Resilient Wetlands Research Programme Update 9: July 2019 to June 2020

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Overview

Our Resilient Wetlands research programme is funded by the Strategic Science Investment Fund (SSIF) Crown Research Institutes from the Ministry of Business, Innovation and Employment's Science and Innovation Group (previously 'core' funding). The following update summarises the major outputs and successes between July 2019 and June 2020.

Integrated Constructed Wetlands.

Suzanne Lambie held a workshop with Taupiri Marae, Taupiri Primary School and the Ministry for the Environment (MfE) on 11 March 2020 to discuss the importance of wetlands in grazed landscapes. The workshop was part of the Whangamaire Constructed Wetlands project, which is funded by the Community Environment Fund. The project includes the construction of two integrated constructed wetland systems: one with a series of four cells holding a different monoculture of emergent macrophytes in each cell; and a separate wetland on a different property that is a single cell with a mix of all four macrophytes. The purpose of the project is to test the ability of this kind of constructed wetland to reduce nitrogen, phosphorus, and sediment by treating run-off from the existing farm drainage system before it enters the Whangamaire Stream in Taupiri. More information on this project can be found at https://www.stuff.co.nz/environment/climate-news/120960649/wetland-construction-project-brings-north-waikato-rural-community-together and https://vimeo.com/409597059.

The workshop had four learning stations where pupils learnt about plants (lead by MWLR staff Bev Clarkson and Yvonne Taura), birds (John Innes (MWLR)), and fish (James Sukias, Brandon Goeller, Watene Campbell (NIWA)) in wetlands and how wetlands can remove contaminants from water (Suzanne Lambie (MWLR)). We had about 40 students and fielded a wide range of questions (Fig. 1A). We also had fun building mini constructed wetlands (Fig. 1B).

Figure 1A (left) Pupils of Taupiri Primary School and Suzanne Lambie discussing how wetlands can be used to enhance water quality in pastural systems. **1B** (right) Building a mini constructed wetland (Photos: Ilka Pelzer, MfE).

Policy

Bev Clarkson was a member of the Science and Technical Advisory Group (STAG) that oversaw the science evidence for development of Government freshwater policy to restore and protect the health of freshwater ecosystems, including wetlands. Details on the 'Action for healthy waterways' package is provided on the

MfE webpage with specific information for iwi/Māori, farmers, horticulturalists, and regional councils. The package includes the new National Policy Statement for Freshwater Management 2020 (Freshwater NPS 2020) that will provide local authorities with updated direction on how they should manage freshwater under the Resource Management Act 1991. The Freshwater NPS 2020 will come into force later this year. Together with the new National Environmental Standards for Freshwater (NES-FW), the legislation provides for increased protection for wetlands, including avoiding further loss/degradation, detailed national mapping (to at least 0.05 ha), and encouraging restoration.

Winton Wetlands Science Forum, Benalla, Victoria, Australia, August 2019

In August 2019, Yvonne Taura and Cheri van Schravendijk-Goodman were invited to the Winton Wetlands Annual Science Forum as guest speakers. The science forums are an opportunity to share key information about the wetland restoration project, monitoring, and research with passionate or curious locals, wider research community, and state government. Representatives from community groups and/or community-based researchers across NSW and Vic often attend to share their own learnings in wetland restoration. A more in-depth account of our time at Winton, and what we learnt, can be found here: https://mailchi.mp/d9d398e3afba/he-pnui-te-reo-o-te-repo-issue-5-winton-wetlands

Figure 2 Lake Mokoan, the inundation of the wetland area submerged the very old river gums, which have been left standing since 1971. Winton, Vic, Australia (Photo: Cheri van Schravendijk-Goodman).

Te Reo o Te Repo Volume 2

With the support of the Resilient Wetlands Programme and endorsement of Waikato-Tainui, the development of the second volume of the Te Reo o Te Repo series is well underway. The original editing team – Yvonne, Cheri, and Bev – have been working with contributors to finalise chapters. Abby Davidson has made herself available to design the handbook similar to the last edition. Twelve new chapters will be showcased in the new handbook. The contributions range from whānau/marae/iwi led restoration projects to academic research. Themes include: whakapapa and whakataukī Māori; rongoā Māori; iwi led dune lakes restoration; iwi led wetland restoration and monitoring; and cultural indicators – taonga plant and animal species. The new edition promises not to disappoint readers of the previous handbook, providing a helpful guide for those embarking on wetland restoration as well as highlighting the importance of mātauranga Māori and whānau involvement in these processes. The printing of hard copies has yet to be funded; however, the team will be conducting a comprehensive survey and utilising website data to support funding applications.

Figure 3A (left) Front cover of Robert Pa Ropata McGowan's chapter, Ngā rongoā o ngā repo – A wetland perspective. **3B** (right) Front cover of Cheri van Schravendijk-Goodman and Brenda Greene's chapter, The wetland paddlers of Aotearoa – Ducks, swans and grebes (Photos: 3A: Kathryn Brownlie, 3B: Neil Fitzgerald).

Te Reo o Te Repo: Te Reo Māori Repo Rauemi

Manaaki Whenua and the Science Learning Hub (SLH) have partnered to create a suite of bilingual, digital educational wetland resources drawn extensively from Maori-led wetland research in Te Reo o Te Repo. Funded by Unlocking Curious Minds (MBIE) and supported by the Resilient Wetlands Programme, these resources will focus on wetland restoration and best-practice, drawing on both mātauranga Māori and western science. The team from SLH, experienced science educators and communicators, will be leading the development of the digital educational wetland resources. We are also fortunate to have Māori science educators on our team who will contribute greatly in this project. We are currently trialling these resources with a selection of kura kaupapa Māori, who have a keen interest in restoring their local repo throughout the country. Once refined, the resources will be hosted on the SLH website for all kura and schools in Aotearoa to access. These resources are expected to be available at the end of 2020.

Repo Ropū pānui (Wetland Group Newsletter)

The repo rōpū recieved one pānui throughout the year 19/20. This was a special edition focused on Winton Wetlands and our trip to the Science Forum. The pānui includes: profiles of members from Winton Wetlands, the science forum, the Winton Wetland restoration project, funding opportunities, upcoming conferences, recently developed tools and resources, a spotlight on a native wetland animal (Southern Bell frog, *Litoria raniformis*), and a spotlight on a chapter from Te Reo o Te Repo (Harakeke). These pānui are written and edited by Yvonne and Cheri. The link to this edition: https://mailchi.mp/d9d398e3afba/he-pnui-te-reo-o-te-repo-issue-5-winton-wetlands

Modified/intact restiad bog comparisons

Our research team published a trilogy of papers comparing the vegetation, invertebrate community, and microbial functional capacity (C and N cycling) of an agriculturally affected bog remnant at Moanatuatua with an intact raised bog at Kopuatai. The Moanatuatua remnant had a significantly lower water table and

higher nutrients (N, P) than the intact system, a consequence of adjoining agricultural practices. Although both restiad peat-formers (*Sporadanthus ferrugineus, Empodisma robustum*) are still present, the long-term ecological prognosis for the site is uncertain, with a shift to higher productivity and woody species, e.g. *Epacris pauciflora*, better adapted to the changing conditions (Clarkson et al. 2020). Invertebrate communities, including threatened species, e.g. *Houdinia flexilissima*, have persisted at Moanatuatua; however, other Lepidoptera peatland specialists were missing. In addition, introduced species were more common (Watts et al. 2020). The increased functional capacity at Moanatuatua compared with Kopuatai indicates different microbial assemblages, leading to increased C and N turnover and decreased C sequestration as C inputs may be more rapidly converted to gaseous or waterborne exports (Lambie & Ratcliffe 2020). Our wetland programme research at Moanatuatua over the past 20 years informed the development of a restoration plan for Department of Conservation to manage and restore this important scientific reserve (Watts et al. 2019).

Kopuatai bog ecohydrology and carbon exchange research.

The research site operated by the University of Waikato at Kopuatai bog has been operational for nearly 9 years and has provided near continuous datasets of CO_2 exchange, and hydrological and meteorological conditions, as well as several years of methane fluxes. These datasets have provided a basis for two PhD theses, three MSc theses, and several published papers. A 4-year subset of data has been incorporated into the global Fluxnet CH_4 collaboration (Knox et al. 2019) and is becoming something of a magnet for ongoing synthesis studies.

Figure 4 Sabbatical visitor from Iceland, Hlynur Óskarsson, with UOW students, Alice Wheatley-Wilson and Isabella Redder, at the Kopuatai EC site (Photo: Dave Campbell).

Clara Wilson submitted her MSc thesis at the University of Waikato under the supervision of Dave Campbell and Chris Lusk. Titled *The role of fire in shaping vegetation structure and composition in a New Zealand restiad bog*, Clara's thesis examined aspects of the recovery of restiad bog ecosystems following contemporary and historic fires at Kopuatai Bog. She made repeat vegetation surveys at a 2017 lightning-strike burn site on the western side of the peat dome, along with measurements of peat and vegetation chemistry and microclimate, and compared the earliest stages of vegetation recovery with recovery 15 and 45 years post-fire at two other sites. Clara's research included a peat seedbank germination experiment.

Joss Ratcliffe successfully defended his PhD thesis in March 2020, via Zoom from Umeå, Sweden, where he is a Postdoctoral Researcher in the Peatland and Forest Biogeochemistry Group at the Swedish University of Agricultural Sciences. In addition to his 2019 paper comparing CO_2 balances between the hydrologically pristine Kopuatai bog and drainage-impacted Moanatuatua, he successfully published Ratcliffe et al. (2020), which examined the somewhat surprising strengthening of the CO_2 sink at Moanatuatua across a 16-year period, despite a deep and fluctuating water table. This occurred because increased shrub (*Epacris pauciflora*) dominance under the lowered water table conditions had led to higher photosynthesis rates while CO_2 losses by respiration actually declined. Joss has also had a third paper from his thesis 'Rapid carbon accumulation in a peatland following Late Holocene tephra deposition, New Zealand', accepted by *Quaternary Science Reviews*. The paper provided insights into the role of volcano-derived nutrient inputs in shaping the rate of carbon accumulation in restiad peatlands, which have important implications for present-day peatland ecosystem carbon balances due to anthropogenic modifications to global nutrient cycling.

Snippets

- Brandon Goeller, NIWA, is leading a project on biodiversity of constructed wetlands. Five Waikato constructed wetlands, each with characteristics spanning a range from low to high biodiversity, were selected and sampled for number and abundance of plants, presence of open water, fish, insects, small wildlife (using tracking tunnels) and larger wildlife (using baited trail cameras), and birdlife (using bird song recording). Data are being analysed and a manuscript prepared for publication.

Figure 4 Aerial view of Whangamarie Integrated Constructed Wetland cells before planting with wetland plants (Drone photo: James Sukias).

- Academic visitor: Dr Hlynur Óskarsson, a peatland ecology and soil science academic from the Faculty of Environmental Sciences at The Agricultural University of Iceland, spent his sabbatical based at The University of Waikato, hosted by Dave Campbell. He learned a lot about intact NZ restiad peatland ecosystems and provided valuable insights for ongoing research into greenhouse gas, hydrology, and soil research on our drained peatlands.
- Monitoring of the kahikatea restoration experiment at Whangamarino Wetland was undertaken for 2019-20, 5 years after set-up. Sampling included plant survival, health, height, diameter at base and at breast height, and length of major axis. Environmental parameters involved water quality sampling at each plot, and soil cores were collected for analysis of nutrients and bulk density.

Figure 5 Scott Bartlam and James Arbuckle measuring the kahikatea restoration experiment plots at Whamgamarino Wetland. Note the vigorous growth of raupo and *Carex secta*, and the dead willow spars (Photos James Arbuckle).

References (selection)

Papers/Theses

Burge OR, Clarkson BR, Bodmin KA, Bartlam S, Robertson H, Sukias JPS, Tanner CC 2020. Plant responses to nutrient addition and predictive ability of vegetation N:P ratio in an austral fen. *Freshwater Biology* https://doi.org/10.1111/fwb.13452

Clarkson BR, Cave VM, Watts CH, Thornburrow D, Fitzgerald NB 2020. Effects of lowered water table and agricultural practices on a remnant restiad bog over four decades. *Mires and Peat* 26: 19. 13 p.

Knox SH, Jackson RB, Poulter B, McNicol G, Fluet-Chouinard E, Zhang Z, Hugelius G, Bousquet P, Canadell JG, Saunois M, Papale D, Chu H, Keenan TF, Baldocchi D, Torn MS, Mammarella I, Trotta C, Aurela M, Bohrer G, Campbell DI & 45 others 2019. FLUXNET-CH_4 Synthesis Activity: Objectives, Observations, and Future Directions, *Bulletin of the American Meteorological Society*, https://doi.org/10.1175/BAMS-D-18-0268.1.

Lambie SM, Ratcliffe JL 2020 Multi-substrate induced respiration (functional capacity) in agriculturally degraded and intact restiad bogs: implications for carbon and nitrogen cycling. *Mires and Peat* 26: 21. 17 p.

Pan Y, Cieraad E, Clarkson B, Colmer T, Pedersen O, Visser E, Voesenek L, van Bodegom P 2020. Drivers of plant traits that allow survival in wetlands. *Functional Ecology* 34: 956–967. https://doi.org/10.1111/1365-2435.13541

Ratcliffe JL 2020. Carbon dynamics in restiad peatlands across different timescales (Thesis, Doctor of Philosophy (PhD)). The University of Waikato, Hamilton, New Zealand. Available: https://researchcommons.waikato.ac.nz/handle/10289/13540

Ratcliffe JL, Campbell DI, Schipper LA, Wall AM, Clarkson BR 2020. Recovery of the CO_2 sink in a remnant peatland following water table lowering. *Science of The Total Environment*, 718, 134613. https://doi.org/10.1016/j.scitotenv.2019.134613

Taura Y, Duggan I 2020 (in press). The relative effects of willow invasion, willow control and hydrology on wetland zooplankton assemblages. *Wetlands: the Journal of the Society of Wetland Scientists*.

Watts C, Clarkson B, Cave V Thornburrow D, Thorpe S 2020. Invertebrate communities in a modified isolated raised bog compared to an intact raised bog in New Zealand. *Mires and Peat* 26: 20. 12 p.

Wilson CR 2020. The role of fire in shaping vegetation structure and composition in a New Zealand restiad bog (Thesis, Master of Science). The University of Waikato, Hamilton, New Zealand. (Under examination.)

Presentations/ contract reports/ pānui

Clarkson BR 2020. Wetland delineation protocols. Manaaki Whenua – Landcare Research Contract Report LC3770 for Ministry for the Environment. 12 p.

Clarkson B, Paynter Q, Winks C, Bartlam S, Watts C, Thornburrow D 2019. Best-practice guidelines for managing *Tradescantia* threats to native biodiversity. Manaaki Whenua – Landcare Research Contract Report: LC3570 for Living Water, Wairua River Catchment. 11 p.

Clarkson BR, Bartlam S, Watts CH 2019 Reversing biodiversity decline in forest remnants: a restoration experiment using biocontrol beetles and hand-cleared treatments. Oral presentation, Society for Ecological Restoration 8th World Conference, Century City, Cape Town, South Africa 24–30 September 2019.

Goeller B, Sukias J, Tanner C, Clarkson B 2019. How do on-farm constructed wetlands shape up for enhancing native biodiversity? Oral presentation, New Zealand Ecological Society Conference, Lincoln 1–5 December 2019.

Taura Y, van Schravendijk-Goodman C 2019. He Pānui – Te Reo o Te Repo, Issue 5: Winton Wetlands Special, December 2019.

Taura Y, van Schravendijk-Goodman C 2019. Te Reo o Te Repo: The Voice of the Wetland, a cultural wetland handbook. Oral presentation, 5th Annual Wetland Restoration Science Forum 2019, 15–16 August 2019, Winton Wetlands, Melbourne, Australia https://wintonwetlands.org.au/category/events/

Taura Y, Wilcox M, Thompson K, Keelan W 2019. Ngāti Hauā Wetland Mauri Framework. Report prepared for Ngāti Hauā Mahi Trust. Hamilton, NZ: Manaaki Whenua – Landcare Research.

Watts CH, Clarkson BR, Campbell DI 2019. Moanatuatua Peat Scientific Reserve Restoration Plan. Landcare Research Report LC3605 for Department of Conservation. 35 p.

Media Release

Te Ao News January 2020. University researchers swamped with pūtea
https://www.teaomaori.news/university-researchers-swamped-putea

University of Waikato January 2020. Funding for bilingual wetland education project.
https://www.waikato.ac.nz/news-opinion/media/2020/funding-for-bilingual-wetland-education-project

Manaaki Whenua – Landcare Research 2020. Repo research gets the green light. Pūtaiao Newsletter, Issue 2.
https://www.landcareresearch.co.nz/publications/newsletters/putaiao/issue-2/repo-research-gets-the-green-light

Science Learning Hub 2019. Mātauranga Māori series – Te Reo o Te Repo http://bit.ly/2OLUksS