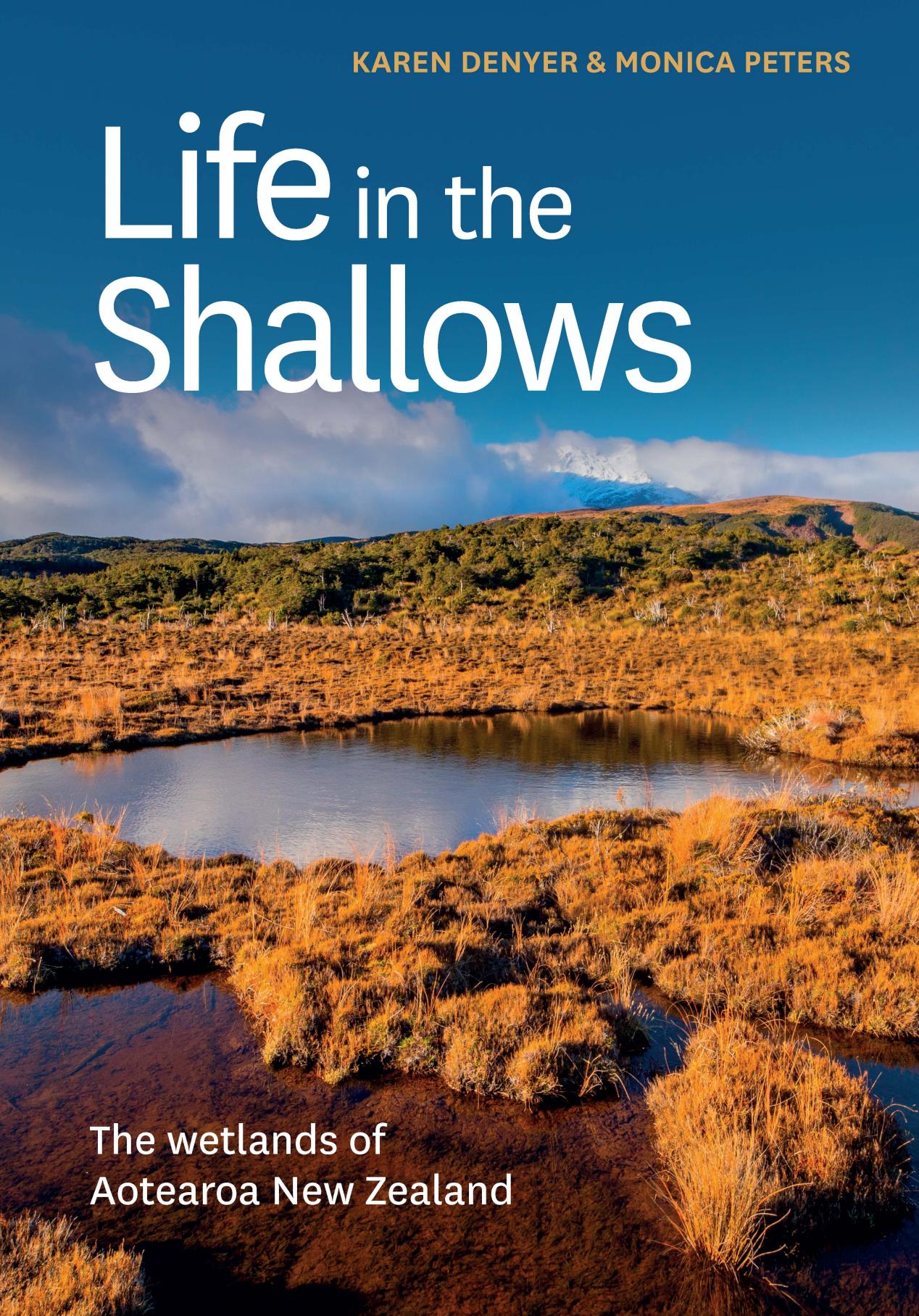


KAREN DENYER & MONICA PETERS

Life in the Shallows

A scenic landscape featuring a wetland in the foreground with golden grasses and shallow water. Behind it is a hillside covered in green and yellow vegetation. In the distance, a majestic mountain peak is partially covered in snow under a blue sky with scattered clouds.

The wetlands of
Aotearoa New Zealand

Life in the Shallows



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Aotearoa New Zealand

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Foreword

WHEN I READ BOOKS like this one, I immediately lose a lot of time: hours, days or even more. I just can't help myself. Wetlands are places of endless fascination to me, and reading these stories instantly takes me on a virtual, dry-footed wetland tour. But this book isn't just for people who love nature and science, it's also for people who love people. It cleverly blends the weird and wonderful (and often hidden) features of our bogs, swamps and estuaries with stories about the very people who work to reveal their secrets.

When we hear the word 'scientist' it's easy to defer to the old stereotype — white lab coats and thick-rimmed glasses. This book will utterly dispel that image! You will read about people venturing into the wilderness in waders or kayaks, grappling with slippery apex predators or ornery giant herons, and coming up with clever ideas to make a fish feel at home. You will also read about researchers connecting with local hapū and community volunteers, pooling their knowledge and drawing on mātauranga Māori to learn about our wetlands and how to protect or restore them.

The scientists profiled here are a mere sample of New Zealand's scientific talent, but nonetheless impressive. The chapter themes weave and meander like a braided river, but blend together perfectly to accurately sketch the facets of 'a day in the life of a wetland scientist'. It paints the picture of a place where I can crawl on hands and knees, looking at life in all its glorious forms: orders, families, genera, species with associated ecosystem connections and jobs to do; organisms ranging in size from trees to microscopic and sometimes as small as e-DNA. (No wonder my 'field-trips' are usually no longer than 50 metres!)

When it comes to wetlands, New Zealand is not doing too well at all. In fact, just 10 per cent of our original wetlands are still hanging in there. Our European settlers, a product of their time, set out to cultivate the wild lands and to turn them into productive fields for pasture or crops. Thankfully we now appreciate that wetlands — those small springs, soaks, swamps, and the margins of rivers and streams and lakes — are nature's vital tools for maintaining water tables, filtering and recycling waste, pollutants, nutrients and sediment washed from the land. We also now know that functioning wetlands are right up there when it comes to sequestering carbon!

This book exposes the reason we have a National Wetland Trust in Aotearoa: modern-day *Homo sapiens* appear to have lost the operating manual for Planet Earth, and the passionate scientists of these wetland stories are doing their darndest to point us all in the direction of conservation, or better still, restoration of these life-sustaining habitats, and recognition of the traditional knowledge that can help us get there.



*Entomologist, media personality and passionate educator
Ruud Kleinpaste is the patron of the National Wetland Trust.*

This storytelling is of crucial importance to the way we teach young New Zealanders to understand that we live on a biological planet, which is run by aquatic life forms, botanical giants, fungi, birds and bats, grazers, predators, algae, snails, parasites and pathogens, lichens, barnacles, bogs and bugs.

Just think for a moment about all that life in a wetland. It started about 3.8 billion years ago and through evolution the resulting assemblies of organisms are our most senior, sacred, inspirational and perfectly adapted elders from which we can learn how to behave on this watery planet.

Let's listen to what they have to say!

Ruud Kleinpaste

Getting into Wetlands

MY ALL-TIME FAVOURITE MOVIE is Taika Waititi's *What We Do in the Shadows*. Not just because of its fabulous portrayal of our uniquely Kiwi sense of humour, but also because it almost perfectly encapsulates the livelihood of many of my colleagues featured in this book. *What We Do in the Shallows* was my personal working title for this book. Wading into amphibious ecosystems — sometimes wet, sometimes dry — or paddling around the shallow margins of lakes, ponds, rivers and estuaries is what wetland scientists do. But how many people know who they are or what their work entails?

New Zealanders are notoriously humble. It's almost a national crime to stick your head above the parapet and say, 'Look at me, look what I've done'. It's not part of the Kiwi psyche to blow your own trumpet, so to speak. Which is why most of the people featured in this book, irrespective of the incredibly significant contributions they have made to New Zealand science and wetland conservation, may be little known outside their science circle, family and friends. We certainly have scientists who are household names — Ashley Bloomfield, Nanogirl, Ernest Rutherford — but I challenge the average New Zealander to name one wetland scientist, living or passed on.

Perhaps science in general is underappreciated in Aotearoa New Zealand, or perhaps that's just true of wetlands, still shackled with negative connotations in Western society. Even in the cancel culture of the 2020s, there are still lingering images of the cartoon-like Creature from the Black Lagoon, enduring miserable European names for wetlands (Dismal Swamp, Boggy Lagoon), and Donald Trump vowing to 'drain the swamp'.

The National Wetland Trust, which championed this book, felt it was not only time to stop 'body shaming' wetlands but also to celebrate the humble, hard-working and incredibly dedicated scientists who are willing to pull on a pair of waders and head into the shallows. That is the purpose of this book: to bring wetlands, and wetland scientists, out of the shadows. It's a smorgasbord of science; a book that readers can dip in and out of and read in any order. Each chapter features a New Zealand scientist and one or more aspects of their work — new species they have discovered, novel applications of emerging technology, a better appreciation of the important role of wetlands in our landscape, and guidance on how to restore wetlands or protect their wildlife. Side boxes offer fascinating facts, and a featured wetland to visit brings the chapter to life by allowing the reader to experience some aspect of that person's research.



Karen Denyer has a life-time fascination with New Zealand's natural places. Wetlands are a particular passion of hers.

But who to include? Who to leave out? It was an incredibly hard decision, and Monica and I could fill another two books with those we left out. But, in reality, very few scientists in New Zealand work only on wetlands. Many are specialists in a particular field, and they apply that expertise variously to wetlands and other ecosystems. Dr Corinne Watts is an example; her expertise in invertebrate ecology is applied to forests, river margins, wetlands and other ecosystems. Many others, when approached with an invitation to appear in the book, hung back . . . 'Well, I'm not really a wetland scientist.'

It's a fair point. What do we mean by wetland? Even for our aquatic scientists, the default tends to be: wetlands = bogs + swamps + fens; in other words, soggy but well-vegetated areas. The legal definition in New Zealand's Resource Management Act 1991 and indeed the international definition under the Ramsar Convention are much broader. Wetlands are places where water sits long enough, and often enough, to alter the soil, vegetation and animal communities that live there. They include permanently or intermittently wet areas, shallow water and land-water margins that support a natural ecosystem of plants and animals adapted to wet conditions. They are diverse ecosystems,

with the different types determined by their water — amount, depth, permanence, temperature, the chemicals found there — and its source, whether groundwater, surface water, rainwater or a combination of these. The book reflects this wider definition by including scientists working on a wide range of wetland types: bogs, swamps, gumlands, estuaries, lakes, rivers and even semi-frozen pools. Each scientist has fascinating stories to tell, but often most intriguing was how they got into wetlands in the first place.

I FORGET HOW OLD I was when I had my first memorable encounter with a wetland. Probably around seven or eight. I didn't actually know it was a wetland at the time. It was just a muddy, mucky mangrove swamp that stood between me and a challenge.

With my childhood buddy and co-conspirator Michael — a fellow fearless adventurer — we slopped our way through the mangroves on the banks of the Whau River in West Auckland. Our goal? To swim to the other side. We didn't make it across, but we did survive to write about it.

I don't remember how we got out of the current, but I do recall slinking back home, covered in mud, legs bloodied from barnacle-sharpened mangrove roots, faces streaked with frightened and guilty tears, sneaking round to the outdoor hose at Michael's house to wash away the evidence. As far as I know, neither of us ever told our parents.

My Whau River adventure was the sort of experience that could scar a person for life (and not just from those sharp barnacles). Wetlands didn't really factor in my life again until high school science expeditions, back to the muddy mangrove forests, but with a better appreciation for their positive values. Even with an intense interest in ecology and conservation, wetlands still weren't really front of mind for me when I studied science at university. Marine biology, as ever, was totally cool, and definitely my career path, until the cold reality hit me — it's your job, you have to go scuba diving when the weather is rubbish, or when you're tired, or hungover, or in murky, uninviting water. Plan B was a career in something on slightly more solid ground. There was one paper on limnology (lakes) where I learnt the name *Vallisneria australis* on a field trip to Auckland's Lake Pupuke, but next to nothing about wetlands. I came out with a double major in botany and zoology, and went straight into forest ecology.

I got into wetlands, in both senses of the word, when I took a job at what was then called Environment Waikato (now the Waikato Regional Council). The Waikato is 'wetland central' for New Zealand. Just about every type of wetland can be found here, including geothermal and plutonic (underground) wetlands. It has three of our seven internationally recognised Ramsar wetlands, and one of the nation's largest proportions of remaining wetlands. Little wonder then that many wetland experts are based in the Waikato or have conducted research here, which is perhaps why it features a little heavily in this book.

This was where I was inducted into the world of wetlands. It was where I bought my first pair of waders, and where I first got lost in a wetland (with two other women, and thank goodness we had chocolate with us!). It was where I first met incredible Māori wetland scientists and learnt to think beyond biology. It was where I learnt that Aotearoa

New Zealand has fish that can breathe through their skin, plants that eat insects, aquatic micro-organisms that can withstand 120°C. It's also where I first heard the word 'repo', despite leaving high school with a Sixth Form Certificate in te reo Māori.

AT THE TIME OF PUBLICATION, New Zealand universities still don't have any dedicated degrees for would-be wetland scientists. You might graduate with a BSc in ecology, and a few aquatic papers under your belt; but while you can get a degree in marine biology, even today few New Zealand universities offer a wetland-centric undergraduate degree.

To encourage more students to consider researching wetlands for their Master's degree, the National Wetland Trust established the Golden Plover Wetland Research Award, a small financial incentive, recently doubled in value through a partnership with the New Zealand Freshwater Sciences Society. Despite being open to post-graduate researchers across the country, there are still some years with no applications.

Things are slowly changing. Wetlands were given strong legal protection in a new environmental law in 2020, and the University of Waikato is developing bilingual multimedia educational resources based on New Zealand wetland research. But there are still so many things we have yet to learn about our wetlands. Many wetland species are cryptic (rarely seen), or tiny. Few undamaged wetlands remain to tell us what they were once like, to guide restoration goals. Māori knowledge, built from centuries of interacting with, living in and collecting resources from wetlands, has the potential to radically improve wetland management in Aotearoa, but there is a lot of work to do to integrate mātauranga Māori into all restoration projects, while respecting intellectual property and cultural knowledge.

It is our hope that the stories so generously shared by the scientists featured in this book, including their personal insights, their highlights and even their 'oopsie' moments, will encourage a greater investment in wetland science at our universities. We also hope it will inspire a new generation of future scientists to get into their gumboots, muck in and carry on the quest for knowledge about New Zealand's wetlands.

Writing about people you know as peers, hearing their backstory, learning about their pathway into science and hoping to capture just a little bit of their personality as well as their science in each chapter, has been a thoroughly humbling and enjoyable process. We hope these stories will inspire everyday New Zealanders to explore the wetlands in their backyard, to experience what motivates our wetland scientists, and to learn more about the significant cultural, spiritual, recreational and ecological value of what the late Gordon Stephenson, founder of the National Wetland Trust, called our 'shy places'.

Karen Denyer

Preface

Engaging Communities

Ko Rangitoto te maunga te rū nei taku ngākau.
Ko Tāmaki te awa e mahea nei aku māharahara.
Nō Tāmaki Makaurau ahau.
E mihi ana ki ngā tohu o nehe, o Kirikiroa e noho nei au.
Ko Monica Peters ahau.

Rangitoto is the mountain that speaks to my heart.
Tāmaki is the river that alleviates my worries.
I'm from Auckland.
I recognise the ancestral and spiritual landmarks of Hamilton where I live.
My name is Monica Peters.

MANY OF THE SCIENTISTS in this book honed their research skills and shaped their careers from a young age. My pathway has been much more eclectic, with years spent zigzagging between fine arts, conservation and international development. I eventually did study science, but not before volunteering in ever more remote places. From Te Hauturu-o-Toi Little Barrier Island to Raoul Island in the Kermadecs, to Malaysian Borneo and then Mongolia, my roles ranged from habitat-control volunteer to expedition artist. I've always seen art and science as different lenses through which to explore and understand the environment. I knew I wasn't cut out to specialise in one tiny area of either, but not because delving into detail isn't my thing. For science, in particular, I saw that to really make a difference it needs to be positioned within a sociocultural, economic and political setting. Unless it's relevant to society and decision-makers, science won't be picked up and applied. I also saw that an increasingly big part of doing science is how well it can be communicated to a broad and varied audience. And creativity is a big part of communication.

In my work — which sits at the interface between science, the public and conservation — the word 'community' crops up a lot. It's a convenient catch-all term that describes a group of people who have something in common. Community could easily be applied to the scientists in this book — they're united by a shared passion for learning about wetlands. Collectively, they're unpacking the mysteries and complexities of these extraordinarily diverse ecosystems: how wetlands work; the fascinating life within them; how we understand, value



Monica Peters applies her skills in conservation, research, international development and fine arts to understand our environment and our relationship to it.

and manage them; and how to right the wrongs of their past mismanagement. Most of the scientists profiled have worked together in one way or another. But perhaps what's not fully appreciated is how many of these scientists encourage, advise and support community groups all around Aotearoa New Zealand to restore their local wetlands and surrounds — and vice versa. How many of these scientists may have benefitted from community environmental groups with decades of hands-on wetland restoration experience?



Community groups and citizen scientists are adopting wetland monitoring techniques used by professionals to track the state of wetland health.

But it's not just scientists who study wetlands. Our understanding of these soggy sites and their inhabitants has been built on a much wider body of knowledge. This includes people with no formal science training but who are naturally curious, have a keen eye and appreciate the need to study, document and learn from nature. When people without formal science qualifications or who don't work in a science-based profession do science, they're commonly called citizen scientists. This includes backyard bird surveys, keen amateur botanists uploading their observations to iNaturalist,* and those who volunteer to regularly monitor stream water quality.

Citizen science, a particular passion of mine, is an umbrella term that covers community-based environmental monitoring. There are synergies between mātauranga Māori (traditional knowledge) and citizen science with data collection, analysis and the co-production of new knowledge commonly featuring in both. However, an important difference lies in provenance: mātauranga Māori is embedded in the Indigenous worldview of Te Ao Māori, while citizen science is built on the foundations of Western thinking. As both a social movement and a collaborative research method, citizen science often takes a more holistic approach to science-based studies, incorporating community engagement, education and outreach alongside data collection. It also complements the work of scientists: there simply aren't enough scientists to carry out the research needed to better understand and manage our environment.

We don't really know how many community groups are scattered throughout Aotearoa working to restore wetlands. We do know that it takes a phenomenal effort to haul degraded wetlands back from being unloved and uncared for, to being places that are a safe haven for our native species and amenable to visit. Sure, years of dedicated weeding, planting and controlling introduced predators (and sometimes putting the actual 'wet' back into the wetlands) typically produces a profound visual change — more water, cleaner water, lush native plants and secretive wetland birds slowly reappearing. But have the years of hard work resulted in a net gain in native species biodiversity? Nationally, the trend for our unique, quirky and remarkable indigenous species still shows a steady downward trajectory.

For my PhD I asked 296 community groups to describe their restoration objectives.¹ Many were very general — 'restore biodiversity', 'bring back native birds'. To better understand how they measured progress towards achieving their restoration objectives, I also asked them about their monitoring programmes. Did they use any science-based methods? If no, why not? If yes, did they measure the direct outcomes of their efforts, such as the numbers of predators trapped (rats, possums, stoats, cats, hedgehogs)? Or did they measure the indirect outcomes of their work, such as changes in birdlife or lizards resulting from their predator control? The difference is important: one paints a picture of what and how many introduced predators there are in the landscape; the other reveals whether reducing predator numbers is actually making a difference to our native species.

I'm still passionate about developing a more nuanced understanding of the institutional, bureaucratic and social barriers that hinder or block groups' monitoring efforts and

* See <https://inaturalist.nz>.

encouraging a culture where their data are valued more widely. Their data could, and should, be used to help flesh out how we, as a nation, are faring with respect to enhancing our indigenous biodiversity. Quantifying what community groups have achieved is important, because I (and many others working in the conservation sector) know through years of observation that their work is significant. Many of the wetlands we have left would be much worse off if it weren't for community groups and those organisations and individuals that support them: the National Wetland Trust and other environmental NGOs, funders and the science/technical advisors in councils, the Department of Conservation, universities and consultancies.

CREATING RESOURCES TO HELP COMMUNITY GROUPS manage wetlands means sweeping away desiccated formal language, jargon and tight stylistic conventions to create content that can be understood and then applied. I've had plenty of opportunities to put this philosophy into practice with my colleagues.

Working with Dr Beverly Clarkson (Manaaki Whenua — Landcare Research) to bring together *Wetland Restoration: A Handbook for New Zealand Freshwater Systems* (2010) was a matter of fortuitous timing.² We were already working on an experimental wetland restoration project translocating rare restiads (rushes) to new sites in the Waikato,³ when the opportunity arose to revamp a much earlier version of the handbook. The content was due for a major makeover to reflect new developments in the field and, importantly, to expand readership from technical experts to community wetland restoration practitioners.

In the updated version, experts each contributed a chapter on one aspect of wetland restoration, and each also included a case study of a community group's project(s) and achievements. A rich array of photos, diagrams and illustrations were also added. Several years later, colleagues at Manaaki Whenua used the design template of the handbook for two further publications, *Te Reo o Te Repo: The Voice of the Wetland* (2017)⁴ and *Te Reo o Te Repo: Kei Konei Tonu Au* (2021). Both are grounded in Māori culture and values, and expand on the mahi (work) of restoring wetlands.

I've previously joined forces with Karen Denyer on projects where we've turned techno-speak into everyday language. It started with the 2014 Wetland Monitoring and Assessment Kit (WETMAK).⁵ With more community groups restoring wetlands, an ecosystem-specific guide was desperately needed to help them measure change over time — both big picture (for example, carrying out a 'wetland warrant of fitness') and fine grain (such as surveying for weeds). Karen, as an ecologist skilled at working with communities, drove the science component of the project, developing modules written in everyday language. I wrangled funding and designed two 'how to' videos (vegetation plots and photopoints). We carried out WETMAK training for community groups around Aotearoa and taught groups' agency supporters how to use each module. In the meantime, technology has marched ahead, so the paper templates for data entry seem quaint. It's a project that's waiting to be modernised: an app to speed data entry and

instantly visualise and share results would be ideal. That's one we'd still love to tackle!

Broadening the citizen science theme, we again collaborated (this time with Peter Handford of Groundtruth*) to develop the grandly titled: *Auckland Community Ecological Monitoring Guide* (2018).⁶ It's a framework designed to help environmental restoration groups choose science-based monitoring protocols. Monitoring can be a complicated business for non-scientists: What do we monitor? Why? Which protocol should we use? Why this one and not that one? We researched these questions with groups as well as council staff who support community groups, and brought together 42 established environmental monitoring protocols. They cover all ecosystem types, but none need specialist expertise, expensive equipment or iron-clad health and safety plans. So, electrofishing didn't make the cut, but gauging fish diversity and abundance by spotlighting at night did. We developed a set of 11 criteria that groups and council staff could systematically work through to find the protocol that best matched their project objective, skill level, time commitment of group volunteers and, of course, budget.

Developing resources and sharing information are integral to broadening and strengthening the network of people who research, restore, manage and protect our remaining wetlands. But so is meeting face to face. The National Wetland Trust symposia have become a who's who of wetland restoration — the biannual event draws together not only scientists but also citizen scientists, mātauranga Māori specialists, landowners, policy makers and dedicated community group members.

I'd like to mihi (give thanks) to not only the scientists Karen and I are proud to have cajoled into sharing their career highlights, specialist knowledge and field anecdotes with us to create this book, but also those restoring their local wetlands and surroundings — the farmers, landowners, iwi, community groups, trusts, schools and others. As much as we need science to underpin the work on the ground, we need the people on the ground doing the hard yards — restoring wetlands takes persistence, dedication and experimentation. We need the research of both scientists and citizens, we need communities that are supported by scientists, and we need scientists who are willing to listen and to learn from communities.

Monica Peters

* See <https://trap.nz>.

Introduction

The Wetlands of Aotearoa New Zealand

LET'S BE HONEST, it rains a lot in Aotearoa New Zealand. According to NIWA (National Institute of Water and Atmospheric Research Taihoro Nukurangi), most areas of the country receive between 600 and 1600 millimetres of rainfall each year. That's an average. Te Tai Poutini, the West Coast of Te Waipounamu South Island, can have more than 4 metres of precipitation per year. All that rain needs somewhere to go. Much of it flows out to sea, but in low-lying areas, basins, and land blocked off by dunes or gravel bars, it forms freshwater or semi-salty wetlands.

Just how you define a wetland appears to depend on who you are talking to. The authors of the latest calculations of the amount of wetland area in New Zealand, who titled their paper 'Revised Extent of Wetlands in New Zealand', define them as 'terrestrial ecosystems that are permanently or intermittently wet' and exclude saline wetlands such as estuaries.¹

The International Convention on Wetlands* takes a broader view, defining wetlands as 'all lakes and rivers, underground aquifers, swamps and marshes, wet grasslands, peatlands, oases, estuaries, deltas and tidal flats, mangroves and other coastal areas, coral reefs, and all human-made sites such as fish ponds, rice paddies, reservoirs and salt pans'.

New Zealand law is relatively vague. The Resource Management Act 1991 defines wetlands as 'permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions'. This definition could potentially apply to a poorly maintained gutter depending on how you define 'natural ecosystem', which the Act does not do.

A national wetland classification developed for New Zealand identifies nine hydroystems (including saline) and nine wetland classes, differentiated by water source, substrate and nutrient status.² The compilers of the directory of New Zealand wetlands link these hydroystems and classes to processes that formed them: 'rivers and bogs from

* The full name of the convention is the Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat. See www.ramsar.org.



From the mountains to the coast, Aotearoa has a diverse range of wetland types. The alpine tarns pictured here are at Key Summit, on the Routeburn Track in Fiordland National Park.

frequent rain; lakes from glaciation and volcanic actions; swamps from the deposition of erosion products by rivers and the sea; estuaries and lagoons from tidal flooding of old Pleistocene valleys.³ Less common, or naturally rare, wetland types include ephemeral kettle holes formed on glacial moraines, and geothermal wetlands.

Most of the freshwater wetlands found in Aotearoa today formed at or after the end of the last glaciation, about 18,000 years ago.⁴ As the world warmed up, the glaciers melted, forming herbaceous fens.⁵ By the time humans arrived about 800 years ago, they had developed into either wooded swamps dominated by conifers including kahikatea (white pine, *Dacrycarpus dacrydiodes*) and manoao (silver pine, *Manoao colensoi*), or extensive bogs dominated by rush-like restiads (*Sporadanthus* and *Empodisma* species) and *Sphagnum* mosses.

Prior to the arrival of humans, about 10 per cent of the landscape was freshwater wetlands.⁶ In addition, the nation has mapped 425,000 kilometres of rivers and streams,⁷ and more than 50,000 lakes. Today, wetlands occupy only a small part of New Zealand — less than 1 per cent of the total land area. Extensive and repeated burning of the woody vegetation drastically altered catchment hydrology, resulting in wetter, herbaceous wetlands of harakeke (flax, *Phormium tenax*), raupō (bulrush, *Typha orientalis*) and rush and sedge species (for example, *Carex*, *Juncus*, *Cyperus* and *Machaerina*). Drainage later caused the total loss or fragmentation of these wetlands, with many of the remnants invaded by introduced species, including tree willows (*Salix* species). The latest figure for the extent of freshwater wetlands with emergent vegetation (technically termed ‘palustrine’) in New Zealand is now calculated at 249,214 hectares, or 10 per cent of the pre-human extent.⁸ In addition, many of the lakes, lowland rivers and estuaries are affected by pollution, introduced plants or animals, channelisation, infilling, impounding or water diversion.