# OUR CHANGING OCEANS
## ALL ABOUT OCEAN ACIDIFICATION

*If all the world were paper,*
*And all the sea were ink,*
*If all the trees were bread and cheese,*
*How should we do for drink?*
*— Anon*

Centuries have passed since the notion of the sea becoming ink appeared in a child's rhyme. Yet, in the 21st century the seas are changing — their acidity is increasing.

Since the start of the industrial revolution in the 18th century, carbon emissions have been taken up by the oceans, increasing their acidity by 30% — part of the unfolding global change resulting from human activity.

The oceans play an essential role in reducing the amount of carbon in the atmosphere. They take up 25% of man-made carbon dioxide ($CO_2$), every day. When $CO_2$ is absorbed, it dissolves in ocean water to form carbonic acid. Unless carbon emissions are reduced, acidity in the oceans is expected to continue to increase by 150% by the end of the 21st century as ever more $CO_2$ is absorbed.

There are already signs that rising ocean acidity is affecting fisheries and marine organisms. "The world's coasts and oceans, which make up around 70% of the earth's surface, face serious man-made threats from pollution, unsustainable extraction of resources and climate change. Nuclear and isotopic techniques help us to understand the pressures on the marine environment and to find more effective responses," said Yukiya Amano, the IAEA's Director General, in introducing the 2013 Scientific Forum that focuses on preserving marine environments.

The IAEA Environment Laboratories based in Monaco host the Ocean Acidification International Coordination Centre (OA-ICC). Its research is contributing to greater understanding of the phenomenon.

Radioactive isotopes, such as calcium-45, are used by IAEA scientists as radioactive tracers to examine the growth rates in calcifiers, such as corals, mussels, limpets and other molluscs, whose skeletons are composed of calcium. Tracers are used extensively at the IAEA to determine how ocean acidification is affecting the eggs and juveniles of vertebrate fish species, such as finfish, and among cephalopods, such as squid, octopus and cuttlefish.

As ocean water acidity increases, the consequences for marine life may be severe. Scenarios for ocean acidification include far-reaching impacts on shellfish harvests, such as oysters, mussels and abalone. Coral reefs, a diverse interlinked habitat and nursery for many marine species, are expected to deteriorate, setting in motion a series of negative consequences resulting from reduced biodiversity and shrinking sanctuaries for fish. Changes to marine food webs will have effects, among others, on marine fish health and harvests. Globally, as of 2012, fish provide 3 billion people with 20% of their animal protein intake. Artisanal fishing communities, seafood-related employment, commerce and trade, tourism and those whose subsistence is linked to seafood availability are all confronted with falling revenues, fewer jobs and less seafood.

The consequences of ocean acidification are global in scale. More research into ocean acidification and its consequences is needed. It is already known, for example, that there are regional differences in the vulnerability of fisheries to acidification. The combination of other factors, such as global warming, the destruction of habitats, overfishing and pollution, need to be taken into account when developing strategies to increase the marine environment's resilience. Among steps that can be taken to reduce the impact is better protection of marine coastal ecosystems, such as mangrove swamps and seagrass meadows, which will help protect fisheries. This recommendation was one of the conclusions of a three-day workshop attended by economists and scientists and organized by the IAEA and the Centre Scientifique de Monaco in November 2012. In their recommendations the workshop also stressed that the impact of increasing ocean acidity must be taken into account in the management of fisheries, particularly where seafood is a main dietary source.

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