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House Appropriations Subcommittee on Interior, Environment and Related Agencies

Hearing on Ecosystem Impacts of Marine Debris/Ocean Plastic Pollution

September 19, 2019

Written Testimony of Dr. Chelsea Rochman, PhD

Dear Chair McCollum and Ranking Member Joyce,

Thank you for holding this hearing on such an important topic. Plastic pollution presents a momentous challenge and it is heartening to see so much interest in finding solutions to tackle the issue on Capitol Hill. I'm thrilled to have the opportunity to share my expertise with you on this important issue and to help facilitate the use of science and evidence in informing policy.

I am Dr. Chelsea Rochman, an American citizen working abroad as a professor in Ecology at the University of Toronto. My expertise is in marine ecology, environmental chemistry and toxicology, I have been researching this issue for more than a decade. I currently run a research program where we investigate the sources, transport and effects of plastic pollution in our environment. I also serve as a Science Advisor to Ocean Conservancy, a nonprofit organization which works to create science-based solutions to the challenges facing our ocean. Ocean Conservancy is a leader in the global fight to address the proliferation of mismanaged plastic waste that has entered our oceans. In my capacity as a Science Advisor, I work with the organization to develop scientific research priorities and distill scientific findings into actionable information that can be used to provoke change, both here in the U.S. and abroad.

With more than a decade of experience researching plastic pollution, I have a vast knowledge base on this issue. I have published many papers about the topic and have advised managers and policy-makers in several countries. For example, I presented at the 2016 Our Ocean Conference at the U.S. State Department and in front of the UN General Assembly in 2017. I have also traveled to Washington, D.C. for one-on-one discussions with the offices of several Members of Congress.

My work in this field began in the middle of the ocean, aboard the first scientific expedition to the Great Pacific Garbage Patch with the Scripps Institution of Oceanography in 2009. Every four hours we dropped our net in the water to quantify plastic at the surface and 24 hours a day we had observers on deck looking for large debris. Day after day, we were not seeing much in terms of an island of garbage in the middle of the Pacific. Then, on the fourth day, the observers called us all up for assistance. On the bow of the ship were two rulers being used by observers to count debris as it passed. Up to that point, they had counted a buoy, a drink tray, a fishing net here and there. But then, all of a sudden there were too many pieces of plastic to count and the two observers needed the eyes of many. Looking over the bow of the ship were thousands of little pieces of plastic smaller than a pencil eraser. This was not a garbage patch, this was a soup of microplastic (plastic particles <5 mm in size). At that moment, I knew that this small plastic material could infiltrate every level of the food web. I also knew that this was not just an issue of cleanup – but also one of prevention.

Coming back to land, we analyzed the samples that were collected on the expedition. We found that there was plastic in every single one. This finding, that the majority of plastic pieces in the garbage patches were microplastics, demonstrated a need to shift the conversation in terms of the way we were thinking about mitigation by putting a stronger focus on preventing plastic from leaking into the environment in the first place. It also demonstrated a need for more science to better quantify the magnitude of the problem, including sources, transport, and impacts of microplastics in the marine environment.

Since this expedition, I have witnessed our scientific field grow globally and expand from oceans to freshwater to land. We've learned that microplastics are not just an ocean contaminant, but a global contaminant. We've learned that they are found in the stomachs of animals big and small and that this contamination extends beyond our environment - into seafood, salt and drinking water.

As a pioneer in this field, my research program is globally known for doing work on method development, contamination in the environment and effects to wildlife. We study microplastics across the United States, including in the San Francisco Bay, the Chesapeake Bay, the Great Lakes, and the Arctic. We also measure contamination in animals, exposure to humans via drinking water and seafood consumption, and the effects of plastic pollution to animals and ecosystems. The topic my lab focuses on the most is impacts to wildlife and their ecosystems.

Today, there is no doubt that anthropogenic debris of all shapes and sizes litters our oceans and freshwater ecosystems. This debris is found in hundreds of species of wildlife, including in the species we consider seafood. It is also found in our drinking water. We know that plastic pollution harms individual organisms, wildlife populations and communities. These impacts, combined with evidence for accelerating plastic production and leakage into the environment, suggest the international community should come together to limit future environmental leakage of anthropogenic litter now, before they transform ecosystems irreparably. Below, I will speak specifically to microplastics followed by plastic pollution in general.

Microplastics

My research mainly focuses on microplastics (plastics 5mm in size or less) and demonstrates that microplastics are ubiquitous in the environment, including in seafood and waters extracted for drinking water. My research has also shown that microplastics are associated with a cocktail of toxins, including 78% of those we currently consider priority pollutants under the Clean Water Act. It also demonstrates that microplastics can be toxic to fish and invertebrates.

Although we often think of microbeads when we think of microplastics, the term microplastic incorporates a large diversity of plastic types, including those that were produced as microplastics (e.g., microbeads, pre-production pellets often referred to as "nurdles") and those that are literally degraded bits of larger plastic products (e.g., tire dust, microfibers and fragments of bottles, bags and film). The former is called primary microplastics and the latter is referred to as secondary microplastics. Secondary microplastics are the most common type of microplastic waste found at sea. Still, we must not forget the primary sources of microplastics as well as the sources that emit secondary microplastics into the oceans (e.g., microfibers). These particles, specifically microfibers, are some of the most common microplastic types found in global ecosystems.

Researchers estimate that there are between 15 and 51 trillion microplastic particles floating around in our oceans (van Sebille et al., 2015), reaching from the poles to the equator. Microplastic particles are found in large concentrations in Arctic sea ice (Obbard et al., 2014) and are also present in sediments (Browne et al., 2011) and wildlife from the deepest parts of the ocean (Woodall et al., 2014). Consequently, this widespread contamination has led to the contamination of hundreds of species of wildlife across all trophic levels (GESAMP, 2016). In our own work, for example, we find microplastics in several species of Great Lakes fish, including white sucker, brown bullhead, lake trout, shiners and minnow – and sometimes at concentrations of more than 100 pieces per fish sampled.

For microplastics, there have been many studies testing the effects on organisms. Although the results are variable, there is irrefutable evidence that microplastics can impact organisms. In laboratory studies, microplastics have been shown to cause a variety of biological effects including: changes in gene expression (e.g. Paul-Pont et al., 2016), inflammation (e.g von Moos, Burkhardt-Holm, & Köhler, 2012), disruption of feeding behaviour (e.g. Cole, Lindeque, Fileman, Halsband, & Galloway, 2015), decreases in growth (e.g. Au, Bruce, Bridges, & Klaine, 2015), decreases in reproductive success (e.g. Au et al., 2015; Sussarellu et al., 2016), changes in larval development (e.g. Nobre et al., 2015), reduced filtration and respiration rates (e.g. Paul-Pont et al., 2016), and decreased survival (e.g. Au et al., 2015; Cui, Kim, & An, 2017). In my own work, we have seen deformities in larval fish (Figure 2) and tumor promotion in the liver of adult fish (Figure 3; Rochman et al., 2013) from exposure to microplastic debris. Although we do not yet understand how they affect human health, we know we are exposed via sea salt, seafood and drinking water – and thus relevant research is necessary.

Although policies that mitigate large plastic debris also reduce microplastic debris, we need to make sure we consider microplastics when we consider all of the policy options for plastic pollution. Policies specific to microplastics may include, but are not limited to, leakage standards for microplastics (e.g., from washing machine effluent, wastewater, stormwater, etc…), filters on washing machines to trap microfibers, bioretention cells (or rain gardens) on stormdrains, increasing industry participation in the voluntary initiative to reduce pellet loss (Operation Clean Sweep) and extend this model to textiles, material innovation, and banning microbeads.

The above mitigation strategies are simple solutions to combat some sources of microplastics. Still, when it comes to plastic pollution, we know the least about sources, fate and effects of microplastics. As such, while we begin implementing policies now related to known sources of microplastics, we must continue to put resources into research that helps us better understand what some other sources of microplastics are and which may be prioritized for policy based on contamination and risk.

By weight, large plastic debris such as fishing nets, make up the largest percentage of plastic floating in our oceans. However, as discussed above, microplastics are ubiquitous and infiltrate every level of the food web. As we develop policies aimed at plastic pollution, we must be mindful that sources of plastic pollution are diverse, and the policies to address them must therefore include unique considerations for microplastics and macroplastics. We cannot make the mistake of assuming that one policy intervention will fix all aspects of the problem.

Macroplastics

When it comes to large plastic debris, there is no doubt that plastic pollution can have an impact on wildlife, and there is compelling evidence suggesting macroplastics are already impacting marine populations, species, and ecosystems. Studies have reported contamination via entanglement or ingestion in hundreds of species of wildlife. This contamination can lead to laceration of the tissues, mortality of an individual organism, declines in population size, and/or changes in the assemblages of species. A recent study published in *Science* found that plastic debris was correlated with disease in coral reefs (Lamb et al., 2018). In a recent systematic review, we found reports of adverse effects in 23 species of marine mammals, 4 species of turtles, 11 species of birds, 4 species of fish, many species of invertebrates, and one species of algae. The weight of evidence for how microplastic debris impacts wildlife suggests that the time to act is now.

Researchers estimate that about eight million metric tons of plastic enters the oceans annually from land (Jambeck et al., 2015). If we continue business as usual, this number is expected to increase by an order of magnitude by 2050.

I hope my words have expressed to you that the issue is large - and urgent. This issue is complex. The sources of plastics into the environment are diverse. The types of plastics we produce, sell and find in nature are diverse. The ecosystems and organisms this pollution contaminates are diverse. As a consequence, the solutions need to be diverse. As you know, there is no one size fits all solution. Instead, we need a toolbox of solutions that include plastic reduction, the building of a circular economy, improved waste management systems, innovation of new materials and technologies for prevention, cleanup, outreach and education. We also need everyone working together, including the plastics industry, waste managers, communities, scientists and all levels of government.

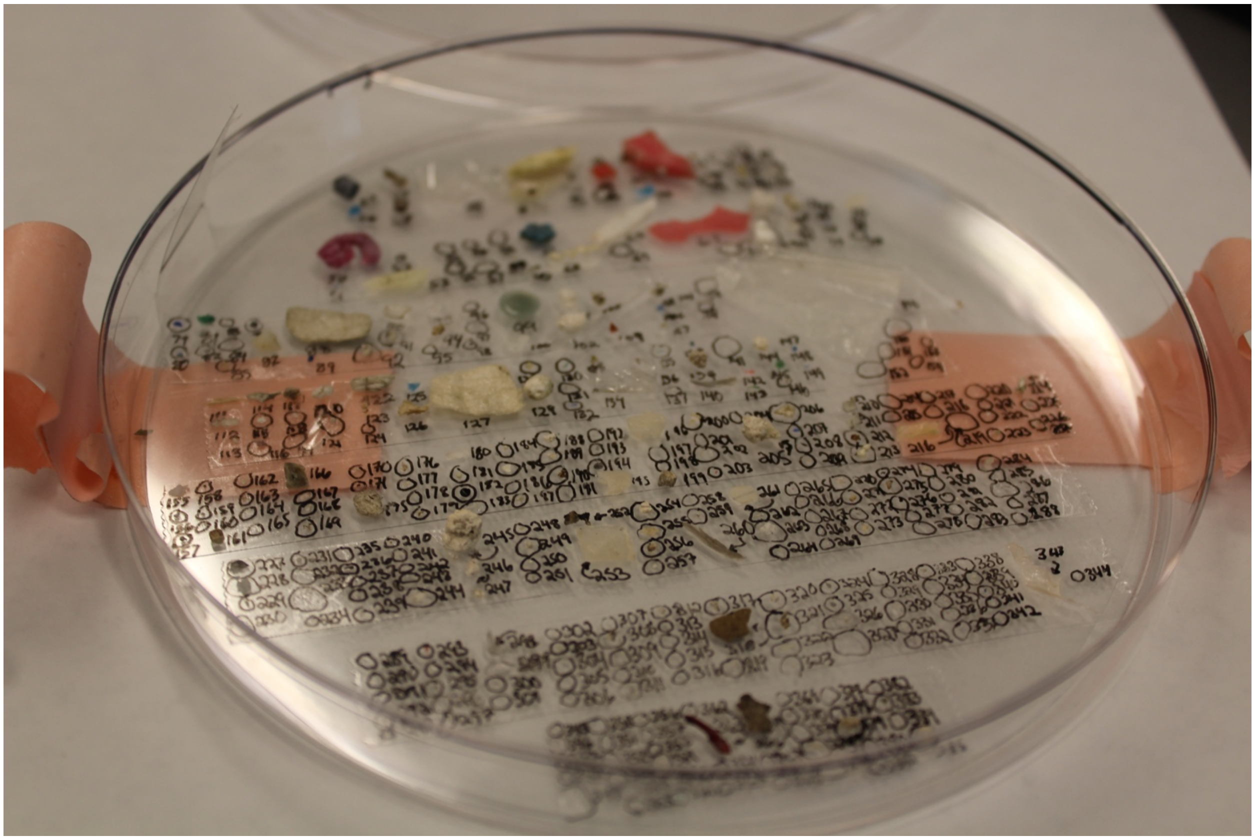
In the U.S., I think we have an opportunity to lead in this space. The U.S. can and should be a large part of the solution, and show other countries that reducing leakage of plastic is possible. I envision diverse policies that work in tandem to reduce our plastic leakage. For example, we may adopt container deposit schemes to improve recycling rates, implement standards that increase the use of recycled content in new products, eliminate the use of some single-use plastic items that are unnecessary and/or replaceable (e.g., microbeads, straws), improve waste collection and recycling infrastructure, and agree to market only plastics that are recyclable and/or reusable in their region. We should also consider providing aid to build new infrastructure for waste collection and recycling in emerging economies abroad and also here at home. I welcome the chance to sit down with any of you and discuss the state of the science and how it might inform policy around this important issue both nationally and internationally.

Thank you for this opportunity to speak with you and I'd be very happy to answer any questions today or in the future.

Many thanks for your time.

Sincerely,

Chelsea M. Rochman
Assistant Professor



Microplastics picked from surface water samples in the San Francisco Bay, California, USA.

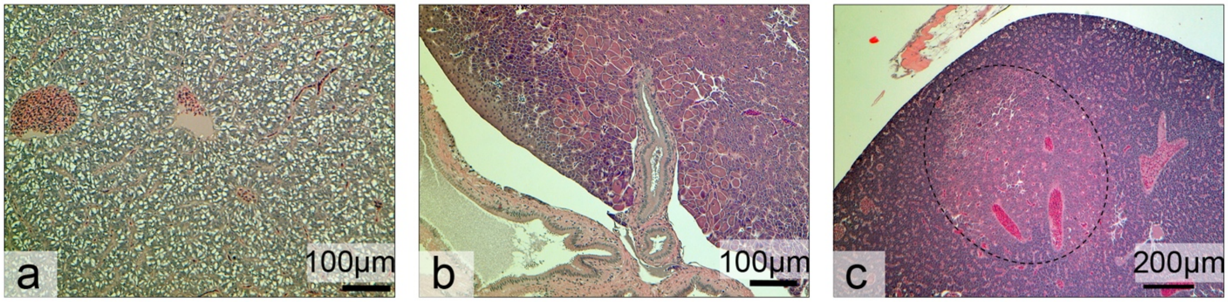


Image of the livers of fish taken under a microscope after exposure to different treatments in a laboratory experiment. The liver on the left is from a fish exposed to a no-plastic control and is healthy, the liver in the middle is from a fish exposed to virgin polyethylene and has an abnormal proliferation of cells, and the liver on the right is from a fish exposed to polyethylene that was soaking in the San Diego Bay, California for a 3-month period. The image of the liver on the right is zoomed out to highlight a tumor comprising 25% of the liver. (Rochman et al., 2013)

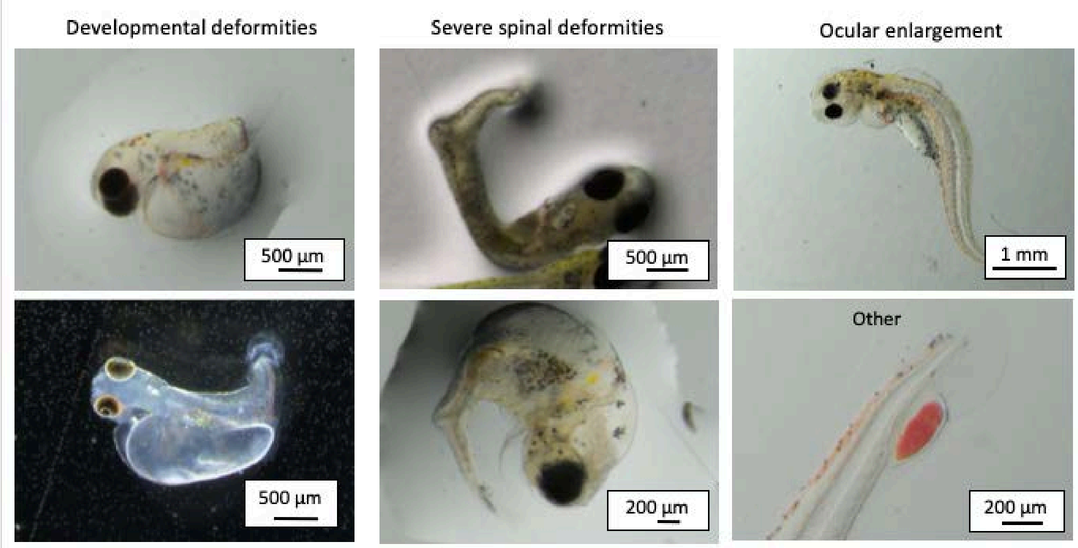


Image of larval fish with deformities taken under a microscope after exposure to microplastic debris collected from the shorelines of Lake Ontario. (Bucci et al., unpublished work)