



Agribusiness and Economics Research Unit

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The Contribution of Antarctic- Related Activities to the Canterbury and New Zealand Economy

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Client Report

Prepared for

Antarctica New Zealand

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Executive Summary

This report builds on earlier work conducted by the Agribusiness and Economics Research Unit (AERU) at Lincoln University; and it assesses the contribution of Antarctic – related activities to the Canterbury and New Zealand economies. These previous projects have shown that these contributions are significant (Saunders et al, 2007; 2013). The report, as in previous reports, also considers issues around the Antarctica activities for the businesses and other stakeholders as well as new initiatives of Antarctic-related activities with potential to benefit the Canterbury and New Zealand economies in the future.

The research methods used in this project included interviews with senior staff members from key organisations to obtain information and data about Antarctic-related activities, and an economic impact analysis of Antarctic-related activities in Canterbury and New Zealand was conducted.

Since the previous study Canterbury and New Zealand have seen a real increase in Antarctic-related initiatives. These include; new science funding, particularly the National Science Challenge *the Deep South*; the XXXIII Scientific Committee for Antarctic Research (SCAR) and the COMNAP XXVI meetings; the current upgrade of Scott Base; the completion of a major phase in conservation work in Antarctica by the Antarctic Heritage Trust; the 6-year-extension of the COMNAP Secretariat at Gateway Antarctica; the creation of an Antarctic Office at the Christchurch City Council; visits of British Navy Vessel *HMS Protector* and China's icebreaker and polar research vessel *Xuě Lóng*. These have attracted considerable attention both from the general public and other stakeholders.

The economic analysis of the contribution of Antarctic-related activities to the regional and national economies was for the five categories (1) National Antarctic Programmes, (2) Tourism and Events, (3) Fishing, (4) Education and Research, and (5) Antarctic Heritage. Results show that the aggregated direct economic impact of the surveyed Antarctic-related activities was \$124 million for the Canterbury economy and \$178 million for the New Zealand economy. To obtain the total impact, a multiplier analysis estimated the downstream and household expenditure consequences of the direct impacts. The total impacts were **\$235 million for Canterbury** and **\$432 million for New Zealand**. The employment impact of this show that 3,675 jobs in Canterbury depend on Antarctic-related activities in the region and 6,838 jobs nationally are based on Antarctic-related activities.

Table: Total Impacts of Antarctic-related Activities, Canterbury and New Zealand, 2015

Industry Sector millions	Canterbury	Rest of NZ	New Zealand
National Antarctic Programmes	\$95.1	\$72.0	\$167.1
Tourism	\$117.8	\$31.8	\$149.6
Fishing	\$13.5	\$71.8	\$85.3
Education and Research	\$4.7	\$17.4	\$22.1
Antarctic Heritage	\$4.3	\$3.1	\$7.4
TOTALS (Millions)	\$235.4	\$196.1	\$431.5

A number of new Antarctic-related developments are proposed with potential to have a significant impact on Canterbury and New Zealand in the future. These include:-

- The investment into the McMurdo reconstruction by the US Antarctic Programme with an estimated total expenditure of US\$300 million.
- The Scott Base reconstruction which is proposed to, not only replace, but enhance the facilities and logistical support. This is seen as essential for New Zealand to support science and fulfil its objectives under the Treaty.
- The establishment of an Antarctic Office to enhance Antarctic-related business and tourism for Christchurch.
- The investment into the *Antarctic Endeavour Christchurch*, a purpose-built research facility.
- The redevelopment of the Antarctica Attraction by Real Journeys.
- The increase in activities of the National Programmes, e.g. the Chinese government's plan to build a research facility in the Ross Sea region.

Overall, these developments and opportunities have potential to increase benefits to the Canterbury and New Zealand economies in the future and the importance of Antarctica to the local and national economies.

1. Introduction

1.1 Background to this report

In 2007, the Agribusiness and Economics Research Unit (AERU) at Lincoln University was commissioned by the Canterbury Development Corporation (funded by Antarctica New Zealand) to assess *the Contribution of Antarctic-Related Activities to the Canterbury and New Zealand Economies* (see Saunders *et al*, 2007). That study concentrated on the local and national impacts of Antarctic-related activities based in Canterbury. In 2013, Antarctica New Zealand commissioned the AERU to update and extend the previous study. The new study maintained a focus on Antarctic-related activities in Christchurch (and their contribution to the Canterbury economy) but also estimated the contribution of national level activities (such as research programmes in Universities outside Canterbury).

The change in coverage means that the 2007 and 2013 measures cannot be compared; nevertheless, both studies showed significant contributions of Antarctic-related activities to the regional and national economies, as shown in Table 1. In 2013, the direct economic impact of the surveyed Antarctic-related activities in Canterbury was \$103 million and \$162 million on New Zealand. Taking into account multiplier effects on indirect and induced expenditure, the 2013 study found the direct, indirect and induced impacts amounted to \$188 million in Canterbury and \$394 million in New Zealand.

Table 1: Direct and Total Impacts of Antarctic-related Activities on Canterbury and New Zealand Economies, 2007 and 2013

NZ\$ millions	Direct Impacts		Total Impacts (Direct, Indirect and Induced)	
	Canterbury	New Zealand	Canterbury	New Zealand
2007	88	133	155	282
2013	103	162	188	394

Note: The 2007 data focused on activities in Canterbury only; the 2013 data included national activities. Hence the 2007 and 2013 data cannot be compared.

Source: Saunders *et al*. (2007; 2013).

In this study, the estimates of the economic benefits of Antarctic-related activities at the regional and national levels are updated using a range of different sources. In addition, opportunities as well as potential issues concerning these activities are assessed.

1.2 Research methods

The research methods used in this study followed those used in the 2013 study. The project began by arranging interviews with senior people from key organisations to request background information and data about Antarctic-related activities. All of the people approached to be interviewed were very helpful. The AERU research team is grateful to all those who participated in this part of the research. In most cases, the interviews took place at the participant's place of business attended by Professor Caroline Saunders and Research Fellow Meike Guenther. A small number of interviews were conducted by telephone or e-mail. Handwritten notes were made during the interviews (which were not recorded), which were the basis for much of the material contained in this report after cross-checking with web-based documents.

The second part of the project involved an economic impact analysis of economic-related activities in Canterbury and New Zealand. This required gathering data on expenditures generated for these activities. The project identified over 900 firms that supply goods and services for the National Antarctic programmes and it was possible to obtain data on these items aggregated by industry sector (to maintain privacy). Data on research programmes was obtained by searching websites of the Ministry of Business, Innovation and Employment (MBIE), Marsden Fund, Crown Research Institutes, New Zealand Antarctic Research Institute (NZARI), National Science Challenge among others. Other information was obtained from the interviews and web-based sources. These expenditure flows were sorted by location, in Canterbury, in New Zealand, or overseas. Antarctic-related activity from companies or organisations located overseas was excluded. The allocation of an organisation's expenditure to Canterbury required that the supplying firm has a locally operating business unit.

The data collected from the interviews, databases and other sources were used to estimate the economic contribution provided by Antarctic-related activity to the Canterbury and New Zealand economies. Three types of contribution – direct, indirect and induced impacts – were calculated for the total value of output.

1. *Direct impact* – this is a result of direct revenue injected into the local and national economy by Antarctic-related activities.
2. *Indirect impact* – this is a result of downstream revenue created by other firms selling goods and services organisations operating in the Antarctic-related sector.
3. *Induced impacts* – these are the effects of the above two contributions on further household spending which generates revenue as a result of increased purchases of household goods and services.

Multipliers for indirect and induced expenditure flows in Canterbury were obtained from output multiplier tables in Butcher (2007) while multipliers for expenditure in New Zealand used Butcher (2005). The Canterbury multiplier tables were composed of 114 sectors, while New Zealand multiplier tables consisted of 53 sectors. Thus, sectors from the Canterbury multiplier tables had to be mapped to the sectors in the multiplier tables for New Zealand and sector composites for the Canterbury multipliers had to be created using averages.

Employment estimates associated with the total expenditure – including the direct, indirect and induced impacts – were calculated for the different categories using relevant multipliers obtained from Butcher (2007) for Canterbury and Butcher (2005) for New Zealand. The multiplier tables estimate the average number of employees required to produce a million dollars of output by industry. These multipliers were applied to the direct, indirect and induced impacts of expenditure on Antarctic-related activities to obtain estimates of employment for firms supplying or servicing these activities.

1.3 Structure of the report

The remainder of this report is structured as follows.

Chapter 2 provides an overview of significant Antarctic-related activities that materially involve New Zealand. These activities are classified under eight headings:

1. Scientific research and innovation
2. Historical heritage and conservation
3. Natural environment and protection
4. Cultural exploration and education
5. International diplomacy and profiling
6. Gateway logistics and business support
7. Antarctic-related tourism and events
8. Southern Ocean commercial fishing

Chapter 3 presents the economic impact analysis and its method. It estimates that the aggregated direct economic impact of the surveyed Antarctic-related activities is \$124 million for the Canterbury economy and \$178 million for the New Zealand economy. These are significant increases from the values estimated in Saunders *et al.* (2013).

Chapter 4 discusses themes that arose from the interviews with organisations involved in Antarctic-related activities. The chapter focuses on potential opportunities and issues concerning these activities in Canterbury and New Zealand.

2. New Zealand's Involvement in Antarctic-Related Activities

New Zealand has a long association with Antarctica, arguably going back to 1642 when Abel Tasman's sighted the west coastline of New Zealand during his expedition in search for the unknown southern continent, the Terra Australis. Similarly, James Cook circumnavigated and landed on New Zealand in 1769 following orders to search for the Terra Australis after sailing to Tahiti. In December 1901, the British National Antarctic Expedition led by Commander Robert Scott (the Discovery Expedition) spent three weeks in New Zealand preparing for the trip south. Since then, Lyttelton Harbour and the Christchurch International Airport have been important gateways for travellers to Antarctica.

The purpose of this chapter is to provide an overview of significant Antarctic-related activities that materially involve New Zealand. It is based on interviews undertaken for this project, complemented with desk-based research by the AERU research team. These activities are categorised under eight headings, however it should be noted that there are considerable synergies among these different categories. The eight headings are as follows.

1. Scientific research and innovation
2. Historical heritage and conservation
3. Natural environment and protection
4. Cultural exploration and education
5. International diplomacy and profiling
6. Gateway logistics and business support
7. Antarctic-related tourism and events
8. Southern Ocean commercial fishing

2.1 Scientific research and innovation

All of New Zealand's universities and many of its Crown Research Institutes are engaged in Antarctic research, including some recognised centres of research excellence. The oldest dedicated centre is the Antarctic Research Centre, established by Professor Peter Barrett in the Department of Geology at Victoria University of Wellington in 1972, building on a research programme going back to 1957 shortly after Scott Base was opened in December the previous year (see Hatherton, 1967; Clark, 1967). The current director is Professor Timothy Naish. The centre's mission is "to better understand Antarctic climate history and processes, and their influence on the global climate system, especially in New Zealand and the southwest Pacific region" (see www.victoria.ac.nz/antarctic).

In August 2012 Prime Minister John Key launched the New Zealand Antarctic Research Institute (NZARI) a charitable trust which was made possible by a donation of \$5.3 million from New York philanthropist, Julian Robertson. The Director of the Institute is Professor Gary Wilson of the University of Otago (see <http://nzari.ag/>). The Institute has now completed three rounds of research grants for Antarctic research. The University of Otago has a longstanding research theme on Polar Environments, which it describes as “a multidisciplinary synthesis of life, earth and physical sciences research applied to Antarctica and the oceans of the Southern Hemisphere” (<http://polarresearch.otago.ac.nz/>).

The University of Canterbury is based in Christchurch and has the centre for Antarctic studies and research - Gateway Antarctica (see www.anta.canterbury.ac.nz/). Led by Professor Bryan Storey, its purpose is to “contribute to increased understanding and more effective management of the Antarctic and the Southern Ocean by being a focal point and a catalyst for Antarctic scholarship, attracting national and international participation in collaborative research, analysis, learning and networking”. In 2015, Professor Bryan Storey was appointed Director of the International Antarctic Institute (IAI), a global consortium of 20 universities and agencies throughout the world aiming to provide international opportunities in undergraduate and postgraduate multi-disciplinary Antarctic education by sharing resources between partner universities and developing innovative courses and pathways. Gateway Antarctica hosts the IAI secretariat and is responsible for its operations (see www.anta.canterbury.ac.nz/documents/events%20and%20news/October%202015.pdf).

At the University of Waikato, the International Center for Terrestrial Antarctic Research (ICTAR; see www.ictar.ag/) “aims to provide the science that will underpin the conservation, protection, and management of terrestrial ecosystems of the Ross Sea region”. The Director of ICTAR is Professor Craig Cary. Its mission is “to promote the protection of Antarctica through integrated international research into Antarctic terrestrial ecosystems assuring New Zealand’s continued leadership in this area”.

The National Institute of Water and Atmospheric Research (NIWA) is also involved into scientific research in Antarctica with its mission to conduct leading environmental science to enable the sustainable management of natural resources for New Zealand and the planet. In Antarctica, NIWA scientists work on atmospheric processes and aquatic ecosystems, with its research vessel RV Tangaroa providing logistical support for scientific studies and hydrographic surveys in the Southern Ocean (see www.niwa.co.nz/our-science/oceans/antarctica). In February 2015, the RV Tangaroa completed a six-week voyage in the Southern Ocean. On that journey, 40 scientists and crew led research on Antarctic populations of blue whales as well as Antarctic toothfish and what they feed on. The voyage which included significant funding from Antarctica New Zealand collected atmosphere and ocean data for improved weather forecasts and climate change predictions (Antarctica New Zealand, 2015a).

New Zealand has a permanent research support station located on Ross Island in the Ross Sea region of Antarctica, managed by Antarctica New Zealand (<http://antarcticanz.govt.nz/scott-base>). Scott Base was originally constructed in connection with the Trans-Antarctic Expedition and the International Geophysical Year of 1956-59. All but three of the original buildings were replaced with a larger base in the late 1970s, which was further extended with the opening of

the Hillary Field Centre in 2005. Scott Base now caters for up to 85 people during the summer research season. The New Zealand government (2011, p. 11) has identified three key high level research outcomes for New Zealand's Antarctic and Southern Ocean science within a unifying theme of global change:

- Climate, Cryosphere, Atmosphere and Lithosphere
- Inland and Coastal Ecosystems
- Marine Systems

In 2013, the government announced eleven research areas as New Zealand's first National Science Challenges, one of which is *The Deep South (Te Kōmata o Te Tonga)* with the objective to understand the role of the Antarctic and the Southern Ocean in determining the world's climate and its future environment. This Challenge focuses on the effects of a changing climate on key climate-sensitive economic sectors, infrastructure and natural resources. Within the Challenge, six projects will receive over \$9 million funding over four years. Funding allocation started in 2013. These projects start to develop a numerical earth system model to simulate current climate and possible future climates under different scenarios of future global greenhouse gas emissions. The model will support to understand southern hemisphere influences on the global climate. Professor Dave Frame from Victoria University and Director of the Deep South National Science Challenge commented (cited in NIWA, 2015):

Modelling the earth system is the only way to coherently integrate the diverse processes that govern the climate. This is the first time New Zealand has invested in this kind of capability, which is really at the centre of modern physical climate science. If we're to plan and execute sensible responses to climate change, we have to have a good understanding of how the climate works and how it is likely to change.

The Challenge is hosted by NIWA and is in collaboration with other Crown Research Institutes, universities and other research providers such as Antarctica New Zealand, GNS Science, Landcare Research, New Zealand Antarctic Research Institute, NIWA, University of Otago and Victoria University of Wellington (see www.deepsouthchallenge.co.nz/).

2.2 Historical heritage and conservation

The Antarctic Heritage Trust (www.nzah.org/) is a registered charity established in 1987 to care for five expedition bases in the Ross Sea region of Antarctica. The Trust has a twofold mission: to ensure the expedition bases and the thousands of associated artefacts survive for the benefit of future generations; and to inspire people through the values associated with adventure, discovery and endurance. The five sites are:

- Carsten Borchgrevink's Hut, Cape Adare
- Robert Falcon Scott's Hutt, Hut Point
- Ernest Shackleton's Hut, Cape Royds
- Robert Falcon Scott's Hut, Cape Evans
- Hillary's Hut, Scott Base

In 2002, the Trust launched a major international Ross Sea Heritage Restoration Project with the support of HRH Princess Anne. Prior to 2002, only basic hut maintenance was carried out. The Getty Foundation provided significant funding for this project and the five sites were listed in 2008 on the World Monuments Fund's 100 most endangered sites. The Ross Sea Heritage Restoration Project is the largest heritage project ever undertaken in polar regions. It is protecting and saving both the buildings and artefacts *in situ*. In early 2015, a major phase of conservation work on Ross Island was completed which included the conservation of three historic bases and more than 18,000 artefacts. These were Sir Ernest Shackleton's 1908 base and its collection of more than 6,000 artefacts; Captain Robert Falcon Scott's last expedition base at Cape Evans and its 12,000 artefacts; and Scott's first expedition base at Hut Point. These three sites have a comprehensive monitoring and maintenance programme in place until at least 2040. For Carsten Borchgrevink's 1899 base and Hillary's 1957 historic base, conservation work is yet to be undertaken (Antarctic Heritage Trust, 2015a). Furthermore, the Trust's Conservation Plan to save Hillary's Trans-Antarctic Expedition Hut at Scott Base was launched at Parliament by the New Zealand Prime Minister Rt. Hon. John Key in March 2015. Since 2016, the Antarctic Heritage Trust employs four permanent Antarctic conservators located in Christchurch (personal communication, Sue McFarlane, CCC, 2 March 2016).

The Canterbury Museum in Christchurch has very strong Antarctic collections. The Antarctica display has a large impact on visitors, and is consistently rated as one of the top three attractions in the museum (alongside Māori history and Canterbury history). The Antarctic Gallery is a major point of difference to other museums worldwide and it has one of the best collection of Antarctic artefacts globally from the heroic age of Antarctic exploration, outside the five huts listed above. The museum is constantly acquiring new Antarctic artefacts to the collection. In 2016, for example, numerous medals from Ernest Shackleton's were purchased. In the future, the museum aims to quadruple the size of the Antarctic Gallery.

More than 650,000 visitors visiting the Canterbury Museum each year with numbers constantly increasing. In the first month of 2016, for example the museum counted more than 100,000 visitors, this was the first time ever that the 100,000 visitor per month mark was reached. Also, there is an increase in organised bus tourism visiting the museum which may increase visitor numbers in the future. An internal survey found that of all visitors, 41 per cent reported visiting the Antarctic gallery which accounts for 273,060 visitors in 2014/2015. The four contributing local authorities, Christchurch City Council, Hurunui District Council, Selwyn District Council and Waimakariri District Council provide a significant proportion of the Museum's funding (see www.canterburymuseum.com/). The museum has to move temporarily to another site in the city which is a major and costly undertaking considering the valuable artefacts collected in the museum. However, this is not expected to seriously impact on visitors.

For the centennial of Scott's death (2012), the Canterbury Museum and the Antarctic Heritage Trust collaborated with the Natural History Museum in London to create an exhibition on Scott's Last Expedition, curated by Elin Simonsson. This included a replica of the Cape Evans hut. This exhibition appeared at the Australian National Maritime Museum as well as at Canterbury Museum and the Natural History Museum in 2012.

From August to October 2014, Auckland War Memorial Museum in partnership with the Antarctic Heritage Trust hosted the digital polar exhibition “Still Life: Inside the Antarctic Huts of Scott and Shackleton” which was based around the work of New Zealand photographer Jane Ussher and allowed visitors to step inside landscape, isolation and lives left behind by these heroic explorers. The exhibition was also showcased at the Australian National Maritime Museum in Sydney (<http://www.aucklandmuseum.com/whats-on/exhibitions/2014/still-life>).

The Museum of New Zealand Te Papa Tongarewa in Wellington displays a colossal squid which was gifted to the museum in May 2007 by the Minister of Fisheries Jim Anderton (see <http://squid.tepapa.govt.nz/the-squid-files/article/catching-the-colossal-squid>). The squid was caught in the Ross Sea while fishing for Antarctic toothfish in February 2007. In a two-hour process the 495 kilogrammes heavy squid was maneuvered onto the boat where it was frozen and placed in a massive freezer below decks (National Geographic News, 2007 Colossal Squid Caught off Antarctica, 22 February 2007).

2.3 Natural environment and protection

The New Zealand government maintains a very strong commitment to protection of the Antarctic natural environment. The seriousness of this commitment is reflected in the Antarctica (Environmental Protection) Act 1994, for example, which is “an Act to provide for the comprehensive protection of the Antarctic environment and to recognise Antarctica as a natural reserve devoted to peace and science and to implement the Protocol on Environmental Protection to the Antarctic Treaty” (the Act can be seen at www.legislation.govt.nz/act/public/1994/0119/latest/DLM342783.html).

This commitment continues to be restated in official strategic documents. In 2002, the Revised New Zealand Statement of Strategic Interest declared “that New Zealand is committed to conservation of the intrinsic and wilderness values of Antarctica and the Southern Ocean, for the benefit of every country and for present and future generations of New Zealanders”, supported by seven specific interests (see www.mfat.govt.nz/Foreign-Relations/Antarctica/1-New-Zealand-and-Antarctica/1-NZ-Strategy-in-Antarctic.php):

- i. National and international peace and security through a commitment to keeping Antarctica peaceful, nuclear free, and its environment protected
- ii. Continued influence in Antarctica governance through maintaining an effective role in the Antarctic Treaty System, and maintaining its long term interest, commitment to and credible presence in the Ross Dependency
- iii. Conserving, protecting and understanding the biodiversity of Antarctica and the Southern Ocean, in particular the biodiversity of the Ross Sea region, including the promotion, protection, and management of representative special areas, and enhancing biosecurity
- iv. Conservation and sustainable management of the marine living resources of the Southern Ocean, and in particular the Ross Sea, in accordance with CCAMLR and the Antarctica Environmental Protocol, and within this context supporting strong environmental standards and sustainable economic benefits

- v. Supporting and where appropriate leading, high quality Antarctic and Southern Ocean science that benefits from the unique research opportunities provided by Antarctica
- vi. Demonstrating and advocating for best practice in environmental stewardship and all other activities throughout Antarctica, and in particular the Ross Sea region
- vii. Ensuring all activity is undertaken in a manner consistent with Antarctica's status as a natural reserve devoted to peace and science.

On 27 April 2011, the New Zealand Government published *The New Zealand Antarctic and Southern Ocean Science Directions and Priorities 2010-2020* document. The Foreword by the three relevant Ministers (Hon Murray McCully, Hon Dr Wayne Mapp and Hon Phil Heatley) summarised the commitment to natural environment conservation as follows (New Zealand Government, 2011, p. 2):

Antarctica is a unique and fragile environment. It is also part of our heritage and part of our future as New Zealanders. As the key Ministers responsible for New Zealand's investment in Antarctic and Southern Ocean science, we expect that the science undertaken within this framework will contribute to the protection and wise stewardship of the continent and surrounding environs. We encourage all those involved in the implementation of this framework to be guided by its priorities and directions to ensure we deliver the best science outcomes we can for the benefit of New Zealanders and the wider international community who share our fascination with this special part of the world.

2.4 Cultural exploration and education

The isolation and wilderness of Antarctica are sources of inspiration for artists and their audiences. Since 1997/98, Antarctica New Zealand (originally with the support of Creative New Zealand) has operated its Artists and Writers Programme that each season invites two to three writers, poets, composers, painters, ceramicists, photographers, sculptors, choreographers, jewellers or designers to spend time at Scott Base. In February 2015, this programme was renamed as the Community Engagement Programme which aims to support media and artists travelling to Antarctica as part of Antarctica New Zealand's outreach strategy (see <http://antarcticanz.govt.nz/scholarships-fellowships/community-engagement-programme>). The programme aims to inspire people to connect with Antarctica, through knowledge and collaboration.

Antarctica is part of New Zealand's cultural heritage available to be passed on to following generations. There are several programmes offering educational resources on Antarctica (see, for example, the lists maintained at <http://antarcticanz.govt.nz/resources/education> and at www.nzah.org/AHT/FurtherInfo/). The International Antarctic Centre in Christchurch offers education programmes for groups of students (www.iceberg.co.nz/pages/8/education.htm). Kelly Tarlton's Sea Life Aquarium in Auckland also offers access for school parties, including a day visit called Antarctica & Explorers (www.kellytarltons.co.nz/schools/excursions-info/) and the possibility of a curriculum-based classroom lesson. The Aquarium has zones devoted to Scott Base, Antarctic Ice Adventure home to the only colony of Antarctic penguins in New Zealand, and NIWA Southern Oceans Discovery.

2.5 International diplomacy and profiling

On 1 December 1959, twelve countries who had a scientific presence in or around Antarctica during the International Geophysical Year of 1957-58 signed the Antarctic Treaty. New Zealand was one of those original signatories along with Argentina, Australia, Belgium, Chile, France, Japan, Norway, Russia, South Africa, United Kingdom and United States. Since then, a further 17 countries have been accepted as consultative parties (indicating substantial research activity in the region) along with 21 non-consultative parties, so that there are now 50 signatories to the Antarctic Treaty (www.ats.aq/).

The Ministry of Foreign Affairs and Trade is the government agency responsible for New Zealand's overall interests in Antarctica and the Southern Ocean (www.mfat.govt.nz/Foreign-Relations/Antarctica/index.php). The Ministry comments:

Antarctic cooperation is an important part of New Zealand's relations with other countries. For example, New Zealand, the United States and Italy share resources by operating a joint logistics pool out of Christchurch in support of their respective Antarctic programmes. New Zealand scientists cooperate on Antarctic research with scientists from many countries.

Involvement in Antarctica offers New Zealand the opportunity to play a constructive and influential role in a region of direct interest to it, which is managed according to principles of international cooperation, environmental protection and pursuit of scientific knowledge.

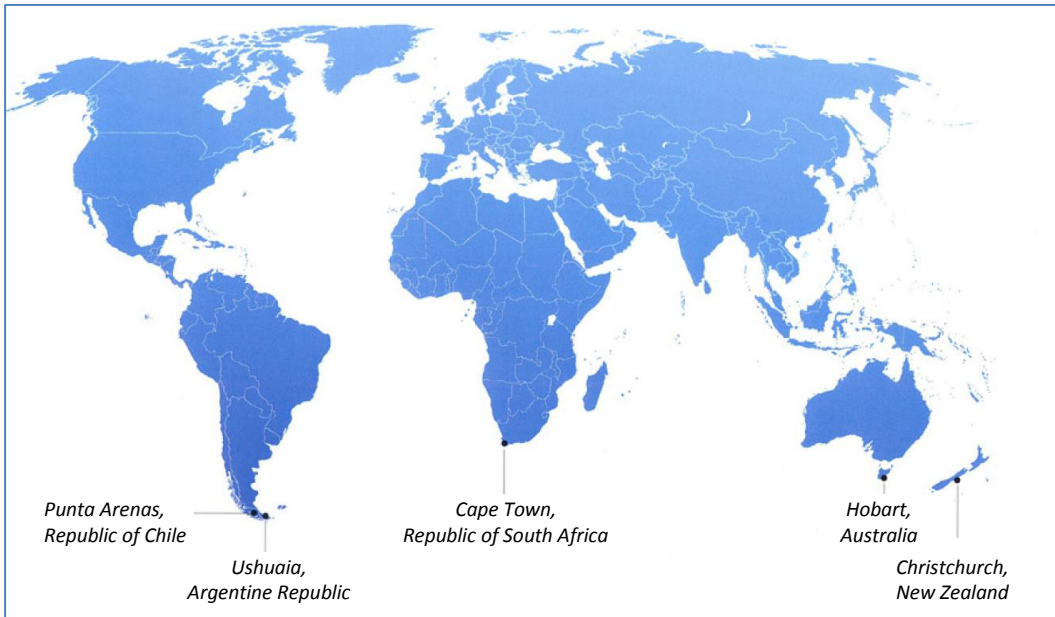
COMNAP is the Council of Managers of National Antarctic Programs, made up of all the consultative parties to the Treaty (<https://www.comnap.aq/SitePages/Home.aspx>). The purpose of COMNAP is to "develop and promote best practice in managing the support of scientific research in Antarctica". The Secretariat for COMNAP has been located at Gateway Antarctica (University of Canterbury) since 2009, with Michelle Rogan-Finnemore being its Executive Secretary. This has been extended in 2016 for another 6 years which is an achievement.

2.6 Gateway logistics and business support

There are five gateway cities to Antarctica (see Figure 1): Christchurch, New Zealand; Hobart, Australia; Ushuaia, Argentina; Punta Arenas, Chile; and Cape Town, South Africa. Christchurch hosted a gathering of civic representatives from these five cities in September 2009, at which a Statement of Intent was signed, committing the cities to "a joint exploration into the benefits of a cooperative programme of academic and best practice exchange", particularly in the areas of education, workforce development, tourism and economic development.

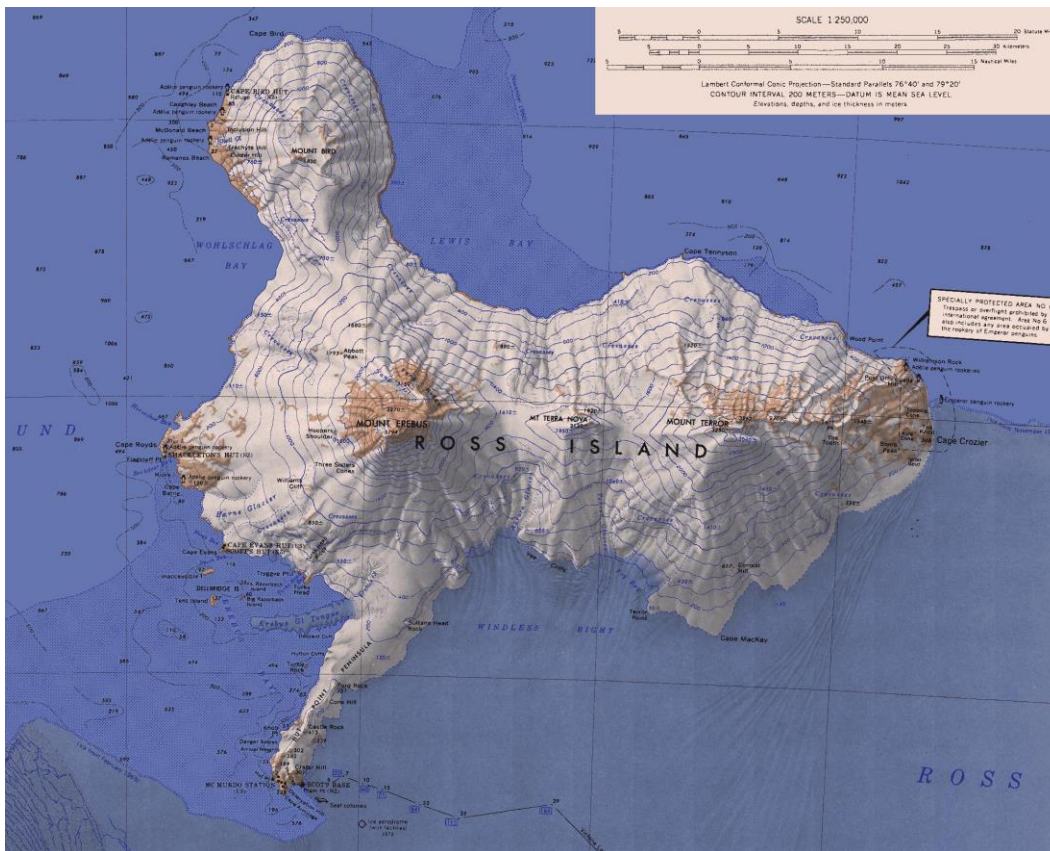
An Antarctic Office was established by the Christchurch City Council in February 2016. The office is recognised as the single point of contact for the Christchurch Antarctic industry "to ensure that the city maximises the tourism and servicing opportunities associated with the Antarctic programmes and to ensure those programmes currently using Christchurch as a base are not lost to alternative gateways to Antarctica, such as Hobart, Tasmania." (CCC, 2014, p. 2). The office is further aimed at coordinating and leading the city as well as the region in better realising opportunities from its Gateway City status. Eric Assendelft has been appointed as the first Antarctic Officer (CCC, 2014).

Figure 1: The Five Gateway Cities



Source: *Gateway Cities to the Antarctic: Statement of Intent between the Southern Rim Gateway Cities to the Antarctic.*

Figure 2: Ross Island



Source: United States Antarctic Resource Center (2015).

A feature of Christchurch's gateway position is its role in the large national Antarctic research programmes of New Zealand and of the United States. As shown in Figure 2, Scott Base and McMurdo Station are located close to each other at the southern-most point of Ross Island. There is a long history of cooperation between the two programmes (the 50th Anniversary was commemorated in January 2007) and they operate a joint logistics pool based at Christchurch International Airport.

As noted in our previous studies (Saunders *et al*, 2007, p. 12; 2013, p.11), the combined infrastructure of Lyttelton Port and Christchurch International Airport was a key factor influencing the original choice in the 1950s of Christchurch as the gateway for the United States Antarctic Programme and the combination of Christchurch's international airport, sea port, dry dock and engineering facilities provide effective support for Antarctic activities.

Participants in the national Antarctic research programme of Italy (based at the Mario Zucchelli research station at Terra Nova Bay) also pass through Christchurch. Further, the Republic of Korea signed an Antarctic Co-operation Agreement with New Zealand in 2012. The Korean Antarctic Program (KOPRI) services its new base Jang Bogo Station, Terra Nova Bay, from Christchurch and since November 2014 it operates an office in the city. Both these programmes use Lyttelton Port for their Antarctic vessels.

Lyttelton Port is often used for refuelling and stocking up on supplies for vessels heading to Antarctica. In January 2016, the British Navy Vessel 'HMS Protector' docked in Lyttelton port to refuel and take on supplies before heading back to Antarctica. It was the first time in 70 years that a British ship has been in the Ross Sea region. The main purpose of the mission was to undertake, with colleagues from the New Zealand Ministry for Primary Industries, fisheries patrol inspections of vessels harvesting Antarctic toothfish (*Dissostichus mawsoni*) under the terms of the Convention for the Conservation of Antarctic Marine Living Resources to protect the Southern Ocean from illegal fishing activities.

While in the port, the ship hosted a public day for Cantabrians to visit the ship. More than 3,000 people took advantage of the opportunity to board the Royal Navy's only icebreaker (Sinclair, J., 2016, January 18; Stewart, A., 2016, January 24). Similarly, in January 2015, China's icebreaker and polar research vessel Xuě Lóng, berthed in Lyttelton Port for refuelling and cargo transfer (Antarctica New Zealand, 2015b). On board the ship there are laboratories supporting marine physics chemistry and biology, meteorological instruments as well as a data processing centre. More than 125 researchers and passengers can be accommodated on board the vessel (www.scoop.co.nz/stories/AK1501/S00242/chinese-icebreaker-to-visit-lyttelton-port.htm).

Infrastructure around the different National Antarctic Programmes in Christchurch can have spin-offs to other science programmes. For example, NASA – the US National Aeronautics and Space Administration – engaged in scientific deployments in New Zealand, focusing primarily on astronomical research. For the programme of the Stratospheric Observatory for Infrared Astronomy (SOFIA) – a joint venture between NASA and the German Aerospace Centre – German and US personnel were based at the USAP in Christchurch in 2013 and 2015. The programme's total funding for these years (as estimated by NASA) was approximately US\$77.5 million and US\$87.3 million, respectively (NASA 2015; NASA 2016). The SOFIA programme is

focused on the observation of celestial objects, such as Pluto and the wider Milky Way Galaxy, using infrared telescopes. A modified Boeing 747SP aircraft carries the giant telescope and makes it the largest airborne observatory globally (Spink, 2015). It can fly at altitude as high as 13,700 metres to observe the infrared universe. During SOFIA's 2013 New Zealand deployment approximately 60 scientists, technicians and engineers, as well as 13 telescope experts from the University of Stuttgart stayed in Christchurch (Mehlert, 2013; MPIRA 2013) while in 2015 SOFIA employed approximately 60 science and support personnel making 18 missions in six weeks in Christchurch (SOFIA Science Center, 2015; Veronico 2015). In June/ July 2016, SOFIA is scheduled to return to Christchurch for a cycle of 24 science flights (SSC, 2016a).

Antarctic Link Canterbury, an informal network of Antarctic suppliers was created in 2000 is currently chaired by Sue Stubenvoll from the Canterbury branch of the New Zealand Antarctic Society. Until September 2014, the network met regularly, involving representatives from the full range of organisations in Christchurch that have an interest in Antarctic-related activities. This function has now been taken over by the Antarctic Office.

2.7 Antarctic-related tourism and events

The heading of Antarctic-related tourism and events covers several categories of economically important activities:

- Travellers on commercial sea cruises to Antarctica and Sub-Antarctic islands;
- Tourists spending time and money (entrance fees) in Christchurch because they want to experience the Antarctic-related facilities in the city;
- International scientists and support personnel spending time in Christchurch to acclimatise on their way to or from Antarctica; and
- People travelling to New Zealand to participate in an Antarctic-related conference or event.

The International Association of Antarctica Tour Operators (IAATO) has noted large growth in tourism to the Antarctic region, with visitor numbers increasing from around 12,000 in 2001 to more than 36,700 in 2015 (IAATO, 2016). However, only a small share of these visit the Ross Sea region. The majority of tours are to the Antarctic Peninsula region, closer to South America. In 2003, the New Zealand Government adopted a policy statement committing itself "to limit tourism and other non-governmental activities in Antarctica, and to ensure that where they do occur they are conducted in a safe and environmentally responsible manner" (Antarctica New Zealand, 2003).

The major New Zealand based provider of sea cruises to Antarctica and New Zealand's Sub-Antarctic islands is Heritage Expeditions, based in Christchurch (see www.heritage-expeditions.com/). During a short season from October to January, the company has two annual expeditions of approximately 30 days length to the Ross Sea Region with a total of 200 people. For these, the company employs 26 full-time staff at their office in Christchurch, 50

crew members on ship and additional 35 crew members per season. Shorter cruises are offered to the Sub-Antarctic islands with options of cruises of 8 to 19 days.

Section 2.4 has already made mention of tourist attractions such as Kelly Tarlton's Sea Life Aquarium in Auckland and the International Antarctic Centre in Christchurch. The Canterbury Museum, the Air Force Museum of New Zealand and Ferrymead Heritage Park also offer Antarctic-themed exhibits for visitors. A free Penguin Express shuttle takes visitors from the Canterbury Museum/ Information Centre to the International Antarctic Centre on the hour between 10am and 4pm, returning on the half hour. The International Antarctic Centre attracts more than 200,000 visits a year, illustrating the significance of this activity. In 2015, the International Antarctic Centre has expanded its attraction by adding a new visitor experience. A new historic hut exhibit and a new 'Flying to Antarctica' exhibit, a purpose built 'C17 aircraft' fuselage, was erected (www.christchurchnz.com/trade/product-updates/fresh-new-look-for-antarctic-centre/).

The United States Antarctic Programme reports that more than 10,000 science and operations personnel participate in Antarctic activities transiting through New Zealand. As well as their spending during the transit, many of these people take time to travel around New Zealand, contributing to the country's international tourism sector. Similarly, the Korean programme reports that more than 200 science and operations personnel participate in Antarctic activities during the summer season with slightly smaller numbers of personnel from the Italian programme.

New Zealand's links with Antarctica mean that it regularly hosts conferences and other events related to Antarctic themes. Antarctica New Zealand hosts an annual conference at one of New Zealand's universities each year, attracting up to 180 delegates including several international visitors. In 2015, NZARI hosted a conference under the theme "Antarctica – A Changing Environment" hosted by the University of Canterbury. In 2014, the Royal Society of New Zealand, sponsored by Antarctica New Zealand hosted the XXXIII Scientific Committee for Antarctic Research (SCAR) Biennial Meeting and Open Science Conference in Auckland, which attracted more than 1,200 science and policy experts from 39 countries (Antarctica New Zealand, 2015a), this was followed by the COMNAP XXVI Symposium which was held in Christchurch. The COMNAP Annual General Meeting was attended by representatives from 27 (of 29) COMNAP Member organisations and had over 100 delegates. (Business Events New Zealand, 2015; COMNAP, 2014). This event was the largest gathering of Antarctic researchers ever in New Zealand. The most recent International Symposium on Antarctic Earth Sciences (ISAES) XII was held in Goa, India in 2015 (see www.scar.org/scarmeetings/conferences).

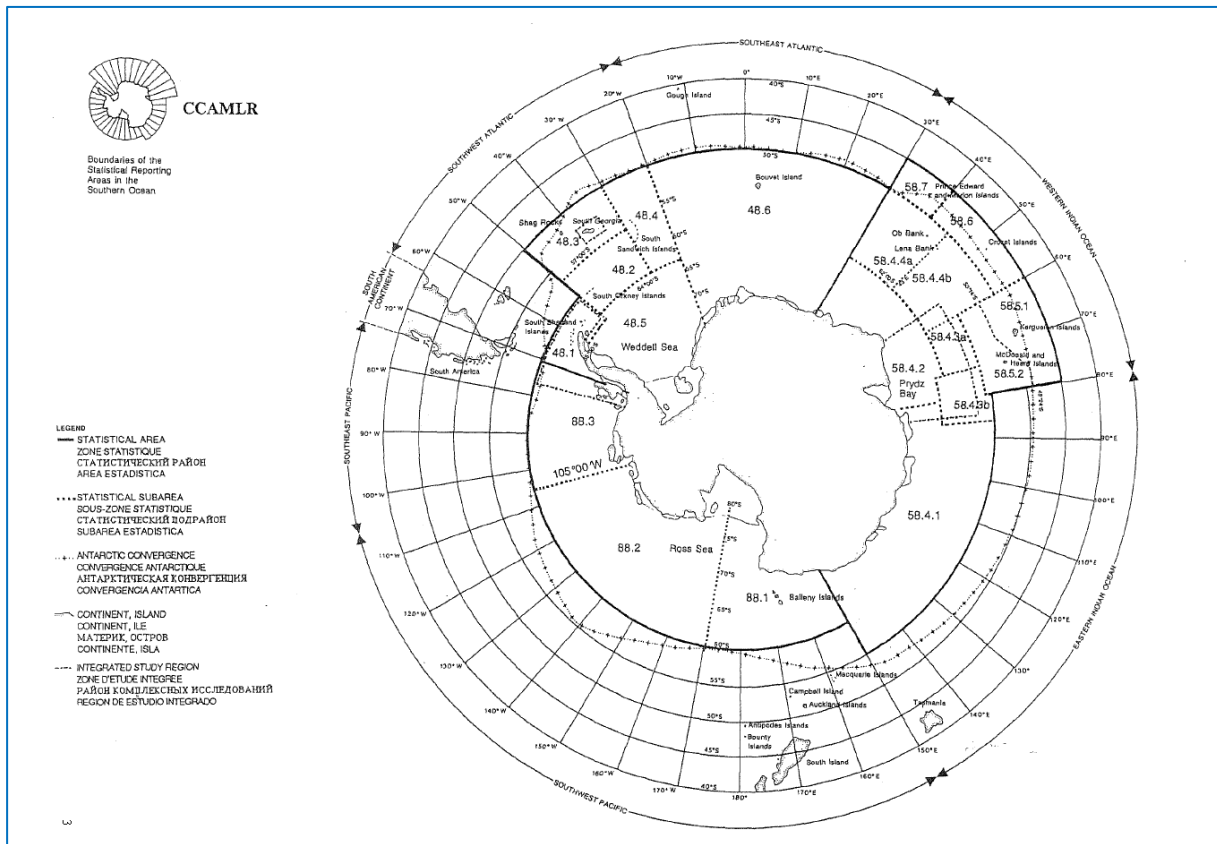
Christchurch launched the New Zealand IceFest in 2012, building on the Christchurch Antarctic Festival that began in 2006. The IceFest is a programme of Antarctic themed events held in the city (but with a national focus) every two years. The 2012 IceFest attracted 97,000 people, including 60 overseas guests. The 2014 IceFest had 60,000 unique visitors and 100,000 total visits over the 16 days of the festival. Of those, approximately 50,000 people visited the exhibitions that were not at the Festival Hub on Christchurch's Cathedral Square itself at Canterbury Museum (see Section 2.2), Form Gallery, Jonathan Smart Gallery and Selwyn Gallery (New Zealand IceFest, 2014). Ongoing are the Christchurch Antarctic public talks which are informal lectures presented by Gateway Antarctica at the University of Canterbury. The

lectures are on current Antarctic topics from expeditions to science and heritage to wildlife, they attract 70-100 people every time (www.canterbury.ac.nz/events/active/public-lectures-and-seminars/christchurch-antarctic-public-talks-sea-level-rise-and-how-much-we-know-about-it--an-antarctic-perspective.html).

2.8 Southern Ocean commercial fishing

Commercial fishing in Antarctic waters is regulated by the Convention on the Conservation of Antarctic Marine Living Resources, which is supervised by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) based in Hobart. New Zealand was one of the original signatories to this convention, which was concluded in Canberra in 1980. The CCAMLR collects and publishes catch data categorised into statistical reporting areas; the Ross Sea fishery is reported in areas 88.1 and 88.2 (see Figure 3). The predominant species caught in the Ross Sea is the Antarctic Toothfish (*Dissostichus mawsoni*). The CCAMLR reports that in the fishing season of 2013/14, 3,348 tonnes of this species were caught in areas 88.1 and 88.2 by vessels from six countries: New Zealand (25 per cent), Norway (9 per cent), Republic of Korea (27 per cent) Russian Federation (12 per cent), Spain (9 per cent) and the United Kingdom (15 per cent) (CCAMLR, 2015).

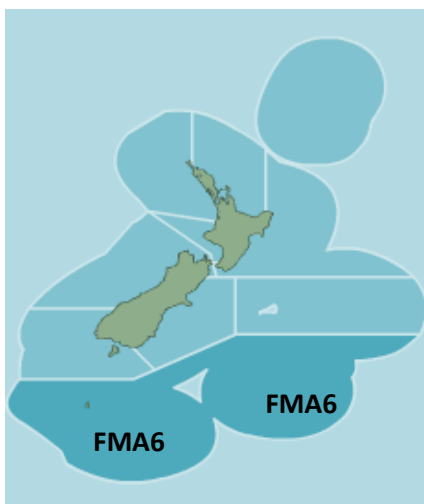
Figure 3: Antarctic Statistical Reporting Areas 88.1 and 88.2



Source: CCAMLR (2012, p. 3).

As well as the Antarctic fishery, this study also includes New Zealand’s Sub-Antarctic Fisheries Management Area (FMA 6) shown in Figure 4. Southern Blue Whiting and Squid are the two principal species caught in FMA6.

Figure 4: Sub-Antarctic Fisheries Management Area (FMA 6)



Source: MPI (2015).



The Royal New Zealand Navy operates two off-shore patrol vessels (HMNZS OTAGO and HMNZS WELLINGTON) that regularly patrol the waters of the Sub-Antarctic Islands and the Southern Oceans (see www.navy.mil.nz/oa/ops/saaso/default.htm). This includes missions to patrol the Southern Ocean Toothfish fishery.

3. Economic Benefits to Canterbury and New Zealand

The economic impact analysis was carried out using the same five headings adopted in Saunders *et al.* (2013). This is to allow a simple comparison with the findings in the previous study. The five headings are:

- National Antarctic Programmes
- Tourism and Events
- Fishing
- Education and Research
- Antarctic Heritage

The sections in this chapter provide a description of how the calculations were made for each item. The final section then presents the aggregated tables with a commentary on the significance of the figures.

3.1 National Antarctic Programmes

The analysis covered four international Antarctic programmes: New Zealand, United States, Italy and the Republic of Korea. The New Zealand, Italian and American programmes provided data on their expenditure on goods and services (including the Christchurch office costs of Antarctica New Zealand), aggregated by industry sector using standard categories determined by the AERU. The Korean programme provided us with data on number of ship visits as well as expenses on air fuel and ship oil and helicopter hire. For Korea, estimates were made for these ships for refuelling and stocking up on supplies for the vessels heading to Antarctica.

Similarly, estimates were made for the 2015 visit of China's icebreaker *Xuě Lóng* mentioned in Section 2.6. The vessel docked in Lyttelton for refuelling and stocking up on supplies before heading to Antarctica.

Based on these calculations, the annual total direct expenditure of the programmes in Canterbury is estimated to be \$51 million and in New Zealand estimated to be \$70 million.

3.2 Tourism and Events

The Korean, Italian and United States Antarctic Programme were able to advise how many extra nights their personnel spent in New Zealand following the end of their duties on the programme. The total expenditure from these tourist nights were valued using the Statistics New Zealand average spend per guest night (Statistics New Zealand, 2015).

Antarctic Heritage Cruises was able to provide an estimate of their tourism revenue associated with cruises to Antarctica and Sub-Antarctic Islands, and it was further assumed that each of its passengers spend on average one night in New Zealand before and after the cruise.

In 2015, Queenstown-based tourism operator Real Journeys purchased Christchurch's International Antarctic Centre from Christchurch Airport. They were able to provide data on their total revenue, which they noted had been affected by fewer tourism visitors to Christchurch after the 2010 to 2011 earthquakes. Similarly, the Canterbury Museum was able to provide an estimate of the proportion of its annual budget that is devoted to their Antarctic collection. It was further assumed that these Canterbury-based attractions (i.e., the International Antarctic Centre and the Canterbury Museum) kept visitors an extra night in Canterbury, a night that they would otherwise have spent in another part of New Zealand.

The Christchurch City Council was able to advise the total budget for the New Zealand IceFest and the Mayoral reception at the beginning of the Antarctica Summer Season in 2014.

International conferences on Antarctica are commonly held in New Zealand. In 2014, the Royal Society of New Zealand, sponsored by Antarctica New Zealand hosted the XXXIII Scientific Committee for Antarctic Research (SCAR) Biennial Meeting and Open Science Conference in Auckland, which attracted more than 1,200 delegates. This event was the largest gathering of Antarctic researchers ever in New Zealand. It was assumed that these delegates spent three nights in Auckland and paid a conference fee.

Based on these calculations, the annual total direct expenditure on tourism sector from Antarctic-related activities in Canterbury is estimated to be \$60 million and elsewhere in New Zealand are estimated to be \$61 million.

3.3 Fishing

The Ministry of Primary Industries provided an estimate of the average annual catch in the 2014/2015 fishing season in its Fisheries Management Area FMA6. The analysis assumed that 25 per cent of the catch was landed in Canterbury and 75 per cent in the rest of the country. This allocation is based on actual data used in the Saunders *et al.* (2007) report. Based on these calculations, the annual total direct expenditure of the programmes in Canterbury is estimated to be \$9 million and in New Zealand estimated to be \$34 million.

3.4 Education and Research

Data on research programmes and their funds was obtained by searching websites of the Ministry of Business, Innovation and Employment (MBIE), Marsden Fund, CRI Core Funding, New Zealand Antarctic Research Institute (NZARI), National Science Challenge and LU research programme. For Canterbury research funding from the University of Canterbury; Callaghan Innovation; Landcare Research was included. In addition to that, the national figure included funding for AUT; Bodeker Scientific, GNS Science, NZARI; Niwa; University of Auckland; University of Otago; University of Waikato; Victory University of Wellington.

Allowance was also made for PhD, Masters, Post-graduate certificate and students doing undergraduate course at Gateway Antarctica at Canterbury University. This was 11 PhD, 6 Masters, 16 Post graduate certificate and 284 students undertaking an undergraduate course. Additionally, Lincoln University identified one PhD student undertaking Antarctic related research. For these students, domestic tuition fees for the related degree/ course were applied; and for the PhD and Masters students the SAC subsidy (from the Student Achievement Component fund) for a science postgraduate degree (approximately \$16,000) was added.

Based on these calculations, the annual total direct expenditure on research and education in Canterbury is estimated to be \$3 million and in New Zealand estimated to be \$10 million.

3.5 Antarctic Heritage

The value of Antarctic heritage activities was taken from the *Annual Report* of the Antarctic Heritage Trust (2015b) based on the average of the Trust's 2014/2015 (June years) revenue. This source does not provide a detailed breakdown of expenditure and so the analysis adopted the same distribution between Canterbury and the rest of New Zealand (75 per cent and 25 per cent respectively) as was adopted in Saunders *et al.* (2013). This produced a figure for Canterbury of \$2.5 million and for New Zealand of \$3.3 million.

3.6 Aggregated Economic Impacts

Table 2 summarises the direct economic impacts explained in the previous sections of this chapter. It estimates that the aggregated direct economic impact is \$125 million for the Canterbury economy and \$178 million for the New Zealand economy. It also shows that the tourism sector is particularly important, accounting for almost 50 per cent of the total value at the regional level. A further 41 per cent comes from the National Antarctic Programmes. Similarly, the National Antarctic Programmes are also particularly important for the national benefits (39 per cent of the total value).

Table 2: Direct Impacts of Antarctic-related Activities, Canterbury and New Zealand, 2015

Industry Sector \$ millions	Canterbury	Rest of NZ	New Zealand
National Antarctic Programmes	51.1	18.9	70.0
Tourism	59.9	0.7	60.6
Fishing	8.6	25.8	34.4
Education and Research	2.7	6.9	9.5
Antarctic Heritage	2.5	0.8	3.3
TOTALS	124.7	53.0	177.7

Source: AERU calculations.

These findings, whilst not directly comparable with those in the AERU's earlier study, do show a change. Where possible, similar sources have been used for the two studies, however more robust data was available for 2015, in particular for fishing and the Korean and Italian programmes. Table 3 reproduces the same table from Saunders *et al.* (2013). Nevertheless, the analysis records an overall increase in the direct impact in Canterbury, with large increases in the National Antarctic Programmes and Tourism, offset by a significantly smaller estimate for fishing.

Table 3: Direct Impacts of Antarctic-related Activities, Canterbury and New Zealand, 2013

Industry Sector \$ millions	Canterbury	Rest of NZ	New Zealand
National Antarctic Programmes	38.7	7.8	46.5
Tourism	31.8	-2.8	29.0
Fishing	23.3	47.6	71.0
Education and Research	4.9	4.8	9.8
Antarctic Heritage	4.1	1.4	5.5
TOTALS	102.9	58.8	161.7

Source: Saunders *et al.* (2013).

The AERU research team analysed the expenditures shown in Table 2 by industry category to show how the economic impact is distributed in different parts of the Canterbury and national economies. These aggregate values are shown in Table 4. Again tourism (recorded in the category Accommodation, Restaurants and Bars) dominates the New Zealand impacts, followed by fishing (recorded in the Primary Industries), then Business Services. Similarly, in the Canterbury region, Accommodation, Restaurants and Bars is the largest sector, reflecting

the importance of accommodation (and associated spending) for Antarctic personnel and for tourists attracted by Antarctic themes, followed by wholesale and retail trade, then the transport sector.

Table 4: Antarctic-related Activities Expenditure Analysed by Industry Sector, 2015

Industry Sector \$ millions	Canterbury	New Zealand
Primary Industries	8.6	34.4
Manufacturing	1.0	1.6
Utilities	0.0	0.0
Construction	0.7	0.8
Wholesale and Retail Trade	18.2	20.0
Accommodation, Restaurants and Bars	69.6	70.6
Transport	15.6	21.2
Communication Services	0.1	1.0
Finance, Insurance and Property	0.1	0.1
Business Services	8.3	21.3
Cultural and Recreational Services	0.1	3.3
Other services	2.5	3.3
TOTALS	124.7	177.7

Note:

Source: AERU calculations.

The final stage of the analysis is to use standard multipliers (obtained from Butcher, 2005; 2007) to estimate the downstream and household expenditure consequences of the direct impacts. The analysis has been undertaken separately for Canterbury and for New Zealand, using regional and national multipliers respectively. In both tables, the direct impact is taken from Table 2; these figures show the revenue received by suppliers of goods and services to the five categories of activities. These suppliers demand goods and services from their own supply chain, and this impact is known as the indirect impact. Finally, households receiving income from the direct and indirect impacts spend some of that income on further consumption goods and services; this is known as the induced impact. The sum of the direct, indirect and induced impacts is termed the total impact.

Finally, it is possible to use another set of multipliers (obtained by Butcher, 2005; 2007) to estimate the impact that these impacts have on full-time equivalent employment. This is based on current employment ratios in the economy. The final column of Tables 5 and 6 show the number of full-time equivalent employment associated with the total impact.

Table 5: Direct, Indirect, Induced, Total and Employment Impacts of Antarctic-related Activities, Canterbury, 2015

Industry Sector \$ millions	Direct Impacts	Indirect Impacts	Induced Impacts	Total Impacts	Total Employment Impact (No. of FTE Jobs)
NAPs	51.1	35.4	8.7	95.1	1,161
Tourism	59.9	46.4	11.4	117.8	2,355
Fishing	8.6	4.2	0.6	13.5	44
Research	2.7	1.5	0.6	4.7	58
Heritage	2.5	1.5	0.4	4.3	56
TOTALS	124.7	89.0	21.8	235.4	3,675

Note: NAPs is National Antarctic Programmes. FTE is Full Time Equivalent.

Source: AERU calculations.

Table 6: Direct, Indirect, Induced, Total and Employment Impacts of Antarctic-related Activities, New Zealand, 2015

Industry Sector \$ millions	Direct Impacts	Indirect Impacts	Induced Impacts	Total Impacts	Total Employment Impact (No. of FTE Jobs)
NAPs	70.0	61.6	35.6	167.1	2,516
Tourism	60.6	57.6	31.5	149.6	3,003
Fishing	34.4	37.5	13.4	85.3	908
Research	9.5	6.5	6.1	22.1	315
Heritage	3.3	2.7	1.4	7.4	96
TOTALS	177.7	165.7	88.0	431.5	6,838

Note: NAPs is National Antarctic Programmes. FTE is Full Time Equivalent.

Source: AERU calculations.

This analysis suggests that in the current structure of the New Zealand economy, 3,675 jobs in Canterbury depend on Antarctic-related activities in the region and 6,838 jobs nationally are based on Antarctic-related activities.

4. Future Antarctic-related Developments and Opportunities

Since the first study in 2007, the four National Antarctic Programmes of New Zealand, the United States, Korea and Italy have continued to develop. The benefits of tourism to Antarctica and the Antarctic-related attractions in Christchurch and New Zealand have also increased, while the resources devoted to Antarctic science *in situ*, in Christchurch and in other parts of New Zealand have continued to grow.

As in previous reports, interviews with organisations involved in Antarctic-related activities resulted in feedback that was almost entirely positive. This chapter will describe these positive aspects but will also point out some issues that organisations identified in our discussions. The chapter will further outline future developments around the Antarctic-related activities in Christchurch, their potential opportunities for economic contribution but also any identified issues that may affect the sector in the future.

4.1 USAP investment into Antarctic infrastructure: McMurdo reconstruction

The USAP is dedicated to high long term capital investments in Antarctic infrastructure spread across three major stations on the continent: McMurdo, Palmer, and the South Pole. This includes support of USAP's scientific mission through a series of redevelopments and upgrades to the buildings, logistics and technology of these stations. This work will serve Antarctica's ongoing scientific mission over the next 50 years. McMurdo is planning its largest long term capital investment arising from the 2010 review of the station to determine how it can best serve its scientific and diplomatic role in the future. This project is named *Antarctic Infrastructure and Modernization for Science (AIMS)* and its planning will re-evaluate the station's structures from a long term, strategic perspective, focusing on how the station will serve the scientific community for the next 50 years (NSF, 2015a). This would provide for upgrades of current systems, such as communications and ship support, as well as shifting and refining core on-site facilities (NSF, 2015b). For example, 19 distributed warehouses will be consolidated into three. This project is significant with estimated total expenditure of US\$300 million. It aims to start in 2019/20 and will take several years (NSF, 2016).

The McMurdo reconstruction presents opportunities for Christchurch and other parts of New Zealand as there will be a need for specialist machinery, warehousing, geotechnical support and the like. Also, in order to undertake the McMurdo reconstruction, the US will undertake winter flights, starting from the 2016 winter season; hence there will be a constant, all-year-round flow of people travelling from Christchurch to Antarctica. Furthermore, this will ensure all-year-round supply support with the US C17 aircraft, which may open up science possibilities in the winter season. Additional logistic and personnel requirements arising from

these winter flights need to be catered for, which presents further value and opportunities for businesses in Christchurch and would further contribute to the city's economy.

4.2 Investment into the expansion of Antarctic science in Christchurch

Christchurch City hosts some major assets for Antarctic-related activities, including the facilities at Christchurch International Airport, Lyttelton Port, and the New Zealand base for the United States Antarctic Programme, the offices and logistics depot of Antarctica New Zealand, Gateway Antarctica at the University of Canterbury, the International Antarctic Centre and the Antarctic collection at Canterbury Museum.

As mentioned in the previous report, a Working Group chaired by Margaret Austin, CNZM, proposed that “the opportunity exists for a dedicated Antarctic Research Initiative at Christchurch International Airport as the keystone of a global centre of excellence to facilitate and enhance all aspects of Antarctic and Southern Ocean Research, Education, Logistics and Tourism”. The name Antarctic Endeavour Christchurch (AEC) was suggested for this initiative.

The aim of the facility would be to provide dedicated science facilities to support Antarctica research. The facility would complement and enhance existing research facilities in New Zealand and encourage and enhance collaboration and integration of science activity within New Zealand and between New Zealand and international scientists. Critical to the facility would be extension and communication of the activities undertaken in Antarctica to inform New Zealanders and visitors about the contribution that Antarctic science makes.

At the SCAR conference in 2014, the facility was given high priority for future research needs of Antarctica research. It would also support the high priority of reducing the human foot print at Antarctica by facilitating more research at the facility rather than on the ice. An international example is the University of Tasmania's science facility in Hobart – the Institute for Marine and Antarctic Studies (IMAS). The construction of this at Hobart's waterfront was completed at the end of 2013 (www.utas.edu.au/commercial-services-development/building-works/completed-projects/institute-for-marine-and-antarctic-studies-imas).

It is understood by several people who participated in the interviews for this report that the AEC would be important for Christchurch's ambition as a Gateway City, but the business case evidence is still to be developed. There are also plans to include it as part of the Christchurch earthquake rebuild. A developer has already indicated that subject to a favourable business case they would be prepared to invest in the proposed purpose-built research facility. Different operational models are now being explored for the establishment and initiation of the facility including the possibility of being a Centre of Research Excellence with funding from the Tertiary Education Commission.

4.3 Investment into the expansion of science in Antarctica

Science in Antarctica undertaken by Antarctica New Zealand is expanding – not in numbers of people involved – but in ambition and complexity as well as time and expertise. This includes the geographical expansion of research sites being as far as 1,000km from Scott Base. As a consequence, logistics and support requirements around this research are becoming more

complex, more specialist equipment needs to be transported over longer distances but also extra personnel such as engineers are required to conduct the more complex scientific research.

Investment in expansion of scientific research in Antarctica will help increase scientific knowledge. Several interviewees commented on New Zealand's very advanced science in Antarctica with the country's scientific excellence and knowledge in Antarctic research acknowledged by other National Programmes. This intellectual property of scientific research can be useful for emerging Antarctic science countries such as China and Korea with their plans to expand research in Antarctica. Hence, Antarctica New Zealand could assist to promote this knowledge and the country as a place of innovation and scientific excellence in Antarctic research.

4.4 Current upgrade of Scott Base in Antarctica

As mentioned in Section 2.1, the building of Scott Base began in 1956 to support the Trans-Antarctic Expedition (TAE) and International Geophysical Year (IGY) of 1956-1959. The first building of the first base built by New Zealand in Antarctica was completed on 20 January 1957. The replacement of the original base with a larger more permanent base began in 1976/77 and today only three buildings of the original Scott Base remain: the TAE/IGY Hut, which contains material recording New Zealand's involvement in Antarctica since 1957, and two science huts built for the IGY.

The base is currently comprised of a collection of green buildings which are linked by all-weather corridors. These buildings can accommodate up to 85 people over summer, with a "skeleton staff" of between 10 and 14 people remaining over the winter (see <http://antarcticanz.govt.nz/scott-base/history>). Hence, buildings and other assets at Scott Base are almost 40 years old and in order to host and cater for operational and science personnel in the future, these need further upgrading

Some of this work has commenced. In a first stage in 2014/ 2015 an eight-bed bunkroom was reconfigured into two single rooms with ensuites and a communal lounge for "invited visitors" (cost \$161,000). Also, the base's administration block was being transformed into an open-plan area (cost \$293,000; www.stuff.co.nz/science/10137387/Multimillion-dollar-revamp-for-Antarctic-Base). The second stage which is the major project of this upgrade includes a major reconfiguration of the Hillary Field Centre (HFC). The HFC is a two-storey, 1,800 square metre heated field support facility at Scott Base providing cargo receipt and issue, field party preparation, general stores storage, refrigerated stores including a -30 degree freezer, drying room for field gear, offices, briefing and training rooms, gym, field equipment maintenance and storage areas. It became operational for the 2005/06 Antarctic season. The HFC project has been in construction at Scott base since 2015 and is due for completion in April 2017. Antarctica New Zealand will invest \$6.25 million for this science upgrade to the Field Centre, 70 per cent of which will come from Christchurch suppliers. This aims to enhance both the quality of Antarctica New Zealand's science facilities and New Zealand's position as a leader of science capability on ice and consequently would increase economic contribution, regionally and nationally.

4.5 Future reinvestment of Scott Base in Antarctica

The physical assets at Scott base are coming to the end of their useful life. This needs to be addressed for Antarctica New Zealand to continue to meet its overarching strategic goal for New Zealanders that *"New Zealand's ability to influence the future of Antarctica and the Southern Ocean is secured"* (Antarctica New Zealand, 2014, p. 10).

Antarctica New Zealand currently contributes to this goal primarily through:

- ensuring New Zealand maintains its **active permanent presence** in Antarctica through the continuous operation of Scott Base (permanently occupied since 1957)
- supporting **high quality Antarctic science** conducted by New Zealand researchers
- demonstrating **environmental leadership** through high standards of environmental management and protection of the wider Antarctic environment.

The New Zealand Government has set out *New Zealand Antarctic and Southern Ocean Science Directions and Priorities 2010-2020* for New Zealand. In order to support the science required to address these priorities and to achieve New Zealand's broader strategic objectives for its science and innovation systems, it is suggested that there needs to be a major reinvestment into the facilities at Scott Base, leveraging off the rebuild of US McMurdo. This would allow collaboration and sharing of building equipment with the reconstruction by the US within their AIMS programme (see section 4.1).

It is estimated that to replace the existing infrastructure would cost in the order of \$100 million. If the aim is to enhance the facilities so they are fit for purpose over the next 50 years (taking into account the trend towards greater complexity in Antarctic research discussed in section 4), the total cost is estimated to be \$150 million.

4.6 Increased tourism and business for Christchurch

Christchurch has many Antarctic-related tourist attractions such as the Antarctic Gallery in the Canterbury Museum and the International Antarctic Centre. However, as mentioned in the AERU's 2013 report, greater use could be made of these assets to raise the tourism profile of Christchurch and Canterbury as this could assist to distinguish the city and the region from other cities/ regions nationally and internationally.

The first step in this direction was undertaken by establishing an Antarctic Office in February 2016 (see Section 2.4). The Antarctic Office has a number of roles but one objective is to help facilitate businesses. Regional and national businesses have developed specialist technology and equipment to work in one of the harshest environment in the world and New Zealand scientists are undertaking some technologically very advanced work in Antarctica. Several interviewees pointed out that there is a lack of promotion of these skills which could assist to raise the profile of New Zealand's businesses internationally.

Another objective of the Antarctic Office is to ensure that the city maximises the tourism associated with the Antarctic programmes. There are some plans in place after the tourism industry in Christchurch was greatly affected by the 2010 and 2011 earthquakes. Cruise ships

berth at Akaroa, rather than Lyttelton, and this results in fewer tourists coming into Christchurch. There has been a shortage of hotel beds. Nevertheless, growth over the last twelve months has been strong, returning towards pre-earthquake levels.

As mentioned in Section 3.2 the tourism operator Real Journeys bought the International Antarctic Centre at the airport in 2015. Real Journeys have plans to upgrade the tourist attraction to attract more visitors at an estimated cost of \$2 million to \$3 million. This will be a mix of refurbishment and new development. They are scoping new attractions with two objectives: first, to give the most authentic experience of Antarctica outside that region; and second, to showcase the activities that occur on the ice (especially the science) to enable the general public to understand what the research does and its value. They are consulting with the wider Antarctica community on these purposes.

4.7 Growth in research opportunities

Research in Antarctica is growing, and so are research opportunities and collaborations between polar research institutes and universities. Antarctica New Zealand and the Scott Polar Research Institute at the University of Cambridge in the UK are working together to enhance future research collaboration. This will provide a link between Christchurch and Cambridge as the British researchers aim to use the research facilities in Christchurch and Antarctica which would present an opportunity to promote Christchurch's research profile by contributing to increased understanding of Antarctica. There is also the future growth in astronomical research in Antarctica with new technology meaning that data analysis can be undertaken in New Zealand rather than in Antarctica.

4.8 Strategic value of Lyttelton Port as supplier to Antarctic vessels

Lyttelton Port provides infrastructure for docking, ship maintenance, refuelling and replenishing supplies for vessels heading to Antarctica. However, this strategic value is sometimes not recognised. In particular, the port lacks berthing facilities for Antarctic vessels for both short-term stay for unloading and refuelling or long-term stay for docking the vessel over the winter season. Layup charges at the port can be up to \$1,000 per day. Hence, if a vessel is not able to dock at the port, this can be seen as a 'lost' economic opportunity to Canterbury and is then gained by other ports in New Zealand, predominantly by Port Chalmers in Dunedin.

4.9 Increased activities from National Programmes

Other National Programmes are expanding their facilities in Antarctica. Currently, the Italian and Korean Antarctic programme do not operate their own planes to Antarctica. However, they are building the own (rock) runway in Antarctica, planned to be finished by 2017 (<http://koreaioongangdaily.joins.com/news/article/Article.aspx?aid=2984887>). This would increase the number of flights coming into Christchurch from Antarctica and would further increase the flow of science and staff personnel into the city. This would present an opportunity for Christchurch to increase the economic contribution from Antarctic-related activities from the Italian and Korean Programme.

The Chinese government has recently announced plans to build a fifth research base in in the near future located in the Ross Sea region (www.chinadaily.com.cn/china/2015-01/08/content_19274361.htm and www.aspistrategist.org.au/considering-chinas-strategic-interests-in-antarctica/). This has the potential to increase benefits to New Zealand.

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Appendix 1: Organisations Interviewed

Managers and other staff in the following organisations were interviewed or provided data for this report. The research team is grateful to everyone who agreed to participate in the study.

- Antarctica New Zealand
- United States Antarctica Programme
- Italy Antarctica Programme
- Korea Antarctica Programme
- Canterbury Museum
- Real Journeys
- Heritage Tours
- Gateway Antarctica, University of Canterbury
- Polar Environments, University of Otago
- Antarctic Research Centre, Victoria University of Wellington
- Faculty of Environment, Society and Design, Lincoln University
- Antarctic Office
- IceFest, Christchurch City Council
- Ministry for Primary Industries

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