**Bait and switch: Anchovies eat plastic because it smells like prey**

August 15, 2017 Plastic trash on San Francisco’s Ocean Beach.  **Author:** [**Matthew Savoca**](https://theconversation.com/profiles/matthew-savoca-313547)

As you bite down into a delicious piece of fish, you probably don’t think about what the fish itself ate – but perhaps you should. Over 50 species of fish have been found to consume plastic trash at sea. This is bad news, not only for fish but potentially for humans who rely on fish for sustenance.

Fish don’t usually die as a direct result of feeding on the [enormous quantities of plastic trash](http://www.ready-for-the-resource-revolution.com/en/marine-plastic-debris-and-microplastics-a-new-unep-report-on-plastic-pollution-in-our-oceans/) floating in the oceans. But that doesn’t mean it’s not harmful for them. Some negative effects that scientists have discovered when fish consume plastic include [reduced activity rates and weakened schooling behavior](http://dx.doi.org/10.1021/es5053655), as well as [compromised liver function](http://dx.doi.org/10.1038/srep03263).

Most distressingly for people, toxic compounds such as [PBDEs](https://en.wikipedia.org/wiki/Polybrominated_diphenyl_ethers) that are associated with plastic transfer to and bioaccumulate in [fish tissues](http://dx.doi.org/10.1021/acs.est.5b06280). This finding is troubling because it means these toxic substances could further bioaccumulate in us if we consume fish that have eaten plastic. Numerous species sold for human consumption, including mackerel, striped bass and Pacific oysters [have been found with these toxic plastics in their stomachs](http://dx.doi.org/10.1038/srep14340) too.

It is well-known that our plastic trash poses [a serious threat](http://dx.doi.org/10.1073/pnas.1502108112) to marine animals, but we are still trying to understand why animals eat it. Typically, research has concluded that marine animals visually mistake plastic for food.

Sea turtles can starve to death because they feel full after swallowing plastic bags or other debris.

While this may be true, the full story is likely more complex. For example, in a recent study with colleagues at the University of California, Davis, we showed that [plastic debris may also smell attractive to marine organisms](http://advances.sciencemag.org/content/2/11/e1600395). That study focused on seabirds, but now my co-authors and I have found that plastic trash [has a similar effect on anchovies](http://rspb.royalsocietypublishing.org/content/284/1860/20171000) – a critical part of ocean food chains.

**Sniffing out the role of smell**

Olfaction (smell) is a very important sense for marine animals, including fish. Sharks can smell minute quantities of blood [over long distances](http://www.amnh.org/learn/pd/sharks_rays/rfl_myth/myth_page5.html), which helps them find prey. And scientists believe that salmon’s sense of smell helps them [navigate up rivers](https://www.sciencedaily.com/releases/2013/02/130207131713.htm) to the specific tributaries where they were born to spawn. Fish may use their sense of smell in behavioral contexts including mating, homing, migrating and foraging.

We tested the idea that [plastic debris might smell attractive](http://rspb.royalsocietypublishing.org/content/284/1860/20171000) to the [Northern anchovy](http://wdfw.wa.gov/fishing/forage_fish/northern_anchovy.html) (*Engraulis mordax*), a common schooling fish found off the West Coast of North America. Known as forage fish, anchovies are critically important species ecologically and economically. Unfortunately, they have also been found to [eat plastic in the wild](http://dx.doi.org/10.1038/srep34351).

Working with anchovies is challenging because they require very specific water conditions and school size to behave normally. They need to be in cold, fast-flowing water in schools of at least 100 individuals. When that happens, the anchovies display their contentment by swimming slowly and directly into the flow of water – a behavior known as positive rheotaxis. Luckily, we were able to collaborate with the [Aquarium of the Bay](https://www.aquariumofthebay.org/) in San Francisco, where they have expertise in keeping these fish happy and healthy.

**Our olfactory experiment**

When we started the experiment, we did not know whether adult anchovies used their sense of smell to find food at all, let alone whether smell might lead them to consume plastic. To test our hypothesis that it would, we soaked [krill](http://www.nationalgeographic.com/animals/invertebrates/group/krill/) (tiny shrimp-like crustaceans that anchovies eat) or plastic debris and clean plastic in seawater for several hours, allowing the water to take on the smell of the material steeping in it. We then filtered our krill or plastic “tea,” presented it to the anchovy schools, and observed their behavior.

When fish are searching for food in groups, their behavior changes in predictable ways: They clump together near the interesting stimulus and dart around, altering their body position relative to the water current. To compare how anchovies responded to the scents of krill and plastic, we hung a specially designed apparatus with a GoPro camera attached over their tank to film the school’s behavior from above.

In addition to analyzing what anchovies did when they detected these odors, we also filmed their anchovies’ behavior while feeding on krill and when they were presented with control treatments of unscented seawater. This gave us baseline information about the schools’ behavior, which we could compare to their responses when they were presented with the different odors.

[](https://cdn.theconversation.com/files/182000/area14mp/file-20170814-14751-w61yev.jpg)

Anchovies schooling in a tank before being exposed to the odor of plastic debris.

Using a combination of automated computer analyses and diligent observer scoring, we evaluated how tightly the schools clumped together and how each fish’s body positioning relative to the direction of water flow changed before and after adding an odor solution to the tank. As we predicted, when the anchovies were feeding, schools became more densely clumped and changed their body positioning so that instead of all fish facing directly into the oncoming current, their bodies aligned more haphazardly as they searched for food morsels. In the control treatments, with no food or food odors present, we did not observe these changes.

[](https://cdn.theconversation.com/files/182001/area14mp/file-20170814-5720-1nwtbh3.jpg)

The same anchovies displaying feeding behavior after being exposed to the odor of plastic debris.

When we injected seawater scented with krill into the tank, the anchovies responded as if they were searching for food – which in this case was not there. And, importantly, when we presented them with seawater scented with odors of plastic debris, the schools responded in nearly the same way, clumping together and moving erratically as they would if they were searching for food. This reaction provided the first behavioral evidence that a marine vertebrate may be tricked into consuming plastic because of the way it smells.

**Reducing plastic pollution**

This research confirms several things. First, we showed that Northern anchovies use odors to locate food. This may sound intuitive, but before we did this study there was scant behavioral evidence that adult [forage fish](https://en.wikipedia.org/wiki/Forage_fish), such as anchovies, sardines and herring used smell to find food.

Our main finding was that plastic debris is likely confusing for marine consumers because of both its appearance and its smell. That’s a problem, because if plastic looks and smells interesting to fish, it will be very hard for them to discern that is it not food.

This study also suggests that our consume-and-dispose culture is coming back to haunt us via the fish we eat. The next big question that it raises is whether plastic-derived contaminants can be transferred from plastic-eating fish to fish-eating humans.

One way to mitigate the problem is to figure out why animals confuse plastic for prey so frequently, and our research has helped to do that. However, everyone can do something right now about ocean plastic pollution by avoiding single-use plastic items and recycling plastic upon disposal. There is more work to be done, but we know enough now to make substantial headway on this global environmental issue.