

Aoraki Mackenzie International Dark Sky Reserve, New Zealand

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1. Identification of the property

1.a Country/State Party: New Zealand

1.b State/Province/Region: Canterbury Region, Te Manahuna / Mackenzie Basin

1.c Name: Aoraki Mackenzie International Dark Sky Reserve

1.d Location

The geographical co-ordinates for the two core sites are:

- Mt John University Observatory near Tekapo: latitude 43° 59' 08" S, longitude 170° 27' 54" E, elevation 1030m above MSL.
- Mt Cook Airport and including the White Horse Hill Camping Ground near Aoraki/Mt Cook village: latitude 43° 46' 01" S, longitude 170° 07' 59" E, elevation 650m above MSL.



Fig. 11.1. Location of the property in New Zealand South Island. Satellite photograph showing the locations of Lake Tekapo (A) and the Aoraki/Mt Cook National Park (B). Source: Google Earth

1.e Maps and Plans

See Figs. 11.2, 11.3 and 11.4.



Fig. 11.2. Topographic map showing the primary core boundary defined by the 800m contour line

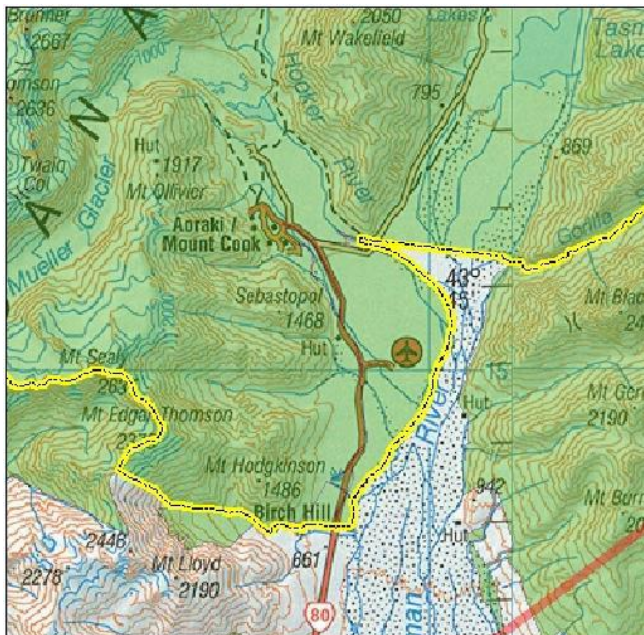


Fig. 11.3. Map showing the boundaries of the secondary core at Mt Cook Airport. The boundaries are clearly defined by State Highway 80, Tasman Valley Rd, and Mt Cook National Park's southern boundary

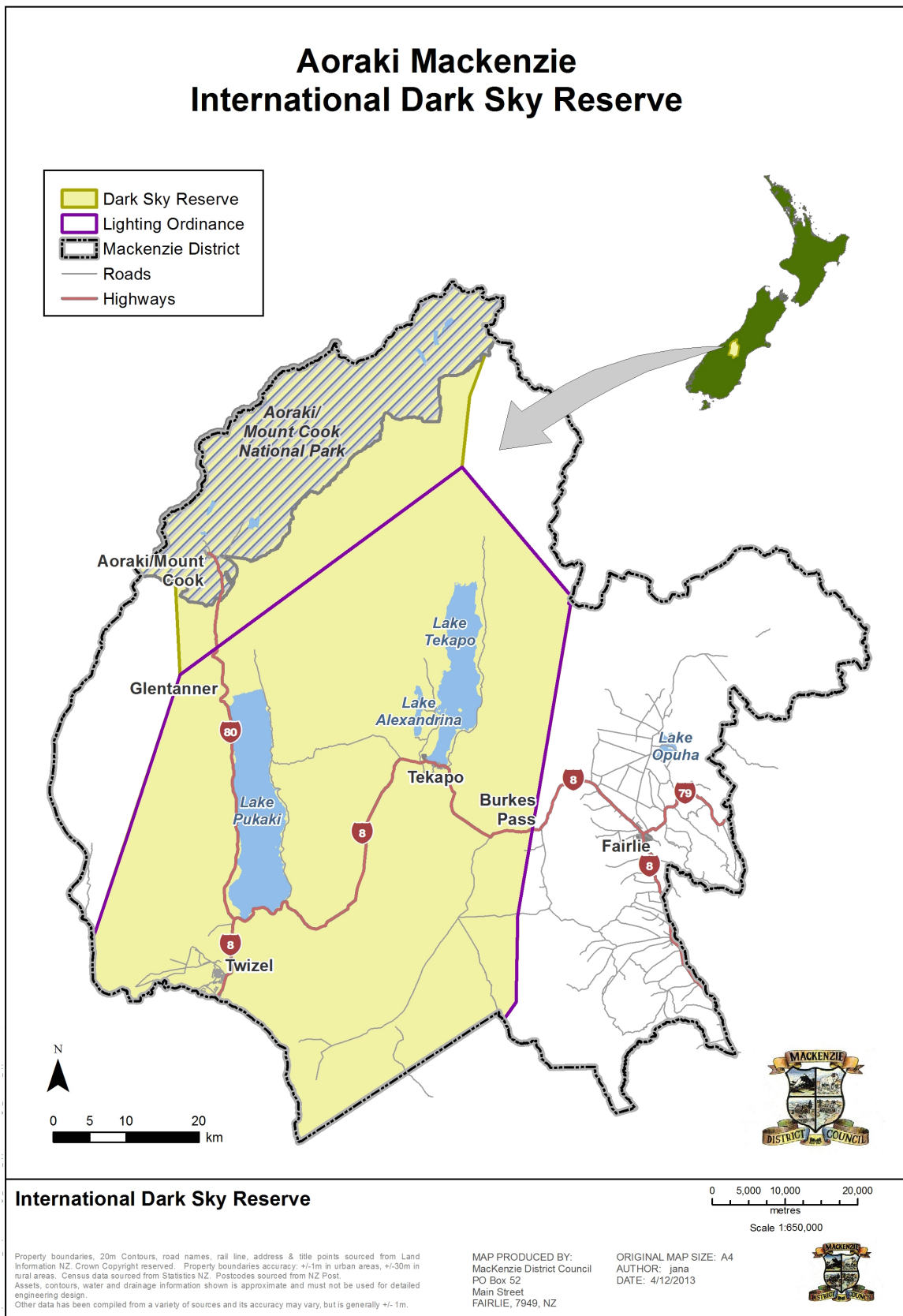


Fig. 11.4. Map showing the boundaries of the secondary core at Mt Cook Airport. The boundaries are clearly defined by State Highway 80, Tasman Valley Rd, and Mt Cook National Park's southern boundary

1.f Area of the property

Aoraki Mackenzie International Dark Sky Reserve is located in the centre of the South Island of New Zealand, in the Canterbury Region, in the place known as Te Manahuna or the Mackenzie Basin (see Fig. 11.1). The property consists of an extensive buffer zone around two core sites at Mount John Observatory and Mount Cook Airport.

Aoraki Mackenzie International Dark Sky Reserve includes

- Lake Tekapo and its tributary, the Godley Valley;
- Lake Pukaki; and
- Aoraki/Mount Cook National Park Village within Te Wāhipounamu – South West New Zealand World Heritage Site (#551).

Aoraki Mackenzie International Dark Sky Reserve extends approximately 70 km (43 miles) from north to south and 90 km (56 miles) from east to west at its longest and widest points (see Fig. 11.1). The Southern Alps and Aoraki/Mount Cook National Park, which is also within Te Wāhipounamu – South West New Zealand World Heritage Site (#551), constitute its western edge.

The buffer zone of *Aoraki Mackenzie International Dark Sky Reserve* includes the whole of the Aoraki/Mount Cook National Park (see Fig. 11.4).

The areas concerned are:

Mount John University Observatory Core	23 hectares
Mount Cook Village Airport Core	c. 15 km ²
Buffer zone in Mackenzie Basin including Aoraki/Mount Cook National Park	4,367 km ²
Aoraki/Mount Cook National Park	70 km ²

2. Description

2.a Description of the property

Significant Features of the Property

Aoraki Mackenzie International Dark Sky Reserve is described as a Mixed Starlight Reserve as defined by the *Starlight Reserve: Concept, Dimensions, Categories, Criteria, Recommendations* criteria (Marín and Orlando 2009), where two or more different categories of Starlight Sites are combined. These could be astronomical and scientific sites of significance, natural sites and Starlight Landscapes, and human inhabited Starlight Oases. Additionally, the ICOMOS/IAU Thematic Study (Ruggles and Cotte 2010) describes the Reserve as a “multifunctional” window to the universe as the site exhibits several significant qualities and exceptional natural and cultural values in one location. A “layering” approach is used to build a case for a Mixed Starlight Reserve whereby the natural, cultural, scientific and astronomical heritage values of the site are interwoven.

Natural Property – Important Physical Attributes

The Mackenzie Basin is a large, dry, flat area of land covered in grasses and tussocks ringed with high snow-capped mountains. The many lakes of glacial origin, tarns and kettleholes define the character of the whole area. Pastoral farming introduced fauna and flora and hydro-

electricity developments have altered the landscape over the last 150 years. The Mackenzie Basin experiences extremes of cold, drought and wind. It has shallow, stony, porous and infertile soil. Tough, slow-growing grasses and woody plants make the most of the formidable soil. The Mackenzie has a very low risk of fire, despite the dry, drought-prone terrain. This unique environment means there are a number of important ecosystems which were relatively uncommon even before the arrival of Māori and European settlers. Access to irrigation water will determine the spread of landscape change in the future. Given the variability of income from dryland farming, some “run holders” (holders of Crown pastoral leases) supplement their incomes from farming with tourism and other businesses and this may increase.

Natural Beauty

The Mackenzie Basin is an immense golden tussock-covered floodplain wide open to a vast sky surrounded by soaring mountain peaks. Volumes of glacial water pour into long braided rivers and deep lakes. The *Canterbury Regional Landscape Study Review* (Environmental Canterbury 2010: 142) recently identified the entire Mackenzie Basin, including the valley floor and surrounding slopes and ridgelines, as an Outstanding Natural Feature and Landscape (ONF/L). Only a small section around and to the south of Twizel has been excluded owing to high levels of modification in this area. This means that the Aoraki Mackenzie International Dark Sky Reserve site bounded by the current Outdoor Lighting Restriction area falls within this area of ONF/L. ONF/L was granted on the basis of several key landscape values, including aesthetic values such as the striking colour of Lakes Tekapo and Pūkaki forming “one of the most memorable landscapes in the country”. The sky is a crucial element by day as the open plains mean that the dramatic cloud effects of “norwester” weather are more vividly experienced than anywhere else in the country. The mountains of the Te Wāhipounamu World Heritage Site ring the western and northern boundaries of the International Dark Sky Reserve. The contrast between these mountains and Aoraki/Mt Cook itself and the plains is considered a highlight of the view.

The landscape as it appears now has been altered by human activity. With the arrival of Māori (750–1300 CE) the landscape began to undergo a process of change, converting from a mixture of forest, scrub and tussock grassland to predominately dense tall and short tussocks (Walker 2010). This process of change was intensified by the pastoral grazing techniques of Pākehā (European) settlers since the late 19th century and the introduction of foreign species of flora and fauna. This resulted in the more sparsely covered tussock landscape present today, though essentially the landscape looks as it would have when the first Pākehā (Europeans) arrived in the area. Farming sheep and cattle maintains landscape features such as the extensive tussock grasslands and it is these features that contribute to the natural beauty of the area. UNESCO’s *Operational Guidelines for the Implementation of the World Heritage Convention* indicate that human activity of “traditional societies” (Māori) and “local communities” (pastoral farmers) is acceptable as it is consistent with the OUV of the area. The man-made features such as the open tussock grassland combined with natural features such as glacial lakes and braided rivers provide the scenic beauty and aesthetic importance of the landscape.

Tekapo and Aoraki/Mt Cook are major tourist destinations between Christchurch and Queenstown. As well as providing inspiration for artists and writers, the Basin’s natural beauty features prominently in local television commercials and international marketing campaigns promoting New Zealand as a tourist destination. The general absence of people and human activity serve to enhance the area’s natural scenic beauty and aesthetic importance.

The night sky and its celestial bodies are superlative natural phenomena. The lack of light pollution, the clarity of the night sky and the wide open vistas of the Mackenzie Basin are features that make this site special and distinguish it from other locations around the world with



Fig. 11.5. The Milky Way, Mt John, Tekapo. Photograph: Fraser Gunn

equally beautiful night-time vistas. These features combine to create an area in which to view the exceptional natural beauty and aesthetic importance of the night sky. The stars and planets visible in the night sky contribute to a sense of place and the site's natural heritage. The sky is a cultural resource common to all humanity, as outlined in the Introduction of the first Thematic Study (Ruggles and Cotte 2010: 6).

Aoraki Mackenzie International Dark Sky Reserve is appreciated for the integrity, character and beauty of its rural landscape where the natural beauty and the rural beauty of the landscape combine with the area's astronomical heritage. The landscape also has an historical and social context in addition to its ecological and geological context. The issue of past human influence being viewed as "spoiling" the physical attributes of the basin's natural beauty becomes less applicable.

Furthermore, the physical attributes of the geology and biodiversity of Aoraki Mackenzie International Dark Sky Reserve are interpreted here as enhancing the heritage value of the dark night sky.

Geology

The Mackenzie Basin, the largest inter-montane basin in New Zealand, is a geomorphically significant area. Many of the landforms present in the Basin are the result of late Pleistocene glacial advances and retreats occurring 13,000 to 130,000 years ago. A large number of geo-preservation sites exist in the area and can be found listed in the *Mackenzie District Council District Plan 2004* (Mackenzie District Council 2004). The most notable sites within the Lighting Ordinance include G7, G8, G9, G10, G11, G13, G14, G15, G16, G21, G23 and G25. Several of these are situated within the buffer zone for the Aoraki Mackenzie International Dark Sky

Reserve, as delineated by the Outdoor Lighting Restriction area (Fig. 11.4). This is significant for World Heritage status for this particular part of the Basin. These notable sites include the Tasman River Outwash Plain (G7), one of the biggest fluvio-glacial outwash plains in New Zealand; Landslip Creek Lateral Moraine (G8), the best example of a lateral moraine in New Zealand; Glenmore Station Kame (G11), the best example of a large kame in New Zealand; and Mount John itself (G16), which is an excellent example of a *rôche moutonnée* and provides a superb view of many of the features listed. All sites are identified as having extremely high scientific and educational value. The recent identification of the entire Mackenzie Basin as an ONF/L by the *Canterbury Regional Landscape Study Review* resulted from the legibility of the Basin's formative glacial processes, expressed by landscape features such as moraines, *rôches moutonnées*, hanging valleys, terraces, fans and the glacial outwash plains. The original Te Wāhipounamu World Heritage Site nomination contended "the only limitation to the integrity of the Pleistocene imprint is the absence of the glacial outwash basins and large lakes along the eastern margin" of the site (Department of Conservation 1989: 57).

Biodiversity

The Mackenzie Basin contains many important naturally rare ecosystems. Naturally rare ecosystems are types of ecosystems that were uncommon even before the arrival of humans in the area. The inland alluvial surfaces, inland dune systems, kettleholes and braided rivers of the Mackenzie Basin provide the habitat for many rare and threatened native and endemic species of flora and fauna. Notably, braided river landscapes are globally rare and the Mackenzie Basin contains the largest concentration of braided river habitat in New Zealand at approximately 20,000 ha. All or parts of the Godley, Macaulay, Cass, Tekapo and Tasman tributaries fall within the buffer zone or Outdoor Lighting Restriction area.

There are conservation areas managed by the Conservation Department scattered throughout the Aoraki Mackenzie International Dark Sky Reserve area. Important endemic and threatened species are found within these reserve areas as well as outside them where they may not be as well protected as they would be under Department of Conservation administration.

The Mackenzie Basin is home to a number of freshwater fish species including Lowland Longjaw Galaxias; Bignose Galaxias; Upland Longjaw Galaxias; Koaro; Longfin Eel; Alpine Galaxias; Canterbury Galaxias; Upland Bully; and Common Bully. There are also significant populations of endemic invertebrates in the Basin: Knobbled Weevil; Robust Grasshopper; Small High Country Grasshopper; Moths and Butterflies; Ground Beetle; Ground Weta and large Dragon Flies. Birds living in the Mackenzie Basin include Black Stilt; Black-Billed Gull; Black-Fronted Tern; Grey Duck; Southern Crested Grebe; Eastern Falcon; Banded Dotterel; Wrybill; Caspian Tern; Rockwren; New Zealand Pipit; South Island Oystercatcher; Kea and Pied Stilt. The Mackenzie is also home to the lizard species Spotted Skink, Scree Skink, Long-Toed Skink, and the rarely seen Jewelled Gecko. Additionally, the Mackenzie Basin is an important habitat for flora, and is home to approximately 39% of threatened flora in Canterbury. There are at least 32 plant varieties in the area that can be classified as threatened, which means these species are considered to be nationally critical, vulnerable, or endangered.

"Project River Recovery" (PRR) was launched in 1991 to mitigate the effects of the hydroelectricity developments on wetland and braided riverbeds. It is funded by Meridian Energy and the Department of Conservation to control weeds, research riverbed predators, undertake ecological monitoring, advocacy, and the construction of new wetlands to encourage native birds to nest there. A review of the project by Brian Caruso (2006) noted that about half of New Zealand's bird habitat on braided riverbed is in the Mackenzie Basin. While braided rivers



Fig. 11.6. Altar window in the Church of the Good Shepherd, designed “to encompass the beauty of God’s creation”. Photograph: Fraser Gunn

are geologically unusual, “their plant and animal communities make them unique” as birds adapt to this dynamic and complex environment. Biodiversity work is focused on the kakī/black stilt, one of the world’s rarest wading birds. Increasing kakī numbers and the strength of the research are among the indicators that this is a world class, effective ecological programme.

Aoraki Mackenzie International Dark Sky Reserve as Cultural Landscape

Aoraki Mackenzie International Dark Sky Reserve is a Cultural Landscape that includes the Dark Sky and Observatories. The sky is very much part of the landscape in the Reserve and is identified by both Māori and Pākehā as an integral part of their natural and cultural heritage.

Both Māori and Pākehā speak of spiritual connections and spiritual places within the Aoraki Mackenzie International Dark Sky Reserve area. Participation and attachments are expressed through food collection and pastoral livelihoods and the meanings given to the sky, the land, the waters and stargazing. These expressions are made visible in literature, drawing, painting, sculpture, oral traditions, scientific endeavour, cultural heritage sites, and tourist and educational interpretations.

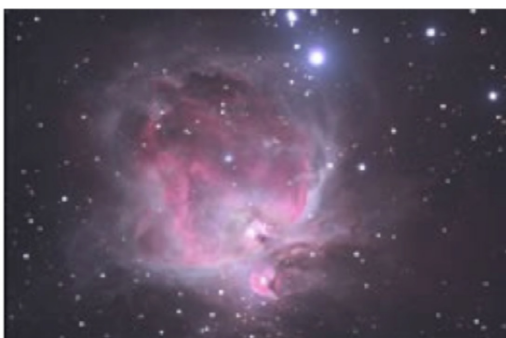


Fig. 11.7. Orion nebula. Photograph: Fraser Gunn

Astronomy

Significant sites exist at Mt John University Observatory, Tekapo, Mt Cook Village and Mt Cook Airport for observing the stars. These sites are important for astronomy and science as well as providing access for the general public to pursue wonderment about stars and celestial phenomena in an outstanding rural environment. Because of the clarity of the skies and Lighting Ordinances protecting the dark-sky from village lights, astrophotography is possible from the balconies of accommodation in Tekapo, Aoraki/Mt Cook and surrounds. There are four research telescopes at Mt John. The most recent is a result of collaboration between scientists in New Zealand and Nagoya University in Japan aimed at discovering extrasolar planets using the gravitational microlensing technique. The Microlensing Observations in Astrophysics (MOA) project has had an involvement in all the extrasolar planet discoveries that have used this technique since the first discovery in 2003.

Traditional Māori Culture

Aoraki/Mt Cook, visible from many parts of the Mackenzie Basin, is the ancestor of Ngāi Tahu Whānui (members of the Ngāi Tahu *iwi* or tribe) and contains many powerful messages. The story of Aoraki is told in any important document to do with the area, from tourist websites to resource management plans and a 20-minute 3D digital presentation at Aoraki/Mt Cook Planetarium. It is a notable feature in the Department of Conservation's presentation of the area because of the *tōpuni* status (an official statement of cultural values) over Aoraki/Mt Cook. The recent Cultural Impact Assessment undertaken for the proposed change to the Mackenzie District Plan highlights the value of unimpeded vistas. "Visual catchments were seen by Ngāi Tahu as essential to maintaining the relationships with these culturally significant landscapes". "The visual catchments and view shafts between the southern shores of the lakes and the mountains in the north were particularly important to Ngāi Tahu for the purpose of maintaining relationships with those places". The entire Mackenzie Basin is a significant ancestral landscape to Ngāi Tahu.

Te Manahuna is the traditional name for the Mackenzie Pass and Basin. The nearest *marae* is Arowhenua, near Timaru, but the area is also important to Ngāti Māmoe who travelled to it up the Waitaki River. Māori continue to travel into Te Manahuna to fish and gather food from land and water sources (*mahinga kai*). Access to several Nohoanga sites that are reserves allowing Ngāi Tahu access to natural resources within the agricultural landscape fall within the International Dark Sky Reserve. Like *Tōpuni*, these have been guaranteed by the Ngāi Tahu Claims Settlement Act 1998.

Pākehā land management has changed Māori relationships to the area, however. Ngāi Tahu, in collaboration with Outward Bound based at Anakiwa, have developed an enterprise with an educational focus. "Aoraki Bound" (www.ngaitahu.iwi.nz/whanau/aoraki-bound/) is a course that combines 8 days at an Outward Bound facility with 12 days on a journey from Anakiwa in the Marlborough Sounds to the base of Aoraki/Mt Cook. One of its main objectives is for students "to experience the majesty of our lands and waters; to gain an understanding of *kaitiakitanga* [guardianship] ... and commit to the protection and enhancement of our environment and its *Taonga*". The purpose is to develop an "increased understanding of Ngāi Tahu culture, beliefs, language and history" and to enhance a "sense of connection and identity" among participants. The course is open to anyone; however, its central aim is the cultural revitalization of Ngāi Tahu as individuals and as a collective and is part of reclaiming traditional relationships with the land through participation and asserting control over the interpretation of their heritage landscapes.



Fig. 11.8. Farming requires working dogs.
Photograph: Mark Ivey

Māori Rock Art (Tuhituhi Neherā) and Oral History (Tāhuhu Kōrero)

Te Ana Ngāi Tahu Rock Art Centre (www.teana.co.nz) opened in December 2010 and is based within the Timaru Visitor Information Centre. It provides accessible and culturally authentic interpretation of some of the most significant examples of Māori rock art in New Zealand offering insights into the mythology and cultural heritage of Māori from the surrounding region. The Rock Art sites are located on the traditional pathways to Aoraki Mackenzie International Dark Sky Reserve and are connected by these ancient pathways to the sites and knowledge within the Reserve. Visitors follow the journey of the people who created the rock art where attention is drawn to time, seasons, earthly and spiritual worlds through an educational, “virtual” rock art experience. Stories are told by Manawhenua (local Ngāi Tahu people). The Rock Art Centre also contributes to the protection and management of the rock art sites as a commitment to future generations, as part of Ngāi Tahu cultural revitalization and as education for visitors about cultural meanings embedded in the landscape.

Pastoral Farming and Cultural Values

Aesthetic, spiritual and cultural values attached to the Aoraki Mackenzie International Dark Sky Reserve area have inspired expression in drawing, painting, sculpture, photography and written and oral literature. Artists including Grahame Sydney describe the effect the landscape has on those who witness it. He says it has “a particularly powerful grip ... imaginations, emotions and memories ... profound and mysterious contentment ... mystical and complex ... in short, we feel spiritually connected” (Sydney 2009: 2).

Dryland pastoral farming began with Pākehā (European) settlement and is orientated around large-scale exports of wool and meat. There is little cropping in the area and the main product is fine wool. Forestry is uncommon and raises concerns over change in the landscape values. Recently deer have also been farmed. The basin was traditionally managed by farmers leasing crown land. Established practices, supported by legislation, maintained this crown property in a difficult environment over the last 150 years. Art tends to emphasise the wilderness values of the landscape or dryland farming and the pioneering element of farming in this difficult and isolated area.

- *Contemporary art — Painting and architecture*

The painter Esther Hope (1885–1975) lived at “The Grampians”, a high-country farm in the Mackenzie Basin. She exemplifies the qualities of much art of the basin. As well as her legacy of paintings from this area, her commissioned drawings and models were turned into design plans by the architect R.S.D. Harman of Christchurch for the Church of the Good Shepherd at Tekapo. The church was built in 1935. As an expression of the relationship between the community and the environment, the church sits on ground left in its natural state covered with matagouri, tussock and rock as requested by the land donor, Mr George

Murray from Braemar Station. Adjoining land was also gifted to ensure the church remained in distinctive isolation.

- *Sculpture*

Sculptor Innes Elliot also lived on a pastoral farm in the Mackenzie Basin. Her commissioned public sculpture at Tekapo celebrates not only the “collie dog, without the help of which, the grazing of this mountain county would be impossible” but also the history of the Scottish Highland shepherds who helped manage the properties of run holders. Mackenzie, the folk hero who was the first European to find the route into the Basin, and his dog Friday are also remembered with the phrase “Beannachdan Air na Cu Caorach”, which means “Blessings on the sheep dog”, on the monument plaque.

- *Photography*

Fraser Gunn’s spectacular photography is featured in this Extended Case Study. A remarkable astro-photographer, he captures and interprets the beauty of the dark sky of Aoraki Mackenzie International Dark Sky Reserve. A plethora of photography and digital media — amateur, professional and commercial — is inspired by the outstanding vistas of this area.

- *Writing*

Alan Curnow and Owen Marshall are two of New Zealand’s most significant writers connected to the Mackenzie Basin, the former a poet and the latter a leading fiction writer: “the affinity he feels with its people and landscapes is evident in much of his writing”.

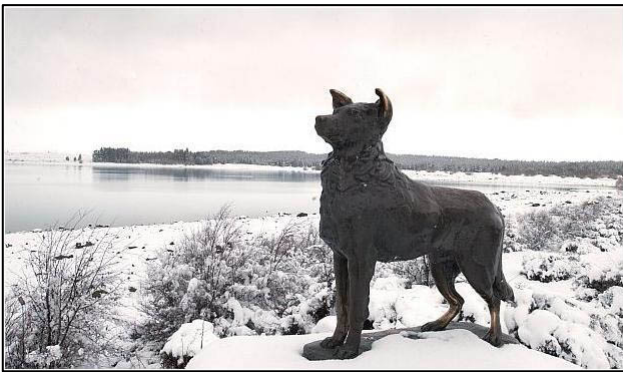


Fig. 11.9. Sculpture: Innes Elliot.
Photograph: John Bisset / Timaru Herald



Fig. 11.10. Matariki. Photograph : Fraser Gunn

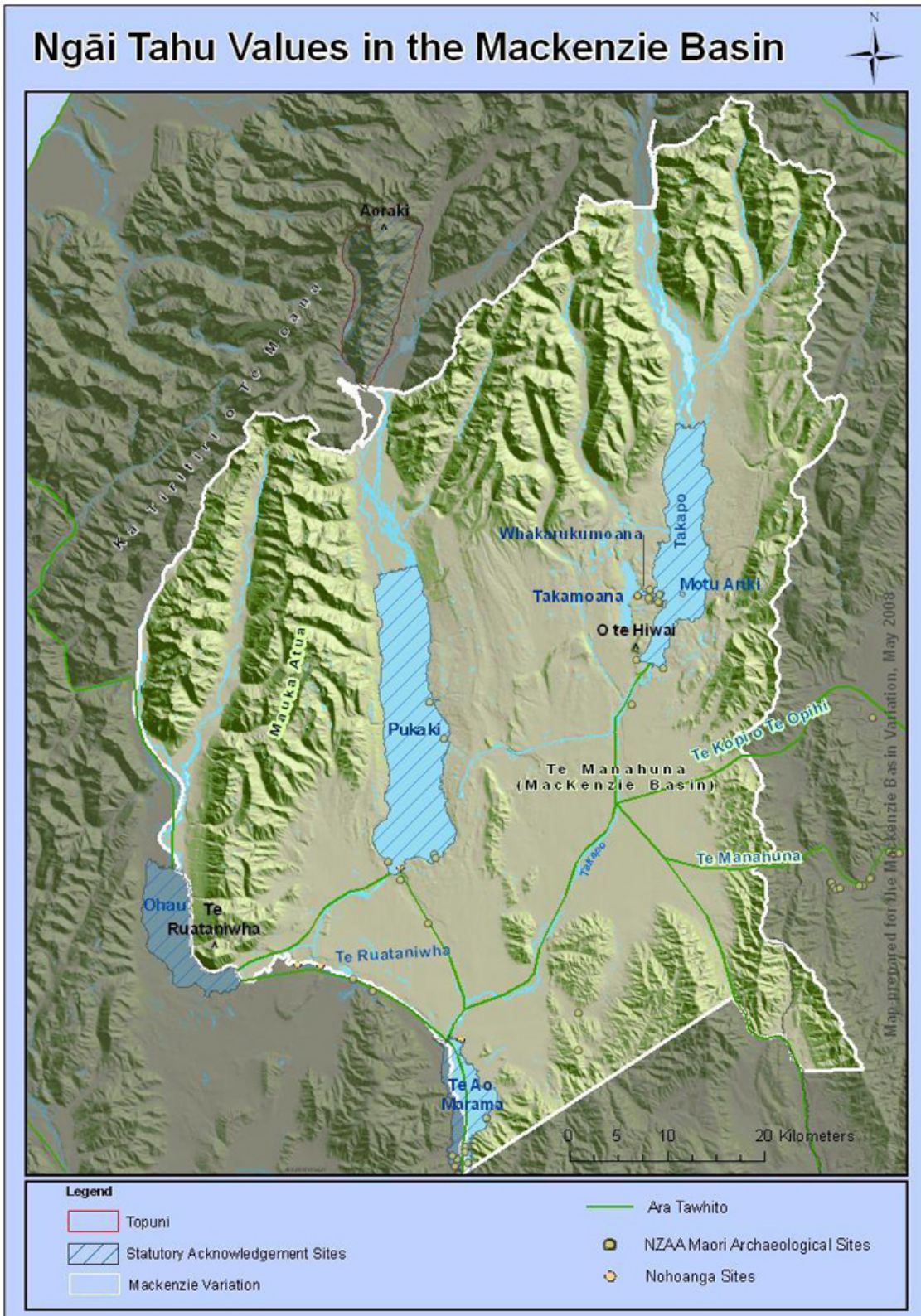


Fig. 11.11. Sites of importance to Maori in the Cultural Impact Assessment carried out for Mackenzie District Council Plan Change 13. This is not a full record of all significant sites.

2.b History and development

Matariki ahunga nui	When Pleiades,	
Matariki tāpuapua	The gatherer,	
Matariki hunga nui	Is bright in the sky	
Ngā kai a Matariki	The year begins.	
Nāna i ao ake ki runga.		(Grace & Grace 2003)

Waitaha Māori are identified as the first people to travel into the Mackenzie Country between 750 and 1300 CE. Other tribal identities later linked to this area include Ngāti Māmoe and Ngāi Tahu. The Mana Whenua (overall guardians or customary authority) at the present time are Ngāi Tahu Whānui. Before European settlement large parties travelled into the Basin to harvest the local resources. Māori from mid-Canterbury travelled through the valleys to Te Kopi o Opihi (Burkes Pass) and Te Manahuna (The Mackenzie Pass). These valleys contain some of the rock art sites thought to be areas where traditional learning took place. From the South, people travelled on the Waitaki river, using craft made from reeds as the rapids were dangerous to heavier wooden canoes. Māori collected stone such as silcrete for tool making, and travelled to the west coast, where greenstone (*pounamu*) was found, or to another greenstone site near the head of Lake Wakatipu.

Travel began while moa were still important to local subsistence and resulted in landscape change, converting the Basin from a mixture of forest, scrub and tussock grassland to predominately dense tall and short tussocks. Moa were large flightless birds, now extinct. Little is known about Waitaha occupation of the Basin until the late 16th and early 17th centuries when a series of skirmishes took place between Waitaha and Ngāi Tahu. While family groups sometimes settled for longer periods, most occupation was seasonal. Māori were not living there permanently when the area was surveyed between 1852 and 1860. Archaeological evidence and first-hand accounts from the 19th century point to small encampments of coastal people clustered on the shores of lakes or waterways. Some settlements have been inundated by the expansion of the lakes for the production of hydroelectricity. Weka, kākāpō and other waterfowl were important. The Cultural Impact Assessment carried out for the *Mackenzie Basin Proposed Plan Change 13* (Boffa Miskell Limited *et al.* 2008) noted “Flora gathered from land adjoining the lake included matagouri, taramea, tutu, tatarahaka, manuka, snowgrass, and raupo. The succulent *kiore* (Polynesian rat) was once an important food resource”. Eeling was also important. Ram Island or Take Karaka (now commonly known as Motuariki) in the middle of Lake Tekapo was once the home of the ancestors of Arowhenua. “Such was the reputation of Takapo as a mahika kai that people came from as far away as Kaiapoi, several hundred kilometers to the north, to trade for food.” As Māori moved through the area, each locality was given a name. Important ones are listed in the Cultural Impact Assessment. The Kāi Tahu Ki Otago *Natural Resource Management Plan* (Kāi Tahu Ki Otago 2005) notes in its discussion of cultural landscapes in the Waitaki catchments (including the Mackenzie Basin) that “The value attached to the land is evident from the fact that every part of the landscape was known and named ... every hillock, streamlet and valley”. The stories associated with each locality are also listed in statutory acknowledgements in official documents. For instance, the story associated with Lake Pūkaki is:

Pūkaki is one of the lakes referred to in the tradition of “Ngā Puna Wai Karikari o Rakaihautu” which tells how the principal lakes of Te Wai Pounamu were dug by the *rangatira* (chief) Rakaihautu. Rakaihautu was the captain of the canoe, Uruao, which brought the tribe, Waitaha, to New Zealand. Rakaihautu beached his canoe at Whakatū (Nelson).

From Whakatū, Rakaihautu divided the new arrivals in two, with his son taking one party to explore the coastline southwards and Rakaihautu taking another southwards by an inland route. On his inland journey southward, Rakaihautu used his famous *kō* (a tool similar to a spade) to dig the principal lakes of Te Wai Pounamu, including Pūkaki.

Māori expeditions into the area overlapped with European settlement, and were interrupted by the establishment of rabbits in the area and the laying of poison, which also killed the birds. Oral testimony by the Maiharoa family in response to development projects confirms that Māori returned to the area:

We live beside the Waitaki Awa (river) which, as a child, was our playground, we learnt to row a boat, how to make a *mokihi* (reed raft made of raupo), to swim and fish, and we planted by the phases of the moon and stars)... When people say “*Kei hia tou mana e tipu ana?*”... where is your mana tree growing?” they ask where our families came ashore. And we reply: “Tahunanui, 67 generations ago.” He was the Ancestor of Waitaha who came with his digging stick or spade. (Tu Whakaroria [the spade] dug and named many lakes — Takapo, Pukaki and Ohau.)

Travels and seasonal activities have been traditionally linked to the stars, which are considered ancestors from whom one receives direction. “We often refer to our ancestors as *rātou kua wheturangitia* (those who have become stars). With the passing of seasons the stars come and go just like people and the seasons.” In order to memorize, make sense of, and pass on precise astronomical knowledge, it was often woven into stories that adopted the mythical nature of astrology. Myths, with characters and stories, have helped to preserve knowledge throughout the generations. These stories include references to the sky. There are ten myth cycles or eras, each with its own context, that place different creation events in their own time. “If a feature such as the Milky Way is called Te Waka o Māui, then the correct context in which to consider it is: the discovery of the world, the development of knowledge and the origin of death”, and the whole of the Maui Cycle is relevant. In this cycle the Waka or canoe is the South Island, which Maui stood on when he fished up the North Island from the sea. For Māori, “the Milky Way is a more important seasonal marker than the Zodiac” which marks the seasons in ‘Western’ traditional astronomy.

Māori mythology chronicles the creation of land, water bodies, and sky, attributing spiritual qualities to them. What Europeans would call ‘the landscape’, for Māori includes the sky and is not merely physical, but is relevant to culture and society as well. Myths provide messages as to how people should live, so ‘the landscape’, imbued with messages, tells people how to live. As one Māori proverb from the Graces’ collection says: “By the forest vines Earth and Sky were bound together”. In the Māori creation story, before the time of light, the primal parents Earth and Sky lay together in darkness, bound by vines. They were thrust apart, light came to earth and life as we know it evolved.

In Waitaha, traditional knowledge of the stars was as important as any other knowledge. Ruka Te Korako and Ruka Te Korako (2006) note: “They long held that every child should have a song of the geography of the land sung to them during their infancy”. As well as songs and stories, string patterns (*mahi whai*) were created for different constellations and used as a teaching tool to pass on astronomical knowledge. These string patterns are similar to those that Pākehā ‘play’ with as children, manipulating a continuous piece of string (tied in a circle) into various symmetrical patterns with their fingers. However Māori did not practise this as a child’s game; rather, the various patterns resembled specific constellations full of meaning and were taught by adults. Ruka Te Korako and Ruka Te Korako (2006) describe how:

The elders looked into the heavens and marked the various star houses into the landscape, normally into rock overhangs or scribed into the sides of caves. If the star

movements indicated that devastation was approaching, they would scribe the star message onto small tablets of clay, and fire them in the umu ukurangi.

The arrival of Matariki (the Pleiades) low in the eastern sky in early June signals the beginning of a new year. The counting of the full moons recommences. Māori have traditionally-set times for planting, making safe journeys across mountains seeking rock and food resources, and fishing and voyaging on the inland lakes and rivers and coastal seas. Anthropologist Eidsdon Best stated in 1922 (Best 2002):

An old saying is, “When Matariki [Pleiades] is seen, then game is preserved”; for it marked the season when such food-supplies have been procured and preserved in fat in certain vessels.

He also claimed Ngāi Tahu said that

Women awaited the appearance of Rigel and regarded intently its aspect. If when it appeared above the horizon its rays were directed towards the south, then an inclement season followed; products of field, forest, and sea would suffer. If directed to the northward, then a fair season followed; all products were plentiful, floods were not, and merely desirable rains fell.

Lunar cycles were also associated with medicines. The effects of the lunar phases on members of the communities were carefully observed and Waitaha elders noted “at the optimum times of the effects of the moon on some of the patients of the teachers and healers, special medicines were gathered and prepared for use only on these times of critical power of the moon” (Ruka Te Korako and Ruka Te Korako, 2006). The elders believed that the moon affected the water within the body of the patient, much as it does the tides of the sea. Changes in energy levels were also observed to be related to phases of the moon and used to time heavy manual labour.

Context is an important issue. There are no fixed borders in Māori astronomy and constellations and their names may change from season to season. At different times of the year stars may symbolize different things. For example, when Māori observed Orion they also observed its position in the sky and its orientation. The same stars could be used over and over again with different names in different contexts and different symbolism. Different *iwi* have their own star names, which indicate different associations that are appropriate in different contexts. Therefore, a star name is likely to be specific not only to a certain season or related activity, but to a specific tribal region. The boundlessness of Māori astronomy and astrology often ties the land and its features together with the celestial ancestors.

It can be inferred that observing the stars was an integral part of the journey to Tekapo to gather up winter supplies. Astronomy was pivotal for Māori navigation and arrival in New Zealand and further research and input from Māori is being sought with regard to building knowledge and information about the importance of astronomy for terrestrial navigation in relation to Te Manahuna. Pauline Harris, an alumna of the University of Canterbury, is currently writing a book on Māori astronomy.

European History and Development

Astronomy was also related to the European arrival in New Zealand. After observing the Transit of Venus in Tahiti, Captain James Cook first came upon New Zealand in 1769 in his quest to find a great southern continent. He mapped what he found and made extensive astronomical observations for determining latitude and longitude. He came three times in all, bringing explorers, astronomers and botanists.

European settlement and high-country pastoral farming commenced in the late 1800s after Europeans became aware of the Te Manahuna area. Europeans named the area after the



Fig. 11.12. Recreation in the Mackenzie. Photograph: Keith Payne

first European to locate it—the folk hero and Scottish Highlander, James Mackenzie (Seumas MacCoinneach in Scottish Gaelic). He was captured in 1855 for being “in the company of a thousand stolen sheep” as he rustled them with his remarkable dog Friday, through a remote alpine pass into “a plain of immense extent”.

Tourism was established at Mt Cook village in the late 19th century. The first Hermitage Hotel was “believed to have been a small cob building” (McIntyre, 2007). This was later sold to the Mount Cook–Hermitage Company, which also ran its own coach service between Fairlie and The Hermitage. It took a visitor 3 days to travel from Timaru to Mount Cook. Later exotic game animals, such as chamois and Himalayan tahr, were introduced to attract wealthy hunters. In 1935 an airstrip was built.

One of the few other enterprises in the early history of the Mackenzie Basin was the design of the Hamilton Jet. Hamilton owned a station at Irishman Creek and the first private hydroelectricity was generated on this run from 1927. In the late 1930s he began an experimental engineering workshop there. Despite the difficult logistics of being 40 miles from the nearest railhead and down a road that was often impassable during winter, Hamilton’s team proved efficient enough to compete with imported machinery. Loader dozers, scrapers, road graders and other earth-moving machinery were manufactured there. During the Second World War the factory also produced munitions. After the war the factory was relocated to Christchurch and the original premises devoted principally to experiments, producing the first water-jet prototypes in the 1950s, developed by Hamilton to travel up the shallow local rivers.

The Upper Waitaki Hydroelectric Schemes

Production of hydroelectricity has had a major impact on the landscape of the Mackenzie Basin. Construction of the first dam on the Waitaki River was begun in 1928 and the Upper Waitaki Scheme stage one commenced in 1938. By the 1980s the scheme had expanded to five power stations, on Lakes Ohau, Pūkaki and Tekapo, followed by the construction of Lake Ruataniwha. The greatest visual impact may be from the canals which transfer water between the powerhouses and dams, described for tourists as “like turquoise highways—ribbons of blue on the scorched brown earth”. The schemes raised the lake levels of Pūkaki, Tekapo and Ohau and have an ongoing impact on river levels. Despite these controls, a large area of the basin will not be developed because it is designated as flood plain. The Upper Waitaki scheme includes Tekapo B, New Zealand’s only powerhouse completely surrounded by water, which stands on “floating” concrete foundations because of the depth of clay and ice covering the bedrock 1.6 km below. Engineers met many challenges to complete the interlinked projects in the harsh climate, at high altitude, working with the gravel of the glacial moraines. The earth dams and canals were New Zealand’s largest earthmoving project. Lake Pūkaki is New Zealand’s largest single controllable storage reservoir and the scheme as a whole contributes to the supply of power to the North Island over the High Voltage Direct Current Link which was the world’s largest and longest when it was built in 1965 and includes the world largest submarine cable

(popularly known as the Cook Straight Cable). The link runs from Lake Benmore just south of the Aoraki Mackenzie International Dark Sky Reserve to Wellington. All elements were recognised as contributing to New Zealand's engineering heritage by the Institution of Professional Engineers New Zealand (IPENZ) at the time of the sesquicentenary in 1990 (ipenz.org.nz/heritage/).

Although the early construction camps, which might house up to 500 people, were disassembled as work finished, the last settlement was Twizel, which had a maximum population of 6,000. When the last dam was completed in the mid 1980s, residents argued that housing should be retained and Twizel is now a settlement with about 1,000 people whose main purpose is recreation and tourism. Lake Ruataniwha, like the other lakes, is now a major recreational resource in the area, its speciality being competitive rowing.

3. Justification for inscription

3.c Comparative analysis

Aoraki Mackenzie International Dark Sky Reserve is located far away from cities and currently contains only three small village populations of typically less than 1,000 people. There are no World Heritage Sites with which to compare the Aoraki Mackenzie International Dark Sky Reserve. It would be more meaningfully compared with other International Dark Sky Reserves that have been certified by the International Dark-Sky Association (IDA). As at November 2013, Aoraki Mackenzie is one of just two International Dark Sky Reserves to receive a Gold Tier award, the highest designation possible. The other is NambiRand Nature Reserve in Namibia. Three International Dark Sky Reserves have been designated at the Silver level: Mont-Mégantic in Canada, and Exmoor National Park and the Brecon Beacons National Park in the United Kingdom.

Minimal light pollution—a naturally dark sky combined with human efforts to reduce lighting in its three small villages—makes the Mackenzie a premier location for viewing the stars. Mt John University Observatory has good accessibility (SH 8) and good weather with 68% of nights being useable for astronomical observations including phenomena such as the Magellanic Clouds. It is home to the southernmost observatory in the world apart from the ones at the South Pole. Aoraki Mackenzie International Dark Sky Reserve is a superlative location for stargazing.

3.d Integrity and/or authenticity

Authenticity

The authenticity of the Cultural Heritage of Aoraki Mackenzie International Dark Sky Reserve is upheld in the official documents of the Mackenzie District Council as well as the Treaty of Waitangi Settlement between the Government of New Zealand and the Ngāi Tahu *iwi* of the South Island of New Zealand. Tōpuni status (official statement of cultural value) is given to Aoraki/Mt Cook as the ancestor of Ngāi Tahu Whānui and as the spiritual link between this community and its environment. Māori cultural history embedded in the landscape as names and genealogical heritage is recorded in written form by the Mackenzie District Council District Plan (2004) and is presented to visitors in the area at the Aoraki/ Mount Cook Visitor Centre, the Lake Pukaki Information Kiosk and Te Ana Ngāi Tahu Rock Art Centre at the Timaru Visitor Information Centre. The history of Pākehā, as European settlers in the area and their relationship with the land, is also profiled at these venues through their involvement in the arts, the mountains and farming and with their technological inventions and innovations. There is also an extensive collection of farming and domestic artefacts and buildings at the local museum in Fairlie.

Integrity

The first ICOMOS/IAU Thematic Study views authenticity of use as a key issue for consideration. Scientific use of the Mt John University Observatory and the general public's relationship with both the daytime and night-time skyscape of Aoraki Mackenzie International Dark Sky Reserve mixes both natural and cultural elements. Integrity relates both to the physical features of the site, and to the site's uses. The integrity of the significant geological and biodiversity features of Aoraki Mackenzie International Dark Sky Reserve are protected and managed as a result of the requirements of the *Mackenzie District Council Plan Change 13* and all development must meet the criteria of the regional environmental agency (Environment Canterbury) and the Resource Management Act.

3.a Potential criteria under which inscription might be proposed

Criterion (iii): Te Manahuna (the Mackenzie Basin) is the gateway to Aoraki, ancestor of Ngāi Tahu Whānui and the highest peak in New Zealand and contains ancestral pathways, identity, knowledge and food resources for local Māori associated with the Rūnangas (Māori governance areas related to tribal sub-groups) of Arowhenua, Waihao and Moeraki.

Meanings woven around land and sky are vibrant within their cultural traditions. Contemporary research as well as inclusion of the area within management plans and the presentation to visitors of information about local cultural significance such as Aoraki/Mt Cook or the rock art sites also contribute to the cultural revitalization of Ngāi Tahu Whānui (combined South Island tribal sub-groups) as individuals and as a collective.

Criterion (vi): The Mackenzie Basin is a broad and spacious vista for the powerful physical and spiritual presence of Aoraki/Mt Cook. The beauty of the area impacts on those who live there, those who visit there and those who return time and time again.

Criterion (vii): The openness and extensiveness of the landscape is exceptionally beautiful with an immense expanse of starry night sky. The dark night sky values are enhanced by cultural meanings and remarkable natural attributes. The International Dark Sky Reserve site has multiple layers of importance that when combined together form a compelling argument where astronomy is just one aspect of the significance of this area.

Criterion (viii): in a recent presentation to a High Country Symposium in Twizel, Dr Les Molloy, an expert on natural World Heritage, included a discussion on the heritage values of the Mackenzie Basin, with reference to Te Wāhipounamu World Heritage Site and the possible relationship between the two. The Te Wāhipounamu Nomination contends "the only limitation to the integrity of the Pleistocene imprint is the absence of the glacial outwash basins and large lakes along the eastern margin" of the site (Department of Conservation 1989, p. 57). Such an area along the eastern margin of the existing World Heritage Site would include Lakes Pūkaki and Tekapo with their distinctive Tasman and Godley braided riverbeds respectively. This would complete the representation of the impact of the Pleistocene epoch included as contributing to the superlative natural features of the Te Wāhipounamu site. To date, the Department of Conservation has not considered that the International Dark Sky Reserve area could be formally included in the existing Te Wāhipounamu site, which is a pristine natural environment. However, if the continuity of the cultural aspects of the landscape were given more weight in relation to the landscape and biodiversity values, an extension of Te Wāhipounamu to include the Aoraki Mackenzie International Dark Sky Reserve should be discussed with the Department of Conservation (DOC). Aoraki/Mt Cook National Park is included in the extended buffer zone to the Reserve. Regardless of the final tenure and conservation

status of the International Dark Sky Reserve, the relationship between the outstanding geological and geomorphic features that exist within the Reserve site to those features recognised in the Te Wāhipounamu site will be emphasized.

The Te Wāhipounamu World Heritage Site Nomination argues that the glacial lakes of Tekapo and Pūkaki and their surrounding tussock grassland landscapes “act as a scenic access way or visual corridor, allowing the visitor to place the mountains beyond in their true perspective and scale”. This argument can also be applied to the night sky. The vast open landscape surrounded by mountains in all directions that characterises this inter-montane basin provides perspective and a “scenic access way” to the night sky for those stargazing from the top of Mt John or the basin floor. Likewise, clear pollutant-free days and night skies provide a simple and outstanding backdrop for the geological features of the Basin.

Combining these two important natural features of geology and pristine dark skies opens the door for additional educational or tourism-based activities operating from the site. There is no reason for tourist activities to stop when the sun goes down. Stargazing provides locals and tourists alike an opportunity to appreciate and interpret the geology of the land in a night-time context. The day-time, dusk and night-time tours that Earth & Sky (www.earthandskynz.co.nz) currently operate at Tekapo are well positioned to educate visitors about the geological history of the area. Big Sky Stargazing night-time tours do the same for visitors to Mt Cook Village. Other groups operate in the area using smaller or no telescopes.

Criterion (x): Owing to the global rarity of braided river habitat it could be argued that the International Dark Sky Reserve site has international significance and value from the point of view of conservation. A focus on the nocturnal wildlife of Aoraki Mackenzie International Dark Sky Reserve links the quality of the dark night sky with the ecological integrity and conservation of the natural environment for the purposes of World Heritage Status. Currently, there needs to be more information gathered about the Mackenzie Basin’s nocturnal species. The current Outdoor Lighting Restrictions in place to preserve the clarity of the night sky provide an unintentional conservation tool. Potentially, sustainable tourism activities could combine stargazing with walking tours of night-time habitats of nocturnal species (dependent on the type of nocturnal species inhabiting the area and the appropriateness and feasibility of viewing these species in their natural habitat). Incorporating stargazing with conservation would firmly establish Tekapo and the Mackenzie Basin as a Starlight Destination, where people not only come to learn about the night sky and the nocturnal landscape, but also the unique and special biodiversity of the Mackenzie Basin.

3.b Suggested statement of outstanding universal value

Aoraki Mackenzie International Dark Sky Reserve has multiple layers of importance. Natural and cultural heritage values embedded in this area enhance the pristine, dark sky and remarkable astronomical attributes. There is a wealth of scientific knowledge available from the University of Canterbury Mount John Observatory staff. Specific details of the astronomical value and scientific importance of the observatory site are relevant for incorporation as yet another layer of significance.

Aoraki Mackenzie International Dark Sky Reserve is a mixed site that represents astronomical, natural and cultural heritage values as well as being a human-inhabited Starlight Oasis. This type of site can also be considered a “Window to the Universe” where pristine starlit conditions combine with an observatory site protected by outdoor lighting restrictions to create a dark-sky area – in other words a “Night Cultural Landscape”.



Fig. 11.13. Visitors in the Astro Café, Mt John, Tekapo. Photograph: Fraser Gunn

4. Factors affecting the property

4.a Present state of conservation

Aoraki Mackenzie International Dark Sky Reserve is a human-inhabited Starlight Oasis where the dark-sky values are protected by quality outdoor lighting systems. Regulation of land use that could impact on the biodiversity and geology of the area is part of ongoing negotiation involving the Regional Council (Environment Canterbury), the Mackenzie District Council and the local community.

The quality of the night sky has been well documented from records at Mt John University Observatory since the 1960s. Useful observation hours amount to an average of 1,600 in any one year at Mt John where photometric, partly photometric and spectroscopic hours are included. Light pollution is comparable to the unpolluted night sky with measurements for sky brightness around 21.6 magnitude per arc-second squared or a Bortle Scale of 2. Recent measurements using Sky Quality Meters were taken for the International Dark Sky application in the core areas and some parts of the buffer zone. Water vapour in the air in the Tekapo area is lower than the New Zealand national average, which is ideal for stargazing. There appear to be no quantitative data on dust in the air in the Mackenzie partly because it is not a problem. Dust issues are brief episodes such as an occasional north-west wind bringing dust down river valleys. Data on general air transparency can be derived from measurements formerly taken at Mt John when photometric programmes were running. The changing brightness and colours of variable stars were measured and the amount of light absorbed by the air in the different colours was calibrated. The results showed that the air at Mt John University Observatory is much clearer than at many northern hemisphere sites. Being able to see distant mountains in daylight is a simpler way of quantifying air transparency and this is one of the

exceptional qualities of the Aoraki Mackenzie International Dark Sky Reserve. New land developments generate dust when there is a gale blowing, but as these areas are soon grassed they do not present an ongoing problem. Some ploughing is done on small areas for growing silage; however, dust is rarely a problem from them. Smoke from burn-offs can hang around for a few days but is generally too low to affect the night sky. On the other hand, smoke from Australian bush fires can be a serious problem for a few days and there was a particularly long episode in January 2007. Radio-electric interference tests show no interference with equipment at Mt John. There are three Vodafone antennae, a National Radio FM repeater and an (undocumented) Port FM repeater in the Mackenzie Basin. A radio-noise survey at the bottom of Mt John, near the Godley Peaks gate, showed little noise there. According to the Superintendent at the Mt John University Observatory, Alan Gilmore (meeting with one of the authors in January 2011), there is no significant effect on the night sky at Tekapo from the above factors and there is no reason for him to mitigate or manage any issues with regard to them.

The second core, at Mt Cook Airport, is cut off from Mt Cook Village by the nearby mountains and there is no local development using lighting at night (see Fig. 11.3).

4.b.i Developmental pressures

Land in the Mackenzie Basin is largely crown-owned leasehold or privately owned, so that protection and management of flora and fauna are largely out of the hands of the Department of Conservation (DOC). The Mackenzie Basin's indigenous flora and fauna have suffered significantly from human-related activities and the presence of introduced species of fauna and flora such as wilding pines. The scattered Conservation Areas are managed by the DOC, and a Drylands Park is proposed by sectors of the public who seek to protect this flora and fauna. Crown land is currently subject to a tenure review process that will affect ownership and the management of the Mackenzie Basin. Despite these developments, landowners will continue to be bound by the Lighting Ordinances of the Mackenzie District Council and the conditions of the Resource Management Act. Consequently, change of ownership is unlikely to affect a Reserve based solely on the dark-sky values of the area nor the distinctive beauty of the area.

In 2007, the Mackenzie District Council introduced a change to their 2004 District Plan: *Plan Change 13, Rural Zone – Mackenzie Basin*. Submissions were called for and heard from interest and farming groups since District Plans are one of the key tools for enforcing the Resource Management Act. The outcome of the proposed Plan Change 13 has significant implications for the protection and management of the International Dark Sky Reserve site. In December 2011, an interim decision was made in the Environment Court by Judge Jon Jackson that favoured greater recognition of conservation and the “outstanding natural landscape” of the Mackenzie Basin and protection of the area for future generations (*High Country Rosehip Orchards Ltd v Mackenzie District Council*, NZEnvC 387, 12 December 2011). The judge was also concerned that the responsibility for conservation and management of the Mackenzie Basin should not fall solely upon the farmers concerned and that ways to share the costs of conservation management with the wider public needed to be addressed. A definitive judgement will eventually be made.

4.b.ii Environmental pressures

The Mackenzie Basin experiences extremes of weather, has relatively poor soils, and is under pressure from introduced species, all of which create considerable challenges to management. It is claimed that pastoral farming techniques require considerable local knowledge and that these are continuing to improve. Environment Canterbury's *Canterbury Regional Environment Report* (2008: 104) states: “There has been a net decrease in bare ground in the Mackenzie Basin between 1994 and 2002.” Farming techniques are affected by economic factors as,

historically, farm incomes have not always been sufficient to ensure that what has been understood to be best practice can be achieved. For instance, the 1990s saw pressure from rabbit populations explode at a time when prices for fine wool were low. This pressure was relieved by the introduction of Rabbit Calicivirus (RCD), but other challenges may arise in the future. Rabbit numbers are increasing rapidly, as the influence of RCD becomes attenuated. Hawkweed (chiefly *Hieracium pilosella*) is widespread on the lower and drier areas. This introduced weed can restrict the growth of indigenous species. The Parliamentary Commissioner for the Environment's report *Change in the High Country* (2009: 26) describes the high country as follows:

The high country climate is harsh and unpredictable with long winters and dry summers. Growing seasons are short, frost frequency is high in all seasons, and temperature constraints increase significantly with altitude. Precipitation is high close to the Main Divide, but in the alpine rain shadow to the east the land becomes increasingly arid. Pristine high country headwaters feed the East Coast rivers that power major hydroelectric schemes in the Clutha and Waitaki catchments, and irrigate the lowland plains.

The recent Environment Court decision relating to the Mackenzie District Council's Plan Change 13 notes that wilding pines are currently a major challenge to the environment and that climate change policy (The Climate Change Response Act 2002) has the potential to impact the environment through encouraging tree planting within the Basin.

In general, the impact of climate change as outlined by the Parliamentary Commissioner for the Environment will require ongoing attention (2009: 31):

Climatic change over the next several decades is projected to increase the contrast between the conditions along the main divide and those on the eastern hill and high country in the alpine rain shadow. Higher rainfall is predicted for the west and the alpine zone, with drier and more drought-prone conditions to the east. The snowline is predicted to rise, and wind and rainfall events to become more intense.

Agricultural intensification to maintain farm income is likely to impact on water quality within the Basin, and though the quality is currently high, there is potential for this to deteriorate. DOC has noted that fertiliser use around Lake Alexandrina is the lake's greatest management issue.

4.b.iii Natural disasters and risk preparedness

The Mackenzie District Civil Defence Emergency Management Local Arrangements 2005 (Mackenzie District Council 2005: 4–5) identify the higher priority hazards as follows.

- Earthquakes – from the Alpine fault line.
- Floods – extremely heavy rainfall can be expected which may block local streams.
- Cyclonic storms are experienced from time to time. The highest recorded wind speed in NZ of 250 km/h (155 mph) was recorded on top of Mt John.
- Snowfalls: “Heavy snowfalls from time to time cause disruptions to telephones, power supply, road traffic and can cause the isolation of townships for several days. While there is seldom any risk to human life, people may need to be rescued from stranded vehicles or from back country stations.”

The Mackenzie District Council is a member of the Canterbury Civil Defence Emergency Management (CDEM) Group established under the Civil Defence Emergency Management Act 2002. Its own resources will be supplemented by those of other organisations. Aoraki/Mt Cook Village and the Glentanner area have their own Emergency Response Plan because of their isolation and vulnerability to extreme weather. Emergency headquarters will be set up in Fairlie, with Twizel also hosting a Community Welfare centre. The key local response will come from

the Police, Fire Brigade and St John Ambulance. There is no local hospital. The local volunteer Fire Brigades in Fairlie, Lake Tekapo and Twizel are all trained in Basic Rescue and will help with emergencies as required. National Urban Search and Rescue (USAR) Resources will be provided through the Canterbury CDEM team.

4.b.iv Visitor/tourism pressures

The Mackenzie attracted more than 450,000 visitors in 2010 and provided employment for approximately 30% of the population there. 300,000 people visit Mt Cook Village per annum. Approximately two thirds of these are international visitors. Accommodation at Lake Tekapo includes backpackers, farmsteads, homesteads and holiday homes, motels and hotels. The Mackenzie District Council has information on its website for campers with their Independent Overnight Camping Guide (www.mackenzie.govt.nz/Site/A-Z/A-C/Camping.aspx).

Mt Cook village has lodges, motels, chalets, holiday parks and backpackers and the Hermitage Hotel (which organises Big Sky Stargazing tours for its guests and others). Astro-tourism is enjoyed by close to 20,000 people per annum, with possibly twice as many missing a planned trip because of poor weather.

According to Phil Brownie, then manager of the Mackenzie District Tourism and Development Trust, meeting with one of the authors in January 2011, approximately 30% of visitors to Lake Tekapo are aware of the extraordinary opportunities for stargazing in the area. The Japanese market is already well established: a survey conducted in Japan by Air New Zealand showed that 72% of people listed stargazing as the main reason they wanted to visit New Zealand. Lake Tekapo is situated about tenth or eleventh in terms of visitor numbers to New Zealand locations.

4.b.v No. of inhabitants

Approximately 1,900 inhabitants live permanently within the Aoraki Mackenzie International Dark Sky Reserve area, consisting of around 500 in Lake Tekapo, 150 in Mt Cook Village and 1,000 in Twizel with the remainder in the outlying areas. The population fluctuates with the seasonal occupation of holiday homes, tourist-busy periods and related temporary-job, short-term residents working in hospitality (data from Statistics New Zealand, Population by Territory [apps.nowwhere.com.au/StatsNZ/Maps/default.aspx], retrieved 10/01/2012).

5. Protection and management

5.a Ownership

The Mt John University Observatory core is located on 23.8 hectares of Crown land leased from the Government by the University of Canterbury. This lease is for 33 years and was renewed on Jan. 1 1997. It includes the summit of Mt John, the private access road maintained by the University of Canterbury, which must provide day-time access to Mount John (as stipulated in the lease), plus a small grassed area at the bottom of the road where the Mt John road meets the Godley Peaks Road. This latter road is a public highway leading to Glenmore and Godley Peaks sheep stations. The land surrounding Mt John is freehold and belongs to Mt John Station.

The second core at Mt Cook Airport is located within the Aoraki/Mt Cook National Park and is on land administered by DOC as the local airport and subject to restrictions on its use related to this function.

The vast majority of land situated in the Buffer Zone of the Aoraki Mackenzie International Dark Sky Reserve is or was once in Crown Pastoral Leases. This land has been leased to run holders by the Crown for pastoral grazing since the 1850s. Leases have been for 33 years with a perpetual right of renewal. Since 1998 individual run holders have been able to

enter into a Tenure Review process initiated by the Crown Pastoral Land Act 1998, which allows them to gain freehold title to areas of productive land leased from the Crown. The remaining land not converted to private ownership is usually transferred to the Department of Conservation for management. Under the pastoral lease system, run holders have been relatively restricted in the type of agricultural and development activities they can undertake on the land. This has resulted in the general appearance of the landscape remaining relatively unchanged for the past 150 years or so. As run holders gain private ownership of land via Tenure Review, they are free to undertake a much wider range of activities. Tenure review has resulted in some changes to the Mackenzie Basin landscape over the last ten years, especially in the south of the Mackenzie Basin away from the Reserve area. Changes are related to factors such as the availability of irrigation water as well as land tenure and are controlled by the Resource Management Act.

There are approximately 38 pastoral leases in the Aoraki Mackenzie International Dark Sky Reserve area. Some are not in the review process, some are in the consulting phase and some have completed the entire Tenure Review (eight properties). Approximately 80% of the properties have been or will be converted from Crown ownership to a mixture of private ownership and conservation land in the near future.

5.b Protective designation

Mackenzie District Council District Plan 2004, section 12, Signs and Outdoor Lighting

The Mackenzie District Lighting Ordinance (www.mackenzie.govt.nz/includes/download.aspx?ID=118114), first enacted in 1981 in the District Plan of that year and included under the Town and Country Planning Act 1977 (which it is now part of the Resource Management Act 1991). It is the legal document that protects the Mackenzie Basin from light pollution.

Mackenzie District Council District Plan 2004, Plan Change 13, 2007

This document was a response to the Resource Management Act 1991 (RMA) giving local authorities more governance in the sustainable management of regional resources and the designation of what constitutes permissible activities and developments. The primary purpose was to protect the basin from “inappropriate subdivision, development and use”. It was also a response to increased development activities in the Mackenzie Basin over the previous five years and was instituted to protect the landscape values of the area.

5.c Means of implementing protective measures

Resource Management Act 1991 (2011) (RMA)

Under the RMA, environmental management is centred on concepts of sustainable and integrated management of resources. Environmental management is mainly achieved through the statement of overall goals in the Act itself, the establishment of a hierarchy of policy statements and plans, the granting of resource consents and the provision of mechanisms for enforcement.

At a regional level, policy statements are compulsory and regional plans are optional, with the exception of a regional coastal plan. District plans must be prepared at a territorial authority level. District plans are generally required to be ‘not inconsistent’ with regional plans, district and regional plans are required to ‘give effect to’ regional policy statements, and all these documents are in turn required to ‘give effect to’ national policy statements. This helps to promote consistency and integration.

The RMA focuses on managing the effects of activities rather than regulating the activities themselves. The RMA adopts an enabling approach that seeks only to intervene

where activities are likely to result in unacceptable environmental impacts. This approach has the advantage of focusing on the reduction of environmental impacts.

The overriding purpose of the RMA is 'to promote the sustainable management of natural and physical resources'. This is defined in section 5(2) as meaning

managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety while

- a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations;
- b) safeguarding the life-supporting capacity of air, water, soil and ecosystems; and
- c) avoiding, remedying or mitigating any adverse effects on the environment.

The conservation land within the buffer zone is managed by the Department of Conservation (DOC), which manages approximately one third of the land in New Zealand, as well as marine reserves, on behalf of all New Zealanders. The Conservation Act 1987, the National Parks Act 1980 and the Reserves Act 1977 set out how DOC should look after this land, water, and vegetation, and the living things that inhabit it. In a manner similar to that prescribed under the RMA, the Conservation Act provides a framework of management policies, strategies and plans for the management of Conservation Land.

Canterbury Conservancy has a management strategy that lists all the reserves and farm parks etc. for which it is responsible and the specific issues that DOC must attend to in each area. National Parks have individual management plans. The Waitaki area covers the area relevant to the Aoraki Mackenzie International Dark Sky Reserve. The Department also prepares other plans that cover specific functions, such as pest management and recreation and public awareness strategies.

5.d Existing Plans

Currently there is no single property management plan for land other than that managed by the Department of Conservation, which has individual plans for its large holdings such as National Parks or Farm Parks and a district-wide conservancy plan which covers smaller areas. Environment Canterbury has a number of relevant plans on landscape values and water quality, has a Biodiversity Strategy for the Canterbury Region, and is generally responsible for monitoring its achievements in relation to these plans. Outcomes are reported through a series of Canterbury Regional Environment Reports, the latest of which came out in 2008. Outcomes are also reported annually. These plans and reports comment specifically on the Mackenzie Basin where relevant.

5.e Property Management Plan

The two Core Zones of the Aoraki Mackenzie International Dark Sky Reserve, Mt John and Mt Cook Airport, are managed in accordance with the requirements of the *Starlight Reserve: Concept, Dimensions, Categories, Criteria, Recommendations* (Marín and Orlando 2009) as an exclusion zone—an area untouched by light pollution where the natural conditions of the night sky are intact. Mt John is heavily protected with no artificial outdoor lighting. The Mt Cook Airport Core Zone only operates during the day as an airport. There is no outdoor lighting at night although it is accessed at night for stargazing tourists by Big Sky Stargazing Tours. The Buffer Zone for the Aoraki Mackenzie International Dark Sky Reserve includes the whole of the Outdoor Lighting Restriction Area and Aoraki/Mt Cook National Park as demonstrated in Fig. 11.4. The Starlight Reserve Concept document calls this area an external zone and defines it as “an area where existing larger human settlements or activities could negatively impact on the

night sky quality of the Reserve". Within the Aoraki Mackenzie International Dark Sky Reserve this wider area is included in the Buffer Zone. The Reserve thus combines the requirements of the *Operational Guidelines* with the requirements of the Starlight Reserve Initiative.

In relation to the natural heritage values of geology and biodiversity, the Department of Conservation Commercial Business Unit was set up in Feb 2010 to foster conservation values through partnerships with the business community. Most of the current partnerships involve funding of specific conservation projects for rare species and regional plans for encouraging the use of conservation land, both of which are consistent with the promotion of an International Dark Sky Reserve. As well as working with eco-tourism operators, DOC has worked with private landowners and expects such partnerships to increase employment and income within specific communities, as well as spreading conservation values among users of the conservation estate. Along with involvement of new people in management DOC expects "benefit from the different ideas and initiatives likely to come from interactions with the commercial sector". There is potential here for the development of partnerships with landowners in the The Aoraki Mackenzie International Dark Sky Reserve area.

However, if a new category of World Heritage is proposed that recognises the natural heritage of the night sky and night-time landscapes, then it is possible that the issues around other natural heritage values would become less of a challenge, especially if zones drew upon the current guidelines for Starlight Reserves, set out in the various starlight reserve concept documents. Zoning then hinges upon delineated areas that protect night-time light conditions, supported by appropriate areas of intelligent lighting and outdoor lighting restrictions.

5.f Sources and levels of finance

Current funding from various sources is devoted to protection of the night sky and is adequate to continue protection of the two core areas. There is currently no funding set aside to manage a Starlight Reserve in the buffer zone, but other types of funding are available which will ensure that current levels of night-sky darkness continue in the short term. Increased protection of the night sky through international certification should ensure increased attention to this issue and targeted funding.

5.g Sources of expertise and training

Currently, training for management of the night sky is available from the University of Canterbury. Training in management of landscape is available from Lincoln University, which offers a Bachelor of Landscape Architecture and several postgraduate degrees and diplomas. DOC employs staff members who are specialists in conservation management. Other expertise in management of both the cultural and biophysical aspects of the reserve concept is available from the universities, *wananga* (predominantly Māori Further Education Institutes), and Crown Research Institutes. Local government organisations also employ specialists in management of cultural and biophysical resources in order to prepare management plans and to monitor management of resources.

5.h Visitor facilities and infrastructure

International tourists to the Mackenzie Basin originate mainly from Australia, North America, the United Kingdom, Europe and Asia. The average length of time people stay is 1.32 nights and there are approximately 2,400 accommodation beds. Of the 300,000 people who visit Mt Cook Village annually, about one third stay overnight. Mt Cook Village can sleep 600 people. Different types of accommodation are available including lodges, motels, chalets, hotels, holiday parks and backpackers that cater for all accommodation demands and price ranges. Five restaurants in the Mt Cook area cater for a variety of tastes and budgets. There are three main points of

information for tourists about the area, at the Aoraki/Mt Cook Visitor Centre, the Lake Pukaki Information Kiosk and Te Ana Ngāi Tahu Rock Art Centre at the Timaru Visitor Information Centre.

5.i Presentation and promotion policies

The Aoraki Mackenzie International Dark Sky Reserve Board, which includes representatives of tourism organisations, confirms that the number of visitors to the area with an interest in the dark sky has increased since the reserve was established in June 2012. Interest is sufficient for plans to be developed to manage pressure on the Mt John visitor facilities with a purpose-built facility in Tekapo with its own telescope.

During the preparation of the application for reserve status, the Aoraki Mackenzie Starlight Working Party collected letters of support for the International Dark Sky Association application from heads of local enterprises such as Genesis Energy and key tourism figures. The supporters included former Prime Ministers and the current Prime Minister John Key also supported the Working Party's activities. The Chief Executive of the Christchurch International Airport noted that the airport was not only known as New Zealand's Tourism Gateway to the South Island but was becoming known as the "Gateway to the Stars".

The protection of the night sky was spontaneously supported by residents at the Lake Tekapo meeting to discuss the future of the area as part of the consultation for the Mackenzie District's Long Term Community Plan in November 2005. When asked how the existing vision could be enhanced, protection of the night sky was mentioned more often than any other additional element.

In relation to commercial promotion, there are currently two commercial businesses operating within the Aoraki Mackenzie International Dark Sky Reserve that offer extended opportunities for the public to familiarize and educate themselves about the night sky:

- *Big Sky Stargazing* (www.hermitage.co.nz/en/the-sir-edmund-hillary-alpine-centre/big-sky-stargazing) offers educational and public outreach to inform visitors about the night sky with a well established planetarium facility located in the Sir Edmund Hillary Centre at Aoraki/Mt Cook. Digital experiences include "Infinity Express" (pictured), "Space Traveller", "Black Holes" and other dark-sky digital experiences prior to going 'out into the field' with the telescope at the Aoraki/Mt Cook airport observatory.
- *Earth & Sky* (www.earthandskynz.co.nz) based at Tekapo township offer guided day or evening tours for the public to the Mt John University Observatory. The day-time, dusk and night-time tours operated by Earth & Sky are well positioned to educate visitors about the geological history of the area. This fits in well with the education and public outreach priorities of Earth & Sky and with the World Heritage Committee's goal to educate and raise awareness of World Heritage by involving schools, universities and other local and national education providers.

Other businesses assist tourists wishing to view the night sky on a more informal basis.

5.j Staffing levels and expertise

No staff are engaged in full time administration and promotion of the International Dark Sky Reserve at present.



Fig. 11.14. Digital Dome Planetarium at the Sir Edmund Hillary Centre.
Photograph courtesy of The Hermitage, Aoraki/Mt Cook



Fig. 11.15. View from Mt John with Lake Alexandrina and Lake Tekapo in the background.
Photograph: Fraser Gunn

6. Monitoring

6.a Key indicators for measuring state of conservation

Monitoring is currently carried out by Environment Canterbury as part of its ongoing programmes to maintain or improve the resources within the Canterbury Region and through its approval and monitoring of resource consents. Monitoring occurs around their key areas:

- Air quality
- Coastal environment
- Democratic process
- Energy
- Emergency management
- Hazards
- Land
- Navigation safety
- Pests and biosecurity
- Public passenger transport

- Regional land transport
- Waste, hazardous substances and contaminated sites
- Water quality, quantity and aquatic biodiversity.

The areas most relevant to the Mackenzie Basin are the Regional Pest Management Strategy and Biodiversity Strategy. Water quality is generally good in the large lakes and waterways but will become more important as farming intensifies. Many of the monitoring staff are employed to identify hazards, but can also provide technical information and advice in the areas identified above. The goal of the Environmental Quality and Hazards Section is to be

“involved in monitoring Canterbury’s environment in these areas and in making that information available in a way that can contribute to the maintenance and enhancement of environmental quality ... The section carries out both long-term monitoring programmes, designed for such things as identifying the current state of the environment and any trends that may be occurring, and shorter-term investigations relating to specific environmental quality issues.”

Monitoring is carried out in conjunction with:

- Other territorial local authorities
- Crown research institutes
- Government departments such as DOC
- Tangata Whenua (Ngāi Tahu and local *runanga*)
- Non-government agencies such as the Queen Elizabeth II Trust, NZ Landcare Trust, [Forest and Bird](http://www.forestandbird.org.nz/) (www.forestandbird.org.nz/), Fish and Game, and Federated Farmers
- Other local organisations such as Landcare groups
- Individual landowners.

6.b Administrative arrangements

The Mackenzie District Council and the Department of Conservation have overall responsibility for the District as outlined in the Case Study. The current Superintendent of the Mt John University Observatory has agreed to undertake management of the Aoraki Mackenzie International Dark Sky Reserve.

6.c Results of previous reporting exercises

The main documentation providing an inventory comprises:

- DOC conservancy and national park management plans;
- Environment Canterbury’s various plans and reports;
- The Ngāi Tahu environmental management plans for Canterbury and Otago:
 - Kāi Tahu Ki Otago, *Natural Resource Management Plan 2005* (which specifically mentions the dark sky as a value that could be preserved through planning),
 - Te Whakatau Kaupapa, *Resource Management Strategy for Canterbury – Part A*,
 - Canterbury Iwi Management Plans.

7. Documentation

7e. Bibliography

Abarri, J., Duell, R., Moffat, M. and Loveridge, A., 2010. *Review of World Heritage Committee Operational Guidelines in relation to Starlight Reserves: WHC Guidelines and Starlight Reserves: Report for the Astro-Tourism Lake Tekapo Aoraki/Mt Cook Starlight Reserve Working Group*. School of Social and Political Sciences, University of Canterbury, Christchurch.

- Austin, M., Hearnshaw, J. and Murray, G., 2009. *A Case Study for a Starlight Reserve at Lake Tekapo, New Zealand*. Working Group Starlight Reserves, Astronomy and World Heritage Initiative. www.starlight2007.net/pdf/SLReserves/LakeTekapoNewZealand.pdf
- Austin, M. *et al.*, 2012. *An Application to the International Dark-Sky Association for a Starlight Reserve in the Aoraki/Mt Cook National Park and the Mackenzie Basin of the central South Island of New Zealand*. University of Canterbury, Christchurch. www.darksky.org/assets/Night_Sky_Conservation/New_Zealand_IDSP_app.pdf
- Best, Elsdon. 2002. *The Astronomical Knowledge of the Maori: Genuine and Empirical*. Kiwi Publishers, Christchurch. First published in 1922 as Dominion Museum monograph no 3, Government Printer, Wellington.
- Boffa Miskell Limited, Te Runanga o Arowhenua, Te Runanga o Waihao, and Te Runanga o Ngai Tahu, 2008. *Mackenzie Basin Proposed Plan Change 13: a Cultural Impact Assessment of the Proposed Plan Change 13 to Mackenzie District Plan*. Boffa Miskell, Tauranga.
- Caruso, B., 2006. Project River Recovery: Restoration of Braided Gravel-Bed River Habitat in New Zealand's High Country. *Environmental Management* 37(6), 840–861.
- Department of Conservation, 1989. *Nomination of South-West New Zealand (Te Wāhipounamu) by the Government of New Zealand for inclusion on the World Heritage List*. New Zealand Government – Department of Conservation, Wellington.
- Department of Conservation, 2000. *Canterbury Conservation Management Strategy*. www.doc.govt.nz/about-doc/policies-and-plans/conservation-management-strategies/canterbury/
- Department of Conservation, 2004. *Aoraki/Mount Cook National Park Management Plan*. www.doc.govt.nz/about-doc/policies-and-plans/national-park-management/aoraki-mount-cook-national-park-management-plan/
- Environment Canterbury, 2008. *Canterbury Regional Environment Report 2008*. Environment Canterbury, Christchurch. ecan.govt.nz/publications/Pages/regional-environment-report.aspx
- Environment Canterbury. 2010. *Canterbury Regional Landscape Study Review 2010*. Environment Canterbury, Christchurch. ecan.govt.nz/publications/Plans/canterbury-regional-landscape-study-review-2010.pdf
- Grace, P & Grace, W. 2003 *Earth, Sea, Sky: Images and Māori proverbs from the natural world of Aotearoa New Zealand*. Huia, Wellington.
- Hamilton, P., 1969. *Wild Irishman: the story of Bill Hamilton, New Zealand farmer, inventor, engineer, and jet boat pioneer*. Reed, Wellington.
- IPENZ, n.d.a. H.V.D.C. *Link: the Benmore to Haywards electricity cable*. Engineering Heritage record 53.
- IPENZ, n.d.b. *Upper Waitaki Power Development*. Engineering Heritage record 124.
- Kāi Tahu Ki Otago, 2005. *Natural Resource Management Plan*. Kāi Tahu Ki Otago Dunedin. ecan.govt.nz/publications/Plans/kai-tahu-ki-otago-natural-resource-mgmt-plan-05.pdf
- Leather, K. and Hall, R., 2004. *Taatai Arorangi – Maori Astronomy: Work of the Gods*. Viking Sevensseas NZ, Paraparaumu.
- Land Information New Zealand (LINZ), n.d. *Strategic Direction for Crown Pastoral Land*. www.linz.govt.nz/crown-property/pastoral-land-tenure-review/high-country-policy-update/govt-objectives/index.aspx.
- Mackenzie District Council, 2004. *District Plan 2004*. www.mackenzie.govt.nz/Site/Documents_and_Policy/key_documents/district_plan.aspx
- Mackenzie District Council, 2005. *Mackenzie District Civil Defence Emergency Management Local Arrangements 2005*. www.hurunui.govt.nz/assets/GroupPlan/Mackenzie.pdf
- Mackenzie District Council, 2011. *Annual Report 2010–2011*. www.mackenzie.govt.nz/Site/Documents_and_policy/key_documents/annual_report.aspx

- Marin, C. and Orlando, G. (coordinators), 2009. *Starlight Reserve: Concept, Dimensions, Categories, Criteria, Recommendations*. UNESCO-WHC (Initiative Astronomy and World Heritage), MaB Urban Ecology Programme of UNESCO, International Astronomical Union, World Tourism Organisation, Instituto de Astrofísica de Canarias, International Commission on Illumination. www.starlight2007.net/pdf/StarlightReserve.pdf
- Marin, C., Wainscoat, R. and Fayos-Solá, E., 2010. 'Windows to the Universe': Starlight, Dark Sky Areas, and Observatory Sites. In C.L.N. Ruggles and M. Cotte, *Heritage Sites of Astronomy and Archaeoastronomy in the Context of the UNESCO World Heritage Convention – A Thematic Study*, ICOMOS/IAU, Paris, pp. 238–245.
- Maturin, S., 2010. *Managing Land use change in the High Country*. Paper presented at the 2010 Environmental Defence Society National Conference, Environmental Defence Society, Auckland. www.edconference.com/content/docs/2010_papers/Maturin,%20S%20powerpoint.pdf
- McGlone, M. S., 2001. The origin of the indigenous grasslands of southeastern South Island in Relation to pre-human woody ecosystems. *New Zealand Journal of Ecology*, 25(1), 1–15.
- McIntyre, Roberta. 2007. *Historic heritage of high-country pastoralism: South Island up to 1948*. Department of Conservation, Wellington. www.doc.govt.nz/upload/documents/science-and-technical/sap240.pdf
- Mikaere, B., 1998. *Te Maiharoa and the promised land*. Reed Publishing (NZ), Auckland.
- Molloy, L., 2007. *New Zealand's Wilderness Heritage*. Craig Potton Publishing, Nelson.
- Molloy, 2010. *Landforms and Soils of the Mackenzie Basin*. Paper presented at the Future of the Mackenzie Country Symposium, Twizel, 27 November 2010. eds.org.nz/content/documents/events/mackenzie/papers/Molloy%2C%20Les.pdf
- Parliamentary Commissioner for the Environment, 2009. *Change in the High Country: Environmental Stewardship and Tenure Review*. www.pce.parliament.nz/assets/Uploads/Reports/pdf/Change_in_the_high_country.pdf
- Relph, D., 2010. *The Mackenzie Country: a Fine Plain Behind the Snowy Range*. David Ling, Auckland.
- Robinson, R. and Wattie, N., 1998. *The Oxford Companion to New Zealand Literature*. Oxford University Press, Melbourne and Auckland.
- Ruggles, C.L.N. and Cotte, M., 2010. Heritage Sites of Astronomy and Archaeoastronomy in the context of the UNESCO World Heritage Convention – A Thematic Study. ICOMOS/IAU, Paris. www.astronomicalheritage.net/index.php/thematic-study
- Ruka Te Korako, M. and Ruka Te Korako, T.P., 2006. *Whispers of Waitaha: Traditions of a Nation*. Wharariki Publishing Ltd, Christchurch.
- Starlight Initiative, 2007. *Declaration in Defence of the Night Sky and the Right to Starlight*. Available in English, French and Spanish
- Sydney, G.C., 2009. Submission to Environment Canterbury, 2 December 2009. www.ecan.govt.nz/publications/Consent%20Notifications/upper-waitaki-submitters-evidence-mackenzie-guardians-grahame-sydney-071209.pdf
- UNESCO World Heritage Centre, 2013, *Operational Guidelines for the Implementation of the World Heritage Convention*. whc.unesco.org/en/guidelines
- Walker, S., 2010. *Ecology and Ecological Values of the Mackenzie Basin Floor*. Paper presented at the Future of the Mackenzie Country Symposium, Twizel, 27 November 2010.
- Wilson, R. K., 1949. *The Mackenzie Basin: a regional study in the South Island high country*. A thesis for the degree of Master of Arts (honors) in Geography, University of New Zealand.