

By Marah Hardt

# THE OCEAN REVEALED



Photo: Rich Walsh/Scripps Institution of Oceanography

Seen from the shore, the ocean looks the same today as it did centuries ago: a vast shimmering silver-blue mirror of sky. This reflective veneer, however, masks an emptier, more polluted, warmer, and chemically changed sea. The collective weight of humanity presses upon the ocean now as never before, as we pull out too many fish and pour in too much garbage, fertilizer, and other pollutants. Our fishing and mining techniques scrape the bottom of the seafloor, raking up sea fans and crushing corals, destroying productive habitat. And by burning fossil fuels we not only raise the temperature of the water but also make it more acidic.

Why does this matter? Because the ocean supports all creation, in the sea and on land, including us. We are

not as disconnected from this watery world as we may think. Tied to the shore, we also remain bound to the sea—by our need for food, oxygen, a stable climate, and the countless other life-sustaining services the ocean provides. We should understand something of how the ocean works, why we depend upon a healthy ocean, and why, despite all the damage that has been done, we can still be hopeful.

## THE STRUCTURE AND SUPPORT OF OCEANS

We all know that the moon pulls the tides, rhythmically sliding the sea back and forth across the sand. But below the surface, seawater is traveling an epic journey around the globe, driven by the sun and wind, carrying heat and particles across the planet.

It begins in the far north Atlantic, where strong winds cool and cause evaporation of the water. This leaves behind colder, saltier surface waters, which are more dense than the warmer, fresher waters below. The colder waters sink and flow south across the seafloor and into the Indian and Pacific oceans. As they travel, these waters warm, eventually rise upwards and after many centuries, flow back into the Atlantic, completing their lap around the globe. This is the giant ocean conveyor belt. It distributes heat from the tropics to the poles and transports nutrients throughout the ocean. Without it, life on earth would be very different. Southern Europe would not have a mild Mediterranean climate, for instance, which would affect growing seasons and crop production.

Winds also drive ocean circulation patterns. Winds blowing offshore (from land to sea) push warm surface

have dense root and plant structures that hold onto the soil, preventing erosion and absorbing the force of waves from storms. But since 1900, people have destroyed over 50% of worldwide wetlands for coastal development, timber, and fuel, or to make space for aquaculture farms. The 2004 Indian Ocean tsunami and 2005 Hurricane Katrina reveal the hidden costs, borne mostly by the poor, of wetland loss. In India, villages located behind healthy mangrove forests survived the tsunami; villages without mangroves were washed away by the waves. In the U.S., the loss of coastal marshes exacerbated flooding damage done to the entire Gulf coast by Hurricane Katrina.

Besides food and shoreline protection, people also benefit from the untold number of chemical compounds, many with disease-fighting qualities, found in the ocean. Many marine species still unknown

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waters away from the coast, causing deeper waters, full of nutrients, to rise up and fill the space—a process known as upwelling. The nutrients feed surface-dwelling single-celled algae called phytoplankton. Phytoplankton comes from the root *phyton* for plant and *plankton* for wanderer. Like plants on land, the phytoplankton use nutrients, carbon dioxide and sunlight to make sugars through photosynthesis, creating oxygen as a “waste product.” These tiny algae, many too small to see without the aid of a microscope, produce half of all the oxygen made by plants on the planet. Without them, we wouldn’t have air to breathe. The oceanic food chain starts with phytoplankton—which are prey for bigger plankton—and moves up through fish and mammals. If you have ever dined upon fresh, wild, West Coast salmon, you have feasted upon the products of upwelling ecosystems.

Most of the seafood we eat comes from habitats near the coast—such as seaweed forests formed by giant algae called kelp, which can grow to be 60 feet tall—or from tropical coral reefs. These habitats provide sea life with food, shelter, places to breed, and hiding places for baby fish to grow.

These coastal ecosystems also protect our homes. Wetlands such as salt marshes and mangrove forests

to science could hold potential cures to illnesses such as arthritis, bacterial infections, and cancer.

Biological systems—the living parts of the ocean—supply all these services. But it is the chemical and physical structure of the water that allows life to thrive. Climate change alters the chemical and physical properties of the ocean, and threatens these life-support systems on a global scale.

## CLIMATE CHANGE AND THE SEA

Carbon dioxide, released mostly by the burning of fossil fuels, traps heat in the atmosphere, raising the temperature of the air and ocean. This increase in temperatures causes sea level to rise as warmer water expands and as glaciers melt and release more water into the ocean.

A higher sea level means higher tides and bigger storm waves—both of which cause beaches and cliffs to erode faster, washing away habitats where turtles and seabirds build their nests and people build their homes. Over half of the world’s population lives within 50 miles of the coast, and many, especially the poor, will be displaced as seawater floods their farms and taints the fresh groundwater supply. For residents of small island nations, such as Palau, these changes are already

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occurring, and there is no “higher ground” to go to. Warmer temperatures cause sea ice to melt sooner and faster. Marine life, including seals, walrus, polar bears, fish and penguins, depend on sea ice for hunting, birthing, resting, or feeding activities. Less sea ice makes

it more difficult to catch a meal or care for their young.

The ocean also absorbs carbon dioxide from the air—over one third of that produced since industrialization. When carbon dioxide dissolves in seawater, it makes the water more

acidic (by lowering its pH) and reduces the water’s number of carbonate ions. More carbon dioxide in ocean water leads to more carbon dioxide inside the bodies of marine animals, changing their internal pH. These animals must then spend energy balancing such chemical change, diverting energy away from their normal growth and reproduction. Also, fewer carbonate ions in the ocean water make it harder for corals, mollusks, and shelled plankton to build strong, thick shells and skeletons, which are made from carbonate. If we continue to follow current trends in fossil fuel consumption, scientists predict that oceans will be too acidic for corals and some seaweeds by 2050.

## HIDDEN CHANGES IN THE SEA

The trouble is, climate change is not the only stress on ocean life. Long before greenhouse gases ever rose to record highs, fishermen—from the big commercial captains to small island locals—were taking fish from the sea. Scientists like me who conduct research on coral reefs have become accustomed to a new undersea loneliness, emptiness on reefs that were formerly filled with sea life. What happened to all the fish? We ate them. And we continue to do so around the globe.

When we take out more fish than the fish themselves can replace by reproduction, the number of fish declines. Also, our fishing gear can damage the homes and

habitats that produce the fish, or it can catch and kill unwanted species—called “bycatch”—in the process. Longline fishing fleets set hundreds of miles of line and millions of hooks in the water, targeting tuna but also killing unsuspecting leatherback turtles and albatross. Each year tens of thousands of seabirds drown on these hooks. Large fishing boats drag heavy steel plates and enormous nets along the sea bottom. This flattens into rubble the complex rocky hiding spots, coral reefs, and other places where fish like to live. The nets engulf everything in their path—whether wanted or not. Fishermen discard dead, unwanted species overboard. In some places, shrimp fishermen discard as many as ten pounds of sea life for every pound of shrimp they keep. When we buy the shrimp, we commission the waste.

Much of this destruction remains unseen, hidden beneath the mirrored surface of the sea. But we do feel the consequences. Over one billion people rely on fish as their primary or only source of animal protein. The collapse of wild-caught fish and their habitats threatens the health of people across the world, especially in developing countries.

For millennia we have taken from the sea, and given back only our garbage. Rivers carry pesticides and fertilizers from farms into coastal ecosystems, causing increased disease outbreaks, blooms of toxic algae, and dead zones—areas too low in oxygen to support sea life. Ships dump an estimated 6.5 million tons of plastics into the ocean every year. In the northern Pacific, our waste stretches across an area the size of Texas and washes up on remote island atolls. Seabirds, turtles, mammals, and fish are killed by entanglement and choking, or are poisoned by chemicals trapped in the plastic particles. Mercury and other industrial pollutants exhaled through factory chimneys rain down onto the sea, where bacteria absorb the toxins and pass them up the food chain. Animals at the top of the food chain, such as tuna and seals, accumulate the poisons and can become unsafe to eat.

Today, Inuit mothers’ breast milk is so laden with toxins from consuming poisoned marine mammals that it is hazardous to their infants. For communities where marine life is the sole source of protein, damage to marine ecosystems is devastating. When our actions threaten the innocent among us, those actions become morally questionable and require swift change.

## REMAINING OPTIMISTIC

The ocean may be embattled, but it is not defeated. Hope lies in the remarkable capacity of the ocean to restore its abundance and health when given enough space and time. Few extinctions due to human activities have occurred in the ocean, which means the potential for recovery still exists in most circumstances.

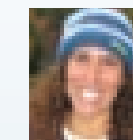
Marine reserves are protected areas that limit fishing, mining, drilling, or collecting for aquariums. These areas allow sea life to recover, with some reserves showing an increased number and size of fish after only five years of protection. Some large reserves (bigger than 40 square miles) protected for over 20 years hold 10 times more fish than nearby sites outside of reserves. Despite the proven success of marine reserves, social and political conflicts have limited them to less than one one-hundredth of one percent (<0.01%) of all United States’ waters. Reserves are one of the most powerful and under-used tools for restoring ocean health. Establishing and enforcing new and larger reserves will go a long way toward promoting the recovery of diminished marine life and habitats.

When we alleviate some of the stress of human activities, sea life stands a much better chance of warding off threats to its survival such as disease or climate change. For example, corals located offshore, away from pollution sources, resist disease better than corals living in polluted waters. So if we can clean up pollution, we may be able to reduce disease. In the South Pacific, coral reefs exposed to abnormally high water temperatures all showed signs of illness. However,

reefs located in remote islands free from overfishing and pollution recover much more quickly than reefs that suffer multiple stresses.

Positive change can come quickly within oceans. Twenty years ago, officials recommended tetanus shots for sailors who fell into Boston harbor. Now, those waters are safe to swim and fun to fish. On the West Coast, efforts to restore Santa Monica Bay since the 1980s have seen fish numbers increase and sickness among surfers and swimmers decrease. We don’t have to stop all of our marine activities, but we do have to manage those activities wisely. Fishing laws, when based on science and properly enforced, have helped sea life rebound, sometimes in short time periods.

Healthy ecosystems withstand and recover from disturbances—whether oil spills or hurricanes—far better than degraded ones. In the face of climate change, creation’s own natural resilience provides the best defense. There are many ways we can effectively restore this resilience: by creating reserves, supporting effective management, cleaning up land-based pollution, and making educated choices about what seafood we buy. All hope is not lost, but we must make these changes now. Caring for creation, and protecting the life-support systems we depend upon, means that we must care for the ocean that supports us all.



Marah Hardt is a research fellow at Blue Ocean Institute where she works to share the message of climate change effects on oceans and potential solutions with people around the globe.

## TO GET INVOLVED AND MAKE A DIFFERENCE:

**1** Make educated choices when purchasing seafood in restaurants or grocery stores. See [www.blueocean.org/Seafood](http://www.blueocean.org/Seafood) for a guide to healthy, sustainable seafood and for information about their text messaging service for on-the-go seafood information.

**2** Tell your local representatives that you support expansion of marine reserves to protect valuable and threatened marine species and habitats. To learn more about marine reserves and take action see [www.piscoweb.org/outreach/pubs/reserves](http://www.piscoweb.org/outreach/pubs/reserves); [www.sanctuaries.noaa.gov](http://www.sanctuaries.noaa.gov).

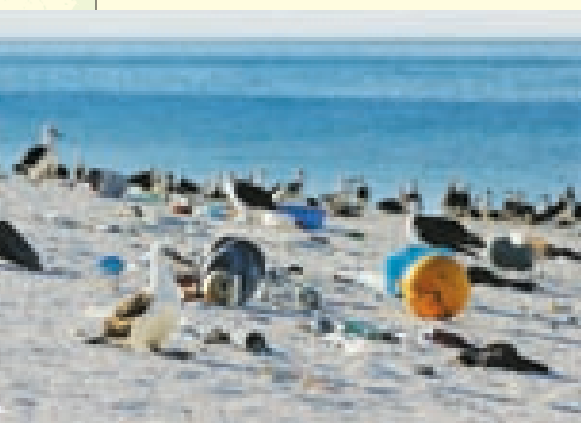
**3** To learn about management of marine areas in your neck of the woods, visit the National Oceanic and Atmospheric Administration website and click on a link to your local fisheries management council: [www.nmfs.noaa.gov/councils.htm](http://www.nmfs.noaa.gov/councils.htm). These sites will provide information about upcoming council meetings and other events in your area.

**4** Help reduce climate change. Take steps to curb your own carbon footprint, and encourage action by your local community, church, and schools. Support urgent action to reduce

greenhouse gas emissions by writing to your representatives in Congress. Several bills are currently in Congress regarding ocean legislation and climate change—you can make a difference by voicing support for the measures that need to be taken now to protect the seas and the people who depend on them.

### SOME RESOURCES:

[www.christiansandclimate.org/act](http://www.christiansandclimate.org/act)  
[www.oceanconservancy.org/site/PageServer?pagename=ta\\_actionalerts](http://www.oceanconservancy.org/site/PageServer?pagename=ta_actionalerts)



The negative effects of human waste products are washing up on distant island atolls

Photo: Carl Safina