RECTO

Refugia and ecosystem tolerance in the Southern Ocean

POLICY RECOMMENDATIONS

Parts of Antarctica are currently exposed to intense environmental changes with noticeable modifications of ecosystems and their organisms. In the RECTO project, we already observed shifts in the microbiomes of *Trematomus* fish in the last century. At the ecosystem level, we found that benthic communities on the sea floor can change from autotrophic to heterotrophic communities under glacial melt down. When sea ice is not breaking up local food webs become simplified. Given the high vulnerability of Antarctic organisms and ecosystems to higher temperatures, the first policy recommendation should therefore be to reduce further temperature increase as soon as possible.

Furthermore, RECTO found an overall large incongruence in patterns of biodiversity, trophic status, food webs and ecosystems between Antarctic regions, also at low spatial scales. Ecological modelling illustrated that species with narrow ecological niches, and which are endemic to coastal regions are at the highest risk of extinction owing to global warming. We further obtained evidence for several benthic organisms that their populations show strong genetic differentiation between different Antarctic regions, indicating local adaptations and genetic isolation. The reconstruction of responses to past climate changes revealed retractions to diverse refugia often causing population bottlenecks with loss of genetic variability and adaptability. All of these features make the Antarctic marine fauna especially vulnerable to global change. There is thus a high need to preserve this diversity in the near future, by designing more Marine Protected Areas (MPAs) and improving their representativity to accommodate the great variety of Antarctic diversity, food webs and ecosystems, including also local endemicity, local adaptations and ecoregions. Given the possible range shifts of Antarctic organisms under temperature changes, it would further be recommended to design more dynamic MPAs. Ecological modelling of echinoderms revealed that most drastic changes of biodiversity through global warming can be expected along the Antarctic Peninsula, East Antarctica and the sub-Antarctic islands. The Peninsula and the sub-Antarctic islands are also increasingly exposed to other anthropogenic disturbances including tourism and exposure to microplastics and pollution. These areas should be protected by MPAs as soon as possible.
This will unfortunately not suffice, as oceanic modelling of RECTO identified a high vulnerability of the Antarctic Peninsula to invasive species through ballast water exchange. We found that MPAs at the Western coast of the Peninsula could be protected if ships would exchange ballast water at least 200 nautic miles from the coast. However, because of strong currents, the eastern coast of the Peninsula cannot be protected from invasive species through ballast water exchange at all and we would therefore recommend restricting any ballast water exchange in this Antarctic region.

RECTO also found that alien species like the Patagonian crab can expand to the Western Antarctic Peninsula (WAP) by 2100 under ‘strong mitigation’ and ‘no mitigation’ greenhouse gas emission scenarios. Human activities can further facilitate the translocation of alien species and should be restricted as much as possible, especially if future temperature conditions would allow the survival of non-Antarctic taxa.

Finally, we found that it has taken many millions of years for Antarctic taxa to evolve and diversify. It can therefore not be expected that populations or species can recover quickly from extinction when exposed to fast global change.