

# Research Plan

## The Arrow River: Haihainui/Haehaenui – “Big Scratches”



*Figure 1 – Haihainui/Haehaenui – “Big Scratches”, The Arrow River. From Susan Cleaver 2019*

**LUAC014 - Te-Tu-a-Uri**

**INTRODUCTION TO MAORI CULTURE AND SOCIETY**

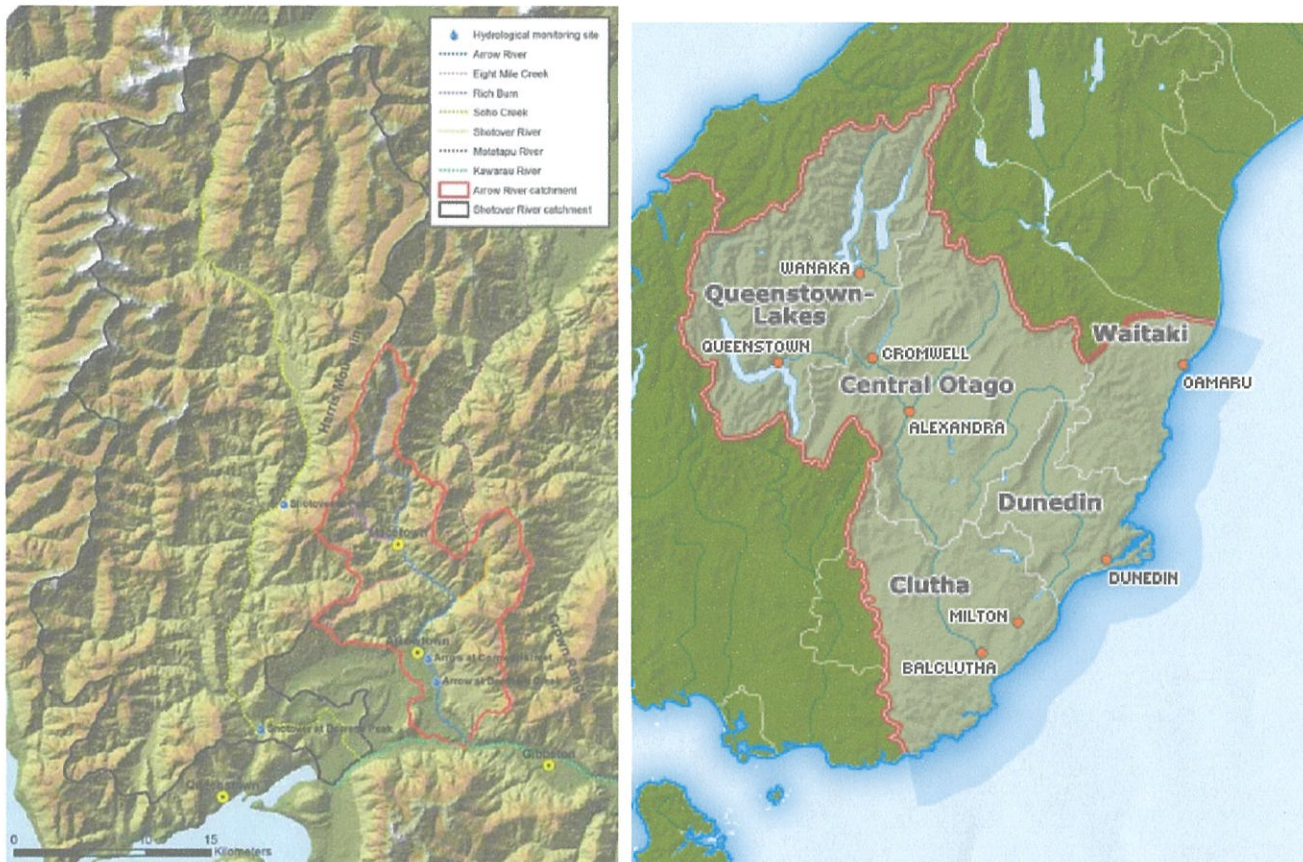
**CAROL BUNN - STUDENT I.D. NUMBER: 1032694**



## Introduction

### Location, Geology, History

The Arrow River begins in the Harris Mountains, 1600m above sea level (asl), 34 kilometres northwest of Arrowtown. The river descends rapidly through tussock-covered mountain slopes and an ice-carved gorge to Arrowtown; where it leaves the mountains and changes direction, flowing along the base of the Crown Range passing through a narrow rocky gorge joining the Kawarau River, 300m asl, just west of Gibbston. (Williams & Goldsmith 2015; Olsen, Lu and Ravenscroft, 2017).



Left: Figure 2: Map of the Arrow River catchment. (From Williams & Goldsmith, 2015 p. 4) Figure 3: Otago Regional Council boundaries. From: [http://www.localcouncils.govt.nz/lcip.nsf/wpg\\_URL/Profiles-Councils-by-Region-Otago](http://www.localcouncils.govt.nz/lcip.nsf/wpg_URL/Profiles-Councils-by-Region-Otago)

The Arrow River catchment geomorphology is 237 km<sup>2</sup>, 42 km long and 23 km wide at its widest point (Williams & Goldsmith, 2015). The vegetation changes along the river, from tall alpine tussock with pockets of mountain beech forest, to grey shrub-lands and briar, with short tussock exotic grasses, trees, and weeds in the mid to lower reaches. (Olsen et al., 2017).

### Geology

The Otago Schist basement formed about 200 million years ago, deep in the Earth's crust when thick sediment was thrust together and heated up off the coast of the super continent Gondwana. The landscape submerged beneath the sea 60 million years ago and re-emerged 25 million years ago when the Alpine Fault developed through tectonic forces. Basement rocks were formed by progressive uplifting, stacking, and heating that eroded over time creating rich alluvial gold deposits of the Arrow River. By about five million



years ago the continuous chain of the Southern Alps had largely formed (Craw, n.d.). The main drainage patterns of the Arrow River flow down an ancient fault line and was most-likely well established before the onset of the ice age in geological recent times" (Bell, 1973).

## History

Settlement of the Wakatipu area dates back about 700 years by three local Māori tribes; the Waitaha settled first, then the Kāti Māmoe and then the Kāi Tahu, eventually forming peaceful alliances (Southern Discoveries, 2015). Local iwi called the Arrow River **Haihainui/Haehaenui** (meaning "big scratches") most likely referring to the Matagouri that dominated the riverbed at the time (Olsen et al., 2017).

"The Haihainui/Haehaenui has long been a place of cultural significance to Māori, forming part of the extensive network of kāika mahika kai [areas traditionally significant for food gathering] and ara tāwhito [traditional travel routes] throughout this area" (Hale, 2019, p.3). It is likely that **aruhe** (bracken fern root) was gathered along the river and hunting weka was carried out well into the 19<sup>th</sup> century, as this was considered an important and "an original birding area for these birds" (Kleinlangevelsloo, 2017, p. 17).

Two Māori of the Tātūrau iwi, chief Reko and Kaikōura guided the first European visitor to the area Nathanael Chalmers in September 1853, however it was not until 1860 that the first Europeans settled (Phillips, 2007). Gold was discovered in the Arrow River by Jack Tewa in 1862 and by January of 1863 the goldrush was in full swing. Much of the Arrow River and its tributaries was prospected for gold with most of the mining happening in the headwaters above Arrowtown in the "now" Macetown Historic Reserve (Petchey, 2002).



Figure 4 Left: Exotic trees & shrubs around Macetown. Right: Macetown Bakery amongst Sycamore trees.  
From <https://www.doc.govt.nz/parks-and-recreation/places-to-go/otago/places/macetown-historic-reserve/>

The Arrow Irrigation Scheme was constructed during the depression and completed in 1936 by labour of the Unemployment Board. The scheme obtains its water from a weir at the top of the Arrow River gorge via five kilometres of pipeline which is distributed around the Arrow Basin through 50 kilometres of water-race and six kilometres of pipe syphons (Bell, 1973). The scheme was originally constructed to provide irrigation water to the local farms, however, today it supplies households, farmers, international golf courses, rural residential development and tourism (Kleinlangevelsloo, 2017) and is administered by the Otago Regional Council (ORC).



## The changed ecosystem (the new “naturalness”)

From an archaeological point of view, the Historic Macetown Reserve and its surrounding area is very rich (Petchey, 2002). However, much of the archaeological evidence associated with Māori significance has not been investigated or has been lost due to goldmining and is not recognised archaeologically (Kleinlangevelsloo, 2017).

The area is managed by the Department of Conservation (DOC) as it is considered to have a diverse historic heritage and associated conservation values (DOC, 2016, part one). Large numbers of people visit the upper reaches of the Arrow River by four wheel-drive (4WD) vehicles, crossing the river many times; or walk there via the mountain trails. The steep tussock-covered mountain slopes are generally considered as unmodified where the “character of wildness and naturalness is retained” (Greenaway, 2017, p. 14). However, remnants of a bygone era and the impacts of the goldminers are still apparent today.

In the mining heyday, Macetown stretched nearly a mile along a narrow river terrace and the headwaters of many tributaries were extensively dredged and mined. Advance Peak (1749m asl) and the spurs of Vanguard Peak (1781m asl), supported the highest elevation mines in New Zealand, and today these sites still bear extensive evidence of hard-rock mining (Petchey, 2002).

Furthermore, more than 150 years on, hawthorn trees are still growing in the original hedge lines around Macetown and are naturally spreading, along with broom and sweet briar (Petchey, 2002). Sycamore and Douglas Fir trees are rapidly spreading and encroaching into the open tussock land and exotic willow trees grow in and along the river itself.



*Figure 5 Arrowtown Autumn Colours on the hillside below Glencoe Station: a mix of Sycamore, Larch, Pine, Rowan, and other exotic species. From: Susan Cleaver 2015.*

The sycamores are valued for their autumn colours and “form an integral part of the picturesque setting of today’s Arrowtown” (Olsen, et al., 2017, p. 1). “The Arrowtown Plan was developed for the [Queenstown



Lakes District Council] (QLDC) by the 'Arrowtown Workshop Project Team' in 2003. This 'outlines the community's proposals for their place'." (Greenaway, 2017 p. 14). The Arrow River is referred to as important to the town; its characteristics and features are valued and the retention of the sycamores are sought, as they bring many tourists into the area. However, they are spreading rapidly into the sub-alpine tussock land of Glencoe Station, directly bounding Arrowtown. Imagine this hillside full of colour with flowering Kōwhai; alive with the sound of tui and bellbird song in the spring?

## Management of the River

The river itself and associated lands are managed by the Otago Regional Council (ORC), as required by Section 30 of the Resource Management Act 1991 (RMA). ORC is setting minimum flows and allocation limits, with the aim "to protect aquatic ecosystems, the natural character of rivers, recreational and cultural values" (Kleinlangevelsloo, 2017, p. 5).

Important tributaries flow into the Arrow River contributing to its overall flow and velocity supporting indigenous ecosystems. The notable change in the river's gradient just upstream from Arrowtown affects the velocity and flow of the water and can affect what is happening further downstream.

At the national level, the Arrow River has never been identified as significant and has only local in-river recreation values...tourism and landscape and scenic values (Greenaway, 2017). However, the value of clear and clean water and the river functioning in its natural state are important to Kāi Tahu and the local community (Kleinlangevelsloo, 2017). In 2014 Didymo was confirmed in the Arrow River by the ORC (Roxburgh, 2014) and poses a serious threat to the aquatic ecosystem and the natural values of the river.



Figure 6 A popular swimming hole in the Arrow river, surrounded by willows, gorse, and lupins. From: Susan Cleaver 2014.



## Aquatic ecosystem values of the Arrow River

Soho Creek is a tributary of the Arrow River not far from the Macetown Historic Reserve. It has been identified by the ORC as having the following values:

- Weed free,
- Presence of a rare macro-invertebrate. (Olsen et al., 2017, page 17).

Furthermore, a single record of the Koaro (*Galaxias brevipinnis*); a native fish species has been found near the confluence of the Arrow River and Soho Creek. The Koaro is listed as "At Risk, Declining" (Olsen et al., 2017); they are often found long distances inland at high altitudes. The greatest adverse effects to the decline in abundance of the Koaro is from humans and trout predation (McDowall, 2011). There are also no longfin eel/Tuna found in the Arrow river, due to the impact of goldmining, the introduction of salmonids and the construction of the Roxburgh and Clyde dams on the Clutha River/Mata-au. (Kleinlangevelsloo, 2017).

## Water Conservation - kaitiakitanga

"On the 23<sup>rd</sup> of October 1990, an original application was made by the Minister of Conservation for a water conservation order to be created for the Kawarau River. This application included Lake Wakatipu, its inflowing streams and rivers and all the tributaries" (Harris, 2008, p. 12).

DOC in its Otago Conservation Management Strategy 2016 (OCMS) part two, state that "the outstanding values of the Kawarau River and many of its tributaries are formally recognised and protected by the Water Conservation (Kawarau) Order 1997, covering the main stem of the river, and many of its headwaters and tributaries". (DOC, 2016, part two, p. 7). The Arrow River and its tributaries are part of the Kawarau and Clutha/Mata-au river system, which is significant to Kāi Tahu spiritual and cultural beliefs. "Water is seen as a reflection of the health of Papatūānuku" (Kleinlangevelsloo, 2017, p. 34), so any loss or pollution of this resource "degrades the mauri of the water and threatens the Ki Uta Ki tai philosophy (management of resources through the connectedness from mountain to seas) (Hale, 2019. p.2).



Figure 7 Left: Rocky outcrops forming rapids; Right: Bracken/aruhe growing on the banks of the Arrow River. From: Susan Cleaver 2019.



## Flora and fauna

The Otago mountains is a botanist's paradise, supporting a diverse range flora with much of it unique and some endemic. Many plants appear to be unnamed and some are presently being studied. Regionally, "more than 1000 species have been recorded" (Simpson, 1998, p. 48), with many appearing on the NZ Threatened Plants list.

Simpson (1988) argues that the Tenure Review process is having great gains for conservation. The high sub-alpine tussock lands, wetlands and mountain beech forest patches are being restored and recovering, because of very conservative grazing, or complete removal of stock, with no burning in these areas. These areas provide vital habitat for vulnerable bird species such as silvereye, bellbirds, grey warblers, kea, and other threatened species such as skinks, butterflies, and tussock insects (Cumming, 2015).



Figure 8 Birds currently seen in the Arrow River gorge. From left; falcon, fantail, tomtit, bellbird, wax eye. From: Susan Cleaver 2014 – 2019.

## Cycle and walking Trails

Almost all the Arrow River is now accessible to the public, either by walking, 4WD, or mountain bike. The Queenstown Trails Trust in collaboration with DOC, local landowners, businesses and individuals constructed (as part of a wider trail network) the Arrow River Bridges Trail which connects Arrowtown (incorporating the Millennium Track) to Gibbston and Lake Hayes, along parts of the Arrow River, that were previously inaccessible. The Arrowtown end of the trail connects to the 4WD road to Macetown and mountain walking tracks in the headwaters of the Arrow River through to Wanaka via the Te Araroa national walkway, possibly taking riders and walkers on a similar journey that Māori used as their ara tāwhito (traditional travel routes) (C. Bunn, Personal communication, September 18, 2019).

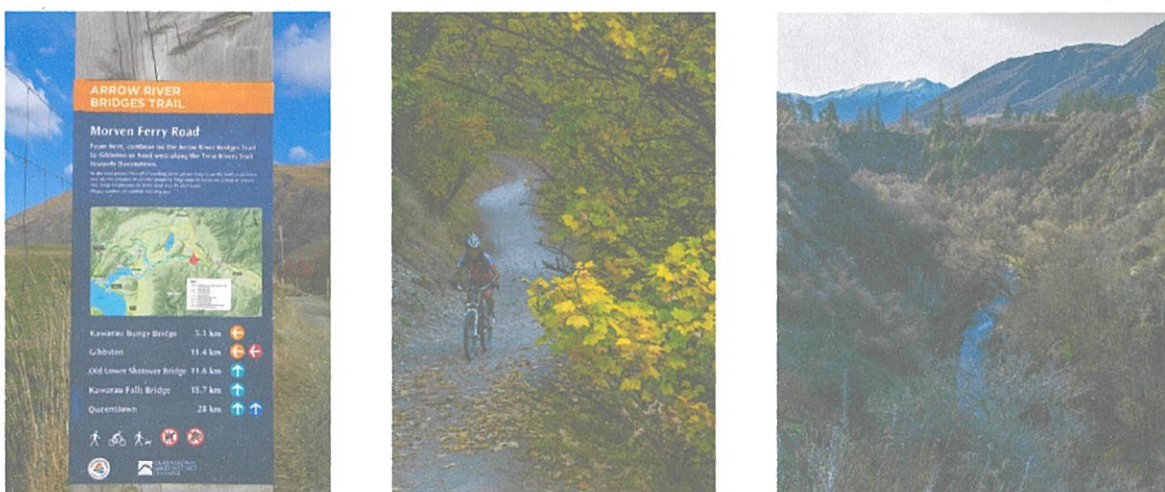


Figure 9 from Left: Arrow River Bridges Trail; Centre: Cyclist on trail in Autumn; Right: View up the Arrow River from Edgar Bridge. From: Susan Cleaver 2019.



## Mahu Whenua covenants – kaitiakitanga

Between 2003 and 2011, Robert “Mutt” Lange (Soho Properties) obtained Overseas Investment Office (OIO) approval to purchase Crown pastoral leases for four high country stations that bound the Arrow River catchment. He purchased 55,500 hectares, covering the back-country area from Wanaka to Arrowtown. These properties are Motatapu and Mt Soho stations (purchased 2003), Glencoe Station (2009) and Coronet Peak Station (2011) (Cumming, 2015).

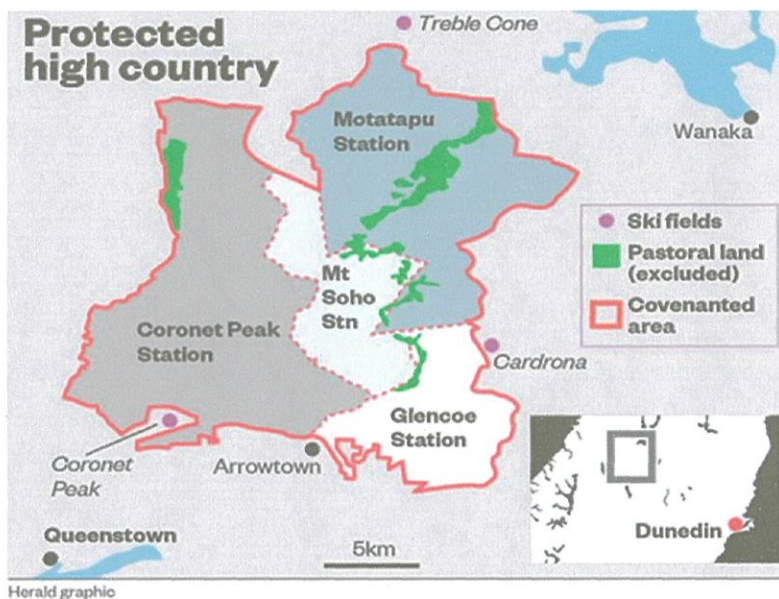


Figure 10 Soho Properties QEII covenant map. Photo: Alan Gibson. From NZ Herald.

OIO approval was initially gained after Lange undertook to increase public access to Mount Motatapu and Mount Soho Station by building a walking track that now forms part of the national walkway Te Araroa and “what’s unfolded is likely the most ambitious individually-funded ecological restoration effort undertaken in New Zealand” (Cumming, 2015, p. 1).

Covenants called “The Mahu Whenua” (healing the land) were placed on the land in 2015 and are administered by the QEII National Trust to ensure that any future leaseholders are bound to protect the landscape, ecological and heritage values of the land. These covenants will effectively prevent Soho Properties land from ever going through Tenure Review, with conservation areas being resumed by the Crown and therefore less access for the public to freely roam (Cumming, 2015).

Local farmer, Russell Hamilton fronts the regeneration and restoration project for Soho Properties under The Mahu Whenua covenants; he believes that they are custodians of the land for future generations (kaitiakitanga). They specifically aim to restore habitat first so native flora and fauna can survive in a pristine environment. The high, sub-alpine pasture is being de-stocked, with sheep replacing cattle on lower productive land. War is being waged against wilding pines, goats, stoats, weeds and other pests and erosion prone land is being stabilised with the planting hundreds of thousands of native trees and shrubs. They are building walking tracks and huts for public use, with 21 tracks in total (Cumming, 2015).

Small native stands of mountain beech forest still exist in the high-country valleys on the western side of the Arrow River catchment (Coronet Peak/Harris Mountains), some cling to life in the most impossible places. Remnants of grey shrubland are also found supporting natives such as matagouri, coprosma, oleria, bracken/aruhe and even pockets of kowhai and totara have stood the test of time on the Glencoe Station and are regenerating on chopped off stumps. Beekeepers who struggled for years, are now making good



amounts of honey off new and re-generated native plant species (R. Hamilton, personal communication, September 7, 2019).

However, these tenuous remnants of native forest and shrubland continue to be under considerable threat from wilding conifers (especially Douglas Firs) and sycamores. Hamilton says, they are spreading faster than rabbits in the Arrow River high-country (Cumming, 2015).



*Figure 11 Russell Hamilton in the Arrow River high-country. Sprayed wilding conifers in the background. Photo: Alan Gibson, From NZ Herald.*

## **Wilding Conifers – major threat to indigenous ecosystems**

Dense infestations of wilding conifers are associated with historical plantings throughout the district. Seeds easily disperse, therefore young trees grow and spread very rapidly; estimated to be around five percent annually, especially in locations that are lightly vegetated and lightly grazed (ORC, 2017).

Controlling the spread of wilding conifers is a complex issue and the costs are escalating exponentially. “If nothing is done in Otago to control this problem, the area infested in this region is likely to triple from 300,000 ha to 900,000 ha over the next 20 years if current management approaches remain” (ORC, 2017, para. 4).

The Wakatipu Wilding Conifer Control Group (WCG) was set up in 2009, by a volunteer group of community residents. They have put thousands of hours into controlling and eradicating wilding conifers and have produced a wilding conifer control strategy (ORC, 2017). Each year the WCG removes thousands of trees because they outcompete regenerating natives and destroy indigenous tussock lands.

Beside Coronet Peak Station, the Queenstown Lakes District Council (QLDC) have made the commitment to remove the Arrowtown forest (Hensman, 2019), which has rapidly spread to the surrounding hills and mountains of the Arrow River catchment. Soho Properties are also committed to controlling the pines and restoring biodiversity of the land under The Mahu Whenua covenants.



Central Wilding Tree Control has been contracted out by DOC for the last ten years to eradicate wilding trees, including sycamores. In the past year they have been working along the banks of the Arrow River, making big inroads into controlling the number of wilding trees. A dedicated volunteer group of 70 Arrowtown residents have also adopted a section of river catchment behind Arrowtown eradicating both sycamores and Douglas Firs, allowing a patch of mountain beech forest to regenerate (A. Saunders, personal communication, September 6, 2019).



Figure 12 Arrow River Bridges Trail, wilding pine control. Left: wilding pine control sign August 2019. Right: View of Arrow River Gorge from Edgar Bridge, showing fallen conifers. From: Susan Cleaver 2019.

Where possible, many of the trees felled are used locally for firewood, however many trees remain where they fall, because DOC and the WCG don't have the resources to take every tree out (A. Saunders, personal communication, September 6, 2019).

In 2017, the WCG entered a three-year joint community project, with The Wakatipu Beech Seeding Project, receiving technical support from Scion Research Institute and Otago University. Areas of sprayed conifers will be sowed with native seeds; collected in a mast year to maximise seed collection. Native species do not tend to produce large quantities of viable seed, however there is hope that they will out-compete rapid colonising wilding trees (WCG, 2019).

## Rabbits and other “weeds” – major threat

Rabbits are a big problem in Central Otago and a serious threat to biodiversity and the environment. The ORC considers rabbits to be the number one pest in Otago (ORC, 2019).

In the lower reaches of the Arrow River Bridges Trail rabbits have spread rapidly and are causing major damage, by digging holes that cause soil degradation and erosion, as well as eating tree seedlings. They prefer dry habitats and like to hide in shrubs, trees and wood piles, and barrow holes in inaccessible places. A rabbit as young as five months' old can have up to 50 offspring in one year (ORC, 2019).

The cycle trail is maintained by the Queenstown Trails Trust, and the riverbanks are owned by the Crown, which is administered by DOC. DOC and local landowners have collaborated and erected rabbit proof fencing, however since the trail has been constructed weeds such as sweet briar, hawthorn, gorse, broom and hemlock are spreading; serving as a “breeding ground” for the rabbits.



The Wakatipu Reforestation Trust has planted pockets of native shrubs and trees; however, they have not survived due to a lack of water, destruction from rabbits and competition from weeds (D. MacColl, personal communication, September 6, 2019).



*Figure 13 Left: Rabbit burrows degrading the land; Right: Rabbits out in big numbers. From: Susan Cleaver 2019*

The ORC no longer carries out rabbit management, therefore it is the responsibility of the landowner (ORC, 2019). Many of the local landowners along The Arrow River Bridges Trail are absentee owners, so efforts to control rabbits can be futile. The introduced biological control virus RHDV1 K5 is having very little effect on rabbit populations to date (D. MacColl, personal communication, September 6, 2019).

## Conclusion

Haihainui/Haehaenui formed from tectonic forces, long before local Māori iwi settled the area, calling the river 'Big Scratches'. Its formation was perhaps the biggest scratch of all? For many millennia the Arrow River has flowed pure and clean from its headwaters in the Harris Mountains, to the Kawarau and Clutha/Mata-Au rivers out to the ocean; thus forming part of an integral network of indigenous ecosystems that formed and adapted over long periods of geological time to create its own unique ecosystem.

The significance of this ecosystem was recognised by Māori and the "Kāi Tahu Whānui has always held a strong, innate connection to the waters of this area". They considered "that water was left by tūpuna (ancestors) to provide and sustain life" (Hale, 2019, p. 2). For around 700 years, the Haihainui/Haehaenui became an integral part of their inland seasonal hunts and food gathering network of kāika mahika kai, as well as part of the traditional travel routes ara tāwhito.

Arguably, the biggest and deepest scratches of all, happened during the goldrush of the 1860's. In a few short years, almost the entire length of the Arrow River and many of its tributaries were mined and dredged; some occurring at high elevations in the headwaters, forever changing the indigenous ecosystem.

Over 150 years, much of the native flora and fauna has disappeared, with only remnants remaining. Exotic sycamore trees cover the hills around Arrowtown and are valued for their autumn colours. For 75 years, the water from the River, has provided vital sustenance to local farmers to irrigate their land. Now there are many other users of the water. Exotic pests and weeds have taken up residence in the river catchment and appear to be staying.

Many people value the Arrow River catchment. Some are exercising kaitiakitanga/stewardship to restore its indigenous ecosystems, some value it for its clean and clear water, some value it for the exotic autumn



colours. Whatever the reason, it is important to view the river in its entirety; in a holistic way, so as not to diminish its mauri, to sustain its life force and vital essence and special nature. Restore its mana whenua.



*Figure 14 Big Hill Saddle, view towards Arrowtown and Arrow River tributary. Foreground alpine tussocks, to the right a native stand of mountain beech forest remains, middle to back the spread of exotic trees on Glencoe Station. From: Susan Cleaver 2015.*

## **Haihainui/Haehaenui: ‘Let us flow this out for the good of everything’**



*Figure 15 Haihainui/Haehaenui: Whirlpool at ArrowJunction. From: Carol Bunn, 2019*



## References

- Bell, J. B. (1973). *Arrow river irrigation scheme preliminary reassessment report*. Dunedin: Ministry of Works.
- Craw, D. (n.d.). *Geological evolution of Otago and its gold*. University of Otago. Retrieved from:  
<https://www.otago.ac.nz/geology/research/gold/otago-gold-background.html>
- Cumming, G. (2015, February 28). Can foreign owners save our country? *New Zealand Herald*. Retrieved from: [https://www.nzherald.co.nz/nz/news/article.cfm?c\\_id=1&objectid=11409283](https://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=11409283)
- Department of Conservation. (2016). *Otago conservation management strategy. Part one*. Retrieved from:  
<https://www.doc.govt.nz/about-us/our-policies-and-plans/statutory-plans/statutory-plan-publications/conservation-management-strategies/otago/part-one/>
- Department of Conservation. (2016). *Otago conservation management strategy. Part two*. Retrieved from:  
<https://www.doc.govt.nz/about-us/our-policies-and-plans/statutory-plans/statutory-plan-publications/conservation-management-strategies/otago/part-two/>
- Greenaway, R. (2017). *Arrow river social values assessment*. Otago Regional Council. Retrieved from:  
<https://www.orc.govt.nz/media/4257/social-values-assessment.pdf>
- Hale, P. (2019). *Cultural Values statement Queenstown lakes district council wastewater overflow discharge Queenstown lakes district*. Otago Regional Council. Retrieved from:  
<https://www.orc.govt.nz/media/6939/cultural-values-statement.pdf>
- Harris, J. (2008). *A review of the nevis valley and its values: in response to potential hydro electric development*. University of Otago. Retrieved from:  
<https://www.otago.ac.nz/wildlife/otago016057.pdf>



Hensman, G. (2019, June 8). *WCG 10<sup>th</sup> anniversary dinner speech – Chairperson, Grant Hensman*.

Retrieved from:

<https://www.wakatipuwilding.co.nz/wcg-10th-anniversary-dinner-speech-chairperson-grant-hensman/>

Kleinlangevelsloo, M. (2017). *Cultural values report. Arrow river/Wakatipu basin aquifers Cardrona River*.

Otago Regional Council. Retrieved from:

<https://www.orc.govt.nz/media/4196/cultural-value-report-aukaha.pdf>

McDowall, R. M. (2011). *Ikawai freshwater fishes in Māori culture and economy*. Christchurch: Canterbury University Press.

Olsen, D., Lu, X., & Ravenscroft, P. (2017). *Update of scientific information for the Arrow catchment: 2012-2017*. Otago Regional Council. Retrieved from:

[https://www.orc.govt.nz/media/4204/arrow-river-science-update-dec-2017\\_web.pdf](https://www.orc.govt.nz/media/4204/arrow-river-science-update-dec-2017_web.pdf)

Otago Regional Council. (2017). *Wilding conifers*. Sourced from:

<https://www.orc.govt.nz/managing-our-environment/biodiversity-and-pest-control/pest-control/wilding-conifers>

Otago Regional Council. (2019). *Rabbits*. Sourced from:

<https://www.orc.govt.nz/managing-our-environment/biodiversity-and-pest-control/pest-control/rabbits>

Petchey, P. (2002). *Archaeological survey of the Arrow river and Macetown, Otago*. Department of Conservation. Retrieved from:

<https://www.doc.govt.nz/documents/science-and-technical/Macetowntentire.pdf>



Phillips, J. (2007, September 24). European exploration - Otago and Southland. *Te Ara - the encyclopaedia of New Zealand*. Retrieved from: <https://teara.govt.nz/en/european-exploration/page-7>

Roxburgh, T. (2014, May 2). Didymo confirmed in Arrow river. *Otago Daily Times*. Retrieved from: [https://www.orc.govt.nz/media/4204/arrow-river-science-update-dec-2017\\_web.pdf](https://www.orc.govt.nz/media/4204/arrow-river-science-update-dec-2017_web.pdf)

Southern Discoveries. (2015, December 21). *A brief history of Queenstown*. [Blog post]. Retrieved from: <https://www.southerndiscoveries.co.nz/blog/a-brief-history-of-queenstown>

Simpson, N. C. (1998). *The flora and landscape of the Otago and northern Southland mountains*. The Lucy Cranwell Lecture of 1998. Retrieved from: [http://bts.nzpcn.org.nz/bts\\_pdf/Auck\\_1998\\_53\\_2\\_48-51.pdf](http://bts.nzpcn.org.nz/bts_pdf/Auck_1998_53_2_48-51.pdf)

Wakatipu Wilding Conifer Control Group. (n.d.). *Beech seeding project*. Retrieved from: <https://www.wakatipuwilding.co.nz/beeceh-seeding-project/>

Williams, J. & Goldsmith, M. (2015). *Flood and erosion hazard in the Arrow river at Arrowtown*. Otago Regional Council. Retrieved from: <https://www.orc.govt.nz/media/2954/flood-and-erosion-hazard-of-the-arrow-river-at-arrowtown-web.pdf>



## Images and Photos

Figure 15: Photo from Carol Bunn

Figure 1, 5- 9, 12-14, Photos from Susan Cleaver

Figure 2: Map of the Arrow River catchment. From (Williams & Goldsmith, 2015 p. 4)

Figure 3: Otago Regional Council boundaries. From:

[http://www.localcouncils.govt.nz/lqip.nsf/wpg\\_URL/Profiles-Councils-by-Region-Otago](http://www.localcouncils.govt.nz/lqip.nsf/wpg_URL/Profiles-Councils-by-Region-Otago)

Figure 4: From: <https://www.doc.govt.nz/parks-and-recreation/places-to-go/otago/places/macetown-historic-reserve/>

Figure 10 and 11, From: [https://www.nzherald.co.nz/nz/news/article.cfm?c\\_id=1&objectid=11409283](https://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=11409283)