative. The Clean Water Act's section 303(d) requires each state 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."<sup>37</sup> A

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<sup>34</sup> 40 CFR §131.11(b).

<sup>35</sup> 33 USC §1313(b).

<sup>36</sup> 33 USC §§1311, 1342.

<sup>37</sup> 33 USC §1313(d)(1)(a).

waterbody failing to meet any numeric criteria, narrative criteria, waterbody use, or antidegradation requirements shall be identified, and states “shall” establish total maximum daily loads (“TMDLs”) for pollutants “at a level necessary to implement the applicable water quality standards.”<sup>38</sup> Therefore, water quality standards provide a mechanism for states to regulate all sources of pollution that are degrading water quality.

The EPA’s 304(a) criteria are at the heart of protecting water quality across the nation. The result is that, effectively, the national recommended water quality criteria are the floor for water quality standards (with states free to establish a higher ceiling); when federal criteria do not exist, water quality throughout the nation suffers.

### **III. The Latest Scientific Information on Endocrine Disrupting Chemicals**

There are a number of contaminants that have recently been discovered to have the potential for deleterious effects on aquatic ecosystems. These contaminants include pesticides, pharmaceuticals and personal care products (“PPCPs”), and other compounds that can evoke hormonal responses in fish and wildlife. These are collectively referred to as endocrine disrupting chemicals or compounds, or simply EDCs.<sup>39</sup> The EPA defines an EDC as “an exogenous chemical substance or mixture that alters the structure or function(s) of the endocrine system and causes adverse effects at the level of the organism, its progeny, populations, or subpopulations of organisms....”<sup>40</sup> EDCs can interfere with the synthesis, secretion, transport, binding, or elimination of natural hormones in the body. They can compromise normal reproduction, development, growth, and homeostasis. EDCs have become ubiquitous in our nation’s waterbodies, entering them largely through runoff and treated wastewater discharges.

There is emerging consensus that EDCs present unacceptable human health and environmental risks. In November 2009, the American Medical Association’s House of Delegates adopted a resolution calling on the AMA to work with the U.S. government to enact laws to help decrease the public’s exposure to EDCs. Part of the emerging concern is over the growing omnipresence of these products. Pesticides with endocrine-disrupting effects have long been present in our environment, and now the EDC loading is burdened by the additions of PPCPs including cosmetics, detergents, deodorants, antibiotics, antihistamines, oral contraceptives, veterinary and illicit drugs, analgesics, sunscreen, insect repellent, synthetic musks, disinfectants, surfactants, plasticizers, and caffeine.<sup>41</sup>

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<sup>38</sup> 33 USC §1313(d)(1)(c).

<sup>39</sup> For information on PPCPs, see generally Sass, J., 2008, Testimony of Jennifer Sass, PhD and Senior Scientist for Natural Resources Defense Council, *Pharmaceuticals in the Nation’s Water: Assessing Potential Risks and Actions to Address the Issue*, Apr. 15, 2008; Daughton, C.G., 2007, *PPCPs in the Environment: an Overview of the Science* (PowerPoint); Daughton, C.G., 2005, “Emerging” Chemicals as Pollutants in the Environment: a 21<sup>st</sup> Century Perspective, *Renewable Resources Journal* Winter 2005; see also Alpert, M., 2008, Fighting Toxins in the Home: Everyday materials may pose health and environmental threats, *SciAm* (Jan. 2008), p. 46; Emery, G., 2007, Scented oils linked to male breast growth, *The Australian* (Feb. 1, 2007).

<sup>40</sup> USEPA 1997.

<sup>41</sup> Daughton, C.G., 2007, Pharmaceuticals and Personal Care Products Symposium (PowerPoint), *California Department of Toxic Substances Control, Sacramento, CA, May 22, 2007*.

These EDCs can mimic estrogens and other hormones, disrupting endocrine systems and interfering with reproduction, growth, and development. And there is new alarming evidence that there may be transgenerational effects of EDCs due to the mutation of gene expressions.

Mandated by the Safe Drinking Water Act, the EPA manages the Endocrine Disruptor Screening Program (“EDSP”). The program’s three longterm goals are to: (1) provide a better understanding of the science underlying the effects, exposure, assessment, and management of endocrine disruptors; (2) determine the extent of the impact of endocrine disruptors on humans, wildlife and the environment; and (3) support the EPA’s screening and testing program. While these goals are laudable, they do nothing to prohibit or limit the quantity or kind of EDCs in our environment, despite myriad studies proving EDCs are having profound effects on both the environment and humans. Furthermore, the EDSP Tier I screening process is primarily for the effects of pesticides on humans through exposure from food, drinking water, residential use, and occupational hazards. It will not look at EDC effects to wildlife and fish, human exposure through other methods, or the effects of non-pesticide EDCs.

### **Multiple Sources of EDCs**

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 are then returned to our waterways as treated wastewater effluent. EDCs leach from municipal landfills and can be found in runoff from confined animal feeding operations and medicated pet excreta. EDCs come from aquaculture, spray-drift from agriculture, and the direct discharge of raw sewage (from storm overflow events & residential “straight piping”). There are also lesser known and quantified mechanisms of exposure, including illegal drug labs (i.e. meth labs), oral contraceptives used as soil amendment and plant growth tonic, transgenic production of proteinaceous therapeutics by genetically altered plants (molecular farming or biofarming), and through the dislodgement/washing of externally applied PPCPs.

The EPA recognizes that EDCs discharged from wastewater treatment plants are contaminants of emerging concern with potentially widespread environmental effects.<sup>42</sup> Municipal wastewater contains a multitude of EDCs, many of which are derived from the domestic application of active ingredients found in PPCPs. PPCPs are constantly being infused to 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. These EDCs are affecting the biological, chemical, and physical integrity of our water, and are having profound effects on the flora and fauna that rely on them.

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<sup>42</sup> Aquatic Life Criteria for Contaminants of Emerging Concern, Part I, General Challenges and Recommendations, OW/ORD Emerging Contaminants Workgroup, June 3, 2008.

In 2008, the Associated Press reported that pharmaceutical residues were detected in drinking water in 24 major metropolitan areas, serving 41 million people.<sup>43</sup> This included antibiotics, anti-convulsants, and mood stabilizers. These results were supported by findings of a USGS study that sampled 139 streams in 30 states and found organic wastewater contaminants and pharmaceuticals in 80% of sampled sites – including antibiotics, hypertensive and cholesterol-lowering drugs, antidepressants, analgesics, steroids, caffeine, and reproductive hormones.

Many pesticides are also EDCs. A recent USGS Report found that “the 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.”<sup>44</sup> The Report noted that “concentrations of pesticides were frequently greater than water-quality benchmarks for aquatic life and fish-eating wildlife.”<sup>45</sup> It found that of 186 stream sites sampled nationwide, 83 percent of 30 urban streams had concentrations of at least one pesticide that exceeded one or more aquatic-life benchmarks at least one time during the year, and 42 percent of 65 mixed-land-use streams had concentrations of at least one pesticide that exceeded one or more aquatic-life benchmarks at least one time during the year. In urban streams, most concentrations greater than a benchmark involved the insecticides diazinon (73 percent of sites), chlorpyrifos (37 percent), and malathion (30 percent). In agricultural streams, most concentrations greater than a benchmark involved chlorpyrifos (21 percent of sites), azinphos-methyl (19 percent), atrazine (18 percent), *p,p'*-DDE (16 percent), and alachlor (15 percent). All of these pesticides are known endocrine disruptors and enter our nation’s waterbodies through runoff and spray drift.

### **EDCs Harm Fish and Wildlife Across the U.S.**

A litany of studies confirm that EDCs are presently harming fish and wildlife throughout the nation. A recent study by Jenkins et. al. (2009) investigated the impacts of effluents from wastewater treatment plants using the western mosquitofish as a surrogate fish model.<sup>46</sup> Fifteen organic wastewater compounds and EDCs were detected, and the site showing compounds having the highest influence on sex steroid hormone activities was

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<sup>43</sup> Donn, M.M. and J. Pritchard, Associated Press, March 2008, <http://www.msnbc.msn.com/id/23503485/>; Barber, L.B., S.F. Murphy, P.L. Verplanck, M.W. Sandstrom, H.E. Taylor, and E.T. Furlong, 2006, Chemical loading into surface water along a hydrological, biogeochemical, and land use gradient – A holistic watershed approach, *Environmental Science and Technology*, v. 40, no. 2, p. 475-86, available at [http://toxics.usgs.gov/highlights/pharm\\_watershed/](http://toxics.usgs.gov/highlights/pharm_watershed/).

<sup>44</sup> Gilliom, R.J., J.E. Barbash, C.G. Crawford, P.A. Hamilton, J.D. Martin, N. Nakagaki, L.H. Nowell, J.C. Scott, P.E. Stackelberg, G.P. Thelin, and D.M. Wolock, 2007, The quality of our nation’s waters—pesticides in the nation’s streams and ground water, 1992–2001, *U.S. Geological Survey circular 1291*, available at <http://pubs.usgs.gov/circ/2005/1291/pdf/circ1291.pdf>.

<sup>45</sup> *Id.*

<sup>46</sup> Jenkins, J.A., S.L. Goodbred, S.A. Sobiech, H.M. Olivier, R.O. Draugelis-Dale, and D.A. Alvarez, 2009, Effects of Wastewater Discharges on Endocrine and Reproductive Function of Western Mosquitofish (*Gambusia spp.*) and Implications for the Threatened Santa Ana Sucker (*Catostomus santaanae*), *U.S. Geological Survey Open-File Report 2009-1097*, 46p. (Revised May 2009), available at <http://pubs.usgs.gov/of/2009/1097/pdf/OF2009-1097.pdf>.

the point source for the wastewater effluent. The study found that male mosquitofish sex steroid hormone levels, secondary sex characteristics, organosomatic indices, and sperm quality parameters indicating impairment of endocrine and reproductive function were worse off closer to the wastewater treatment plants' effluent discharges. It found 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. In a 2004 EPA study, fathead minnows were exposed to treated wastewater effluent to assess whether they would exhibit change in vitellogenin gene expression above or below lab controlled water. Of the 51 municipal wastewater treatment plant effluents tested, six samples resulted in 100% mortality, of the ones that were not acutely toxic, 10 showed elevated *Vg* levels in males and two showed reduced *Vg* levels in females.<sup>47</sup> These are just a few of the many studies that identify a connection between wastewater effluent, EDCs, and environmental harm.<sup>48</sup> The frightening truth is that unchecked EDC pollution is occurring throughout the U.S. and is affecting fish and wildlife in troubling and catastrophic ways.

### ***EDCs in the Lower Columbia River***

In the only comprehensive large-scale study of toxics in the lower Columbia River, dioxins and furans, metals, polychlorinated biphenyls ("PCBs"), polycyclic aromatic hydrocarbon ("PAHs"), and pesticides were found to impair the water, sediment, fish and wildlife.<sup>49</sup> The study found that dioxins, furans, PCBs, and DDE, a DDT metabolite, are affecting river otter and mink, including causing reproductive abnormalities. DDE and PCBs are accumulating in nesting bald eagles at levels that impair reproduction. PCBs, PAHs, and polybrominated diphenyl ethers ("PBDEs") were found in water quality and salmon samples, including stomach contents, and bioaccumulating to concentrations that pose health risks. These contaminants were above the estimated threshold levels for health effects and vitellogenin was found in blood samples of juvenile salmon. Sediment contamination exceeded levels of concern for DDE, PCB, PAHs, dioxins, and furans. The report concluded that the beneficial uses, including fishing, shellfishing, wildlife, and water sports are impaired due to EDC pollution.

The EPA acknowledges that the contaminants found in the lower Columbia River "threaten the health of people, fish, and wildlife inhabiting the Basin."<sup>50</sup> Fish consumption advisories are widespread across the Basin. The EPA has determined that PCBs in fish exceed human health concern levels and that levels of PBDEs are

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<sup>47</sup> Lazorchak, J.M. and M.E. Smith, 2004, National Screening Survey of EDCs in Municipal Wastewater Treatment Effluents, *EPA/600/R-04/171*.

<sup>48</sup> See Fent, K., A.A. Weston, and D. Caminada, 2006, Ecotoxicology of human pharmaceuticals, *Aquatic Toxicology* 76, 122-159.

<sup>49</sup> Lower Columbia River Estuary Partnership, 2007, Lower Columbia River and Estuary Ecosystem Monitoring: Water Quality and Salmon Sampling Report, [*hereinafter* "LCREP"] available at <http://www.lcrep.org/pdfs/WaterSalmonReport.pdf>.

<sup>50</sup> EPA, Columbia River Basin: State of the River Report for Toxics, Jan. 2009, available at <http://www.lcrep.org/pdfs/EPA%20Columbia%20River%20Basin%20State%20of%20the%20River%20Report%20for%20Toxics.pdf>.

increasing. Unacceptable levels and combinations of EDCs are polluting the lower Columbia River and harming the fish, wildlife and humans that rely on the river.

### ***EDCs in the Lower Colorado River***

Organochlorine compounds (“OC”), PAHs, phthalates, phenols, dioxins, synthetic musks, and furans have been found in water, sediment and carp tissue from Lake Mead and present concerns for wildlife in the lower Colorado River.<sup>51</sup> More troublingly, carp from these waterbodies exhibit endocrine disruption relative to fish from other nearby waterbodies.<sup>52</sup> Results of a study by Linder and Little (2009) indicate that the reproductive condition of fish at Las Vegas Bay (of Lake Mead) are markedly reduced compared to other fish farther away from Las Vegas Wash (the singular tributary that feeds Las Vegas Bay) and the influx of EDCs.<sup>53</sup> Studies have also shown that male carp from Las Vegas Bay have significantly lower levels of the sex steroid hormone 11-ketotestosterone (11KT), a major androgen responsible for testicular function and sperm production in fish.<sup>54</sup> These fish have smaller testes (gonadosomatic index) and higher levels of testicular macrophage aggregates (biomarkers of contaminant exposure).<sup>55</sup> Degradation products of triclosan, a commonly used antimicrobial compound, have been found in these carp, but not in male fish from the reference site.<sup>56</sup>

A study by Leiker (2009) identified methyl triclosan and four halogenated analogues in male carp collected from Las Vegas Bay as well as from semipermeable devices deployed in Las Vegas Wash.<sup>57</sup> Methyl triclosan is a microbially methylated product of triclosan. Triclosan is an antibacterial and antimicrobial agent used in liquid detergents,

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<sup>51</sup> Marr, C.L.H., 2007, Endocrine Disruption in Razorback Sucker and Common Carp on National Wildlife Refuges along the Lower Colorado River, *Environmental Contaminants Program On-Refuge Investigations Final Report*.

<sup>52</sup> Rosen, M.R., S.L. Goodbred, R. Patino, T.A. Leiker, and E. Orsak, 2006, Investigations of the Effects of Synthetic Chemicals on the Endocrine System of Common Carp in Lake Mead, Nevada and Arizona, Fact Sheet 2006-3131, available at <http://pubs.usgs.gov/fs/2006/3131/>; Osemwengie, L.I. and S.L. Gerstenberger, 2004, Levels of synthetic musk compounds in municipal wastewater for potential estimation of biota exposure in receiving waters, *J. Environ. Monit.* 6, 1-8.

<sup>53</sup> Linder, G. and E.E. Little, 2009, Competing risks and the development of adaptive management plans for water resources: field reconnaissance investigation of risks to fishes and other aquatic biota exposed to endocrine disrupting chemicals (EDCs) in Lake Mead, Nevada USA, *EWRI 2009 World Environmental & Water Resources Congress*, Kansas City, Missouri May 17-21, 2009.

<sup>54</sup> Schulz, R.W. and T. Miura, 2002, Spermatogenesis and its endocrine regulation, *Fish Physiology and Biochemistry*, vol. 26, p 43-56.

<sup>55</sup> Patino, R., S.L. Goodbred, R. Draugelis-Dale, C.E. Barry, J.S. Foott, M.R. Wainscott, T.S. Gross, and K.J. Covay, 2003, Morphometric and histopathological parameters of gonadal development in adult common carp from contaminated and reference sites in Lake Mead, Nevada, *Journal of Aquatic Animal Health*, vol. 15, p. 55-68.

<sup>56</sup> Goodbred, S.L., T.J. Leiker, R. Patino, J.A. Jenkins, N.D. Denslow, E. Orsak, and M.R. Rosen, 2007, Organic chemical concentrations and reproductive biomarkers in common carp (*Cyprinus carpio*) collected from two areas in Lake Mead, Nevada, May 1999-May 2000, *U.S. Geological Survey Data Series 286*, 18 p.

<sup>57</sup> Leiker, T.J., S.R. Abney, S.L. Goodbred, M.R. Rosen, 2009, Identification of methyl triclosan and halogenated analogues in male common carp (*Cyprinus carpio*) from Las Vegas Bay and semipermeable membrane devices from Las Vegas Wash, Nevada, *Science of the Total Environment* 407, 2102-2114.

hand soaps, deodorants, cosmetics, creams, lotions, mouthwash and toothpaste and is impregnated in many fabrics, plastics, carpets, plastic kitchenware, and toys. Studies suggest a variety of effects of triclosan including the inhibition of fatty acid and lipid biosynthesis, the resistance of some bacteria to triclosan, altered activity of kinase enzymes, reduced membrane stability of immune cells, interference with redox balance in organs, endocrine disruption of the thyroid system, augmented estrogenic and androgenic activity, and effects as a nonspecific depressant on the central nervous system.

### ***EDCs in Chesapeake Bay***

A recent study by the Maryland Pesticide Network found that about 11 million pounds and over 280 pesticides were used in Maryland in 2004, that pesticide use since then has only increased, and that the majority of these pesticides end up in Chesapeake Bay.<sup>58</sup> A 2005 USGS study found that 82-100 percent of male smallmouth bass in the Bay tested positive for female germ cells.<sup>59</sup> A separate study in 2003 found vitellogenin production in male common carp in the Bay.<sup>60</sup> It is highly likely that these abnormalities are the result of exposure to endocrine disrupting chemicals including PPCPs and pesticides.

A 2007 study was the first to conclusively draw the connection between EDC contamination in the Chesapeake Bay, percent of intersex fish in the Bay, and reduced sperm mobility.<sup>61</sup> Between 67-89 percent of the fish sampled from the Bay were positive for intersex. The sample locations had correlative loading of contaminants. Not only was there a correlation between the percent of intersex fish and contaminant loading, but the intersex fish had relatively declined sperm quality with regard to motility and progressive motility.

### ***EDCs in Southern California***

There are at least 17 suspected endocrine-disrupting pesticides used in the Imperial Valley at the rate of 300,000 kilograms a year. Fish and bed sediment have higher concentrations of hydrophobic pesticides. It is believed that exposure to pesticides chlorpyrifos, diazinon, and malathion used in the Imperial Valley are contributing to the endocrine disruption. Evidence of endocrine disruption has been found in western mosquito fish in the Imperial Valley in the form of lower levels of 17 beta-estradiol in females, skewed ratio of estrogen to testosterone in males, altered secondary sex

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<sup>58</sup> Maryland Pesticide Network, 2009, Pesticides and the Maryland Chesapeake Bay Watershed, available at <http://www.mdpestnet.org/publications/MPN-2009WhitePaper.pdf>.

<sup>59</sup> USGS, Intersex fish: Endocrine disruption in smallmouth bass, Fact Sheet, available at <http://www.fws.gov/ChesapeakeBay/pdf/endocrine.pdf>.

<sup>60</sup> McGee, B.L., A.E. Pinkey, D.J. Fisher, and L.T. Yonkos, 2003, Evaluation of Endocrine Disrupting Effects in Potomac River Fish, *Final Report CBFO-C03-01*, available at <http://www.fws.gov/ChesapeakeBay/pdf/CBFO-C0301.PDF>.

<sup>61</sup> Henderon, H., 2007, The Effects of Contaminants on Sperm Quality and Intersex Condition of Smallmouth Bass (*Micropterus dolomieu*) in the Potomac River, *Masters Thesis, Morgantown, WV*.

characteristics in males, reduced gonopodium size, and significantly lower sperm counts and proportions of mature sperm.<sup>62</sup>

In a recent study, 30 EDCs were 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 in fish from the Santa Ana River.<sup>63</sup> The Santa Ana River is impacted by effluents from wastewater treatment plants and urban runoff. In western mosquitofish, mean E2/T values were well above the 1.0 male ratio and were closer to the female value. The study found a strong negative correlation between di-(2-ethylhexyl) phthalate (“DEHP”) levels and testosterone levels in males.

### **EDCs are Harming Endangered and Threatened Species**

The Endangered Species Act (“ESA”) prohibits the “take” of endangered species. The ESA defines take as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect” endangered species.<sup>64</sup> 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.”<sup>65</sup> EDCs enter our waterways pursuant to the delegated authority of the EPA. 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.<sup>66</sup> Therefore, EPA has a heightened duty under the ESA, to establish and enforce water quality criteria for EDCs for their harm to endangered species.

### ***EDCs Harm the Razorback Sucker***

The endangered razorback sucker is found in Las Vegas Bay and Lake Mead and has federally designated critical habitat throughout these waterbodies. Razorback suckers are long-lived fish that can grow up to three feet long. However, they are struggling to survive and face threats from habitat loss and competition with other fish species. Blackbird Point at Las Vegas Bay is known spawning habitat for the razorback sucker and is fed by treated wastewater effluent from four upstream wastewater treatment plants. Distinct differences have been found in razorback suckers from Las Vegas Bay and razorback suckers from other locations.<sup>67</sup> One study found concentrations of E2 were

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<sup>62</sup> Goodbred, S.L., S.A. Sobiech, and C.A. Roberts, 2006, Evidence of Endocrine Disruption in Western Mosquitofish (*Gambusia affinis*) from the Imperial Valley, California, U.S. Fish and Wildlife Service, Carlsbad Fish and Wildlife Office, Carlsbad, CA, 93p.

<sup>63</sup> Jenkins 2009.

<sup>64</sup> ESA §9(a)(1).

<sup>65</sup> 50 CFR §17.3.

<sup>66</sup> Jobling, S., S. Coey, J.G. Whitmore, D.E. Kime, K.J.W. Van Look, B.G. McAllister, N. Beresford, A.C. Henshaw, G. Brighty, C.R. Tyler, and J.P. Sumpter, 2002, Wild Intersex Roach (*Rutilus rutilus*) Have Reduced Fertility, *Biology of Reproduction* 67, 515-524.

<sup>67</sup> FWS 2001.

significantly higher, concentrations of 11KT were lower, and the ratio of E2 to 11KT higher in male razorback suckers from Las Vegas Bay than those from Echo Bay.<sup>68</sup> In another study, a razorback sucker from Las Vegas Bay had nine OC compounds, while none were detected in a razorback sucker from Echo Bay. 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.

### ***EDCs Harm the Desert Pupfish***

The Salton Trough has only one endemic species, the endangered desert pupfish. It was listed as endangered because of habitat alteration and the effects of water contamination. The species is threatened by contamination from EDCs born from pesticides and effluent. Pesticides suspected of endocrine disruption are used throughout the Imperial Valley at high rates. Evidence of endocrine disruption has been found in western mosquito fish in the form of lower levels of 17 beta-estradiol in females, skewed ratio 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.<sup>69</sup> Fish and bed sediment in the Imperial Valley have higher concentrations of these hydrophobic pesticides. It is believed that exposure to pesticides chlorpyrifos, diazinon, and malathion used in the Imperial Valley are contributing to the endocrine disruption. In addition to pesticides, Imperial Valley irrigation water comes from the lower Colorado River, a water source that causes concern due to potential EDCs effects.

### ***EDCs Harm the Santa Ana Sucker***

The Santa Ana River is impacted by effluents from wastewater treatment plants and urban runoff. 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.<sup>70</sup> In western mosquito fish, mean E2/T values were well above the 1.0 male ratio and were closer to the female value. The study found a strong negative correlation between DEHP levels and testosterone levels in males. These endocrine and reproductive effects are likely negatively impacting the Santa Ana sucker.

### **EDCs Harm Humans**

A 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 where there may be increased susceptibility to EDCs. However, there are multiple studies that show EDCs are affecting human health.

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<sup>68</sup> *Id.*

<sup>69</sup> Goodbred 2006.

<sup>70</sup> Jenkins 2009.

A multi-state epidemiologic study, found that women exposed to DEHP had a two day longer gestation length and higher odds for caesarian section delivery. These findings suggest that DEHP may interfere with hormonally controlled signaling that initiates birth.<sup>71</sup> Another study found that women with detectable levels of DDT and DDE higher than typical of U.S. women had menstrual cycles approximately four days shorter and decreased progesterone metabolite levels.<sup>72</sup>

An EPA funded study discovered that breast fed daughters exposed to high levels of PBB *in utero* had an earlier age of menarche than breast fed girls exposed to lower levels of PBB *in utero*. 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.<sup>73</sup> Another study identified a link between persistent pesticides in human breast milk and cryptorchidism (undescended testicles) in male offspring.<sup>74</sup>

In another EPA-funded report, it was found that exposure to fungicides and herbicides is associated with 1.5-2 fold risk of endometriosis in women 18-49 years old.<sup>75</sup> Another epidemiological study discovered a positive association between elevated serum PCBs, DDE, and HCB and diabetes in Native Americans.<sup>76</sup> There is overwhelming evidence that humans are unnecessarily being exposed to EDCs and those EDCs are having harmful effects.

#### **IV. EPA Must Establish Water Quality Criteria for Endocrine Disrupting Pollutants**

The EPA has established National Recommended Water Quality Criteria for some of the EDCs in this Petition. However, the criteria was not designed to protect against EDC harm. Further, not every pollutant indentified by the EPA as a priority pollutant has recommended national water quality criteria.

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<sup>71</sup> Adibi, J.J., R. Hauser, P.L. Williams, R.M. Whyatt, A.M. Calafat, H. Nelson, R. Herrick, and S.H. Swan, 2009, Maternal urinary metabolites of Di-(2-Ethylhexyl) phthalate in relation to the timing of labor in a U.S. multicenter pregnancy cohort study, *Am J Epidemiol*, 169(8):1015-24.

<sup>72</sup> Windham, C.G., D. Lee, P. Mitchell, M. Anderson, M. Petreas, and B. Lasley, 2005, Exposure to organochlorine compounds and effects on ovarian function, *Epidemiology*, 16(2):182-90.

<sup>73</sup> Blanck, H.M., M. Marcus, C. Rubin, P.E. Tolbert, V.S. Hertzberg, A.K. Hernderson, and R.H. Zhang, 2002, Growth in girls exposed in utero and postnatally to polybrominated biphenyls and polychlorinated biphenyls, *Epidemiology*, 13(2):205-210; Marcus, M., 2000, The Michigan PBB Cohort 20 Years Later: Endocrine Disruption?, available at

[http://www.epa.gov/ncer/science/endocrine/pdf/humanhealth/r825300\\_marcus\\_0415.pdf](http://www.epa.gov/ncer/science/endocrine/pdf/humanhealth/r825300_marcus_0415.pdf).

<sup>74</sup> Damgaard, I.N., N.E. Skakkebaek, J. Toppari, H.E. Virtanen, H. Shen, K. Schramm, J.H. Petersen, T.K. Jensen, K.M. Main, and the Nordic Cryptorchidism Study Group, 2006, Persistent Pesticides in Human Breast Milk and Cryptorchidism, *Environmental Health Perspectives* vol. 114, no. 7.

<sup>75</sup> Final Report: Persistent Organic Pollutants and Endometriosis Risk, Holt, Victoria L., Dana Barr, and Chu Chen, Mar. 2007,

[http://cfpub.epa.gov/ncer/abstracts/index.cfm/fuseaction/display\\_abstractDetail/abstract/2361/report/F](http://cfpub.epa.gov/ncer/abstracts/index.cfm/fuseaction/display_abstractDetail/abstract/2361/report/F).

<sup>76</sup> Codru, N., M.J. Schyuma, S. Negoita, The Akwesasne Task Force on the Environment, R. Rej, and D.O. Carpenter, 2007, Diabetes in Relation to Serum Levels of Polychlorinated Biphenyls and Chlorinated Pesticides in Adult native Americans, *Environmental Health Perspectives* 115:10 1442-1447.

**Therefore, the EPA must revise the water quality criteria and publish information on the following EDCs: butylbenzyl phthalate, chlordane, chlorpyrifos, diazinon, dieldrin, DDT and its metabolites, endosulfan (alpha, beta, sulfate), endrin, HCB, isophorone, gamma BHC/lindane, naphthalene, PCBs, pyrene, selenium, toxaphene, and 2,4-D.**

Butylbenzyl phthalate: Butylbenzyl phthalate is a widely used plasticizer primarily found in PVC, rubbers, and polyurethane. These products are used in PVC floorings, wall coverings, and foams, expanded leather, and in polyurethane-based sealing and adhesive systems. An EPA funded study showed that certain phthalates including butyl benzyl phthalate are significantly associated with reduced anogenital distance in human male infants. These effects were noted with median and 95<sup>th</sup> percentile of daily exposures of 0.50 - 2.47 µg/L/kg/day.<sup>77</sup> In rats, exposure to various levels of butylbenzyl phthalate led to reduced anogenital distance, delayed acquisition of puberty, and other malformations of both male and female reproductive systems.<sup>78</sup> Another study found that rats exposed to near the EPA safe dose for humans and lower than the estimated exposure rate for infants and children, experienced effects in the gene expression profile of the mammary gland.<sup>79</sup>

Despite these troubling findings, the EPA's National Recommended Water Quality Standard for butylbenzyl phthalate for human health is 1500 µg/L (water plus organism) and 1900 µg/L (organism only). The EPA clearly recognizes its potential for human health effects as evidenced by its placement on the EPA's EDSP Tier 1 List. However, the EPA has not yet published complete aquatic criteria, anticipating that industry will publish draft aquatic life criteria. Not only is butylbenzyl phthalate having effects on wildlife and water quality now, it continues to be detected in U.S. drinking water.<sup>80</sup> EPA must revise its National Recommended Water Quality Criteria to reflect the latest scientific knowledge that butylbenzyl phthalate has endocrine disrupting effects on humans, fish, and wildlife.

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<sup>77</sup> Marsee, K., T.J. Woodruff, D.A. Axelrad, A.M. Calafat, and S.H. Swan, 2006, Estimated Daily Phthalate Exposures in a Population of Mothers of Male Infants Exhibiting Reduced Anogenital Distance, *Environmental Health Perspectives*, v. 114, n. 6 p. 805, available at <http://www.ehponline.org/members/2006/8663/8663.html>.

<sup>78</sup> Tyl, R.W., Myers, C.B., Marr, M.C., Fail, P.A., Seely, J.C., Brine, D.R., Barter, R.A., and J.H. Butala, 2004, Reproductive toxicity evaluation of dietary butyl benzyl phthalate (BBP) in rats, *Reproductive Toxicology* vol. 18, iss. 2; Moral, R., Wang, R., Russo, I.H., Mailo, D.A., Lamartiniere, C.A., and J Russo, 2007, The plasticizer butyl benzyl phthalate induces genomic changes in rat mammary gland after neonatal/prepubertal exposure, *BMC Genomics* 8:453; Hotchkins, A.K., L.G. Parks-Saldutti, J.S. Ostby, C. Lambright, J. Furr, J.G. Vandenbergh, and L.E. Gray, A Mixture of the "Antiandrogens" Linuron and Butyl Benzyl Phthalate Alters Sexual Differentiation of the Male Rat in a Cumulative Fashion, *Biology of Reproduction* vol. 71, no. 6.

<sup>79</sup> Moral, R., R. Wang, I.H. Russo, D.A. Mailo, C.A. Lamartiniere, and J. Russo, 2007, The plasticizer butyl benzyl phthalate induces genomic changes in rat mammary gland after neonatal/prepubertal exposure, *BMC Genomics* 8:453.

<sup>80</sup> Benotti, M.J., R.A. Trenholm, B.J. Vanderford, J.C. Holady, B.D. Stanford, and S.A. Snyder, 2009, Pharmaceuticals and Endocrine Disrupting Compounds in U.S. Drinking Water, *Environ. Sci. Technol.* 43, 597-603.

Chlordane (including trans-chlordane, trans-nonachlor, oxychlordane, heptachlor, and heptachlor epoxide): Chlordane is a persistent organochlorine pesticide made up of a mixture of related chemicals, including heptachlor. It bioaccumulates readily in fish and wildlife and is highly toxic to freshwater invertebrates and fish. Its use is banned in the U.S. but it is still manufactured for export. Chlordane, trans-chlordane, and oxychlordane have been statistically significantly linked to testicular germ cell tumor risk.<sup>81</sup> One study examined the impacts of pesticides on the expected sex ratio of turtle eggs and found that the sex ratio was altered by each of the pesticides used (a PCB mixture, trans-nonachlor, and chlordane).<sup>82</sup> Specifically, chlordane suppressed testosterone levels in hatchling males and progesterone levels in hatchling females, indicating that chlordane's impact on sex ratio is a result of anti-androgenic activity. Trans-nonachlor worked as an estrogen mimic, while alachlor suppressed testosterone levels but not progesterone levels. The study concluded that different hormone disrupting compounds can achieve similar end results via different biochemical mechanisms. Another study found that very low doses of trans-nonachlor and chlordane, 0.125-0.5 ng/egg, resulted in altered sex ratios in red-eared slider turtles.<sup>83</sup> Chlordane, at levels of 1 and 10 ng/L caused an increase in estrogen, reduction in testosterone, morphological changes in masculine appendage, and vitellogenin-like protein production in male green neon shrimp (*Neocaridina denticulata*), and reproductive obstacles in female green neon shrimp.<sup>84</sup>

The EPA has recognized that longterm exposure to this pollutant can result in adverse health effects at .002 µg/L and has established a public health goal of zero exposure.<sup>85</sup> Yet chlordane has an EPA water quality standard of 2.4 µg/L CMC and .0043 µg/L CCC. Heptachlorepoide is the degradate of heptachlor, a manufactured chemical used to make mothballs. The EPA has recognized that longterm exposure to this pollutant can result in adverse health effects at .0002 µg/L and has established a public health goal of zero exposure.<sup>86</sup> However, heptachlorepoide has freshwater criteria at .52 µg/L CMC and .0038 µg/L CCC, saltwater criteria at .053 µg/L CMC and .0036 CCC, and criteria for human health consumption at .000039 µg/L (for both water plus organism and organism only). Heptachlorepoide has been detected in common carp in Las Vegas at .62

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<sup>81</sup> McGlynn, K.A., S.M. Quraishi, B.I. Graubard, J. Weber, M.V. Rubertone, and R. L. Erickson, 2008, Persistent Organochlorine Pesticides and Risk of Testicular Germ Cell Tumors, *J. Natl. Cancer Inst.* 100:663-671.

<sup>82</sup> Willingham, E.T., et al. 2000. Embryonic Treatment with Xenobiotics Disrupts Steroid Hormone Profiles in Hatchling Red-Eared Slider Turtles (*Trachemys scripta elegans*). *Environmental Health Perspectives* 108(4): 329-332.

<sup>83</sup> Willingham, E., 2004, Endocrine-Disrupting Compounds and Mixtures: Unexpected Dose-Response, *Arch. Environ. Contam. Toxicol.* 46, 265-269.

<sup>84</sup> Huang, D., Wang, S., and Chen, H., 2004, Effects of the endocrine disruptor chemicals chlordane and lindane on the male green neon shrimp (*Neocaridina denticulata*), *Chemosphere* vol. 57, iss. 11; Huang, D., H. Chen, J. Wu, and S. Wang, 2006, Reproduction obstacles for the female green neon shrimp (*Neocaridina denticulata*) after exposure to chlordane and lindane, *Chemosphere* vol. 64, iss. 1.

<sup>85</sup> EPA, 2009, National Primary Drinking Water Regulations, available at <http://www.epa.gov/safewater/consumer/pdf/mcl.pdf>.

<sup>86</sup> EPA, 2009, Occurrence of Contaminants of Emerging Concern in Wastewater From Nine Publicly Owned Treatment Works, EPA-821-R-09-009, available at <http://www.epa.gov/waterscience/ppcp/studies/9potwstudy.pdf>.

micrograms per kilogram (approximately .0062 ppb) and these carp show evidence of endocrine disruption.<sup>87</sup> Other chlordane degradates have been found in common carp in Las Vegas Bay at 13 micrograms per kilogram,<sup>88</sup> in the Santa Ana River, the lower Colorado River, and the Imperial Valley watershed.<sup>89</sup> EPA must revise its National Recommended Water Quality Criteria for chlordane and its related compounds to reflect the latest scientific knowledge that these chemicals act as EDCs on fish, wildlife, and humans.

Chlorpyrifos: Chlorpyrifos, also known as chloropyrifos, is an organophosphate pesticide (“OP”) that has been linked to neurological effects and birth defects.<sup>90</sup> It is the most widely used insecticide with both agricultural and urban uses, has more pounds of active ingredient applied to cropland than any other OP, and is the most widely used OP in surface water.<sup>91</sup> Bioconcentration of chlorpyrifos in ponds and estuarine areas can cause acute and/or reproductive risks to aquatic birds and mammals feeding adjacent to treated areas.<sup>92</sup> Additionally, synergistic interactions between chlorpyrifos and a variety of other chemicals have been observed—enhancing the potency of chlorpyrifos.<sup>93</sup> Endangered species levels of concern are exceeded for small mammals, birds, freshwater fish and invertebrates, and estuarine fish and invertebrates for most chlorpyrifos uses.

The EPA has established water quality criteria for chlorpyrifos for freshwater CMC at .083 µg/L and CCC .041 µg/L, and for saltwater at CMC .011 µg/L and CCC .0056 µg/L. However, the results of a recent study shows that chlorpyrifos is highly toxic to *P. regilla* and *R. boyllii* with the median lethal concentrations in the few hundreds of a part per billion range.<sup>94</sup> Likewise, the time to metamorphosis increased with concentration of chlorpyrifos in both species. Cholinesterase activity, a key step of metamorphosis, declined with exposure concentration. In Las Vegas Bay, chlorpyrifos has been detected

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<sup>87</sup> Goodbred 2007, Table 3; Intertox, 2008, Las Vegas Wash Monitoring and Characterization Study: Ecotoxicologic Screening Assessment of Selected Contaminants of Potential Concern in Sediment, Whole Fish, Bird Eggs, and Water 2005-2006, Table 15.

<sup>88</sup> Goodbred 2007, Table 3; Intertox 2008, Table 15.

<sup>89</sup> Jenkins 2009; Marr 2007; Hinck, J.E., V.S. Blazer, N.D. Denslow, K.R. Echols, T.S. Gross, T.W. May, P.J. Anderson, J.J. Coyle, and D.E. Tillitt, 2007, Chemical contaminants, health indicators, and reproductive biomarker responses in fish from the Colorado River and its tributaries, *Science of the Total Environment* 378:376-402; and Goodbred 2006.

<sup>90</sup> ATSDR, 1997, Toxicological Profile for Chlorpyrifos, available at <http://www.atsdr.cdc.gov/toxprofiles/tp84.html>.

<sup>91</sup> Hopkins, E.H. et al., 2000, Organophosphorous pesticide (“OP”) occurrence and distribution in surface and ground water of the United States, 1992–97, *U.S.G.S. Open-file report 00-187*.

<sup>92</sup> EPA, 2001, Chlorpyrifos IRED, 09/2001, p. 52.

<sup>93</sup> Cox, C., Insecticide Factsheet, Chlorpyrifos, Part 3: Ecological Effects, *Journal of Pesticide Reform*, Summer 1995, vol.15, no.2, p. 17.

<sup>94</sup> *P. regilla* populations seem to be stable or declining at a slower rate. A possible cause of their relative success is their reduced dependence on standing water. *P. regilla* adults lay their eggs in water and move to upland habitat shortly afterwards; hatching is rapid compared to some of the other species; and time to metamorphosis is less than that of *R. boyllii*.

in water and in common carp at 8.65 micrograms per kilogram.<sup>95</sup> These carp suffer from endocrine disruption and chlorpyrifos pollution is likely partially to blame.

The EPA acknowledges chlorpyrifos' endocrine disrupting effects and has identified it in its Endocrine Disruptor Screening Program, Tier I Screening List.<sup>96</sup> However, the EPA has not established human health criteria, despite its presence throughout the nation. Chlorpyrifos has been detected in the Colorado River, Imperial Valley watershed, lower Columbia River water and sediment, and source water.<sup>97</sup> It has also been detected in streams in Arkansas, groundwater in Oregon, in the lower Tallapoosa River watershed in Alabama, in intersexed fish in the Shenandoah River, and in Colorado streams and ground water.<sup>98</sup> EPA must revise its National Recommended Water Quality Criteria to reflect the latest scientific knowledge that chlorpyrifos is an EDC affecting human health, fish, and wildlife.

Diazinon: Diazinon is an insecticide used for indoor, commercial property, lawn/ornamental, animal treatments, rangeland, and has multiple other food and feed uses. Approximately 6 million pounds are applied annually, with about 70% applied for urban uses. Diazinon is the most commonly detected OP in urban streams.<sup>99</sup> It is very highly toxic to birds, mammals, beneficial insects, and freshwater, estuarine and marine animals.<sup>100</sup> Acute and chronic levels of concern are exceeded for all uses for freshwater and estuarine/marine fish, terrestrial animals, and aquatic invertebrates.<sup>101</sup> Endangered species levels of concern are exceeded for wildlife, aquatic life and terrestrial plants.<sup>102</sup> It

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<sup>95</sup> Rosen, M.R., D.A. Alvarez, S.L. Goodbred, T.J. Leiker, and R. Patino, 2009, Sources and distribution of organic compounds using passive samplers in Lake Mead National recreation Area, Nevada and Arizona, and their implications for potential effects on aquatic biota, *Journal of Environmental Quality*, Table 2, Table 3; Goodbred 2007, Table 3.

<sup>96</sup> EPA, 2009, Final List of Initial Pesticide Active Ingredients and Pesticide Inert Ingredients to be Screened Under the Federal Food, Drug, and Cosmetic Act, 74 *Federal Register* 17579 (Apr. 15, 2009).

<sup>97</sup> See Goodbred 2006; LCREP 2007; and Kingsbury, J.A., G.C. Delzer, and J.A. Hopple, 2008, Anthropogenic organic compounds in source water of nine community water systems that withdraw from streams, 2002-2005 *U.S. Geological Survey Scientific Investigations Report 2008-5208*, 66 p.

<sup>98</sup> Galloway, J.M., B.E. Haggard, M.T. Meyers, and W.R. Green, 2005, Occurrence of Pharmaceuticals and Other Organic Wastewater Constituents in Selected Streams in Northern Arkansas, 2004, *Scientific Investigations Report 2005-5140*; Hinkle, S.R., R.J. Weick, J.M. Johnson, J.D. Cahill, S.G. Smith, and B.J. Rich, 2005, Organic wastewater compounds, pharmaceuticals, and coliphage in ground water receiving discharge from onsite wastewater treatment systems near La Pine, Oregon – Occurrence and implications for transport, *U.S. Geological Survey Scientific Investigations Report 2005-5055*, 98 p.; Oblinger, C.J., A.C. Gill, A.K. McPherson, M.T. Meyer, and E.T. Furlong, 2007, Occurrence of selected pharmaceuticals, personal-care products, organic wastewater compounds, and pesticides in the lower Tallapoosa River watershed near Montgomery, Alabama, 2005, *U.S. Geological Survey Scientific Investigations Report 2007-5266*, 23 p.; Alvarez, D.A., W.L. Cranor, S.D. Perkins, V.L. Schroeder, S.L. Werner, E.T. Furlong, and J. Holmers, 2008, Investigations of organic chemicals potentially responsible for mortality and intersex in fish of the North Fork of the Shenandoah River, Virginia, during spring of 2007, *U.S. Geological Survey Open-File Report 2008-1093*, 16 p.; and Sprague, L.A. and W.A. Battaglin, 2006, Wastewater Chemicals in Colorado's Streams and groundwater, *Fact Sheet 2004-3127*.

<sup>99</sup> Hopkins 2000.

<sup>100</sup> EPA, 1999, EFED RED Chapter for Diazinon, 05/1999, p. 4.

<sup>101</sup> *Id.*

<sup>102</sup> *Id.*

has been shown to decrease testes size and weight.<sup>103</sup> It can also have significant effects on brain acetylcholinesterase activity at environmentally relevant doses.<sup>104</sup>

The primary environmental concerns associated with diazinon use are bird kills, contamination of surface water, and impacts on aquatic species.<sup>105</sup> Urban use, which is prone to runoff, has resulted in widespread contamination of surface water.<sup>106</sup> Approximately 300 incidents of wildlife mortality, mostly birds, have been attributed to diazinon use.<sup>107</sup> Based on this information, diazinon has caused the second largest number of total known incidents of bird mortality of any pesticide, exceeded only by carbofuran.<sup>108</sup> However, the documented kills is believed to be a very small fraction of the total mortality caused by this pesticide.<sup>109</sup> Diazinon has also been shown to interfere with salmon behavior at environmentally relevant doses.<sup>110</sup> Salmon exposed to 1.0 µg/L inhibited the olfactory-mediated alarm response of salmon, and at 10 µg/L, caused homing behavior impairment.

Diazinon is on the EPA's EDSP Tier 1 List. The EPA has established water quality criteria for freshwater CMC and CCC at .17 µg/L, and saltwater CMC and CCC at .82 µg/L. It has been detected in treated wastewater, Boulder Creek, Colorado, and source water.<sup>111</sup> It has also been detected in streams in Arkansas, groundwater in Oregon, in waste, surface, ground and drinking water in Minnesota, in the lower Tallapoosa River watershed in Alabama, in intersexed fish in the Sheandoah River, and in Colorado streams and ground water.<sup>112</sup> EPA must revise its National Recommended Water Quality Criteria to reflect the latest scientific knowledge that diazinon is an EDC affecting human health, wildlife and fish.

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<sup>103</sup> Fattahi, E., K. Parivar, S.G.A. Jorsaraei, and A.A. Moghadamnia, 2009, The effects of diazinon on testosterone, FSH and LH levels and testicular tissue in mice, *Iranian Journal of Reproductive Medicine* vol. 7 no. 2 pp. 59-64; *see also* Dutta, H.M. and H.J.M. Meijer, 2003, Sublethal effects of diazinon on the structure of the testis of bluegill, *Lepomis macrochirus*: a microscopic analysis, *Environmental Pollution* vol. 125, iss. 3.

<sup>104</sup> Oruc, E.O., N. Uner, Y. Sevgiler, D. Usta, and H. Durmaz, 2006, Sublethal Effects of Organophosphate Diazinon on the Brain of *Cyprinus Carpio*, *Drug and Chemical Toxicology* vol. 29, no. 1.

<sup>105</sup> *Id.* at 1.

<sup>106</sup> *Id.*

<sup>107</sup> *Id.* at 2.

<sup>108</sup> *Id.* at 144.

<sup>109</sup> *Id.*

<sup>110</sup> Scholz, N.L., N.K. Truelove, B.L. French, T.P. Quinn, E. Casillas, and T.K. Collier, 2000, Diazinon disrupts antipredator and homing behaviors in Chinook salmon, *Can. J. Fish. Aquat. Sci.* 57(9): 1911-1918, *see also* Moore, A. and N. Lower, 2001, The impact of two pesticides on olfactory-mediated function in mature male Atlantic salmon, *Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology*.

<sup>111</sup> EPA 2009; Barber 2006; and Kingsbury 2008.

<sup>112</sup> Galloway 2005; Hinkle 2005; Lee, K.E., L.B. Barber, E.T. Furlong, J.D. Cahill, D.W. Kolpin, M.T. Meyer, and S.D. Zaugg, 2004, Presence and Distribution of organic wastewater compounds in wastewater, surface, ground, and drinking waters, Minnesota, 2000-02, *U.S. Geological Survey Scientific Investigations Report 2004-5138*, 47 p.; Oblinger 2007; Alvarez 2008; and Sprague 2006.

Dieldrin: Dieldrin is a chlorinated insecticide that was used as an alternative to DDT until it was banned in 1987 because of its toxicity. Dieldrin has low solubility in water, and persists in soil and sediment where it can move to organisms and bioaccumulate. Exposed to sunlight, dieldrin can transform into photodieldrin, an even more toxic compound. In one study, dieldrin caused sex ration disruption, reducing the number of male Daphnia.<sup>113</sup> The results of this study are of particular concern because insects are at the bottom of the food chain, serving as a food source for many higher life forms including fish, and may have implications for wildlife throughout the food web. Other studies show that very low levels of dieldrin exposure can result in reduced testosterone secretion and affect the fetal human Leydig cell, potentially leading to dysregulation of reproductive development.<sup>114</sup> It has also been shown to increase uterine weight during short-term exposure of low doses.<sup>115</sup>

EPA set a human health consumption limit of .000052 µg/L (for water plus organism) and .000054 µg/L (for organism only). Dieldrin has been detected in the water and in common carp from Las Vegas Bay at 3.9 micrograms per kilogram (approximately .0039 µg/L, considerably over the EPA recommended standard).<sup>116</sup> It has also been detected in treated wastewater, in fish tissue from the Colorado River, in source water throughout the U.S., and in the lower Tallapoosa River watershed in Alabama.<sup>117</sup> The EPA must revise the National Recommended Water Quality Criteria and update information reflecting the latest scientific knowledge about the endocrine-disrupting potential of dieldrin.

DDT, DDE, DDD: DDT is an organochlorine pesticide.<sup>118</sup> Though it was banned in the U.S. in 1972, it and its breakdown products DDE and DDD, are highly persistent and can stay in soil and sediment. They bioaccumulate and biomagnify up the food chain. They are known to have acute and longterm effects on microorganisms, invertebrates, amphibians, fish, mammals, and birds. One study found that low levels of *p,p'*-DDE at 7-28 ng/egg resulted in altered sex ratios in red-eared slider turtles.<sup>119</sup> Another showed that *p,p'*-DDE is statistically significantly linked to testicular germ cell tumor risk.<sup>120</sup>

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<sup>113</sup> Dodson, S.I., et al., 1999, Dieldrin Reduces Male Production and Sex Ratio in Daphnia (*Galeata mendotae*), *Toxicology and Industrial Health: An International Journal*, vol.15, nos. 1&2, 192-199.

<sup>114</sup> Fowler, P.A., D.R. Abramovich, N.E. Haites, P. Cash, N.P. Groome, A. Al-Qahatni, T.J. Murray, and R.G. Lea, 2007, Human fetal testis Leydig cell disruption by exposure to the pesticide dieldrin at low concentrations, *Human Reproduction* vol. 22, no. 11; Hallegue, E., K.B. Rhouma, O. Tebouri, and M. Sakly, 2003, Impairment of Testicular Endocrine and Exocrine Functions after Dieldrin Exposure in Adult Rats, *Polish Journal of Environmental Studies* vol. 12, no. 5.

<sup>115</sup> El-Mubarak, A. and D. Huisingh, 2001, Environmental Xenoestrogens: Short-term Exposure of Low Doses of Lindane, Dieldrin, Dibutyl Phthalate, and Diethylhexyl Phthalate Increases Uterine Weight in Young Female Mice, *Analytical Sciences* vol. 17 supplement.

<sup>116</sup> Intertox 2008, Table 6, Table 19 and Goodbred 2007, Table 3.

<sup>117</sup> Hinck 2007; Goodbred 2006; LCREP 2007; Kingsbury 2008; and Oblinger 2007.

<sup>118</sup> See ATSDR, 2002, Toxicological Profile for DDT, DDE, and DDD, available at <http://www.atsdr.cdc.gov/toxprofiles/tp35.html>.

<sup>119</sup> Willingham 2004.

<sup>120</sup> McGlynn, K.A., S.M. Quraishi, B.I. Graubard, J. Weber, M.V. Rubertone, and R. L. Erickson, 2008, Persistent Organochlorine Pesticides and Risk of Testicular Germ Cell Tumors, *J. Natl. Cancer Inst.* 100:663-671.

The EPA has established water quality criteria for DDT in freshwater at CMC 1.1 µg/L and CCC .001 µg/L, and in saltwater at .13 µg/L CCC and .001 µg/L CMC. It has established human health consumption concentration of .00022 µg/L (for water plus organism and organism only). EPA has established water quality criteria for DDE for human health consumption at .00022 µg/L (for water plus organism and organism only), and for human health consumption for DDD at .00031 µg/L (for water plus organism and organism only). These EDCs have been detected Lake Mead in both water and fish samples.<sup>121</sup> They have also been detected in fish from the Santa Ana River, from water and fish tissue from the lower Colorado River, in intersexed fish from the Shenandoah, and from the Imperial Valley watershed.<sup>122</sup> The EPA must revise the National Recommended Water Quality Criteria and update information reflecting the latest scientific knowledge about the endocrine-disrupting potential of DDT and its metabolites.

Endosulfan (including alpha-endosulfan, beta-endosulfan, and endosulfan sulfate):

Endosulfan is an organochlorine insecticide widely used on food crops. The EPA has estimated the total average annual use of endosulfan in the United States to be 1.38 million pounds of active ingredient. Endosulfan has been known to affect the central nervous system as well as the reproductive system of vertebrates and has been implicated in altered sexual development of males.<sup>123</sup> EPA's ecological assessment indicates the endosulfan is "very highly toxic to both terrestrial and aquatic organisms."<sup>124</sup> Endosulfan is likely to result in acute and chronic risk to both terrestrial and aquatic organisms.<sup>125</sup> Mortality to nontarget fish is probable; there is a 90% probability that roughly 60% of all aquatic species will suffer 50% mortality for the most vulnerable uses.<sup>126</sup> Current endosulfan use rates on 88% of the crops modeled will exceed acute high risk levels of concern more than 99% of the time.<sup>127</sup> Additionally, given the reproductive and developmental effects of endosulfan coupled with the chemical's ability to bind to the human estrogen receptor, these chronic effects have a considerable impact on nontarget organisms.<sup>128</sup>

Researchers have examined the effects of continuous exposure to environmentally relevant concentrations endosulfan on the growth and survival of leopard frog tadpoles.<sup>129</sup> The concentrations used are comparable to those estimated to be found in water bodies near agricultural fields. Shenoy et al. (2009) looked at the impacts of endosulfan on tadpoles of the northern leopard frog (*Rana pipiens*), a common North American amphibian species found in a variety of habitats, including agricultural fields and golf

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<sup>121</sup> Intertox 2008, Table 6, Table 15, Table 19 and Rosen 2009, Table 2.

<sup>122</sup> Jenkins 2009; Marr 2007; Alvarez 2008; and Goodbred 2006.

<sup>123</sup> EPA, 2001, Endosulfan EFED Risk Assessment for the Reregistration Eligibility Decision for Endosulfan (Thiodan), 04/2001, at Endosulfan Summary [*hereinafter* "Endosulfan RED"].

<sup>124</sup> Endosulfan RED, p. 2.

<sup>125</sup> *Id.* at 24.

<sup>126</sup> *Id.*

<sup>127</sup> *Id.* at 25.

<sup>128</sup> *Id.*

<sup>129</sup> Shenoy, K., B.T. Cunningham, J.W. Renfroe, and P.H. Crowley, 2009, Growth and Survival of Northern Leopard Frog (*Rana pipiens*) Tadpoles Exposed to Two Common Pesticides, *Environmental Toxicology and Chemistry* 28:7, 1469-1474.

courses. Exposure to endosulfan resulted in significant mortality among the tadpoles. Results demonstrated that even low concentrations, 0.2 µg/L of endosulfan, which may well be expected in water bodies around agricultural fields, can be lethal, or can inhibit growth when sublethal. Also, an EPA funded study showed that exposure to endosulfan resulted in decreased reproduction in grass shrimp.<sup>130</sup>

The results of another study shows that endosulfan is highly toxic to *P. regilla* and *R. boylei*.<sup>131</sup> Endosulfan is 21 times more toxic than chlorpyrifos in *P. regilla* and nearly 121 times greater in *R. boylei*. Scientists have also documented interference with reproduction in red-spotted newts, *Notophthalmus viridescens*, from exposure to endosulfan.<sup>132</sup> The study noted that endosulfan disrupted the development of glands that synthesize a pheromone used in female communication which in turn led to lower mating success. The study revealed an impact at just 5 parts per billion, the lowest concentration used in the study and a concentration which is well within the range of endosulfan contamination regularly encountered in the real world.

In a second study examining endosulfan's impact on tadpoles, Relyea added endosulfan at a very low concentration (6 ppb) to mesocosm communities containing tadpoles. The single application of endosulfan killed 84% of leopard frog tadpoles, but this mortality did not appear to occur in the first few days of the experiment. This observation is consistent with the current study's discovery of substantial lag effects in leopard frogs, American toads, and spring peepers.

The EPA has established water quality criteria for alpha-endosulfan, beta-endosulfan, endosulfan sulfate for freshwater at CMC .22 µg/L and CCC .056 µg/L, for saltwater at CMC .034 µg/L and CCC .0087 µg/L, and human health criteria at 62 µg/L (water plus organism) and 89 µg/L (organism only).<sup>133</sup> The EPA has acknowledged that endosulfan is an endocrine disruptor,<sup>134</sup> and it is on the EPA's EDSP Tier 1 List, yet the EPA's water quality standards do not appear stringent enough to prevent endocrine disrupting harm to

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<sup>130</sup> Bejarano, A.C. and G.T. Chandler, 2003, Reproductive and developmental effects off atrazine on the estuarine meiobenthic copepod *Amphiascus tenuiremis*, *Environmental Toxicology and Chemistry* 22(12):3009-3016; Cary, T.L., G.T. Chandler, D.C. Volz, S.S. Walse, and J.L. Ferry, 2004, Phenylpyrazole insecticide fipronil induces male fertility in the estuarine meiobenthic crustacean *Amphiascus tenuiremis*, *Environmental Science & Technology*, 38(2):522-528; See also Chandler, G.T., 2002, Environmentally-Mediated Endocrine Disruption in Estuarine Crustaceans: A3-Taxon Multi-Generational Study of Sediment-Associated EDC Effects from the Genetic to Population Levels, available at [http://www.epa.gov/ncer/science/endocrine/pdf/wildlife/r827397\\_chandler-03015-final.pdf](http://www.epa.gov/ncer/science/endocrine/pdf/wildlife/r827397_chandler-03015-final.pdf).

<sup>131</sup> *P. regilla* populations seem to be stable or declining at a slower rate. A possible cause of their relative success is their reduced dependence on standing water. *P. regilla* adults lay their eggs in water and move to upland habitat shortly afterwards; hatching is rapid compared to some of the other species; and time to metamorphosis is less than that of *R. boylei*.

<sup>132</sup> Park, D., S.C. Hempleman, and C.R. Propper, 2001, Endosulfan exposure disrupts pheromonal systems in the red-spotted newt: A mechanism for subtle effects of environmental chemicals, *Environmental Health Perspectives* 109:669-673.

<sup>133</sup> Endosulfan sulfate currently does not have freshwater or saltwater criteria.

<sup>134</sup> EPA Memorandum, Dec. 11, 2000, Endosulfan: Evaluation of Registrant Submission *Endosulfan: Evaluation of Possible Endocrine Effects in Mammalian Species*, US EPA, Office of Prevention, Pesticides and Toxic Substances; Endosulfan RED, p. 30.

fish, wildlife, and humans. Endosulfan and its metabolites have been detected in Imperial Valley, fish tissue from the Colorado River, in intersexed fish from the Shenandoah River, and in Lake Mead.<sup>135</sup> The EPA must revise the National Recommended Water Quality Criteria for endosulfan to reflect the latest scientific knowledge.

Endrin: Endrin was once a registered pesticide in the U.S. and is a highly toxic persistent organic pollutant. Persistent organic pollutants are resistant to environmental degradation and bioaccumulate in animal tissue. Endrin has been found to impair liver and brain tissue.<sup>136</sup> At high levels, endrin blocks inhibitory neurotransmitters in the central nervous system resulting in excitation and seizures.<sup>137</sup> In lower levels, it can cause skeletal abnormalities and cleft palate in the offspring of treated rodents.<sup>138</sup> The EPA has recognized that longterm exposure to this pollutant can result in adverse health effects at .002 µg/L.<sup>139</sup> The EPA has established National Recommended Water Quality Criteria for freshwater at .086 µg/L CMC and .036 µg/L CCC, and saltwater at .037 µg/L CMC and .0023 µg/L CCC. It has also established human health criteria at .059 µg/L (water plus organism) and .060 µg/L (organism only). Endrin has been detected at Meadows Detention Basin at Lake Mead at .053 µg/L.<sup>140</sup> It has also been detected in fish tissue from the Colorado River and from the Imperial Valley watershed.<sup>141</sup> The EPA must revise its National Recommended Water Quality Criteria to reflect the latest scientific knowledge regarding endrin's harm as an EDC.

Hexachlorobenzene: Hexachlorobenzene or HCB is a well studied persistent organic pollutant fungicide that was banned in the U.S. in 1966 and is a suspected carcinogen.<sup>142</sup> It has been shown to cause disruption of glucocorticoids, that regulate glucose synthesis in the liver, and hepatic receptors.<sup>143</sup> Another study discovered that childhood body mass index increase relative to prenatal exposure to hexachlorobenzene.<sup>144</sup> It has also been

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<sup>135</sup> Goodbred 2006; Alvarez 2008; and Hinck 2007.

<sup>136</sup> Bagchi, D., J. Balmoori, M. Bagchi, X. Ye, C.B. Williams, and S.J. Stohs, 2002, Comparative effects of TCDD, endrin, naphthalene and chromium (VI) on oxidative stress and tissue damage in the liver and brain tissue of mice, *Toxicology* vol. 175, iss. 1-3.

<sup>137</sup> Narahashi, T., J.M. Frey, K.S. Ginsburg, M.L. Roy, 1992, Sodium and GABA-activated channels as the targets of pyrethroids and cyclodienes, *Toxicol Lett* 64-65 Spec. No.:429-436.

<sup>138</sup> Kavlock, R.J., H. Chernoff, R.C. Hanisch, J. Gray, E. Rogers, and L.E. Gray, 1981, Perinatal toxicity of endrin in rodents. II. Fetotoxic effects of prenatal exposure in rats and mice, *Toxicology* 21:141-150; Chernoff, N., R.J. Kavlock, R.C. Hanisch, D.A. Whitehouse, J.A. Gray, L.E. Gray, et al., 1979, Perinatal toxicity of endrin in rodents. I. Fetotoxic effects of prenatal exposure in hamsters, *Toxicology* 13:155-165.

<sup>139</sup> EPA 2009.

<sup>140</sup> Intertox 2008, Table 6.

<sup>141</sup> Hinck 2007 and Goodbred 2006.

<sup>142</sup> ATSDR, 1997, Toxicological Profile for Hexachlorobenzene, available at <http://www.atsdr.cdc.gov/toxprofiles/tp90.html>.

<sup>143</sup> Lelli, S.M., N.R. Ceballos, M.B. Mazzetti, C.A. Aldonatti, and L.C. San Martin de Viale, 2006, Hexachlorobenzene as hormonal disruptor-studies about glucocorticoids: Their hepatic receptors, adrenal synthesis and plasma levels in relation to impairs gluconeogenesis, *Biochemical Pharmacology* vol. 73, iss. 6.

<sup>144</sup> Tenenbaum, D.J., 2008, Obesity: Childhood BMI Rises with Prenatal Exposure to Hexachlorobenzene, *Environ Health Perspect.* 116(12): A520.

shown to disrupt auditory function in rat,<sup>145</sup> and cause apoptosis in thyroid cells.<sup>146</sup> Hexachlorobenzene exposure decreases testicular weight and decreases the spermatozoid content of the seminiferous tube.<sup>147</sup> Crabs that were fed hexachlorobenzene treated green alga experienced structural damage.<sup>148</sup>

The EPA has recognized that longterm exposure to this pollutant can result in adverse health effects at .001 µg/L and has established a public health goal of zero exposure.<sup>149</sup> The EPA has established National Recommended Water Quality Criteria for human health consumption at .00028 µg/L (water plus organism) and .00029 µg/L (organism only). However it has not established water quality criteria for aquatic life and wildlife.

It has been found in common carp in Las Vegas Bay at 3.8 micrograms per kilogram.<sup>150</sup> It has also been detected in the Imperial Valley watershed, in fish tissue from the Colorado River, and in carp tissue from the lower Colorado River.<sup>151</sup> The EPA must revise its National Recommended Water Quality Criteria to reflect the latest scientific knowledge that HCB is an EDC that is impairing our nation's waters.

Isophorone: Isophorone is used as a solvent in ink, paint, adhesives, and pesticides and can be found in wood preservatives and floor sealants. Some studies have shown that isophorone may cause birth defects and growth retardation in offspring of rats, and possible reproductive effects in male rats.<sup>152</sup> The EPA has identified it in its EDSP, Tier I Screening List as a potential EDC.<sup>153</sup> The EPA has not established water quality standards for the protection of aquatic life and wildlife, however it has established recommended water quality standards for human health at 35 µg/L (water plus organism) and 960 µg/L (organism only). It has been detected in Lake Mead, in streams in Arkansas, in Oregon, in the lower Tallapoosa River watershed in Alabama, and in source and finished water for Atlanta, Georgia.<sup>154</sup> The EPA must revise its National Recommended Water Quality Criteria to reflect the latest scientific knowledge that isophorone acts as an EDC and is impairing aquatic biota.

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<sup>145</sup> Hadjab, S., D. Maurel, Y. Cazals, and P. Siaud, 2003, Hexachlorobenzene, a dioxin-like compound, disrupts auditory function in rat, *Hearing Research* vol. 191, iss. 1-2.

<sup>146</sup> Chiappini, F., L. Alvarez, V. Lux-Lantos, A.S. Randi, and D.L. Kleiman de Pisarev, 2009, Hexachlorobenzene triggers apoptosis in rat thyroid follicular cells, *Toxicol. Sci.*

<sup>147</sup> Bitri, L., W. Darragi, L. Ouertani, D. Maurel, and M. Ben Saad, 2008, Effect of hexachlorobenzene on some male reproductive parameters in *Meriones unguiculatus*, *Comptes Rendus Biologies* vol. 331, iss. 5.

<sup>148</sup> Chaufan, G., An. Juarez, S. Basack, E. Ithuralde, S.E. Sabatini, G. Genovese, M.L. Oneto, E. Kesten, and M. del Carmen Rios de Molina, 2006, Toxicity of hexachlorobenzene and its transference from microalgae (*Chlorella kessleri*) to crabs (*Chasmagnathus granulatus*), *Toxicology* vol. 227, iss. 3.

<sup>149</sup> EPA 2009.

<sup>150</sup> Goodbred 2007, Table 3; Intertox, Table 15.

<sup>151</sup> Goodbred 2006; Hinck 2007; and Marr 2007.

<sup>152</sup> Available at <http://www.atsdr.cdc.gov/toxprofiles/phs138.html>.

<sup>153</sup> 74 Fed. Reg. 17579.

<sup>154</sup> Rosen 2009, Table 4; Galloway 2005; Hinkle 2005; Oblinger 2007; and Frick, E.A. and M.S. Dalton, 2005, Characterization of anthropogenic organic compounds in the source water and finished water for the city of Atlanta, October 2002-September 2004, *Proceedings of the 2005 Georgia Water Resources Council*.

Lindane and related compounds: This chlorinated hydrocarbon ( $\gamma$  hexachlorocyclohexane – HCH or lindane) is banned for agricultural uses but is still allowed as a pharmaceutical. It may accumulate in sediment and can be toxic to fish at high concentrations, and at lower concentrations can affect growth, hormones, and the immune system. Lindane is a persistent and moderately mobile organochlorine previously widely used throughout the U.S., and currently only used to treat lice and scabies.<sup>155</sup> It acts as an endocrine disruptor in birds, mammals, and fish.<sup>156</sup> It has been shown to increase uterine weight during short-term exposure of low doses.<sup>157</sup> Embryo exposure to lindane during early stages of gametogenesis severely impairs the number and survival of germ cells in fetal gonads.<sup>158</sup> Acute toxicity occurs at 0.122  $\mu\text{g/L}$  for embryos and 0.318  $\mu\text{g/L}$  for larvae – effects include weak swimming, incapacity to respond to external stimuli, and uncoordinated movements.<sup>159</sup> Lindane has also been shown to act as an endocrine disruptor during female reproductive system development and on the male reproductive system.<sup>160</sup> Another study has shown that lindane, at low levels (3 mg/g of body mass), acts as a juvenile hormone analogue.<sup>161</sup> Lindane, at levels of 0.1 and 1  $\mu\text{g/L}$  cause an increase in estrogen, a reduction in testosterone, and morphological changes in masculine appendage in male neon shrimp, and reproductive challenges in female neon shrimp.<sup>162</sup>

The EPA has recognized that longterm exposure to this pollutant can result in adverse health effects at .0002  $\mu\text{g/L}$ ,<sup>163</sup> and has placed alpha-hexachlorocyclohexane on the drinking water Contaminant Candidate List for further evaluation.<sup>164</sup> The EPA has established water quality standards for lindane for freshwater at .95  $\mu\text{g/L}$  CMC, for saltwater at .16  $\mu\text{g/L}$  CMC, and for human health consumption at .98  $\mu\text{g/L}$  (water plus organism) and 1.8  $\mu\text{g/L}$  (organism only). Although its agricultural uses have been phased

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<sup>155</sup> EPA, 2001, EFED RED Chapter for Lindane, 08/2001.

<sup>156</sup> *Id.* at 11.

<sup>157</sup> El-Mubarak, A. and D. Huisin, 2001, Environmental Xenoestrogens: Short-term Exposure of Low Doses of Lindane, Dieldrin, Dibutyl Phthalate, and Diethylhexyl Phthalate Increases Uterine Weight in Young Female Mice, *Analytical Sciences* vol. 17 supplement.

<sup>158</sup> La Sala, G., D. Farini, and M. De Felici, 2009, Proapoptotic Effects of Lindane on Mouse Primordial Germ Cells, *Toxicological Sciences* 108(2):445-451.

<sup>159</sup> Oliva, M., C. Garrido, D. Sales, and M.L. Gonzalez de Canales, 2008, Lindane toxicity on early life stages of gilthead seabream (*Sparus aurata*) with a note on its histopathological manifestations, *Environmental Toxicology and Pharmacology* vol. 25, iss. 1.

<sup>160</sup> Maranghi, F., M. Rescia, C. Macri, E. Di Consiglio, G. De Angelis, E. Testai, D. Farini, M. De Felici, S. Lorenzetti, and A. Mantovani, 2007, Lindane may modulate the female reproductive development through the interaction with ER-B: an *in vivo-in vitro* approach, *Chemico-Biological Interactions* vol. 169, iss. 1; Kniewald, J.R., B. Simic, I. Kmetec, and Z.M. Kniewald, 2008, Effects of Lindane on Male Reproductive Parameters in Rats, *Biology of Reproduction* 78:183. 545.

<sup>161</sup> Goudey-Perriere, F., F. Lemonnier, V. Bergougnoux, and C. Perriere, 2007, Low doses of the pesticide lindane induce release by the fat body of femal cockroach *Blalerus craniifer* (Dictoptera), *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology* vol. 146, iss. 4.

<sup>162</sup> Huang, D., H. Chen, J. Wu, and S. Wang, 2006, Reproduction obstacles for the female green neon shrimp (*Neocaridina denticulata*) after exposure to chlordane and lindane, *Chemosphere* vol. 64, iss. 1; Huang, D.J., S.Y. Wang, and H.C. Chen, 2004, Effects of the endocrine disrupter chemicals chlordane and lindane on the male green neon shrimp (*Neocaridina denticulata*), *Chemosphere* 57(11):1621-7.

<sup>163</sup> EPA 2009.

<sup>164</sup> EPA, 2009, Fact Sheet: Final Third Drinking Water Contaminant Candidate List (CCL3), available at [http://www.epa.gov/ogwdw000/ccl/pdfs/ccl3\\_docs/fs\\_cc3\\_final.pdf](http://www.epa.gov/ogwdw000/ccl/pdfs/ccl3_docs/fs_cc3_final.pdf).

out, it has been detected in treated waste water, Boulder Creek, Colorado, and fish tissue from the Colorado River.<sup>165</sup> It has also been detected in intersexed fish from the Shenandoah River and in water and in common carp in Las Vegas Bay at 9.9 micrograms per kilogram with the carp exhibiting evidence of experience endocrine disruption.<sup>166</sup> The EPA must revise its National Recommended Water Quality Criteria to reflect the latest scientific knowledge that lindane is an EDC impairing our nation's waters.

**Naphthalene:** Naphthalene is a PAH and is a component of jet fuel, cigarette smoke, and mothballs. It is also an intermediate in manufacturing some pharmaceuticals. It has the ability to damage or destroy red blood cells. Similar compounds, 1-methyl-naphthalene and 2-methyl-naphthalene are considered to act similarly to naphthalene. Exposure to naphthalene decreases plasmatic cortisol and 17B-estradiol levels in rainbow trout.<sup>167</sup> Naphthalene can also affect liver and pineal organ function.<sup>168</sup> Human exposure to naphthalene can lead to hemolytic anemia and jaundice, and irritated eyes or respiratory tract. High dose and chronic exposure can lead to cataracts or lens opacities.<sup>169</sup>

The EPA has identified naphthalene as a priority toxic pollutant, but has not established National Recommended Water Quality Criteria for it. 1-methyl-naphthalene has been detected in the Lake Mead at concentrations up to 1200 pg/L. 2-methyl-naphthalene has been detected in Lake Mead at concentrations up to 1200 pg/L. It has been detected in the waterbodies at concentrations of at least 1600 pg/L.<sup>170</sup> Naphthalene has also been detected in source water throughout the U.S., in streams in northern Arkansas, in groundwater in Oregon, in waste, surface, ground, and drinking water in Minnesota, in the lower Tallapoosa River watershed in Alabama, in intersexed fish in the Shenandoah River, in groundwater throughout the U.S, and in streams and groundwater in

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<sup>165</sup> EPA 2009, Barber 2006, and Hinck 2007.

<sup>166</sup> Alvarez 2008; Rosen 2009, Table 2, Table 3, Table 4; Goodbred 2007, Table 3.

<sup>167</sup> Gesto, M., A. Tintos, J.L. Soengas, and J.M. Miguez, 2006, Effects of acute and prolonged naphthalene exposure on brain monoaminergic neurotransmitters in rainbow trout, *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology* vol. 144, iss. 2; Gesto, M., J.L. Soengas, and J.M. Miguez, 2008, Acute and prolonged stress responses of brain monoaminergic activity and plasma cortisol levels in rainbow trout are modified by PAHs (naphthalene, B-naphthoflavone and benzo(a)pyrene) treatment, *Aquatic Toxicology* vol. 86, iss. 3.

<sup>168</sup> Tintos, A., M. Gesto, J.M. Miguez, and J.L. Soengas, 2006, Naphthalene treatment alters liver intermediary metabolism and levels of steroid hormones in plasma of rainbow trout (*Oncorhynchus mykiss*), *Ecotoxicology and Environmental Safety* vol. 66, iss. 2; Gesto, M., A. Tintos, A. Rodriguez-Illamola, J.L. Soengas, and J.M. Miguez, 2009, Effects of naphthalene, B-naphthoflavone and benzo(a)pyrene on the diurnal and nocturnal indoleamine metabolism and melatonin content in the pineal organ of rainbow trout, *Oncorhynchus mykiss*, *Aquatic Toxicology*, vol. 92, iss. 1; Pollino, C.A., E. Georgiades, and D.A. Holdway, 2009, Physiological changes in reproductively active rainbowfish (*Melanotaenia fluviatilis*) following exposure to naphthalene, *Ecotoxicology and Environmental Safety* vol. 72, iss. 4.

<sup>169</sup> Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological profile for naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene. August 2005 (update), Available online at <http://www.atsdr.cdc.gov/toxprofiles/tp67.html>.

<sup>170</sup> Rosen 2009, Table 2.

Colorado.<sup>171</sup> The EPA must establish National Recommended Water Quality Criteria to reflect the latest scientific knowledge that naphthalene is an EDC that is harming fish and wildlife.

**PCBs:** The manufacture of polychlorinated biphenyls (PCBs) were banned in the U.S. in 1979, where they were once widely used as insulators and cooling compounds in electrical equipment. They have been incorporated into a variety of consumer products including lubricants, paints, varnishes, and inks. PCBs come in 209 forms, or congeners. They do not degrade readily or dissolve in water, and therefore bioaccumulate in body fat and biomagnify up the food chain. Many studies have shown a correlation between PCB body burden and impaired endocrine and neurological development.<sup>172</sup>

A recent study found that some tissues may be especially vulnerable to PCBs interfering with thyroid hormone signaling by reducing thyroid hormone levels and exerting direct effects on thyroid hormone receptors.<sup>173</sup> Thyroid hormone is necessary for normal brain development. Another study showed that PCBs act as weak estrogens and cause disruption to the perinatal development of the female reproductive tract.<sup>174</sup> An EPA study showed that gulls from areas with high-PCB exposures have altered thyroid function which compromises their ability to respond to changing environmental conditions.<sup>175</sup> In this study, gulls collected from sites with high concentrations of PCBs showed evidence of decreased thyroid function compared with those from reference sites with 7 to 28 times lower concentrations of PCBs.<sup>176</sup> In another EPA funded study, Atlantic croakers treated

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<sup>171</sup> Kingsbury 2008; Galloway 2005; Hinkle 2005; Lee 2004; Oblinger 2007; Alvarez 2008; Barnes, K.K., D.W. Kolpin, E.T. Furlong, S.D. Zaugg, M.T. Meyer, and L.B. Barber, 2008, A national reconnaissance of pharmaceuticals and other organic wastewater contaminants in the United States – 1) Groundwater, *Science of the Total Environment* 402:192-200; and Sprague 2005.

<sup>172</sup> Schantz, S.L., J.J. Widholm, and D.C. Rice, 2003, Effects of PCB exposure on neuropsychological function in children, *Environ Health Perspective* 111:357-576; Grandjean, P., P. Weihe, V.W. Burse, L.L. Needham, E. Storr-Hansen, and B. Heinzow, 2001, Neurobehavioral deficits associated with PCB in 7-year-old children prenatally exposed to seafood neurotoxins, *Neurotoxicol Teratol* 23(4):305-17; Jacobson, J.L. and S.W. Jacobson, 1996, Intellectual impairment in children exposed to polychlorinated biphenyls in utero, *N Engl J Med* 335:783-89; Bortolotti, G.R., K.J. Fernie, and J.E. Smits, 2003, Carotenoid Concentration and Coloration of American Kestrels (*Falco sparverius*) Disrupted by Experimental Exposure to PCBs, *Functional Ecology* vol. 17, no. 5.

<sup>173</sup> Gauger, K.J., S. Giera, D.S. Sharlin, R. Basnal, E. Iannaccone, and R.T. Zoeller, 2007, Polychlorinated Biphenyls 105 and 118 Form Thyroid Hormone Receptor Agonists after Cytochrome P4501A1 Activation in Rat Pituitary GH3 Cells, *Environmental Health Perspectives* 115:11 1623-1630.

<sup>174</sup> Ma, Risheng and D.A. Sassoon, 2006, PCBs Exert an Estrogenic Effect through Repression of the Wnt7a Signaling Pathway in the Female Reproductive Tract, *Environmental Health Perspectives* 114:6 898-904.

<sup>175</sup> EPA, Final Report: Field and Laboratory Studies of the Effects of Polychlorinated Biphenyls and Other Persistent Organic Pollutants on Thyroid Function During Avian Development, 2003, available at <http://cfpub.epa.gov/ncer/abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/444/report/F>.

<sup>176</sup> McNabb, F.M.A. and G.A. Fox, 2003, Avian thyroid development in chemically contaminated environments: is there evidence of alterations in thyroid function and development? *Evolution & Development* 5(1):76-82; see also McNabb, F.M.A., 2001, Field and Laboratory Studies of the Effects of Polychlorinated Biphenyls and Other Persistent Organic Pollutants on Thyroid Function During Avian Development, available at [http://www.epa.gov/ncer/science/endocrine/pdf/wildlife/r827400\\_mcnabb-032205-final.pdf](http://www.epa.gov/ncer/science/endocrine/pdf/wildlife/r827400_mcnabb-032205-final.pdf).

with the PCB, Aroclor, experienced decreases in testicular testosterone and decreases in estrogen production. Larvae from parents exposed to Aroclor had significantly lower growth rates and slower startle responses.<sup>177</sup> Aroclor has also been found to mimic the effects of hypothyroidism on white matter composition.<sup>178</sup> Also, a series of studies provide evidence that low-level exposure to PCBs alters the normal development of brain cells in mice.<sup>179</sup>

The EPA has recognized that longterm exposure to this pollutant can result in adverse health effects at drinking water exposure levels greater than .0005 µg/L and has established a public health goal of zero exposure.<sup>180</sup> The EPA has also established water quality criteria for freshwater at .014 µg/L for CCC, for saltwater at .03 µg/L CCC, and human health consumption criteria at .000064 µg/L (for both water plus organism and organism only).

However, PCBs are still found readily throughout our environment. They have been found in the water and in common carp in Las Vegas Bay at 1.25 micrograms per kilogram,<sup>181</sup> and have been detected in fish from the Santa Ana River, in carp tissue and sediment from the lower Colorado River, and in the lower Columbia River's water and sediment.<sup>182</sup> It is clear that current levels of water-borne PCB pollution are affecting aquatic life. The EPA must revise its National Recommended Water Quality Criteria to reflect the latest scientific knowledge that PCBs act as EDCs and are impairing our nation's waters.

Pyrene: Pyrene is a PAH used in dyes and is known to be toxic to the kidneys and liver. PAHs are frequently found in groups of two or more, and can exist in over 100 different combinations. Although little information is available on the individuals chemicals within the PAH group, there are many studies demonstrating the EDC harm of the PAH group as a whole.<sup>183</sup> Mice exposed to pyrene have developed decreased weight and disease of the kidneys, as well as increased weight of the liver, and changes in blood.<sup>184</sup>

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<sup>177</sup> See also Thomas, P., 2000, Evaluation of Endocrine-Disrupting Chemical Effects Across Multiple Levels of Biological Organization: Integration of Physiology, Behavior, and Population Dynamics in Fishes, available at [http://www.epa.gov/ncer/science/endocrine/pdf/wildlife/r827399\\_thomas-031705-final.pdf](http://www.epa.gov/ncer/science/endocrine/pdf/wildlife/r827399_thomas-031705-final.pdf).

<sup>178</sup> Sharlin, D.S., R. Bansal, and R.T. Zoeller, 2006, Polychlorinated Biphenyls Exert Selective Effects on Cellular Composition of White Matter in a Manner Inconsistent with Thyroid Hormone Insufficiency, *Endocrinology* 147(2):846-858.

<sup>179</sup> Kim, K.H., S.Y. Inan, R.F. Berman, and I.N. Pessah, 2009, Excitatory and inhibitory synaptic transmission is differentially influenced by two ortho-substituted polychlorinated biphenyls in the hippocampal slice preparation, *Toxicol Appl Pharmacol*, 237(2): 168-77; Rubin, B.S., J.R. Lenkowski, C.M. Schaeberle, L.N. Vandenberg, P.M. Ronsheim, and A.M. Soto, 2006, Evidence of Altered Brain Sexual Differentiation in mice Exposed Perinatally to Low, Environmentally Relevant Levels of Bisphenol A, *Endocrinology* 147(8):3681-3691.

<sup>180</sup> EPA 2009.

<sup>181</sup> Rosen 2009, Table 2, Table 3; Goodbred 2007, Table 3; and Intertox 2008 Table 15.

<sup>182</sup> Jenkins 2009; Marr 2007; Hinck 2007; and LCREP 2007.

<sup>183</sup> Chakravarti, D., D. Venugopal, P.C. Mailander, J.L. Meza, S. Higginboham, E.L. Cavalieri, and E.G. Rogan, 2007, The role of polycyclic hydrocarbon-DNA adducts in inducing mutations in mouse skin, *Mutation Research/Genetic Toxicology and Environmental Mutagenesis* vol. 69, iss. 1-2; Perera, F.P., Z. li,

EPA has recommended human health consumption of 830 µg/L (water plus organism) and 4000 µg/L (organism only). It has been detected in Las Vegas Bay, in biosolids, and in source water.<sup>185</sup> It has also been detected in streams in northern Arkansas, in groundwater in Oregon, in waste, surface, ground, and drinking water in Minnesota, in the lower Tallapoosa River watershed in Alabama, in intersexed fish in the Shenandoah River, and in streams and groundwater in Colorado.<sup>186</sup> The EPA must revise its National Recommended Water Quality Criteria to reflect the latest scientific knowledge that pyrene is an EDC that is impairing our nation's waterways.

**Selenium:** Selenium is a naturally occurring trace mineral and byproduct of sulfuric acid production. Other anthropogenic sources include coal burning. It bioaccumulates and causes reproductive effects at very low concentrations. Waterborne selenium in the Las Vegas Wash is currently between 3-4 ppb, a level of concern for wildlife. Elevated levels of selenium pose a concern for razorback suckers because adults readily bioaccumulate selenium in various tissues, including egg tissues. Fish collected in Las Vegas Wash exhibited selenium in whole body tissue ranging from 3.5-13.7 ppm, and 2.5-6.9 from the Bay.<sup>187</sup> By comparison, the majority of selenium literature supports a whole-body toxicity threshold of 4 ppm dry weight.<sup>188</sup>

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R. Whyatt, L. Hoepner, S. Wang, D. Camann, and V. Rauh, 2009, Prenatal Airborne Polycyclic Aromatic Hydrocarbon Exposure and Child IQ at Age 5 Years, *Pediatrics* vol. 124, no. 2; Hsu, P., I. Chen, C. Pan, K. Wu, M. Pan, J. Chen, C. Chen, G. Chang-Chien, C. Hsu, C. Liu, and M. Wu, 2006, Sperm DNA damage correlates with polycyclic aromatic hydrocarbons biomarker in coke-oven workers, *International Archives of Occupational and Environmental Health*, vol. 79, no. 5; Kummer, V., J. Maskova, Z. Zraly, J. Neca, P. Simeckova, J. Vondracek, and M. Machala, 2008, Estrogenic activity of environmental polycyclic aromatic hydrocarbons in uterus of immature Wistar rats, *Toxicology Letters*, vol. 180, iss. 3; Detmar, J., M.Y. Rennie, K.J. Whiteley, D. Qu, Y. Taniuchi, X. Shang, R.F. Casper, S.L. Adamson, J.G. Sled, and A. Jurisicova, 2008, Fetal growth restriction triggered by polycyclic aromatic hydrocarbons is associated with altered placental vasculature and AhR-dependent changes in cell death, *Am J Physiol Endocrinol Metab*; Schafer, S. and A. Kohler, 2009, Gonadal lesions of female sea urchin (*Psammechinus miliaris*) after exposure to the polycyclic aromatic hydrocarbon phenanthrene, *Marine Environmental Research* vol. 68, iss. 3.

<sup>184</sup> EPA pyrene fact sheet, available at

<http://www.epa.gov/waste/hazard/wastemin/minimize/factshts/pyrene.pdf>.

<sup>185</sup> Rosen 2009, Table 2; Kinney, C.A., E.T. Furlong, S.L. Werner, and J.D. Cahill, 2006, Presence and distribution of wastewater-derived pharmaceuticals in soil irrigated with reclaimed water, *Environmental Toxicology and Chemistry* v.25, no. 2, p. 317-326; Kinney, C.A., E.T. Furlong, S.D. Zaugg, M.R. Burkhardt, S.L. Werner, J.D. Cahill, and G.R. Jorgensen, 2006, survey of Organic Wastewater Contaminants in Biosolids Destined for Land Application, *Environ. Sci. Technol.* 40(23) pp. 7207-7215; and Kingsbury 2008.

<sup>186</sup> Galloway 2005; Hinkle 2005; Lee 2004; Oblinger 2007; Alvarez 2008; and Sprague 2005.

<sup>187</sup> USFWS, 2007, Biological Opinion for Systems Conveyance and Operations Program for the Discharge of Municipal Wastewater into Lake Mead, Clark County, Nevada.

<sup>188</sup> See Hamilton, S.J., K.M. Holley, and K.J. Buhl, 2002, Hazard assessment of selenium to endangered razorback suckers (*Xyrauchen texanus*), *The Science of the Total Environment e Science of the Total Environment* 291, 111-121; Hamilton, S., 2003, Review of residue-based selenium toxicity thresholds for freshwater fish, *Ecotoxicology and Environmental Safety* 65, 201-210; Intertox 2008, Table 21, Table 22.

The EPA has established National Recommended Water Quality Criteria for freshwater at 5 µg/L CCC, and saltwater at 290 µg/L CMC and 71 µg/L CCC. Human health consumption criteria have been established at 170 µg/L (water plus organism) and 4200 µg/L (organism only). The EPA has also established drinking water regulations at .05 µg/L for which exposure above this amount can cause numbness and circulatory problems in humans. Selenium has also been detected in fish tissue from the Colorado River.<sup>189</sup> The EPA must revise its National Recommended Water Quality Criteria to reflect the latest scientific knowledge that selenium acts as an EDC and is impairing our nation's waters.

Toxaphene: Toxaphene was one of the most heavily used pesticides in the U.S. until it was banned in 1982. It persists in the environment and bioaccumulates in organisms. It is a complex mixture of chlorinated bornanes, bornenes, and bornadienes. Toxaphene induces apoptosis and affects the immune system.<sup>190</sup> It can also affect reproductive systems.<sup>191</sup>

The EPA has established drinking water criteria for toxaphene at .003 µg/L for which if exceeded will cause kidney, liver, or thyroid problems, or cancer. EPA has established a public health goal of zero exposure. The EPA has also established National Recommended Water Quality Criteria for freshwater at .73 µg/L CMC and .002 µg/L CCC, saltwater at .21 µg/L CMC and .002 µg/L CCC, and human health consumption at .00028 µg/L (for organism plus water and organism only). It has been detected in the Imperial Valley watershed, and in fish tissue from both the Santa Ana River and the Colorado River.<sup>192</sup> The EPA must revise its National Recommended Water Quality Criteria to reflect the latest scientific knowledge that toxaphene acts as an EDC and is impairing our nation's waters.

2,4-D (2,4-dichlorophenoxy) acetic acid: 2,4-D is a widely used herbicide. Research shows how a single application of 2,4-D at low concentrations (2–16 ppb) affects aquatic communities composed of zooplankton, phytoplankton, periphyton, and larval amphibians (gray tree frogs, *Hyla versicolor*, and leopard frogs, *Rana pipiens*).<sup>193</sup> 2,4-D was tested in combination with other pesticides to determine if any of the concentrations

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<sup>189</sup> Hinck 2007.

<sup>190</sup> Lavastre, V., C.J. Roberge, M. Pelletier, M. Gauthier, and D. Girard, 2002, Toxaphene, but Not Beryllium, Induces Human Neutrophil Chemotaxis and Apoptosis via Reactive Oxygen Species (ROS): Involvement of Caspases and ROS in the Degradation of Cytoskeletal Proteins, *Clinical Immunology* vol. 104, iss. 1.

<sup>191</sup> Kashian, D.R., 2004, Toxaphene detoxification and acclimation in *Daphnia magna*: do cytochrome P-450 enzymes play a role?, *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology* vol. 137, iss. 1; Yang, C. and S. Chen, 1999, Two organochlorine pesticides, toxaphene and chlordane, are antagonists for estrogen-related receptor  $\alpha$ -1 orphan receptor, *Cancer Res.* 59:4519-4524.

<sup>192</sup> Goodbred 2006; Hinck 2007; Jenkins 2009; Scribner, E.A., W.A. Battaglin, J.E. Dietze, and E.M. Thurman, 2003, Reconnaissance Data for Glyphosate, Other Selected Herbicides, their Degradation Products, and Antibiotics in 51 Streams in Nine Midwestern States, 2002, *Open-File report 03-217*; and Frick 2005.

<sup>193</sup> Relyea, R.A., 2009, A cocktail of contaminants: how mixtures of pesticides at low concentrations affect aquatic communities, *Oecologia* 159:363–376.

caused deleterious effects unique to chemical mixing. Results of the study show that a single application of insecticides and herbicides (alone and in combination at low concentrations) can have dramatic effects on several taxonomic groups. For many of the taxa (zooplankton and algae) the effects of the pesticide mixtures were largely predictable from the individual pesticide effects. In contrast, mixtures of globally common pesticides (driven by the mixture of the insecticides) can cause up to 99% mortality in larval amphibians, and this effect was not completely explained by the individual pesticide effects. 2,4-D can also cause deleterious effects on the nervous system.<sup>194</sup> It can also produce changes in maternal behavior, serum prolactin and monoamine levels in the AcN of treated rats.<sup>195</sup>

Despite being on the EPA's EDSP Tier 1 List and having a National Primary Drinking Water Standard of .07 µg/L, EPA has not published water quality criteria and considers 2,4-D a non-priority pollutant. It has been detected in the source water and finished water for Atlanta, Georgia, the lower Columbia River and other source water throughout the U.S.<sup>196</sup> The EPA must revise its outdated National Recommended Water Quality Criteria to reflect the latest scientific knowledge that 2,4-D acts as an EDC and is impairing our nation's waters.

**The EPA must establish National Recommended Water Quality Criteria for the following pesticides for their endocrine-disrupting effects on fish, wildlife, and humans: atrazine and desethyl atrazine, benfluralin, dacthal/DCPA, diuron, metolachlor, phenanthrene, prometon, simazine, and trifluralin**

Atrazine and desethyl atrazine: Perhaps the most infamous endocrine-disrupting pesticide is atrazine, which has been found to disrupt sexual development of frogs at concentrations 30 times lower than levels allowed by EPA.<sup>197</sup> Atrazine was the most heavily used herbicide in the U.S. during a USGS study period, and was found together with one of its several degradates, desethyl atrazine, in about 75 percent of stream samples and about 40 percent of ground-water samples collected in agricultural areas

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<sup>194</sup> Ateeq, B, M.A. Farah, and W. Ahmed, 2006, Evidence of apoptotic effects of 2,4-D and butachlor on walking catfish, *Clarias Batrachus*, by transmission electron microscopy and DNA degradation studies, *Life Sciences* vol. 78, iss. 9; Bortolozzi, A., R. Duffard, M. Anoneli, A.M. Evangelista de Duffard, 2002, Increased sensitivity in dopamine D(2)-like brain receptors from 2,4-dichlorophenoxyacetic acid (2,4-D)-exposed and amphetamine-challenged rats, *Ann. N.Y. Acad. Sci.* 956, 314-323; Duffard, R., G. Garcia, S. Rosso, A. Bortolozzi, M. Madariaga, O. DiPaolo, A.M. Evangelista de Duffard, 1996, Central nervous system myelin deficit in rats exposed to 2,4-dichlorophenoxyacetic acid throughout lactation, *Neurotoxicol. Teratol.* 18, 691-696.

<sup>195</sup> Sturtz, N., R.P. Deis, G.A. Jahn, R. Duffard, and A.M. Evangelista de Duffard, 2008, Effects of 2,4-dichlorophenoxyacetic acid on rat maternal behavior, *Toxicology* vol. 247, iss. 2-3.

<sup>196</sup> Frick 2005; LCREP 2007; and Kingsbury 2008.

<sup>197</sup> Hayes, T.B., et al, 2002, Hermaphroditic, demasculinized frogs after exposure to the herbicide atrazine at low ecologically relevant doses, *Proceedings of the National Academy of Sciences*, Vol.99, Issue 8, 5476-5480; Hayes, T.B., P. Case, S. Chui, D. Chung, C. Haeffele, K. Haston, M. Lee, V.P. Mai, Y. Marjua, J. Parker, and M. Tsui, 2006, Pesticide Mixtures, Endocrine Disruption, and Amphibian Declines: Are We Underestimating the Impact? *Environmental Health Perspectives* 114:1.

across the nation.<sup>198</sup> Atrazine can cause sub-lethal effects in aquatic organisms and amphibians at .1 m/L. Exposure to 21 ppb of atrazine during metamorphosis for only two days can impair the development of the reproductive organs in frogs.<sup>199</sup> Therefore, exposure to both low concentrations over time and elevated spikes over a short period of time can have adverse effects to aquatic life.

Another study exposed frogs to low levels of atrazine, levels which can often be found in the environment.<sup>200</sup> The results showed that low levels of atrazine demasculinized male frogs, preventing male characteristics from fully forming. The study found hermaphroditism in frogs at exposure levels as low as 0.1 ppb, far below the level established by EPA as safe for aquatic organisms. Hayes noted that amphibians are at great risk because the highest atrazine levels coincide with the breeding season for amphibians. Additionally, the low-dose endocrine-disrupting effects are of great concern because the described effects are all internal and may go unnoticed by researchers. Thus, “exposed populations could decline or go extinct without any recognition of the developmental effects on individuals.”<sup>201</sup>

The EPA has found that there is “widespread environmental exposure that (1) has resulted in direct acute effects on many terrestrial plant species at both maximum and typical use rates, (2) may have caused direct effects on aquatic non-vascular plants which in turn could have caused reductions in primary productivity, (3) may have caused reductions in populations of aquatic macrophytes, invertebrates, and fish, (4) may have caused indirect effects on aquatic communities due to loss of species sensitive to atrazine and resulting in changes in structure and functional characteristics of the affected communities.”<sup>202</sup> Atrazine is on the EPA’s EDSP Tier 1 screening list,<sup>203</sup> and can cause cardiovascular system and reproductive problems in individuals exposed longterm to .003 µg/L.<sup>204</sup> It has been detected throughout U.S. water including in Lake Mead, treated waste water, Boulder Creek, Colorado, in drinking water, in the lower Columbia River, in source water, in streams throughout the Midwest, in the lower Tallapoosa River watershed in Alabama, and in source and finished water in Atlanta, Georgia.<sup>205</sup>

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<sup>198</sup> Gilliom, R.J., J.E. Barbash, C.G. Crawford, P.A. Hamilton, J.D. Martin, N. Nakagaki, L.H. Nowell, J.C. Scott, P.E. Stackelberg, G.P. Thelin, D.M. Wolock, 2007, The quality of our nation’s waters—pesticides in the nation’s streams and ground water, 1992–2001, *US Geological Survey circular 1291*.

<sup>199</sup> Tavera-Mendoza, L., et al., 2002, Response of the amphibian tadpole *Xenopus laevis* to atrazine during sexual differentiation of the testis, *Environ. Toxicol. Chem.* 21:527-531; Tavera-Mendoza, L., et al., 2002, Response of the amphibian tadpole *Xenopus laevis* to atrazine during sexual differentiation of the ovary, *Environ. Toxicol. Chem.* 21:1264-1267.

<sup>200</sup> Hayes 2002 and Hayes 2006.

<sup>201</sup> *Id.*

<sup>202</sup> EPA, Atrazine RED, p.2.

<sup>203</sup> 74 Fed. Reg. 17579.

<sup>204</sup> EPA 2009.

<sup>205</sup> EPA 2009; Benotti 2009; LCREP 2007; Kingsbury 2008; Scribner 2003; Oblinger 2007; and Frick 2005.

Benfluralin: Benfluralin is a pre-emergent dinitroaniline herbicide used to control grass and weeds. It is toxic to the kidneys, liver and thyroid.<sup>206</sup> It has caused reproductive effects in chronic avian studies. It is very highly toxic to freshwater fish on an acute basis, moderately toxic to freshwater aquatic invertebrates on an acute basis. Tests indicate that growth and development are the most sensitive end points for benfluralin and that it may affect fish length and survival at concentrations greater than 1.9 ppb. The EPA recognizes it is a possible human carcinogen, and it is on the EPA's EDSP Tier 1 screening list. Benfluralin has been detected in Lake Mead.

Dacthal: Dacthal, or DCPA (chlorthal-dimethyl), is used to kill weeds. It and its degradates are toxic to the liver, kidneys, and thyroid.<sup>207</sup> Longterm health effects can be expected at .07 µg/L exposure.<sup>208</sup> Dacthal is on the EPA's EDSP Tier 1 List. It has been detected in fish from the Santa Ana River, the lower Colorado River, the lower Columbia River's water and sediment, and in the lower Tallapoosa River watershed in Alabama.<sup>209</sup> It has also been detected in Lake Mead, in fish tissue from the Colorado River, in the Imperial Valley watershed, in source water, and in intersexed fish in the Shenandoah River.<sup>210</sup>

Diuron: Diuron is an herbicide used to control a wide variety of broadleaf and grassy weeds. Diuron exposure results in reproductive toxicity in reptiles.<sup>211</sup> Low levels of diuron can also affect coral metamorphosis.<sup>212</sup> Diuron can affect fish behavior by impacting chemical perception.<sup>213</sup> Diuron is on the EPA's CCL3 list for further research on its human health effects from exposure through drinking water. It has been detected in the lower Columbia River in water and sediment, in source water, and in source and finished water for Atlanta, Georgia.<sup>214</sup>

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<sup>206</sup> EPA, 2004, RED for Benfluralin, available at [http://www.epa.gov/oppsrrd1/REDS/benfluralin\\_red.pdf](http://www.epa.gov/oppsrrd1/REDS/benfluralin_red.pdf).

<sup>207</sup> Summary from the Health Advisory for Dacthal and Dacthal Degradates available at [http://www.epa.gov/safewater/ccl/pdfs/reg\\_determine2/healthadvisory\\_ccl2-reg2\\_dacthaldegradates\\_summary.pdf](http://www.epa.gov/safewater/ccl/pdfs/reg_determine2/healthadvisory_ccl2-reg2_dacthaldegradates_summary.pdf); and Cox, C., 2001, DCPA (Dacthal), *Journal of Pesticides Reform* available at <http://www.pesticide.org/dacthal.pdf>.

<sup>208</sup> EPA, Summary from the Health Advisory for Dacthal and Dacthal Degradates, Document Number: 822-S-08-002, available at [http://www.epa.gov/ogwdw000/ccl/pdfs/reg\\_determine2/healthadvisory\\_ccl2-reg2\\_dacthaldegradates\\_summary.pdf](http://www.epa.gov/ogwdw000/ccl/pdfs/reg_determine2/healthadvisory_ccl2-reg2_dacthaldegradates_summary.pdf).

<sup>209</sup> Jenkins 2009; Marr 2007; LCREP 2007; and Oblinger 2007.

<sup>210</sup> Rosen 2009, Table 2, Table 3; Hinck 2007; Goodbred 2006; LCREP 2007; Kingsbury 2008; and Alvarez 2007.

<sup>211</sup> Cardone, A., R. Comitato, and F. Angelini, 2008, Spermatogenesis, epididymis morphology and plasma sex steroid secretion in the male lizard *Podarcis sicula* exposed to diuron, *Environmental Research* vol. 108, iss. 2.

<sup>212</sup> Negri, A., C. Vollhardt, C. Humphrey, A. Heyward, R. Jones, G. Eaglesham, and K. Fabricius, 2005, Effects of the herbicide diuron on the early life history stages of coral, *Marine Pollution Bulletin* vol. 51, iss. 1-4.

<sup>213</sup> Saglio, P. and S. Trijasse, 1998, Behavioral Responses to Atrazine and Diuron in Goldfish, *Archives of Environmental Contamination and Toxicology* vol. 35, no. 3; Bretaud, S., J.P. Toutant, and P. Saglio, 2000, Effects of Carbofuran, Diuron, and Nicosulfuron on Acetylcholinesterase Activity in Goldfish (*Carassius auratus*), *Ecotoxicology and Environmental Safety* vol. 47, iss. 2.

<sup>214</sup> LCREP 2007; Kingsbury 2008; and Frisk 2005.

Metolachlor: Metolachlor is a broad spectrum herbicide used for general weed control in many agricultural food and feed crops (primarily corn, soybeans, and sorghum), and on lawns and turf, ornamental plants, trees, shrubs and vines, rights of way, fencerows and hedgerows, and in forestry. It is the second most widely used herbicide in the United States. Extensive leaching can occur in soils with low organic carbon content, and precipitation or irrigation can move metolachlor very rapidly to ground water. Therefore, it has a high potential to contaminate ground water. Acute as well as chronic exposures to nontarget organisms can result from direct applications, spray drift and runoff.<sup>215</sup> Metolachlor may affect agonistic behavior in crayfish,<sup>216</sup> and is considered moderately toxic to cold and warm water fish.<sup>217</sup> It is well absorbed dermally.

Metolachlor is on the EPA's EDSP Tier 1 List and is also on the EPA's CCL3 List, indicating the EPA is already aware of the likely EDC affects of this chemical. It has been detected in ground and drinking water, Boulder Creek, Colorado, in the lower Columbia River's water and sediment, and in source water.<sup>218</sup> It has also been detected in streams in northern Arkansas, ground water in Oregon, waster, surface, ground, and drinking water in Minnesota, in 51 streams in the Midwest, in the lower Tallapoosa River watershed in Alabama, in Colorado streams, and in source and finished water for Atlanta, Georgia.<sup>219</sup>

Phenanthrene: Phenanthrene is a PAH used in dyes. It targets fat tissues, kidneys and liver. PAHs have caused tumors and reproductive problems in laboratory animals, as well as birth defects and decreased body weight in offspring.<sup>220</sup> Phenanthrene can also significantly prolong the time to hatch for fish embryos.<sup>221</sup> The EPA has identified phenanthrene as a toxic pollutant, but has not established any water quality criteria. It has been detected in Lake Mead at concentrations up to 1300 pg/L, and in intersexed fish in the Shenandoah River.<sup>222</sup>

Prometon: Prometon is a widely used herbicide. Exposure to 20 µg/L of prometon significantly increased female plasma testosterone concentrations in fathead minnows.<sup>223</sup> It has been detected in Boulder Creek, Colorado, in the lower Columbia River's water

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<sup>215</sup> EPA, 1995, RED for Metolachlor, available at <http://www.epa.gov/oppsrrd1/REDS/0001.pdf>.

<sup>216</sup> Cook, M.E. and P.A. Moore, 2008, The Effects of the Herbicide Metolachlor on Agonistic Behavior in the Crayfish, *Orconectes rusticus*, *Archives of Environmental Contamination and Toxicology* vol. 55, no. 1.

<sup>217</sup> Rivard, L., 2003, Environmental Fate of Metolachlor, available at <http://www.cdpr.ca.gov/docs/emon/pubs/fatememo/metolachlor.pdf>.

<sup>218</sup> USGS 2008; Barber 2006; Benotti 2009; LCREP 2007; and Kingsbury 2008.

<sup>219</sup> Galloway 2005; Hinkle 2005; Lee 2004; Scribner 2003; Oblinger 2007; Sprague 2005; and Frick 2005.

<sup>220</sup> EPA, Phenanthrene Fact Sheet, available at <http://www.epa.gov/waste/hazard/wastemin/minimize/factshts/phenanth.pdf>.

<sup>221</sup> Horng, C., H. Lin, and W. Lee, 2009, A Reproductive Toxicology Study of Phenanthrene in Medaka (*Oryzias latipes*), *Archives of Environmental Contamination and Toxicology*.

<sup>222</sup> Rosen 2009, Table 3 and Alvarez 2007.

<sup>223</sup> Villeneuve, D.L., M.B. Murphy, M.D. Kahl, K.M. Jensen, B.C. Butterworth, E.A. Makynen, E.J. Durhan, A. Linnum, R.L. Leino, L.R. Curtis, J.P. Giesy, and G.T. Ankley, 2006, Evaluation of the methoxytriazine herbicide prometon using a short-term fathead minnow reproduction test and a suite of in vitro bioassays, *Environmental Toxicology and Chemistry* vol. 25, no. 8.

and sediment, and in source water.<sup>224</sup> It has also been detected in streams in northern Arkansas, in streams in the Midwest, in the lower Tallapoosa River watershed in Alabama, in Colorado streams, and in source and finished water for Atlanta, Georgia.<sup>225</sup>

Simazine: Simazine is a triazine herbicide and can be applied via ground sprayer, banded application, or aerial broadcast. It is used on fruit, nuts, non-agricultural trees, and for weed control. It has been found in surface water, air, and precipitation indicating that runoff, spray drift, volatilization, atmospheric transport and subsequent deposition are occurring. Simazine has a differential immunomodulating effect on macrophage secretory and cellular activities.<sup>226</sup> It can also cause reproductive disruption in rats.<sup>227</sup> Another study showed that triazine pesticides have an additive (rather than synergistic) impact on olfactory-mediated endocrine function in salmon.<sup>228</sup> Simazine is on the EPA's EDSP Tier 1 List and has a National Priority Drinking Water Standard of .004 µg/L. It has been detected in treated wastewater, in the lower Columbia River's water and sediment, in source water, in streams throughout the Midwest, and in source and finished water for Atlanta, Georgia.<sup>229</sup>

Trifluralin: Trifluralin is a preemergent herbicide used to control annual grasses and broadleaf weeds on a variety of food crops and residential use sites. EPA is concerned about the exposure of threatened and endangered plant and animal species to trifluralin.<sup>230</sup> Endangered species levels of concern are exceeded for birds, mammals, and semi-aquatic and aquatic plants.<sup>231</sup> It can cause liver and kidney damage, decreased fetal weight and size, and increased miscarriages. It is also on the EPA's Tier 1 EDSP list.<sup>232</sup> It has been detected in the Lake Mead, in carp tissue and sediment in the Colorado River, in the Imperial Valley watershed, in the lower Columbia River water and sediment, in source water throughout the U.S., and in source and finished water for Atlanta, Georgia.<sup>233</sup>

**The EPA must establish water quality standards for the following PPCPs: 1,7-dimethylxanthine and caffeine, 2,6-dimethyl-naphthalene, 4-nonylphenol, 4-tert-octylphenol, 17B-estradiol, acetaminophen, acetone and acetophenone, atenolol, atorvasatin and cholesterol, benzophenone, beta sitosterol, caffeine, carbamazepine,**

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<sup>224</sup> LCREP 2007 and Kingsbury 2008.

<sup>225</sup> Galloway 2005, Scribner 2003, Oblinger 2007, Sprague 2005, and Frick 2005.

<sup>226</sup> Kim, K., E. Son, D. Rhee, and S. Pyo, 2002, The immunomodulatory effects of the herbicide simazine on murine macrophage functions in vitro, *Toxicology in Vitro* vol. 16, iss. 5.

<sup>227</sup> Tennant, M.K., D.S. Hill, J.C. Eldridge, L.T. Wetzel, C.B. Breckenridge, and J.T. Stevens, 1994, Possible antiestrogenic properties of chloro-s-triazines in rat uterus, *J. Toxicol Environ Health* 43(2):183-96.

<sup>228</sup> Moore, A. and N. Lower, 2001, The impact of two pesticides on olfactory-mediated endocrine function in mature male Atlantic salmon (*Salmo salar* L.) parr, *Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology* vol. 129, iss. 2-3.

<sup>229</sup> EPA 2009; LCREP 2007; and Kingsbury 2008.

<sup>230</sup> EPA, 1995, Trifluralin RED, 09/1995, p. 72.

<sup>231</sup> *Id.*

<sup>232</sup> 74 Fed. Reg. 17579.

<sup>233</sup> Rosen 2009, Table 3; Marr 2007; Goodbred 2006; LCREP 2007; Kingsbury 2008; and Frisk 2005.

**cimetidine, clarithromycin, cotinine, dehydronifedipine, diazepam, diltiazem, diphenhydramine, erythromycin, ethynylestradiol, fluoxetine, gemfibrozil, indole, methyl salicylate, octachlorostyrene, sulfamethoxazole and trimethoprim, synthetic musks, and triclosan.**

1,7-dimethylxanthine and caffeine: Also known as paraxanthine, 1,7-dimethylxanthine is a methylated derivative of xanthine. It is a psychoactive central nervous system stimulant and can act as an inhibitor of adenosine receptors. It has been detected in Lake Mead, in ground and drinking water, in Boulder Creek, Colorado, and in soil treated with reclaimed water.<sup>234</sup> It has also been detected in waste, surface, ground and drinking water in Minnesota, the lower Tallapoosa River watershed in Alabama, and in intersexed fish in the Shenandoah River.<sup>235</sup>

Caffeine is also a methylated xanthine derivative. Effects of caffeine include decreased insulin sensitivity and can have adverse effects on the adrenal glands. It has been detected in Lake Mead, Boulder Creek, Colorado, in soil irrigated with reclaimed water, in the lower Columbia River, and in source water.<sup>236</sup> It has also been detected in streams in northern Arkansas, in groundwater in Oregon, in waste, surface, ground, and drinking water in Minnesota, in Pennsylvania waters, in the lower Tallapoosa River watershed in Alabama, in intersexed fish in the Shenandoah River, and in streams and groundwater in Colorado.<sup>237</sup>

2,6-dimethyl-naphthalene: Dimethylnaphthalene is a PAH.<sup>238</sup> PAHs are frequently found in groups of two or more, and can exist in over 100 different combinations. Although little information is available on the individual chemicals within the PAH group, there are many studies demonstrating the EDC harm of the PAH group as a whole.<sup>239</sup> It has

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<sup>234</sup> Rosen 2009; USGS 2008; Barber 2006; and KF 2006.

<sup>235</sup> Lee 2004; Oblinger 2007; and Alvarez 2008.

<sup>236</sup> Rosen 2009, Table 4; Barber 2006; Kinney 2006; LCREP 2007; and Kingsbury 2008.

<sup>237</sup> Galloway 2005; Hinkle 2005; Lee 2004; Loper 2007; Oblinger 2007; Alvarez 2008; and Sprague 2005.

<sup>238</sup> Unger, M.A., M.C. Newman, and G.G. Vadas, 2007, Predicting survival of grass shrimp (*Palaemonetes pugio*) during ethylnaphthalene, dimethylnaphthalene, and phenanthrene exposures differing in concentration and duration, *Environmental Toxicology and Chemistry* vol. 26, no. 3.

<sup>239</sup> Chakravarti, D., D. Venugopal, P.C. Mailander, J.L. Meza, S. Higginboham, E.L. Cavalieri, and E.G. Rogan, 2007, The role of polycyclic hydrocarbon-DNA adducts in inducing mutations in mouse skin, *Mutation Research/Genetic Toxicology and Environmental Mutagenesis* vol. 69, iss. 1-2; Perera, F.P., Z. Li, R. Whyatt, L. Hoepner, S. Wang, D. Camann, and V. Rauh, 2009, Prenatal Airborne Polycyclic Aromatic Hydrocarbon Exposure and Child IQ at Age 5 Years, *Pediatrics* vol. 124, no. 2; Hsu, P., I. Chen, C. Pan, K. Wu, M. Pan, J. Chen, C. Chen, G. Chang-Chien, C. Hsu, C. Liu, and M. Wu, 2006, Sperm DNA damage correlates with polycyclic aromatic hydrocarbons biomarker in coke-oven workers, *International Archives of Occupational and Environmental Health*, vol. 79, no. 5; Kummer, V., J. Maskova, Z. Zraly, J. Neca, P. Simeckova, J. Vondracek, and M. Machala, 2008, Estrogenic activity of environmental polycyclic aromatic hydrocarbons in uterus of immature Wistar rats, *Toxicology Letters*, vol. 180, iss. 3; Detmar, J., M.Y. Rennie, K.J. Whiteley, D. Qu, Y. Taniuchi, X. Shang, R.F. Casper, S.L. Adamson, J.G. Sled, and A. Jurisicova, 2008, Fetal growth restriction triggered by polycyclic aromatic hydrocarbons is associated with altered placental vasculature and AhR-dependent changes in cell death, *Am J Physiol Endocrinol Metab*; Schafer, S. and A. Kohler, 2009, Gonadal lesions of female sea urchin (*Psammechinus miliaris*) after

been detected in the Lake Mead at concentrations of 860 pg/L, in source water throughout the U.S, in groundwater in Oregon, in the lower Tallapoosa River watershed in Alabama, and in streams and groundwater in Colorado.<sup>240</sup>

4-nonylphenol: 4-nonylphenol can modulate gene expression of the same genes in a different manner than estradiol-17B.<sup>241</sup> Rainbow trout exposed to 4-nonylphenol showed a decreased shoaling tendency, were more likely to be attacked by other trout, and was less successful in competing for food resources than control fish.<sup>242</sup> In male clams exposed to non-lethal concentrations of 4-nonylphenol, 0.1-0.2 µg/L, vitellogenins levels increased significantly.<sup>243</sup> Exposure to 4-nonylphenol can also delay smolt development and downstream migration in Atlantic salmon.<sup>244</sup> Another effect on Atlantic salmon can be the significant induction of P450arom and estrogen receptor isoform patterns in the brain.<sup>245</sup> It has been detected in Boulder Creek, Colorado, in biosolids, in drinking water, and in groundwater.<sup>246</sup>

4-tert-octylphenol: Chronic exposure to 4-tert-octylphenol (“OP”) can interfere with the secretion of luteinizing hormone, follicle-stimulating hormone, prolactin, and

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exposure to the polycyclic aromatic hydrocarbon phenanthrene, *Marine Environmental Research* vol. 68, iss. 3.

<sup>240</sup> Rosen 2009, Table 2; Kingsbury 2008; Hinkle 2005; Oblinger 2007; and Sprague 2005.

<sup>241</sup> Ruggeri, B., M. Ulbaldi, A. Lourusamy, R. Ciccocioppo, G. Hardiman, M.E. Baker, F. Palermo, and A.M. Polzonetti-Magni, 2008, Variation of the genetic expression pattern after exposure to estradiol-17B and 4-nonylphenol in male zebrafish (*Danio rerio*), *General and Comparative Endocrinology* vol. 158, iss. 1.

<sup>242</sup> Ward, A.J.W., A.J. Duff, and S. Currie, 2006, The effects of the endocrine disrupter 4-nonylphenol on the behavior of juvenile rainbow trout (*Oncorhynchus mykiss*), *Can. J. Fish. Aquat. Sci.* 63: 377-382.

<sup>243</sup> Matozzo, V. and M.G. Marin, 2005, Can 4-nonylphenol induce vitellogenin-like proteins in the clam *Tapes philippinarum*?, *Environmental Research* vol. 97, iss. 1.

<sup>244</sup> Lerner, D.T., B.T. Bjornsson, and S.D. McCormick, 2007, Larval Exposure to 4-Nonylphenol and 17B-Estradiol Affects Physiological and Behavioral Development of Seawater Adaptation in Atlantic Salmon Smolts, *Environ. Sci. Technol.* 41(12), pp 4479-4485; Madsen, S.S., S. Skovbolling, C. Noelsen, and B. Korsgaard, 2004, 17-B Estradiol and 4-nonylphenol delay smolt development and downstream migration in Atlantic salmon, *Salmo salar*, *Aquatic Toxicology* col. 68, iss. 2.

<sup>245</sup> Meucci, V. and A. Arukwe, 2006, The environmental estrogen, 4-nonylphenol modulates brain estrogen-receptor- and aromatase (CYP19) isoforms gene expression patterns in Atlantic salmon (*Salmo salar*), *Marine Environmental Research* vol. 62, supp. 1; Meucci, V. and A. Arukwe, 2006, The xenoestrogen 4-nonylphenol modulates hepatic gene expression of pregnane X receptor, aryl hydrocarbon receptor, CYP3A and CYP1A1 in juvenile Atlantic salmon (*Salmo salar*), *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology* vol. 142, iss. 1-2; Meucci, V. and A. Arukwe, 2006, Transcriptional modulation of brain and hepatic estrogen receptor and P450arom isotypes in juvenile Atlantic salmon (*Salmo salar*) after waterborne exposure to the xenoestrogen, 4-nonylphenol, *Aquatic Toxicology* vol. 77, iss. 2; McCormick, S.D., M.F. O’Dea, A.M. Moeckel, D.T. Lerner, and B.T. Bjornsson, 2005, Endocrine disruption of parr-smolt transformation and seawater tolerance of Atlantic salmon by 4-nonylphenol and 17B-estradiol, *General and Comparative Endocrinology*, vol. 142, iss. 3.

<sup>246</sup> Barber 2006; Kinney 2006; Benotti 2009; and Barnes, K.K., D.W. Kolpin, M.J. Furlong, M.T. Meyer, S.D. Zaugg, S.K. Haack, L.B. Barber, and E.M. Thurman, 2008, Water-quality data for pharmaceuticals and other organic wastewater contaminants in ground water and in untreated water sources in the United States, 2000-01, *U.S. Geological Survey Open-File Report 2008-1293*, 7 p. plus tables.

testosterone.<sup>247</sup> OP can inhibit osteoblast differentiation causing a lineage shift toward adipocytes.<sup>248</sup> OP can also inhibit development in tadpoles, particularly when also exposed to UV.<sup>249</sup> It has been shown to decrease the production of luteinizing hormone in rats.<sup>250</sup> It has been detected in Las Vegas Bay, biosolids, and Boulder Creek, Colorado.<sup>251</sup> It has also been detected in streams in northern Arkansas, ground water in Oregon, in the lower Tallapoosa River watershed in Alabama, and in streams and ground water.<sup>252</sup>

17B-estradiol (also known simply as estradiol): Male trout exposed to low levels of 17B-estradiol have reduced semen volume, sperm density, and sperm fertility.<sup>253</sup> Largemouth bass exposed to 17B-estradiol had changes in expression of hepcidins, a highly conserved antimicrobial peptide and iron-regulatory hormone, reducing hep-1 levels in the liver.<sup>254</sup> It is on the EPA's CCL3 list. It has been detected in Lake Mead, in drinking water, and in intersexed fish in the Shenandoah River.<sup>255</sup>

Acetaminophen: Acetaminophen has the ability to antagonize the effects of E2. It has been detected throughout the U.S. including in Boulder Creek, Colorado, in soil irrigated with reclaimed water, in Lake Mead, and in the lower Columbia River.<sup>256</sup> It has also been detected in waste, surface, ground and drinking water in Minnesota, in Pennsylvania waters, in the lower Tallapoosa River watershed in Alabama, and in intersexed fish in the Shenandoah River.<sup>257</sup>

Acetone and Acetophenone: Acetophenone is an aromatic ketone used in fragrances, is an excipient used in some pharmaceuticals and is an additive in cigarettes. Oral exposure can cause central nervous system depression and hematologic effects. *Daphnia magna*

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<sup>247</sup> Lee, Y.M., J.S. Seo, I.C. Kim, Y.D. Yoon, and J.S. Lee, 2006, Endocrine disrupting chemicals (bisphenol A, 4-nonylphenol, 4-tert-octylphenol) modulate expression of two distinct cytochrome P450 aromatase genes differently in gender types of the hermaphroditic fish *Rivulus marmoratus*, *Biochem Biophys Res Commun.*, 345(2): 894-903.

<sup>248</sup> Miyawaki, J., S. Kamei, K. Sakayama, H. Yamamoto, and H. Masuno, 2007, 4-Tert-Octylphenol Regulates the Differentiation of C3H10T1/2 Cells into Osteoblast and Adipocyte Lineages, *Toxicological Sciences* 102(1):82-88.

<sup>249</sup> Croteau, M.C., M. Davidson, P. Duarte-Guterman, M. Wade, J.T. Popesku, S. Wiens, D.R.S. Lean, and V.L. Trudeau, 2009, Assessment of thyroid system disruption in *Rana pipiens* tadpoles chronically exposed to UVB radiation and 4-tert-octylphenol, *Aquatic Toxicology* vol. 95, iss. 2.

<sup>250</sup> Furuta, M., T. Funabashi, M. Kawaguchi, T.J. Nakamura, D. Mitsushima, and F. Kimura, 2006, Effects of p-Nonylphenol and 4-tert-Octylphenol on the Anterior Pituitary Functions in Adult Ovariectomized Rats, *Neuroendocrinology* 84:14-20.

<sup>251</sup> Rosen 2009, Table 2, Table 4; Kinney 2006; and Barber 2006.

<sup>252</sup> Galloway 2005; Hinkle 2005; Oblinger 2007; and Sprague 2005.

<sup>253</sup> Lahnsteiner, F., B. Berger, M. Kletzl, T. Weismann, 2006, Effect of 17B-estradiol on gamete quality and maturation in two salmonid species, *Aquatic Toxicology* 79 (2006) 124-131.

<sup>254</sup> Robertson, L.S., L.R. Iwanowicz, and J.M. Marranca, 2009, Identification of centrarchid hepcidins and evidence that 17B-estradiol disrupts constitutive expression of hepcidin-1 and inducible expression of hepcidin-2 in largemouth bass (*Micropterus salmoides*), *Fish & Shellfish Immunology* 26 (2009) 898-907.

<sup>255</sup> Benotti 2009 and Alvarez 2008.

<sup>256</sup> Barber 2006; Kinney 2006; and LCREP 2007.

<sup>257</sup> Lee 2004; Loper, C.A., J.K. Crawford, K.L. Otto, R.L. Manning, M.T. Meyer, and E.T. Furlong, 2007, Concentrations of selected pharmaceuticals and antibiotics in south-central Pennsylvania waters, March through September 2006, *U.S. Geological Survey Data Series 300*, 101 p.; Oblinger 2007; and Alvarez 2008.

exposed to acetone suffered from deformed antennae development and deformed offspring.<sup>258</sup> Acetone is on the EPA's CCL3 List. It has been detected in Lake Mead, source water, in streams in northern Arkansas, in groundwater in Oregon, in the lower Tallapoosa River watershed in Alabama, in groundwater throughout the U.S, and in streams and groundwater in Colorado.<sup>259</sup>

Atenolol: Atenolol is a beta blocker used to treat cardiovascular diseases, and is not appreciably metabolized in humans. It is considered a human carcinogen and is known for reproductive and development toxicity, neurotoxicity, and acute toxicity. It can cause chronic toxicity to fish exposed to environmentally relevant concentrations.<sup>260</sup> It has been detected in Lake Mead and drinking water.<sup>261</sup>

Atorvastatin (including *o*-hydroxy atorvasatin and *p*-hydroxy atorvasatin) and cholesterol: Popularly known as Lipitor, atorvasatin is a statin used for lowering blood cholesterol. Statins may lower testosterone levels. They have been shown to change cholesterol levels in rainbow trout.<sup>262</sup> They have been detected in treated waste water, Lake Mead, and drinking water.<sup>263</sup>

Cholesterol has also been detected in treated waste water, in ground and drinking water, in Boulder Creek, Colorado, in biosolids, and in source water.<sup>264</sup> It has also been detected in streams in northern Arkansas, in groundwater in Oregon, in waste, surface, ground, and drinking water in Minnesota, in Pennsylvania waters, in the lower Tallapoosa River watershed in Alabama, in intersexed fish in the Shenandoah River, in groundwater, and in streams and groundwater in Colorado.<sup>265</sup>

Benzophenone: It is a UV-absorbing chemical and is considered toxic. Benzophenone has had reproductive effects on organisms.<sup>266</sup> It has been detected in Lake Mead, in waste,

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<sup>258</sup> Leoni, B., R. Bettinetti, and S. Galassi, 2008, Sublethal effects of acetone on *Daphnia magna*, *Ecotoxicology* vol. 17, no. 3.

<sup>259</sup> Rosen 2009, Table 2, Table 4; Kingsbury 2008; Galloway 2005; Hinkle 2005; Oblinger 2007; Barnes 2008; and Sprague 2005.

<sup>260</sup> Winter, M.J., A.D. Lillcrap, J.E. Caunter, C. Schaffner, A.C. Alder, M. Ramil, T.A. Ternes, E. Giltrow, J.P. Sumpter, and T.H. Hutchinson, 2008, Defining the chronic impacts of atenolol on embryo-larval development and reproduction in the fathead minnow (*Pimephales promelas*), *Aquatic Toxicology* vol. 86, iss. 3.

<sup>261</sup> Benotti 2009.

<sup>262</sup> Estey, C., X. Chen, and T.W. Moon, 2008, 3-Hydroxy-3-methylglutaryl coenzyme A reductase in rainbow trout: Effects of fasting and statin drugs on activities and mRNA transcripts, *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology* vol. 147, iss. 3.

<sup>263</sup> EPA 2009 and Benotti 2009.

<sup>264</sup> EPA 2009, USGS 2008, Barber 2006, Kinney 2006, Kingsbury 2008.

<sup>265</sup> Galloway 2005; Hinkle 2005; Lee 2004; Loper 2007; Oblinger 2007; Alvarez 2008; Barnes 2008; and Sprague 2005.

<sup>266</sup> Schlecht, C., H. Klammer, H. Jarry, and W. Wuttke, 2004, Effects of estradiol, benzophenone-2 and benzophenone-3 on the expression pattern of the estrogen receptors (ER) alpha and beta, the estrogen receptor-related receptor 1 (ERR1) and the aryl hydrocarbon receptor (AhR) in adult ovariectomized rats, *Toxicology* 205(1-2):123-130; Schlompf, M., B. Cotton, M. Conscience, V. Haller, B. Steinmann, and W.

surface, ground and drinking water in Minnesota, in the lower Tallapoosa River watershed in Alabama, and in streams and groundwater in Colorado.<sup>267</sup>

Beta sitosterol: Beta sitosterol can affect gonadal cholesterol in fish.<sup>268</sup> It has been detected in treated waste water, in ground and drinking water, in biosolids, and in source water.<sup>269</sup> It has also been detected in streams in northern Arkansas, in groundwater in Oregon, in waste, surface, ground, and drinking water in Minnesota, in the lower Tallapoosa River watershed in Alabama, and in streams and groundwater in Colorado.<sup>270</sup>

Carbamazepine: Carbamazepine is a mood stabilizing drug used to treat epilepsy and bipolar disorder. It is also a known endocrine disruptor. Carbamazepine exposure may result in growth retardation after in utero exposure.<sup>271</sup> It may also induce hypothyroidism.<sup>272</sup> It has been detected in Lake Mead, in Pennsylvania waters, in the lower Tallapoosa River watershed, and in intersexed fish in the Shenandoah River.<sup>273</sup>

Cimetidine: Cimetidine is a histamine used to treat heartburn and peptic ulcers. It also inhibits many isozymes of the cytochrome enzyme system. It can enhance estrogen activity and cause spontaneous lactation in females and gynecomastia in males.<sup>274</sup> It has been detected in Lake Mead, in treated waste water, in soil irrigated with reclaimed water, in the lower Tallapoosa River watershed, and in intersexed fish in the Shenandoah River.<sup>275</sup>

Clarithromycin: Clarithromycin is a macrolide antibiotic. It has been associated with kidney and liver failure. It has been detected in waterbodies. It has been detected in Lake Mead, in treated waste water, and in soil irrigated with reclaimed water.<sup>276</sup>

Cotinine: Cotinine is a metabolite of nicotine. Nicotine exposure can reduce height and hinder physostigmine-stimulated growth hormone release.<sup>277</sup> Neonatal exposure to

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Lichtensteiger, 2001, In vitro and in vivo estrogenicity of UV screens, *Environ Health Perspect* 109(3):239-244.

<sup>267</sup> Rosen 2009, Table 4; Lee 2004; Oblinger 2007; and Barnes 2008.

<sup>268</sup> Sharpe, R.L., M. Drolet, and D.L. MacLatchy, 2006, Investigation of de novo cholesterol synthetic capacity in the gonads of goldfish (*Carassius auratus*) exposed to the phytosterol beta-sitosterol, *Reproductive Biology and Endocrinology* 4:60.

<sup>269</sup> EPA 2009; USGS 2008; Kinney 2006; and Kingsbury 2008.

<sup>270</sup> Galloway 2005; Hinkle 2005; Lee 2004; Oblinger 2007; and Sprague 2005.

<sup>271</sup> Liguori, A. and S. Cianfarani, 2008, Postnatal onset of severe growth retardation after in utero exposure to carbamazepine and phenobarbital: a case report, *Journal of Medical Case Reports* 3:7300.

<sup>272</sup> Mettayil, J., R. Quinton, and S. Ball, 2009, Anticonvulsant induced central hypothyroidism, *Endocrine Abstracts* 19; Horacek, J., J. Simko, and G. Waberzinek, 2007, Carbamazepine and risk of hypothyroidism: a prospective study, *Endocrine Abstracts* 14.

<sup>273</sup> Loper 2007; Oblinger 2007; and Alvarez 2008.

<sup>274</sup> Sasso-Cerri, E., 2009, Enhanced ERbeta immunexpression and apoptosis in the germ cells of cimetidine-treated rats, *Reproductive Biology and Endocrinology* 7:127; Eilati, E. 2006, A review of cimetidine (tagamet) effects as a reproductive toxicant in male rats prostate and seminal vesicle, *Endocrine Abstracts* 11.

<sup>275</sup> EPA 2009; Kinney 2006; Oblinger 2007; and Alvarez 2008.

<sup>276</sup> EPA 2009 and Kinney 2006.

nicotine can impair reproductive capabilities in offspring.<sup>278</sup> Cotinine has been shown to have adverse effects on sperm parameters.<sup>279</sup> It has been detected in Lake Mead, in ground and drinking water, in Boulder Creek, Colorado, and in soil irrigated with reclaimed water.<sup>280</sup> It has also been detected in streams in northern Arkansas, in groundwater in Oregon, in waste, surface, ground, and drinking water in Minnesota, in Pennsylvania waters, in the lower Tallapoosa River watershed in Alabama, in intersexed fish in the Shenandoah River, and in streams and groundwater in Colorado.<sup>281</sup>

Dehydronifedipine: It is a by-product of heart medication. It has been detected in Lake Mead, in treated waste water, and in soil irrigated with reclaimed water.<sup>282</sup> It has also been detected in Pennsylvania waters, in the lower Tallapoosa River watershed, and in intersexed fish in the Shenandoah River.<sup>283</sup>

Diazepam: It is a pharmaceutical that may affect male reproductive organs. Diazepam increase the number of Ehrlich tumor cells in mice.<sup>284</sup> It can also affect the social behavior of rats in relatively low doses (0.2 mg/kg).<sup>285</sup> It has been detected in Lake Mead, and in drinking water.<sup>286</sup>

Diltiazem: Diltiazem is used to treat heart conditions. It has been detected in Lake Mead, in treated waste water, in Boulder Creek, Colorado, in soil irrigated with reclaimed water, in the lower Tallapoosa River watershed in Alabama, and in intersexed fish in the Shenandoah River.<sup>287</sup>

Diphenhydramine: Diphenhydramine is an antihistamine commonly used to treat allergies and colds, and can be used as a sedative. Its metabolites are excreted through the human body and into our wastewater systems.<sup>288</sup> It acts as an H1 receptor antagonist, and

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<sup>277</sup> Fedi, M., L.A. Bach, S.F. Berkovic, J.O. Willoughby, I.E. Scheffer, and D.C. Rutens, 2008, Association of a Nicotinic Receptor Mutation with Reduced Height and Blunted Physostigmine-Stimulated Growth Hormone Release, *Journal of Clinical Endocrinology & Metabolism* vol. 93, no. 2.

<sup>278</sup> Holloway, A.C., L.D. Kellenberger, and J.J. Petrik, 2006, Fetal and neonatal exposure to nicotine disrupts ovarian function and fertility in adult female rats, *Endocrine* vol. 30, no. 2.

<sup>279</sup> Jorsarei, S.G.A., Shibahara, H., M.D. Ayustawati, Y. Hirano, Y. Shiraishi, A. Khalatbari, Y.Y. Pasha, M. Suzuki, 2008, The in-vitro effects of nicotine, cotinine and leptin on sperm parameters analyzed by CASA system, *Iranian Journal of Reproductive Medicine* vol. 6, no. 3.

<sup>280</sup> Boyd 2002; USGS 2008; Barber 2006; and KF 2006.

<sup>281</sup> Galloway 2005; Hinkle 2005; Lee 2004; Loper 2007; Oblinger 2007; Alvarez 2008; and Sprague 2005.

<sup>282</sup> Boyd 2002; EPA 2009; and Kinney 2006.

<sup>283</sup> Loper 2007; Oblinger 2007; and Alvarez 2008.

<sup>284</sup> Sakai, M., E.S.M. Fonseca, M.L.Z. Dagli, and J. Palermo-Neto, 2006, Diazepam effects on Ehrlich tumor growth and macrophage activity in mice, *Life Sciences* vol. 78, iss. 6.

<sup>285</sup> Dronjak, S., N. Spasojevic, L.J. Gavrilovic, and V. Varagic, 2007, Behavioral and endocrine responses of socially isolated rats to long-term diazepam, *Acta Veterinaria* vol. 57(4).

<sup>286</sup> Benotti 2009.

<sup>287</sup> Boyd 2002; EPA 2009; Barber 2006; Kinney 2006; Oblinger 2007; and Alvarez 2008.

<sup>288</sup> Baldacci, A., F. Prost, and W. Thormann, 2004, Identification of diphenhydramine metabolites in human urine by capillary electrophoresis-ion trap-mass spectrometry, *Electrophoresis* vol. 25, iss. 10-11.

is more readily processed by adults.<sup>289</sup> It can also inhibit the cytochrome P450 2D6 enzyme, causing excitability.<sup>290</sup> Diphenhydramine that enters our nation's waters through wastewater treatment plant discharges is ending up in fish.<sup>291</sup> It has been detected in treated waste water, in Boulder Creek, Colorado, in soil irrigated with reclaimed water, in biosolids, and in the lower Columbia River's water and sediment.<sup>292</sup>

Erythromycin: At low, environmentally relevant doses, erythromycin can affect the growth of organisms.<sup>293</sup> Erythromycin is on the EPA's CCL3 list to be further researched of human health exposure through drinking water. It has been detected in the lower Columbia River's waters and sediment, in treated waste water, and in soil irrigated with reclaimed water.<sup>294</sup> It has also been detected in streams in northern Arkansas, in waste, surface, ground, and drinking water in Minnesota, in Pennsylvania waters, in the lower Tallapoosa River watershed in Alabama, and in intersexed fish in the Shenandoah River.<sup>295</sup>

Ethinylestradiol (alpha-ethynyl estradiol or EE2): Ethinylestradiol is a potent endocrine modulator present in the aquatic environment at biologically active concentrations. Lifelong exposure to 5ng/L EE2 in zebrafish led to a 56% reduction in fecundity and complete population failure with no fertilization.<sup>296</sup> Fathead minnows chronically exposed to low concentrations of EE2 led to feminization of males through the production of vitellogenin mRNA and protein, impacts on gonadal development, and near extinction of species from the lake where they were being tested.<sup>297</sup> Trout exposed to EE2 during sexual development had increased levels of aneuploid sperm, leading to decreased

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<sup>289</sup> Au-Yeung, S., K.W. Riggs, N. Gruber, and D.W. Rurak, 2007, The use of Microdialysis for the Study of Drug Kinetics: Central Nervous System Pharmacokinetics of Diphenhydramine in Fetal, Newborn, and Adult Sheep, *Drug Metabolism and Disposition* vol. 35, no. 8.

<sup>290</sup> De Leon, J. and D.M. Nikoloff, 2008, Paradoxical excitation on diphenhydramine may be associated with being a CYP2D6 ultrarapid metabolizer: three case reports, *CNS Spectr.* 13(2):133-5; Akutsu, T., K. Kobayashi, K. Sakurada, H. Ikegaya, T. Furihata, and K. Chiba, 2006, Identification of Human Cytochrome P450 Isozymes Involved in Diphenhydramine N-Demethylation, *Drug Metabolism and Disposition* vol. 35, no. 1.

<sup>291</sup> Ramirez, A.J., R.A. Brain, S. Usenko, M.A. Mottaleb, J.G. O'Donnell, L.L. Stahl, J.B. Wathen, B.D. Snyder, J.L. Pitt, P. Perez-Hurtado, L.L. Dobbins, B.W. Brooks, and C.K. Chambliss, 2009, Occurrence of Pharmaceuticals and Personal Care Products in Fish: Results of a National Pilot Study in the United States, *Environmental Toxicology and Chemistry*, vol. 28, no. 12.

<sup>292</sup> EPA 2009, Barber 2006, Kinney 2006, and LSREP 2007.

<sup>293</sup> Alighardashi, A., D. Pandolfi, O. Potier, and M.N. Pons, 2009, Acute sensitivity of activated sludge bacteria to erythromycin, *Journal of Hazardous Materials* vol. 172, iss. 2-3; Pomati, F., A.G. Netting, Dd. Calamari, and B.A. Neilan, 2004, Effects of erythromycin, tetracycline and iduprofen on the growth of *Synechocystis* sp. and *Lemma minor*, *Aquatic Toxicology* vol. 67, iss. 4.

<sup>294</sup> LCREP 2007; Kinney 2006; and EPA 2009.

<sup>295</sup> Galloway 2005; Lee 2004; Loper 2007; Oblinger 2007; and Alvarez 2008.

<sup>296</sup> Nash, J.P., D.E. Kime, L.T.M. Van der Ven, P.W. Wester, F. Brion, G. Maack, P. Stahlschmidt-Allner, and C.R. Tyler, 2004, Long-term Exposure to Environmental Concentrations of the Pharmaceutical Ethinylestradiol Causes Reproductive Failure in Fish, *Environ Health Perspective* 112:1725-1733 (2004), available at <http://www.ehponline.org/members/2004/7209/7209.pdf>.

<sup>297</sup> Kidd, K.A., P.L. Blanchfield, K.H. Mills, V.P. Palace, R.E. Evans, J.M. Lazorchak, and R.W. Flick, 2007, Collapse of a fish population after exposure to a synthetic estrogen, *PNAW*, May 2007, available at <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1874224/pdf/zpq8897.pdf>.

embryonic survival and ultimately diminished reproductive success.<sup>298</sup> *Lumbriculus variegatus* exposed to EE2 accumulated high amounts, indicating secondary poisoning of predators might be possible.<sup>299</sup> Low concentrations (5-6 ng/L) led to the feminization of male fathead minnows, including the production of vitellogenin mRNA and protein, impacts on gonadal development, and altered oogenesis in females, and ultimately extinction of the species from the waterbody.<sup>300</sup> EE2 is on the EPA's CCL3 list.<sup>301</sup> It has been detected in Lake Mead, Boulder Creek, Colorado, in drinking water, and in intersexed fish from the Shenandoah River.<sup>302</sup>

Fluoxetine: Fluoxetine is a member of a widely described class of antidepressants – selective serotonin reuptake inhibitors. It can significantly delay metamorphosis in amphibian development.<sup>303</sup> Fluoxetine can disrupt food intake and estrous cyclicity in rats.<sup>304</sup> It can also affect social behavior in rats, including stress and sexual motivation.<sup>305</sup> It can also affect reproductive function and behavior in the brain of female goldfish.<sup>306</sup> It has been detected in Lake Mead, in treated waste water, in soil irrigated with reclaimed water, in biosolids, and in drinking water.<sup>307</sup> It has also been detected in Pennsylvania waters in the lower Tallapoosa River watershed in Alabama, and in intersexed fish from the Shenandoah River.<sup>308</sup>

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<sup>298</sup> Brown, K.H., I.R. Schultz, J.G. Cloud, and J.J. Nagler, 2008, Aneuploid sperm formation in rainbow trout exposed to the environmental estrogen 17 $\alpha$ -ethynylestradiol, Dec. 16, 2008, *PNAS* 19786-19791, vol. 105, no. 50, available at <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2604943/pdf/zpq19786.pdf>.

<sup>299</sup> Liebig, M., P. Egeler, J. Oehlmann, and T. Knacker, 2005, Bioaccumulation of C-17 $\alpha$ 0ethynylestradiol by the aquatic oligochaete *Lumbriculus variegatus* in spiked artificial sediment, *Chemosphere* 59 (2005) 271-280.

<sup>300</sup> Kidd, K.A., P.J. Blanchfield, K.H. Mills, V.P. Palace, R.E. Evans, J.M. Lazorchak, and R.W. Flick, 2007, Collapse of a fish population after exposure to a synthetic estrogen, *PNAS* v. 104, no. 21 8897-8901.

<sup>301</sup> EPA 2009 CCL3.

<sup>302</sup> Boyd 2002; Barber 2006; Benotti 2009; and Alvarez 2008.

<sup>303</sup> Conners, D.E., E.D. Rogers, K.L. Armbrust, J. Kwon, and M.C. Black, 2009, Growth and Development of Tadpoles (*Xenopus laevis*) exposed to selective serotonin reuptake inhibitors, fluoxetine and sertraline, throughout metamorphosis, *Environmental Toxicology and Chemistry* vol. 28, iss. 12; Rogers, E.D. and M.C. Black, 2003, Effect of Fluoxetine on Amphibian Development.

<sup>304</sup> Uphouse, L., J.G. Hensler, J. Sarkar, and B. Grossie, 2006, Fluoxetine disrupts food intake and estrous cyclicity in Fischer female rats, *Brain Research* vol. 1072, iss. 1.

<sup>305</sup> Rygula, R., N. Abumaria, E. Domenici, C. Hiemke, and E. Fuchs, 2006, Effects of fluoxetine on behavioral deficits evoked by chronic social stress in rats, *Behavioral Brain Research* vol. 174, iss. 1; Roche, M., A. Harkin, and J.P. Kelly, 2006, Chronic Fluoxetine Treatment Attenuates Stressor-Induced Changes in Temperature, Heart Rate, and Neuronal Activation in the Olfactory Bulbectomized Rat, *Neuropsychopharmacology* 32, 1312-1320; Gouvea, T.S., H.K. Morimoto, M.J. S.S. de Faria, E.G. Moreira, and D.C. Ceccatto Gerardin, 2008, Maternal exposure to the antidepressant fluoxetine impairs sexual motivation in adult male mice, *Pharmacology Biochemistry and Behavior* vol. 90, iss. 3.

<sup>306</sup> Mennigen, J.A., C.J. Martyniuk, K. Crump, H. Xiong, E. Zhao, J. Popesku, H. Anisman, A.R. Cossins, X. Xia, and V.L. Trudeau, 2008, Effects of fluoxetine on the reproductive axis of female goldfish (*Carassius auratus*), *Physiol. Genomics* 35:273-282.

<sup>307</sup> EPA 2009; Kinney 2006; Kinney 2006; and Benotti 2009.

<sup>308</sup> Loper 2007; Oblinger 2007; and Alvarez 2008.

Gemfibrozil: Gemfibrozil is a lipid regulator which is metabolized by humans and excreted into wastewater.<sup>309</sup> It is considered harmful to aquatic biota,<sup>310</sup> and interferes with fish metabolic systems.<sup>311</sup> It has been shown to bioconcentrate and reduce testosterone in fish.<sup>312</sup> It has been detected in treated waste water, in soil irrigated with reclaimed water, in drinking water, and in the lower Tallapoosa River watershed in Alabama.<sup>313</sup>

Indole: Indole is an aromatic heterocyclic organic compound found in fragrances and pharmaceuticals. Indole has a stimulatory effect on CYP2A6 expression, an enzyme involved in hepatic metabolism.<sup>314</sup> It has been detected in Lake Mead, biosolids, and drinking water.<sup>315</sup> It has also been detected in streams in northern Arkansas, in groundwater in Oregon, in the lower Tallapoosa River watershed in Alabama, in intersexed fish from the Shenandoah River, and in streams and groundwater in Colorado.<sup>316</sup>

Methyl salicylate: Methyl salicylate is a fragrant oil, known as wintergreen. It is found in numerous consumer products including insect repellents, topical treatments for muscle and joint pain, and in suntan lotion. Toddlers exposed to only 5 mL or less of methyl salicylate have been fatal.<sup>317</sup> It has been detected in Lake Mead and source water.<sup>318</sup> It has also been detected in streams in northern Arkansas, in groundwater in Oregon, in the lower Tallapoosa River watershed in Alabama, in intersexed fish from the Shenandoah River, in streams and groundwater in Colorado, and in waste, surface, ground and drinking water in Minnesota.<sup>319</sup>

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<sup>309</sup> Brown, J.N., N. Paxeus, L. Forlin, and D.G.J. Larsson, 2007, Variations in bioconcentration of human pharmaceuticals from sewage effluents into fish blood plasma, *Environmental Toxicology and Pharmacology* vol. 24, iss. 3.

<sup>310</sup> Zurita, J.L., G. Repetto, A. Jos, M. Salguero, M. Lopez-Artiguez, and A.M. Camean, 2007, Toxicological effects of the lipid regulator gemfibrozil in four aquatic Systems, *Aquatic Toxicology* vol. 81, iss. 1.

<sup>311</sup> Thibaut, R., S. Schnell, and C. Porte, 2006, The interference of pharmaceuticals with endogenous and xenobiotic metabolizing enzymes in carp liver: An in-vitro study, *Environmental Science & Technology* vol. 40, no. 16.

<sup>312</sup> Mimeault, C., A.J. Woodhouse, X.S. Miao, C.D. Metcalfe, T.W. Moon, and V.L. Trudeau, 2005, The human lipid regulator, gemfibrozil bioconcentrates and reduces testosterone in the goldfish, *Carassius auratus*, *Aquatic Toxicology* vol. 73, iss. 1.

<sup>313</sup> EPA 2009; Kinney 2006; Benotti 2009; and Oblinger 2007.

<sup>314</sup> Chen, G., R. Cue, K. Lundstrom, J.D. Wood, and O. Doran, 2007, Regulation of CYP2A6 Protein Expression by Skatole, Indole, and Testicular Steroids in Primary Cultured Pig Hepatocytes, *Drug Metabolism and Disposition* vol. 36, no. 1.

<sup>315</sup> Rosen 2009, Table 4; Kinney 2006; and Kingsbury 2008.

<sup>316</sup> Galloway 2005; Hinkle 2005; Oblinger 2007; Alvarez 2008; and Sprague 2005.

<sup>317</sup> Davis, J. Are one or two dangerous? Methyl salicylate exposure in toddlers, *Journal of Emergency Medicine*, vol. 32, iss. 1.

<sup>318</sup> Rosen 2009, Table 4 and Kingsbury 2008.

<sup>319</sup> Galloway 2005; Hinkle 2005; Oblinger 2007; Alvarez 2008; Sprague 2005; and Lee 2004.

Octachlorostyrene: Octachlorostyrene is a halogenated aromatic compound. It is a persistent and bioaccumulative toxicant with estrogenic effects.<sup>320</sup> It can affect reproduction on the aquatic midge.<sup>321</sup> Human Chang liver cells treated with octachlorostyrene experienced death.<sup>322</sup> It has been detected in Lake Mead, and in fish from the Santa Ana River and Colorado River.<sup>323</sup>

Sulfamethoxazole & Trimethoprim: Sulfamethoxazole is commonly used to treat urinary tract infections and sinusitis. It can combine with other pharmaceuticals to have synergistic effects on aquatic biota.<sup>324</sup> It has been detected in Lake Mead, in treated waste water, in ground and drinking water, in Boulder Creek, Colorado, in soil irrigated with reclaimed water, and in drinking water.<sup>325</sup> It has also been detected in streams in northern Arkansas, in Pennsylvania waters, in the lower Tallapoosa River watershed in Alabama, in intersexed fish from the Shenandoah River, and in groundwater.<sup>326</sup>

Trimethoprim is also an antibacterial agent and acts similarly to sulfamethoxazole. It has been detected in Boulder Creek, Colorado, in soil irrigated with reclaimed water, and in drinking water.<sup>327</sup> It has also been detected in streams in northern Arkansas, in Pennsylvania waters, and in intersexed fish from the Shenandoah River.<sup>328</sup>

Synthetic musks: Synthetic musks are chemicals used in fragrances. Among the most abundant are Galaxolide and Tonalide.<sup>329</sup> Galaxolide can have synergistic effects with other pollutants, like cadmium, that intensify over time.<sup>330</sup> These chemicals

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<sup>320</sup> Oh, S.M., H.R. Kim, and K.H. Chung, 2009, In vitro estrogenic and antiestrogenic potential of chlorostyrenes, *Toxicology in Vitro* vol. 23, iss.7; Yanagiba, Y., Y. Ito, M. Kamijima, F.J. Gonzalez, and T. Nakajima, 2009, Octachlorostyrene Induces Cytochrome P450, UDP-glucuronosyltransferase, and Sulfotransferase via the Aryl Hydrocarbon Receptor and Constitutive Androstane Receptor, *Toxicological Sciences* 111(1):19-26.

<sup>321</sup> Lee, S. and J. Choi, 2009, Multi-level ecotoxicity assay on the aquatic midge, *Chironomus tentans* (Diptera, Chironomidae) exposed to octachlorostyrene, *Environmental Toxicology and Pharmacology* vol. 28, iss. 2.

<sup>322</sup> Park, E. and Park, K., 2008, Induction of oxidative stress in human Chang liver cells by octachlorostyrene, the persistent and bioaccumulative toxicant, *Toxicology in Vitro* vol. 22, iss. 2.

<sup>323</sup> Rosen 2009, Table 2; Jenkins 2009; and Marr 2007.

<sup>324</sup> Yang, L., G. Ying, H. Su, J.L. Stauber, M.S. Adams, and M.T. Binet, 2008, Growth-inhibiting effects of 12 antibacterial agents and their mixtures on the freshwater microalga *Pseudokirchneriella subcapitata*, *Environmental Toxicology and Chemistry* vol. 27, no. 5.

<sup>325</sup> Boyd 2002; EPA 2009; USGS 2008; Barber 2006; Kinney 2006; and Benotti 2009.

<sup>326</sup> Galloway 2005; Loper 2007; Oblinger 2007; Alvarez 2008; and Barnes 2008.

<sup>327</sup> Barber 2006; Kinney 2006; and Benotti 2009.

<sup>328</sup> Galloway 2005; Loper 2007; and Alvarez 2008.

<sup>329</sup> Ramirez 2009; Kannan, K., J.L. Reiner, S.H. Yun, E.E. Perrotta, L. Tao, B. Johnson-Restrepo, and B.D. Rodan, 2005, Polycyclic musk compounds in higher trophic level aquatic organisms and humans from the United States, *Chemosphere* vol. 61, iss. 5; Horii, Y., J.L. Reiner, B.G. Loganathan, K.S. Kumar, K. Sajwan, and K. Kannan, 2007, Occurrence and fate of polycyclic musks in wastewater treatment plants in Kentucky and Georgia, USA, *Chemosphere* vol. 68, iss. 11.

<sup>330</sup> Chen, F. and Q. Zhou, 2009, Joint toxic effects of galaxolide and cadmium on *Carassius auratus* under polluting flow conditions containing soil-water interfaces from urban areas, *Journal of Zhejiang University* vol. 35, no. 2; Chen, F. and Q. Zhou, 2009, Toxic effects of galaxolide and cadmium on *Daphnia magna*

bioaccumulate in fish and have been detected in Las Vegas Wash and Lake Mead.<sup>331</sup> Galaxolide has been detected in drinking water, in the lower Columbia River's water and sediment, in fish from the Santa Ana River, in drinking water, in biosolids, and in intersexed fish from the Shenandoah River.<sup>332</sup>

**Triclosan:** Triclosan is used in soaps and toothpaste and can act as an endocrine disruptor at concentrations found in US streams. More than 55% of streams examined in 2002 had a median concentration of 0.14 ppb. Research indicates that .15 ppb is capable of perturbing hormonal signaling mechanisms. It has a similar chemical structure to PBDEs and PCBs and bioaccumulate in fish and can be found in human breast milk.<sup>333</sup> It has been detected in Lake Mead, Boulder Creek, Colorado, biosolids, drinking water, and source water.<sup>334</sup> It has also been detected in streams in northern Arkansas, in groundwater in Oregon, and in the lower Tallapoosa River watershed in Alabama.<sup>335</sup>

**The EPA must establish water quality standards for the following flame retardants and plasticizer: 5-methyl-1H-benzotriazole, Bisphenol A, diethylhexyl phthalate, para-cresol, pentachloroanisole, perchlorate, PBDEs, triphenol phosphate, tributyl phosphate, tris(2-chloroethyl) phosphate, and tris (2-butoxyethyl) phosphate.**

**5-methyl-1H-benzotriazole:** It can be found in aircraft deicing and anti-icing fluid. It bioaccumulates in fish fat and has adverse effects on aquatic life.<sup>336</sup> It has been detected in Lake Mead at concentrations up to 20,000 pg/L and in source water.<sup>337</sup> It has also been detected in streams in northern Arkansas, in groundwater in Oregon, in the lower Tallapoosa River watershed in Alabama, in groundwater, and in streams and groundwater in Colorado.<sup>338</sup>

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under polluting flow conditions containing soil-water interfaces from urban areas, *China Environmental Sciences* vol. 29, no. 1.

<sup>331</sup> Osemwengie, L.I. and S.L. Gerstenberger, 2004, Levels of synthetic musk compounds in municipal wastewater for potential estimation of biota exposure in receiving waters, *J. Environ. Monit.*, 2004, 6, 1-8; Goodbred 2007, Table 3; Rosen 2009, Table 2, Table 3.

<sup>332</sup> Kingsbury 2008; LCREP 2007; Jenkins 2009; Benotti 2009; Kinney 2006; and Alvarez 2008.

<sup>333</sup> Pelley, Janet, 2006, Germ fighter works as endocrine disruptor: Triclosan, popular in soaps and lotions, perturbs the thyroid system of frogs and humans, *Science News* (Oct. 24, 2006); Veldhoen, N., R.C. Skirrow, H. Osachoff, H. Wigmore, D.J. Clapson, M.P. Gunderson, G. Van Aggelen, and C.C. Helbing, 2006, The bactericidal agent triclosan modulates thyroid hormone-associated gene expression and disrupts postembryonic anuran development, *Aquatic Toxicology*, August 2006; Fair, P.A., L. Hing-Biu, J. Adams, C. Darling, G. Pacepavicus, M. Alae, G.D. Bossart, N. Henry, and D. Muir, 2009, Occurrence of triclosan in plasma of wild Atlantic bottlenose dolphins (*Tursiops truncatus*) and in their environment, *Environmental Pollution* 157, 2248-2254.

<sup>334</sup> Leiker 2009; Barber 2006; Kinney 2006; Benotti 2009; and Kingsbury 2008.

<sup>335</sup> Galloway 2005; Hinkle 2005; and Oblinger 2007.

<sup>336</sup> Cancilla, D.A., J.C. Baird, S.W. Geis, and S.R. Corsi, 2003, Studies of the environmental fate and effect of aircraft deicing fluids: detection of 5-methyl-1H-benzotriazole in the fathead minnow (*Pimephales promelas*), *Environmental Toxicology and Chemistry*, vol. 22, iss. 1; Corsi, S.R., S.W. Geis, J.E. Loyo-Rosales, and C.P. Rice, 2006, Aquatic Toxicity of Nine Aircraft Deicer and Anti-Icer Formulations and Relative Toxicity of Additive Package Ingredients Alkylphenol Ethoxylates and 4,5-Methyl-1H-benzotriazoles, *Environ. Sci. Technol.* 40:7409-7415.

<sup>337</sup> Rosen 2009, Table 4 and Kingsbury 2008.

<sup>338</sup> Galloway 2005; Hinkle 2005; Oblinger 2007; Barnes 2008; and Sprague 2005.

Bisphenol A: Bisphenol A or BPA is a manmade chemical found in plastic products frequently used as food and beverage containers, and in epoxy resins found in dental sealants. Over 6 billion pounds are used annually to manufacture these products. The ester bond linking the BPA molecule to the products undergoes hydrolysis which releases the BPA into food, beverages, and the environment. BPA has estrogenic effects and acts as a selective estrogen receptor modulator.<sup>339</sup> It has been shown to show changes in cell function at very low levels.<sup>340</sup> Water born exposure can come from ingestion or through skin contact including bathing and swimming. BPA can affect the brain, prostate gland, and behavior of subjects exposed to it at environmentally relevant doses.<sup>341</sup> It can also affect the mammary gland and can be found in breast milk.<sup>342</sup> It has been shown that postnatal exposure to BPA affects the steroid hormone-responsiveness of uterine stroma in adulthood.<sup>343</sup> There is also evidence that BPA may have effects on obesity and diabetes.

It is very common that the dose-response curve for BPA to be nonmonotonic and form an inverted U. For example, a study on rat pituitary glands showed BPA having its greatest effect at 1nM, with the magnitude of the response decreasing at 10nM.<sup>344</sup> Also, perinatal exposure to environmentally relevant concentrations (25-250 ng BPA/kg body weight) results in persistent alterations in mammary gland morphogenesis.<sup>345</sup> Therefore, even very small amounts of BPA can have very large and lasting effects.

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<sup>339</sup> Savabieasfahani, M., K. Kannan, O. Astapova, N.P. Evans, and V. Padmanabhan, 2006, Developmental Programming: Differential Effects of Prenatal Exposure to Bisphenol-A or Methoxychlor on Reproductive Function, *Endocrinology* 147(12):5956-5966.

<sup>340</sup> Welshons, W.V., S.C. Nagel, and F.S. vom Saal, 2006, Large Effects from Small Exposures. III. Endocrine Mechanisms Mediating Effects of Bisphenol A at Levels of Human Exposure, *Endocrinology* 147(6) S56-S69.

<sup>341</sup> Ramos, J.G., J. Varayoud, L. Kass, H. Rodriguez, L. Costabel, M. Munoz-de-Toro, and E.H. Luque, 2003, Bisphenol A Induces Both Transient and Permanent Histofunctional Alterations of the Hypothalamic-Pituitary-Gonadal Axis in prenatally Exposed Male Rats, *Endocrinology* 144(7):3206-3215; Leranthe, C., K. Szigeti-Buck, N.J. MacLusky, and T. Hajszan, 2008, Bisphenol A Prevents the Synaptogenic Response to Testosterone in the Brain of Adult Male Rats, *Endocrinology* 149(3):988-994; Khurana, S., S. Ranmal, and N. Ben-Jonathan, 2000, Exposure of Newborn Male and Female Rats to Environmental Estrogens: Delayed and Sustained Hyperprolactinemia and Alterations in Estrogen Receptor Expression, *Endocrinology* vol. 141, no. 12.

<sup>342</sup> National Toxicology Program Center for the Evaluation of Risks to Human Reproduction, 2008, NTP-CERHR Monograph on the Potential Human Reproductive and Developmental Effects of Bisphenol A, *NIH Publication No. 08-5994*, available at <http://cerhr.niehs.nih.gov/chemicals/bisphenol/bisphenol.pdf>.

<sup>343</sup> Varayouf, J., J.G. Ramos, V.L. Bosquiazzo, M. Munoz-de-Toro, and E.H. Luque, 2008, Developmental Exposure to Bisphenol A Impairs the Uterine Response to Ovarian Steroids in the Adult, *Endocrinology* 149(11):5848-5860.

<sup>344</sup> Wozniak, A.L., N.M. Bulayeva, and C.S. Watson, 2005, Xenoestrogens at picomolar to nanomolar concentrations trigger membrane estrogen receptor-a mediated Ca<sup>2+</sup> fluxes and prolactin release in GH3/B6 pituitary tumor cells, *Environ Health Perspect* 110:A703-A707.

<sup>345</sup> Munoz-de-Toro, M., C.M. Markey, P.R. Wadia, E.H. Luque, B.S. Rubin, C. Sonnenschein, and A.M. Soto, 2005, Perinatal Exposure to Bisphenol-A Alters Peripubertal Mammary Gland Development in Mice, *Endocrinology* 146(9):4138-4147.

It has been detected in ground and drinking water, in Boulder Creek, Colorado, in biosolids, Lake Mead, the lower Columbia River's water and sediment and in source water.<sup>346</sup> It has also been detected in streams in northern Arkansas, in groundwater from Oregon, in waste, surface, ground, and drinking water in Minnesota, in groundwater, and in groundwater and streams in Colorado.<sup>347</sup>

Diethylhexyl phthalate: DEHP is a plasticizer and is found throughout our environment. DEHP has strong estrogenic effects,<sup>348</sup> and has effects on the male reproductive system.<sup>349</sup> It has been shown to increase uterine weight during short-term exposure of low doses.<sup>350</sup> DEHP also has transgenerational effects.<sup>351</sup> It has been detected in biosolids and drinking water.<sup>352</sup>

Para-cresol: Cresols have a variety of uses including disinfectants, fragrances, herbicides, pharmaceuticals, and wood preservatives. Para-cresol is absorbed by skin and the respiratory system and is classified as a possible human carcinogen.<sup>353</sup> Para-cresol has been detected in Lake Mead, biosolids, and source water.<sup>354</sup> It has also been detected in streams in northern Arkansas, in groundwater in Oregon, in the lower Tallapoosa River watershed in Alabama, in intersexed fish from the Shenandoah River, and in groundwater.<sup>355</sup>

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<sup>346</sup> Benotti 2009; USGS 2008; Barber 2006; Kinney 2006; LCREP 2007; and Kingsbury 2008.

<sup>347</sup> Galloway 2005; Hinkle 2005; Lee 2004; Barnes 2008; and Sprague 2005.

<sup>348</sup> Hirosawa, N., K. Yano, Y. Suzuki, and Y. Sakamoto, 2006, Endocrine disrupting effect of di-(2-ethylhexyl)phthalate on female rats and proteome analyses of their pituitaries, *Proteomics* vol. 6, iss. 3.

<sup>349</sup> Borch, J., M. Axelstad, A.M. Vinggard, and M. Dalgarrd, 2005, Disobutyl phthalate has comparable anti-androgenic effects to di-*n*-butyl phthalate in fetal rat testis, *Toxicology Letters* vol. 163, iss. 3; Wilson, V.S., K.L. Howdeshell, C. Lambright, J. Furr, and L.E. Gray, 2008, In Utero Exposure to Diethylhexyl Phthalate Differentially Affects Fetal Testosterone and insl3 Levels in the Testes of Male Sprague Dawley and Wistar Rats: A Dose Response Study, *Biology of Reproduction* 78:183- 548; Borch, J., S.B. Metzdorff, A.M. Vinggaard, L. Brokken, and M. Dalgaard, 2006, Mechanisms underlying the anti-androgenic effects of diethylhexyl phthalate in feral rat testis, *Toxicology* vol. 223, iss. 1-2; Howdeshell, K.L., J. Furr, C.R. Lambright, C.V. Rider, V.S. Wilson, and L.E. Gray, 2007, Cumulative Effects of Dibutyl Phthalate and Diethylhexyl on Male Rat Reproductive Tract Development: Altered Fetal Steroid Hormones and Genes, *Toxicological Sciences* 99(1):190-202.

<sup>350</sup> El-Mubarak, A. and D. Huisingh, 2001, Environmental Xenoestrogens: Short-term Exposure of Low Doses of Lindane, Dieldrin, Dibutyl Phthalate, and Diethylhexyl Phthalate Increases Uterine Weight in Young Female Mice, *Analytical Sciences* vol. 17 supplement.

<sup>351</sup> Gray, L.E., N.J. Barlow, K.L. Howdeshell, J.S. Ostby, J.R. Furr, and C.L. Gray, 2009, Transgenerational effects of di (2-ethylhexyl) phthalate in the male crl: cd(sd) rat: added value of assessing multiple offspring per litter, *Toxicological Sciences*; Lin, H., Q. Lian, G. Hu, Y. Jin, Y. Zhang, D.O. Hardy, G. Chen, Z. Lu, C.M. Sottas, M.P. Hardy, and R. Ge, 2008, In Utero and Lactational Exposures to Diethylhexyl-Phthalate Affect Two Populations of Leydig Cells in Male Long-Evans Rats, *Biology of Reproduction* vol. 80 no. 5.

<sup>352</sup> Kinney 2006 and Benotti 2009.

<sup>353</sup> Michalowicz, J. and W. Duda, 2007, Phenols – Sources and Toxicity, *Polish J. of Environ. Stud.* Vol. 16, no. 3.

<sup>354</sup> Rosen 2009, Table 4; Kinney 2006; and Kingsbury 2008.

<sup>355</sup> Galloway 2005; Hinkle 2005; Oblinger 2007; Alvarez 2008; and Barnes 2008.

Pentachloroanisole: Pentachloroanisole is a chlorinated aromatic compound, a degradate of pentachlorophenol and pentachloronitrobenzene, and is toxic to rodents.<sup>356</sup> It is a suspected carcinogen and has been linked to liver lesions. It is a chlorinated aromatic compound and has been found all around Lake Mead, and been detected in common carp from Las Vegas Bay at 3.8 micrograms per kilogram.<sup>357</sup> It has been detected in carp tissue and sediment from the Colorado, fish tissue from the Santa Ana River, and in intersexed fish from the Shenandoah River.<sup>358</sup>

Perchlorate: Perchlorate is derived from perchlorate acid and used to treat thyroid disorders. Perchlorate can cause hypothyroidism in most vertebrates,<sup>359</sup> and can enhance arsenate toxicity to juvenile zebrafish.<sup>360</sup> Chronic exposure to the offspring of exposed threespine stickleback results in impairment to nearly every aspect of fitness.<sup>361</sup> It is on the EPA's CCL3 list. It reduces iodine uptake into the thyroid gland.<sup>362</sup> A 2002 EPA report proposes secondary acute values for short-term and long-term exposure to perchlorate. Perchlorate concentrations substantially exceeded those levels in sampling from Las Vegas Wash.<sup>363</sup>

Polybrominated diphenyl ethers: PBDEs are a class of synthetic flame retardants used in plastics, cushions, and clothing. They are similar to PCBs, and like PCBs, they come in 209 different congeners. They bioaccumulate in freshwater and marine fish, and their effects are believed to be similar to that of PCBs. PBDE and a-hexabromocyclododecane (HBCD) are flame retardant additives used in household and commercial applications. Captive American kestrels exposed to DE-71 and HBCD resulting in the birds laying eggs that contain concentrations currently found in wild herring gulls and peregrine falcons. It resulted in delayed egg laying and smaller eggs being laid, causing thinner eggshells and differential weight loss during embryonic development, and reduced fertility and reproductive.<sup>364</sup> Another study found that PBDE may reduce reproductive

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<sup>356</sup> ATSDR, 1997, Toxicological Profile for Pentachlorophenol, available at <http://www.atsdr.cdc.gov/toxprofiles/tp51.html>.

<sup>357</sup> Rosen 2009, Table 2, Table 3 and Goodbred 2007, Table 3.

<sup>358</sup> Hinck 2007; Marr 2007; Jenkins 2009; and Alvarez 2008.

<sup>359</sup> Park, J., J. Rinchard, F. Liu, T.A. Anderson, R.J. Kendall, and C.W. Theodorakis, 2006, The thyroid endocrine disruptor perchlorate affects reproduction, growth, and survival of mosquitofish, *Ecotoxicology and Environmental Safety* vol. 63, iss. 3; Crane, H.M., D.B. Pickford, T.H. Hutchinson, and J.A. Brown, 2005, Effects of Ammonium perchlorate on Thyroid Function in Developing Fathead Minnows, *Pimephales promelas*, *Environ Health Perspect.* 113(4): 396-401.

<sup>360</sup> Liu, F., A. Gentles, and C.W. Theodorakis, 2008, Arsenate and perchlorate toxicity, growth effects, and thyroid histopathology in hypothyroid zebrafish *Danio rerio*, *Chemosphere* vol. 71, iss. 7.

<sup>361</sup> Bernhardt, R.R., 2008, The effects of perchlorate exposure on a model vertebrate species: The threespine stickleback, *University of Alaska Fairbanks*.

<sup>362</sup> EPA, 2008, Interim Drinking Water Health Advisory for Perchlorate, available at [http://www.epa.gov/safewater/contaminants/unregulated/pdfs/healthadvisory\\_perchlorate\\_interim.pdf](http://www.epa.gov/safewater/contaminants/unregulated/pdfs/healthadvisory_perchlorate_interim.pdf).

<sup>363</sup> Intertox 2008, p. 50; ADEQ, 2004, Perchlorate in Arizona: Occurrence Study of 2004, available at <http://www.azdeq.gov/function/about/download/perchl201.pdf>.

<sup>364</sup> Fernie, K.J., J.L. Shutt, R.J. Letcher, I.J. Ritchie, and D.M. Bird, 2009, Environmentally Relevant Concentrations of DE-71 and HBCD Alter Eggshell Thickness and Reproductive Success of American Kestrels, *Environ. Sci. Technol.*, 2009, 43(6), pp. 2124-2130.

success in ospreys.<sup>365</sup> BDE 47, BDE 99, and BDE 100 have been detected in Lake Mead at varying concentrations.<sup>366</sup> BDE 47, 99, 100, 153, 154 have been detected in fish from the Santa Ana River.<sup>367</sup> BDEs have also been detected in carp tissue and sediment from the Colorado River.<sup>368</sup>

Triphenol phosphate: It is a flame retardant added to computer products. It is water resistant and is a neurotoxin in animals. Triphenol phosphate inhibits the human androgen receptor.<sup>369</sup> It has been detected in Lake Mead and source water.<sup>370</sup> It has also been detected in streams from northern Arkansas, in waste, surface, ground, and drinking water from Minnesota, in the lower Tallapoosa River watershed in Alabama, in intersexed fish from the Shenandoah River, from groundwater and streams in Colorado, and in groundwater in Oregon.<sup>371</sup>

Tributyl phosphate: Commonly known as TBP, it is an organophosphorus compound used as an extractant and plasticizer. It has been detected in Lake Mead and source water.<sup>372</sup> It has also been detected in streams from northern Arkansas, in waste, surface, ground, and drinking water from Minnesota, in the lower Tallapoosa River watershed in Alabama, in groundwater in Oregon, and from groundwater and streams in Colorado.<sup>373</sup>

Tris(2-chloroethyl) phosphate: It is used as a flame retardant in automobiles and furniture. It has been shown to decrease cell viability, DNA synthesis, and cell numbers. It has been detected in Lake Mead and source water.<sup>374</sup> It has also been detected in streams from northern Arkansas, in waste, surface, ground, and drinking water from Minnesota, in the lower Tallapoosa River watershed in Alabama, in intersexed fish from the Shenandoah River, from groundwater and streams in Colorado, in groundwater in Oregon, and in groundwater throughout other parts of the U.S.<sup>375</sup>

Tris(2-butoxyethyl) phosphate: It is a flame retardant used in floor polish and as a plasticizer in rubber and plastics. It has been detected in Lake Mead and source water.<sup>376</sup> It has also been detected in streams from northern Arkansas, in waste, surface, ground, and drinking water from Minnesota, in the lower Tallapoosa River watershed in

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<sup>365</sup> Henry, C.J., J.L. Kaiser, R.A., Grove, B.L. Johnson, and R.J. Letcher, 2009, Polybrominated diphenyl ether flame retardants in eggs may reduce reproductive success of ospreys in Oregon and Washington, USA, *Ecotoxicology* June 10, 2009.

<sup>366</sup> Rosen 2009, Table 2, Table 3.

<sup>367</sup> Jenkins 2009.

<sup>368</sup> Marr 2007 and Hinck 2007.

<sup>369</sup> Honkakoski, P., J.J. Palvimo, L. Penttila, J. Vespalainen, and S. Auriola, 2004, Effects of triaryl phosphate on Mouse and human nuclear receptors, *Biochemical Pharmacology*, vol. 67, iss. 1.

<sup>370</sup> Rosen 2009, Table 4 and Kingsbury 2008.

<sup>371</sup> Galloway 2005; Lee 2004; Oblinger 2007; Alvarez 2008; Sprague 2005; and Hinkle 2005.

<sup>372</sup> Rosen 2009, Table 4 and Kingsbury 2008.

<sup>373</sup> Galloway 2005; Lee 2004; Oblinger 2007; Hinkle 2005; and Sprague 2005.

<sup>374</sup> Rosen 2009, Table 4 and Kingsbury 2008.

<sup>375</sup> Galloway 2005; Lee 2004; Oblinger 2007; Alvarez 2008; Sprague 2005; Hinkle 2005; and Barnes 2008.

<sup>376</sup> Rosen 2009, Table 4 and Kingsbury 2008.

Alabama, in intersexed fish from the Shenandoah River, and from groundwater and streams in Colorado.<sup>377</sup>

## V. Requested Rulemaking

The new information on endocrine disrupting chemicals contained in this Petition has triggered the EPA's duty to update the National Recommended Water Quality Criteria and information.

Section 304(a) of the Clean Water Act imposes a duty on the EPA to periodically update water quality criteria and information. The Act requires the EPA to develop and publish and "from time to time thereafter revise" water quality criteria and information.<sup>378</sup> New information that controverts previously held beliefs about water quality and pollutants triggers the EPA's duty to review and revise criteria. Here, the EPA must revise water quality criteria and information to reflect the latest science on EDCs.

### **EPA Must Establish National Water Criteria for EDCs**

The Center for Biological Diversity formally requests that the EPA initiate a rulemaking pursuant to the Clean Water Act to address water quality threats posed by EDCs. This Petition for rulemaking specifically requests that the EPA:

- (1) Establish national recommended water quality criteria for the EDCs described in this Petition to reflect the latest scientific knowledge; and**
- (2) Publish information on EDCs as pollutants contaminating our nation's waterbodies.**

Section 304 of the Clean Water Act requires the EPA to publish and revise water quality criteria "from time to time" to "accurately reflect the latest scientific knowledge."<sup>379</sup> As presented herein, there is extensive new information concerning EDCs and the adverse effects they are having on water quality, fish, wildlife, and humans. Pursuant to its duties under the Clean Water Act, the EPA must consider this new information and consequently establish water quality criteria for the EDCs.

The water quality criteria must reflect the latest scientific knowledge related to the effects of pollutants on "plankton, fish, shellfish, plant life, shorelines, beaches, esthetics, and recreation" and human health.<sup>380</sup> The criteria must also reflect the latest scientific knowledge "on the concentration and dispersal of pollutants, or their byproducts, through biological, physical, and chemical processes; and...on the effects of pollutants on biological community diversity, productivity, and stability."<sup>381</sup>

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<sup>377</sup> Galloway 2005; Lee 2004; Oblinger 2007; Alvarez 2008; and Sprague 2005.

<sup>378</sup> 33 USC §§1314(a)(1)-(2).

<sup>379</sup> 33 USC §1314(a)(1).

<sup>380</sup> 33 USC §1314(a)(1)(a).

<sup>381</sup> 33 USC §1314(a)(1)(b)-(c).

According to the EPA, a “water quality criterion is a level of a pollutant or other measurable substance in water that, when met, will protect aquatic life and/or human health.”<sup>382</sup> Water quality criteria developed under section 304(a) must be “based solely on data and scientific judgments...[t]hey do not consider economic impacts or the technological feasibility of meeting the criteria.”<sup>383</sup> The data and scientific information presented in this Petition indicates that updated water quality criteria are needed to prevent EDC pollution.

### **Current Criteria Do Not Reflect the Latest Scientific Knowledge**

With regard to what the EPA coins “Contaminants of Emerging Concern” (largely referring to EDCs), the EPA has acknowledged that “[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.”<sup>384</sup>

Currently, water quality 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. CMC is derived from 48-96 hour tests for lethality or immobilization while CCC is from longer term tests measuring survival, growth, or reproduction.<sup>385</sup> Water quality 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.<sup>386</sup>

However, EDCs defy the typical “dose makes the poison” paradigm of toxicology.<sup>387</sup> The guidelines “anticipated that rote application of the basic procedures may not yield the most appropriate criteria” and therefore, provide flexibility in moving away from normal procedures whenever.<sup>388</sup>

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

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<sup>382</sup> *Final Aquatic Life Ambient Water Quality Criteria for Diazinon*, 71 Fed. Reg. 9336 (Feb. 23, 2006).

<sup>383</sup> *Notice of Availability of Final Aquatic Life Criteria Document for Tributyltin*, 69 Fed. Reg. 342, 343 (Jan. 5, 2004).

<sup>384</sup> EPA, 2008, White Paper: Aquatic Life Criteria for Contaminants of Emerging Concern, Part 1: General Challenges and Recommendations, *Draft Document*.

<sup>385</sup> EPA, 1994, *Water Quality Standards, 2ed.*, Chapter 3: Water Quality Criteria, 3-3, available at <http://www.epa.gov/waterscience/standards/handbook/handbookch3.pdf>.

<sup>386</sup> *Id.* at 3-4.

<sup>387</sup> See Willingham, E., 2004, Endocrine-Disrupting Compounds and Mixtures: Unexpected Dose-Response, *Arch. Environ. Contam. Toxicol.* 46, 265-269.

<sup>388</sup> Stephan et. al., 1985, *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, p. 18 and 57.

-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.

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 their 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.<sup>389</sup> The standard procedures for deriving CMC and CCCs use only toxicity tests meeting certain requirements, however, the *Guidelines* mandate that the collation and examination of other data should be considered.<sup>390</sup>

Pertinent information that could not be used in earlier sections might be available concerning adverse effects on aquatic organisms and their uses. The most important of these are data on...any other adverse effect that has been shown to be biologically important. Especially important are data for species for which no other data are available...such data might affect a criterion if the data were obtained with an important species, the test concentrations were measured, and the endpoint was biologically important.

The case of tributyltin should serve as an example for the EPA in establishing and revising its water quality standards for the pollutants addressed in this Petition. The final acute value using standard ALC derivation procedures for tributyltin was .0658 µg/L even though concentrations linked to imposex and immuno-suppression in snail and bivalves was in the range of 0.0093-0.334 µg/L. The EPA rightly took this new scientific knowledge into account and lowered the CCC for tributyltin to .0074 µg/L.

The EPA has established national recommended water quality 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. 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 water quality criteria, that criteria development “needs to focus efforts on chemicals that demonstrate a

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<sup>389</sup> Gore, A.C., J.J. Heindel, and R.T. Zoeller, 2006, Endocrine Disruption for Endocrinologists (and Others), *Endocrinology* 147(6) S1-S3.

<sup>390</sup> Stephan at 54.

reasonable potential to adversely affect aquatic life.”<sup>391</sup> 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.”<sup>392</sup> The EPA must revise these water quality criteria to reflect the latest scientific knowledge. Further, for those EDCs not currently listed as pollutants, the EPA must publish National Recommended Water Quality Criteria and information reflecting the latest scientific knowledge.

### **Criteria for EDCs Will Better Protect Aquatic Life**

The Clean Water Act has been construed to provide robust protection of waters of the United States. Under the Clean Water Act, the Administrator of the EPA is obligated to protect water quality for “the protection and propagation of fish, shellfish, and wildlife.”<sup>393</sup> The courts have stated that the provisions of the Clean Water Act are to be construed generously.<sup>394</sup> Furthermore, the courts have indicated that it is the intent of the Clean Water Act to cover all of the waters of the United States, and to regulate such waters “to the fullest extent possible under the Commerce Clause.”<sup>395</sup>

Through the Clean Water Act, Congress gave the EPA the duty to protect and maintain the water quality of our nation. EDCs jeopardize the health of our nation’s waters and aquatic ecosystems. Addressing EDC pollution beings with accurate, science-based water quality criteria.

The EPA is intimately involved in water quality standards through two mechanisms. First, the EPA must publish water quality criteria under section 304, which are important because they form the basis for state water quality standards.<sup>396</sup> Second, the EPA must review and approve or disapprove state water quality standards.<sup>397</sup> If the EPA finds that the state’s standards are inadequate, the EPA must promulgate water quality standards for the state guided by the national water quality criteria. In turn, a state’s water quality standards are the basis for effluent limitation for point sources, the identification of impaired water bodies requiring additional protection through TMDLs, the requirements for section 401 certification, and National Pollutant Discharge Elimination System permits.

Water quality criteria under section 304 serve a regulatory function. EPA’s water quality criteria provide guidance to states and tribes in the development and adoption of water

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<sup>391</sup> EPA White Paper 2008.

<sup>392</sup> Stephan at 27.

<sup>393</sup> 33 USC §1251(a)(2).

<sup>394</sup> *United States v. Hamel*, 551 F.2d 107, 112 (6<sup>th</sup> Cir 1977).

<sup>395</sup> *Quivera Mining Co. v. United States EPA*, 765 F.2d 126, 130 (10<sup>th</sup> Cir. 1985).

<sup>396</sup> 40 CFR §131.11.

<sup>397</sup> 33 USC §1313(a)-(c).

quality standards that will protect the designated uses for their waters.<sup>398</sup> In fact, the EPA encourages states to use EPA's section 304(a) criteria as guidance. States must revise their water quality criteria to reflect changes in the published sections of 304 guidelines.<sup>399</sup> Once adopted, the criteria are a basis for developing regulatory controls on the discharge or release of pollutants. Additionally, the EPA uses the water quality criteria for promulgating federal water quality regulations under section 303(c) of the Clean Water Act.

The Clean Water Act can provide the tools to protect water quality from degradation due to EDC pollution if it promulgates water quality criteria for the EDCs. Specifically, section 303(d) requires states to identify waters for which existing controls are inadequate to ensure compliance with water quality standards.<sup>400</sup> A waterbody failing to meet any numeric criteria, narrative criteria, waterbody use, or antidegradation requirements shall be included on the 303(d) list.<sup>401</sup> Once listed, states must take steps to reduce the pollution causing the impairment by establishing TMDLs. TMDLs limit the total amount of a pollutant that can be loaded into a waterbody from all combined sources. Updated water quality standards would aid states in identifying whether their waterbodies are at risk from EDC pollution.

### **EPA Must Publish Information Regarding EDC pollution**

The Clean Water Act requires the EPA publish and "from time to time thereafter revise" information regarding four factors of water quality: (A) the maintenance of chemical, physical, and biological integrity of all of the nation's waters; (B) the protection and propagation of fish, shellfish, and wildlife; (C) measurement and classification of water quality; and (D) which pollutants are suitable for measuring maximum daily loads related to water quality.<sup>402</sup> States require this information to adequately evaluate section 304(a)(1) criteria and their applicability to the state's waters. In addition, the information may play a valuable role in the education of state personnel and during management of state water resources. It is prudent for the EPA to publish new information under section 304(a)(2) because there is new scientific knowledge on the effects of EDCs are having as water pollutants.

## **VI. Conclusion**

The information contained in this Petition represents the latest scientific knowledge. The EPA has a mandatory duty to establish National Recommended Water Quality Criteria protective of our nation's waters. Currently, the EDCs entering and persisting in these waterbodies are having profound effects on wildlife, fish, and humans.

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<sup>398</sup> See *National Recommended Water Quality Criteria for the Protection of Human Health*, 68 Fed. Reg. 75507, 75509 (Dec. 31, 2003).

<sup>399</sup> See, e.g. 71 Fed. Reg. 67548 Part III (1998).

<sup>400</sup> 33 USC §1313(d).

<sup>401</sup> 40 CFR §130.7(b)(3).

<sup>402</sup> 33 USC §1214(a)(2).

If any provision of this Petition is found to be invalid or unenforceable, the invalidity or lack of legal obligation shall not affect other provisions of the Petition. Therefore, the provisions of the Petition are severable.

As previously stated, the EPA is required by law to respond to this Petition. Please contact Jaclyn Lopez at 415-436-9682 x. 305 or [jlopez@biologicaldiversity.org](mailto:jlopez@biologicaldiversity.org) with any communications regarding this Petition. We look forward to your reply.