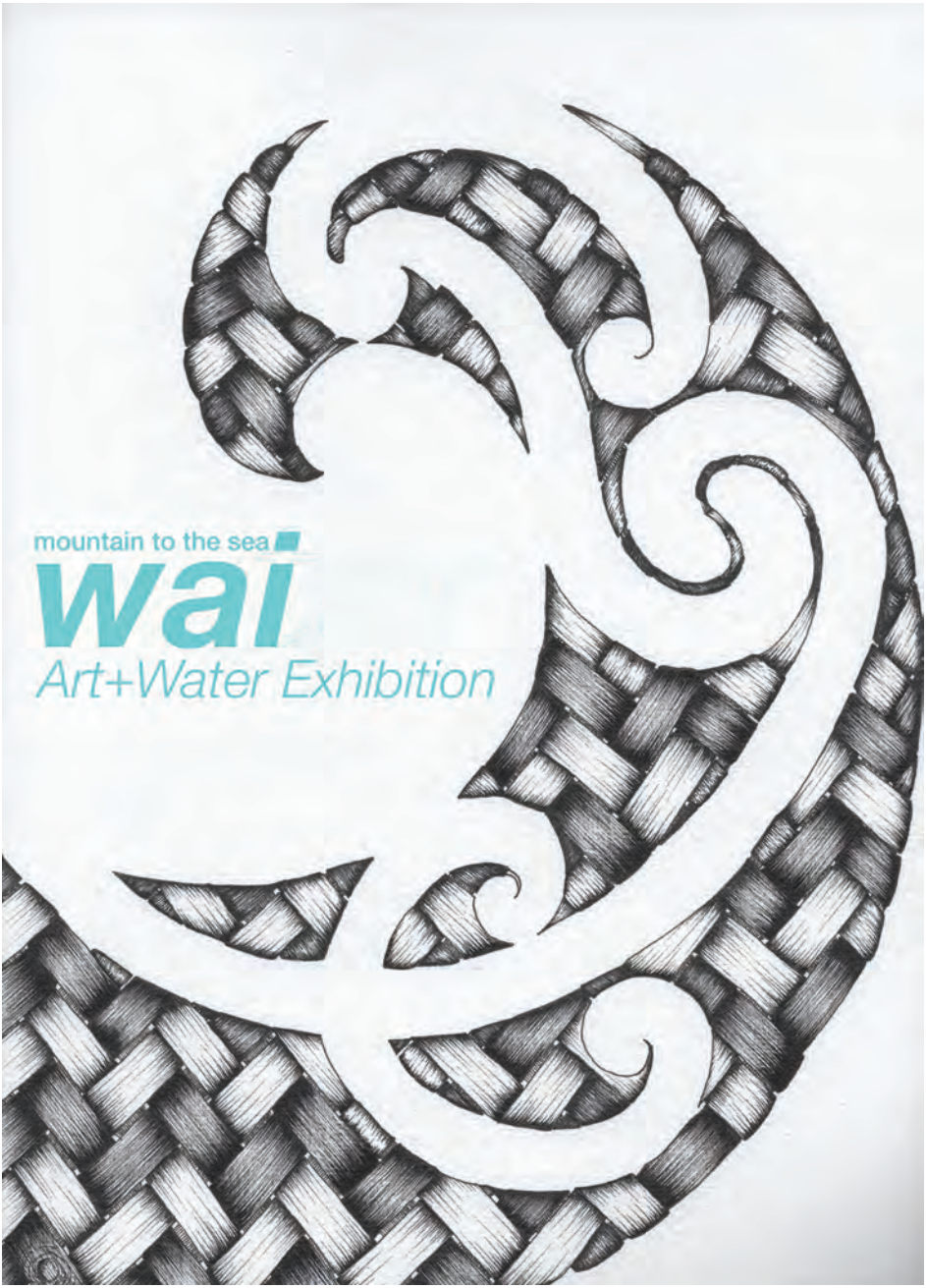

Exhibition Poster image: Heramaahina Eketone (*Waikato and Ngāti Maniapoto),* Pam McKinlay and Joanna Wernham.

Art + Water

Exhibition Catalogue

Curated by Pam McKinlay
and Jenny Rock

In collaboration with
the University of Otago,
the Dunedin School of Art,
and the Otago Museum

Art + Water exhibition

An Introduction

In 2019, the seventh in the Art and Science Series embarked on 'Art + Water' with the theme of 'Water: Mountains to the Sea'. The project participants included artists and scientists from a range of organisations in Dunedin and the wider Otago area, including: Dunedin School of Art at Otago Polytechnic (alumni artists and current staff); University of Otago (researchers from Biochemistry, Microbiology, Computer Science, Geology, Anatomy, Marine Science, Zoology, Science Communication, and the National Centre for Peace and Conflict Studies); the Dunedin Loom Room; Sinclair Wetlands and Ecosystems Consultants; and the Touchstone Citizen Project (Wanaka).

Collaborative projects in 'Art + Water' explored widely, from the source of water, to the structure of water, and the journey of water on its way from the mountains to the sea. The artists interpreted research on a wide range of topics including the forms of water, ice-formation, water-related protein structures, water-born disease in birds, fossilized structures made by aquatic/marine animals, impacts of land-use on water quality, water-born environmental DNA, effects of ocean acidification on marine calcifiers, ecology of the coastline shallows and the deep ocean canyons, bioengineering on farmland and conflicts in communities around water scarcity. Several of the projects revolved around implementation of research in environmental restoration work, including volunteer projects at Sinclair Wetlands and the Touchstone Citizen Project.

As is traditional for this Series, the aim of the 'Art and Water' project was not illustration of the science but an artistic response to scientific research. Throughout, both artists and scientists were involved in sharing their process and describing their work in monthly communal meetings. It has been a long rich journey, from source to exhibition, and we hope it enriches your thoughts and involvement in helping to solve the huge challenges our waters face, now and in the future.

Pam McKinlay and Jenny Rock, Co-ordinators

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Craig Marshall

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Scientist

Complexity, simplicity, and error

I work with living things that survive the transition of water from liquid to solid and back again. The freezing of water is fascinating in its own right. Water doesn't actually freeze at its freezing point but that is the temperature where ice crystals grow. Living things add layers of complexity to this already complex process. Some suppress the formation and growth of ice, others control where and when ice forms and alter the effects of removing the liquid water from solution.

Most natural systems show a similar combination of complexity generated from a set of simple rules that are interspersed with flaws and errors. When water freezes, the crystals have hexagonal symmetry but they are never perfect even when grown inside glacial caves. The basic hexagonal pattern is interrupted and collisions between adjacent crystals lead to new patterns. If you look carefully at frost flowers and ice patterns on a cold morning you'll see how each is unique because of the random errors that punctuate the following of simple rules involving ice crystal growth.

Biological systems show the same sort of patterns too. The rules here are more complex than those for ice crystal growth, but they are often simpler than we might imagine. The uniqueness of individual organisms (and the asymmetry of our left and right sides) arises from random errors in the rule following patterns.

The role of error in patterning makes it essentially impossible to predict exactly what the final structures will look like. We know, for example, that snow flakes all show hexagonal symmetry, but it is impossible to guess exactly what shape any snow flake will take however carefully we define the starting conditions.

The kinds of patterns Stella is able to make illustrate these properties of natural systems. The introduction of error produces changes in the pattern that are not always easy to predict. New symmetries appear and disappear as the pattern evolves and defining a beginning and an end is difficult.

Stella Lange

Designer

Disruption

Craig's interest in and description of the patterns and disruptions formed in ice crystals when contaminants are present intrigued me. When ice crystals form the structure is regular with a repeating element. The idea that a slight change in the water – a contaminant or chemical can result in a deformation or disruption to the ice crystal structure intrigues me and I wanted to explore how mimicking that disruption in a regular established knitted lace pattern could be interpreted in a garment designed for frosty conditions.

This design is a pattern for a lace cowl, designed to be worn outdoors where there is ice and the conditions that cause freezing. The lace pattern references the triangular nodes of ice crystal formation, and at points around the cowl – a disruption to the established lace pattern is introduced. The lace shifts in both scale and frequency at the point of disruption, changing and evolving into a new and different yet regular repeating pattern.

I am drawn to pattern, and repeating patterns. I work with slow design, collaborative design and knitwear design for hand-knitters. The goal was a pattern with a unique charted coded to create a disrupted lace outer layer over a softer contrast inner layer. Conventions of charting the pattern are used so knitters can create a work themselves. Hand knit pattern design is a particularly collaborative participatory system, the design is only finished when it is initiated by a knitter. Each knitter adds in their own variations, through their individual selections of yarn and colour. The pattern will be released and freely available on Ravely.com –

Geoff Wyvill

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Scientist

Simply Ice?

Ice has eighteen distinct types of crystal structure that we know about. The latest of these, recently discovered, was reported only four years ago.* But this is only the beginning of the complexity of ice structure.

At ordinary pressure on the earth's surface, most of the ice assumes the common hexagonal structure, but within this, it has many subtly different appearances. It can be clear when pure, or white with trapped air bubbles.

Formed by freezing water, it is mostly dense and hard. Formed directly from water vapour, it can be light, as snowflakes, or tightly stuck as frost to a cold surface such as a glass window.

John Tyndall's famous 'Ice Flowers' demonstration from the 1930s showed that in blocks of natural ice, separate areas of hexagonally symmetrical structure are all aligned. So even a clear, solid block of natural ice can reveal the history of its formation when we look at it in detail.

In many natural scenes, ice appears at a larger scale, as a texture overlaying whatever structure is beneath it. So a mountainside covered in snow has a texture shaped by the land, the vegetation, and the ice in layers at different scales.

On a small scale, ice is transparent and like all transparent materials it causes light to bend and the amount of bending depends on the colour of the light. So the 'white' of snow includes small sparkling flashes of colour, literally all the colours of the rainbow.

*Nature, Volume 519, Issue 7544, pp. 443-445 (2015)

Image Credit: Ice in Nature (Components of this image were taken from http://www.peakpx.com under the Creative Commons License)

Pam McKinlay

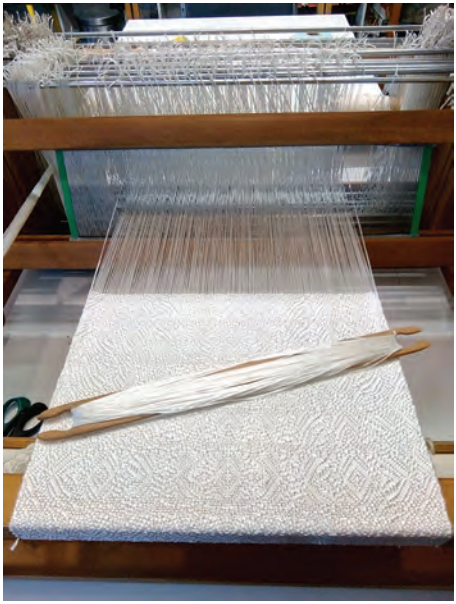
Artist

Every glacier begins with a snowflake

John Tyndall is often cited as the "father of climate change". His work on the properties of gases to absorb and transmit radiant heat led to speculation on how fluctuations in water vapour could be related to climate. He was an avid mountaineer pondering the forms and motion of glaciers. The mass that is the glacier is all underpinned by the minutiae of the individual ice crystals from which it is made. The regular structure/s of ice in the cryosphere is determined by a balance of heat and gas in the water cycle. Crystals stack, distort, melt and flow mountain to the sea, sea to mountain. Sun, air and water, in a planetary Feng Shui.

Ice is Cool is woven as white on white in a homage to *khata* – white silk scarves, bearing mantras symbolising purity from the Himalayas, the home of much of the world's ice and snow. Hand weaving the piece with single ply rayon thread, meant progress was made at a glacial pace!

In *Ice is Cool,* the surface shimmers as my snowflakes are carried in their glacial dance from mountain to the sea. The pattern distorts as it responds to the massive forces and underlying topography that determine rates of flow. In the second piece the ice is looking less "pure" and the surface "smutted". Surface meltwater is making itself known, affecting the internal shapes within the glacier until it disintegrates into runaway riverlets.



Pam McKinlay, *Ice is Cool* (work in progress), hand woven white on white textile, wool/silk and rayon 24cm x 3m, (derived from multiple tabby weave by Joan McCulloch)

Geoff Wyvill

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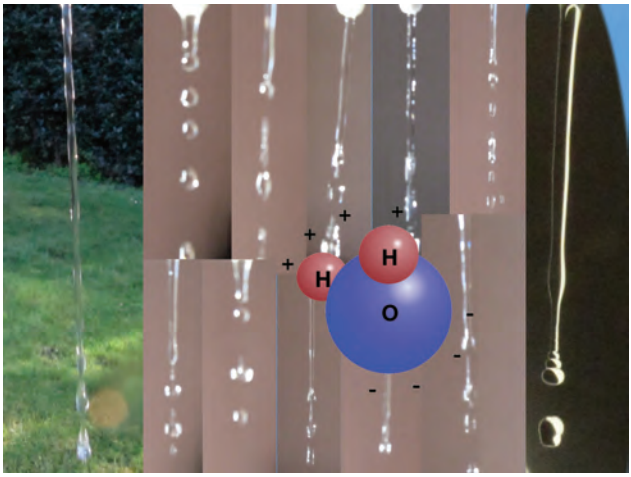
Scientist

Asymmetric water molecule

A water molecule consists of two atoms of hydrogen and one of oxygen - H_2O. The atom of hydrogen is the lightest and oxygen the eighth lightest. Much heavier molecules still form gases at ordinary temperature, but water is a liquid because the geometry of this very small molecule causes a separation of the natural electric charges of the atoms which, in turn, causes the water molecules to attract each other and stick together.



"Streams breaking and the asymmetric water molecule"

Because of this attraction, small amounts of water contract into spherical droplets. The water behaves as though it had a skin trying to minimise its area. We call this effect surface tension. A thin, falling stream of water becomes a smooth cylinder for the same reason. As the falling water speeds up, the cylinder is stretched and eventually must break into droplets. But where will it break?

Imagine a thin ring of water around the cylinder. It is like a rubber band, compressing a soft tube. But unlike a rubber band, the surface tension force does not get smaller as the ring shrinks. So we have the same force working on a smaller area and this creates a larger internal pressure. So an adjacent ring which is larger, will get forced outwards. The large ring grows and the smaller ring shrinks. Where does it start?

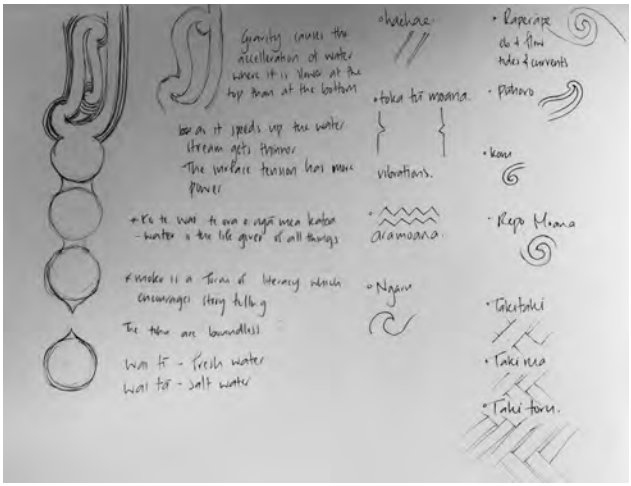
It begins with a tiny instability due to vibration or air movements. Once started, smaller rings will contract and force adjacent rings to grow until the smaller ring contracts to nothing and the stream separates. This process is known as the "Plateau-Rayleigh Instability".

Because of the random start to the process, streams of water can go through an amazing variety of shapes as they break up. Nature creates these delightful, changing, miniature, abstract sculptures all by herself.

Heramaahina Eketone

Artist

Kōpata



Tohu are a form of literacy and are boundless within 'te ao toi' but there are particular tohu that encourage story telling or interpretations of the different forms or even the personifications of wai.

This piece is an attempt at a figurative description of what happens when water falls. Beginning from the top, the pūhoro represents the acceleration of water caused by gravity. The tohu within the pūhoro are the koru, the haehae and the pākati. The koru presses the necessity of wai to all life while not forgetting that although water can take on many shapes and seem almost weak it can also be strong and unyielding. The haehae and its spaces simply shows that water acts as if it has a skin. And the pākati, while representing whakapapa, acknowledges the multiple deities to do with water who include but are not limited to Tangaroa, Kiwa, Kaukau, Te Wainui, Parawhenuamea, Hine-moana, Hine-kohu, Hine-wai, Hine-te-Ihorangi or Te Ihorangi.

Towards the bottom of the pūhoro the stream has reached a point where it has become thinner. By this time the surface tension has more power and as you travel down the image the stream is indented due to vibrations resulting in the wai snapping off. Each droplet has been given a different technique of raranga.

The first being takitahi, it shows that water can expand thus the loose weave. The second droplet is takirua, reinforcing that water is almost incompressible. The third droplet is takitoru, and acknowledges the three forms that water can be in, solid, liquid and gaseous. The final droplet has broken away from the forces holding the stream together. This encompasses all whakapapa, knowledge and wonders of water.

"Ko te wai te ora o ngā mea katoa" – Water is the life giver of all things.

Heramaahina Eketone
Waikato and Ngāti Maniapoto

Chris Arbuckle

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Scientist Touchstone Project

How do you clean water?

We do! I fell in love with water and the things that live in it at a young age. Lake Wanaka and its high-country rivers are very special to me. That interest in water led to a lifelong career in trying to understand and fix it. At the heart of what challenges me is to find ways to clean water of all the things humans pollute it with, there is a saying "Dirty water can't be washed". So, my interest is stopping stuff getting into it in the first place – so it does not need to be washed.

This needs people to respect water or even love water. "The Touchstone Project" builds on people's love of water. The water in Lake Wanaka is our Touchstone. It remembers what we humans pollute it with. With that in mind, friends and I started Touchstone to stir others into action, a way to engage, but mostly have fun with locals in Wanaka. The focus is on people, the lake and water. This photograph is of Bremner Bay in Wanaka, a very popular swimming spot and of a storm water drain discharging dirty water into the pristine lake after rainfall. Its very emotive. Drains in Wanaka do this regularly when it rains. They should not.

The main outcome of Touchstone has been to raise awareness locally (using images like this) to the water quality challenges we cause, and we have fixed some stuff. For example, doing some science with lake swimmers in turn cleaned up a sewerage leak to the lake that had gone un-noticed for 7 years. And school kids are looking at ways of fixing up the dirty stormwater by trapping dirt in wetlands that intercept the stormwater before it gets to the lake.

Many people ask for more science to understand what damage we are doing to the environment and demand action of agencies like the Regional Council, to stop images like that above, but many of the pollution issues need to be fixed by US, before stuff happens and that needs US to stop stuff getting into it in the first place.

Vivien Dwyer

Artist

How do you clean water?

I began this project with no real idea as to where it was going but it was always attached to this question which has stuck in my mind ever since the cleanliness of our local rivers came into the limelight. I put this together with my knowledge of the water cycle and my love of landscape which has been a mainstay of my art ever since I can remember and came up with a multi level way of depicting the cycle of water through many repeats. This is how water is freed of its pollutants but is that really still the case with so much pollution now being in the air as well as the land and the sea?

I built multiple layers into my weaving to illustrate nature trying to clean up our mess. There are landscapes upon landscapes in my work, each trying to clean things up as the water comes and goes.

My process involves recycled threads of all dimensions and made from all types of material. None of this is new and most is recycled from other projects done by a myriad of people. I like to use variations in thread thickness and texture and a variety of weaving and knotting techniques to add depth to the finished pieces.

Adan E. Suazo

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Scientist

Water is the foundation of life

Rangitata River Source: In its purest form, water from the Rangitata River emanates from the very heart of the Southern Alps, as featured in the picture.

Water is one of the most precious substances in the planet. What makes Earth capable of sustaining life, both human and non-human, is the existence of water systems. To say that water is the foundation of life is not a romantic or idealistic passage: It is a fact.

The scenarios that come to mind in the face of water scarcity are obvious: without water, ecosystems collapse, biodiversity becomes diminished, and human societies run the risk of clashing over what water is left to sustain their livelihoods. Conflict over scarce water seems like the natural pathway for societies to take. Despite of what we know about scarcity-driven water conflicts, little is understood about how and why water conflicts emerge and intensify in areas where, for all intents and purposes, water abounds.

By several accounts, New Zealand is one of the most water abundant countries in the world. This, combined with the country's several socio-economic and democratic indicators, has generated a perception that conflicts over freshwater in New Zealand do not exist. Even though violent conflict over water does not normally materialise in New Zealand, conflicts and incompatible claims over water have surfaced, and continue to do so. The myth of a conflict-free nation is consistently challenged by a rising number of water-based disputes motivated by activities such as water bottling, the growth of industrial agriculture, tourism, and water treatment strategies. To examine the reasons that drive communities in New Zealand to engage in conflicts over water, this project examines the conflict-causing effects of water bottling and water chlorination in the towns of Ashburton (Canterbury) and Glenorchy (Otago).

Lot 9 Ashburton: The prospective purchase of Lot 9 in Ashburton for water bottling was a significant source of conflict for the local community.

Christine Keller

Artist

We have to change

We need to change our attitude to the everyday objects we use, our levels of consumption and the way we do agriculture.

I started producing hand woven kitchen towels in Dunedin a few years ago. They are simple everyday objects which cost much more than their mass-produced sisters due to the time and effort which goes into them. The added value is due to the hand made touch of the maker. They are very good at what they do – drying dishes and giving pleasure.

In the first series I responded to the research of Adan E. Suazo in Peace and Conflict Studies, who told me about conflicts arising when people's water rights are sold. I am deeply concerned about future consequences of selling off our rights to water to entities outside of New Zealand.

There is a link to a website in the label, aotearoawateraction.org, where the object starts to tell its story of the group fighting for water rights to remain within the country.

The colours are inspired by images of bottled water and pin stripes. These lines represent money changing hands and my worry that once those rights are gone for us, we are stuck with the consequences.

I hope that I can encourage more people to buy less, buy local, and treat their objects with care to last a very long time.

Simone D. Langhans

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Scientist

SABER CULTURAL

SABER CULTURAL is a research project funded by the European Commission, in which I'm investigating the role of cultural values in improving freshwater management to protect biodiversity and ecosystem services, thereby seeking inspiration from New Zealand's indigenous people, the Māori.

Freshwater ecosystems are essential to people's economic, cultural and social wellbeing, yet are still one of the most seriously threatened ecosystems on the planet.

This conflict is reflected in political regulations that ask to develop management plans that halt the loss of, restore and safeguard freshwaters, their biodiversity and the services they provide to people, for example water for crop irrigation, fish as food etc. In SABER CULTURAL, I use a well-known participatory decision support framework called Multi-Criteria Decision Analysis (MCDA) to tackle a major challenge in the development of freshwater management plans; including cultural values besides traditionally considered ecological and socio-economic ones. I use MCDA because it is transparent, allows for the whole range of community values to be quantified and accounted for, can be used to robustly test outcomes of different management scenarios, and can ultimately be used to prioritise cost-effective management actions with collective buy-in from the community.

Accounting for cultural values embraces the paradigm of managing freshwaters as social-ecological systems, i.e. considering people as part of nature. Cultural values that people relate to freshwaters also build a conceptual link between natural resources and biodiversity, and local knowledge, which is a major source of ecological information that so far has mostly been ignored in top-down driven management processes. For indigenous communities, such as the Māori in New Zealand, a holistic worldview where people are part of nature and vice versa is not new. They consider rivers and lakes as their ancestors and treat them accordingly when gathering food or using water.

Annemarie Hope-Cross

Artist

Leave it for the future

Growing up in New Zealand, it was not until I moved to Central Otago over ten years ago that I began to question our water sustainability and the health of related ecosystems. It has been a huge shock and learning curve to understand that we face so many significant issues.

Using historic photographic processes such as cyanotype and photogenic drawing, I frequently work without a camera – 'cameraless' photography - whereby images are created using the UV rays of the sun.

Simone's project fascinates me and I interpret it as the weaving together of science and Māori cultural values. Central to this artwork is a kete aronui (basket of knowledge) surrounded by some of the key indicators of a healthy freshwater ecosystem; vegetation, birds, fish and shellfish. Intended as metaphors, these symbols indicate the relative health of their environment, and their importance to Māori. The kete weaves together whakataukī (Māori pearls of wisdom) and elements of Simone's MCDA management plan. A kete is synonymous with a basket of choice. Decisions made now will affect the future of our land, our water and our people.

Inspired by the gateway at the historic Pa a Te Wera on the Huriawa Peninsula and the Puketeraki Marae at Karitane, which overlooks it, I have created guardians to stand guard by the kete. As Simone offers her scientific knowledge and training to this project, at the heart of the kete I offer an image of my own taonga tuku iho (prized heirloom); a hei matau inherited from my Father. Representing prosperity, strength, land and safe voyaging over water, it also references the importance of fishing, and the god of the seas, Tangaroa.

Tukua ki tua, ki ngā rā o te waru e: Leave it for the future, for the days when food is scarce.

kete aronui
1. (noun) basket of knowledge of aroha, peace and the arts and crafts which benefit the Earth and all living things - one of the three baskets of knowledge. This basket relates to knowledge acquired through careful observation of the environment. It is also the basket of ritual, of literature, philosophy and is sometimes regarded as the basket of the humanities.

Nic Rawlence

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Scientist

Foulden Maar

An Australian company's application to mine a fossil-rich site in the south of New Zealand has been met with fierce criticism and a campaign to protest it in perpetuity. Foulden Maar, near Dunedin, is arguably the most important terrestrial fossil site in New Zealand. It comprises a complete ecosystem. This makes it one of the most important sites from the Miocene in the southern hemisphere and comparable to the famous, UNESCO-protected Messel Pit in Germany.

A maar is a small deep volcanic crater lake. Foulden Maar formed 23 million years ago after an explosive eruption . It contains tens of thousands of exquisitely preserved fossils of plants and animals, all of which represent extinct biodiversity. The fossils are preserved between layers of diatomite, itself the fossilised microscopic remains of siliceous aquatic algae called diatoms. Plaman Resources, a majority Malaysian-owned subsidiary of Australian company Plaman Gobal, has applied to create an open pit mine to extract the diatomite, trademarked as 'black pearl', to turn it into pig and poultry feed.

This would be like mining volcanic ash at Pompeii for pig food.

The maar crater formed 23 million years ago, filled with a small hydrologically closed lake that gradually filled in and preserved an entire subtropical rainforest ecosystem that once flourished there. It links New Zealand to what was occuring at the time in New Caledonia, Australia, and even South America.
The site is about a kilometre wide and nearly 200 metres deep. It contains fossils of plants and animals that lived in the lake and surrounding rainforest, including the world's oldest galaxiid fish (whitebait) and scale insects on leaves. Of the tens of thousands of exquisitely preserved fossils, only 30 have been described so far by the international team working at the site.

Research at the northern hemisphere equivalent, the Messel Pit, has been ongoing for over a century and shows no signs of slowing down. There are hundreds of new species yet to be described at Foulden Maar. Each fossil must be painstakingly separated from its diatomite tomb and preserved, a process that can take around a week per fossil. Bringing this lost world to life is incompatible with the Plaman Resources proposal for a 24/7 operation.

There is more to Foulden Maar than the fossils. At its deepest point, it preserves a unique climate record covering 120,000 years. It is the only site in the southern hemisphere with a climate record that shows annual resolution of this kind and shows links between the tropics and Antarctica 23 million years ago.
Data from the site are being used in predictive global climate models. There is no way in which the full thickness of the maar lake could be preserved for ongoing climate research if the mining proposal went ahead.

Ruth Evans

Artist

Exploratory

Like many other parts of Central Otago, the visual landscape of Foulden Marr is neither striking nor inspiring. Grassy paddocks cover the horizon, in various tones of brown, beige and green. Very few trees can be seen upon this land, once home to forests. They have long been removed and opened up for pasture, grazed by the sheep that rest around the bulging schist rocks. It is not until you scratch the surface that the wonders of this site is revealed in the fossilised forms of life long past, immaculately preserved in the diatomite earth beneath. But if scratched too deep, strip-mined and scared, Foulden Marrs geological past will be lost forever.

Henrik Moller

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Scientist

Dung beetles to the rescue!

Soil is not just dirt! It's a living ecosystem that holds nutrients and water, stores carbon and grows plants upon which all animals depend. Soils are also the world's composting system - a thriving community of bacteria, fungi, and invertebrates drives a vast, spread-out, recycling system to break down dead plants and animals into nutrients which can be reused by the next generation of plants and animals.

This army of decomposers have some special allies which ecologists call 'ecosystem engineers' – the earthworms and dung beetles. They build and maintain the soil habitat itself and thereby enable all those other critters to do their great life work. Earthworms and dung beetles gently till the soil to spread the nutrients. They disperse organic matter that glues the soil particles together and create tunnels and pores which let the air and water into the soil.

Converting much of New Zealand to farmland created a smelly problem - how to disperse and breakdown all that cow and sheep poo! So far eight species of dung beetle and 23 species of earthworm have been introduced to help. Some dung beetles are "tunnellers" that act like miniature bulldozers: they that shove dung down tunnels that they have dug directly under the dung pat. Others are "rollers": they shape the dung into neat balls and roll them away from the pat to bury them. And there are "dwellers": they live entirely within the dung pat. All feed on and lay their eggs on the dung.

Dung beetles provide "ecosystem services": they make and maintain soils, improve water penetration and storage, reduce run-off of nutrients and sediment to streams, improve carbon capture, disrupt the transmission of parasites and improve the productivity of pastures for us to grow food and fibre. Dung beetles are our unsung friends.

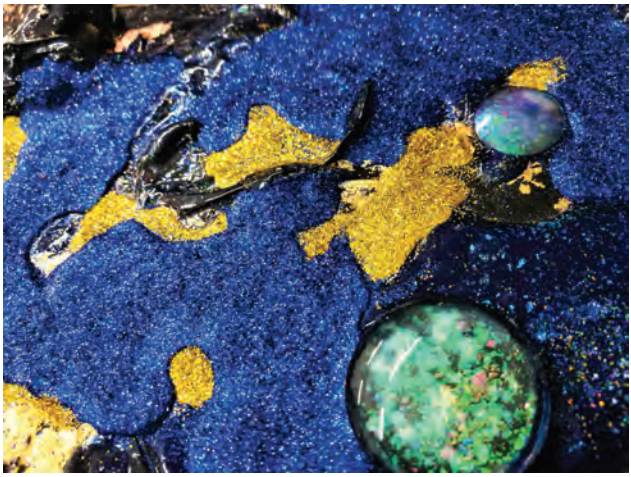
Jessica Ritchie

Artist

Dung Beetles

The inspiration for this work is the work of the dung beetle, regeneration, and inter-connectedness between the land, communities and water.

Dung beetles are entwined with history, myth and science. Symbolising regeneration and restoration of life. Egyptian scarab beetles are connected to Khepri, the scarab-headed god of the morning sun. According to Egyptian mythology, this god renews the sun daily, by rolling the rising sun across the sky, over the horizon, and then later he carries the sun through the underworld, so that it is renewed for the next day. The scarab is worshipped as the embodiment of rebirth and regeneration.



Crawling out of the darkness and navigating the world by the sun, acrylic, glass, glitter, gold and copper leaf, and shellac on wood panel (detail) 2019.

Ecologist Henrik Moller is currently involved with Beef and Lamb New Zealand, who have got a new concept called 'regenerative Agriculture'. The idea is that people farm with nature rather than drive natural systems into new states, looking after natural regenerative cycles, and a holistic approach to sustainability. Working with farmers to implement dung beetle projects, and advocating for conservation through sustainable management of resources and land through farmer-led approaches and cross-cultural partnerships captures the best economic, social and environmental outcomes for farmers and their communities.
The inspiration for this work is the work of the dung beetle, regeneration, and inter-connectedness of the land, communities and water.

Jie Ying (Jessica) Ong

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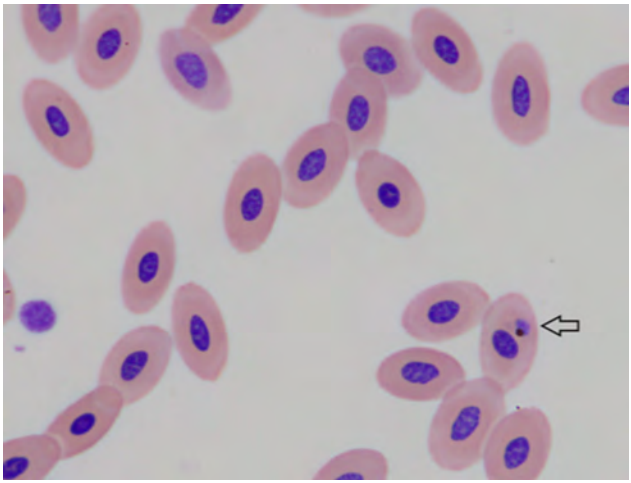
Scientist

Malaria in New Zealand

Here in New Zealand, malaria is not an emerging threat to humans as the species which carries human malaria is not present in these islands. However Culex mosquitos thrive in New Zealand and transmit avian malaria. Avian malaria can lower immunity in birds, and limits native bird populations because unhealthy birds struggle with reproduction. The disease infects multiple bird species such as South Island Saddlebacks, Mohua, Kiwis, Penguins, and many more. Soon with a significant increase in temperatures, native bird populations at higher elevations in the mountains with no prior exposure to malaria will be threatened.



Giemsa stain of a thin blood film from Yellow-Eyed Penguin / Hoiho. The arrow points to a young parasite of the *Plasmodium spp* residing in a mature red blood cell. Separate to nucleus of red blood cell, the parasite's cytoplasm is also rich in genetic material is stained blue, and hemozoin in black.

As malaria is carried by mosquitos, limiting the mosquito habitat would significantly reduce the spread of malaria. As more research is done to understand the trend of malaria over seasons, there is undoubtedly increased potential for malaria transmission in warmer climates that is occurring from climate change. Soon, higher temperatures will improve conditions for mosquito vectors to reproduce, take blood meals and lay eggs.

In a collaboration with Penguin Rescue (Moeraki, New Zealand), post-doctorate research fellows in Russell Lab at the Microbiology Department are in the process of understanding malaria species and their development in Yellow-Eyed Penguins. Blood smears are regularly examined by trained microscopists to identify parasites in penguin blood. Even with this most reliable approach, slide examination is labour intensive and low-level parasitemias go undetected.

The research team of which I am a member, also does extensive research on human malaria parasites. Evidence suggests that controlling the habitats in which mosquitos breed is the first step towards control of malaria transmission. Human activities do have a strong influence on how well mosquitos thrive in our environment. Increased awarenenss of the need to reduce still “pockets” of water from gardening, construction work or even dug by ground animals, will help to prevent breeding mosquitos and thereby help to conserve our birds.

Emily Brain

Artist

How do we control Avian Malaria?

Mosquitos are the vectors for a variety of diseases and parasites, and pose a threat to both humans and animal species. While malaria is not a present threat to humans in New Zealand, avian malaria is infecting native species of birds and can affect future population growth.

To monitor human diseases spread by mosquitos, Australian scientists use traps to collect samples of adult populations and water samples to look for larvae. In New Zealand additional information is gathered by testing blood samples from infected populations and performing manual counts of the avian malaria parasites in a blood smear. This takes place under a microscope and is time consuming and labour intensive.

Not a lot is known about how we can control mosquito populations and the illnesses they carry in New Zealand but countries like Australia, with a high risk of human infection, use public awareness as a tool to help limit the spread. In Australia, advice on managing mosquito-spread illnesses is split into two common categories: preventing mosquito bites, and preventing mosquito breeding. There is little we can do to prevent bites in wild bird populations; preventing mosquito breeding is a more achievable goal. With community action in mind, the "Fight the Bite" campaign in Western Australia includes advice such as preventing stagnant water from gathering in containers and encourages families to check their home for, and cover or remove, containers which might be breeding places for mosquito larvae.

This approach can be utilised in New Zealand as mosquito populations grow in the rising temperatures of climate change. Digital and print media can be a resource for educating the public, and people can better understand and take action to prevent mosquito breeding within their household, or in industrial or farming areas.

Pauline Uyseco & Sigurd Wilbanks

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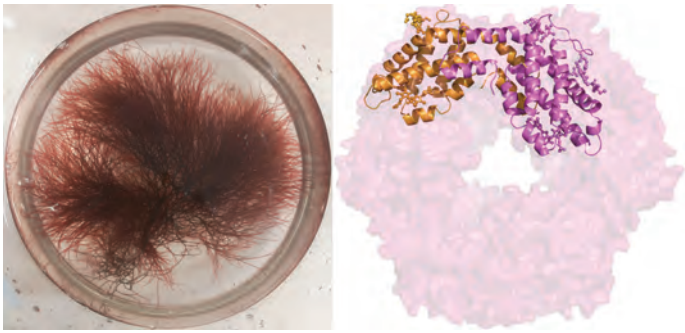
Scientists

Proteins respond to water

Living cells are about 60% water and 15% proteins, the molecules that allow cells to live, doing everything from sensing their environment to consuming energy. Two proteins of keen interest to us are also intimately connected with water: phycoerythrin and PCO1.

Phycoerythrin is found in the red algae – seaweed – of the Otago Harbour. It collects light for the seaweed to use in photosynthesis as it makes the sugars it needs. Its bright red hue is perfect for collecting the green light which penetrates deepest in seawater.

PCO1 protects land plants against flooding. We usually think of plants needing water and making oxygen, but they also need air. When starved of oxygen, PCO1 activates genes needed to survive flooding.



At left is an individual red seaweed (*Griffithsia sp.*) about fifteen centimeters across. Its red colour is conferred by the phycoerythrin. At right is a cartoon depiction of phycoerythin's molecular structure. Two different polypeptides chains are shown in orange and purple, respectively, with the α-helices of their mature shapes emphasised. The pink surface shows the extent of disc made up of twelve polypeptide chains.

Once a gene is turned on, the instructions passed down in DNA direct the creation of a specific protein by joining building blocks in a *polypeptide chain*. This chain automatically folds into the precise three-dimensional shape which is needed for the protein to do its job. The spontaneous conversion of DNA's one-dimensional information into three dimensions of the enzyme is as surprising and wonderful as a tapestry stitching itself would be, and protein shapes are at least as complex.

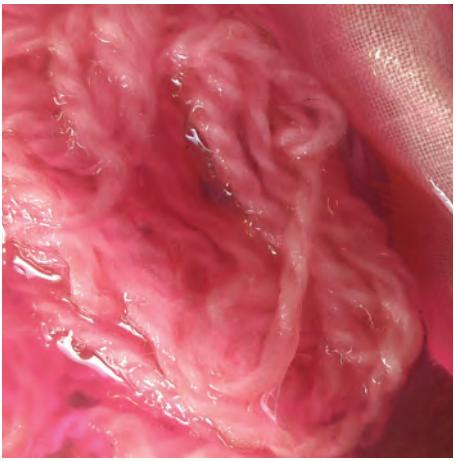
Protein scientists represent the folding polypeptide chain as exploring a hilly landscape of possible shapes, flowing away from unstable hilltops and into valleys representing relatively stable shapes and finally down to its home, a low basin of greatest stability. The most powerful influence on the journey to stability is how the polypeptide chain interacts with water. The chain has oily sections and water-soluble sections. The same forces which separate oil from water drive like sections of the polypeptide chain to coalesce. Only in the cell's watery interior will these proteins fold into their mature form.

Georgina May Young

Artist

Stories within seaweed

Indicative embroidery work.



Experiment in natural dyeing with sea weed.

We carry our stories within us as our landscapes and flora hold stories in their layers - a whisper of this place beyond this ancient conversation recorded in our genes, a knowledge shared, a path followed - an expression of instructions within enzymes passed down and responding to their environment, as a river flows from mountains through valleys to its lowest point of stability taking with it an optimism for a survival in our changing ecosystem.

Working and responding to Sigurd and Pauline's studies I explored a way in which the protein phycoerythrin (from red sea algae) could be used as a natural dye on wool or silk which are both also proteins, with the help of Sigurd and Pauline collecting and making the dye concentrate, just as they do for their research.

There is a strong connection with textiles and the way proteins fold themselves up - in both cases something one-dimensional (the thread or the protein chain as it is made from the gene) must fold to give the final shape. As it assumes three dimensions, new, unguessed features emerge, transcending their one-dimensional origins. Working with chain stitch is representing the shaping of protein structures connecting and sharing.

These studies invoke the need for better understanding and tools to insure our future resilience, with environmental circumstances of climate change and flooding, the idea of plants able to grow underwater as in the rice terraces of Indonesia and the Philippines, may be a necessity. It offers a way to respond and a chance to look for different ways of cultivating and growing food in our changing ecosystems, a co evolution.

Glen Riley

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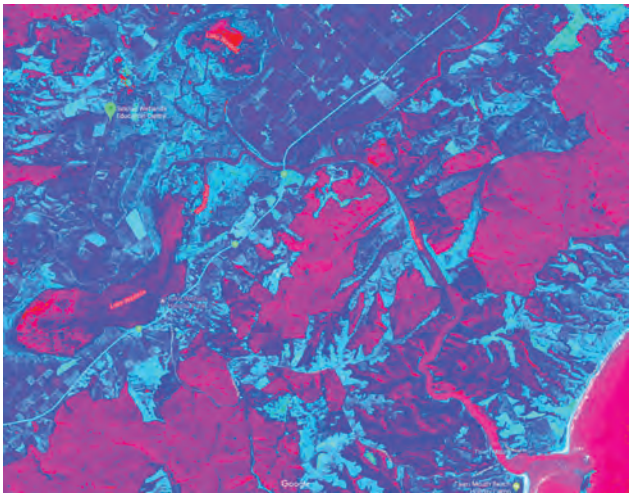
Sinclair Wetlands kaitiaki / coordinator

Sinclair Wetlands



Wetlands are a critical player in our natural environment. They not only provide food for many animals and plants, but also improve quality of water and prevent floods. They form nurseries for fish and other freshwater and marine life and are critical to commercial and recreational industries like fishing, duck shooting, kayaking and hiking.

The Sinclair Wetlands consist of 315.3 hectares. The area is protected in perpetuity by a Queen Elizabeth II National Trust Open Space Covenant. The wetlands was privately owned by Mr Horrie Sinclair, who purchased the wetland in 1960 as farmland. In 1984, Mr Sinclair announced his intention to gift the wetlands to Ducks Unlimited New Zealand Inc. In 1998, The Crown returned this property to Te Rūnanga o Kāi Tahu ownership as part of the Kāi Tahu Claims Settlement Act. Historically, the land was owned by a local chief Tukiauau and his Ngāti Mamoe iwi.

The wetlands was formed by the Taieri – Tokomariro – Clutha depression, which caused by the Titri fault. The landforms of the wetlands are determined by the patterns of water flow and silt deposition of Lakes Waihola and Waipori. A network of waterways and lakes connected the Taieri and Waipori River systems allows approximately 85 bird species have been recorded in the area. Pukio, mingimingi and harakeke are the three distinct habitats within the Sinclair wetlands. Lonely Island and Ram Island were once covered in native forest but have been cleared for livestock grazing. Today the islands have largely reverted to broom and gorse. Remnant patches of native bush cling to the steeper slopes of Ram and Lonely Islands.

Sinclair Wetlands Trust vision is to protect, restore, and promote the spiritual, physical, ecological, cultural, of the wetlands area. It encourages scientific research and educational engagement with the land. Volunteers from the Conservation Corps, Taskforce Green, Forest and Bird and other conservation groups have helped plant, release and mulch the first two years' plantings. An estimated 64,000 native trees and shrubs will be required over the next 10 years to replant the Ram and Lonely islands and higher ground. The aim is to produce 3,000 native plants a year on site.

https://www.tenohoaka.org.nz/

Siau-Jiun Lim

Artist

Let's wet the land

Human impacts on the natural environment are an overwhelming debate in the 21st century. Glenn Albrecht, former Professor of Sustainability, suggests this overload of ecology information has invaded our mind such that we might not even be aware of it. In short, it is an earth related mental health issue. However, not many of us understand the implications of our emotional reaction to this information.

It is essential to stimulate our sense of personal responsibility, which translates to accountability and action to limit these impacts, and leads to a positive outcome. Albrecht thinks it is vital that people connect their emotions with the overwhelming environmental situation. He has coined the term "soliphilia" to express the sense of belonging to the environment and to nurture people's feeling of personal responsibility for nature and sustainable living. Kramarz and Park (2016) claim that to convert accountability is a key environmental process; all levels of society must work together to comprise effective global environmental governance.

The Create Art and Plant Trees project came with an objective of "soliphilia" to encourage people to ignite their senses from nature and to get involved in community connection. This project was first run in March 2019 and involved individuals and organisations, including Otago Polytechnic Sustainable Practice, Sinclair Wetlands, and supportive friends who contributed their time to this project in various ways.

Art and Water triggers a question to my project. Where does the water come from and where does it go? Geographically, water follows a channel from the wetlands through Lake Waipori and Lake Waihola, and discharges to the Pacific Ocean at Taieri Mouth. The water comes from a number of ranges, including the Lammermoor and Lammerlaw Ranges, Rock and Pillar Range, Taieri Range and Kakanui range. In a picture, it would be a formation of river flows by the community.

Bryce Peebles

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Scientist

The Changing Oceans

Marine calcifiers (chitons, snails, and a worm) on a rock at North Beach, Portobello, Dunedin.

As the ocean gets warmer and relatively more acidic, it becomes harder for marine animals to form their shells. Marine creatures that form shells are called “calcifiers” since they use calcium carbonate to build their shells. These animals can pull calcium and carbonate ions directly from the water around them to form their shells, skeletons, or almost any hard part on their body. Many of the local organisms that we eat are marine calcifiers including: pāua, mussels, oysters and pipi, some of which live in or near rock pools on the Otago coast. The amount of shell material present in the water column depends on the temperature and pH of the ocean. Marine calcifiers have evolved with the current balance of dissolved calcium and carbonate in the ocean, so they can form their shells without any problems under normal conditions. However, if the water is too warm or too acidic, the balance will be thrown off and any existing shells will start to dissolve.

This dissolution happens because the ocean always tries to maintain an equilibrium, so if there is too little carbonate in the water it will be taken from the shells of marine animals. This weakens the shell, makes the animal vulnerable to predators, and forces the critter to spend energy fixing its shell instead of on: gathering food, mating, regulating body functions, and other things necessary for it to stay alive. Current research shows that the ocean is steadily getting warmer and more acidic, which is bad news for both marine calcifiers and us since the health of our oceans (and some of the tastiest food) relies on these organisms.

Fortunately, we can to mitigate this process and protect our oceans by reducing our carbon footprint and studying how marine caclifiers can cope with changing oceans.

Anne Marie Basquin

Artist

The Changing Oceans: Rock Pools

Drawing on Bryce's work with chitons for inspiration, I explored. I took underwater images at noon from inside rock pools on the South Otago coastline, creating submerged still-lifes of creatures which experience a process akin to ocean acidification during any low tide at peak sunlight hours. Hours spent peering into these pools led to long exposures at dusk, capturing the tide on its way in, leading to even longer exposures of star trails rising over the Southern Ocean, rock pools glittering in the star-shine beneath.

The canyon maps Bryce sent me led me deeper. I sketched and traced and coloured their lines until my hand had memorized them. Neither Bryce nor I could pick an area to focus and refine: the rock pools? The stars? The canyons? What we kept coming back to was the intrinsic connection between all things.

A quote from Elizabeth Kolbert's The Sixth Extinction, describing the end-Permian world struck me: "glassy purple seas released poisonous bubbles that rose to a pale green sky." I imagined epochs beginning and ending and couldn't get the colours out of my mind. Nor the whales I swam with in the South Pacific whose migratory routes pass right through the deep canyons I had been tracing.

Bryce Peebles

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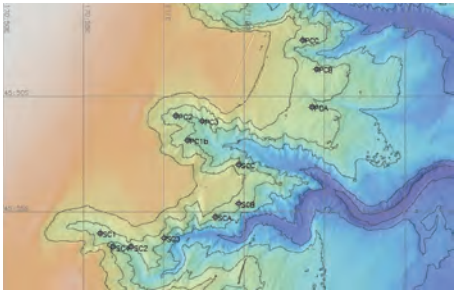
Scientist

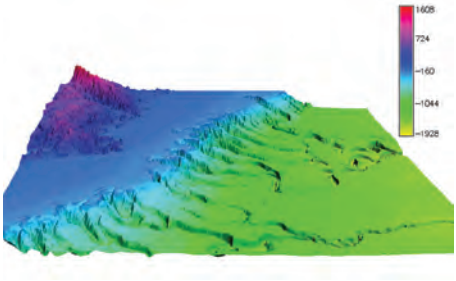
Deep Canyon Work

The deep-sea is the most expansive area on earth (around 324 million km^2) but also is the least explored. There are multiple features of the deep sea – flat plains-like areas, underwater mountain ranges, hydrothermal vents, and submarine canyons that are carved into the sea floor. Submarine canyons are similar to canyons and valleys on land and are caused by a combination of factors, including: earthquakes, glacial movement, sediment transport and other geological processes. These canyons are a unique environment since they provide a habitat for deep-sea life to flourish. Deep, nutrient-rich water flows through the canyons and helps build an ecosystem that can have 3 – 100x more biomass than the surrounding non-canyon areas. New Zealand has several submarine canyons, including a network of them just offshore of the Otago Peninsula. Typical animals found in the Otago submarine canyons are a variety of sponges, sea stars, brittle stars, fish, worms, and molluscs. These canyons also provide good hangout spots for larger organisms too, like whales who can dive to greater depths closer to shore than otherwise possible.

Sediment transfer within the canyons is a major aspect of the environment since they connect the offshore and the deep sea areas. Not only does the amount and type of sediment within a submarine canyon affect the organisms living there, but sediment flow is an excellent example of how interconnected our world is and one of the ways humans can affect ecosystems without realising it. The sediment removed by dredging a harbour can end up in these canyons and make it more difficult for organisms to settle since extra sand and silt is flowing through the canyon. What seems like a small action done by humans can ripple outwards and have an effect on an entire ecosystem and the critters within it, large and small.



Topographical map of canyons off Otago coast



3d map of canyons off Otago coast

Anne Marie Basquin

Artist

The Changing Oceans: Deepwater Canyons

I feel a responsibility to be submerged and to tell the tale. The origins of humiliate: to make humble or bring low–I want to bring people low down to the earth; I want to draw them under, into the deep below. Listen, we are as fragile and insignificant as a mollusc in a rock pool next to an ocean twenty million square kilometres wide–and yet we have changed the oceans beyond how we believed they could be changed.

The further you go from the known world, the faster time falls into eternity: When one enters deep water, human construct falls away. There is no artist, woman, daughter, sister; no time, or boat, or depth, or end. Only concentrations of thought and matter, treading water at the surface, no body but the pacific body, no body but all the bodies of all things moving through the world.

Song rang out over the great expanse of blue and all the while we were swimming sharks and their prey, manta rays, pilot whales and great pelagic fish were circling below. I looked down to see where the light fell and there was no end. My heart broke open in the water and everything that didn't belong to me poured out.

Jon Lindqvist

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Scientist

Trace Fossils

The study of trace fossils, ichnology (from Classical Greek *ichnos*, footprint), links the geological fields of sedimentology and paleontology. Trace fossils are a record of animal activity and include burrows, foot prints, tracks, and trails. In New Zealand they are best seen on clean surfaces of sedimentary rock along the coast. Besides their inherent interest as evidence of past animal behaviour, trace fossils are of use in helping to understand the environment where particular sedimentary rock formations were deposited. They are also of potential economic significance; animal burrowing and sediment churning is known to influence the permeability of rock formations to flow of groundwater, petroleum, and natural gas in the subsurface. The sedimentary profile and trace fossil examples given here are from the Whakapohai Formation, southern West Coast. This formation, composed of thinly layered sandstone and mudstone, was deposited in a tidal inlet and bay setting during a prolonged period of sea-level rise around 70 million years ago. It contains abundant trace fossils that record the activities of invertebrates such as shrimps, starfish, brittle stars, sea urchins, bivalve molluscs, and various worms.

Only minor traces of animal activity appear in this 25 cm high vertical rock profile. The wavy-layering of dark mud and pale sand is typical of a tidal setting. The upward increase in mud layers may well represent changes in water flow during a spring-neap tidal cycle.

This 8 mm wide *Gyrochorte* trail was left on a rippled sand surface covered by a thin mud layer. Smaller 'worm' burrows and trails are preserved in the centre of the photograph.

Madison Kelly

Artist

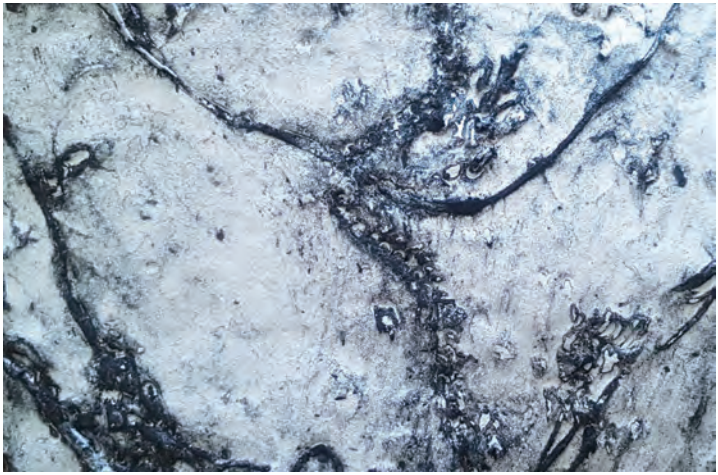
Paths of travel

The questions embedded (and revealed) in trace fossils are plentiful. Who made this mark? When? How many intersecting events (ecological, geological, institutional) led to my viewing of this mark at this time, several era beyond its maker's life? What marks are being made now? Of those, which will be lost, and which preserved?

These questions are asked in relation to a South Dunedin site threatened by sea level rise. Here, present and forthcoming interplays of water/sediment/life offer ground for documenting and acknowledging the complexity of systems affected by global change.

A compelling aspect of trace fossilisation is the levelling of biotic and abiotic appearances in the fossil record. The tool-marks of twigs dragged along a sandy surface speak with the same mark-making language as the burrowing trails of the wormlike ichnogenus *Gyrochorte*.

This language of a mark reliant record is explored through observational drawing at the threatened site. Activity at different vertical points of the sample area is observed over set periods of time. Paths of travel, encounters or avoidances, movements in the wind (or of the wind), the eventual settling of disturbed soils: all are equal agents. These initial drawings, made in clay, become negative moulds for recycled paper pulp and charcoal dust. Resultant sheets are layered upon one another to develop a multidimensional archive of the site. The laminations presented are not concerned with concrete data collection, but rather with attention towards complex networks in flux, as they exist now, and in a nearby future.



Present and Forthcoming, 2019. Charcoal and handmade paper.

Sally Carson

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Scientist

Discovering Our Coastal Connections

While local issues of river health are gaining awareness in NZ, the flow-on effect of deteriorating catchments on the marine ecosystem is 'out-of-sight, out-of-mind' for inland communities. However land use is strongly linked to water quality. Mismanagement of land can result in increased sedimentation, agrochemical point source pollution, reduced stream flow, and habitat degradation. These all contribute towards the severe depletion of the ecosystem services that our catchments provide. Increased awareness and understanding and improve management practices can make a difference to our waterways.

The Aquavan, with its recirculating seawater system, travels from sea to source to ignite community interest in learning more about their river catchment. Bringing live marine critters and science investigations to inland schools creates awareness and understanding of the connectivity between river health and the coastal environment in a dynamic and hands-on way. The marine animals and plants provide a focus for discovery learning and stimulus for discussion about environmental issues and responsibilities.

The programme has strong emphasis on empowering communities to regain their roles as guardians of their environment. Participants gain science understanding of the issues affecting their catchment and develop skills in environmental monitoring and knowledge mapping. Participation in environmental action highlights what they can do on a local level to improved environmental conditions.

Working alongside the wider community allows for local knowledge and skills to be profiled and creates opportunities for further engagement around both issues and solutions. Through work with artists, iwi and interest groups we hope to grow community interest and capacity for environmental action. Christine Keller, through her weaving, captures the visual change of a deteriorating environment and the kitchen towel medium provide us with a daily reminder of the need for change.

Christine Keller

Artist

Effects of sediment plumes

We need to change our attitude to the everyday objects we use, our levels of consumption and the way we do agriculture.

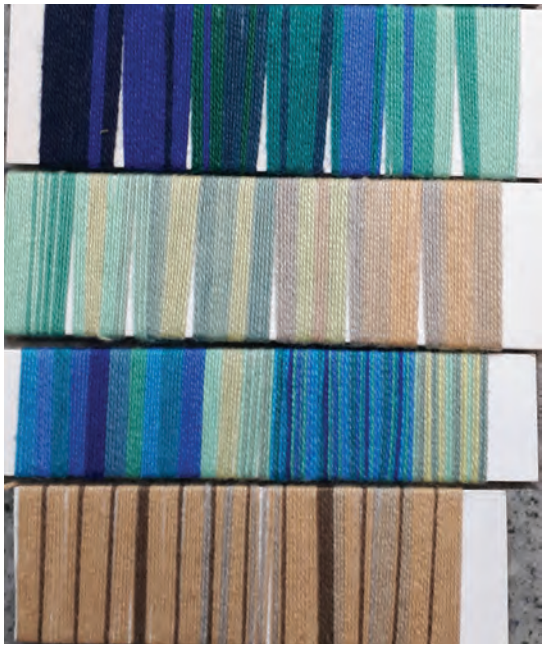
I started producing hand woven kitchen towels in Dunedin a few years ago. They are simple everyday objects which cost much more than their mass-produced sisters due to the time and effort which goes into them. The added value is due to the hand made touch of the maker. They are very good at what they do – drying dishes and giving pleasure.

In the second Series I worked with Sally Carson from the Marine Studies Centre of Otago University. I learned about sediment plumes which appear in the river mouth if the land along the river is not cared for properly. I also saw the beautiful and amazingly colourful animals who live in the waters at the river mouth.

The label links to marine.ac.nz/marinelifeart, which gives people an insight of the work of the Aquavan project.

Education is important and I am using my art to help transport a message. These towels come in pairs and one towel has the colour of that sediment plume while the other one is inspired by the images of sea tulips, starfish, sea anemones and other inhabitants of our ocean.

I hope that I can interest more people to buy less, buy local and treat their objects well enough to last a very long time.



Yarn interpretations of sediment plumes.

Clare Adams

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Scientist

DNA in the environment

The world is in a state of continuous change, now more than ever. As scientists, we are broadly interested in quantifying this change, and, in some cases, using that knowledge to preserve the biodiversity around us. My research is concerned with monitoring changes at the genetic level. Greater genetic diversity within a population indicates a healthier population with more evolutionary potential, but monitoring diversity on a broad scale while having minimal impacts on the animals we seek to conserve can be a challenge. Environmental DNA (eDNA) is one new tool being developed for this purpose.

The dusky waters keep their secrets for now.
Port Pegasus, Stewart Island. Sampling site for environmental DNA.

Environmental DNA is just as it sounds, DNA in the environment. As aquatic animals move through the water they shed cells from skin, saliva, and urine which all contain traces of their DNA. Much like forensic detectives, scientists can take an environmental sample which contains this DNA, filter out the cells, extract the DNA, and then use molecular genetics techniques to amplify the DNA. After amplification, we match the DNA strand to our database of known DNA to determine our target. Currently, we are trying to use eDNA technique to understand differences between populations. Pāua (*Haliotis iris*) were chosen as a study organism because of their economic and cultural importance and because we would like to see healthy, diverse, sustainable populations for generations to come.

A central theme of environmental DNA methodology is distilling out information of interest. From a large water sample, we end up analysing a lot of nucleotides – DNA building blocks – searching for the right sequence. Working with Kate, we tried to illustrate this idea by having the nucleotides, represented by coloured lines, juxtaposed to each other. Looking from different angles, different comparisons between the coloured lines can be made and the farther one looks towards the centre, the more clearly a pattern emerges – thus, we are able to find what we are looking for.

Kate Elder

Artist

DNA barcode

Through conversations with Clare about eDNA, it quickly became apparent that an important part of the research process was dealing with a vast quantity of data, and filtering that down. It seems that finding the DNA sequence of her study organism can be like searching for a needle in a haystack.

I wanted to demonstrate this quantity of data in the artwork, as well as the repetition and comparison involved in the research. All this, while also trying to show the intangibility and wonder of this relatively new branch of genetic research.

With the DNA sequence of pāua (*Haliotis iris*) being central to Clare's research, I decided to work with this. One way in which a DNA sequence can be represented is through DNA barcoding: Hundreds of fine lines with a combination of four colours - representing nucleotides - that is unique to each species.

DNA barcode: Haliotis iris

Working with various layers of clear acrylic panel, I reproduced a DNA barcode of pāua onto each one. The layered areas produce a multicoloured moiré effect confusing the eye. Only at the centre – where overlying sections are carved back to reveal the final layer - is the sequence clear.

Michelle Wilkinson

Guest Artist

The Grayling Draught

In recent decades an estimated 20 per cent of the world's freshwater-fish species have become threatened, endangered or extinct. But New Zealand's only extinct freshwater fish—the Grayling or Upokororo— was long gone before the current wave of species extinctions.

The cause of its extinction remains unknown. The catchments within which it lived were varied and widespread, once the most common freshwater fish in New Zealand, the Grayling appeared to disappear almost overnight. As early as the 1870's a decline was suspected. There were reports of the fish's disappearance from the Waikato River as early as 1874, and from the Buller district in 1884. Both areas had had previously very high populations.

Ironically, by the time legislative protection was granted in 1952 the fish was probably extinct. New Zealand's foremost freshwater-fisheries scientist at the time wrote of Grayling as illustrative of "the indifference with which many natural resources of this country have been treated". His strong sentiments spilled over into the advice that anyone knowing the location of any remaining Grayling should keep it a profound secret.

By 1996 the Red List of Threatened Species, compiled by IUCN, categorised the Grayling as extinct.

Grayling Draught

The display is made up of individual Grayling brooches, or pins, attached to a base that slowly turns, moving the Graylings in and out of the light. The individual fish pins have their own unique markings and patterns, just like the morphological variations reported within the species. Each is designed to be worn as an individual piece, as well as being a component of the larger artwork.

The pins are removed from the turntable during the exhibition period, allowing the shoal to slowly decrease. This removal of the objects on display emulates the removal of the individuals from the greater gene pool, eventually leaving nothing behind but the supporting structure itself.

Michelle Wilkinson

Guest Artist

The Grayling Draught

Grayling Draught shadows. Photo: P. McKinlay

Heramaahina Eketone

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Artist

From the mountains to the sea / aramoana

The designs embedded in this piece (pūhoro, koru, repo moana, mangopare) all relate to the element of water in some form or another. Within the ngaru (wave) the aramoana is woven; this is the pathway to the ocean, from the mountains to the sea.

Heramaahina Eketone

From the mountains to the sea / aramoana

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Pam McKinlay and Jenny Rock, Co-ordinators

Front cover image: Pam McKinlay.