Environmental News

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Kauri Dieback on Aotea|Essential Kererū|*Caulerpa brachypus*, the invasion by this non-native seaweed|Oruawharo Bay Wetland Restoration|Stoats in the Gulf

Aotea Great Barrier ENVIRONMENTAL TRUST

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GUEST EDITORIAL: A Time to Pause

TIM HIGHAM

Tim Higham has owned a property near Kaitoke for 20 years. His love of wild places and writing has taken him to our southernmost nature reserves and Antarctica, and through Asia and the Pacific with the United Nations Environment Programme. More recently he's championed the Hauraki Gulf Marine Park and Predator Free 2050 Limited.

Tim's new book Island Notes: Finding my Place on Aotea Great Barrier Island[1] *is a meditation on what the island may teach us.*

Before I start each day, I sit for an hour.

Some days are still, and a slight breeze might cross my cheeks from an open window in the garden shed that has become my meditation studio.

On others, wind may thrash around its concrete walls, branches of spruce and eucalypts knocking on the iron roof.

Through October and much of November it seemed rain drummed incessantly above me.

At least the water table will be rising and the creek won't dry up like last summer …

Return to the breath and body, let thoughts pass …

There are days when kākā and tūī are raucous; others when the *kek-kek-kek* calls of kōtare intrude; or I hear *pipiwharauroa*, the shining cuckoo.

… sounds, thoughts, arising, passing away.

It's difficult not to engage with the usual rush of ideas and irritants, those habits of mind …

But I've been putting in the practice, sitting

Photo: Jonny Goosman

The setting at Kaitoke.

Cover: Kererū. Photo: Guy McIndoe

Back cover: Kaitoke Estuary . Photo: Jo Ritchie

silently on 10-day Vipassana retreats in a small valley near the Kaipara harbour each winter for the past three years.

After an hour of sitting, I might do some writing, some work on the computer, a few of the long list of jobs around my place.

Julie Anne and I bought our property off Kaitoke Lane nearly 20 years ago.

I've snorkeled and fished since I was a boy, but snorkeling has become freediving and specialist shops have sprung up to service it. A few years ago, I enrolled on a course in town with a group of young men busting for weekend action.

Our first instruction was to swim a length of the pool underwater. We all plunged in and reached the other end blowing hard. We were told to repeat the exercise but sit on the bottom and wait thirty seconds before setting off. We came up with less explosion.

These days I am usually choosing not to pull the trigger of my speargun and rarely take a crayfish from the reef.

Over the last two years, I've watched the shallow kelp-covered reefs inside Tryphena harbour collapse. Places I know intimately - hidden crayfish lairs, channels where butterfish drift above the weed, sun speckled depths where a squadron of kingfish might suddenly appear - turned to ruin, kelp stipes laid waste by a march of kina.

Photo: Getty Images

New Zealand crayfish.

Their prognosis is not good. It took decades for kelp forests to return to the reefs within the marine reserve at Leigh, only after big snapper and crayfish capable of breaking kina shells became residents again.

Is the way of the world finally catching up with us here, the last mad rush and grasping for what remains of wild nature?

I've been helping, as best I can, a project that could transform Aotea's ecological future.

It is the result of nearly 20 years advocacy by the Aotea Great Barrier Environmental Trust: important work documenting the loss and vulnerability of the island's fauna and promoting a rat and feral cat free future.

I want to dive in and get started, with plans and calls to action, now the trust has secured funding through the Jobs for Nature programme.

But something keeps niggling me.

How am I implicated in the problem we're trying to address?

John Andrews in *No Other Home Than This*[2] unpacks what European New Zealanders brought with them to this country: Christianity, Roman law, democracy and freedom, hyper-rationality, faith in markets, fascination with maps and measurement, preferred tastes in literature and art, a diet that favoured a few staple crops, and axes, saws, ploughs, oxen, horses …

Geoff Park, author of *Ngā Uruora*[3], was troubled by our 'particular settler history', by the theodolite – 'the three-headed monster' - which consigned, grid-by-grid, the forests of the plains to destruction, and by our attachments to progress and improvement.

How this played out here in Aotea can be found in the Office of Treaty Settlement's summary report of the Deed of Settlement between the Crown and Ngāti Rehua Ngātiwai ki Aotea[4]. It includes a Crown apology for historical actions or omissions that caused prejudice, in breach of the Treaty of Waitangi, which resulted in the hapū being left 'virtually landless' within 50 years.

What accompanies this process? Rachel Buchanan in *Ko Taranaki Te Maunga*[5] writes 'for people who have been colonized and their descendants, there are many possible shades of whakamā, from big shames to little ones … about the loss of language and land, and about the loss of resources, traditions and leaders … about lack of understanding of what to do at a tangi; insufficient seafood on the table at a feast, or insufficient speakers on the paepae, or insufficient numbers of women to karanga; or about lack of knowledge of waiata and failure to transmit what knowledge you do have to your children; or even about your own average pronunciation of Māori words …'

Here, some of us have listened to the korero of Rodney Ngawaka, of the pou that mark the spiritual and metaphysical world of Ngāti Rehua Ngātiwai ki Aotea. When I listen, I glimpse - through a glass, darkly – alternative ways of explaining and organizing things. Ways of seeing the world that are less black and white, where opposites might co-exist, where the collective trumps individual expression and past and the future are interwoven.

The Aotea Great Barrier Environmental Trust can take great credit for championing the 'Tū Mai Taonga project', from its beginnings with the Aotea Conservation Park Advisory Committee, then garnering support from Auckland Council, the Department of Conservation and Predator Free 2050 Limited, and exciting the community about its potential. Now as the environmental trust hands the mana of leadership over to the Ngāti Rehua Ngātiwai ki Aotea Trust it feels like a time *to pause, to take a breath, to let thoughts pass, to hold off pulling the trigger*, and to listen for new voices that will inform and guide it.

Photo: Saskia Koerner

Tim Higham in dunes at Kaitoke beach.

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Jo Ritchie, Programme Leader for the Tū Mai Taonga project

Interview with BARRY SCOTT

I describe myself as "Like a spider in a web. I am constantly linking people and ideas together to make projects hum."

Can you give us some background on your work in the conservation space. What was your first job and which other organisations have you worked for over the years?

My first conservation job was with DOC, Auckland Region, in 1988 as the recreation/tourism planner. Fresh out of uni where I completed a degree in Town Planning at Massey University I thought I knew it all. How wrong I was. I did that for two years and learnt I needed field experience so spent the next 10 years as a field ranger relieving on islands, managing reserves, building tracks, being the field officer at whale strandings. During the first two years I had several stints on Aotea Great Barrier working under the guidance of Field Centre Manager Don Woodcock. I learnt a lot from him. From DOC I went to Waitakere City Council and worked as a stormwater/wastewater planner and project engineer.

Then Auckland Council decided they were going to do the Tāwharanui Open Sanctuary project and I decided I wanted to work for myself so I started my own business, *Natural Logic Environmental Management Ltd*. I was the project manager for Tāwharanui for several years but during this time also did a number of other pest eradication projects for community groups. I wrote the pest eradication plan for Tāwharanui, managed the construction of the predator proof fence and helped established what is now a successful community group to support the project. A highlight of that work was the reintroduction of North Island brown kiwi to the sanctuary[1]. My work attracted the eye of Ed Chignell, CEO of Treescape, a large arboricultural company who wanted to set up an environ-

Photo: Jo Ritchie

Jo Ritchie sailing with partner Chris Roberts in Hauraki Gulf.

mental division, so I went to work for them for eight years. I started with two staff and ended up with over 40. We worked on a wide range of projects from conservation ones to rehabilitation work on SH1 in Northland. I learnt how effective very talented people with large machinery can be! I also learnt valuable lessons in working in a highly competitive commercial business as I was one of seven business managers in a company of over 600 people.

I then went contracting again and have been involved in several island restoration projects including Rotoroa, Pakihi and Rakitu but have also been working with Predator Free NZ on their apprentice programme to train up new people to work in animal pest management throughout NZ.

What drew you to conservation work?

My heritage. My parents were great gardeners and always took us on amazing holidays as kids all over NZ. I grew up outside – as kids we had to make our fun outdoors unless it was a cyclone. My mother and grandfather whakapapa to Te Ātiawa, which brought with it a strong connection to the whenua, especially through my grandfather who was a kaumātua within that Iwi. So the genesis of my conservation interests came from both parents and grandparents. After my town planning degree at Massey I went to Montana in the USA where I did post graduate work on recreation planning, forestry and fire management. The time in the USA in places like Glacier National Park cemented my interest in conservation. Things just clicked. When I came home DOC had just recently been formed as a new government department so it made sense to learn more about conservation with them. My 12 years in DOC taught me so much, especially the 10 years working in the field where I acquired so many different skills. It was the engagement with people and the community that I enjoyed the most.

You have been involved in many different

Photo: Jo Ritchie

Jo Ritchie releasing North Island brown kiwi on Rotoroa Island.

conservation projects. Which ones stand out for you as the most satisfying to have been involved in?

Tāwharanui Open Sanctuary: This project highlighted the power of a community to restore a park through the inspirational generosity of ordinary people with passion. Tāwharanui Open Sanctuary is a unique blend of conservation, recreation and sustainable farming within the Auckland Council managed Tāwharanui Regional Park. Formation of the Tāwharanui Open Sanctuary Society (TOSSI) in 2002 has made the dream a reality. With the help of TOSSI, 14 species of birds have been reintroduced or have returned to breed on this peninsula.

Mataia Farm on the Kaipara harbour. This was a project started by Kevin and Gill Adshead in 2005 on their 1300 Ha farm *Mataia* where they set aside 400 Ha of coastal native forest and swamp for conservation. We wrote the restoration plan – but it's hard to be green when you're in the red. They did such a good job with this project that Northland brown kiwi were reintroduced after a 100 year absence in the Kaipara. This experience led the people of the region to establish the 'Forest Bridge Trust' in 2014, which helps farmers with restoration and pest control in the Hoteo River catchment. Their goal is to establish a predator controlled corridor of land, the Central Bridge, connecting the wildlife sanctuaries of Mataia Restoration Project in the west to Tāwharanui Open Sanctuary in the east.

The Noises Island Group: The power of the Neureuter family who love our marine environment in Tikapa Moana. Together, thanks to funding from DOC, we developed a restoration plan for the Islands that highlighted how you cannot disconnect the land from the sea. This family is tenacious and passionate about these islands and have gained the support of many people because of their willingness to work collaboratively and explain in simple language why our present practices with overfishing is a death by a thousand cuts. They are 'solutions focussed' positive people effecting change.

Rotoroa Island: Here I gained the experience of the power of private philanthropy combined with good business management to restore the ecology of an island in the southern Hauraki Gulf. This was one of my big projects while

Photo: James Russel

Rakitu Cove.

working with Treescape. We planted around 400,000 trees over a four year period. It was a huge logistical exercise shipping 100,000 trees each year out on a barge then planting them. I followed a planting plan developed by Boffa Miskell and adapted it using the idea of mirror plantings as we found out what species survived best on the island. Like many small islands Rotoroa is wind swept, with poor soil, making it a difficult environment to replant. We ended up planting 50 of the 80 Ha of this island. Now we have tīeke, pōpokatea, takahē and kiwi – sharing these with people is what conservation success is all about.

You were involved in the ship rat and kiore eradication programme by DOC for Rakitu? What were some of the highs and lows of that eradication programme?

Yes, I was contracted by DOC to be the project manager/eradication planner. I had recently been involved in Brook Sanctuary near Nelson as the aerial operations contractor so had that experience behind me. The high was the fantastic local DOC team and the camaraderie that developed and enabled us to remove all ship rats and kiore from the island. The low was that we could have done better with communication and advocacy with the community, even knowing not everyone would support the project. Everyone's voice deserves to be heard.

We were a little nervous whether the project would be successful. I remember when George Taylor jumped out of the helicopter and disappeared up to his waist in the kikuyu and the helicopter crew feeling rats moving under their feet while moving gear. We wondered whether the brodifacoum bait would be able to penetrate this deep vegetation to get 100% kill. However, the project was very successful with the island declared predator free in 2020 following ground surveillance over a two year period after the two aerial drops in September of 2018 .

A missed opportunity was the absence of a base data survey of the flora and fauna on the island before the eradication. The DOC team

Photo: Lotte McIntyre

Children from Kaitoke school with their bird protection signs.

were very keen to do it but their budget did not allow it. Money for the Aotea DOC conservation work is very tight. However, it would be cool to have some open days on the island for the community of Aotea Great Barrier to see for themselves what a great step this is toward a predator free Aotea and how dedicated the Aotea DOC team is.

You have been Programme Leader for the Tū Mai Taonga (TMT) project since January 2021. What excites you about this project?

The challenge of it and the opportunities. Challenges of working out how to remove feral cats and rats from an inhabited and topographically challenging island. Opportunities are building on the inspiring work of many people on the island, the desire of local people to do this work themselves, the leadership being provided by the Ngāti Rehua Ngātiwai ki Aotea Trust and the unrivalled opportunity to bring back biological abundance to all of Aotea, including its many islands. I am very excited about this project. Power is in the people. Many of the locals hunt in these forests and know them so well. Their knowledge is gold and a huge advantage to build on. There are so many conservation groups on the island doing such great things. I just loved seeing the kids at Medlands preparing signs to protect the birds and wildlife on the beach at Oruawharo Bay. Many of the building blocks for TMT are in place to realise this extraordinary opportunity. Aotea Great Barrier has never had this amount of funding for conservation. There will be great opportunities for employment.

While we will utilise a lot of high tech to achieve the objectives of TMT, it is important that we don't over complicate how we do this. I liken it to the use of the computer. The users don't necessarily need to understand the technical details of the hardware and software on their computer but just how to use it effectively. We need people on the ground with devices tapping into powerful remotely-controlled systems. Making sure we have devices and systems that work in remote places will be very important.

There are also some great projects underway

Photo: Jo Ritchie

Te Paparahi from Windy Canyon.

overseas that we can learn from such as the Dudley Peninsula feral cat programme on Kangaroo Island in Australia. For their trail camera work they are using a company called Evorta who have a computer-based programme to analyse photos with 95-99% accuracy. It is important we use these existing services rather than reinvent the wheel.

Technology and new tools are essential components of these large landscape scale projects, but the most important component is smart and capable people on the ground. A 'can do' attitude is essential and we are fortunate to have this on Aotea, with the diverse wealth of local knowledge and experience with existing control work. We can build on this to step up to eradication. It's an invaluable position to be in. I genuinely believe that with the people resource on Aotea, combined with a training and mentoring programme, we can fill all the positions that the project needs.

This includes the job I am doing. I see myself as the initiator of the project and a measure of my success is that I can step away and a local person leads the project. This is essential once the project becomes operational.

The work with mana whenua has been ground breaking and very satisfying. For the project to come under the korowai of Ngāti Rehua Ngātiwai ki Aotea is really forward thinking. They are relentlessly positive about this project. The timing is just right.

What is your vision for restoration of the ecology and biodiversity of Aotea Great Barrier? How can that be achieved? What are some of the main barriers?

Clouds of seabirds around every island, a dawn chorus like no other natural symphony every morning, kōkako back in Te Paparahi, everything as it should be on an island where people live, work and play. Done by island people and in a way that enables people to come home, live a good life and know they are hugely valued and appreciated for what they do and that they feel this way about their work and themselves. Barriers are that we need technology and research to develop to a point where we can confidently do this work without the use of vertebrate pesticides, and we have compliance systems in place to ensure when we remove feral cats and rats that we can stop them from coming back.

Photo: New Zealand Geographic

New Zealand north island kōkako.

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Making sense of kauri dieback surveillance

RICHARD WINKWORTH (Massey University)

In April 2021 the Department of Conservation announced that kauri dieback had been detected at two new sites on Aotea Great Barrier. These detections followed the largest testing programme yet undertaken on the island. The two new sites, one above the Kaitoke Swamp and one in the Awana catchment, bring the total of kauri dieback positive sites on Aotea Great Barrier to five. That this number remains in single digits despite it being nearly 50 years since the first detection is in stark contrast to trends in the Waitakere Ranges and elsewhere. What might these new detections mean?

Introduction

Kauri (*Agathis australis*, Araucariaceae) is New Zealand's largest tree species growing to over 50 m tall and living for upwards of 1,000 years[1]. Iconic to many New Zealanders and a culturally significant taonga to Māori, the long-term survival of kauri and the unique kauri forest ecosystem is threatened by an as yet incurable disease. Kauri dieback affects all age classes from seedlings to forest giants; symptoms of the disease include root rot, gummosis, crown thinning and, ultimately, tree death[2].

The late Peter Gadgil authored the first published account of kauri dieback[3]. His study, at a site in the upper Kaitoke catchment, suggested that the causal agent was a member of the genus *Phytophthora*. This large group of fungus-like microorganisms contains many well-known plant pathogens. Yet, it was not until 2005-2006, when symptoms first appeared in the Waitakere Ranges and Waipoua Forest, that the significance of this earlier work became apparent. Although initially attributed to *Phytophthora heveae*[3], more recent analyses have identified the causal agent as *Phytophthora agathidicida*[4], a species that is closely related to *P. heveae* but distinctive

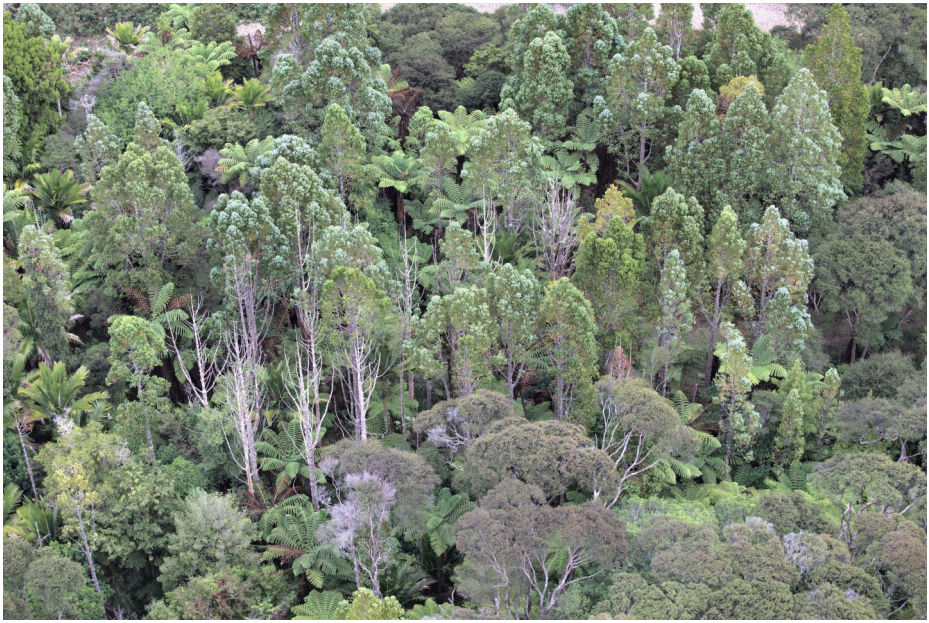

Photo: Wildlands Consultants and Auckland Council

Kauri showing signs of dieback in the crown at Kaiaraara from helicopter aerial survey March 2020.

enough to be formally recognised in its own right.

The kauri dieback pathogen, at the time referred to as "*Phytophthora* taxon Agathis" or PTA for short, was declared an unwanted organism in 2008. Since then, mana whenua, the Department of Conservation, Ministry for Primary Industries and local government have worked towards long-term management[2].

How do we test for kauri dieback?

Before we go any further it is important to point out that there is no test for kauri dieback. Kauri dieback is the disease, the collection of physical symptoms exhibited by an infected tree. Kauri dieback positive sites are identified on the basis of the appearance of symptoms. When we test, it is for *P. agathidicida*, the organism believed to be responsible for the disease. This distinction between disease and pathogen is an important one when it comes to understanding the survey results.

Testing for *P. agathidicida* typically involves a soil bioassay[5]. Although the approach is well established, the time and cost involved limits the volume of testing that it is possible to conduct. Effectively, widespread pathogen surveillance has not been possible and instead sampling has focused on kauri dieback positive sites. The goal of testing at these sites is to confirm pathogen presence.

During the most recent survey of Aotea Great Barrier, aerial photography was used to identify locations of interest[6]. In this case a standardized procedure is used to evaluate photographs of the forest canopy for sites displaying symptoms consistent with kauri dieback (e.g., crown thinning). Ground teams then visited these sites to confirm the presence of kauri, check for disease symptoms (e.g., gummosis), and collect samples for *P. agathidicida* testing. Samples are not usually taken directly from diseased trees but instead consist of a few hundred grams of soil collected from around one or more trees at a site of interest.

Once in the laboratory the soil samples are first air dried, then sprayed with water and moist incubated for two or three days. This process stimulates the production of motile zoospores by *P. agathidicida*. After moist incubation the samples are flooded with water and plant tissue "baits", often with cedar needles or lupin sprouts added. The samples are then left for two or three days to allow the zoospores of *P. agathidicida* and potentially those of other species to colonise the baits. From this point fairly standard microbiological approaches are used to isolate and establish cultures of the organisms that colonised the baits. Identifying isolates of *P. agathidicida* from amongst those recovered for a given sample relies primarily on morphology. A trained eye has to assess each isolate, looking for the physical features characteristic of this species. As a final step in this process the identity of isolates may be confirmed using a genetic test.

Photo: Richard Winkworth

Testing for presence of P. agathidicida *in soil by using lupin sprouts as bait to attract the motile zoospores.*

Interpreting the results

The results of the recent Aotea Great Barrier survey are clear. At two sites there is evidence, beyond the initial aerial photography, of the disease (e.g., gummosis) and the pathogen (e.g., a culture identified as *P. agathidicida*) whereas at the remaining 36 sites neither the disease nor the pathogen was found[6]. However, interpreting these results is somewhat less straightforward.

Typically, new observations of kauri dieback are presumed to reflect pathogen spread. This explanation follows from a recommendation that *P. agathidicida* be treated as recently

introduced until there was evidence otherwise[7]. It implies both that disease-free kauri stands are pathogen-free and that disease is an inevitable outcome of pathogen arrival. Although plausible, because we typically test for the pathogen only after disease symptoms have appeared, there is very little data available against which to test this idea. Indeed, we know so little about the distribution of *P. agathidicida* away from kauri dieback positive sites that this explanation should probably be treated with greater caution than it currently is.Is there an alternative?

The disease triangle[8] views disease expression as a function of the interactions between pathogen, host, and environmental conditions rather than as an inevitable outcome of pathogen presence. Put another way, it suggests that the presence of *P. agathidicida* is just one of several conditions that need to be met before the symptoms of kauri dieback appear. Therefore, the appearance of kauri dieback in previously disease-free sites need not be intimately tied to pathogen spread. Instead, *P. agathidicida* could already be widespread with changes in biotic or abiotic environments resulting in conditions conducive to the appearance of kauri dieback. Such an explanation is not inconceivable. Kauri's own life history traits (e.g., even-aged stands[9,10]) and extreme reductions in the extent of kauri forests over the last 175 years[11] likely make this species vulnerable to dieback. Layer on top of this climate change[12], the introduction of potentially co-acting pathogens[13] and site-specific differences in soil type, aspect, hydrology and the intensity of human activity. There would certainly seem to be the potential for the relationship between kauri and *P. agathidicida* to have been pushed from benign to one of host and pathogen.

There is evidence from overseas to support a more holistic view of plant disease. For example, both biotic (e.g., secondary fungal infections) and abiotic (e.g., extremes in rainfall due to climate change) factors have been shown to contribute to *Phytophthora*-linked decline of stands of European beech (*Fagus sylvatica* L.) in Austria[12]. For kauri dieback the focus has been so fixed on recent introduction and ongoing spread that little work has examined alternatives. That said, patterns of genetic diversity in *P. agathidicida* are consistent with this species having a much longer history in New Zealand[14] and, although the volume of testing away from kauri dieback sites remains limited, there is evidence of *P. agathidicida* being present in disease-free kauri stands[15]. In themselves these results may not be conclusive, but they do not sit easily with current dogma; clearly much more work is needed in this space. Can we afford to simply ignore the possibility of alternative explanations?

For kauri dieback the focus has been so fixed on recent introduction and ongoing spread that little work has examined alternatives. That said, patterns of genetic diversity in *P. agathidicida* are consistent with this species having a much longer history in New Zealand[14] and, although the volume of testing away from kauri dieback sites remains limited, there is evidence of *P. agathidicida* being present in disease-free kauri stands[15].

Negative test results are certainly encouraging but interpreting them is less straightforward than it might seem and they should probably be treated with as much caution as positive results. During the most recent survey of Aotea Great Barrier, approximately 100 soil samples were collected from 38 sites; an average of two or three soil samples per site. Soil is a heterogeneous medium and this level of sampling may not be sufficient to detect *P. agathidicida*, especially if the pathogen were at low densities. This issue may be exacerbated by the testing approach. All diagnostic tests have a detection limit, a threshold below which the target cannot reliably be detected even if present; this also means that, typically, a negative result would not be interpreted as pathogen absence. Side-by-side comparisons of the soil bioassay used for the Aotea Great

Barrier survey and a recently published hybrid bioassay[16] suggest that the former is likely to underestimate the extent of the pathogen. For example, two of six soil samples from diseased stands in the Waitakere Ranges tested positive for *P. agathidicida* using the soil bioassay, whereas the hybrid bioassay detected pathogen in five out of six[16].

What might these results mean for kauri on Aotea Great Barrier? Drawing strong conclusions from a single round of testing is never easy. Often confidence comes only when repeated testing provides consistent results. That said, it is encouraging that since the disease was first reported on the island nearly 50 years ago, only four additional kauri dieback positive sites have been identified. Why has the number of positive sites increased more slowly on Aotea Great Barrier compared to, for example, the Waitakere Ranges? Ultimately, we do not know. Certainly the impact of human activity on forest health is likely to be much higher in the Waitakere Ranges, but there may not be a single explanation for such differences. Potentially, several factors contribute in combinations that differ between sites.

Understanding the distribution of *P. agathidicida* is critical to the management of kauri dieback. We have, by necessity, tended to focus on kauri dieback positive sites and as a result have only part of the picture we need. On Aotea Great Barrier, as in most other areas, we need to be testing more widely and more often in order to inform decision making. Indeed the hybrid bioassay, which is more sensitive, less expensive and has shorter turn around times that soil bioassay, is already beginning to take testing from confirmation of pathogen presence to widespread surveilence[16,17].

Conclusions

Fighting kauri dieback is immensely challenging. Much of what we know about fighting plant pathogens comes from agricultural systems. There is not a step-by-step guide with all the answers; instead we are trying to understand both pathogen and disease while simultaneously attempting to manage them. We are making headway but it remains difficult to provide much in the way of certainty.

Aotea Great Barrier has a long association with kauri dieback and the sad reality is that this disease is likely to remain a threat, both on the island and elsewhere, for some time. We need to get used to the idea that addressing this problem is likely to require a long-term commitment. Ultimately, the future of the kauri forest depends on everybody doing what is best for kauri.

Photo: Barry Scott

Mature healthy kauri in Wairahi stream Witheys track, Aotea.

Acknowledgements

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Immature Kauri cone.

Photo: Berit Hassing

Aotea's kererū: a taonga species and essential to forest survival

KATE WATERHOUSE, with JOHN OGDEN, our Science Advisor

If you park your car in the shade of the large pūriri at Harataonga you are likely to encounter the main seed distribution mechanism of many of our forest trees — the digestive tract and droppings of the kererū. Kererū and kōkako are the only birds that are able to swallow the large fruits of some of our most important forest trees—the taraire, mīro, matai, tawa, karaka and pūriri. If there are no kererū, these trees are unable to disperse their seeds away from the parent tree. The kererū digests the coating around the seed inside the fruit and then distributes the seeds in its droppings all over the forest.

According to the Kererū Discovery Project, kererū (*Hemiphaga novaeseelandiae*) eat the fruit, leaves, twigs, buds, and shoots of over a hundred native, and fifty exotic, shrubs and trees. In an intact ecosystem, a kererū might expect to live for 20 years or more, but they may survive, on average, for around five years before falling victim to pests, cars or collisions with windows. This represents a huge loss to the breeding population. Increasingly, urban gardens are recognised as critical to the survival of kererū, and every Barrier gardener with a guava tree knows they're ripe when the kererū move in. A garden where rats are controlled is even more attractive to kererū.

Kererū are of great significance for Māori

Te iwi Māori have an enduring relationship with kererū that is a spiritual connection, transcending mere sustenance[1]. They were one of the most important birds in the forest and their significance cannot be adequately covered here. To understand something of this, remember that there are early colonisation mainland records of flocks of 300 kererū. The noise and effect of the birds moving in the forest of old would have been very powerful. Feathers had particular uses and there were particular traditions and times that governed

Photo: Tony Stoddard (Wikimedia Commons)

Kererū in flight.

hunting of them. Provision of *kererū* as food demonstrated capacity as *kaitiaki*, to care for the current and future prosperity of the environment. Such were their importance that kaumātua or tohunga were tasked with holding the mana and mauri (life force) of the kererū. Decline in kererū populations has been attributed to government usurping the mana for the kererū and forest from Tuawhenua. Dying kuia or kaumatua are said to have called for a final meal of kererū to help them on their journey to the afterlife. Many iwi now have rāhui in place to protect kererū from hunting. Other names for kererū include kūkū and kūkupa, all similar to the quiet cooing sounds they make while at roost.

E koekoe te tūī, e ketekete te kākā, e kūkū te kererū.
"The tūī chatters, the parrot gabbles, the wood pigeon coos." Or, it takes all sorts…

Why did kererū decline on Aotea?

At Okiwi the forest floor under kererū roost trees is always carpeted with seedlings of nikau, kohekohe, pūriri, taraire and pigeonwood. But these trees are exceptions rather than the rule these days. Kererū are just holding their own on Aotea, and given their role in forest ecology and regeneration, they need our help to recover. The loss of so much of the island's mixed coastal broadleaf and podocarp forests that sustained kererū, and more recently, feral cats and the arboreal ship rat, have decimated their numbers on Aotea in just the last 150 years. Predators have a double impact, preying on eggs and chicks in the nest as well as competing with kererū for fruit, seeds, leaves, and berries.

Gone are the days when flocks of 30 birds rose and swooped in the valleys of Tryphena, Awana, Okiwi or Motairehe. You might see a flock at Windy Hill if you're lucky, but otherwise a single kererū at roost, a pair of kererū feeding on kōwhai during winter (they are monogamous), or perhaps a male engaged in his elegant dives and swoops near the nest, are what we think of as "normal". It most definitely is not, and the fact that kererū were a major

Photo: Kate Waterhouse

Taraire in fruit on Aotea Great Barrier.

food source for Māori and for early settlers tells us how abundant they were before the island's forests changed.

Dr John Ogden had been analysing Aotea's bird data for the upcoming *Status of the Birds, Aotea Great Barrier Island* report[2] (see below), a comprehensive review of bird data, that builds on the 2010 *Great Barrier Island State of Environment Report*[3], which he co-edited with Liz Westbrooke. John says: "I would say, tentatively, that kererū are slowly increasing on Aotea."

Kererū on Aotea (Extract from forthcoming State of our Birds Report)

The kererū is a large endemic pigeon, which was formerly very widespread and abundant in New Zealand and was hunted for food by both Māori and Europeans. Its decline on Aotea Great Barrier Island mirrors that seen elsewhere in the country. Since kererū were protected (1921), there is evidence of a slow recovery throughout New Zealand, but illegal hunting, the species' low fecundity, and vulnerability to predation of the single egg and chick puts it at risk. The species appears dependent on conservation efforts, and introduced food plants, for its gradual increase.

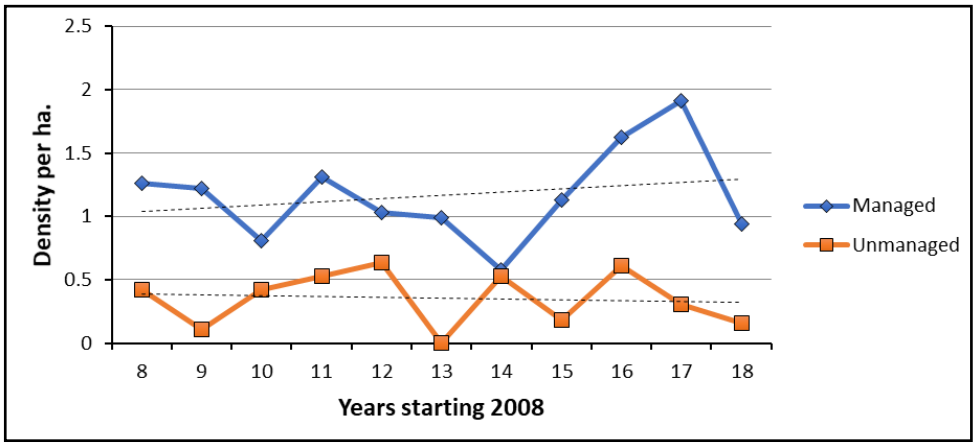
The status of kererū is hard to assess because, except when performing its characteristic display flight, it usually remains well hidden in the forest canopy and makes little noise. In contrast to former times, flocks of more than ten birds are rarely seen on Aotea. Bell & Braithwaite (1964)[4] noted that in 1957 single birds were often seen in the bush, and a flock of 23 was seen flying high near Tryphena. In the same year the number of kererū on Rakitū was estimated at between 25 and 50. It was recorded as "common in forested areas" on Rakitū by Bellingham *et al.* (1982)[5] but the largest flock seen was "up to 11 birds". The overall impression gained from locals involved in the 2006-2008 GBICT surveys, was that kererū were in decline. At that time average frequencies of 20-25% were recorded in areas where there was some mature forest, but much lower frequencies in mānuka/kānuka bush (5%) and open paddocks (1%). However, since then, counts at Windy Hill[6], and the new, annual, Aotea Bird Count (2019 onwards)[7,8] suggest a gradual increase, at least in areas where rat management is occurring. The species was recorded on 14 of the 16 Aotea Bird Count transect lines in 2019, with an estimated mean density of 1.02 individuals/ha in the surveyed areas[7]. This is similar to the estimated density currently in the rat-managed area at Windy Hill[6]. At the currently estimated density of 1.0 kererū/ha in indigenous forest areas, the population on Aotea would be c. 950 birds at most.

The kererū is regarded as a 'keystone species' of the Oceanic Temperate Forest ecosystem because of its role in dispersing the seeds of large-fruited tree species, such as miro, tawa, taraire, pūriri, and karaka, which are too large to be dispersed by other birds. Kererū will congregate in flocks to exploit such a resource; the largest reported flock on Aotea comprised c.50 gathered at Windy Hill in 2021 to exploit the abundant taraire fruit[6]. Kererū may be particularly important on Aotea/Great Barrier Island, where remnant patches of mature forest containing these species cannot easily extend from gullies or lowland sites to replace the ubiquitous kānuka stands, without such 'up-hill' assistance.

What is preventing faster kererū recovery on Aotea?

John Ogden suspects that that while periodic food shortages are a factor limiting kererū recovery on Aotea, the success of kākā, also shown in the Windy Hill data[6], is probably also having an inhibiting effect. As he concludes in the *State of Our Birds* report[2]:

"Like toutouwai/robins, kākā usually increase after pest eradication or control, while kererū do not (Miskelly et al.



Comparison of kererū densities in rat managed area compared to unmanaged control at Windy Hill Sanctuary 2008 – 2018. NOTE: the small increase in the managed area is not statistically significant, but is indicative when compared to the unmanaged trend.

Photo: Gavin Klee (from Predator Free NZ article Nov 11, 2021)

Kererū nesting.

2021)[9]. This 'correlation' is unlikely to be due to *direct* responses to predation or competition between the two species… They co-exist in many forested areas of Aotearoa, but the competitive balance during times of food shortage might favour kākā, many of which migrate off-island in winter. Lower frequencies of kererū in the presence of increased numbers of tui and kākā were observed by Ogden (2010)[10]. He speculated that food resources could limit bird numbers via competitive hierarchies if predation ceased to be the main factor. Whatever the causes, the numerical changes at Windy Hill, following twenty years of pest management, fit the general picture following reduction or elimination of rats: increase for kākā, stasis for kererū."

Mick Clout, Professor of Conservation Ecology and a New Zealand expert on kererū, when queried on this issue, suggested kererū's slower recovery, and slow population growth, is due mainly to their lower reproductive rate, rather than other factors such as competition for food from kākā and tūī, which appear also to be starting to recover on Aotea[11].

A recent Predator Free NZ Trust article on the national decline of kererū described why kererū reproduction is low[12].

"Kererū raise one chick at a time, incubating their single egg in a twiggy nest for about 4 weeks. The parents feed the chick a protein-rich 'milk', which they secrete from their crops, adding partially-digested fruit to their diet after a couple of weeks. The chick leaves the nest at 30-45 days old, but the parents continue feeding them. So in total the single egg/chick is in the nest for 60-75 days. That's a lot of opportunity for nest-raiding predators."

Mick Clout[11] points out that "in comparison, tūī lay clutches of two to four eggs, incubate them for 12-15 days and the chicks can fledge two weeks after hatching. Kākā on the other hand lay between one and seven eggs; usually about four. Tūī and kākā (therefore) have the potential to increase in abundance more rapidly than kererū. So, perhaps it's not just a matter of (increased) competition for food resources, but the lower reproductive rate of kererū being a key factor."

A highly relevant paper, which the Predator Free NZ article draws on is that by Carpenter et al. (2021)[13]. In summary, it confirms that kererū population growth is generally slow, and that many populations (especially in the South

Island) have declined over recent decades. Their analysis of all available data showed that predation is the cause of most nest failures and deaths in kererū. Of the 397 nests in the study, a massive 50% suffered ship rat predation of eggs (and remember that ship rats are the main predator on Aotea). Stoats (not present on Aotea) were the main predator of chicks, and feral cats the main predator of adult kererū.

"Overall, the results support previous studies showing that predation by introduced mammals is the primary limiting factor for kererū in forests, but it also highlights the importance of forest area and food supply for kererū recovery."

Carpenter et al. (2021)[13] go on to state that kererū may be particularly susceptible to the effects of food limitation because their breeding is highly variable and appears to be correlated with food supply. Lack of food can increase mortality of adults and fledglings through starvation. But it can also have an indirect effect by increasing predation risk (because hungry adults are at the nest for less time), and increasing susceptibility of chicks and adults to parasites and disease.

Finally, they suggest that "in warmer, forested sites (like Aotea), where food is less limiting, and median pest densities are highest, kererū should be decreasing most rapidly over time." This is chilling, given that ship rat densities on Aotea are already amongst the highest in Aotearoa[14,15]. But this may be offset on Aotea by more frequent breeding, if Aotea birds are like kererū in Northland, which the authors state may lay eggs at any time of year except when moulting.

So why is there good news for kererū at Windy Hill?

In the study by Carpenter et al. (2021)[13], unpublished data from Aotea, and in particular Windy Hill Sanctuary , was not included in their analysis. It shows a different trend — a slow increase in kererū numbers at that site over time. Only Tāwharanui Sanctuary, north of Auckland, has had similar results. This is a vindication for Judy Gilbert, Sanctuary Manager, and the many people who have worked to keep rat densities low and feral cats out of the area for two decades. Interestingly, this positive change on Aotea is supported by another conclusion Carpenter et al. (2021)[13] came to — that "the low reproductive rate of kererū means that there may be a considerable lag before increased numbers of kererū are observed in sanctuaries."

Complicating the picture, kererū are highly mobile, with home ranges as large as 31,732 ha according to Carpenter et al. (2021)[13], and "an excellent ability to cross habitat gaps". On Aotea, this means kererū could, in theory, move all over the island (which is about 28,000 ha), to and from Rakitū, and to both Moehau and Hauturu/Little Barrier Island, in search of food.

Because of this, Carpenter et al. (2021)[13] suggest that interpretation of the impact of predator management is difficult on the mainland and near-shore islands like Tiritiri-Matangi. "The kererū detected at non-treatment sites (ie: with no predator control) may be the same individuals detected in sanctuaries. Alternatively, increased numbers of kererū at a managed site may simply reflect immigration into the site rather than a net increase of kererū in the wider landscape."

We will soon know more. In 2022, trend data from the Aotea Bird Count will be available for the first time, showing kererū presence over three years across at least 16 sites at a point in time (early December every year). Then we may see whether the 21-year trend at Windy Hill is mirrored across the wider landscape of Aotea, as predator management effort increases on both public and private land.

A taonga and a sentinel

In correspondence over this article, John Ogden[16] pointed out that "we don't really know what the outcomes will be for our forest ecosystems once predators are removed, but that there is abundant evidence that the long-term effects of pest eradication are good for all endemic species. But it is probably the case for

kererū, that due to their low reproductive rate, other species such as tūī and kākā may benefit more rapidly". John posits that the new balance will take several generations (many decades) to stabilise.

Spending time out in the remnant halls of the broadleaf and podocarp forest that used to clothe Aotea, the bush itself tells me that we will need kererū more than ever in the future. As our climate warms, it's clear that species such as taraire and pūriri are becoming more stressed and even dying off in hot dry summers, such as we have had in 2019 and 2020. Kererū are needed to protect and restore Aotea's physical forests and also the mauri of those places. Who of us does not wish to see flocks rising white against the hills and to hear the whoosh as they swoop and flare on the updraughts in our valley, feeling the air move as they pass.

So what can be done to bring more kererū back?

It's pretty simple. Support the recovery of more non-kānuka dominated forest and reduce predation from feral cats and rats, by eliminating them from Aotea. Predators are the handbrakes on kererū recovery, which in turn is slowing forest recovery. Kererū are a sentinel, taonga species and a critical reason for more active protection of mature forests and pursuing the vision of a predator free Aotea. It will take decades to see a return to abundance of the past, but in the meantime, controlling rats and feral cats through projects such as Tū Mai Taonga (see interview with Jo Ritchie), and protecting the pockets of old forests that remain on Aotea are what we must do.

At Okiwi, we'll be planting a few hundred more of those fat berried miro, tawa, matai, taraire and pūriri, for the descendants of the pair of kererū that own the kōwhai round our house. And perhaps we need a few more guavas in the garden too.

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Caulerpa brachypus, a Highly Invasive Non-Native Seaweed Found in Aotea Great Barrier Island Harbours

BARRY SCOTT with Biosecurity New Zealand and NIWA

In July 2021 Biosecurity New Zealand announced that an invasive non-native seaweed had been detected in Blind Bay. Underwater surveillance by NIWA showed that it was very widespread across the seabed in this bay. An extension of this surveillance to neighbouring bays revealed that pockets of the seaweed were also present in Tryphena and Whangaparapara harbours. Following discussion with Aotea mana whenua, Aotea Great Barrier Local Board, Auckland Council and the Department of Conservation, Biosecurity New Zealand imposed legal controls on Blind Bay, Tryphena Harbour, and Whangaparapara Harbour in the form of a Controlled Area Notice (CAN). Mana whenua supported this response with the establishment of a rāhui over the same areas. Detection of this highly invasive seaweed is of considerable concern, so what do we know about it and what are the future plans for managing it?

Background

In June 2021, an image of a seaweed in Blind Bay that appeared to be non-native to New Zealand, was posted on the citizen website iNaturalist[1,2] by Jack Warden, a resident of Aotea Great Barrier. Sergio Díaz-Martínez, a researcher from the National Autonomous University of Mexico who had previously worked at NIWA, spotted the entry and noted it appeared to be a *Caulerpa* species not present in New Zealand. He tagged a NIWA scientist who swiftly notified Biosecurity New Zealand and arranged for samples to be collected from Blind Bay. The Marine Invasive Taxonomic Service at NIWA identified the samples as *Caulerpa brachypus* (Harvey, 1860), a non-native marine macro-alga not previously detected in New Zealand[3]. *C. brachypus* is a seaweed native to the Indo-Pacific region, ranging from Africa to Australia, the Pacific Islands and Japan. It has blade-shaped fronds that are up to 10 cm long, arising from long runners known as stolons. There are two native species of *Caulerpa* in New Zealand that could be confused with *C. brachypus*; *C. articulata* and *C. brownie,* but their morphology is very different[4]. A close relative, *C. taxifolia*, listed as a Notifiable Organism under the Biosecurity Act, has been bred for use in the aquarium trade, and has become established as a serious aquatic weed In NSW[5].

Photo: Jack Warden

Non-native Caulerpa brachypus *on edge of Blind Bay Harbour.*

Biosecurity New Zealand Response

Following the initial detection of *C. brachypus* in Blind Bay, through a Mana – Enhancing Agreement, Biosecurity New Zealand in partnership with Aotea mana whenua, Aotea Great Barrier Local Board, Auckland Council and

the Department of Conservation responded to the incursion.

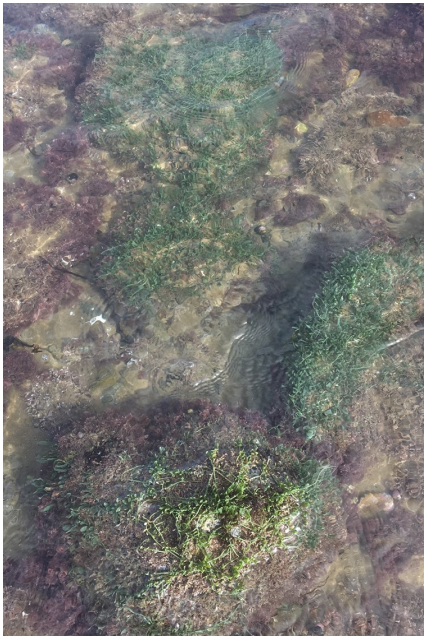

Photo: Jack Warden

Non-native Caulerpa brachypus *on edge of Blind Bay Harbour.*

The response, which operates under a formal structure outlined under the Coordinated Incident Management System (or CIMS), set out to understand the distribution of the exotic Caulerpa, contain the known sites of infestation, and work collaboratively on potential management and surveillance options. Almost immediately they commissioned NIWA to carry out a dive survey of Blind Bay to determine the extent of the invasion. Video footage showed extensive spread of this seaweed across the floor of the bay[6]. Further dives in Tryphena Harbour revealed pockets of *C. brachypus* in this harbour as well[7]. As this species can have impacts on native marine organisms and ecosystems, to minimize its spread, Biosecurity New Zealand placed a Controlled Area Notice (CAN) on Blind Bay and Tryphena Harbour on 20th September 2021. Mana whenua supported this response with the placement of a rāhui over the same areas.

Further surveillance in September showed an exotic *Caulerpa* species was also present in Whangaparapara Harbour, so the CAN controls and rāhui were extended over this bay as well on 16th October 2021. The CAN and rāhui are in place until 30th June 2022[8].

In essence, the CAN makes it illegal to take any marine life (e.g. fish, shellfish, crayfish, seaweed) from the three affected harbours. Vessels that have anchored in the three areas require a permit from Biosecurity New Zealand to lift anchor and move.

These rules are in place because *C. brachypus* is easily broken up and spread by activities such as dredging or anchoring.

For full details of the CAN rules, maps of the controlled areas and what to do if you think you spot *C. brachypus* go to the MPI web site: www.biosecurity.govt.nz/caulerpa [4,7]

Two species

After the initial confirmation that the *Caulerpa* species found in Blind Bay was *C. brachypus,* further molecular analysis was carried out on samples from Tryphena and Whangaparapara harbours. Surprisingly, two closely related species were found to be present in Tryphena: *C. brachypus* and *Caulerpa parvifolia*. Only *C. parvifolia* has been found in Whangaparapara Harbour. Both species are very similar in morphology and growth habit and can only be distinguished by genetic testing. While this is scientifically interesting, that knowledge does not alter response operations. While the source of this introduction is currently unknown it is thought likely to have been introduced on fishing or boating equipment, such as an anchor or anchor chain.

Pathway going forward

Managing marine invasions is even more difficult than managing the invasion of weeds on land. The ability of *C. brachypus* and *C. parvifolia* to reproduce asexually from small vegetative fragments, and the growth habit of spreading by stolons along the sea floor, make this incursion particularly challenging.

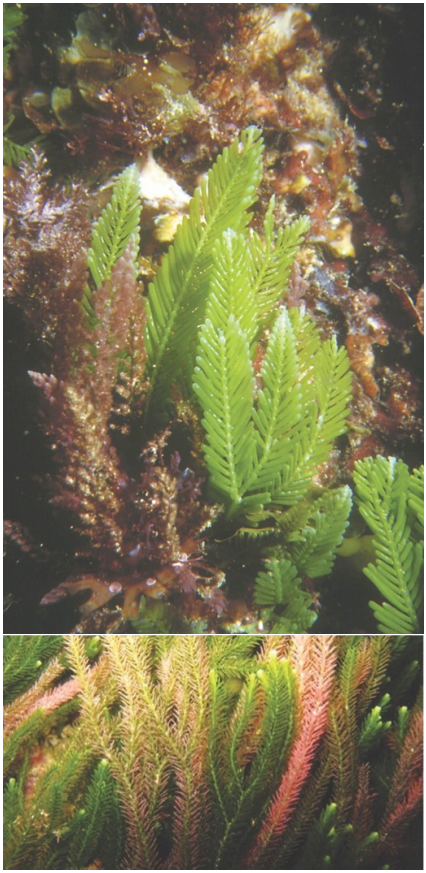

Photo: John Huisman

Native species Caulerpa articulata *(top) and C.* brownie *(bottom).*

To help them in this task, the governance group has set up a technical advisory group (TAG) of nine international and national experts, together with mana whenua representatives to provide mātauranga input, to brainstorm how this invasive species might be controlled and managed. The TAG is charged with providing independent, innovative and technical advice on potential tools to manage *C. brachypus* and *C. parvifolia*.

Initially they will focus on identifying tools and techniques that are available or need to be developed to manage Caulerpa on a large scale. They will consider whether the tool or method has the potential to suppress, contain, control or eliminate aulerpa, whether a commercial benefit could be obtained from harvest to offset control costs, and whether the tool or method could be used on other species in New Zealand. The response team is also interested in knowing whether there are any new and innovative treatments on the horizon that could be considered in the medium to long term, and what sort of reinvasion risk Caulerpa poses.

As a preliminary approach, NIWA, under contract to Biosecurity New Zealand, carried out small scale treatment measures in Whangaparapara and Tryphena Harbours, applying salt to kill the seaweed by osmotic shock. The treated areas were covered with hessian and tarpaulins to contain the salt and shade out any plants that survived the initial treatment. Salt has been used successfully to manage the spread of *C. taxifolia* in NSW, Australia[9].

Photo: Creese et al., 2004

Salt trials in Lake Macquarie, NSW to control C. taxifolia.

The salt will affect some local marine species in the small areas that are treated, but they are likely to recolonise the treated area within months. Where possible, some species such as scallops were removed from the treatment area before the salt was applied. This method may not be a viable treatment for the widespread infestation in Blind Bay, so alternative methods may need to be explored.

Surveillance of our coastline for invasive species

As disappointing as this invasion is, the identification of the species by an informed

member of the community highlights the important role citizen science through such media as iNaturalist can play in keeping New Zealand free of other invasive pest species. Given the New Zealand coastline is over 15,000 km in length, it is almost impossible for regulatory bodies to survey every bay, harbour and fiord of the coastline. Instead, they regularly survey potential 'hotspots' such as Points of arrival by commercial ships and yachts.

Biosecurity New Zealand contracts NIWA to carry out the marine high risk site surveillance programme where regular winter and summer checks are made of all the major ports and Opua Marina, Bay of Islands (where most overseas yachts arrive).

However, many New Zealanders dive at various locations around the country, so it is important they are aware of the species present and inform MPI if they come across what they believe is an unknown species. Suspected sightings can be reported to Biosecurity New Zealand's pest and disease hotline: 0800 80 99 66.

Good information can be found at: https://www.marinebiosecurity.org.nz/what-are-marine-pests/

Postscript

The recent Biosecurity New Zealand updates (23 December 2021 and 28 January 2022) had a mixture of good and bad news. NIWA divers found that the patches of *Caulerpa* in Whangaparapara and Tryphena harbours had grown from 10 to 1750 square metres in the former and from 0.01 to 1840 square metres in the latter since their September dives (Update 5). Where a thick layer of coarse salt was applied in plots in Whangaparapara and Tryphena Harbours no *Caulerpa* was seen indicating the treatment method is effective (Update 7). The challenge now is whether this treatment can be scaled up.

Acknowledgements

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Oruawharo Bay Wetland Restoration project

LOTTE McINTYRE (Project Coordinator, Medlands, Aotea Great Barrier Island)

In late 2018 a small group of Oruawharo/Medlands Bay residents supported the Ecology Vision formed a community conservation group 'Oruawharo Medlands Ecovision (OME)' with the goal of restoring the ecological health and biodiversity of their bay. With financial support from the Local Board and The Department of Conservation they launched an ambitious restoration programme of removing exotic invasive plants, suppressing predators by trapping, and restoring habitat for rare birds such as matuku-hūrepo/Australasian Bittern, mātātā/fern bird, pāteke/brown teal and spotless crake, as well as a range of reptiles and invertebrates. They also plan to improve community access to the wetland with the establishment of paths and boardwalks that will have information boards on the flora and fauna in this important habitat.

Wetlands are often referred to as nature's kidneys due to their natural filtration system and their capacity to mitigate flooding and erosion. Wetlands are a vital link between land and water, shaped by factors such as the underlying geology, soil type and climate, as well as salinity, velocity and permanence or transience of the water.

In the Auckland region, 97% of wetlands have been destroyed due to drainage and development, so protecting and restoring what we have left is now widely seen as a priority; not only in the Auckland region, but nationwide. Wetlands are home to many native species, both plant and animal, some of which are now endangered due to this huge loss of habitat. These areas act as both nurseries and habitat for native fish and eels, as well as many birds and plants adapted to these special conditions.

A key focus of our restoration effort in Oruawharo Bay is on the DoC managed areas of 'The Medlands Wildlife Management Reserve' at the northern end of the bay behind the Medlands settlement, and the estuary and margins of Waitematuku stream at the southern end. Although this area best fits the wetland categorisation of swamp there is also a strong intertidal element more characteristic of estuaries.

Aerial map of Oruawharo wetland showing contours and approximate location of transect line (red). Photo: Auckland City Council ex Thomas Daly

These features strongly influence the types of plants that can grow in this reserve. We are also working on the restoration of the estuary and margins of Oruawharo stream at the southern end of Medlands. The Oruawharo estuary area was known to Māori as Waitematuku – meaning the estuary of the bittern, and this bird has indeed been seen there since we started the project.

This swampland has been heavily modified since the arrival of Māori on Aotea in the

Photo: Auckland Museum Photographic Records

Oruawharo Bay by Henry Winkelmann ca.1892.

1300s. Remnants of vegetable gardens associated with early Māori settlements have been found in the bay[1]. Installation of drains were part of these original farming developments. With the arrival of European farmers on the island, more drainage was installed to improve the land for grazing livestock. In a photo of the wetland area looking toward Sugar Loaf, taken by Henry Winkelmann ca. 1892, it is evident that the natural course of the Oruawharo/ Waitematuku stream is rather different from what we see today, where the creek has been redirected south to make way for more usable land for farming and development[2].

Rodney Ngāwaka, Aotea's local manawhenua storyteller, will tell you that the wetland was once part of a much larger ecosystem, which, before it was drained and used for farming[3], would have spanned from Kaitoke creek in the north to Waitematuku stream at the southern end of Medlands. He also highlights the importance of these wetlands as nurseries for many different species of fish, which were an important source of food for Māori.

Current state of the wetland

Along with the drainage and development of this bay for farming, came the introduction of many exotic plant species. These included the highly invasive kikuyu (Pennisetum clandestinum) and Pampas grass (Cortaderia selloana) which were introduced to the island in the 60's to provide additional forage for grazing animals. Both have since spread all over the island,

Photo: Lotte McIntyre

Wall of Pampas grass along a waterway in the wetland.

with Pampas grass now dominating the wetland landscape and, unless removed, threatening to completely replace the native vegetation. Along with the spread of these invasive weeds has been the loss of crucial native plant habitat for rare birds such as the matuku-hūrepo/Australasian bittern and pāteke/brown teal which have populated this wetland for centuries.

Unfortunately, many members of the public confuse our native toetoe (*Austroderia toetoe*) with Pampas grass, thereby through inaction have allowed the latter to take a foothold in many locations. A number of easy-to-spot features distinguish one from the other[4]. Native toetoe flowers in spring/early summer, produces pure white flower heads, and has a distinctive secondary vein between the midrib and margin of the leaf. Pampas begins flowering late January and some have purple flower heads. The leaves are rough to touch and have a single midrib. Removal of Pampas grass from the swamp is a high priority for OME, but as it is a difficult plant to eradicate this will take considerable time and effort. A recent survey (transect) through the southern end of 'The Medlands Wildlife Management Reserve' identified 30 different plant species, only six of which were native![5] The two main native vegetation types that were present in this swamp were raupo (Typha orientalis) and jointed twig-rush (Baumea articulata) with each associated with differences in sediment depth, suggesting the vegetation type is controlled by hydrological history (water depth).

Another weed that has taken a major hold along the Oruawharo Stream is grapevine, which is thought to have originated from the original Medlands homestead garden site. It has since spread and is now smothering large areas of native vegetation.

Besides the weeds, the other big environmental issue for the wetland, like much of the island, is the high density of mammalian predators, including ship (Rattus rattus) and Polynesian (R. exulans) rats as well as feral cats. To reduce rat numbers to protect both birds and invertebrates in the wetland, OME began trapping in January 2021. Monitoring of rat densities 11 months later revealed that 60% of tracking tunnels had rat prints, indicating that we still have a long way to go to meet a target of 5%,

Photo: John Ogden

*Raupo (*Typha orientalis*)(left) and jointed twig-rush (*Baumea articulata*)(right).*

which is the standard set by Windy Hill and Glenfern Sanctuaries, considered a good measure of predator suppression. By comparison, tracking tunnels in the nearby dunes, where OME have been trapping since November 2019, had more desirable scores of around 7.5%. However, the August 'Covid lockdown', which halted trapping for a period of around six weeks, will have impacted on these numbers.

While it is easy to be pessimistic about the current state of the wetland, there are pockets of natural regeneration such as the beautiful mature tī kōuka/cabbage tree groves. These will flourish once the pressures of weeds and predators are reduced. The driving force for OME is to intervene in a way that accelerates those natural processes.

The Restoration Project

In 2020, OME successfully applied for funding from the Department of Conservation for a three-year project to begin restoration of the DoC-managed wetland. The first steps to this restoration work include reducing introduced pest species, plant as well as animal, and encouraging the natural regeneration of plants in this area, through planting of native plants that will create vegetation cover to outcompete the kikuyu and shade the waterways, as well as stabilise the creek banks to reduce erosion.

Photo: Lotte McIntyre

Monitoring card showing cat, rat and mice paw prints.

Establishing a rat trap network was one of OME's first objectives, which was started in January 2021. We have since kept up with weekly checks until the Covid alert level 4 over the winter period gave the rats a short break. We have added a few more traps recently to include a picturesque area along the main creek. There is still potential to put more traps along the trap lines to provide more effective control. With not all areas currently accessible, there will be some gaps in the network.

An extensive weed eradication process has begun focussing on treating the difficult-to-remove Pampas grass with a glyphosate based herbicide, which is relatively specific for grasses. Given the high density of Pampas grass, completely eradicating them will take some time as seedlings continue to emerge within the wetland from the bank of seeds in the ground and from surrounding areas, but the benefits for the wetland will be considerable. The plants we have managed to treat so far are showing great results.

Feral cats also need to be controlled given they prey on many of the native birds as well as invertebrates. Reducing their numbers within the wetland is a high priority for OME who are working closely with Council and DoC in support of their feral cat management plan. Given their nocturnal nature they are not often seen, but cat scat is frequently observed within the wetland, and their distinctive prints have been detected in the tracking tunnels.

The wetland is also a favourite place for wild pigs, who like the muddy areas around the creeks. They do immense damage to the vegetation covering the stream banks. While fencing the area to exclude the pigs would be the ideal solution, it is also very expensive, so OME has been in discussions with the Local Board and the community to find solutions that minimise damage to the vegetation, especially the new plantings: this process has proved to be not straightforward.

OME has also initiated a 'Wai Care' water quality monitoring program with four sampling sites, two at either end of Oruawharo Bay. This is an Auckland Council freshwater initiative that enables communities to undertake simple tests to measure pH, dissolved oxygen, nitrate levels and a macro invertebrate check, to assess the ecological 'health' of rivers, lakes and streams[6]. These tests are done quarterly on-site at the sea-end of the creeks which have brackish water, and in the upper freshwater-reaches. These tests indicate that within the areas tested the streams entering Oruawharo Bay are in a very healthy state, with scores falling well within the

Photo: Lotte McIntyre

Pied shag in Oruawharo/Waitematuku creek.

guidelines provided by the 'Wai Care' programme. However, this may not invariably be the case for the seaward ends of these streams.

In October last year, OME finally managed to have their first planting day after postponing twice, firstly due to flooding and the second time due to a Covid 19 lockdown. Our OME community volunteers planted 50 tī kōuka/ cabbage tree (Cordyline australis), 50 mānuka (Leptospermum scoparium)/kānuka (Kunzea ericoides), 10 kōwhai (Sophora microphylla) and approximately 60 harakeke/flax (Phormium tenax), split over two sites. There are plans to have at least one planting day per year during the three years of the project, depending on availability of sustainably sourced plants.

Oruawharo Medlands Ecovision vision

There are many challenges working in a wetland with unpredictable conditions.

Earlier this year, the wetland was flooded with sea water, subsequent to a storm that blocked the creek exit at high tide and left all the brackish stormwater trapped for a couple of weeks. The dead mature mānuka one can see from a plane, highlight the impact of this flooding on the vegetation. This was just prior to OME's first planned planting day, and we were very grateful for the timing. Imagine if we had planted first! This particular couple of weeks also saw most of our rat traps floating in the area, which was a bit of a novelty, though not very conducive to catching rats. The ever-changing conditions require an adaptable approach as we find the best ways to restore this complex ecosystem.

Over time, OME envisages the area becoming more accessible and inviting to the community, with paths and information signs highlighting the plant and animal species of the area, to encourage everyone to see it as a beautiful, rich habitat to be valued. The abundant rainfall in the Winter and Spring of 2021 has shown us just how incredible the wetland looks with a lot more water, compared with the previous drier seasons of 2019 and 2020. The many ponds that have formed across the wetland created safe niches for the nesting birds. We have sighted white-faced heron (*Egretta novaehollandiae*), paradise shelducks (*Tadoma variegata*), pied shags (*Phalacrocorax varius*), little black shags (*Phalacrocorax sulcirostris*), and of course the ubiquitous pūkeko (*Porphyrio melanotus*) frequenting the ponds within the wetland, and welcome swallows (*Hirundo neoxena*) zooming above catching insects. Up to 18 pāteke/brown teal (*Anas chlorotis*) ducks have been observed in the wetland this spring. Although the endangered matuku-hūrepo/Australasian bittern (*Botaurus poiciloptilus*) have been spotted in Oruawharo Bay on several occasions, we are yet to sight them in the wetland itself. We hope to see that situation change. OME would like to see DoC work towards enabling a large pond to become a more permanent feature, though the very nature of this area is that the water levels will always change with the seasons.

For years this area has been a bit of a wasteland with few efforts made to protect and restore what was once a splendid wetland. OME's goal is to see this wetland restored to its former glory as the jewel in the crown of Oruawharo Bay, brimming with native plant and bird life, and breeding fish, and delighting visitors who come to enjoy the biodiversity of this special Aotea natural feature.

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Recent stoat incursions in the Hauraki Gulf

ANDREW VEALE (Manaaki Whenua/Landcare Research, Auckland)

When you arrive on Aotea, the first difference that many visitors note are the kākā. Their abundant shrieks and whistles are one of the many reasons the island is so special. But why are kākā so abundant on Aotea but rare or absent in apparently identical forests in Northland and the Coromandel? The answer is that Aotea does not have New Zealand's most devious predator – the stoat. There have been multiple studies showing that in mainland forests with no stoat control, kākā fledging are almost non-existent, and many females die trying to defend the nest. This results in an extreme male bias in these populations whereby old kākā males live out their long life as bachelors. Kākā chicks and their adult sex ratio are actually the greatest indicator for long-term stoat abundance, because most other forest birds are also affected by rats or cats, but for kākā, stoats are the only animal capable of climbing up to their nests high in trees, while also being tenacious enough to take on a large angry mother kākā.

There are occasional reports of stoat incursions on Aotea, which DOC and Auckland Council take very seriously, but no invaders have ever been confirmed. Most of these incidents occur over summer, and are fleeting glimpses by visitors to the island. It is my opinion that probably most or all of the reported incidents on Aotea were mistaken identities. Banded rails have a long thin body, could have similar colouring to a stoat in the right light, and their darting through the undergrowth could easily look like a stoat. Also, banded rails are particularly common on Aotea, and uncommon on the mainland (again probably because of stoats), so visitors to the island would not be familiar with them. Nevertheless, if you see a stoat on Aotea report it immediately!

Stoats have been recorded on almost all islands in Aotearoa within a distance of 5 km from the mainland. They have not, however, been confirmed on islands further offshore, even

Photo: Andrew Veale

Stoat with dead tūī.

those with regular boat traffic such as Aotea and Rakiura. This indicates that stoats get to islands by swimming, not by hitching a ride on boats. Lab-based tests that I helped perform in collaboration with Professor Kim King showed that stoats can swim several kilometres with relative ease, and there are numerous observations of them swimming long distances in the wild.

It is not impossible that they might hitch a ride to Aotea, particularly if there was a load of hay that was ferried across, but hopefully biosecurity would properly check such loads.

Most other islands in the Hauraki Gulf are not so lucky as they are closer to shore. Over the last two years there have been three pest-free nature sanctuaries in the Hauraki Gulf invaded by stoats. These have resulted in long protracted incursion responses, some of which remain ongoing. The thin silver lining for all of this is that we are improving our incursion responses, adding new tools to the toolbox to catch these cunning animals.

Invasion 1 Motukorea

The first incursion was on Mokukorea (Brown's Island) in April 2020. A biosecurity team from DOC and Auckland Council with dog handlers and three stoat dogs visited Motukorea and detected the presence of a stoat or stoats. They found stoat scat, cached predated pigeons, and stoat footprints on the beach. The scat and dead pigeons were sent to Ecogene® for DNA testing, and stoat DNA was confirmed – proving that the dogs knew what they were talking about. Over the next few months multiple trips were undertaken by the incursion response team: they put out traps and cameras and used detector dogs to find scat. The stoat was living in the cliffs on the north of the island feasting on pigeons, and it had little interest in going into the traps. Auckland Council put out a meat bait with a novel 'humane' toxin (PAPP) in it that has been specifically developed for stoats; some was taken. By mid-May there was no further sign of the stoat on the island, with the inference that it had either died, or swum away…

Invasion 2 Motutapu

Shortly after the stoat sign ceased on Motukorea, stoat footprints were recorded on Motutapu. Had the stoat swum north? Motukorea is 2.6 km from Rangitoto/Motutapu and is the closest point from which it could have swum. DOC immediately put out traps in the vicinity of the footprints and started their incursion response. Multiple cameras were put out, capturing images of the stoat, and the dog handlers even saw it, but were unable to catch it. Months went by without a catch. An adult male stoat, in good condition, was finally caught in September, near the Rangitoto Wharf.

At last the island-hopping stoat had been caught – or had it? There was some suspicion that perhaps this wasn't the only stoat on the island. Stoat sign had recently been recorded near the original site 8 kms away. Why would the wily stoat that avoided traps for months, run across the island in a few days and go into a standard trap baited with boring old bait? These suspicions turned out to be well founded; a month or so later predation events on various critically endangered birds were observed. Again, DNA confirmed the presence of stoats for these predation events. More trapping and work with detector dogs followed, and eventually another stoat was caught near the spot where the original footprints were recorded in January 2021. This was another male. Unfortunately, more stoat sign continued to turn up over the subsequent months, and more predation events occurred. There was a stoat at large that was too clever to go into normal traps. Genetics from scat indicated that this stoat was also a male. Finally, a third stoat was caught in November 2021 near where dogs had found sign. The DOC trapper had created an effective natural-looking trap. The surrounds were made from driftwood, and it was baited with an old infertile penguin egg, some meat, stoat bedding, and a speaker playing baby stoat sounds. Stoat females are fertile from birth, and generally they are mated over September to November before they leave the nest. I had

Photo: Greg van der Lee

Site for reconstructed natal den site on Motutapu Island isthmus beach (2A) comprising two DOC200 traps in tunnel with infertile penguin egg in central chamber with 'sonic' lure.

access to a litter of stoats that were research animals and I recorded their very distinctive high-pitched cries and sent these recordings to DOC. A female stoat den with fertile female kits calling proved irresistible to the male stoat. There is ongoing research at Manaaki Whenua and with Cacophony to investigate the usefulness of sound lures to attract a range of species.

While it is hoped that this was the last stoat on the island, more work is required to confirm there are no more. Genetically this last stoat caught was tied to the scat found, so at least there is some hope. Amazingly, current genetic work indicates that probably all three stoats were unrelated. They independently swam to the island, rather than being born there.

Invasion 3 Shakespear Regional Park

Meanwhile, a third stoat invasion was occurring in Shakespear Regional Park. A female stoat had been recorded in the park in 2020 and avoided all attempts to catch her. Then in January 2021, two juvenile stoats, a male and a female, were caught in traps inside the park. Clearly, the adult female had birthed a litter inside the park, and there were more animals present. Auckland Council threw everything that they could at the response to save the the little spotted kiwi, which are vulnerable to stoat at every stage of their life, tīeke and the recently translocated hihi population they had reintroduced to the park. This included Brad Windust and his stoat detection dog Wero, who were critical in finding stoat dens/caches sites, trail cameras, thermal cameras and DNA techniques. Their rangers monitored these in real time at times at night, trying to respond immediately to any detections. In May, finally a female stoat was caught in a live trap using an old-school Edgar trap from the 1970s. Within a day a second male was live trapped in the same trap, followed a few days later by another. Cameras had shown that the other stoats were coming near the trap when they were inside. Clearly the stoats were interested in the trap because of the sounds of their captured siblings, and the scent indicating they had been there. Another two stoats were caught over July in live traps, and a further one was caught in a kill trap. All of the live-trapped stoats were sent to the animal facilities at Manaaki Whenua Landcare Research where they are the subject of ongoing behavioural research. This research is led by Dr Patrick Garvey and aims to find out what the behavioural differences are for the clever animals that live in sanctuaries and avoid traps.

Genetic tests were conducted at Ecogene® on a selection of fresh scat recovered from the park (with the assistance of detection dogs), identifying which individual they came from and the sex of individuals. This helped refine where traps were placed – knowing the home ranges of each animal, and confirming the number of animals present. It was found that there were two males identified from the scat that had not been caught; one has since been caught. No further detections have been made for months so the last male probably either died of natural causes, or left the park. Again, vigilant surveillance continues, but hopefully this incursion has been successfully controlled.

Conclusions

There are many lessons from all of this. Teams across the country are working on developing far better tools to detect and trap stoats, including thermal cameras, DNA based tools, detector dogs, and sound and scent lures. Many of these are already being deployed or discussed in Te Korowai o Waiheke's ambitious project to remove stoats from Waiheke Island. Similar work is also happening for other pest species relevant to Aotea. The work put in by Auckland Council and DOC has been exemplary, and the costs of these incursion responses has been very significant, but that is what it takes to capture or kill those animals smart enough to avoid traps. The people involved in these responses have worked hard to catch these clever animals, and talking to many of them is like talking to Wile E. Coyote, always scheming on how to do it better next time. It's nice I could play a part but the real work was done by the incursion response teams at Auckland Council and DOC, and the scientists at EcoGene®.

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