REPORT OF THE NEW ZEALAND DELEGATE

TO: THE LIFE SCIENCES STANDING SCIENTIFIC GROUP
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This report covers broadly the life sciences-related projects supported by Antarctica New Zealand, which fit within three research themes outlined in the Antarctic and Southern Ocean Science Strategy (2004-2009); *Antarctica and Global Change, Conservation and Management of the Marine Environment* and *Protection of the Antarctic Environment*.

The draft Science Strategy: *New Zealand Antarctic and Southern Ocean Science Directions and Priorities 2010 - 2020* is now undergoing public consultation and it is anticipated that the document will 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.

All New Zealand programmes for the 2009-2010 years are listed and described on the website www.antarcticanz.govt.nz, as well as programmes which in February 2010 received support for the next 2-4 years.

This report is divided into two sections:
Section 1 covers two large science programmes concerning biological activities related to the natural environment, and

Section 2 are 2010 highlights of selected published papers from New Zealand Life Sciences research.

Section 1
THE LATITUDINAL GRADIENT PROJECT (LGP)

The Latitudinal Gradient Project (LGP) is a framework bringing together diverse science groups to accumulate baseline ecological data along the Victoria Land Coastline, inputting into the SCAR programme Evolution and Biodiversity in Antarctica (EBA). Work undertaken within the LGP also relates to The Long Term Ecological Research (LTER) Network, a collaborative effort run by the National Science Foundation, investigating ecological processes over long temporal and broad spatial scales. The McMurdo LTER is an interdisciplinary study aimed at understanding the influence of physical and biological constraints on the structure and function of dry valley ecosystems. Data is measured from the atmosphere, glaciers, streams, soils, and lakes of the McMurdo Dry Valleys to further this aim.
The McMurdo Valley's LTER involves scientists working in a variety of disciplines including:

- Microbial ecosystem dynamics in arid soils
- Ephemeral streams
- Closed basin lakes
- Resource and environmental controls on terrestrial, stream and lake ecosystems
- Material transport between aquatic and terrestrial ecosystems and
- Ecosystem response to greater hydrologic flux driven by warming climate.

New Zealand had nine events in 2009-2010 directly contributing to the LGP, as follows:

- *Environmental Protection of Soils in the Ross Sea Region:* Research to support environmental protection and management of ice-free areas of the Ross Sea region by increasing the fundamental knowledge and understanding of Antarctic soils including soil distribution and climate, and vulnerability to human impact.
- *Predicting Biocomplexity in Dry Valley Ecosystems:* Using an interdisciplinary approach to determine the present status of the biodiversity, and to predict the effects

of multiple potential impacts on these ecosystems. The main goal of the research will be a dynamic geographic information system in which the specific observations about patterns and processes of the physical environment, plus observations of the presence of particular organisms and their interactions, will be mapped and linked with computer models that allow prediction into as-yet unsampled locations and scenarios for future change in conditions. [additionally, a NZ-funded IPY project.]

- *Dynamics and Change of the Darwin-Hatherton Glacial System:* Studys the response of the Antarctic ice sheet to future climate change, combines glacial, geomorphological and climatological approaches.
- *Antarctic Sea Ice, Algal Productivity and Global Climate Change:* Studying the productivity of algae that live in and under the sea ice. Determining the effects of global climate change will have on this productivity. [additionally, a NZ-funded IPY project.]
- *Latitudinal Patterns in the Abundance of Ross Sea Meroplankton:* Studying the distribution and abundance of meroplankton (larvae of benthic marine invertebrates and fish) in the water column. Uses morphological and molecular approaches to identify common larval types.
- *Physiological and Phylogenetic Relationships Among Antarctic Organisms:* This research aims to understand how terrestrial organisms have adapted to changes in the Antarctic climate during the last 35 million years by conducting physiological and phylogeographic studies of freezing tolerant and freezing resistant invertebrates.
- *Antarctic Aquatic Ecosystems:* Studying various aspects of Antarctic aquatic ecosystems, geochemistry of ponds, photosynthetic and nitrogen fixation rates of microbial mats to assess model predictions against actual observations. [additionally, a NZ-funded IPY project.]
- *Adélie Penguin Population Dynamics:* Long-term study on the population dynamics of the Adelie penguin population of the Ross Sea as a biological indicator of local, regional and global change.
- *Coastal Benthic Ecosystem Structure and Function:* Long-term project aimed at characterising the structure and function of benthic marine communities and determine their relationships to key environmental factors. Important for an improved understanding of Antarctic biodiversity and ecology, and management of the Antarctic coastal zone. [additionally, a NZ-funded IPY project.]
- Objectives for IceCUBE 2009/10.
  To continue to improve our understanding of Ross Sea marine benthic ecosystem structure and function, we continued our investigations of how key benthic organisms (i) respond to ocean acidification, (ii) utilise pulsed addition of primary food sources, and (iii) how the diversity and abundance of benthic communities varies over time. Our 2009/10 objectives were to: (i) collect specimens of key molluscan invertebrates from New Harbour and safely return them to NZ for use in laboratory experiments, (ii) conduct a field experiment at New Harbour to investigate the uptake and incorporation of primary food sources by benthic invertebrates, and (iii) to add to our long term data set by re-surveying one Cape Evans site (sampled on 6 occasions previously).

NIWA-led IPY voyage to the Ross Sea for the Census of Antarctic Marine Life

Scientists returned from the Ross Sea last year with a large volume of environmental data, more than 40,000 specimens and 55 hours of seafloor video footage. Taxonomists have so far identified at least five 'new' fish species and many new records for the Ross Sea region. Excluding octopus and squid, about half of the 4592 invertebrate samples have so far been identified to family level, a third to genus level, and 20% to species level. To date, 21 new invertebrate species have been identified, including two possibly new genera and species of black coral.

As well as providing a stocktake of biodiversity in the area, scientists are trying to understand the role different organisms play in the Ross Sea ecosystem. They are using various techniques and genetic analyses are also being used to determine the level of interconnectedness between organisms in the Ross Sea and other parts of the Southern

Ocean. These have already led to some surprising results, with some evidence for 'cryptic species' (separate species that look very similar) within the Ross Sea region.
Research that helps to advance our understanding of the marine environment will ultimately enhance our ability to manage human activities in the Ross Sea region.

Section 2: 2010 Highlights of selected published papers from New Zealand Life Sciences research.

- A survey of Archaea indicates they are of low abundance, low diversity, and located mainly in coastal soils. Most Archaea (>99% of clones) detected belonged to the Crenarchaeota group 1.1.b which have been implicated in nitrification in temperate soils (Ayton et al. 2010). No trends of overall increase or decrease in active layer depth were evident in up to 8 years of data collected from soil climate monitoring stations at 7 locations in the Ross Sea region (Adlam et al. 2010). Having completed a soil map of the Wright valley, over the next few years, the programme will characterise soil microbial communities to determine whether soil distribution patterns aid prediction of soil microbial diversity and/or abundance.

- Nature Asia Pacific highlighted in April 2010 (http://www.natureasia.com/A-IMBN/article.php?id=362) the study from Mc Kelvey Valley, demonstrating that life has adapted to form highly specialized communities in distinct lithic niches occurring concomitantly within this terrain, containing unreported polar bacteria and fungi,

McKelvey Valley

but archaea were absent from all niches. Lithic community structure did not vary significantly on a landscape scale and stochastic moisture input due to snowmelt resulted in increases in colonization frequency without significantly affecting diversity (Pointing et al. 2009).

- Physiological measurements of both stress and sex hormones, used to estimate the consequences of natural or human-induced change in ecological studies of various animals, were compared using standard methodology of faecal and plasma hormone measurements for the first time in Adelie penguins but data showed that only faecal analysis gave statistically significant results, with implications for future studies (Ninnes et al. 2010).

- In Victoria Land (East Antarctica) the distribution of springtail (Collembola) and mite (Acari) species have been shown to vary at scales that range from a few square centimetres to regional and continental. Different species show different scales of variation that relate to factors such as local geological and glaciological history, and biotic interactions, but only weakly with latitudinal/altitudinal gradients. {Caruso et al 2010.) Cary et al. 2010 reviewed current understanding of extreme Antarctic terrestrial microbial communities, with particular emphasis on the factors that are involved in their development, distribution and maintenance in cold desert environments of the Dry Valleys. More from the Dry Valleys, where the second published report of a leopard seal carcass from the McMurdo Dry Valleys was described in Banks et al. (2010).

- Airborne fungal spores were studied in interior and exterior Ross Island historic sites and both summer and winter viability and quantity of fungal material were significant. Human impact and visitation appears to a negligible factor considering the amount of fungi (Duncan et al. 2010). These findings may have implications to an initiative concerning the 2008 document of the LSSSG Human Biology and Medicine Experts Group which commented on disease risk of introduced microbes and fungi and "proposed fungi as a marker of increased involvement of humans in the Antarctic". Continuing with fungi, Blanchette et al. 2010 demonstrated after sampling where conservation work at the Cape Royds historic site to reduce moisture at the hut exposed fodder, wood, and many different types of organic materials from the stables, the diversity of fungi and species richness was remarkably large and influenced by the huge input of carbon from the introduced wood and other materials brought to the area by the early explorers.

- Back to the LGP, where genetic studies of a common lichen species in the Dry Valleys have shown that isolated populations are genetically distinct from each other. Hogg et al. 2010 concluded their popular article that "We have always worried about letting foreign organisms into Antarctica but it now seems likely that another major quarantine risk may be mixing up local populations and destroying possibly millions of years of history and local adaptation. This is one of the many challenges facing those responsible for protecting Antarctica's unique terrestrial environments and indeed, ultimately, New Zealand. Ongoing research, as part of Antarctica New Zealand's Latitudinal Gradient Project, is a key component of this decision-making process."

Citations

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