

Human impacts on the marine ecosystems of Antarctica

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This is an aggregation of seastars, *Odontaster validus*, at McMurdo Sound, Antarctica, 32 m depth. Also visible are giant ribbon worms, *Parborlasia corrugatus*. The unique seafloor communities of Antarctica are threatened by human disturbance. Credit: Photo by R. B. Aronson

A team of scientists in the United Kingdom and the United States has warned that the native fauna and unique ecology of the Southern Ocean, the vast body of water that surrounds the Antarctic continent, is under threat from human activity. Their study is published this week in the peer-reviewed journal *Annals of the New York Academy of Sciences*.

"Although Antarctica is still the most pristine environment on Earth, its [marine ecosystems](#) are being degraded through the introduction of alien species, pollution, [overfishing](#), and a mix of other human activities," said

team member Dr Sven Thatje of the University of Southampton's School of Ocean and Earth Science (SOES) based at the UK's National Oceanography Centre.

[Biodiversity](#) can be conceptualised in terms of its information content: the greater the diversity of species and interactions between them, the more 'information' the ecosystem has. "By damaging the ecological fabric of Antarctica, we are effectively dumbing it down – decreasing its information content – and endangering its uniqueness and resilience," said lead author Professor Richard Aronson, a paleoecologist at the Florida Institute of Technology, USA.

The team's conclusions are based on an extensive review of the impacts of a wide range of human activities on the ecosystems of Antarctica. The Antarctic Treaty system, which includes environmental and fisheries management, provides an effective framework for the management and protection of the continent, but some of the threats are not currently being fully addressed.

Some of these impacts, such as pollution, can be relatively localised. However, global climate change caused by human emissions of carbon dioxide and other greenhouse gases has the potential to affect the entire Antarctic region for decades to come.

The researchers point out that rising sea temperatures are already affecting marine creatures adapted to living within a particular temperature range.

A second major consequence of carbon dioxide emission from human activities – ocean acidification – is also likely to take its toll. "The [Southern Ocean](#) is the canary in the coal mine with respect to ocean acidification. This vulnerability is caused by a combination of ocean mixing patterns and low temperature enhancing the solubility of carbon

dioxide," noted co-author Dr. James McClintock of the University of Alabama at Birmingham, USA.

"Simultaneous action at local, regional and global scales is needed if we are to halt the damage being done to the marine [ecosystems](#) of the Southern Ocean," urged Dr Aronson.

The researchers have identified a range of historical and ongoing human activities that have damaged or restructured food webs in the Southern Ocean over recent decades. At the local to regional scale, these include –

- The hunting of top predators such as whales and seals.
- Overexploitation of some fish species, leading to stock collapses.
- Air and water pollution from shipping traffic, wrecks, and the transport of invasive alien species on hulls and in ballast tanks.
- Tourism, including potential disturbance to breeding bird and seal colonies, as well as being responsible for chemical and noise pollution, and littering.
- Chemical and sewage pollution from research stations and ships, the legacy of historical waste dumping, and pollution from scientific experiments, including lost or unrecovered equipment.

Antarctica has great, untapped natural resources. The Antarctic Treaty currently prohibits the extraction of oil and other mineral resources from Antarctica. The researchers note, however, that many major areas of the Southern Ocean fall outside the Antarctic Treaty region and could be claimed by nations as valuable 'real estate' for the future.

Although the Antarctic Treaty and other conventions have measures aimed at reducing the local- and regional-scale impacts of human activity on Antarctica and the Southern Ocean, they cannot address global-scale threats. Among these threats, the researchers highlight the following –

- Depletion of atmospheric ozone (O₃). The 'ozone hole' was discovered by BAS scientists in 1985 and is caused by the accumulation of atmospheric chlorofluorocarbons (CFCs) used as refrigerants and spray propellants.
- Introduced species. The researchers are concerned that the warming conditions in Antarctica could facilitate colonisation of species previously unreported from the region, with consequences for the structure of its marine food webs. [Alien species](#) accidentally introduced by humans are also a major concern.
- The vulnerability of cold-adapted species to observed rising sea temperatures caused by global warming. The researchers argue that the extinction of some species is likely, and that changes in the geographical distribution of others are to be expected. They warn that the further spread and establishment of predatory king crabs on the continental slope of the western Antarctic Peninsula could wreak havoc among its unique seafloor animal communities. The possible invasion by bottom-feeding fishes, rays and sharks with crushing jaws could be equally damaging. They also expect increasing dominance of salps over Antarctic krill, with consequences for animals such as whales, penguins and seals that depend either directly or indirectly on krill.
- Ocean acidification. The researchers note that organisms living

in polar regions are uniquely vulnerable to the effects of ocean acidification because of low concentrations of dissolved calcium carbonate in the water column. They cite evidence that declining seawater pH will particularly affect organisms with calcified shells and skeletal elements, such as molluscs, seastars, sea urchins, coralline algae and cold-water corals. They also highlight evidence suggesting that ocean acidification could profoundly alter the structure and functioning of the planktonic food web, with unknown consequences for animals further up the food chain, including commercially exploited fish. They therefore advocate continued and expanded baseline monitoring of ocean chemistry as well as further field and laboratory studies of the impacts of acidification on physiology, growth, and calcification.

"It is clear that multiple causal factors are damaging the health of marine systems in Antarctica; we need to understand the relative importance of these factors and how they interact." concluded Dr Thatje.

More information: Aronson, R. B., Thatje, S., McClintock, J. B. & Hughes, K. A. Anthropogenic impacts on marine ecosystems in Antarctica. *Annals of the New York Academy of Sciences* (published online, 30 March 2011). [DOI: 10.1111/j.1749-6632.2010.05926.x](https://doi.org/10.1111/j.1749-6632.2010.05926.x)

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