

# Medicine Residue Is Everywhere in Our Rivers and Lakes—and Fish Are Behaving Strangely

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## Introduction

For all the well-documented sources of environmental pollution—think chemical manufacturers, energy plants, mining operations, and agricultural processes—there's another major source of contamination that continues to get short shrift by those charged with protecting the nation's waterways and the public's health: Pharmaceuticals and personal care products.

“Across the board, we don't have our heads around this problem,” said Emma Rosi, senior scientist at the Cary Institute of Ecosystem Studies. And considering America's voracious appetite for pharmaceuticals—there were [3.7 billion drugs](#) ordered or provided through physician visits alone in 2015—the scope of the problem is unsurprisingly staggering.

Chemical compounds found in pharmaceutical and personal care products are [showing up ubiquitously](#) in the nation's rivers, lakes, groundwater, and drinking water—even [remote regions of national parks](#). Up to 80 percent of streams in the U.S. alone are contaminated with chemicals, including pharmaceuticals, according to the [U.S. Geological Survey](#) (USGS). What's more, the sheer volume of different persistent compounds found in the environment vastly complicates the regulation and remediation of them.

“These are potent compounds, that's why we use them,” Rosi added. “But if they don't get broken down and they enter the environment, they are just as potent to the organisms there.”

### **How Are These Chemicals Entering the Nation's Waterways?**

The primary culprit is human waste—urine and feces—that makes its way to wastewater treatment plants unequipped to filter out all the various contaminants in the water. But it's not just human waste that's a problem.

In 2018, scientists at the USGS conducted a [study](#) of 20 wastewater treatment plants across the nation. They found that levels of certain pharmaceuticals were “substantially higher” in plants that received wastewater from drug manufacturing facilities compared to those that didn't. The study—which looked at 120 different drugs and pharmaceutical degradates—concluded that these facilities are an “important, national-scale source of pharmaceuticals to the environment.”

Some unwanted drugs are flushed down the toilet or tossed into the trash. Hospital waste is another avenue. But while we know how and where pharmaceutical wastes are getting into the environment, [we don't yet know](#) the full extent of the problem in terms of their myriad impacts on delicate ecosystems.

“There's insignificant research to understand the scope of this issue,” said Rosi. “And I would argue that there's not enough research funding for scientists to really understand the influence of these compounds.”

Even so, what we know is that some of these chemical compounds can profoundly affect aquatic life. Rosi breaks it down three ways—the first is related to their endocrine-disrupting properties.

In 2016, a team of scientists from the USGS and the U.S. Fish and Wildlife Service conducted a [study](#) of fish at 19 different National Wildlife Refuges. They found that between 60 to 100 percent of the fish studied were intersex, meaning they had female egg cells growing on their testes. The scientists linked this phenomenon to elevated levels of estrogen in the water. But estrogen-like chemicals aren't the only culprit.

A [2015 study](#) conducted by researchers at the University of Wisconsin-Milwaukee suggests that higher levels of metformin—a commonly prescribed diabetes drug—cause the development of intersex testes in male fathead minnows, reduce their size, and affect their ability to reproduce.

Pharmaceuticals are also a driver of [environmental change](#), said Rosi. The presence of antidepressants in the nation's waterways, for example, can [disrupt and alter fish behavior](#), including breeding patterns. The presence of cimetidine, a commonly used antacid, and antihistamine, has the potential to negatively impact the health of freshwater invertebrates and bacterial biofilm, [another study](#) suggests. Levels of cimetidine are on the rise in the nation's streams and rivers.

The third way pertains to their potential impact on human health. “There’s a lot of concern about antibiotic resistance,” said Tia-Marie Scott, a physical scientist with the USGS.

More than 250 million antibiotic prescriptions are written in the U.S. each year. But because the human body cannot metabolize antibiotics fully, and because wastewater treatment plants don’t filter them out, [experts fear](#) that the release of these drugs into the environment is contributing to the development and spread of antibiotic-resistant bacteria, which is estimated to be responsible for at least 23,000 deaths in the U.S. every year. And it’s not just human waste that’s a problem; agriculture is another [major contributor](#) to antibiotic releases.

“This is a whole can of worms that we’re only just able to start getting an understanding of,” Scott said.

### **Just How Big Is the Problem?**

Studies conducted in the U.S. illustrate how pharmaceutical compounds and chemicals found in personal care products are present throughout the nation’s rivers, lakes, groundwater, and drinking water at alarming rates.

A 2011 [Government Accountability Office](#) (GAO) report about their impacts on drinking water comprises a number of studies, including one by the USGS that found 53 of 74 testing locations had one or more pharmaceuticals in the water. In 2010, an Environmental Protection Agency (EPA)-funded analysis of 48 research publications found 54 active pharmaceutical ingredients and 10 metabolites that have been detected in treated drinking water.

The Great Lakes have come under scrutiny, too. In a University of Wisconsin-Milwaukee [study of Lake Michigan](#), 32 pharmaceuticals and personal care products were detected in the water, and another 30 were detected in the lake’s sediment. But it’s not just waterways situated near more urbanized areas that are vulnerable to contamination. Pharmaceutical compounds have even made it to isolated regions of the U.S.—including [a number of National Parks in Northern Colorado](#), for example.

“That really gets at how we’re seeing concentrations that are detectable at our most pristine environments,” said Scott. Nor is this a problem confined to the continental U.S. [Europe](#) has been researching the problem in its waterways for quite a number of years, while the [Alaskan Department of Environmental Conservation's Fish Monitoring Program](#) keeps tabs on the presence of pharmaceuticals in the state’s fish populations. “This problem occurs pretty much everywhere,” Scott said.

### **How to Tackle the Problem**

The decades-old [National Environmental Policy Act](#) gives Food and Drug Administration (FDA) administrators “mechanisms” to stop persistent pharmaceutical compounds from entering the environment, said Scott Graham, director of the Public Engagement and Science Communication Laboratory at the University of Wisconsin-Milwaukee.

The problem, said Graham, is that the FDA relies on pharmaceutical companies to conduct their own research into the environmental toll of their products, and this research is then presented to “environmental safety teams” at the agency—teams that are often overworked and understaffed.

This leads to evaluations being conducted by FDA personnel who are “ill-qualified to make accurate judgements” on the drug’s potential environmental impact, he added.

“[Drugs] end up getting approved because we have the pharmaceutical companies doing the wrong kind of science which is then being evaluated by the wrong kind of evaluator,” Graham said, who calls 2016 FDA environmental guidelines regarding drugs with [estrogenic, androgenic, or thyroid activity](#) a “weak” step forward.

The sheer scope of the problem is too vast for one agency to tackle alone. Rather, Graham advocates for a multi-pronged approach between different federal agencies. But with that in mind, EPA officials also admit in the 2011 GAO report that there is “no formal mechanism, such as a long-term strategy or formal agreement, to manage and sustain these collaborative efforts.”

Just take the staggering amount of waste produced in the U.S. Some 32 billion gallons of wastewater flows through [700,000 miles of underground pipes daily](#). But [wastewater treatment plants don’t have the technology](#) to remove all pharmaceuticals during the treatment process—nor are they mandated to. That, and the nation’s sewage infrastructure is old and deteriorating. So much so, it’s estimated that 900 billion gallons of sewage are released each year into waterways through infrastructure leaks and sewage overflows.

According to the USGS’s Tia-Marie Scott, while some wastewater treatment plants are stepping up to the plate, there are no affordable “one size fits all engineering solutions” to tackle the vast variety of different compounds in the environment. Which leads to the EPA’s stance on this issue. No pharmaceuticals are currently under the EPA’s [Primary Drinking Water Regulations](#).

“And I’m not even sure that’s a practical approach, because there are tens of thousands of emerging contaminants we’re identifying in our wastewater that could be of concern,” said Scott. “And the way our regulations are updated to accommodate new compounds, it doesn’t happen in a fast enough manner to deal with how many different chemicals are being used year after year, even day after day.”

There is a “[green pharmacy](#)” movement, pushing for the design of new drugs that biodegrade easily into the environment. But experts caution that the reason pharmaceuticals are so effective is that they’re designed to break down under particular conditions. That’s why some argue that there also needs to be a cultural shift in the way Americans consume pharmaceuticals and personal care products.

“There are lots of things that we use in our everyday lives that we can reduce a little bit,” said Rosi. “Because if people understand that what they’re using and washing down their drains are ending up at their local rivers, streams, lakes, they might think twice. It doesn’t just go away.”