This Is Exactly What Will Happen After the Last Fish in the Ocean Dies

The devastation of the vast majority of the world's marine life is much closer than we think.

by Mike Pearl; illustrated by Cathryn Virginia Sep 20 2019, 3:00am

Picture a beach along the same vast ocean you know today—the same powerful waves and shifting tides, reflecting the same beautiful sunsets, even the same green-blue water. Now imagine a crowd gathered at the shoreline, standing in a big circle, gawking at something that just washed up. Kids tug on their parents' shirt sleeves, asking questions about the dead creature lying on the sand. Reporters arrive. The story is momentous even if the takeaway isn't much fun. Everyone knows there used to be fish in the oceans—kind of like the ones that still live in some rivers and lakes, except they could be much bigger, sometimes meaner, more diverse, more colorful, more everything. But those mythical ocean fish all died. Except maybe this one. This one was alive in there, and now it's dead too.

According to Stanford University paleobiologist Jonathan Payne, an expert in marine mass-extinction events, a scenario where all the ocean's fish, mammals, and other creatures—even tiny animals like krill—are all gone is far from science fiction. The type of die-off that would lead to a largely lifeless ocean has happened before, and we're well on our way to seeing it happen again.

To get into Payne's frame of mind, we have to look at two areas of history. First, there's pre-dinosaur times, where we can find a precedent for the kind of huge-scale extinction we're seeing now. Then, we have to look at the past few

hundred years, to understand why our fishless future kind of looks like, uh, the present.

We know that, about 250 million years ago, some extremely bad stuff happened, because almost everything on Earth that was alive at that time died *very* quickly, taking only a few million years to die off. This event is not to be confused with the meteorite impact that happened 65 million years ago—the one that supposedly wiped out the dinosaurs. That was *nothing*. A lot of those dinosaurs never went truly extinct; they're now known as "birds," and quite a few mammals made it, and evolved into humans, in pretty short order. This earlier event, the Permian–Triassic Extinction, is frequently called "the Great Dying" by paleontologists who like historical events to sound like Morrissey album titles. It made the Earth pretty quiet for a while—the oceans quietest of all.

In 2017, Payne and several colleagues looked into the source of the aforementioned extremely bad stuff that led to the Great Dying. They concluded that temperature-dependent hypoxia—loss of oxygen due to changes in temperature—caused about 70 percent of the losses. An oddly familiar culprit was fingered for this temperature change: "rapid and extreme climate warming." Payne and his pals weren't the first to draw comparisons between the events leading up to the Great Dying and the changes we're seeing today. A previous study had found that the Great Dying had resulted from rising carbon emissions—caused at that time by geothermal events—that occurred over the span of two to 20 millennia; in other words, the blink of a geological eye.

"The relevant thing we know from these recent results is that the patterns of warming, and loss of oxygen from the ocean that can account for the extinction at the end of the Permian are the same features we're starting to see right now," explained Curtis Deutsch, a chemical oceanographer at the University of Washington and one of Jonathan Payne's colleagues on that 2017 study.

This is adapted from an excerpt out of* The Day It Finally Happens*. To buy this book, go here.

Thanks to our species' multi-pronged and comprehensive approach, humanity's present day "Kill All the Marine Life" project is going extremely well. Here's a quick cheat sheet listing our main strategies:

- We dump several metric tons of plastic garbage into the oceans every year.
- Bottom trawling, or dragging fishing equipment across the seafloor, is turning "large portions of the deep continental slope into faunal deserts and highly degraded seascapes" according to a 2014 report on the long-term effects of this widespread practice
- The planet is heating up really fast, and the resulting extinctions are happening in real time. (Although, for the record, at this rate it will take a few more centuries for this effect to reach the lifeforms at the deepest depths of the oceans.)
- Ocean acidification—the other major side effect of CO2 emissions besides global warming—is causing countless die-offs, most famously in corals, the backbone of coral reefs, the most biodiverse ecosystems on earth.
- Fertilizer and pesticides poison the ocean, and when combined with the above factors, they help create "dead zones," nearly oxygen-free patches of ocean where almost nothing can live. According to a 2018 paper published in *Science* magazine, dead zones make up four times as much of the oceans as they did in 1950.
- We eat the sea's living creatures—which is the number-one cause of their declining numbers. There are rates at which we can supposedly fish sustainably—meaning in such a way that we don't run out—but the

> fishing industry operates in volumes that meet, or surpass the peak equilibrium rate. (Right now, we're hauling up 90 percent of fish stocks globally, according to the UN.) In other words, we're killing as many fish as we possibly can as a byproduct of our industries, and then on top of that, we're also *eating* as many as we can.

To be clear, the Great Dying wasn't 100 percent caused by warming either. But whatever the cause, 286 out of 329 marine invertebrate genera we know of died back then. All the trilobites and blastoids died, for instance. Every single one! But no one mourns the trilobites and blastoids, and that actually helps illustrate why we fail to grasp that we're annihilating life in the oceans. There's actually a sociological term for this phenomenon: it's called a *shifting baseline.*

"Shifting baselines" have to do with everyone's gut-level perception of the natural world. The term refers to our tendency to perceive our own early experiences of ecology as the norm, in contrast to what we see later in life. To explain with a non-oceanic example, my own childhood memories of summers in California's Inland Empire include street gutters choked with thousands of California toads. Twenty years later, those toads are mostly gone—likely decimated by chytrid fungus infections. Their loss leaves me with the false impression that the natural order in Southern California has vanished in a very *short* time, when actually, the damage humanity has caused here is of much longer duration and much larger in scale than the loss of one species of toad (a species that arguably wasn't "supposed to be there" in the first place). Much more serious losses of biodiversity have been rolling out for centuries, but I don't miss animals like the Southern California kit fox, which went extinct over a century ago, because my own *baseline* never included them.

Similarly, according to Deutsch, we won't collectively care about the death of all the fish, because when it finally happens, our baselines will have shifted so much that the lack of fish will seem normal.

So back to the first question I asked those scientists: what will the fishless ocean look like?

Aesthetically, it won't be very different, according to Payne. A point I came across again and again in my research is that crystal-clear blue waters are often relatively lifeless. It's rare to look at the ocean and see strong indications of life—even plant life. "It's not carpeted in green, there aren't cells everywhere photosynthesizing," Payne said. "The color you see is mostly just the physics of light absorption and water." So in most places, you wouldn't actually see anything at all by looking at the ocean, just as a flight over the Great Plains doesn't tell you anything about the decline of the American buffalo.

Holistic accounting of the numbers of various species in the oceans have only begun recently, so it's hard to pin down exact numbers, but according to a 2015 report by the World Wildlife Fund, the oceans lost 49 percent of all vertebrates in just the time between 1970 and 2012. So rather, we should try and imagine the perspectives of people who saw the oceans when they were teeming with life, and Deutsch suggests reading accounts from the Age of Exploration. If they could time travel, Deutsch said, the Spanish explorers who first visited the New World would look at our ocean today, and say, *Wow, that's dead.*

"They would describe coming in on their ships through the Gulf of the Caribbean and not even being able to get to shore because the backs of the sea turtles were just so thick they couldn't get their boats in," Deutsch said. Indeed, when Columbus arrived, there were so many turtles, they thunked against the hull of his ship all night, keeping his crew awake. Today, spotting a sea turtle is a momentous event, because the number of sea turtles in the Caribbean is down to about 3 to 7 percent of what it was before Europeans arrived.

I have seen precisely one wild sea turtle in my entire life, and that was because I was searching for one.

I was off the northeast coast of Queensland, Australia, at the time, snorkeling in the Great Barrier Reef in the hopes that it might at least partially correct my own shifting baseline vis-a-vis ocean biodiversity. Even if you've never had the extreme privilege of visiting a coral reef, you've undoubtedly seen one, as magnificently CG-rendered in *Finding Nemo*, or majestically photographed for the BBC's *Blue Planet* TV series, which means you know the broad strokes of what a coral reef is—a place so teeming with life that it's one of the rare places for which the word "teeming" seems appropriate.

But don't picture a technicolored Disney wonderland. Unless you have the right lens filters and the weather is just so, a coral reef just looks like what it is: a section of ocean with, well, a lot of life—like any part of the ocean you've ever seen, except with more brown and yellow (alive) stuff in there. When you look closely, there are the charismatic, photogenic animals down among the corals, and inside the anemones. Your expedition guide will call out when there's something to see, "Does anyone want to see Nemo?" they'll ask, and show off the clownfish, because clownfish are to the reef as the Eiffel Tower is to Paris. But the clownfish down there look pale and brown, and impossibly tiny, nothing like the bright red cartoon characters brought to you by Disney and Pixar. (I'm not implying that the Great Barrier Reef is anything other than breathtakingly beautiful; just that when you see it, it looks more "normal" than you might think.)

Meanwhile closer to the surface, thousands of indifferent, brownish fish dart around in schools that change directions in twitchy unison. In some parts, you can busy your hands at a coral reef by reaching out and gently closing your hand around a fish, feeling it squirm away, and then immediately grabbing another. The sheer density of "biomass" had a mounting emotional effect on me, particularly when my thoughts inevitably drifted to just how much below me had already died. Recently, 30 percent of the coral died in one year, bringing estimates of the total loss to about 50 percent. When I visited in 2018 there hadn't been much coral bleaching recently, and lots of fish were around. The way the future is shaping up, though, finding a lot of life there is likely to become rarer and rarer.

After three hours spent touching what's essentially a closed-off memorial to the living ocean we once had, you inevitably leave, and this gives you an opportunity to test your original perception of the ocean against your fresh memories of a marine wonderland. When you look down at the seafloor off the coast of California, you see the exact opposite of the Great Barrier Reef: bupkis. No visible fish at all. Not *all* patches of coastal ocean can be the Great Barrier Reef, but that doesn't mean they should all look like lifeless deserts. To assume they should be this lifeless isn't natural at all; that's just your already-shifted baseline talking.

If the Great Dying is our model, the process of environmental degradation wouldn't just mean dead marine fish, but massive die-offs in most of the plants and animals eaten by fish, meaning algae and kelp, along with many plankton, krill, worms, and everything else we tend to lump into "the bottom of the food chain." That carnage would, in turn, devastate species that rely on small fish, like most whales, dolphins, seals, penguins, and many humans.

It's a good time to pause and point out that some of fish species, like the coelacanth, a deep sea cave-dwelling monster fish, made it through the Great Dying and survived all the way to the present unchanged—so no, the Great Dying didn't kill *all* the fish on Earth, "great" though it may have been. It was just a very large-scale mass extinction. But as long as we're being pedantic, keep in mind that fish can't all be lumped into any single taxonomic category like

phylum, class, order, or family. From a certain genetic perspective, a shark has more of an obvious connection to its fellow cunning predator the seahorse (look it up) than with a coelacanth, and a coelacanth shares DNA with a salamander that it doesn't share with a shark. So when I say "fish" I'm casting a very wide net (pun intended) that includes *all marine vertebrates with gills that aren't tetrapods—so no salamanders*. That might not mean much to you, but if any jargon-crazed biologists are reading this, they'll be glad I'm making this distinction.

And with the Great Dying as our model, we're imagining the disappearance of about 96 percent of all life in the ocean—not just fish, but just about everything down there with eyes (and a lot of blind species, too). What happens?

Well, in some ways this will be a *vastly* improved business environment for large corporations. Just as the overabundance of marine life in oceans around the New World was bad for business, today's ships also run into problems.

For one example, let's look at retailers that ship globally like Walmart, Amazon, and Alibaba, which increasingly face regulations aimed at preserving marine animal habitats. The container ships—which are the size of a small town—that move merchandise currently have to plot out inconvenient routes to circumvent certain animal habitats, and to avoid some forms of water pollution caused by their 100,000 horsepower diesel engines. And they must carve a path through the seas without making sounds that are too loud, or that fall below 100 hertz because animals like whales use those frequencies to communicate. In the heated, acidified ocean that has killed all fish, baleen whales will have certainly starved to death long ago, obviating the need for any such regulations. The die-off will also allow for the easing of regulations against sewage dumping, and—needless to say—negate most of the public's antipathy toward oil spills.

That's not to say that businesses will make more money and that's that. Environmental remediation, a term that means "cleaning up after businesses that pollute," is currently a growing industry, with some market researchers claiming it'll be worth as much as $123.13 billion by the year 2022—an amount that's almost equal to Google's 2017 revenue. Some of those profits will obviously fall away when there's much less demand for oil spills to be cleaned up. But it's not clear how long the mostly dead oceans could be treated as free and open spaces to dump things.

We can safely predict one very large effect of all that dumping: the marine fishing industry will no longer involve "fishing." It may nonetheless survive with the help of fish aquaculture.

Fish farms appear to be a growing business. Just look at "Bluefin tuna," the marketing term used to describe several giant, silvery fish—all endangered or threatened—that we hoist onto ships, carve up by the thousands every day to extract the $15 morsels of fatty tuna we label on menus with the Japanese word "toro," and serve for the gustatory pleasure of the wealthy inhabitants of coastal cities around the world. Those morsels are about to become even more effective advertisements of wealth when the three or four species of fish they come from go extinct in the wild sometime in the next few decades, and prices skyrocket.

To mitigate this inconvenience, projects exist today to grow Bluefin tuna in tanks, like the ones at Yoni Zohar's marine technology lab at the University of Maryland, Baltimore County. The purpose, currently, is to grow fish larvae, including bluefins, along with smaller species like sea bass, into viable juvenile fish that can be taken out in boats and tossed into overfished bluefin habitats to replenish the depleted population. But this plan will only work as long as the ocean can sustain schools of wild tuna, which it won't be able to for much longer. The death knell has been sounded for even the more plentiful albacore, and the yellowfin species marketed as "ahi," both of which are declining in number as well. That means tanks like Zohar's

have to evolve if these luxury consumer goods are going to continue to exist. Tuna will have to survive in their tanks for multiple decades—long enough to transform from a microscopic and inedible hatchling to a 400 kilogram titan with fatty, palate-pleasing jowl meat. Making the feat even more problematic is that they never stop swimming, which is no big deal when the fish are tiny, but will be harder to accommodate in a tank when they're capable of swimming at speeds exceeding 70 kilometers per hour.

In the case of something like a dolphin, this sort of small-tank captivity is viewed as cruel, but fish taste better than dolphins, and don't squeak happily at children, so, much as has been the case with cows in the U.S., it's doubtful anyone will take an interest in their welfare. We can probably expect vast factory farms full of tuna, along with any other large marine fish humans want to continue to eat in the future since there's no alternative, apart from *not* eating them.

But if we move away from looking at the ocean as a business, it bears mentioning that *not eating any fish whatsoever* is decidedly not an option for a vast swath of humanity. "You'd be looking at a lot of starvation," Payne, the Stanford paleobiologist, told me. According to a 2016 op-ed in *Science* magazine by public health researcher Christopher Golden, 845 million people—about a tenth of the global population—face some form of malnutrition in the near future when traditional fishing ceases to be a viable source of food for many of the world's poor.

We're also in for more big changes to the weather, Payne said. Part of the reason the oceans work as a "carbon sink" is that plankton consume carbon as a part of photosynthesis, turning them into organic matter. A reduction in photosynthesis means more carbon will just stay in the atmosphere and speed up global warming, particularly in the vast dead zone around the equator—a probable cause of the extreme ocean temperatures of the Great Dying; areas that are now usually around 28 degrees Celsius were 40 degrees Celsius or more back then.

Apart from heat, Payne said, "one thing you would see very quickly is the effect of storms on coastal systems would change, because with nothing living on the reefs, the reefs will start to fall apart. That will reduce their ability to protect coastal systems from waves during big storms." This means huge changes in the terrestrial climate near these coastal systems, particularly in places like Australia and the Bahamas.

But even with the combined ocean ecosystem more or less converted into a giant marine desert, there's a very good chance we'll always have a man-made oasis or two. A 2017 proposal by the consortium of tourism businesses and Australia's Reef and Rainforest Research Centre would protect six particularly profitable sites along the reef by literally pumping in cold water at a cost of millions of dollars to lessen the effects of climate change. The idea has been regarded as perverse, with critics noting that pumping cold water into a few areas of the Great Barrier Reef would be nothing but a band-aid, and that large scale action is needed. But large scale action isn't happening, and the mass die-off is proceeding.

Since it appears we lack the willpower to curb our worst impulses when it comes to the oceans, a few band-aids may be all we can hope for.