New Zealand Antarctic and Southern Ocean Science Directions and Priorities 2010–2020

Purpose of Document

This document proposes a framework for New Zealand Antarctic and Southern Ocean Science. It is anticipated that the document, if adopted, would provide a coherent strategy to guide New Zealand Government agencies in investing in research in Antarctica and the Southern Ocean over the next ten years.

Historical Perspective

New Zealand has been directly involved in and has made a significant contribution to scientific research in Antarctica and the Southern Ocean for more than 50 years.

In 1957, Scott Base was established as New Zealand's permanent scientific research station. New Zealand's initial science focus in Antarctica centred on geophysics, geology and later on, the tectonics of the region.

Subsequently the range of Antarctic research carried out by New Zealand has broadened considerably to include terrestrial biology, coastal ecosystems and marine research. Recently, marine research programmes have focused on biodiversity and fisheries research on the Ross Sea shelf and northwards into the outer reaches of the Ross Sea.

New Zealand's contribution to the International Polar Year 2007–2009 included a number of well-connected terrestrial and marine-based programmes as well as the highly successful international collaboration under the ANDRILL project.

Scientific research has advanced New Zealand's national interests through high quality collaborative programmes, both on the continent and in the Southern Ocean. The bulk of New Zealand's Antarctic research effort is supported by Government agencies which provide both science funding and logistics support. Some research priorities are determined by agencies with specific management or policy responsibilities, while others are driven by issues that emerge from the academic science community.

An important issue for science is the scope for a level of more fundamental, "blue sky" research. There is the possibility for blue sky" research inNew Zealand Antarctic science, principally supported by the Marsden fund.

The proposed framework should be reviewed no later than December 2015.

Science Priorities under the Antarctic Treaty System

New Zealand is a founding signatory of the Antarctic Treaty, its Protocol on Environmental Protection and the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR).

Freedom of scientific investigation in Antarctica and the promotion of international scientific cooperation are important tenets of the Antarctic Treaty. Under the Protocol, Antarctica is designated a "natural reserve devoted to Peace and Science".

Three broad areas of priority for science are indicated in the Protocol and in the CCAMLR Convention:

- "scientific monitoring and research on processes of global as well as regional importance" (Protocol);
- "the protection of the Antarctic environment and dependent and associated ecosystems" (Protocol);
- "research into and comprehensive studies of Antarctic marine living resources and of the Antarctic marine ecosystem" (CCAMLR).

Factors that Influence New Zealand's Science Priorities Include:

- Resources for funding Antarctic science are finite and are distributed across Government departments, Crown Reasearch Institutes and Universisites.
- It is difficult and expensive to access and work in Antarctica. New Zealand should only support research in Antarctica that cannnot be carried out elsewhere.
- New Zealand maintains a year round operational presence at Scott Base, which offers opportunities for year round research.
- New Zealand's longstanding cooperation with the United States in Antarctica has been very successful and is highly valued.
- New Zealand should also work with other Antarctic Treaty Parties on issues and topics of common interest. Particular opportunities exist to further cooperation with Australia, Canada, Italy, Russia and Korea.
- As a member of CCAMLR and participant in the Ross Sea toothfish fishery managed under CCAMLR New Zealand has a responsibility to contribute to science which supports the management of the fishery in accordance with CCAMLR's conservation principles.
- The CCAMLR area is relatively close to New Zealand's EEZ.
- Awareness of environmental values and biodiversity in Antarctica is increasing.
- Access to and utilisation of resources in Antarctica is increasing. This includes tourism, fisheries and prospecting (living and non-living resources). As these activities increase, so do the potential threats to the Antarctic environment.
- In spite of increasing access, Antarctica is still a relatively untouched environment and provides a unique opportunity for non-invasive scientific research in a natural laboratory setting. The opportunity to observe, monitor and investigate scientific hypotheses under the extremes of environmental forcing at high latitudes is unique and has global application.
- The importance of the polar-regions to the earth's climate systems has resulted in global climate change rapdily becoming an integrating theme for the scientific activities of Antarctic Treaty Parties,.

UNIFYING THEME

Antarctica plays an integral role in many global processes. Therefore Global Change is proposed as the unifying theme for New Zealand Antarctic and Southern Ocean Science for the next ten years.

Antarctica provides a baseline from which change can be measured and understood, not only regionally (i.e. in Antarctica) but globally. This includes, but is not limited to, climate change, ocean acidification and changes in environmental systems (e.g., flora and fauna distribution and abundance).

The unifying theme is intended to stimulate multidisciplinary and interdisciplinary research that will progress our understanding of the effects of global change, and facilitate appropriate policy responses.

HIGH LEVEL RESEARCH DOMAINS

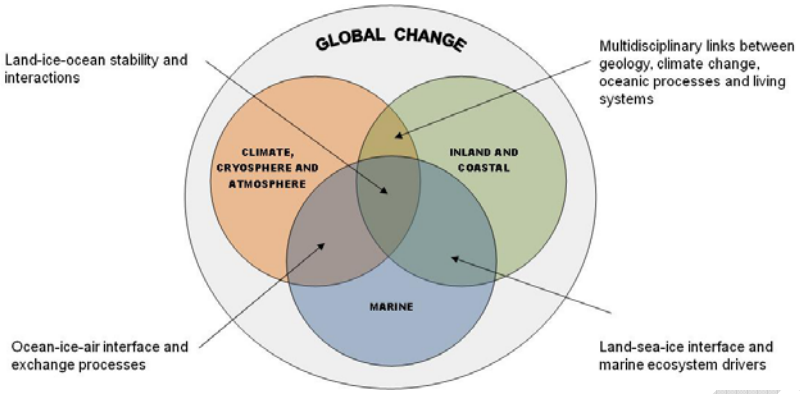
The key research domains in which scientific progress is sought over the next 10 years are:

1. **CLIMATE, CRYOSPHERE, ATMOSPHERE: Improved understanding of the significance and implications of the role of Antarctica in global change, and implications of global change for Antarctica.**
2. **INLAND & COASTAL ECOSYSTEMS: Improved understanding of inland and coastal ecosystems of the Ross Sea Region leading to enhanced knowledge, conservation and protection priorities in Antarctica.**
3. **OPEN MARINE SYSTEMS: Improved conservation and resource management of the Antarctic marine environment.**

These three research domains overlap and will require close collaboration amongst research disciplines to maximise New Zealand's science outcomes.

Government-supported science programmes will be aligned with these research domains in support of research and policy priorities of relevant Government agencies. To make this work Government agencies will need to be aware of current research activities and core skill sets based in New Zealand. Researchers will need to be aware of the outcomes that the agencies are seeking.

The three domains are strongly linked (see diagram). There are a number of benefits that arise from science interactions between the different research domains. There are some examples provided in the diagram below.


GLOBAL CHANGE
Land-ice-ocean stability and interactions
Multidisciplinary links between geology, climate change, oceanic processes and living systems
CLIMATE, CRYOSPHERE AND ATMOSPHERE
INLAND AND COASTAL
MARINE
Ocean-ice-air interface and exchange processes
Land-sea-ice interface and marine ecosystem drivers

DOMAIN 1. CLIMATE, CRYOSPHERE, ATMOSPHERE: Improved understanding of the significance and implications of the role of Antarctica in global change, and implications of global change for Antarctica.

The research aligned with Domain 1 will be of specific interest to a number of Government agencies and the wider public.

Research goals for Domain 1 include:

- improved understanding of Antarctic and Southern Ocean responses to past climate conditions and enhanced modelling of the Antarctic and Southern Ocean impact on, and response to, climate change and variability.
- improved understanding of the role of the cryosphere [1] in the Ross Sea region.
- improved understanding of the Antarctic atmosphere's response to global change and its effect on New Zealand.
- quantifying Antarctica and the Southern Ocean's role in global biogeochemical cycles.

New Zealand contribution

New Zealand is a world leader in sediment coring research in the McMurdo Sound area. We have worked closely with a number of international partners in this specific area of research through joint projects such as the Cape Roberts Project and ANDRILL. The New Zealand programme has also achieved significant international recognition through a strong history of research into many aspects of the cryosphere.

Atmospheric measurements, including sampling the boundary layer green house gases and monitoring the ozone hole, are a key component to understanding global processes, particularly as high latitudes are an ideal location for upper atmospheric research. These and other long-term monitoring projects contribute directly to global networks and will continue to be a core part of New Zealand's research effort in Antarctica.

It is important that New Zealand's Antarctic research linked with Domain 1:

- aligns with two of SCAR's five main Scientific Research Programmes "Antarctica and the Global Climate System" and "Antarctic Climate Evolution". Such alignment will help to facilitate the development of research connections with international research teams.
- meets obligations to provide data to international networks.
- provides innovative leading edge approaches to Antarctic global change research.

We will know we are delivering on this Domain when, for example:

- IPCC global climate predictions are using information from NZ-supported Antarctic research as inputs into global climate models.
- refined IPCC climate predictions, which are being used as input into the Government's climate change policy, include the impact of Antarctica.
- we have an improved understanding of past and present processes that take place in Antarctica and the Southern Ocean to determine the southern influences on New Zealand's land, ocean and climate and hence better identify Antarctica and the Southern Oceans impact on, and response to, climate change.

[1] Cryosphere is the term which collectively describes the portions of the Earth's surface where water is in solid form, including sea ice, lake ice, river ice, snow cover, glaciers, ice caps and ice sheets, and frozen ground (which includes permafrost).

- we have an improved understanding of the Antarctic atmosphere's response to global change, the future status of ozone loss in the Antarctic and Antarctica's role in the global carbon cycle.

DOMAIN 2. INLAND & COASTAL ECOSYSTEMS: Improved understanding of inland and coastal ecosystems of the Ross Sea Region leading to enhanced knowledge, conservation and protection priorities in Antarctica.

Research goals for Domain 2 include:

- an improved understanding of inland and coastal Antarctic ecosystems, their biodiversity and roles in bio-geochemical processes and their functioning, as well as their potential responses to environmental change and anthropogenic threats in the Ross Sea Region.
- a greater understanding of how closely-coupled Antarctic inland and coastal ecosystems interact.
- an increased understanding of how the Antarctic environment (inland and coastal) may respond to climate change.

New Zealand contribution

New Zealand has been active in research that could contribute to this Outcome, for example, the Latitudinal Gradient Project (LGP). Over the past seven years there have been a number of important research events in the LGP. The USA has also been very active in researching the ecosystems of the Dry Valleys through the Long Term Ecological Research Program (LTER) with New Zealand participation. Along with these large projects there have been a number of more spatially focused studies addressing research questions on different species and environments in the region by New Zealand researchers.

Building from research questions arising from these large and small scale projects will strengthen international collaboration, and continue research that can only be addressed through interdisciplinary research.

It is important that New Zealand's Antarctic research linked with Domain 2:

- aligns with one of SCAR's five main Scientific Research Programmes[2], specifically "Evolution and Biodiversity in the Antarctic". Such alignment will help facilitate the development of international research connections.
- facilitates ongoing improvement of policy development and management of human impacts in Antarctica.

We will know we are delivering on this Domain when, for example:

- continued recognition that New Zealand is a leader in the environmental management of the Ross Sea region.
- we have a better understanding of the responses of Antarctic flora and fauna to global change, as well as to anthropengic threats such as the introduction of non-native species, tourism and other human activities.
- New Zealand continues to meet its international obligations under the Protocol on Environmental Protection and contributes to the Committee for Environmental Protection's priority areas of interest.
- New Zealand has leveraged off the knowledge of the ecosystems in the Ross Sea Region to develop world-leading environmental standards for its activities.
- New Zealand's representatives at international Antarctic fora are well-equipped and informed and their input to discussions on Antarctic ecosystems is sought.

[2] http://www.scar.org/researchgroups/#SRP

- international researchers seek to collaborate with their New Zealand counterparts on biodiversity and ecosystem functioning research.

DOMAIN 3. OPEN MARINE SYSTEMS: Improved conservation and resource management of the Antarctic marine environment.

Research goals for Domain 3 include:

- assessment of population status for a range of key species in the Ross Sea ecosystem
- improved understanding of the open marine ecosystems in the Ross Sea Region.
- improved understanding of the oceanography and hydrography of the Ross Sea.
- improved understanding of the dynamics of species of ecological and economic significance.
- understanding of how the marine environment and marine food webs may respond to climate change
- successful management of the Ross sea toothfish fisheries in accordance with CCAMLR's Conservation Principles and adopted Conservations Measures.

New Zealand contribution

Given the high costs of logistic requirements for undertaking many types of marine research, there is a need to create larger collaborative programmes of research rather than have a collection of smaller projects. The International Polar Year Census of Antarctic Marine Life (IPY-CAML) and other collaborative marine projects have provided opportunities to expand New Zealand's Antarctic marine science programme. Defining the Ross Sea ecosystem (taxa, distribution and function, connectivity, fisheries intereactions and climate change) is a key theme that aligns with New Zealand's international obligations under CCAMLR.. Biodiversity research focused on marine protection is well-aligned with New Zealand's objective of establishing a network of marine protected areas in the Ross Sea region..

It is important that New Zealand's Antarctic research linked with Domain 3:

- aligns with New Zealand's Ross Sea Strategy[3].
- aligns with one of SCAR's five main Scientific Research Programmes "Evolution and Biodiversity in the Antarctic". Alignment with this research programme will help facilitate the development of international connections related to this work.
- supports New Zealand's role in managing Antarctic marine living resources through CCAMLR.
- provides strong scientific support for the selection, development and monitoring of marine protected areas as a fisheries and tourism management tool.
- aligns with the NZ Biodiversity strategy.

We will know we are delivering on this Domain when, for example:

- there is improved environmental management of the Ross Sea Region.
- representative areas in the Ross Sea are adequately defined, described and managed through CCAMLR.

[3] The Ross Sea Strategy was approved by the Government in 2006. It states that New Zealand should seek balance between a well managed sustainable harvesting in accordance with the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) Convention's conservation principles and marine protection to safeguard the long-term ecological viability of marine systems and protects Antarctic marine biological diversity and areas potentially vulnerable to human impacts

- a representative network of marine protected areas has been established that, in particular, safeguards the long-term ecological viability of marine ecosystems and protects Antarctic marine biological diversity and areas potentially vulnerable to human impacts.
- there is well managed sustainable harvesting in accordance with the CCAMLR's Conservation Principles and adopted Conservation Measures.

IMPORTANT CHARACTERISTICS OF FUTURE SCIENCE PROGRAMMES

Research programmes developed to deliver the outcomes outlined in this document should have the following characteristics.

- **Science quality**

Excellent science quality will continue to be a key goal for New Zealand's Antarctic and Southern Ocean science programme. Preference will be given to researchers who maintain demonstrably high science quality.

- **Training of new researchers**

The development of young scientists in New Zealand is a key issue for many science areas, including Antarctic research. We note the critical role of universities in ensuring a flow of quality graduates into science careers. Developing new scientists aligns with MoRST's Advanced Skills Action Plan.

- **Science publications and outreach**

The aim will be to build programmes that produce outputs that directly support New Zealand's three research Domains for Antarctic science.

Publications

Timely publication of results will be required.

Wider science outreach

Researchers will be required to develop innovative ways to communicate science to a wider audience of New Zealanders. Web-based science outreach is becoming more widely used and this is encouraged, particularly through established websites.

- **Application of science outcomes**

This will be assisted by good collaboration between Government agencies and scientists.

Contribution to Government policy

Science outputs that help Government agencies achieve their goals will be actively encouraged. This will require greater collaborative efforts from both scientists and Government agencies.

- **National and international connections**

Strong national and international connections will be encouraged to:

  - assemble stronger teams
  - help programmes reach greater critical mass
  - assist dissemination of findings to a wider audience
  - help up-skill researchers and expose scientists to different approaches
  - share the costs of science and logistics
  - assist with building international links and relations.

- **Multi-disciplinary approaches**

Multi-disciplinary approaches to Antarctic science will be encouraged as these continue to show strong results (e.g., the Latitudinal Gradient Project).

- **Collaboration**

Collaboration will be encouraged to allow individuals and small teams to participate and contribute effectively and efficiently. Opportunities for international collaboration, particularly with the United States Antarctic Program, will be given priority.

Environmental Impact

The environmental costs of a project should not outweigh the likely benefits of the scientific research and its outcomes, which are becoming increasingly well prescribed. It should be noted all proposed activities are subject to the Environmental Impact Assessment (EIA) process under the Antarctica (Environmental Protection) Act 1994, and furthermore any activities that require the collection of Antarctic marine living resources are also subject to the AMLR permitting process under the Antarctic Marine Living Resources (AMLR) Act 1981. It is the responsibility of all New Zealand funded researchers in Antarctica to comply with all relevant New Zealand legislation.

- **Logistics Costs and the Efficient Use of Resources**

Projects with large logistics costs will need to be of particularly high scientific merit to justify the allocation of resources.

Over-arching Theme	Research Domain	Research Goals Including	Examples of how we know we've succeeded
Global Change	**CLIMATE, CRYOSPHERE, ATMOSPHERE: Improved understanding of the significance and implications of the role of Antarctica in global change, and implications of global change for Antarctica.**	• improved understanding of Antarctic and Southern Ocean responses to past climate conditions and enhanced modelling of the Antarctic and Southern Ocean impact on, and response to, climate change and variability. • improved understanding of the role of the cryosphere [4] in the Ross Sea region. • improved understanding of the Antarctic atmosphere's response to global change and its effect on New Zealand. • quantifying Antarctica and the Southern Ocean's role in the global biogeochemical cycles.	• IPCC global climate predictions are using information from NZ-supported Antarctic research as inputs into global climate models. • refined IPCC climate predictions, which are being used as input into the Government's climate change policy include the impact of Antarctica. • we have an improved understanding of past and present processes that take place in Antarctica and the Southern Ocean to determine the southern influences on New Zealand's land, ocean and climate and hence better identify Antarctica and the Southern Oceans impact on, and response to, climate change. • we have an improved understanding of the Antarctic atmosphere's response to global change, the future status of ozone loss in the Antarctic and Antarctica's role in the global carbon cycle.
	INLAND & COASTAL	• an improved understanding of inland and coastal Antarctic ecosystems, their	• Continued recognition that New Zealand is a leader in the environmental

[4] Cryosphere is the term which collectively describes the portions of the Earth's surface where water is in solid form, including sea ice, lake ice, river ice, snow cover, glaciers, ice caps and ice sheets, and frozen ground (which includes permafrost).

	ECOSYSTEMS: Improved understanding of inland and coastal ecosystems of the Ross Sea Region leading to enhanced knowledge, conservation and protection priorities in Antarctica.	biodiversity and roles in bio-geochemical processes and their functioning, as well as their potential responses to environmental change in the Ross Sea Region. • a greater understanding of how closely-coupled Antarctic ecosystems interact. • an increased understanding of how the Antarctic environment (inland and coastal) may respond to climate change.	management of the Ross Sea region. • we have a better understanding of the responses of Antarctic flora and fauna to global change. • New Zealand continues to meet its international obligations related to the Committee for Environmental Protection's areas of interest. • New Zealand has leveraged off the knowledge of the ecosystems in the Ross Sea Region to develop world-leading environmental standards for its activities. • New Zealand's representatives at international Antarctic fora are well-equipped and informed and their input to discussions on Antarctic ecosystems is sought. • international researchers seek to collaborate with their New Zealand counterparts on biodiversity and ecosystem functioning research.

	OPEN MARINE SYSTEMS: Improved conservation and resource management of the Antarctic marine environment.	• improved understanding of the marine ecosystems in the Ross Sea Region. • improved understanding of the oceanography and hydrography of the Ross Sea. • improved understanding of the dynamics of species of ecological and economic significance. • understanding of how the marine environment and marine food webs may respond to climate change.	• there is improved environmental management of the Ross Sea Region. • vulnerable marine ecosystems in the Ross Sea are adequately defined, described and managed through CCAMLR. • a representative network of marine protected areas have been established that, in particular, safeguard the long-term ecological viability of marine systems and protect Antarctic marine biological diversity and areas potentially vulnerable to human impacts. • there is well managed sustainable harvesting in accordance with the CCAMLR's principles of conservation and relevant adopted Conservation Measures.