

Wetland Project Update 10: July 2020 to June 2021

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Overview

Our Manaaki Whenua – Landcare Research (MWLR) Resilient Wetlands research project is funded by the Strategic Science Investment Fund (SSIF) for Crown Research Institutes from the Ministry of Business, Innovation and Employment's (MBIE) Science and Innovation Group (previously 'core' funding). This update summarises the major outputs and successes delivered between July 2020 and June 2021. Our 5-year project has now finished, and we are hugely proud of what we have achieved! A continuation of funding to MWLR from MBIE means that wetland ecology work will continue.

Change of leadership

From July 2021 there will be a change of leadership as Bev winds down towards retirement. Olivia Burge, MWLR Lincoln, a plant ecologist specialising in community ecology and who joined the wetland project in 2016, will lead the research into the foreseeable future. Bev would like to thank all wetland team members for their dedication and commitment to improving outcomes for our wetlands over the last 25 years. Our work has contributed to increasing public knowledge and appreciation of wetlands and their values, and has provided scientifically based tools and techniques for management and restoration. With new government policy to protect, manage, and restore wetlands (see below), we are confident the future looks bright for continued research funding.

Informing national policy

Our wetland research contributed to the government's Essential Freshwater package, which came into force on 3 September 2020 to protect New Zealand's freshwater resources. The new National Policy Statement for Freshwater Management 2020 and National Environmental Standards for Freshwater will prevent further loss and degradation of freshwater habitats, including wetlands. Bev Clarkson was member of the government-appointed STAG (Science and Technical Advisory Group) as the wetland science representative and has also contributed to guidance for wetlands. Suzanne Lambie led the development of the hydrology tool for wetland delineation, thus completing all three tools in the wetland delineation toolbox (vegetation, soils, hydrology; Fig. 1), available on the MfE website at <https://environment.govt.nz/publications/wetland-delineation-hydrology-tool-for-aotearoa-new-zealand/>. We also revised and updated the wetland indicator status ratings in the New Zealand wetland plant list, available as an Excel spreadsheet at <https://catalogue.data.govt.nz/dataset/nz-wetland-plant-indicator-status-ratings-2021>



Figure 1 Wetland delineation training of Taranaki Regional Council staff with Scott Fraser, Midhirst. Photo: Bev Clarkson



Figure 3 Ngā atua wāhine o te repo original artwork series. Clockwise from top left: Hine-i-te-repo, Parawhenua, and Wainui-ātea. Illustrator: Te Kura Ormsby (Ngāti Maniapoto)



Figure 4 Pūrekireki (*Carex secta*) at Lake Kanohirua, Te Uruwera. Image used for the front cover of a chapter. Photo: © Neil Fitzgerald Photography

***Tuihonoa Te Reo o Te Repo* – Wetland educational resources**

MWLR (led by Yvonne Taura) and Science Learning Hub (LSH) collaborated to develop a suite of bilingual, digital wetland educational resources, *Tuihonoa Te Reo o Te Repo*, which were drawn extensively from the *Te Reo o Te Repo* wetland handbook series. This was launched on World Wetlands Day, 1 February 2021, at the Te Tuna Haerenga, Lake Ngāroto, Waikato (Figs 4–5). The resources were published in November 2020, with an online launch shared with a selection of guests who supported the year-long project. *Tuia ngā repo me ngā tāngata – reconnecting communities with their wetlands* was funded by the New Zealand Government’s Unlocking Curious Minds initiative and supported by MWLR (SSIF) and the University of Waikato.

The suite of resources includes over 30 articles illustrating Māori-led wetland research, respective teaching learning guides for the classroom, interactive image maps to navigate the site, and a collection of short videos featuring key wetland experts, kaitiaki, and kairangahau Maori who supported the development of these resources. *Tuihonoa Te Reo o Te Repo* is published exclusively on the Science Learning Hub website <https://www.sciencelearn.org.nz/images/4483-tuihonoa-te-reo-o-te-repo> and has been showcased in various media, e.g.

Scoop News, 1 February 2021: New wetland educational resources released to help reconnect tamariki with their local repo. <https://www.scoop.co.nz/stories/PO2102/S00006/new-wetland-educational-resources-released-to-all-schools-to-help-reconnect-tamariki-with-their-local-repo.htm>

The Gisborne Herald, 16 February 2021: Reconnecting tamariki with valuable wetlands <https://static.ew.ghe.navigacloud.com/wp-content/uploads/sites/2/2021/02/17013257/210216GH.pdf>



Figure 1: Yvonne Taura with SLH team members (left to right) – Greta Dromgool, Louis Schipper (UOW researcher), Yvonne Taura, Angela Schipper, and Cathy Bunting, At the launch of *Tuihonoa Te Reo o Te Repo*, Te Tuna Haerenga event hosted by the National Wetland Trust. Lake Ngāroto, Waikato. Photo: National Wetland Trust



Figure 2 Screenshot of webpage – Interactive map for navigating te reo Māori wetland content. Source: Science Learning Hub website https://www.sciencelearn.org.nz/image_maps/96-te-whakamahi-i-nga-rauemi-o-tuihonoa-te-reo-o-te-repo-hei-whakarite-ara-whakaako

Integrated Constructed Wetlands and associated projects

Led by Suzanne Lambie, MWLR is expanding their Integrated Constructed Wetland (ICW) work that is aligned with the wetland programme. Working with the Kimihia Lakes Community Charitable Trust and the Waikato River Authority, a 3.6-hectare degraded wetland system has been assessed and deemed suitable for the implementation of a large ICW system in line with the objectives of the Trust for a community-focused restoration of the Kimihia Lakes system as a whole. The system will be constructed over the next few years and will supplement the information gathered from the Walker and Stokes ICWs near Taupiri.

The Walker and Stokes ICWs (Fig. 6) continue to develop rapidly, despite having to replant the third and fourth ponds due to poor survival, partly because of pūkeko damage and partly due to inadequately sized plants. Plans are in place to continue monitoring the performance of the ICWs for water treatment efficiency. Certainly, the system shows considerable promise for the removal of contaminants from dairy farm run-off, with Cell 1 (of 4) being highly efficient for treatment of nitrate (as high as 96% removal), phosphorus (98%) and suspended solids (99%).

Work aligned with the wetlands project revealed a different microbial community structure in the water compared to the soil, fresh humus and sediment in constructed wetland systems (<https://www.sciencedirect.com/science/article/abs/pii/S0925857421000938>). This work also indicated that Constructed Treatment Wetlands (CTWs) have microbial communities with a high resistance but low resilience to perturbations. Expanding on that work, the presence of plants in the Cells 1 and 2 at the Walker ICW decreased microbial biomass for all the microbial groups isolated and reduced enzymatic function, indicating a reduction in nutrient cycling soils. We also showed that microbes in the water phase were more responsive to perturbations than microbes in the soil in the ponds, implying a buffering effect in the soil, regardless of plant presence, absence, or species composition.

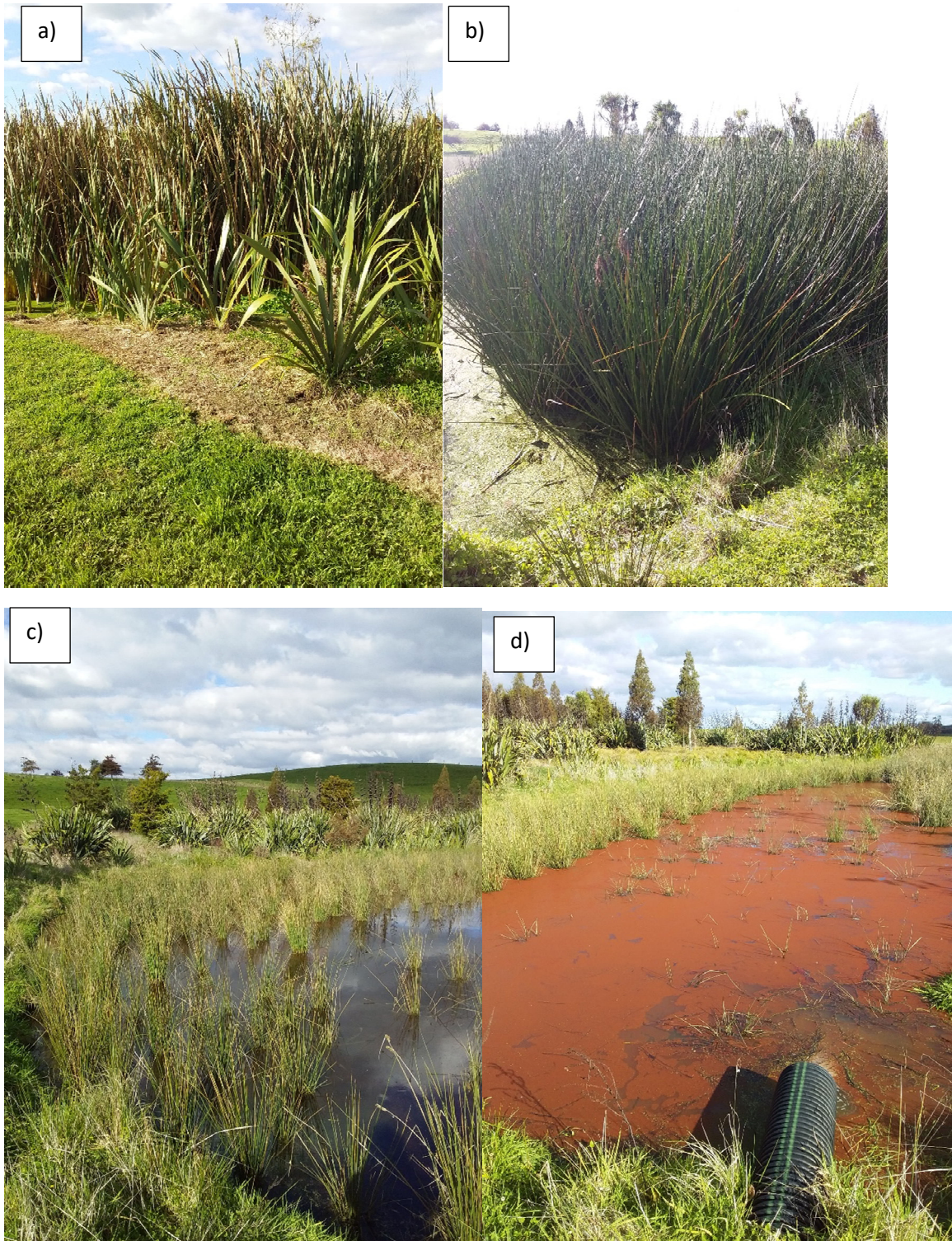


Figure 6 Cell 1 a) with *Typha orientalis*, Cell 2 b) with *Machaerina articulata*, Cell 3 c) with *Juncus pallidus*, and Cell 4 d) with a mix of *Schoenoplectus tabernaemontani*, *Juncus pallidus* and *Machaerina articulata*. Photos: Suzanne Lambie, 28 May 2021.

Carbon exchange research (University of Waikato UOW)

Research in our UOW subcontract has been very productive over the past year. A final paper has been published from Joss Ratcliffe's PhD, titled "*Rapid carbon accumulation in a peatland following Late Holocene tephra deposition, New Zealand*" (Ratcliffe et al. 2020), which yielded insights about the role of volcano-derived nutrient inputs in shaping the long-term rates of carbon accumulation in restiad peatlands. There are important implications for present-day peatland ecosystem carbon balances and carbon-climate feedbacks due to anthropogenic modifications to global nutrient cycling.

A 4-year dataset of methane fluxes was contributed to the global FLUXNET-CH4 project (Campbell & Goodrich, 2020). This consortium of global freshwater wetland research sites has yielded three significant published papers in the year to June (Chang et al. 2021; Irvin et al. 2021; Knox et al. 2021), as well as a fourth paper published in August 2021 (Delwiche et al. 2021). The Kopuatai dataset has played significant parts in all these papers because it is the only Southern Hemisphere peatland represented. Overall, the publications have yielded unprecedented new insights into the factors controlling global wetland methane emissions.

Alice Wheatley-Wilson received an MSc scholarship to support her research on the temperature sensitivity of methane production in both intact and drained peatland settings. The thesis will be submitted in August 2021 and will lead to submission of a journal manuscript. Her supervisors are Jordan Goodrich and Dave Campbell. As the climate warms, studies of the temperature sensitivity of methane production are emerging as a globally important research topic. Alice's study is likely the first globally to use the MMRT theory, developed at the University of Waikato, to model peat methane production rates.

Peatlands in the media (UOW)

Our UOW team has featured regularly in the media recently, with a focus on the role of intact or restored peatlands as significant carbon and GHG sinks, and the negative consequences of draining peatlands for agriculture.

In the May edition of *NZ Geographic*, Veronika Meduna wrote about what it would take to restore peat wetlands in the Hauraki ([link](#)).

In Stuff's *The Forever Project* in July, Eloise Gibson interviewed Dave Campbell and Louis Schipper about research on carbon and greenhouse gas emissions from intact and drained peatlands ([link](#)).

In an article in *The Conversation*, Prof. Sebastian Leuzinger (AUT) wrote about NZ native forests but included a description of the importance of peatland restoration, using Kopuatai as an example ([link](#)).

In another *The Forever Project* article, Eloise Gibson wrote about the politics of Government funding for the Muggeridges pump drainage scheme in the Lower Hauraki, using Kopuatai as an intact peatland example ([link](#)).

UOW informing GHG inventory methods

Dave Campbell and others from the UOW team have been active in the drained agricultural peatland research and GHG inventory spaces, publishing a paper on CO₂ emissions (Campbell et al. 2021) as part of the international PEATWISE project. One outcome of this work has been a revision of the NZ GHG inventory methods, initially recommended by UOW MSc graduate Georgie Glover-Clark (now MWLR), acting as an expert reviewer for MPI. This led to a 21-fold increase in estimated N₂O emissions from drained peatlands in the 2021 inventory (1990–2019) and has encouraged MPI and MfE to seek advice on transitioning NZ to the IPCC 2013 *Wetland Supplement Methodology*.



Figure 7 Georgie Glover-Clark and Dave Campbell in the middle of Kopuatai Bog. Drone photo: Georgie Glover-Clark

Snippets

- Mahuru Wilcox and Yvonne Taura were funded to feature in a documentary to discuss wetlands from a Te Ao Māori perspective. The soil quality episode of the Milk and Money documentary, which features Mahuru and some spectacular images of Toreparu Wetland, has been shown to the public and is also available at: <https://www.renews.co.nz/our-soil-quality-has-been-declining-for-decades-dairy-is-making-it-worse-milk-and-money-episode-5/>
- Suzanne Lambie led a comprehensive literature review on the abiotic and biotic drivers of greenhouse gas production (GHG) from constructed treatment wetlands was completed. The report found that plants regulate GHG production both directly by internal transportation of gases through oxygen transport pathways but also indirectly by impacting microbial communities. The report informs a research strategy for assessing in-farm wetlands.
- Clara Wilson was awarded a graduate completion scholarship to encourage publication of her MSc thesis research on Kopuatai peat bog ecosystem recovery from fire. Her first manuscript, on the Kopuatai peat seedbank, has been submitted to *Austral Ecology* (Wilson et al., submitted).
- Georgie Glover-Clark flew her drone at Kopuatai in May 2021 (Fig. 7) and obtained stunning imagery that has appeared in media articles and a video ([link](#)). The goal is to use these images as an educational resource.

Papers and reports (selection)

Burge OR, Clarkson BR, Eger A, Fitzgerald N 2021. Wetland plant foliage nutrients as indicators of soil nutrients. Envirolink Grant: 2123-HBRC260. Manaaki Whenua – Landcare Research.

Campbell DI, Glover-Clark GL, Goodrich JP, Morcom C, Schipper LA, Wall AM 2021. Large differences in CO₂ emissions from two dairy farms on a drained peatland driven by contrasting respiration rates during seasonal dry conditions. *Science of The Total Environment*, 760, 143410. <https://doi.org/10.1016/j.scitotenv.2020.143410>.

Campbell D, Goodrich J 2020. FLUXNET-CH₄ NZ-Kop Kopuatai, New Zealand, FLUXNET-CH₄ Community Product [data set], <https://doi.org/10.18140/FLX/1669652>.

Chang K-Y, Riley WJ, Knox SH, Jackson RB, McNicol G, Poulter B, Aurela M, Baldocchi D, Bansal S, Bohrer G, Campbell DI et al. 2021. Substantial hysteresis in emergent temperature sensitivity of global wetland CH₄ emissions. *Nature Communications*, 12, 2266. <https://doi.org/10.1038/s41467-021-22452-1>

Clarkson BR, Fitzgerald NB, Champion PD, Forester L, Rance BD 2021. New Zealand Wetland Plant List 2021. Manaaki Whenua – Landcare Research Contract Report LC3975 for Hawke’s Bay Regional Council. 58 p. [report](#)

Clarkson BR, Fitzgerald NB, Champion PD, Forester L, Rance BD 2021. New Zealand wetland plant indicator status ratings 2021. Manaaki Whenua – Landcare Research Datastore. Plant species list downloadable as an Excel spreadsheet: [species list](#)

Delwiche KB, Knox SH, Malhotra A, Fluet-Chouinard E, McNicol G, Feron S, Ouyang Z, Papale D, Trotta C, Canfora E, Cheah YW, Christianson D, Alberto MCR, Alekseychik P, Aurela M, Baldocchi D, Bansal S, Billesbach DP, Bohrer G, Bracho R, Buchmann N, Campbell DI... Goodrich JP et al. 2021. FLUXNET-CH₄: a global, multi-ecosystem dataset and analysis of methane seasonality from freshwater wetlands. *Earth System Science Data* 13: 3607–3689. <https://doi.org/10.5194/essd-13-3607-2021>.

Irvin J, Zhou S, McNicol G, Lu F, Liu V, Fluet-Chouinard E, Ouyang Z, Knox SH, Lucas-Moffat A, Trotta C, Papale D, Vitale D, Mammarella I, Alekseychik P, Aurela M, Avati A, Baldocchi D, Bansal S, Bohrer G, Campbell DI... Goodrich JP et al. 2021. Gap-filling eddy covariance methane fluxes: Comparison of machine learning model predictions and uncertainties at FLUXNET-CH₄ wetlands. *Agricultural and Forest Meteorology* 308–309: 108528. <https://doi.org/10.1016/j.agrformet.2021.108528>.

Knox SH, Bansal S, McNicol G, Schafer K, Sturtevant C, Ueyama M, Valach AC, Baldocchi D, Delwiche K, Desai AR, Euskirchen E, Liu J, Lohila A, Malhotra A, Melling L, Riley W, Runkle BRK, Turner J, Vargas R, Zhu Q, Alto T, Fluet-Chouinard E, Goeckede M, Melton JR, Sonnentag O, Vesala T, Ward E, Zhang Z, Feron S, Ouyang Z, Alekseychik P, Aurela M, Bohrer G, Campbell DI... Goodrich JP et al. 2021. Identifying dominant environmental predictors of freshwater wetland methane fluxes across diurnal to seasonal time scales. *Global Change Biology*. <https://doi.org/10.1111/gcb.15661>

Lambie SM, Clarkson BR, Fraser S, Price R 2021. Wetland delineation hydrology tool for New Zealand. Wellington: Ministry for the Environment. 60 p. Available as: <https://environment.govt.nz/publications/wetland-delineation-hydrology-tool-for-aotearoa-new-zealand/>

Pan Y, Cieraad E, Armstrong J, Armstrong W, Clarkson BR, Colmer TD, Pedersen O, Visser EJW, Voosenek LACJ, van Bodegom PM 2020 Global patterns of the leaf economics spectrum in wetlands *Nature Communications* 11(1): 1–9. <https://doi.org/10.1038/s41467-020-18354-3>

Ratcliffe JL, Lowe DJ, Schipper LA, Gehrels MJ, French AD, Campbell DI 2020. Rapid carbon accumulation in a peatland following Late Holocene tephra deposition, New Zealand. *Quaternary Science Reviews* 246: 106505. <https://doi.org/10.1016/j.quascirev.2020.106505>.

Wilson CR, Lusk CH, Campbell DI Submitted. Germination from the peat seed bank of a fire-prone New Zealand restiad bog. *Austral Ecology*.

Wood J, Burge OR, Bolstridge N, Bonner K, Clarkson B, Cole TL, Davis C, Fergus A, King P; McKeown MM, Morse C, Richardson SJ, Robertson H, Wilmshurst JM 2021. Vertical distribution of prokaryotes communities and predicted metabolic pathways in New Zealand wetlands, and potential for environmental DNA indicators of wetland condition. *PLOS ONE* 16(1): e0243363.

Presentations and other media releases (selection)

Taura Y 2021. *Ngā hurihanga o Hine-i-te-repo – The changing cycles of the swamp maiden*. NZILA Firth conference, 6–7 May 2021, Tauranga NZ. <https://www.youtube.com/watch?v=bqJBGd7TM0g>

Taura Y, van Schravendijk-Goodman C, Dromgool G 2021. *Tuia ngā repo me ngā tāngata – Reconnecting communities with their wetlands*. Re-Peat Peat-Fest 2021.

Taura Y, Wilcox M, Clarkson B 2021. *Te Reo o Te Repo – The Voice of the Wetland, a cultural wetland handbook*. LINK online, 2 February 2021.
<https://www.youtube.com/watch?v=O3g7KMZFIKY>

Wilcox M, Taura Y 2021. *Te Ao Māori – values-based research and wetland health*. LINK online, 13 April 2021. [Te Ao Māori values based research and wetland health - YouTube](#)

Peat emissions have been in the news (*Waikato Times*): <https://www.stuff.co.nz/environment/climate-news/125398921/uncounted-and-unseen-is-this-the-biggest-planet-warmer-youve-never-heard-of>