

Antarctic Ecosystems: Adaptations, Thresholds and Resilience (AntETR)

INTRODUCTION

Antarctica is changing, and parts of it are changing very rapidly. Pressures on the Antarctic environment result mainly from global climate change, invasive species, human impacts, and extreme events. These stresses may be convergent, and their interactions can lead to threshold changes in communities, populations and individual organisms that may lead to widespread challenges to and changes in organism and ecosystem function. AntETR will examine the current biological *processes* in Antarctic ecosystems, to define their tolerance limits and thereby determine resistance and resilience to change.

Large-scale ecosystem processes depend on a cascade of organismal responses from the genomic through cellular to physiological. Recent studies have shown that evolutionary adaptation to the polar environment may constrain an organism's ability to respond to environmental change. The extreme environment and marked difference in community complexity between the Polar Regions and much of the rest of the planet may mean that consequences of stress for ecosystem function and services, and their resistance and resilience, will differ from elsewhere. Polar ecosystem processes are therefore key to informing wider ecological debate about the nature of stability and change in ecosystems.

Goals: Our goal is to define and facilitate the science required to determine the resistance, resilience and vulnerability to change of Antarctic biological systems. In particular, the science needs to determine the likelihood of cataclysmic shifts or "tipping points" in Antarctic ecosystems: How close to the cliff are we?

Key questions:

- What are the genetic underpinnings to the life history, phenotypic plasticity and physiological adaptations of polar organisms that determine their resilience and resistance to ongoing and future change?
- How do species traits impact on community interactions and stability and in turn influence nutrient cycles, energy transfer and productivity? Will invasive species have catastrophic impacts on these community interactions, and thus on ecosystem processes?
- What are the likely consequences of a changing environment for ecosystem functioning and ecosystem services provided by the Antarctic biosphere, how do changing biogeochemical cycles interact with and influence biological systems in Antarctica?

Tools and implementation

AntETR will recommend tools to understand organismal physiology, systems biology and the drivers of productivity in the context of stress. Addressing these questions will encourage new capacity in the Antarctic community and combine bottom-up and top-down application of advanced approaches *in situ*, in the laboratory (e.g. '-omics' approaches) and *in silico* (e.g. process modelling and advanced database mining) to provide an integrative view of the vulnerability of the Antarctic biota. We will exploit the full range of Antarctic ecosystems from continental to sub-Antarctic, and in a manner that facilitates a bipolar approach.

This program will facilitate engagement of Antarctic biologists across disciplines, nations and capacities, and will include interactions with CCAMLR and the SCAR Birds and Mammals Expert Group. We will contribute directly to the SC-ATS, allowing clear scientific information to be provided to CEP and the Antarctic Treaty system as a whole. The programme will integrate information from current projects and encourage new projects to identify stresses and their impacts on key biological processes. It will identify organism and ecosystem thresholds (vulnerability), their resilience to stress, and the implications of crossing biological thresholds. We will prioritise establishing links with physical scientists and modellers to inform predictions, and our focus on *process* will complement that of the proposed STATE programme, which addresses the origins and evolution of current large scale biological *patterns*.

Critical to the identification of tipping points will be the maintenance of long-term environmental data sets such as SOOS, with a key priority being the establishment of parallel observing systems in non-marine environments. The integration of functional process information will be an essential new layer contributing to existing databases such as ANTABIF, essential repositories of data as well as tools for analysis.

Deliverables

Workshops spaced appropriately through the term of the programme will bring the various disciplines together with the aim of producing high-impact synthesis papers and maintaining a continued representation in the mainstream scientific literature, and fostering meaningful interdisciplinary interaction and capacity building. We will also produce a summary of the nature of Antarctic ecosystem vulnerabilities which will be provided to IPCC and SC-ATS as a final outcome of the programme. Note that this will be a predictive document outlining vulnerabilities based on an understanding of ecosystem processes, and will thus, again, be complementary to the intended outcomes of STATE. As a predictive programme focussing on ecosystem processes, AntETR will be in an ideal position to feed into annual updates of the SCAR Antarctic Climate Change and the Environment report.

AntETR will encourage outreach activities via local communities, and will maintain a central website that includes resources suitable for teachers and school students of all ages. We will also issue press releases, and use web-based resources such as blogs, associated with the workshops or key findings to ensure that the critical issues of the vulnerability of Antarctic ecosystems remain high in the public domain and perception, and of political importance.

This programme will build capacity within the Antarctic community by increasing accessibility of data describing Antarctic ecosystem processes and encouraging collaboration to increase the use of new tools. We will also foster the development of the next generation of Antarctic scientists by ensuring the presence of APECS members on both the PPG and the steering committee of AntETR.

Proposed PPG structure

The PPG will consist of 6-8 members, including at least one former member of the EBA steering committee, and representatives from both APECS and the Birds and Marine Mammals Expert Group. We will ensure that the makeup of the PPG provides representative scientific and regional expertise in a range of topics, including terrestrial, marine and freshwater ecosystems, both continental- and sub-Antarctic, and all levels of biological organisation.

Definitions of Acronyms

AntETR – Antarctic Ecosystem Thresholds and Resilience

ANTABIF – Antarctic Biodiversity Facility

APECS – Association of Polar Early Career Scientists

ATCM – Antarctic Treaty Consultative Meeting

CCAMLR – Convention on the Conservation of Antarctic Marine Living Resources

CEP – Committee for Environmental Protection

EBA – Evolution and Biodiversity in Antarctica (current SCAR scientific research programme)

IPCC – Intergovernmental Panel on Climate Change

PPG – Programme planning group

SCAR – Scientific Committee for Antarctic Research

SC-ATS – Standing Committee on the Antarctic Treaty System (the SCAR body that advises the CEP and ATCM)

SOOS – Southern Ocean Observing System

STATE – State of the Antarctic Environment