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FACT SHEET

CLIMATE CRISIS IN THE HEART OF OUR PLANET

Our oceans have been serving as the earth's best defense against climate change since the Industrial Revolution. By absorbing 93 percent of the heat trapped by greenhouse gasses and about one-quarter of the carbon dioxide that we produce when we burn fossil fuels, the oceans have slowed the rate of climate change, saving us from what would otherwise have been catastrophic warming.[1,2] However, this protection has come at a substantial cost to the vitality of our seas and the humans who rely on them.

PHYSICAL CHANGES BENEATH THE WAVES: WORRISOME VITAL SIGNS FOR AN AILING PLANET

Climate change is physically changing the oceans, altering not only their temperature but also their chemical makeup. These changes are alarming—and they come with devastating consequences.

Warming waters:

Since the Industrial Revolution, the average global temperature of our oceans' surface has increased by 0.6 degrees Celsius (1 degree Fahrenheit), and the warming is accelerating.[3] But, as on land, some areas of the ocean are warming much more quickly than others. For instance, the Gulf of Maine has warmed seven times faster than the average over the past 15 years and is projected to increase in temperature by 3.7 °C at the surface and 3.9 °C at the bottom over the next 80 years.[4],[5] Other ocean hot spots include the Bering Sea, the North Sea, the Sea of Japan, the waters adjacent to Western Australia and the Galápagos Islands, and more.[6]

Acidifying seas:

Carbon dioxide from fossil fuels is dissolving in the oceans and changing their chemistry. Since the Industrial Revolution, the average global pH of the oceans' surface has decreased by 0.1 pH units, an increase in acidity of 30 percent.[7] Researchers predict that if we continue to pollute as we are now, average acidity of ocean surface waters will double by 2100.[8]

Declining oxygen:

As ocean water warms, it loses oxygen, which marine life needs to survive. In the past 50 years, available oxygen has dropped by 2 percent, and oxygen minimum zones—where oxygen saturation is lowest (water with <70 μmol kg^{-}oxygen)—have expanded by an area about the size of the European Union.[9] Global models suggest an additional drop of 3.2 to 3.7 percent (relative to 2000 levels) by 2100 for high-emissions scenarios.[10]

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Rising seas:

While projections vary under different emissions scenarios and in different regions, there is no denying that sea levels are rising and will continue to rise for centuries to come. Projections from the Intergovernmental Panel on Climate Change, the National Oceanic and Atmospheric Administration, and the National Climate Assessment predict a rise of 0.17 to 1.3 meters in global mean sea level by the end of the century. And that range may be conservative, especially if ice loss in the Arctic and Antarctic continues at its rapid rate or speeds up.

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CONSEQUENCES FOR OCEAN ECOSYSTEMS AND COASTAL COMMUNITIES

While these physical and chemical changes are often studied—and reported—in isolation, they are happening at the same time, creating a constellation of novel conditions that are hazardous to many marine organisms and the communities that depend on them.

Particularly vulnerable in the United States are the approximately 100 million people (39 percent of our population) who live in coastal counties.[11] In these communities, the ocean plays a central role in shaping recreational opportunities, economic strength, and cultural heritage. However, in recent decades climate change has transformed the sea and disrupted these benefits.

1. Fish Migration

Because fish are cold blooded, they are very sensitive to temperature changes. In response to warming ocean waters, fish are moving toward the poles and/or into deeper waters. In fact, 70 percent of the fish stocks monitored along the east coast of the United States have shifted their range northward in the past 50 years.[12] For example, black sea bass, once abundant off the coast of North Carolina, now concentrate near New Jersey and can even be found in New England.[13] The American lobster fishery has disappeared from Long Island Sound, and landings in Rhode Island have declined steeply from eight million in 1999 to two million in 2017.[14],[15] The Chesapeake Bay's iconic blue crab has arrived in the Gulf of Maine, and Chinook salmon are wandering into Arctic rivers.[16,17]

These ecological upheavals are reverberating through coastal communities. Because fish agencies allocated shares of the total catch quota based on where fish have historically been located and caught, southern states still hold the highest allocations. As a result, southern fishermen are traveling northward to catch their quotas. And fishermen from mid-Atlantic and New England states, for their part, are suddenly surrounded by water full of fish that they are not allowed to catch. The resulting conflicts could lead to overfishing and the reversal of successful efforts to rebuild U.S. fisheries over the past 20 years.

2. Declines in Fishery Productivity

Scientists predict that a warming ocean will mean a decline in fish productivity. As ocean water warms, water density changes, and fewer nutrients are mixed into surface waters. A decline in nutrients leads to a decrease in phytoplankton, which is the base of oceanic food webs. The combined effects of reduced food availability and the physiologic stress of warming will negatively affect many fish species. Examining the net effects of warming waters on 235 populations of fish around the world, scientists estimate that overall global fishery production has already declined by 4 percent over the past 80 years, with decreases in many U.S.-adjacent regions.[18] Scientists predict that if we continue on our current course, there will be further declines in food production from the sea—particularly in shallow tropical waters, which, under high emissions scenarios, could lose up to 50 percent of their fish.[19]

3. Marine Heat Waves

From 2014 to 2015, due to a confluence of oceanographic factors, an unusually warm water mass referred to by scientists as "the Blob" expanded from the Gulf of Alaska to Baja Mexico, resulting in record-breaking water temperatures (between 1 °C and 4 °C above normal) along nearly the entire west coast of North America. The extended marine heat wave devastated the ecosystems of the northeast Pacific Ocean. A large decline in plankton availability triggered a cascade of chaos further up the food chain.[20] Over the two-year event, forage fish populations and their predators plummeted, ultimately leading to closures of important commercial and recreational fisheries. Thousands of dead seabirds washed up on beaches, and hundreds of marine mammals starved on their annual migration to their northern feeding grounds.

Scientists estimate that the frequency of marine heat waves has increased by 34 percent since 1925.[21] Model projections suggest that they will increase by a factor of 20–27 by mid-century and 46–55 by the end of the century under a high-emissions scenario.[22]

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4. Harmful Algal Blooms

Periodically a combination of factors involving waters currents, nutrient levels, ocean pH, and water temperature can trigger a harmful algal bloom (HAB), where nuisance algae rapidly accumulate with toxic or harmful effects. Nearly every year since 2015, HABs with high concentrations of the neurotoxin domoic acid have forced closures of the west coast's profitable Dungeness crab fishery, costing the industry $48 million during the 2015–2016 season alone.[23] Because HABs are associated with warming waters, the Pacific Coast Federation of Fishermen's Associations has taken a stand and sued 30 fossil fuel companies for damages caused by these blooms.[24,25]

5. Corrosive Waters

As mentioned earlier, ocean acidification occurs as excess CO_2 from the burning of fossil fuels dissolves into the sea, forming an acid and making the water more corrosive. This process, happening across the globe, is especially dangerous in the Pacific Northwest, where the waters are naturally more acidic to begin with. In the summer of 2007, the Whiskey Creek Shellfish Hatchery in Oregon noticed a dramatic increase in mortality in their crop of baby oysters. As this hatchery provides oyster seed to dozens of shellfish producers in the region, the Pacific Northwest aquaculture industry—which pumps more than $270 million into coastal and rural economies—was in a state of crisis. Scientists linked the unexpected mortalities to corrosive water made worse by ocean acidification.[26] Through investments in research and development, Whiskey Creek and other aquaculture facilities in Oregon and Washington have found ways to protect their business from ocean acidification, for now.

6. Rising Seas

Sea level rise will cause a degree of global displacement and migration with few, if any, precedents in human history. Some areas (e.g., low-lying islands and atolls) will be rendered completely uninhabitable. Even under the most optimistic scenarios, by 2060 some 316 million to 411 million people globally will be vulnerable to storm surge and coastal flooding.[27] In the United States 4.2 million to 13.1 million Americans could be displaced by the end of this century.[28] According to the Global Commission on Adaptation, "protecting against or accommodating sea-level rise in low-lying areas may no longer be possible—and coastal residents may need to systematically retreat."[29]

In addition to forcing people to leave their homes, rising sea levels threaten to contaminate drinking water aquifers and water used for agriculture. Major upgrades to or replacement of existing infrastructure will be required.

7. Extreme Weather Events

Unusually heavy rains in the Midwest this past spring not only resulted in widespread damage to agriculture crops in the region, but also sent a small tidal wave of freshwater down the Mississippi River and into the Gulf of Mexico. This rapid influx of freshwater into the Gulf's estuaries damaged oyster, crab, and shrimp populations, which need a certain level of salinity to survive. Commercial fisheries were impacted so substantially that the governors of Mississippi and Louisiana requested disaster assistance.[30] Extreme weather events including above-average rainfall are expected to increase with unabated climate change.

URGENT NEED FOR OCEAN CLIMATE ACTION

Historically our oceans have been overlooked in climate action and policy. This is a mistake that we cannot afford to sustain. There are four priority actions we need to take to ensure the health of our ocean and the safety and wellbeing of our coastal residents:

- Increase efforts to reduce greenhouse gas emissions and address the climate crisis, developing specific targets to reduce CO_2 to be certain to combat ocean acidification.
- Enhance climate resilience of ocean ecosystems by establishing highly protected Marine Protected Areas over 30 percent of our oceans.
- Prioritize protection of coastal habitats such as mangroves, seagrass beds, and salt marshes that act as carbon sinks, both to maximize the carbon mitigation potential of the oceans and to provide storm protection to vulnerable coastal communities.
- Shift populations and economic development away from areas vulnerable to sea level rise, and provide equitable and timely assistance for those who need to relocate to higher ground.

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