Restoring Wetlands/Resilient Wetlands Research Programme Update 6: July 2015 to June 2017

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Overview

Our 6-year MBIE contestable Restoring Wetlands research programme ended on 30 September 2016. However, the good news is wetland research (now 'Resilient Wetlands') has long term 'CORE' funding following allocation of new money for freshwater research from the 2016 Government Budget. This will provide much-needed security for ongoing wetland work. The following update summarises the major outputs and successes of the 2-year period between July 2015 and June 2017.

Restoration targets met for Restoring Wetlands programme: Our Restoring Wetlands Programme aim was for a 15% increase in the number and areal extent of wetlands being restored in 2016 compared with 2009. Near the end of the programme we conducted a survey of wetland restoration practitioners around NZ and received results from 26 organisations, reporting on 135 wetland restoration projects (Meinecke et al. 2016). Since 2009, the number of wetland projects has increased by 17%, and the area of wetlands undergoing restoration has increased by 28%. The most common wetland restoration activities reported were planting of native species, fencing, and weed control. This reflects the growing awareness of the values of wetlands and their ongoing degradation, and the desire for on-the-ground management improvements. It also reflects the increasing availability of tools developed by our programme (e.g. wetland monitoring protocols and subsequent updates), best practice techniques (e.g. wetland restoration and wetland cultural handbooks), and knowledge (e.g. transferred via the National Wetland Restoration Symposia) to ensure more successful and cost-effective restoration outcomes.

Best practice handbook for enhancing wetland cultural values: Our national handbook. *Te Reo o te Repo – the voice of the wetland*, is an online wetland handbook created collaboratively between the Waikato Raupatu River Trust and our wetland programme (Taura et al. 2017). It was launched at a World Wetland Day event at Lake Rotopiko, Waikato, in February 2017. The handbook (180 p.) highlights a range of mahi (work) undertaken by iwi and hapū to increase the health and well-being of their repo (wetlands). The articles are written by Māori researchers from around NZ, as well as researchers who work with iwi and hapū partners. Contributed articles from the wetland programme cover a range of topics including noke (worms: Bartlam 2017), invertebrates (Watts 2017), rakau preservation (Taura 2017), Maurea Islands (van Schravendijk-Goodman et al. 2017), and Toreparu Wetland (Robb & Thomson 2017). The handbook aims to provide best practice techniques for enhancement and protection of cultural wetland values to share with tangata whenua throughout the motu (country). It will also help local authorities, research providers, and community groups understand cultural priorities for wetland restoration. The handbook is available on-line at http://www.landcareresearch.co.nz/publications/books/te-reo-o-te-repo

Te Reo o te Repo cover, with editors Yvonne Taura (middle), Cheri van Schravendijk-Goodman (right) and Bev Clarkson (left)

Waikato repo group for cultural guidance

A Waikato repo (wetland) group comprising iwi partners (Waikato-Tainui and iwi from the wider Waikato rohe) has been established. The aim of the group is to share restoration progress and ideas both from within the programme and from independent wetland initiatives, and to provide support. It will also identify collaborative mātauranga Māori-based projects using Kaupapa Māori methodology to meet Māori aspirations in the Waikato rohe, which can be integrated into the wetlands research programme. Mechanisms for uptake include wānanga, annual hui, restoration site field visits, training workshops, and module contribution to our web-based *Te Reo o te Repo* cultural wetland handbook (Taura et al. 2017), which is accessible to iwi throughout the motu, as well as the New Zealand public in general. The inaugural repo hui in January 2016 had a good turnout, with participants representating 7 Maori groups from around the Waikato.

Mahuru Wilcox (nee Robb) (left) taking notes at our inaugural Waikato repo group hui, January 2016, Hopuhopu.

Toreparu Wetland restoration: In August 2016, a Toreparu Wetland Restoration Group community meeting was held to discuss future plans and funding opportunities for wetland restoration. There were 22 attendees, including landowners, iwi representatives, Landcare Research, DOC, Waikato Regional Council, and a contractor who provided options and budget for willow removal. The evening was very productive, and options for willow control were discussed at length. This led to the WRC leading a Freshwater Improvement Fund (MfE) proposal. Landcare Research supported this process as it was seen as an excellent case study site for the LCR Resilient Wetlands work with iwi. Unfortunately, the proposal was unsuccessful in the Freshwater Improvement Fund process and will continue to seek other funding opportunities.

Toreparu Wetland Restoration Group, community meeting, August 2016.

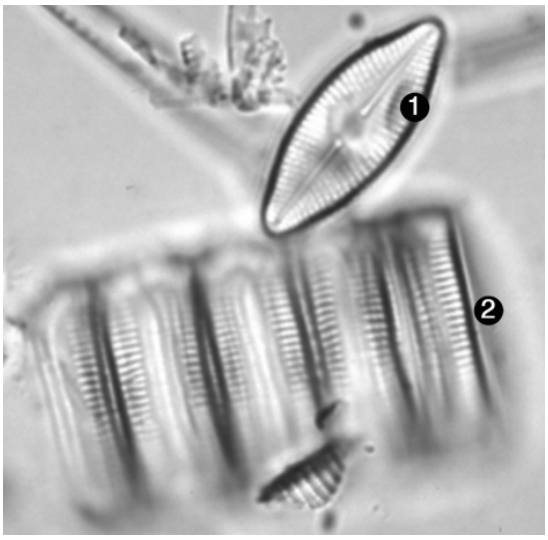
Contribution to national wetland restoration symposium: The biennial National Wetland Restoration Symposium, organised by the National Wetland Trust (NWT), is a key conference for wetland researchers and restoration practitioners. We continue to contribute significantly, with 18 presentations/workshops provided by programme members at the 2016 symposium in Nelson. This included a wetland programme closeout workshop summarsing key research findings and outcomes from the 2010–2016 programme, and several other technical presentations by our wetland researchers. Many of the presentations are available as pdfs on the NWT website: http://www.wetlandtrust.org.nz/Site/Wetland_Events/Restoration_Symposia.ashx

Advances in native vegetation restoration of willow-invaded mires: Willows (*Salix*) are a major threat to wetlands because they alter the structure and composition of native vegetation communities. Aerial application of glyphosate herbicide on grey willow (*S. cinerea*) at Whangamarino Wetland was monitored in a BACI-design experiment to evaluate its effectiveness for control of dense stands and determine the vegetation trajectory. We found glyphosate significantly reduced grey willow cover, but willow regrowth via seedling establishment occurred relatively rapidly. Although native sedge communities had become locally dominant after two years, these are predicted to be overtopped again by the re-establishing willow trees (Burge et al. 2017). Large-scale management options in the long term include repeated application of herbicide once the willow canopy has closed (e.g. every c. 5 years) and/or establishing a more resilient native community, such as kahikatea swamp forest, which can overtop and outcompete the willow. Experimentally testing various treatments for kahikatea establishment are currently underway. The project, a long-term collaboration with DOC's Arawai Kākāriki programme, provides best practice techniques on restoring large-scale, willow-invaded wetlands for land managers, owners, and community groups.

Glyphosate herbicide not directly toxic to invertebrates: Experiments on responses of invertebrates to glyphosate control of grey willow at Whangamarino Wetland (aligned with the vegetation restoration experiment above) showed no direct short-term (0–7 days post-spray) impacts on terrestrial invertebrates (Watts et al. 2016). Instead, after 30 days, significant decreases in invertebrate richness and abundance were recorded in sprayed plots compared with control plots. Decreases were associated with the loss of willow canopy caused rather by leaf fall and death of the willow trees, which occurred 7 days after spraying, than from direct toxic effects of the herbicide. Subsequent monitoring showed invertebrate numbers increased over the next two years, which was associated with an initial influx of introduced annuals, and then recovery of native vegetation, particularly sedges (Watts et al. 2015). Similarly, aquatic invertebrates were not directly affected by glyphosate spraying. However, in contrast to terrestrial invertebrates, aquatic communities in both the control and spray zones did change over time, but in response to environmental factors, such as drought (Wech et al. 2017). Our work showed restoration via invasive plant control can promote the re-establishment of overall invertebrate communities typical of native wetlands, but long-term sustainability is contingent on prevention of grey willow reinvasion and re-establishment of the native plant habitat.

Whangamarino Wetland monitoring after 2012 willow control, L: 2013 (B Clarkson), R: 2015 (K Bodmin).

Algal indicators of wetland condition: We explored the potential for microscopic algae attached to submerged wetland plant stems (epiphytic diatoms) to provide information on wetland condition using data from 77 lowland sites (mainly palustrine swamps) with circumneutral pH (Kilroy et al. 2017). In the South Island, correspondence between diatoms and wetland indices or water quality was weak. In the North Island, conductivity and total dissolved nitrogen (TDN) together explained around half the variance in assemblage composition, and several diatom genera were indicative of high or low conductivity and dissolved nutrient concentrations. Our results showed that diatoms (silicaceous algae) respond rapidly to water quality changes,



suggesting their potential as indicator taxa to provide early warnings of wetland degradation or to track restoration success.

Photo shows *Diadesmis confervacea*, an elongated chain-forming epiphytic diatom found to be strongly indicative of wetland condition index in the North Island sites investigated. Numbers refer to views from different angles. Long axis of frustule ~10–20 µm.

Increasing science research capability: We welcome Joss Ratcliffe (from Highlands and Islands University, Scotland) who started his PhD with Dave Campbell, University of Waikato, on carbon accumulation in restiad peatlands. Joss's research includes reconciling the rate of long-term carbon accumulation, occurring over centuries to millennia, with the comparatively rapid rate of contemporary carbon sequestration. As part of the project, a drainage-impacted site, Moanatuatua, will be compared with an intact peatland, Kopuatai, to forecast the ecosystem trajectory of modified peatlands and the fate of the carbon stored within them. At Kopuatai bog in the Hauraki, University of Waikato researchers are looking towards celebrating the 6-year anniversary of the establishment of their ecosystem water and carbon research site. Their third major publication (Goodrich et al. 2017) found that intact NZ bogs have important feedbacks that make them quite resilient to climatic extremes, such as the severe drought years of 2013 and 2014. Like many similar long-term research sites worldwide, longer datasets become increasingly precious. Currently, Kopuatai bog carbon and water exchange measurements are providing a key reference point for Joss's PhD research.

Otakairangi peatland ecohydrological restoration: Dave Campbell completed a report on the ecohydrology and restoration potential of Otakairangi peat wetland in Northland, a focus of the DOC/Fonterra Living water initiative. Along with surveys carried out by Bev Clarkson and Scott Bartlam, it was discovered that there has been substantial recovery of natural indigenous peatland vegetation, following over 100 years of drainage, fire, and peat degradation.

Dense cover of wire rush (*Empodisma robustum*) and tangle fern (*Gleichenia dicarpa)*, Otakairangi wetland, Northland (D Campbell).

Uptake of wetland monitoring protocols by regional councils: Regional/unitary councils continue to incorporate our wetland monitoring protocols into their monitoring requirements. Over the past year we have assisted several councils develop and/or implement wetland monitoring programmes for State of the Environment (SOE) reporting. This includes establishing programmes for monitoring representative wetlands, training, and setting baseline frameworks. Our ongoing development of and input into monitoring approaches will enable councils, and other stakeholders to use up-to-date national approaches to assess change in the condition of wetlands, particularly when the new wetland management requirements under the National Policy Statement for Freshwater Management (NPS–FM 2014) come into force.

Scott Bartlam and Keiko Hashiba (HBRC): mid-winter monitoring of wetlands in the Tukituki catchment.

Mitigation wetlands: Bev Clarkson was invited to Ireland in August 2015 by Dr Rory Harrington, VESI Environmental for a 5-day field symposium on Integrated Constructed Wetlands (ICWs) to scope application for NZ environments. ICWs consist of a series of 4–5 shallow free-surface-flow constructed wetland cells containing emergent vegetation. They typically have greater land area requirements than conventional surface-flow constructed wetlands, but their larger footprint facilitates a greater range of physical, biological and chemical processes and richer habitat diversity. These 'reanimated' wetlands clean up waterways and provide multiple ecosystem service benefits (biodiversity, recreational, aesthetic, and economic). Dr Harrington pioneered the ICW approach, which has widespread uptake in United Kingdom and Europe. We organised a reciprocal visit to NZ (February 2016) to assess ICW application to Waikato catchments, and Dr Harrington presented an all-day workshop for multi-stakeholders. Workshop presentations are available on our wetland programme website: ICW workshop part 1,2 & 3. We are currently looking for a Waikato site where we can establish an ICW for research and wider educational (university and general public) purposes.

An extensive Integrated Constructed Wetland system, Dunhill, Ireland.

Snippets

- The University of Waikato hosted visiting Canadian peatland researcher on sabbatical, Prof. Peter Lafleur (Trent University, Ontario) for 2 months, Jan–Mar 2017. Peter is known as a pioneering researcher whose focus for several decades has been on the carbon balances of Canadian peatlands and their sensitivity to changes in climate. Much of Peter's current research focus has been on arctic ecosystems that have been undergoing dramatic changes linked to a warming climate.

- Two MSc students at the University of Waikato have started wetland restoration-focussed research projects. Connie Daws will investigate the causes of the modified hydrology at the remnant Moanatuatua bog, utilising measurements of ecosystem-scale evaporation and rainfall collected from our existing eddy covariance tower, and water table measurements collected from a transect of water level loggers in place since 2015, in a partnership with the Department of Conservation. Callum Douglas's research will take place in Otakairangi peatland, a precious remnant of the once vast Hikurangi "Swamp" wetlands that existed before extensive drainage over 100 years ago. He will focus on the ecohydrology and impacts of drains on recovering vegetation communities and peat formation, providing valuable knowledge that will inform future restoration efforts. Callum's project will be in association with DOC and Fonterra under the Living Water initiative.

- The wetland programme hosted two international interns at Landcare Research, Hamilton: Noriko Peeters, Japan, in 2016, and Susan Elcock, Bangor University, UK, in 2017. Their projects were based on various community restoration initiatives at Lake Rotopiko, in collaboration with the National Wetland Trust.

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