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Aotea Great Barrier
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EDITORIAL: Exotic Caulerpa incursion: A monumental failure in marine surveillance and biosecurity preparedness

BARRY SCOTT (Editor)

First identified in Okupu/Blind Bay, on Aotea in June 2021,[1,2] then in the western bay of Ahuahu/Great Mercury Island a few months later[2], the invasive exotic caulerpa seaweed has now been found at Te Rāwhiti in the Bay of Islands[3]. In all three cases the caulerpa was well established as 'meadows' of seaweed, suggesting it had been present at all three sites for a long period before detection. The first report was made by botanist, and Aotea local, Jack Warden while out fishing in a kayak in Okupu. He posted photographs of the unusual green alga on iNaturalist, where it was quickly identified by a caulerpa expert, Sergio Díaz-Martínez, in Mexico. Jack tagged a NIWA scientist in his post who notified Biosecurity New Zealand (BNZ) and arranged for samples to be collected from Blind Bay for identification. Analysis of those samples revealed that the species was Caulerpa brachypus. A second species that is equally invasive, C. parvifolia, was later found at some of the sites. Further surveillance by NIWA divers, under contract to Biosecurity New Zealand, identified further small patches of caulerpa in Tryphena and Whangaparapara harbours and then later a large infestation in the western bay of Ahuahu/Great Mercury. Controlled area notices (CANs) together with Rāhui were imposed at all four bays.

Caulerpa the 'killer alga'

Variously described as 'the killer alga'[4], the 'foot and mouth disease' of the ocean, and 'kikuyu of the sea', exotic caulerpa is one of the most serious invasive seaweeds in the world. It is its rapid and invasive nature that makes it such a serious threat to our marine environment. Caulerpa is a group of single celled, multi-nucleate (coenocytic), green macroalgae, comprised of a horizontal stolon (or rhizome) with erect green photosynthetic fronds, and colourless rhizoids that anchor the alga to both soft and hard seabed surfaces. Its ability to fragment allows for rapid clonal expansion and dispersal. However, there are marked differences among Caulerpa species in their ability to produce fragments and in the ability of the different tissue fragments to regrow. Nine native species of Caulerpa have been identified in New Zealand waters, but it is the exotic species that are problematic—a situation we are all familiar with for our land-based species, such as Clematis vitalba (Old Man's Beard), which has become a serious problem

Caulerpa on the beach at Okupu (Credit: Sidney Wales)

Cover: Kelsey Miller surveying reef at Hauturu after kelp recovery (Credit: Paul Caiger)
Back cover: Hihi | Stitchbird (Credit: Liz Whitwell)

weed, whereas the stunning white flowering native clematis, C. paniculata, is an integral and well adapted component of our native forests. The two Caulerpa species associated with the current incursion, C. brachypus and C. parvifolia, grow naturally in the warm waters of the Indo-Pacific region ranging from Africa to Australia, the Pacific Islands and southern Japan, but also now appear to thrive in the clear open waters of the bays and harbours of the north-east coast of the North Island.

While Okupu was initially thought to be the index or primary site for the incursion, it is now more likely, given how well established the caulerpa is in Omakiwi Bay and the associated Te Rāwhiti channel, that the initial incursion was in the Bay of Islands, with fragments spreading from there by a vessel(s) plying the well-known 'yachtie' blue highways. Whole genome sequencing of samples of the two species from each of these sites should soon allow us to determine the probable initial site and the pathway of spread from there.

First response: Controlled Area Notices, a pilot and public engagement

Following the initial detection of caulerpa at Okupu in June 2021 and the placement of CANs at the infested sites, the first 'on the ground' response to test a method to control it was a small scale pilot mounted in December 2021 at Okupu[2]. Two plots (2 x 12m^2) were covered with rock salt and hessian mats to kill the caulerpa by osmotic shock. Subsequent monitoring revealed that the caulerpa, and most other organisms in the plots, were killed, but the caulerpa quickly re-established. Alarmingly, the patches in Tryphena and Whangaparapara harbours grew from 0.01 to 1840, and 10 to 1750m^2, respectively, in the three-month period from the first surveys there in September 2021 to the time of the pilot in December 2021. No further attempts have been made by BNZ since then to control the growth and spread of these infestations on Aotea.

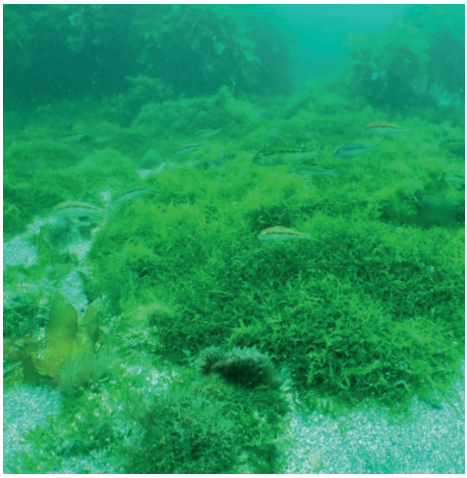
A technical advisory group was set up in late 2021 to provide independent, expert and technical advice on methods/tools to manage caulerpa on Aotea. They reached the conclusion that with the tools available it would not be possible to eradicate caulerpa from the western bays of Aotea[5]. No specific recommendations were made on how to control further spread, apart from the restrictions associated with the CAN, further research, and the implementation of a community ambassador programme. This operated over the summer of 2022/2023 to increase boatie awareness of caulerpa biosecurity risks. Disappointingly, no further removal/eradication methods were trialled on

Caulerpa on the beach at Okupu (Credit: Sidney Wales)

Aotea, despite the fact that successful eradication of exotic C. taxifolia, had been achieved in two lagoons in Southern California[6,7], albeit in relatively small areas by comparison with the areas of infestation on Aotea. As of early 2022 these measured 1.5ha in Whangaparapara, 44ha in Blind Bay and 2.2ha in Tryphena. There is a feeling among many of us that BNZ gave up too easily and gave little consideration to the economic, social and environmental consequences of doing nothing.

How California dealt with it: good surveillance, preparedness and a rapid response

Preventing the establishment of an exotic organism in any country is dependent on three key biosecurity elements: (i) good border controls and surveillance to detect the unwanted organism at an early stage before it can enter or soon after it has crossed the border, (ii) good management plans in place to prepare for specific types of incursions, and (iii) being able to mount a rapid response to the incursion. Ticking all three of these boxes is absolutely essential to prevent the establishment of such a highly invasive marine species as exotic caulerpa. These good practice biosecurity measures are best exemplified by the successful eradication of two small incursions of C. taxifolia in two Southern Californian lagoons – Agua Hedionda Lagoon and Huntington Harbor – by the San Diego Regional Water Quality Control Board. Field containment and treatment by the Southern Californian Caulerpa Action Team (SCCAT)[6,7] commenced within 17 days of detection, a response akin to that of an oil spill. For phase one of the eradication plan they placed tarpaulins over



Prolific growth of caulerpa on the seabed of Schooner Bay, Aotea Great Barrier Island (Credit: Glenn Edney)

the seaweed then added hypochlorite pellets to release chlorine to kill it. This was then followed up with intensive surveillance and manual treatment by divers to remove all residual material from the site over a period of six years (2000-2006), and at a cost of US$7m. With a performance standard of three totally negative detections from consecutive surveys they were able to declare in July 2006 that both lagoons were totally free of exotic caulerpa[8]. However, caulerpa popped up again in March 2021 when an incursion of Caulerpa prolifera was detected in Newport Bay, near Los Angeles, which triggered reactivation of the SCCAT and development of a Rapid Response and Eradication Plan[9]. For this incursion suction dredging was employed as the primary treatment to remove caulerpa, as the topography and hydrology of the site was not suitable for their preferred method of tarpaulins and chlorine treatment. While regrowth of residual caulerpa fragments has since occurred, growth and spread has been prevented by a combination of manual weeding and strategic placement of hypochlorite pellets on the regenerating caulerpa. Since the initial treatment the native eelgrass has regenerated paving the way for ecological restoration of the site.

Surveillance and ongoing treatment are continuing in California, but the SSCAT is confident that the outcome here will also be eradication. You can find out more about the Californian approach through a Webinar by marine biologists, Rachel Woodfield and Robert Mooney, that was part of the 2023 California Invasive Species Action Week Lunchtime Talks[10].

How Biosecurity New Zealand has dealt with it

In comparing California with what has happened at Aotea I am drawn to the conclusion that the level of surveillance, preparedness and response has been a monumental failure. Even though it is well known that Aotea is a sentinel site in New Zealand for marine invasives because of the prevailing currents and winds, and the patterns of yacht movement, there is **very little surveillance** of our waters. There is no regular MPI surveillance of any of the bays and harbours and only annual visits from Auckland Council Biosecurity divers, despite Aotea's marine zone being recognized in the Auckland Unitary Plan as Outstanding Natural Landscape. Caulerpa is now the fourth invasive species to be detected in Aotea waters in recent years with sea squirt, fan worm and Asian Paddle crab being the first three. There is anecdotal evidence that locals in Okupu noticed the green seaweed but did not realise it was a serious invasive pest, highlighting the need for initiatives like Ahu Moana that are community led. Two pilots, led by Glenn Edney from the Tūtūkākā coast, have been underway at Schooner Bay and Katherine Bay and their associated communities over the last year.

In contrast to the high level of **preparedness** in California, the level of surveillance and preparedness in New Zealand for a caulerpa incursion has been found wanting. This is despite caulerpa being highlighted as a potential serious marine invasive at several marine biosecurity conferences since the early 2000's, and in a vast array of reports, conference proceedings[11], publications and management plans following the invasion in the Mediterranean in 1984 and subsequent invasions in Australia and the USA in 2000. It was such a high priority in the USA that a national management plan was developed in 2005[12].

After detection at Okupu in June 2021, Biosecurity NZ did respond quickly but the lack of a management plan to control or eradicate meant the incursion totally got away on them. While it was always going to be difficult to contemplate eradication at Okupu, the relatively small incursions in Tryphena and Whangaparapara harbours could have been contained and probably eliminated if the response had been as rapid as in California, using the methods they used successfully.

Since early 2022 there has been no further surveillance on Aotea. Locals have reported sighting caulerpa in the bays to the north of Whangaparapara, on the reefs on the outer Tryphena harbour and even on Goat Island around the SE coast! These reports are alarming given the very serious impacts this exotic seaweed is known to have on marine life. Experience in the Mediterranean has seen a 30% reduction in biodiversity and a 50% reduction in fish biomass in 6 years[13].

Although there are CANs in place, commercial trawling and dredging, a very high-risk activity for spreading caulerpa, continues along the edges of the CANs. Given it can grow to depths of around 40m in clear waters, a complete ban on commercial trawling and dredging within the 40m contour around Aotea should be put in place immediately. Even with such controls, storms and currents will break up and disperse the caulerpa. This was very evident after 50 tonne-plus of caulerpa washed up on Okupu beach after cyclone Gabrielle in February of this year. This was visually confronting and really brought home to the community the magnitude and the scale of risk we are dealing with. Even the clean-up of this large volume of seaweed on the beach was poorly handled, with bags of caulerpa sitting on the beach for weeks. This event and general concern by communities on Aotea and around the Hauraki Gulf finally led to a public outcry in May over the lack of action and the potential social, environmental and economic impact on the Gulf.

So what can we do?

After two years, it's clear that a change in the response from government is needed now or we will soon have caulerpa in every bay on the Barrier and in many other places. There is also no doubt that communities will have a role to play in the next stage of this campaign, because they will bear the costs of caulerpa if it is not removed. We felt there had to be greater public awareness of the threats posed by caulerpa to create pressure on and to get faster action from both central and local government. We contacted Andrea Vance from Stuff and worked with her on a story that captured all the issues[14]. We presented to the Hauraki Gulf Forum on the 12th of June alongside the Waiheke Marine Project (WMP). This community group have led the way in preparing for spread of caulerpa in the Gulf by initiating their own surveillance of the Waiheke bays using two remotely operated vehicles (ROV)[15]. WMP also initiated a conversation with the Californian biosecurity group and had begun sharing this information with their members and the wider community through events such as the Waiheke Pestival. Submissions to the Minister of Biosecurity, Damian O'Connor, were made by Legasea, Revive our Gulf, and by the Chairs of Ngāti Rehua Ngātiwai ki Aotea and Ngāti Paoa Iwi Trusts[16].

But things really hotted up when Te Rāwhiti environmental restoration and pest control specialist, Rana Rewha (Ngāti Kuta) found clumps of caulerpa on the beach at Omakiwi Cove, in the Bay of Islands[17]. This resulted in a major reaction from the Northland Regional Council on the underwhelming response of government. While it is somewhat galling for Aotea that it takes an outbreak on the mainland to galvanise national action it is now great to hear from Biosecurity NZ that "nothing is off the table", according to John Walsh, who is leading the response. The community of Te Rāwhiti have seen what has happened on Aotea and there is a commitment and determination that not just control but eradication should be the goal for "this maggot of the sea", to quote Kaumātua Hone Martin from Te Rāwhiti[18].

Community concerns about the incursion came to the fore at the Hauraki Gulf Forum on the 12th June. Both John Walsh (Director Readiness and Response Services, MPI) and Stuart Anderson (Deputy Director-General, MPI) were there alongside representatives from Auckland Council, Northland and Waikato regional councils, and most of the key environmental groups that are active in the HG. Chair Kate Waterhouse and I presented on behalf of AGBET our concerns about the management of the caulerpa incursion at Aotea[19].

Among our key messages was a call for:

- The establishment of a new, cross-agency collaborative response model to enable local surveillance, control and possible eradication.
- Provision of funding to establish an Aotea specific response project, with locally based management, surveillance equipment and diving capability, training and compliance, and access to the full range of proven control and removal tools.
- Banning the use of all bottom contact fishing

methods along the west coast of Aotea to help control the spread of caulerpa, until there is data on the depth caulerpa can grow to in our waters so exclusion zones can be more robustly defined.

An outcome of this hui was a letter to Minister O'Connor voicing the serious concerns of the Hauraki Gulf Forum that *"the arrival of caulerpa is the most serious marine biosecurity incursion in our lifetime"*. We are all waiting to see how the government responds.

One significant step taken by MPI indicating they are at last taking this incursion more seriously has been the establishment of a Suction Dredge Technical Advisory Group to consider suction dredging as a tool for management of exotic caulerpa. This committee of 12 has a wide range of expertise and experience with the brief of preparing a report by the 30th of July. As co-chair of this committee, with Mata Hone Martin from Te Rāwhiti, I will be pushing strongly for this report to made public. It is disappointing that the initial TAG report released in February 2022[6] is still not readily available in the public demand. I did receive a redacted copy after waiting two months from an OIA request! To establish trust with communities there is a need for much greater transparency and openness from Biosecurity NZ.

In conclusion: time for a step change in response to head off disaster

Exotic caulerpa in our waters is the most serious marine incursion of our time. The response so far has highlighted severe deficiencies in marine biosecurity surveillance, preparedness and our collective ability to respond. It is clear that marine biosecurity is the very poor cousin of land-based biosecurity. One cannot imagine such a slow response from government if we had an incursion of 'foot and mouth' disease, for example. There is a way forward but it is one that requires much greater inter-regional and inter-organisational cooperation, and urgency. Importantly, there needs to be greater empowerment of local communities by training, certifying and resourcing them to provide the level of surveillance and responsiveness needed to not just help manage this incursion but to prevent any new incursions remaining undetected for so long. We need look no further than to California for the level of preparedness and ability to respond rapidly to serious incursions like caulerpa. Until we have such management and response plans in place we cannot claim to be "a world leader in biosecurity" and our marine environment which is so important to us will decline and degrade.

Okupu post Gabrielle (Credit: *Noel Nancekivell)*

Postscript

Since this article was written exotic caulerpa has been detected in the northern channel off Kawau island and very recent surveillance by NIWA at Aotea has confirmed, what the locals had already suspected, that caulerpa has been detected at Bowling Alley Bay, the Broken Islands (?) and the Southern end (?) of Port Fitzroy. We all know that the most effective measure to control this horrible weed is a rapid response. We await with bated breath to see when/if a rapid response is initiated as this will be a tipping point for control of caulerpa on Aotea.

Acknowledgements

We acknowledge the matters set out in the letter sent to ministers by Ngāti Rehua Ngātiwai ki Aotea together with Ngāti Hei in May. Until recently MPI's processes and governance have failed to properly reflect the concerns of both ahi kā and the community on Aotea.

We acknowledge the tireless work of Local Board Chair Izzy Fordham on the governance group to date as the only Aotea resident included.

We acknowledge the people of Okupu and the western bays of Aotea who have been directly affected by this infestation and those whose vigilance lead to its discovery in the first place, and the work of Glen Edney in recording the spread of this marine scourge in Schooner Bay as part of the Aotea Ahu Moana project.

We echo concerns about the slowness of the response and the poor and slow response from councils.

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Biz Bell, seabird ecologist and island restoration specialist

Interview with BARRY SCOTT (Editor)

Black petrel/tākoketai at Hirakimatā (Credit: Biz Bell Wildlife Management International Ltd.)

How did you get involved in conservation work?

I had a big advantage as I was born into it through my late father Brian Bell who worked for the NZ Wildlife Service and was a dedicated ornithologist and conservationist. As kids we visited lots of places and learnt a lot about seabirds. I fell in love with islands and seabirds. Then in 1995 I got an invitation from the late Mike Limber, a Department of Conservation (DOC) seabird specialist and renowned ornithologist, to study the status of the black petrel/tākoketai on Aotea Great Barrier. So, in January of 1996 I went up Hirakimatā with Mike to start what has become a life time study of the tākoketai. 27 years later we are still monitoring black petrels on Hirakimatā, and I am still learning something new every year.

Could you give us some background to Wildlife Management International?

This is a private company started by my dad in 1992 and then run by my brother Mike for a period before I took over ownership and management. It is a small conservation consulting firm that specialises in avian-related conservation, but also reptiles and frogs. We are also specialists in island restoration work, which we have carried out mainly in Europe and the Caribbean. We have a great team that is passionate about ornithology and ecology. Although we have a steady flow of work, we are always on the lookout for new projects to keep the momentum of the company flowing. A lot of our work in New Zealand is done under contract for regional Councils and for DOC with whom we have close relationships.

What are your stand-out projects?

The black petrel/tākoketai project has to be the stand out project. Such amazing birds that breed in such a special place in the cloud forest of Hirakimatā. I am a real island freak. I just love working closely with island communities and seeing their joy with the outcomes of island restoration work. One stand out I have is meeting with a grandmother on the island of

St Agnes, the southernmost populated island of the Isles of Scilly, who talked about her vivid memories of the Manx shearwaters that were abundant on the island when she was a child, and the joy for her almost 100 years later to once again see and hear these wonderful birds, following eradication of rats on the island in 2013. A key role in working with these communities is to train them on how to look after the wildlife on the island. It is great to see the community throwing themselves behind these projects by maintaining biosecurity to protect what they have and utilising the new status of the island for new ventures such as ecotourism.

There must be some major people challenges in setting up these projects?

Yes there are, but it is important to remember that the communities are the most important part of the island fabric. Before we start any restoration work there are a whole range of different conversations that have to be had. Some understand the importance of the work quickly and are immediately on board. Others have no understanding of why the work is being carried out so have lots of questions and may require several conversations before they are on board.

While there are some common challenges, each island has its unique set that you have to work through. But the rewards are great from working closely with the community. It is important that we do the work as safely as possible for the community using the right techniques and tools. Aotea like any island has its own set of challenges. But what it does have are lots of passionate people all keen to see the ecology of the island restored and protected. Islands are pretty special places with very special communities.

Black petrel/tākoketai chick at Hirakimatā (Credit: Biz Bell Wildlife Management International Ltd.)

You have been coming to Aotea Great Barrier now for 27 years, so what changes have you observed?

Within the community there is now a groundswell of very enthusiastic people wanting to protect the environment. There are many small groups - Glenfern and Windy Hill Sanctuaries; Okiwi, Awana, Medlands, Okupu and Tryphena groups – all around the island with a common goal. It's absolutely amazing. But it is seeing birds like the Cook's petrel and kākā now present in reasonable numbers and nesting on the island that stands out, never mind the chevron skink, pāteke, banded rail and other birds. Kākā used to just visit the island and then fly off to Hauturu and other places to nest. But now there is a good sized breeding population on the island, as a result of improved habitat for them to breed and more abundant food sources following recovery of the forests combined with plantings by individuals all over the island. Underlying all this is increased predator control. Even quite depauperate areas can recover quite quickly once predator numbers are significantly reduced.

Who funds your work?

We have contracts from MPI or DOC but because I am just so passionate about this bird our company is able to subsidise some of this work. I am in love with black petrels and the island. To really understand seabird populations, which are long lived, you need to monitor them over long periods of time. This year might be a bad year for the seabirds because of the impact of the Auckland Anniversary storm, cyclones Hale and Gabrielle, and other storms on the island. It may even be disastrous for black petrel and other seabirds. I am heading out to Aotea again next week to band the chicks so am very concerned at what I might find. We know we have lost ~30% of the chicks already but hope it is not more than that.

Postscript: 2023 has not been as disastrous as we thought with 61% breeding success compared to better years of around 73%. Let's hope climate change does not bring too many of these massive storms.

What does your monitoring programme entail?

We have ~500 burrows that we monitor three times each year during the breeding season. In early December when birds are laying their eggs we determine the number of birds breeding, sex of the birds, and number of eggs. At night we capture young birds returning from their OE who are a bit confused about what they are supposed to be doing. We then go back at the end of January/early February when chicks are hatching to determine the degree of

hatching success and then finally in late April/early May to get a final tally of chicks that have survived and band them before they fully fledge and leave the island. It is very labour-intensive work but I am fortunate to have lots of skilled and enthusiastic helpers each year.

What predator control is there on Hirakimatā?

While we have a network of Good Nature A24 traps for suppressing rat numbers it is feral cats that have the greatest impact on the population. Fortunately, the cats do not seem to like wet and humid sites like Hirakimatā, so we do not see very many feral cats around the mountain. Since DOC started feral cat control around Okiwi, related to pāteke protection, a lot of the learned behaviour within the population has been eliminated. Previously there were cats that had learned to head up the mountain when the black petrels were breeding but now a lot of that 'memory' has gone. But we still observe some cat predation. Now that Tū Mai Taonga is operating on the mountain we expect cat numbers will be even lower.

What differences have you seen 27 years on from when you started?

The population is currently classified as "Stable to Declining". Seabirds like the black petrel are at greatest risk from commercial fishing. Recruitment of young birds seems to be the main issue. Most of the older birds are coming back but the chicks that have been banded are not returning in the numbers we would expect. They migrate to the seas off the coast of South America where they spend 2-3 years before returning. Even those that do return have to find a burrow and a mate before they start breeding. Of the ~5000 birds we have banded since we started back in 1995, less than 400 have been recaptured at the colony, which corresponds to a return rate of less than 10% which is very worrying. Perhaps we need to capture more birds to increase the confidence levels of our numbers, but it is not looking good.

Biz Bell & Emma Cronin banding tākoketai chicks at Hirakimatā (Credit: Murray Job, Aotearoa Fisheries)

Do you have any bilateral relationships with countries in South America?

New relationships are being built with groups in Peru and Ecuador. We recently hosted a Peruvian scientist who is monitoring the birds off their coast and training their local fisherman on how to protect the seabirds. We have produced a seabird guide for them that focuses on tākoketai. They also see tākoketai as a very special bird which is nice to know.

What about the NZ fishing industry?

We host fisherman on the mountain on a regular basis. We want them to fall in love with the birds by visiting the colony and seeing what we are doing and letting them handle the birds. It is hard not to become enamoured with the big fluffy chicks! New Zealand fishing companies are trying hard. They know that catching these protected birds is not good for their business. It did take around 10 years before they would meet with us to discuss the plight of the birds then another couple of years before we got them to visit the colony. Now we have several fishermen who are now strong advocates for the birds. It has been really amazing to see those 'light bulb' moments when they see the birds at the colony and realise that the birds are fisherman like them, heading out to sea to catch fish to bring back to their young. It is super important that we have a good relationship with the fisherman and for them to realise they can help scientists considerably from their observations at sea. They are naturally a bit suspicious of scientists and their motives so it is important to build a strong relationship with them as their observations on the behaviour of these majestic birds at sea will really complement what we are learning on the land where the birds tend to be rather clumsy. They are probably surprised to know they have become citizen scientists.

What does the future hold for Aotea?

I think Aotea is tracking in an incredible way. I have seen some big changes. There are so many diverse conservation projects underway on the island and a groundswell of support for the island to one day become predator free. However, we still need to see greater recognition at a national level of the conservation status of Aotea in New Zealand. The

Black petrel/tākoketai male and female getting to know one another at Hirakimatā (Credit: Biz Bell Wildlife Management International Ltd.)

island is home to some key endemic species and has a remarkably rich biodiversity. But we could also have so much more. There are still a lot of conversations to be held. We need to make sure the community is aware of the new technologies that are being developed around the momentum of Predator Free 2050. Aotea is a perfect location for trialling some of these new tools. Some of these conversations will be difficult so it is crucial there is openness and transparency associated with them. I am looking forward to the day when all the species on the island are flourishing and they are just New Zealand species. Once the island is predator free, we can reintroduce some of the species that have been lost from the island. From what I have seen from islands overseas that have become predator free there will be huge scope for ecotourism. It could be absolutely incredible.

Just have look at Hauturu. It is astonishing to be greeted by so many noisy & nosey birds and to see how they are flourishing on this island. Aotea could be the same. We could have hihi, kōkako, tīeke and many others absolutely flourishing on the island. But we also need greater protection of the marine environment around Hauturu and Aotea and recognition of the strong ecological connection between the sea and the land, rather than the current disconnect.

Will Rakiura become predator free before Aotea?

I would like to see both become predator free. Because the community is more confined on Rakiura than on Aotea it might have the edge, but it is also a much bigger island. What is most important is keeping the momentum going on both islands. As I said above each island is different and has its own challenges.

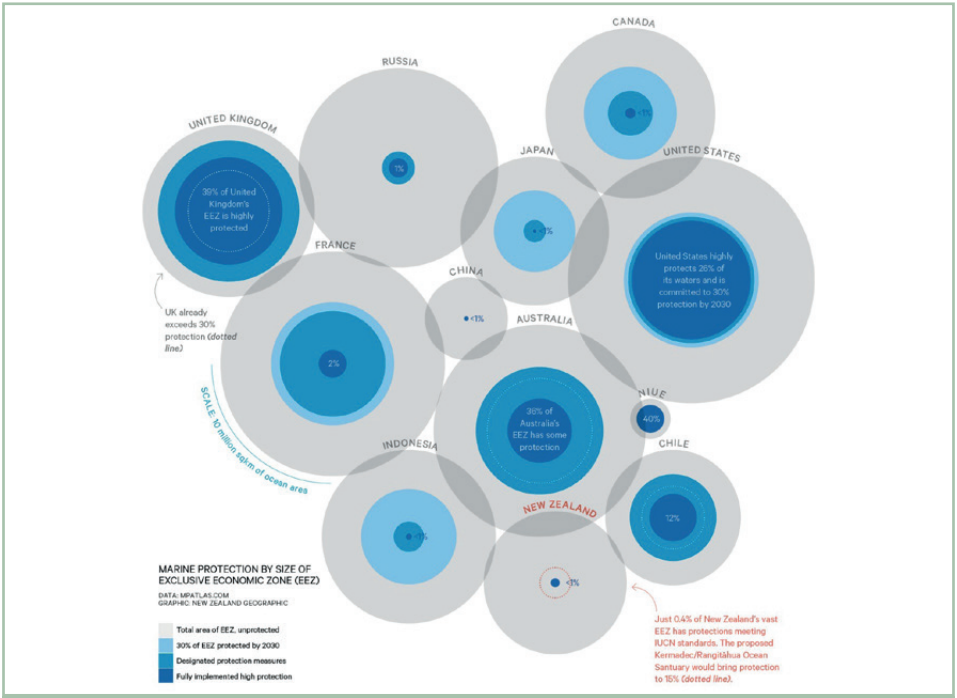
Any other thoughts you would like to share with us?

It is important we all spread the message about the importance of protecting and restoring our natural ecosystems throughout New Zealand. Those of us involved in this process must spread the message by engaging with the communities around us. One thing we have done with the black petrel project is to host tamariki at the colony each year. It is now so satisfying to see those young children 10-20 years later involved in all sorts of amazing jobs but knowing that the tākoketai occupy a special place for them. They are the pulse of the community, the future problem solvers. They are the ones that will get us over the line. It is so cool that there are jobs in this space for these young people. We need to harness that youth power. We all must protect our own backyard and have the responsibility to leave it better than we found it.

The Obligation to Protect and Preserve

BRONWEN GOLDER (Fellow with the Stanford University Centre for Ocean Solutions and Global Lead for the Seamount and Vulnerable Marine Areas campaign of the Deep Sea Conservation Coalition

In 1982 the United Nations Convention on the Law of the Sea (UNCLOS) gave New Zealand the right to extract and exploit marine resources out to 200 nautical miles from our coast line. UNCLOS also obligated New Zealand to preserve and protect that territory - an area 15 times the size of New Zealand's land area and 8% of the planet surface. Forty years later, in December 2022, the New Zealand Government signed up to another ambitious and far reaching United Nations agreement; the Global Biodiversity Framework 2030. It commits New Zealand to protecting 30% of the marine and coastal environment by 2030. Yet, despite those commitments, and in a context of a growing list of global action on marine protection, the extent of New Zealand's ocean territory in fully or highly protected marine areas sits today at 0.4%. The disconnect between commitment and action evidenced by that percentage has defined New Zealand ocean policy and politics for decades, a period of our history strewn with failed marine legislation and marine protection proposals. That our Marine Reserves Act, the only dedicated marine protection piece of legislation on New Zealand Parliamentary books, is now over 50 years old reinforces just how far behind the rest of the world we have fallen. Why that is, and how it might be turned around is complex. It is also urgent and requires that New Zealand honour the commitment it made to the United Nations in 1982: To meet the obligation to preserve and protect the ocean territory over which it has been made guardian, for all global citizens.



Only 0.4% of New Zealand's marine territory is fully or highly protected despite having committed to protecting 30% through the UN Global Biodiversity Framework (Credit: New Zealand Geographic.)

In December 2022 the 196 nations that are Parties to the United Nations Convention on Biological Diversity (CBD) came together in Montreal to negotiate 23 targets of the Kunming-Montreal Global Biodiversity Framework 2030 (GBF). Target 3 of the Framework reads:

> ***"Ensure and enable that by 2030 at least 30 per cent of terrestrial, inland water, and coastal and marine areas of particular importance for biodiversity and ecosystem functions are effectively conserved and managed through ecologically representative, well connected and equitably governed systems of protected areas and other effective area-based conservation measures, recognising indigenous and traditional territories, where applicable, and integrated into wider landscapes, seascapes, and ocean, while ensuring that any sustainable use, where appropriate in such areas, is fully consistent with conservation outcomes, recognising and respecting the rights of indigenous peoples and local communities, including over their traditional territories".[1]***

The significant ambition of the 2030 GBF did not emerge from nowhere. It is the successor to the CBD Aichi 2020 targets, which had a 10% by 2020 protection target for marine and coastal areas, and a partner to the UN Sustainable Development Goal #14 (Life Below the Water)[2], which includes protection of the marine and coastal environment.

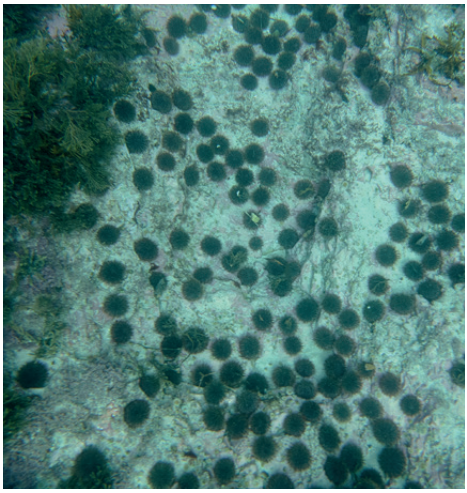
For those who have participated in the evolution of ocean conservation goals and targets since the UN Convention on the Law of the Sea (UNCLOS) set out the obligation of UN members to 'protect and preserve' the marine environment, the GBF 2030 targets represent a level of ambition that is necessary and urgent. While previous targets – like Aichi – were not met (the current level of fully or highly protected areas across the global ocean is 2.9%, while a more relaxed counting of 'protection' has the marine ecosystem at 8.2% protection[3], all available data indicates that 30% is probably the minimum level of protection needed to keep the global ocean healthy and productive for future generations. The growing understanding of the impact of climate change, fishing and pollution on the marine environment, and the implications of those impacts on the lifestyles and livelihoods of millions of people around the world, makes the protection of 30% of the marine environment a well understood collective responsibility and obligation.

For those who have doubts, the UN Sustainable Development Goals Report of 2022 provides some stark points of reference:

- Continuing ocean acidification and rising ocean temperatures are threatening marine ecosystems. Between 2009 and 2018 the world lost 14% of its coral reefs.
- In 2021 17 million metric tons of plastic entered the world's ocean, a volume that is expected to double, or even triple by 2040.
- 35.4% of global fish stocks are over fished.

On signing UNCLOS in 1982 Aotearoa New Zealand became guardians of an additional 4.3 million sq km of ocean territory, the 4th largest ocean territory in the world. This was the result of our national boundary being extended out from 12nm to 200nm, from the Kermadec Islands in the north to the sub-antarctic islands to the south. Marine scientists estimate that as much as 80% of New Zealand's indigenous biodiversity is found within the marine region over which we now have 'sovereign rights'. Those rights – to explore, exploit, conserve and manage the natural resources of the seabed, subsoil and waters above it – are a considerable windfall for a small nation. Alongside the exclusive right to explore and extract, UNCLOS also assigned New Zealand (and other signatories) the obligation to protect and preserve our new marine environment for all States (Article 192). Since signing UNCLOS, consecutive New Zealand governments have put a lot of energy into realising the rights and benefits of exclusive exploitation (e.g. the Quota Management System, the Fisheries Settlement, EEZ [Exclusive Economic Zone] Act, mineral exploration etc.). Disappointingly, the obligation to preserve and protect has been set aside for another day by a succession of governments.

To date, New Zealand has only put 0.4% of its marine territory into fully or highly protected areas. Our single piece of dedicated marine protection legislation (Marine Reserves Act) was passed in 1971. Because it pre-dates UNCLOS it only applies to our territorial sea (out to 12nm). Since 2000, multiple attempts to introduce new marine protection legislation (e.g. Hon Sandra Lee's Marine Reserves Bill in 2002 and Hon Nick Smith's MPA consultation in 2015) and numerous proposals for marine protected areas (e.g. Kermadec Rangitāhua Sanctuary, SE Marine Network, Hauraki Gulf Seachange) have been rejected or stalled for



Kina barren near Cape Brett (an example of our failure to manage fisheries & protect the ecosystem) compared to a healthy kelp forest (Credit: Project Kahurangi image archive)

+10 years by Parliament and various combinations of opposition (political, iwi, industry and recreational fishing community). Despite a growing body of scientific research and data[4,5,6] and a growing portfolio of international commitment to marine protection[7], New Zealand has hardly moved. For over 40 years. Worse than that, any ambition to catch up with the rest of the world is not evident in the international engagement, domestic policy commitments, or of successive New Zealand governments.

That absence of commitment to ocean action is also evident in New Zealand's climate change discourse. Focused on emissions and agriculture, New Zealand's climate positioning continues to exclude substantive ocean reference points or programmes of action.

I attended the first COP to the UN Framework Convention on Climate Change in Berlin in 1995. At that time, rather like in New Zealand today, the ocean was not being discussed. By COP 25 in Madrid, Spain in 2019 the ocean was a significant area of focus for participating nations, scientists, and NGOs. As a result, an ongoing ocean dialogue was mandated. In Glasgow (COP 26) the ocean/climate dialogue report from Madrid was received and an annual dialogue "to consider how to strengthen ocean-based action on climate change" agreed. A year later at Sharm El Sheikh (COP27) nations agreed to have a dedicated Ocean Dialogue, co-facilitated by Parties biennially.

Why is this important for New Zealand? We need look no further than an article published in the Guardian on May 13, 2023, setting out the impact marine heat-waves are already having on our marine territory[8]. Beyond the concern of our scientists for the health & productivity of habitats and species highlighted in the article, you have to wonder why the broader degradation of the ocean by climate change isn't driving a national conversation about ocean protection and resilience.

If you Google 'why is the ocean important' a very long list of links to UN and NGO websites and documents will tell you the same thing. The ocean covers 70% of the planet surface. It feeds us. It regulates the climate. And it generates the majority of oxygen that we breathe. If its ability to perform those functions is diminished - as a result of ocean acidification, sea level rise, species extinction, and habitat degradation - then the lifestyles and livelihoods of global citizens who depend on the marine environment for food, income or health – will be impacted. Not slightly, or peripherally. But significantly.

The frequency and intensity of storms and the diminished health of biodiversity are already being seen across the Hauraki Gulf. In other geographies where those climate driven impacts are being seen and felt, the response has been to embrace known mitigation tools. Fully and highly marine

Pete Burling and Blair Tuke, founders of Live Ocean and advocates for the Hauraki Gulf, with the UN Special Envoy for the Ocean, Peter Thomson at the UN Ocean Conference in Lisbon. They hold 'Nature's Baton', which has messages of hope and ambition from leaders, scientists, and advocates … and the 'Ring of Life' - signed by sports men and women around the world who support the Live Ocean commitment to a healthy and productive ocean. It is an example of international outreach and connection that New Zealand can be proud of (Credit: New Zealand Geographic.)

protected areas (of at least 100 sq km), and large scale restoration programmes, are recognised for their ability to build climate resilience through the elimination of non-climate stressors, protection of blue carbon habitats and provision of sanctuary for species and habitats in damaging climate conditions[9]. And yet across the Hauraki Gulf, and the broader New Zealand marine territory, movement on marine protection and restoration remain stranded in 1971. Ironically, the New Zealand fishing community's opposition to marine protected areas continues to ignore the importance and urgency of building resilience to their livelihood and lifestyle pursuits.

New Zealand's failure to progress marine protection and explicit ocean-climate policy is a frustration for many ocean advocates, not least because the narrative of domestic opposition is out of date. As an advocate for marine protection in New Zealand I am used to hearing that marine protected areas (MPAs) will "lock up" resources and "deny the rights" of iwi and fishers. That line of opposition is based on the 1971 Marine Reserves Act, a piece of legislation conceived at a time when marine protection meant excluding all parties and interests from the marine environment. In using that 50+ year old reference point, those opposing MPAs fail to acknowledge the more recent (2018) MPA criteria and standards produced by the International Union for Conservation of Nature (IUCN). Those standards, which scientists, governments and policy makers from around the world contributed to, recognise within the hierarchy of marine protection the rights and interests of indigenous peoples (just as the 2022 CBD Global Biodiversity Framework does). Customary take is possible within highly protected marine areas, and recreational activity is possible (within limits) in lesser protected areas. What isn't considered protection across all MPAs categories is commercial fishing, or the protection of a single species or a single habitat – like the proposed trawl corridors in the Hauraki Gulf. They are all considered inconsistent with the conservation objectives of an MPA. This modern view of marine protection is sadly absent from New Zealand policy and legislation, not least because there is still no protection of our marine territory beyond 12 nautical miles (and no, I cannot be convinced that Benthic Protection Areas or trawl corridors are MPAs).

New Zealand also has no process by which rāhui, a customary designation being used by iwi across the Hauraki Gulf, can be recognised as marine

protection. Currently rāhui sits squarely in the fisheries management section of New Zealand policy and regulation, is administered by the Minister of Fisheries, and defined by fisheries criteria. To be recognised as a marine protection tool the values, principles and governance of rāhui need to be transferred across to, and elevated within, a framework for marine conservation that aligns customary approaches to ocean guardianship with modern protection standards – just as Canada, Chile and Pacific States are within their ocean policy.

There are many in the international community who ask how it is that New Zealand is so far behind the global commitment to increase marine protection and restoration. We are known internationally as an open, liberal democracy, committed to recognising indigenous rights and interests alongside a 'clean green' brand. Our politicians and diplomats have spoken eloquently about the importance of our marine territory for generations, and our leadership in United Nations negotiations – from Law of the Sea to Fish Stocks and the recent High Seas Treaty – is recognised and respected. But when it comes to marine protection and the climate/ocean dialogue we are seen as languishing, unmoved from the pre UNCLOS world for more than a generation.

I have frequently asked myself that question over recent years. The stalling of the Kermadec Rangitāhua Ocean Sanctuary, the SE Marine Network and Sea Change/Revitalising our Gulf – has left me concerned for the future of our marine environment. It is no exaggeration to say that the future of New Zealand's fishing industry, and New Zealanders' recreational enjoyment of the marine environment will depend on the protection of at least 30% of our ocean territory by 2030. Without that protection habitats and species will be lost, and with them livelihoods and lifestyles, and guardianship over a diminished and dying ocean will be the legacy we leave our grandchildren.

Beyond New Zealand's shores, the UN's agencies, governments, and civil society are moving to honour their UNCLOS obligation to protect and preserve the ocean. Over the past 12 months significant new global ocean commitments have been agreed. The need for urgency has been recognised. The call for action has been heard. Except in New Zealand, where bottom trawling is still allowed on seamounts and other vulnerable marine areas; where commercial and recreational fishers continue to argue that we can leave the future health and productivity of our ocean environment in their hands; and where consecutive governments have failed to progress any meaningful ocean protection & restoration agenda for fifty years.

The international ocean agenda is showing us that there are alternatives to inaction. Across the Pacific region Australia, Chile, Canada, the United States, Ecuador, Niue, Fiji, and Palau are showing the way with large scale marine protection, restoration, and ocean/climate leadership.

It is time for New Zealand to join them.

Having been made guardians of the 4th largest marine territory in the world, it is time to honour our obligation to the United Nations community: To Protect and Preserve.

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Hihi's last stand on Hauturu saved them from extinction, but could they soon be returned here?

KATE WATERHOUSE

Hihi translates as ray of sunlight, reflecting the distinctive yellow bands on the wings of male birds like the one shown here. It was photographed on Hauturu Little Barrier Island, the last refuge for this once widespread forest bird[1]. Called stitchbird by early Europeans, named for its tzit tzit call, it is another of the lost species of Aotea.

It is said that Hihi refused to fetch water for Maui after he had tamed the sun, so Maui threw Hihi aside and he landed in the fire, burning his feathers. The black and yellow is a permanent reminder of the lesson learned. Today Hihi still carries the sunlight through the forest[1].

Early in the settlement of Tāmaki Makaurau, hihi could be found in Grafton Gully. In the 1860s, the ornithologist Sir Walter Buller noted that:

> ***"This handsome species has only a limited range. It is comparatively common in the southern parts of the North Island and may be met with as far north as the wooded ranges between Waikato Heads and Raglan, beyond which it is extremely rare. It is never found in the country north of Auckland, with the exception of one locality, the Barrier Islands"***

A sudden disappearance from mainland forests

When Buller returned six years later in 1874, he was astounded at how rapidly hihi had disappeared from the mainland. The last confirmed sighting was in the Tararua Ranges in 1883. It is miraculous that hihi are not extinct, as the huia was by the early part of the twentieth century. A combination of forest clearance and the introduction of mammalian predators was probably responsible for this catastrophic decline. By the late 1800s only one population remained, on the sanctuary island of Hauturu-o-Toi, Little Barrier. Just as tīeke survived on just one island, Taranga/the Hen, so hihi made their last stand on Hauturu[2].

Hihi persisted there thanks to the diversity and quality of the island's mature forest. But remember that hihi lived there in the presence of kiore and feral cats, strongly implicating the arboreal ship rat as the destroyer of all other hihi populations[2]. One reason they were so vulnerable to predators on Aotea and the mainland is because they are cavity nesters – and they're said to stay on the nest no matter what comes at them. Another reasons is that they are "mature forest specialists" – that is, they need a diversity of forest to thrive; and forest burning and clearance by European settlers destroyed most of their habitat.

An important indicator species for restoration

On Hauturu, hihi are a constant presence in the lower canopy, feeding on small flowering trees and nesting in cavities of old trees which may no longer be present in browsed, logged or burnt forests. This is the only hihi population that is natural and self-sustaining, so Te Hauturu-o-Toi provides a window into what hihi might have been like long ago.

Hihi diets comprise a mix of fruit, nectar and insects/invertebrates—the proportions vary with availability and time of year. Their main food is nectar, but their diet spans more than twenty species of native flowers, thirty species of fruit and many species of introduced plants. Important nectar sources are haekaro, matata, pūriri, rata and toropapa, and they find these in abundance in the mid-canopy on Hauturu[3]. This is also why translocated birds need to be fed – most forests don't have what hihi need to survive the winter, and many have lost the old trees with cavities good for nesting.

Male and female hihi from Buller's Birds (Drawing Credit: John Keulemans)

Top: *Male hihi - translocated to Shakespeare Regional Park.* (Credit: Anna Arrol). Bottom: *Female hihi on Hauturu* (Credit: Dick Veitch)

Hihi are important indicators of the health of New Zealand's northern forests and are regarded as a benchmark for restoration site ecology due to their sensitivity to habitat quality. They thrive in complex habitats with high diversity of invertebrates, nectar producing plants and fruits – and there is very little of this type of forest left in New Zealand today.

Aotea's forests are infested with ship rats, but Rakitū is not. Thanks to the successful eradication project in 2019, the island is recovering. And the exciting thing for hihi lovers is that the original forest of Rakitū (the parts that cattle could never reach) is reported to be remarkably similar to Hauturu's forests, which is after all only 20 km away. About a third of Rakitū's 329-hectare area is still cloaked in such forest, an area larger than the whole of Tiritiri-Mātangi, and so are all but one of the other sites to which hihi have so far been translocated. It means it's likely that Rakitū could once more sustain a population of hihi, without nest boxes and supplementary feeding. It is also likely that the remnant forested parts of Aotea could do the same, once feral cats and rodents are removed.

Why is the return of hihi so significant?

Most critically, hihi are no longer as genetically diverse as they were, and having all their eggs in the Hauturu basket puts them at risk of extinction should that population ever succumb to disease. Without hihi pollination some native plants have already been reduced to lower densities, it is uncertain what other roles hihi play in forest ecosystems[4]. In 2022 research over 4 sites with translocated hihi showed plants produced similar quantities of fruit with or without hihi present[5]. However, plants where hihi were present produced significantly higher quality seeds, suggesting hihi bring a unique pollination benefit.

Managing translocated hihi populations is tricky and expensive, so the Hihi Conservation Charitable Trust works with the Hihi Recovery Group and DOC to monitor and manage them[6]. As well as ensuring birds on Hauturu are protected, DOC's Hihi Recovery Plan has a long-term goal of increasing the number of self-sustaining populations of hihi. The first birds were translocated to Karori Wildlife Sanctuary (now Zealandia) in the late 1980s, but hihi translocations to a number of island and mainland sites (see map) have not resulted in self-sustaining populations[4]. Tragically the most recent one to Shakespear Regional Park failed in November 2021 after 17 months, following a stoat incursion[7].

In 2021, seven reintroduced populations (including Shakespear) existed, totalling 600-800 birds, compared with ~ 2,000 birds on Hauturu. It is hard to say how many hihi are on Hauturu. A study of densities spanning 2005 to 20138 showed big variations over time, fluctuating between 4 per hectare and 0.8 per hectare. It is difficult to know whether these measure the true hihi population size or reflect other patterns of change we don't yet understand.

All of them have to be actively managed—with supplementary feeding and provision of nest boxes because of the lack of quality mature forest to support winter feeding and cavity nesting; as well as predator control, management of parasites, and population monitoring to avoid inbreeding and loss of genetic diversity. Aspergillus fumigatus, a fungus that grows in disturbed habitats such as those in regenerating bush is also believed to be a problem[2]. This is why the possibility of an unmanaged population being safely established on Rakitū (and one day on Aotea) is so exciting. But consider also the significance of the return of hihi, a bird which was lost to the Aotea group around 150 years ago, to tangata whenua, and to the whole community of Aotea.

A bird with character & its own species classification

The male hihi is distinct with a flash of yellow shoulders and white crests on the side of his head which flick up and down when he's excited, which he often is[9]. The bright yellow male plumage is thought to come from carotenoids – pigments from native fruits which hihi eat, and which also contribute to egg yolks and overall health. Females are a less conspicuous brown colour but also with bold white wing bars. There is a distinctive shape to the tail when a hihi perches, although they are almost never still. Their distinct zip or "stitch" like call and high-pitched chatter are unlike any other bird.

Hihi are one of Aotearoa's "deep endemics" – birds that are only found here. They were at first classified as honeyeaters, along with tūī and bellbirds[3,9]. Their closest relatives were thought to be the Callaeidae, the family of perching passerines that include the now extinct huia, tīeke/saddleback and kōkako – which they don't really resemble at all. But unlike them, hihi almost never come to the ground. Because of this and their other unique traits, they were recognised in 2007 as Notiomystis cincta, a new passerine family which contains only hihi[3,9].

Tower nesting and other hihi habits

Hihi are unusual in their nesting habits, along with their social lives. On Hauturu nests have been observed between 2m and 40m off the ground, in natural holes in the trunks of trees such as pūriri, pukatea and taraire[3]. Only one other honeyeater species in the world does this. Some researchers think that their cat-like whiskers may help them navigate the entrances. But here's another surprise – hihi build a tower inside the cavity – between 20 and 40 cm above the height of the entrance. Up there is a deep woven cup lined with tree fern scales, moss, lichen, spider webs and feathers, on top of a stick base of 50 to 200 twigs. This is all built by the female and can take her up to 10 days – and she may try out several cavities before completing her nest.

Important nectar sources for hihi are haekaro and toropapa (Credit (Left): UoA, Credit (Right): Kate Waterhouse)

The male is in charge of finding potential sites, convincing the female that it's a keeper by leading her to the entrances and dancing about, going in and out, sometimes even offering her nest building materials. Up to four clutches of 1-5 tiny white eggs (3 on average) can be laid in spring and summer. The female is really doing all the work at this point and may not start incubating the eggs until the clutch is nearly complete and the final egg is laid. She'll spend about two weeks sitting on the eggs, which is a long time – about 2.5 times longer than other NZ bird species of the same size which makes her very vulnerable to predation. At birth, chicks weigh just 1 to 2 grams, and the female begins a feeding routine, rushing to and from the nest to keep them fed and growing, with only occasional help from the male. All this can be too much for her, and she may die or abandon the nest. Males have reportedly taken over the care of clutches when this happens, but the chicks likely perish.

Sexually unique and socially gregarious hihi

As well as being colourful, curious and charismatic, hihi have unusual social and sex lives, which is amongst the many reasons they've become a model species in conservation biology worldwide.

Hihi enjoy a close social environment and overlap home ranges with their neighbours. A major benefit of this set up is that individuals learn by observing others – crucial for young learning to forage and develop survival skills from adults other than their parents[10]. DOC report that chicks from different nests get together after fledging and perform behaviours that could be interpreted as play; and adult males form groups with juveniles during the winter where hierarchies may be formed.

Within this complex social structure is also a "variable" mating system, which involves multiple interactions between neighbouring males and females. Variable mating systems are unusual in any bird species, with only six other passerines worldwide thought to be polygynandrous (i.e. multiple male partners and multiple female partners). Researcher Isabel Castro's work on hihi mating revealed a reproductive flexibility which means they can adjust the way they behave depending on the ratio of males to females, the availability of nesting and food resources and even the timing of breeding[2].

A breeding group may consist of a pair, or one male tending to several females in his territory, or

one female may have several males in attendance. Analysis of the genetic makeup of some clutches has shown that the male defending the nest may not necessarily be the father of all in that nest. One nest was found to have five eggs from four separate fathers, in a year where there was a near two-to-one ratio of males to females, so competition was very high. Females searching for food may also be aggressive to each other and when the population sex ratio is close to 50:50, a female may assist a male with territory defence. But once a female is nesting, the male may establish a second female in another nest in his territory later in the season. To cope with all this, male hihi testes produce a large amount of sperm and swell during breeding season to four times larger than expected by body size and to about 4% of their body mass, and bigger than the male's brain.

Finally, hihi are the only bird known to copulate face to face[3]. But not usually—most copulate with the male on the female's back, and males compete with each other to do so. But sometimes, a typically unpaired male will harass and then force the female onto her back on the ground to copulate. On Tiritiri Mātangi, 34 (32%) of observed copulations were face-to-face, with only five being with the male partner of the female. While forced copulation is not unique to hihi, they are the only known bird species in the world where face-to-face mating occurs.

What does the future hold for hihi?

On Hauturu hihi still thrive unmolested by predators and in a forest which is still in balance. They occupy a niche that has all but disappeared from other forests. On Tiritiri-Matangi, hihi will not come down to a feeding station until the raucous tūī and bellbirds have had enough, and their breeding and food sources are closely managed by staff. Under intensive management like this hihi have been increasing in numbers at new sites, but they are still at risk of extinction. Introduced predators, disease, low genetic diversity and environmental disturbances like Cyclone Gabrielle continue to pose a risk to their stronghold.

Ever present is the risk of a genetic bottleneck unless hihi populations increase. All hihi are descended from the group of birds that escaped extinction on Hauturu, which creates genetic risk, weakening hihi resistance to disease and other threats. Work by researchers at the University of Auckland showed that the risk of a bottleneck is real. They found three signs of low adaptive potential: a lack of diversity at the genomic level, low heritability in a range of adaptive traits, and lack of genetic variance in relative fitness[11,12]. This is the first time such extensive analysis has been done on a threatened species.

They concluded that the only way for hihi to regain adaptive potential was for them to be supported to grow large populations which will then allow this process to occur naturally[13]. Re-establishing a self-sustaining population of hihi on Rakitū will be an important step on that long journey.

Kate Waterhouse is Chair of AGBET, member of Tū Mai Taonga Steering Committee & Deputy Chair of the Auckland Conservation Board.

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Searching for Libertia (Mikoikoi/New Zealand iris) on Aotea

SOPHIE NEWMARCH (PhD student, Massey University)

When not in flower, species of Libertia, the only iris genus native to New Zealand[1,2], are hard to spot. In the forest, their green to yellow, flax-like foliage is easily missed amongst the abundant kauri grass (Astelia trinervia) or the seedlings of harakeke/NZ flax (Phormium tenax), tī kōuka/cabbage tree (Cordyline australis) and nikau palm (Rhopalostylis rapsida). The key vegetative features distinguishing Libertia from plants with similar morphology are the fan-like arrangement of the leaves that are flat and smooth. The lack of a leaf crease is due to an interesting feature of irises where the upper surfaces are merged, like a closed book, so that all you see is the underside ('abaxial' surface) of their leaves[3]. So, the other monocots listed above differ from Libertia as they have leaves which have creases or appear like open books. If you're in luck, you might spot another clear give-away feature in late summer and autumn; the brown to yellow, balloon-shaped fruits of the larger Libertia species[2].

In late summer, well after the white blooms of Libertia would be expected to have finished, three scientists took up the challenge of finding the native irises on Aotea. They included myself, a Plant Biology PhD student at Massey University; Dr. Richard Winkworth, my PhD supervisor; and Emeritus Professor and local Aotea conservationist, Barry Scott. Our purpose was to sample small amounts of leaf tissue for my PhD project that is focused on better understanding the diversity and evolutionary history of Libertia. I would like to find out, for instance, where New Zealand's irises came from - other Libertia species occur in Australia, New Guinea, and South America[1, 2] - and what the distribution is of their genetic diversity in New Zealand so we can better target conservation actions.

Sophie and Richard discovering L. grandiflora (mikoikoi) near the stairs by Station Rock lookout (Credit: Barry Scott)

The team from left to right, Richard, Sophie, and Barry at the summit of Hirakimatā (Credit: Barry Scott)

Sampling from Aotea was important as the island is a diversity hotspot, hosting 3 out of 8 of the Libertia species native to New Zealand: both species known as mikoikoi (L. grandiflora and L. ixioides) as well as the small, subalpine species, L. micrantha[2]. The Aotea populations are also interesting because they are isolated from mainland populations. All three species also occur across the North Island, with the distribution of L. micrantha extending to the South Island and L. ixioides to both the South and Stewart Islands[2].

On our first day, Barry guided us up the South Fork Track and down the Kaiaraara Track. We located L. micrantha between Mt Heale hut and the summit of Hirakimatā, as well as when descending the steep stairs of the Kaiaraara Track. On the following day we

L. micrantha found between Mt Heale hut and the summit of Hirakimatā, flowering despite the late season (Credit: Sophie Newmarch)

(Left) The large capsules of L. ixioides on the Cooper's Castle Track (Right) The inflorescence of L. grandiflora that is taller than its leaves (and is the species namesake feature). (Credit: Sophie Newmarch)

The size range of L. micrantha across the ridgelines. Locations were, from left to right, Windy Canyon, Cooper's Castle lookout, and Palmer's Track near the summit of Hirakimatā. (Credit: Sophie Newmarch)

summited a second time, this time climbing Cooper's Castle and the Kaiaraara Track then down Palmer's Track and through to Windy Canyon. We found both L. grandiflora and L. ixioides along the Cooper's Castle Track and L. micrantha in three areas; just before the Cooper's Castle lookout, alongside the stairs descending from the summit along Palmer's Track, and in Windy Canyon. Interestingly, L. micrantha differed in size between these sites, the Palmer's Track plants being relatively large, (~20cm), those on the Cooper's Castle and Kaiaraara Tracks midrange (~10cm), and those in Windy Canyon dwarfed (~3cm). These differences may reflect environmental factors such as soil depth or light levels, although genetics may also play a role if isolation occurred along the ridgeline. On the third day, we trekked up to Station Rock from Medlands Road, finding L. grandiflora amongst the much drier bush near the lookout and descending towards Rosalie Bay Road.

Despite not having flowers to easily spot Libertia, the fieldwork trip was very successful. All three species were collected; two from multiple locations including ones that had not previously been reported and so were a pleasant surprise to find (e.g., L. grandiflora and L. micrantha on the Cooper's Castle Track). Our fieldwork took us to several exceptional spots on Aotea, making the trip an unforgettable experience. I cannot thank Barry enough for hosting Richard and myself as well as providing invaluable logistical guidance and knowledge about conservation on Aotea. I hope to provide an update with the results of my study in the not-too-distant future. Mainland samples from the Rodney district and Coromandel have also been collected, so it will be interesting to see if my results suggest dispersal over water and/or movements across a land bridge between the Coromandel and Aotea. Stay tuned!

Acknowledgements

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Burrowing into the past

ANDRÉ BELLVÉ (University of Auckland)

For many people, the word 'seabird' probably conjures the image of a gull cawing for your chips, a shag snatching the under-sized snapper you just threw back, a little blue penguin bobbing in the distance, or maybe a picture/documentary you once saw that featured an albatross. Or at least, that was largely my experience before I began studying seabirds, a realisation I found profoundly dissonant when I learned that Aotearoa is often called the "seabird capital of the world".

Here, I refer to seabirds as "those species that spend some part of their lifecycle at sea, feeding in inshore or offshore water"[1]. There are roughly 370 species of seabird globally, split across four taxonomic Orders; Charadriiformes (e.g., gulls, terns, auks), Suliformes (e.g., gannets, shags, frigatebirds), Sphenisciformes (i.e., penguins), and Procellariiformes (e.g., storm petrels, petrels, shearwaters and albatross). Of these 370 species, 88 breed in Aotearoa (nearly 25% of the total!), and 37 (10%) are endemic breeders (Forest & Bird 2015, Whitehead et al. 2019). In particular, Tikapa Moana o Hauraki (the Hauraki Gulf) is home to at least 28 of Aotearoa's seabirds, at least five of which have been found nowhere else (including Aotea's black petrel - Procellaria parkinsoni), and has led to the Tikapa Moana being recognised as an international "Important Bird Area"[2,3].

So how is it that we have such incredible diversity, but they often exist on the fringes of Aotearoa? Many of these species live most of their life out at sea, only returning to land to breed[4]. While there are obvious exceptions (e.g., Australasian gannets and numerous shag species around Aotearoa), many of these birds are ephemeral residents with cryptic habits. For instance, all of the smaller (< 1.6 kg) procellariiforms (nearly half of Aotearoa's seabird species) typically nest in underground burrows among tree roots and boulders or rock crevices (hereafter 'burrowing procellariiforms'), often favour steeply sloped sites, and typically return after dusk, only to leave in the early hours of the morning[5,6]. Furthermore, many such seabird only reside on our off-shore islands and predator-free sanctuaries, which are carefully managed by mana whenua, DoC and conservation groups[2]. In fact, the best chance to see many of these birds is out on the waters of Tikapa Moana, where they drift as large 'rafts' floating on the surface or the chaotic swirling storm clouds they form to feed on 'boil-up'; a phenomenon where plankton are pushed to the surface by fish and cetaceans feeding from below.

A rako (Ardenna bulleri) breeding pair taken on the Tawhiti Rahi, Poor Knights Islands (Credit: André Bellvé)

Rako (A. bulleri) burrows on Tawhiti Rahi (Poor Knights Island). An endemic species to Aotearoa and only found in the Poor Knights Island group. Recent work suggests there are c. 70,000 breeding pairs[7] (Credit: André Bellvé)

Seabirds' cross-ecosystem lifestyle is the basis of a key ecological function in Aotearoa's terrestrial and near-shore ecosystems. Many of Aotearoa's forests are impoverished of bioavailable phosphorus[8], but the diet of seabirds is rich in this element and many other essential nutrients, which is why seabird guano (fossilised faeces) has long been used as an organic fertiliser[9]. By feeding at sea and then returning to land to breed and raise their chicks, seabirds flux nutrients from the ocean to the land, and hence can fundamentally alter the composition and productivity of their environment. For instance, Bosman and Hockey (1988)[10] showed that seabirds fertilise the intertidal zone, which promotes foliose algae growth, in turn providing habitat for a range of marine invertebrates, which are subsequently prey for many shorebird species. Similarly, McCauley et al. (2012)[11] found that the presence of seabirds on islands not only fertilised the forests they roosted in but that discarded nitrogen-rich foliage from the forest gets blown into coastal waters and together with nutrient run-off from the forest, promotes phytoplankton growth. In turn, the increase in phytoplankton leads to a greater abundance of zooplankton, which attracts manta rays. These rays are typically absent from the relatively nutrient depauperate waters of islands that have lost their seabirds. Numerous studies have explored the effects of seabirds on Aotearoa's forests and demonstrated their multi-faceted influence on ecological communities[12,13]. Given that Aotearoa is home to an incredible diversity and abundance (estimated to be in the hundreds of millions of birds currently!), seabirds play a critical role in our terrestrial and near-shore ecosystems.

Seabirds are the most threatened group of birds on earth[14], and up to 90% of northern Aotearoa's seabirds are threatened with extinction[1]. The loss of seabird species will be accompanied by the loss of the critical ecological functions they supply. The threats in the marine environment primarily stem from pollution, by-catch, and climate change[15]. In Aotearoa, the most significant terrestrial threats arise from predation by introduced mammals (e.g., dogs, cats, rats, mice, stoats, pigs, etc..) and habitat destruction[16], although these are not new. Early accounts by European naturalists describe breeding colonies of burrowing procellariiforms as far inland as the slopes of Mount Ruapehu near the centre of the North Island and throughout the Southern Alps of the South Island. Unfortunately, nearly all of these inland colonies were lost by the start of the 21st century. The writings of some early European naturalists describe the devastating effects of introduced mammals. Reischek (1885)[17] noted:

> ***"[black petrel] were very numerous on the Little Barrier Island [~1880] [which] had become very scarce [~1885], but I found the remains of many which pigs and dogs had destroyed".***

A decline which the author ironically contributed to when he was 'examining' black petrel burrows:

> ***"I examined the burrow […] and on putting my hand in it was severely bitten […]. So, I […] tried to take the egg from under it [… and] I was again severely bitten. My dog went to the bird and attacked him furiously."***

Clearly, mammals had a rapid and devastating effect on many of our seabirds. However, at present we lack an adequate baseline (what was the former distribution of seabirds? How much material did they move from the ocean to the land?) From which to assess the ecological consequences of these changes.

As species decline or disappear, we will lose their ecological functions. Predicting how these 'functional extinctions' (or losses) will affect ecosystems is challenging. However, information from the past may allow us to understand the impacts of previous environmental change (whether by humans or not), which can inform our understanding of what continued losses may mean, and guide restoration interventions. The primary motivation for my doctoral research was to create a methodological framework with which to reconstruct these lost ecological functions, using the ocean-land nutrient fluxes supplied by the burrowing procellariiforms of Aotearoa as a case study. In this article, I will focus on how we determined where burrowing procellariiforms were before the arrival of European mammals.

To determine the former range of our burrowing procellariiforms, I gathered three key lines of evidence on the location of their breeding grounds: fossil data, historical records, and contemporary observations.

First, I compiled fossil data from the Holocene (c. the last 10,000 years), giving us insights into where these species bred in the past, possibly before human arrival. However, fossil records hold intrinsic biases due to the conditions required for a fossil to preserve, meaning fossils cannot inform us about some environments. Moreover, there is also some temporal uncertainty with these records as they have only been dated to the last 10,000 years, so we do not know precisely when these individuals lived.

To complement the fossil records, I scoured historic

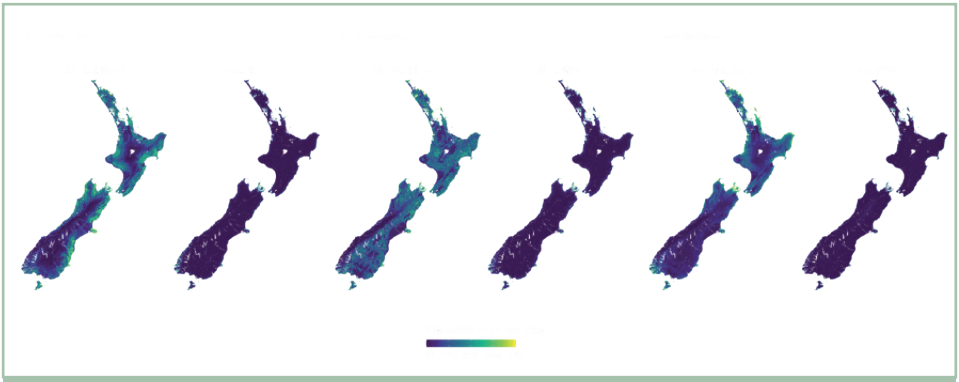
Predicted distribution of breeding colonies for the three size groups of burrowing procellariiforms in the past (historic & fossil records) and present (post-1990). Values can be interpreted as the probability of occurrence, with warmer colours indicating a higher probability (Credit: André Bellvé)

documents and records to identify other sites these birds occupied. The historic records were a combination of old newspapers, using Papers Plus (a national repository of digitised news articles), historical accounts by early naturalists[17,18,19], and early scientific publications that provided breeding colony locations[20, 21]. These historic records covered known breeding locations before 1990, which we used as a cut-off for the "historic" period due to the advent of modern mammalian predator control methods around this time. Historic records can tell us about colony locations that do not occur in sites that favour fossilisation, but they carry their own biases, as authors tend to focus on 'remarkable' locations (e.g., the slopes of Mount Ruapehu) and may already be impacted by anthropogenic influences. Together, historic and fossil records can broaden our understanding of a species' ecological niche and provide insights into where they likely occurred in the past.

Finally, to determine the contemporary (1990 – present) breeding ground distributions, we worked off more recent publications[2,22,23], for sites which have already suffered marked contractions due to human actions. These records of breeding colonies were broken up into three size-classes based on the mass of adult birds. We then linked known occurrences with environmental conditions to predict where each size-class may have occurred in the past and the present.

Aotearoa's seabirds once had breeding colonies much further inland than they do today. In particular, the records of breeding colonies in the Southern Alps and on the ranges around the volcanic plateau of the North Island are highlighted by my model. Furthermore the model predictions suggest that there were many other inland locations with similar conditions that would have been favourable to burrowing procellariiforms.

So while Aotearoa is currently the "seabird capital of the world", it is likely a fraction of its former glory, as it has been hollowed out. Islands in the Tikapa Moana o Hauraki, such as Aotea, would likely have been home to hundreds of thousands, if not millions, of burrowing procellariiformes before the large-scale



Predicted distribution of breeding colonies for the three size groups of burrowing procellariiforms in the past (historic & fossil records) and present (post-1990). Values can be interpreted as the probability of occurrence, with warmer colours indicating a higher probability (Credit: André Bellvé)

clearance of forests with fire and the introduction of predators like cats, rats, and pigs. However, there is still hope. Aotea and Te Hauturu-o-Toi are the last refuges for black petrels, through careful control of introduced predators, the populations appear to have stabilised. However, we cannot be complacent, the climate is changing, and we have seen an increased frequency and intensity of extreme weather events. The last few years have seen two extraordinary marine heat-waves, which can have catastrophic effects on the availability of seabirds' prey and their ability to feed their chicks. Only by being kaitiaki of the oceans and the land will we be able to hand these treasures down to the next generation, and hopefully, they will no longer be cryptic denizens existing on the fringes of Aotearoa's consciousness.

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A vision for the recovery of the kelp forests of the Hauraki Gulf

KELSEY MILLER AND NICK SHEARS (University of Auckland)

The spectacular natural beauty of Te Hauturu-o-Toi/Little Barrier Island is due in part to its stringent terrestrial protections. It became New Zealand's first nature reserve in 1894 and its pest-free status has led to a healthy abundance of many rare plants and animals today[1]. Setting foot on this island is an incredible privilege and requires a permit, but I have been fortunate enough to work in its shallow coastal waters where you can hear its robust chorus of birdsong.

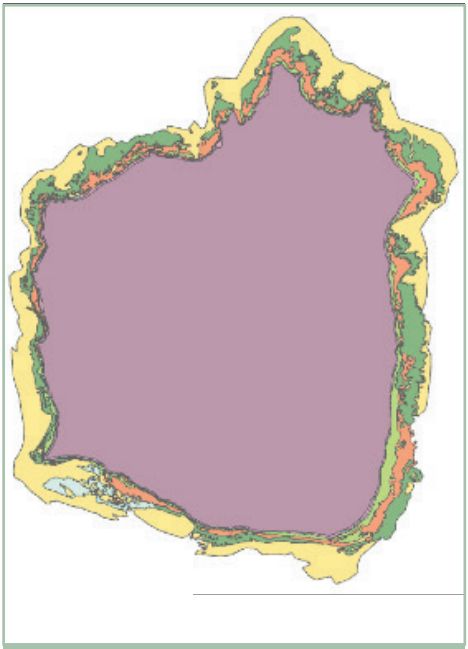
While the terrestrial landscape of the island is a beacon of conservation, the waters surrounding the island tell a very different story. Underwater, the kelp forests that once flourished have receded or are absent, a sign that the marine system is out of balance.

Kelps and fucoids (other large brown seaweeds) frame roughly one fourth of the world's coastlines, and are among the most productive of all ecosystems[2]. They provide habitat, food, and nursery grounds for many fishes, marine mammals, and invertebrates and provide immeasurable ecosystem services[3,4].

A leading (but not the only) cause of kelp decline is overgrazing by sea urchins[5]. When sea urchin populations increase unchecked, they literally eat through forests of kelp, leaving behind urchin barrens (called "kina barrens" in New Zealand). With an absence of kelp and other seaweeds, these areas resemble underwater deserts, with low productivity and a lack of food and habitat for species like crayfish, paua, and kina themselves.

In most parts of the world, the explosion in sea urchin densities is linked to overfishing of their predators, although other factors also play a role in determining the extent and distribution of barrens. In New Zealand, crayfish/kōura (Jasus edwardsii) and large snapper/tāmure (Chrysophrys auratus) are the primary predators of kina Evechinus chloroticus[6]. When these predator densities (and individual sizes) become too low, kina densities increase, and kelp disappears in a process known as a trophic cascade. In the Hauraki Gulf, high kina densities and expanses of kina barrens have been attributed to the overfishing of predators for almost 60 years[7]. The poor state of crayfish populations in the Hauraki Gulf has been widely demonstrated8 and they are considered to be ecologically extinct, meaning they no longer play an important role in the ecosystem.

In 2021, MSc student Lisa Dartnell mapped the shallow rocky reefs (less than 20 m deep) around Hauturu-o-Toi and found large expanses of kina barren, with an estimated 2.95 square kilometres of barrens[9]. Estimating an average of 4 kina/m^2 in barrens, this equates to a rough estimate of ~12 million kina in barrens around Hauturu-o-Toi. The earliest published accounts of the reefs at Hauturu-o-Toi demonstrate that the reefs surrounding the island were once lush forests of mixed species of kelp (Ecklonia radiata) and fucoids (primarily Carpophyllum spp. and Sargassum sinclairii). These early records describe a diversity of seaweed in beds interrupted only by patches of sand, and kelp extending from the surface to the depths of visibility – with no mention of kina[10,11]. Aerial imagery from 1953 also show a kelp-dominated reef with an almost complete absence of barrens (0.4%)[9]. Now, approximately a third of the underwater forests at Hauturu have been lost to kina barrens.



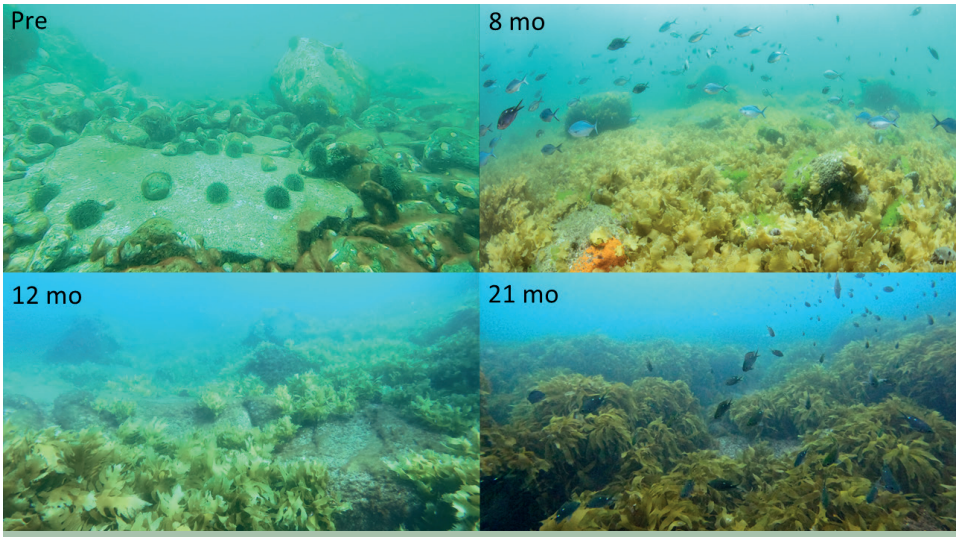
Mapping of Hauturu reef by Dartnall 2022[9]

Kelp recovery on Hauturu reef following removal of kina - Removing kina (Credit: Paul Caiger)

Through time, coinciding with intensive fishing, kina barrens have emerged in many regions across the country, and particularly in the north-eastern New Zealand and the Hauraki Gulf. Once established, these barrens can be hard to reverse. For example, while it takes a lot of kina to demolish a kelp forest, only a few can eat any new kelp and prevent kelp recovery. To return to a kelp forest state, kina densities must be below roughly 1 kina/square metre.[12]

Research from the nearby Cape Rodney-Okakari Point (Te Hāwere-a-Maki, Goat Island) and Tāwharanui marine reserves has shown that with protection of predators, kina barrens will return to kelp forests over time via trophic cascades[13, 14]. Snorkelling and diving in these protected kelp forests show us what these reefs can be like: high densities and diversity of fishes, kelps, and invertebrates. Furthermore, within these areas kina still occur in reasonable numbers, but take on a more natural and less destructive habit, living in crevices hidden from predators and feeding on pieces of kelp that drift by.

Here, as in many parts of the world, there is increasing interest in active kelp restoration. Globally, many projects have experimented with sea urchin removal, which normally results in kelp recovery, but is very nuanced[15]. My PhD research at the University of Auckland with Dr. Nick Shears is evaluating large-scale (1.6-2 ha) kina removal as a tool for kelp restoration - this includes a site at Hauturu-o-Toi. Working closely with Ngāti Manuhiri and other mana whenua, we obtained a special permit from MPI to undertake this research which aimed to understand whether kina removal from barrens promoted kelp recovery and how recovery varied across multiple locations in the Hauraki Gulf. Following kina removal from barrens, we have recorded a remarkable recovery of kelp at all sites in under two years. At Hauturu-o-Toi, kelp cover in the area that was previously kina barrens increased from 7.5% to ~41% over the two-year period. While it is wonderful to see the restoration



Kelp recovery on Hauturu reef following removal of kina - Reef pre-removal (Credit: Sara Kulins), *8 months* (Credit: Paul Caiger) *12 months* (Credit: Kelsey Miller) *and 21 months* (Credit: Kelsey Miller) *after kina removal.*

potential of these undersea forests, especially in such a short time frame, there are many important caveats and considerations in using kina removal for kelp restoration.

Active kina removal does not address the cause of kina over-abundance (e.g. overfishing of kina predators), this can only provide partial benefits[15]. Kina will come back to the removal areas until we have addressed the issue. In contrast to the flourishing life and lots of fish and crayfish in kelp forests in marine reserves, The vast scale of barrens makes manual removal impractical. It takes more than 50 hours/ha to cull kina in place, and twice that time to collect them all[16]. For Hauturu -o-Toi, this equates to roughly 15,000 hours for culling, or 30,000 hours for collecting. Harvest may be an option if the quality of kina in barrens is sufficient (which is typically much lower in barrens), but the fishery is restricted by quotas. While harvest may facilitate kelp recovery and be of value from a kina fishing perspective, it is still not addressing the cause of kina barrens and not restoring a healthy and resilient ecosystem.

While many of us who spend time in the water are eager to restore the beloved forests of the sea, we need to be clear on what we hope to accomplish. Knowing how extensive these kelp forests were at Te Hauturu-o-Toi and across the Hauraki Gulf in previous decades, we can see there is much potential for them to flourish again. Our results clearly show that the environmental conditions on reefs in the Gulf can still support productive kelp forests, if kina numbers can be kept under control. While directly removing kina can help to kick-start kelp recovery on small scales, protecting the large predators that once roamed the reefs is needed to provide a long-term approach to restoring the entire reef ecosystem and building resilience. Our work can help to inform protection, restoration, and rebuilding our coastal ecosystems. Increased protection, such as the proposed High Protection Area on the northern side of Hauturu-o-Toi as part of Tai Timu Tai Pari – The Hauraki Gulf Marine Spatial Plan is a start to restore the diverse kelp forest ecosystems and the diversity of life within them that once occurred in this particular area, but is far short of protecting 30% of our marine environment. In addition to large ecosystem-based management approaches, locally led collaborative protection and restoration are also needed for regeneration of our Gulf and beyond.

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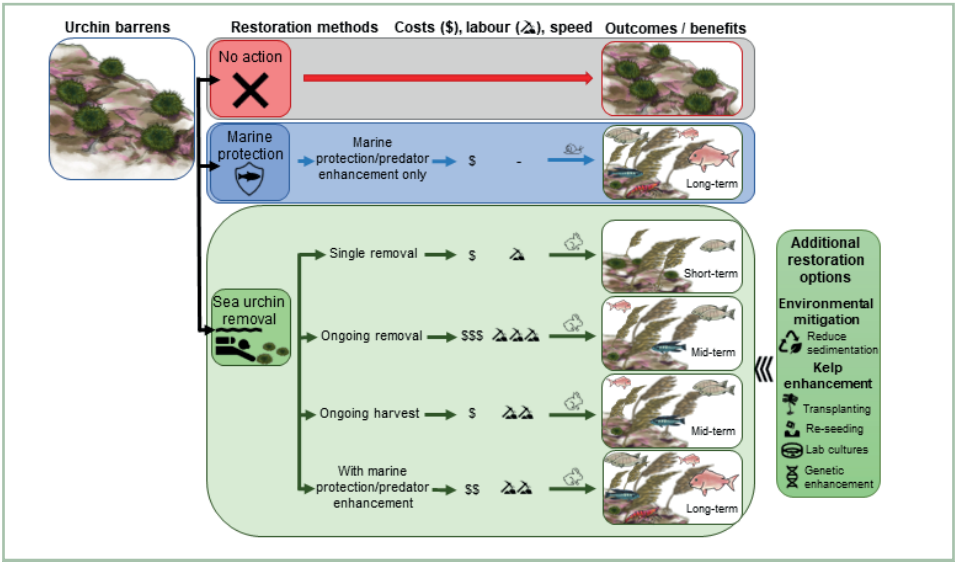

Restoration options for kina barrens (Credit: Miller et al. 2022)

Recovered reef at Hauturu (Credit: Paul Caiger)

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Beyond Barrier - Lord Howe Island (Australia), Mana Island (New Zealand) and Kangaroo Island (Australia)

Lord Howe Island (Credit: Ian Hutton through Lord Howe Island Tourism Association)

Lord Howe Island is now predator free

Lord Howe Island is a tiny (1400 ha) island that sits in the Tasman Sea about 600 km from Port Macquarie on the east coast of NSW. The wildlife on Lord Howe Island is now booming following the eradication of rats and mice in 2019[1]. While feral cats, pigs and goats were eradicated from the island in the late 70s, a number of animals were pushed to the brink of extinction because of the plague of rodents still on the island. One estimate had the number of rats at over 200,000. Black rats invaded the island from the wreck of the SS Makambo steamship when it ran aground at the northern end of the island in 1918. The rats have been implicated in the extinction of five endemic bird species, 13 invertebrates and two plants. In 2019 a $A16m rat eradication programme was finally launched by the New South Wales government after 20 years of discussion between the government and the local community. Gaining acceptance from the island's 350 permanent residents was very difficult and at times split families and divided neighbours[2]. Eradication involved a combination of 2,400 bait stations laid out at 10m intervals combined with aerial drops of toxins in the more inaccessible parts.

Lord Howe Island (Credit: Rian Cope through Lord Howe Island Tourism Association)

Lord Howe Island is an outstanding example of an oceanic island of volcanic origin with a unique flora and fauna as well as the world's most southerly true coral reef. It is home to one of the world's rarest birds, the Lord Howe Island Woodhen, and the world's largest stick insect, the Lord Howe Island Phasmid. Within 12 months of the eradication programme some bird populations have doubled. The rare Lord Howe Island woodhen numbers have increased from around 209 in 2019 to 1147 in 2023. These dramatic increases highlight how quickly populations can recover once the threats of predators are removed. Other animals that have dramatically bounced back include four critically endangered snail species. There are also indications that the native flora is recovering.

Since the eradication programme the NSW government has strengthened biosecurity on the

island. While there was an incursion of two rats in April 2021 they were quickly contained. Probably the biggest threat that remains for the ecology of the island is climate change. The average temperature of the island has increased by 0.8°C since 1950 and in 2019 parts of the lagoon bleached for the first time.

The Transformation of Mana Island from farm to native forest

Over a period of about 40 years Mana Island (217 ha), which sits off the southwest coast near Wellington, has been transformed from a farm to a forest. For over 100 years Mana Island was a Crown-leased sheep farm but in 1972 it became a quarantine research station for exotic sheep breeds. In 1978 there was an outbreak of scrapie disease (the sheep equivalent of mad cow disease) and all 2,000 sheep on the island at the time had to be slaughtered. While the Department of Lands & Survey then ran cattle on the island for a period, the discovery by Tony Whitaker many years earlier that McGregor's skink and the goldstripe gecko had survived on the island as well as the Cook Strait giant wētā, led to the setting aside of the island for conservation purposes. The absence of rats, mustelids and possums on the island meant that just mice needed to be eliminated for the island to become predator free. But at the time mice were at plague proportions with an estimated population of about 5 million. In a mammoth exercise in 1989 led by Colin Ryder from Forest & Bird, 5,500 plastic tubing bait feeder stations were laid out across the island, and within a year the island was declared to be mice free.

McGregor's skink, Mana Island. (Credit: Tony Whitaker. Gift of Vivienne Whitaker, 2020, Te Papa O.049935)

The view south from McGregor's Rock to Shingle Point, showing part of the shore platform damaged by the construction of an unauthorized farm track in 1984. A. June 1972 (Credit: Tony Whitaker, gift of Vivienne Whitaker, 2020, Te Papa CT.066757). *B. June 2022 (*Credit: Maarten Holl, Te Papa, 206599). *The vegetation has recovered naturally from predominantly Coprosma propinqua to taupata (C. repens).*

A native plant nursery was established on the island and over a period of 25 years (1987-2011) volunteers visiting the island planted around 440,000 native trees. Planted forest now covers about 37% of the island, greatly extending the small 4ha remnant that remained after farming. There has also been a lot of natural restoration on the coastal slopes. This year Colin Miskelly from Te Papa examined the state of the flora and fauna on the island, and as part of that exercise took a series of images across the island at points photographed by Tony Whitaker 50 years earlier. The dramatic recovery of the forest on the island is illustrated in a series of paired images recently published by Te Papa[3,4].

With the new forest cover and the absence of mice several bird species re-established themselves on the island including tūī, pūkeko, pied shag, kererū and kārearea while others such as the yellow-crowned parakeet/kākāriki and takahē were successfully translocated to the island. In addition, a wetland has been established and 22 animal species translocated

to the island as part of a comprehensive ecological restoration programme. Today Mana Island is an ecological gem for all New Zealanders to visit and enjoy.

Managing pests on Kangaroo Island post the 2020 destructive fires

In the Summer of 2019/2020 almost half of the vegetation of Kangaroo Island (440,500 ha) in South Australia was destroyed by a devastating series of fires triggered by lightning. Two years on, many of the species are bouncing back. Amazing stories of survival are emerging with dunnarts, pygmy possums and platypus sightings in the green landscape that has sprung up from the blackened land. Plants not sighted for more than a century, known as fire colonisers, have been seen. However, the loss of habitat from the fire has increased the vulnerability of many of the endangered animal species to predators. To help protect these endangered species two strategies are underway: increased predator control and erection of a predator proof fence around some of the fire affected land.

While the island is devoid of foxes there is a large feral cat population. A major initiative is currently underway to remove feral cats from the island by deploying a state-of-the-art technology which takes advantage of the fact that cats are obligate groomers. The new trap (the Felixer Trap) is able to differentiate feral cats from native species based on size, shape and speed of movement and dispense a toxin spray on them as they go past. They are five times more effective than a standard cat trap. Since the devastating fires of 2020 more than 850 cats have been removed. However, it is not a silver bullet and is being used in conjunction with other pest management techniques. A smartphone app is being used to remotely monitor hundreds of standard cage traps.

To provide more immediate protection, the Australian Wildlife Conservancy in a joint project (the Western River Refuge) with the Kangaroo Island Land for Wildlife and private landholders have raised funding to erect an 8.8 km-long cat-proof fence around 370 ha of the fire-affected land on the western end of the island that is known to be the home of the endangered

Cat fence on Western end of island (Credit (Top): Brad Leue, The Australian Wildlife Conservancy)

Kangaroo Island dunnart, southern brown bandicoot and short-beaked echidna. Intensive trapping is also underway on the 38,000 ha Dudley Peninsula at the eastern end of the island as a key first step toward complete removal of feral cats across the island.

The devastating 2020 fires on Kangaroo Island have brought into sharp focus the need to remove predators, especially feral cats, across the island. Along with habitat loss, and now climate change, invasive species constitute the greatest threat to survival of native flora and fauna.

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