PLANET IN CRISIS

“This meticulously researched book underscores what I have been teaching for decades. Albert Bates illustrates the imperative need to act now before it’s too late.”

Captain Paul Watson, founder, Sea Shepherd Conservation Society

DARK SIDE OF THE OCEAN

The Destruction of Our Seas, Why It Matters, and What We Can Do About It

ALBERT BATES

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More than 80 percent of ocean pollution comes from land-based activities. As chemicals from agriculture and other human activities wash from land, they increase the ocean salinity. The saltier a body of water is, the less likely it is to absorb carbon dioxide from the atmosphere, and the more likely it is to give it off. This absorptive capacity is a crucial recovery element at the end of ice ages, when salinity peaks due to ice impoundment of fresh water from rain or snow, causing more CO_2 to off-gas to the atmosphere and to positively force the greenhouse effect, rewarming the world. It is not, however, an effect we want to be encouraging when we are trying to reduce global warming.

From coral bleaching to sea-level rise, entire marine ecosystems are rapidly changing. We can see many of these changes in newspaper headlines and scientific reports:

- Many pesticides, fertilizers, and animal pharmaceuticals end up in rivers, coastal waters, and the ocean, resulting in oxygen depletion and toxins that kill or maim marine plants and shellfish.
- Factories and industrial plants discharge sewage and other runoff into the oceans. This, too, results in oxygen depletion and toxins that kill marine plants and shellfish. In the US, sewage treatment plants discharge twice as much oil each year as tanker spills or drilling disasters.

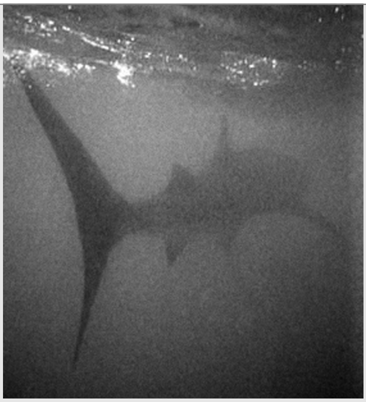
- Oil spills like Deepwater Horizon and nuclear spills like Fukushima pollute the oceans, although air pollution is responsible for almost one-third of the toxic contaminants entering the water.
- Microplastics—dumped by cruise ships, spilled from container ships, or making their way via land or river from factories and garbage dumps—will soon outweigh all the fish in the sea.
- Countless plants and animals, including invasive species such as poisonous algae and cholera, have crossed the border between land and harbor waters and disrupted the ecological balance, due to transoceanic commerce and other human activities.
- Many kinds of seafood are either fished to capacity or overharvested. As the climate rapidly changes and microplastics take their toll, the ability of fish to replenish their populations is dropping dramatically, leading to fishery exhaustion, fish extinctions, and wider famines, seen and unseen.

The ocean is not merely our birth home; it sustains us now. It is possible to live within its limits and the limits of the good Earth. The sooner we can learn how to do that, and get on with it, the better off we will be.

There are sometimes conditions at sea—calm seas, sunlight, sediments—that favor the growth of the algal soup so much that the population of algae explodes to millions per liter of water. It grows so dense that it is dangerous to fish, clogging their gills and mouths. Red algaes produce a “red tide”—and hundreds of tons of floating fish carcasses. As the bloom exhausts its food and dies, the algal cells sink to the bottom, smothering anything living on the seabed.

These overactive algae also tend to concentrate bacteria up the food chain as they are consumed by shellfish, crabs, and baby turtles. Mussels can easily eat over 50 million cells per hour, storing and concentrating the bacteria. Outbreaks of permanent paralysis and other diseases in coastal cities sometimes follow red tides and have been traced to this shellfish toxin. The human communities most vulnerable to these biological hazards are those without sustained monitoring programs and dedicated early warning systems for harmful algal blooms.

As a dilute soup, the algae are life-givers, but as a red tide, they are deadly. A combination of warming oceans, sewage, soils from rivers, and dying fish is providing the conditions to make such tides more frequent. Even as algal blooms increase, the larger forms of ocean life that Xen sees now are getting weaker, and as they weaken, the web of life—not just in the ocean, but also on land—breaks. None of us can survive unless we can repair the web of life.



Whale sharks, currently on the Red List of Threatened Species, first appeared in the geological record, along with manta rays, at the Eocene-Oligocene boundary about 34 million years ago. That was when one of the largest extinctions of marine invertebrates and mammals in Europe and Asia, likely triggered by volcanism, dropped Earth's temperature some 59°F (15°C) over a few hundred thousand years, isolating a warm water niche near the equator at a time when the continents were much closer together. Whale sharks are 100 times older than our current evolutionary form as large-brained, upright humans.

Whale sharks, called "dominoes" in the Caribbean because of their white spots, can live up to 130 years and grow 60 feet (18 m) long. They are well adapted to warming oceans and only rarely found in waters below 70°F (21°C). Their annual migration routes in both the Eastern and Western hemispheres track plankton blooms in warm waters.

Without these plankton feeders, and those that feed on them, more plankton would decompose close to the surface, on their way to the depths, or in shallow sediments, returning their carbon to the atmosphere as carbon dioxide or methane, which are climate-changing greenhouse gases. There would also be a substantial loss of the nutrient flows that fertilize plankton blooms, significantly reducing their extent.

With their vegan diet, whale sharks are giant carbon sequestrators, peacefully migrating north and south to browse on green floating meadows.

What will warming polar oceans be like? One change is being seen in the top frozen layer of the seafloor at high latitudes. Over the past 15,000 years, plankton, fish, and penguins dying and falling to the polar seafloor have been in waters so cold that even cold-tolerant microbes could not easily digest them. The methane, carbon dioxide, and other greenhouse gases released by their slow decomposition froze and remained in the shallow sediments. Called "clathrates," these "cages" of frozen molecules, and other organic deposits trapped by land movements over eons and ice ages, contain vast stores of greenhouse gases that, if warmed suddenly, could rise to the surface and be released into the atmosphere. Current estimates are that permafrost zones, both on land and in the sea, contain almost twice the carbon in the atmosphere.

Widespread permafrost thaw—from 24 to 69 percent—is projected for this century. That equates to tens to hundreds of billions of tons of CO_2 and methane. As permafrost melts in the Arctic circle and

WHAT COLOR IS THE OCEAN?

When full-spectrum sunlight, which we see as white light, hits an object, the object absorbs some of the rays and reflects others. A banana reflects yellow light. A grape reflects green or purple. Any object that absorbs all light waves appears black.

What color is the ocean? Large bodies of water absorb longer (red) wavelengths and shorter (violet) wavelengths of sunlight and reflect the blue we see. Water molecules bouncing off ocean waves scatter the blue light all around, which makes the water appear bluer. Dust fertilizing the water to create algal blooms makes the surface reflect green. Soil and sand entering from land combine to make water reflect brown. Shells on diatoms and floating ice reflect white.

A so-called "blue ocean event" refers to an ice-free Arctic when the ice melts in summer, leaving just the open ocean. Objects that are silver or white, like ice, bounce light, while dark objects, like the blue-green ocean, absorb it. When polar ice melts, it transforms the surface of the oceans from a mirror to a dark sponge. While a mirror would bounce away sunlight and leave its surface cool, a dark sponge absorbs it and warms. In this same way, when a warming ocean and atmosphere melt ice from the surface of the Arctic, Greenland, mountain glaciers, or Antarctica, they cause millions of square miles of the Earth's surface to switch from heat reflecting to heat absorbing. This speeds up the melting process, which increases the heat, which speeds the melting. Scientists call this "positive reinforcing feedback."

beyond, in Canada, Alaska, Siberia, and Lapland, it is already releasing vast stores of carbon to the atmosphere. That warms the air, which warms the land, which melts more permafrost, and so forth, in a positive reinforcing feedback loop.

The North Pole and the South Pole are both covered with ice, but they are quite different kinds of ice. In the South Pole, the ice is formed by snow falling on mountains over the landmass of Antarctica. At the North Pole, the ice is formed when water freezes on the Arctic Sea, and snow adds to its thickness. When ice melts in a glass of water, it does not cause the water in the glass to rise because the volume of the floating ice was already determining the level of the water. When ice melts at the North Pole, it is the same—sea level does not change. Ice melting at Greenland or the South Pole is different. Since that is water stored on land, when the meltwater reaches the ocean, the ocean rises.

THE DOOMSDAY GLACIER

The 74,000-square-mile Thwaites Glacier, flowing into Pine Island Bay in the Amundsen Sea of Antarctica, is sometimes referred to as the "Doomsday Glacier." It rests on dry land and is held back from the ocean by a rocky ridge 2,300 feet (700 m) tall, but now the ice is retreating from that ridge, and already 600 billion tons of ice have melted. Each year the thawing of Thwaites contributes about 4 percent of global sea-level rise. It no longer risks sliding into the sea, but it contains a mass of water roughly the size of Florida or Great Britain, and, entirely melted, Thwaites would raise global sea level by about 25 inches (65 cm).

As climate change has accelerated, so has the melting of Thwaites. At the beginning of 2020, researchers from the International Twaites Glacier Collaboration (ITGC) took measurements to develop scenarios for the future of the glacier and to predict the time frame for a possible collapse. The erosion of the glacier by warmed ocean water seems to be stronger than expected, carving a cavity in the underside of the glacier two-thirds the size of Manhattan. In January 2020, the researchers measured the temperature of the water flowing through the cavity at more than two degrees above freezing.

The loss of Thwaites ice to the ocean is no longer a question of "if," but "when?"

Ice floating on the surface of the ocean changes something else when it melts. It reduces Earth's ability to reflect sunlight. Silvery-white surfaces like ice reflect light to space, especially the low-angle light at the poles. Dark surfaces like the blue-green ocean absorb light and store it as heat.

CHAPTER 12

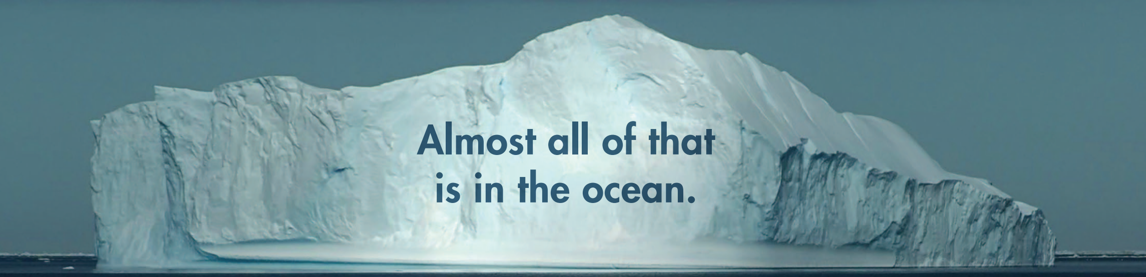
Marine Heat Waves

A marine heat wave is defined as when daily sea surface temperatures are warmer than 99 percent of previous observations for the same time of the year over the baseline period from 1982 to 2016. At the end of 2019 and the start of 2020, the waters off Western Australia met that threshold, with temperatures 2°C (3.6°F) warmer than ever before observed for the Christmas to New Year period. As hot as that water was, the temperatures were not as high as the 2011 heat wave, which occurred later in summer. An intense marine heat wave off the east coast of Tasmania persisted for 251 days—from spring 2015 to autumn 2016.

It should be no surprise, even for a continent with 400 years of recorded wildfires, that Australia's catastrophic 2019–2020 fire season corresponded with a massive offshore heat wave that fueled drought and then-unparalleled bushfire ferocity on land. At least one billion wild animals are estimated to have died (not including frogs and insects), and some may be facing extinction.

What was unseen—hidden in the dark and silent depths—was the marine death toll. In 2013, a large patch of hot water in the north-east Pacific Ocean that scientists dubbed "the Blob" began forming.

Three-quarters of the Earth's surface is covered by water.



Almost all of that is in the ocean.

In captivating detail, Albert Bates explains the ongoing destruction that infiltrates every aspect of ocean life—and its long-reaching impact on humanity. *The Dark Side of the Ocean* conveys a deep appreciation for the fragile nature of the ocean's majesty and compels us to act now to preserve it. Learn what you can do to make a difference.

"If the Ocean dies, we all die! The ecological insanity of humanity is undermining diversity and interdependence as we steal the carrying capacity from every other species in the sea. The choice is simple, we correct our behavior or we die."

CAPTAIN PAUL WATSON, founder, Sea Shepherd Conservation Society

"We are killing the oceans everywhere: from vanishing ice caps, polar bears, seals, whales, walruses, coral reefs, mangroves, kelp beds, and fisheries to ancient deep-sea reefs pulverized by trawlers and remote atolls uninhabitable due to nuclear bomb radiation. This enlightening book plunges in beneath the surface to show how humanity's long-term survival depends on healthy seas, and how we can help get there by regenerating marine ecosystems to naturally reverse climate change and halting the tsunami of lethal plastic garbage fouling the waters."

THOMAS J. F. GOREAU, PhD, President, Global Coral Reef Alliance

The Planet In Crisis series addresses the urgent challenges of climate change by focusing on specific issues, identifying their impact, and illustrating creative solutions that can make a difference.

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