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Introduction to the Ocean Acidification Boundary

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The oceans mirror many of the environmental problems described in the planetary boundaries framework and reported widely in the media, such as overfishing and deep-sea mining (biosphere integrity), plastic islands or microplastics (novel entities), shipping (atmospheric aerosol loading), or dead zones lacking oxygen (biogeochemical flows). Less present in the media is the problem of ocean acidification addressed by the planetary boundary. Like the atmosphere, the oceans are sinks for CO_2 produced by the burning of fossil fuels.

CO_2 absorption changes the chemistry of the oceans, lowering their pH. The resulting acidification also leads to fewer of the calcium carbonate shells produced by numerous creatures sinking carbon to the ocean floor before they dissolve back into the water. The boundary's control variable relates to this by describing the 'carbonate ion concentration in surface seawater' and, more specifically, the 'average global surface ocean saturation state with respect to aragonite' (Richardson et al. 2023). Aragonite is one of the most abundant forms of calcium carbonate. The boundary is at more than 80 per cent of the pre-industrial aragonite concentration, defined as 3.44. In 2023, the level was 81 per cent, meaning the ocean boundary was, at that time, still one of the few that had not been crossed. Thus, Pelejero et al. (2010: 332) describe ocean acidification as the '"evil twin" of global warming' – it is a moot question, though, as to which is of the two is more evil. This also means that reducing greenhouse gas emissions will reduce the pressure on ocean acidification.

Acidification of the oceans and declining concentrations of calcium carbonate are becoming a problem for marine life. Many creatures depend on the presence of these calcium compounds in the water to build their shells or skeletons. Lower pH not only erodes the existing structures of these creatures, but they also find less calcium to rebuild them. These include plankton, corals, crustaceans, and molluscs, which are vital to marine biodiversity, marine food chains, and, ultimately, human food security (Rockström et al. 2009). So, the control variable of the ocean boundary is the global average saturation state of calcium carbonate in surface

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water. The framework sets the preindustrial Holocene base value at 3.44 and the boundary value at 2.75. Since 2009, the actual values have fluctuated between 2.8 and 2.9 (Richardson et al. 2023). In 2025, the ocean acidification boundary was first recognized as having been crossed (Findlay et al. 2025).

Both chapters on ocean acidification take the problem structure of the ocean acidification boundary as the starting point of their ethical reflections. Konrad Ott describes it as post-normal, that is, a situation when problem-solving has to cope with uncertain facts, disputed values, high-stakes, and urgent decisions (Funtowicz & Ravetz 1993). Ott explores the issue of ocean acidification from an environmental ethics perspective. He discusses different ways of justifying why ocean acidification is an ethical problem and what follows from this. In doing so, he aims to show how well the most common environmental ethical approaches can address the issue. They mostly differ in their scope of the moral community, that is, to whom we have direct moral obligations: to humans only, or also to individual animals, species, or ecosystems? Depending on the answer one gives, the reasons for protecting oceans will change. Ultimately, Ott intends to specify the normative building blocks of deep anthropocentrism as his preferred approach to the issue.

Rachel Haug Fossbakk, too, addresses the issue of decision-making relating to uncertainty and risk perception. She argues that the human response to ocean acidification is inadequate. This is despite the fact that there is already enough knowledge to act. Her hypothesis is that action requires an adequate perception of risk, which many people do not have when it comes to ocean acidification. She concludes by asking who has a responsibility to act, and on what ethical basis. Rachel Haug Fossbakk then advocates an ecocentric perspective by which she understands a situation 'where humans are part of nature and need to live sustainably as part of it on the same term as other species'.

References

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