Restoring Wetlands Research Programme Update 5: July 2014 to June 2015

Bev Clarkson, Dave Campbell, Corinne Watts, Kerry Bodmin

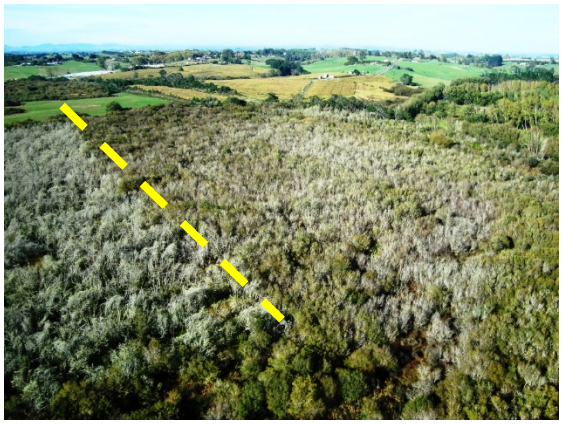
Plant and invertebrate community responses to grey willow control at Whangamarino

Grey willow (*Salix cinerea*) is a troublesome invasive species in many New Zealand mires, as it spreads rapidly and displaces native species. Between January 2011 and March 2014, we investigated the effect of grey willow control on the plant and invertebrate communities in a large-scale BACI-design experiment at Whangamarino wetland, Waikato. In February 2012, half the experimental plots were aerially sprayed with glyphosate, targeted at killing the grey willow present. The recovery of invertebrate and vegetation assemblages has been monitored since then. Initial vegetation results in the treated area showed die back of grey willow canopy with a resultant increase in annuals, perennials (often weedy), and native sedges. The invertebrate community compositional changes were shown to be strongly linked to the plant communities. This suggests that while restoration via invasive plant control can promote the re-establishment of invertebrate communities typical of native wetlands, their long-term sustainability is contingent on prevention of grey willow re-invasions and re-establishment of the native plant habitat. The next phase of the experiment focuses on restoration of a more sustainable native-dominated ecosystem (see next section).

Whangamarino wetland before willow control (left) and 1 year after willow control (right). Photo: D. Thornburrow

Restoration of native vegetation in willow-invaded mires

The second stage of the experiment focuses on enhancing longer-term restoration. This began in 2015 with aerial spraying of the remaining grey willow canopy followed by planting of kahikatea. Kahikatea is one of the few native wetland trees that can overtop and hence out-compete the willow, but there is very little seed source remaining in Whangamarino wetland. Kahikatea re-establishment in willow-dominated areas appears to be hampered by relatively slow growth rate and shading by the willow canopy. Kahikatea seedlings c. 1 m tall, were planted individually and in clumps, under two main treatments. The treatments were based on small-scale community group approaches, e.g. manually maintaining light wells, and large-scale, whole-wetland approaches, e.g. pulse control when willow canopies close. Future monitoring will determine survival and growth rates, and the implications for restoring grey willow wetlands into kahikatea dominated swamps. The experiment is a long-term collaboration between Landcare Research, National Institute of Water and Atmosphere, and the Department of Conservation.




Left: Grey willow experimental block: right side of line aerially sprayed in 2015 showing die-back, left side previously sprayed in 2012.
Right: Planting of kahikatea (circled) in clumps in 2015 by Chris Tanner, James Sukias (NIWA), and Cara Hansen (DOC). Photos: K Bodmin

Peatland carbon research completed

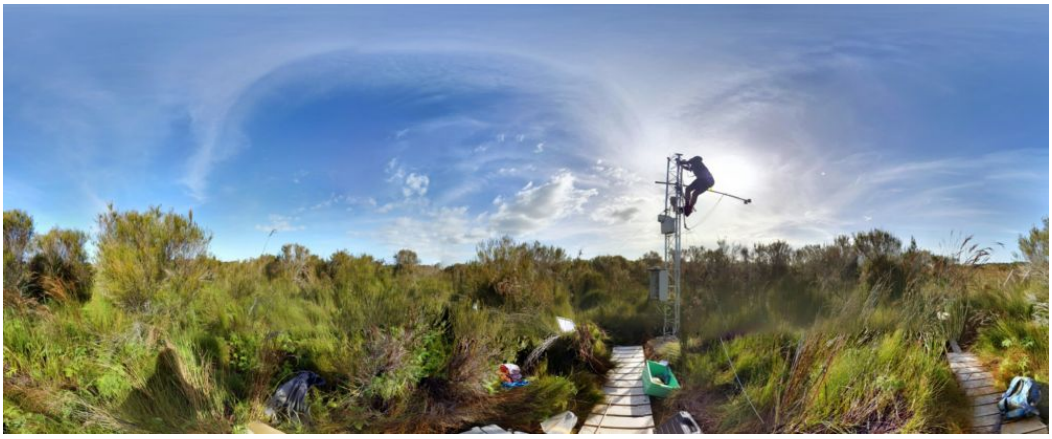
Jordan Goodrich completed his PhD thesis at the University of Waikato on the ecosystem carbon balance at Kopuatai bog, and its sensitivity to climate and hydrology at a range of timescales. Jordan has published two papers out of his thesis so far, with a third currently close to submission. Key research outcomes were that, unlike Northern Hemisphere bogs, the year-round growing conditions and evergreen restiad-dominated vegetation lead to Kopuatai bog having net carbon uptake from the atmosphere for around 9 months of each year. Ecosystem-scale photosynthesis was very sensitive to atmospheric conditions, with greater CO_2 uptake under cloudy, cool, and humid conditions. During the 2013 and 2014 summer droughts, more CO_2 was lost via respiration from the deeper layer of peat exposed to the air, while methane production plummeted. Under normally high water table conditions, Kopuatai bog is a much larger source of methane than its Northern Hemisphere counterparts, but this is outweighed by its ability to extract large amounts of CO_2 from the atmosphere. Overall, the bog's carbon balance appears fairly resilient to the impacts of drought, which is good news, given predictions of more frequent severe droughts.

Elyn Humphries and Jordan Goodrich at Kopuatai. Photo D. Campbell

Research underway at Moanatuatua bog

Driven by a need to understand the impacts of altered hydrology on the functioning and sustainability of rare peatland plant communities in the remnant Moanatuatua peat bog in the southern Hamilton Basin, new research has begun as a collaboration between DOC, the University of Waikato, and Landcare Research. An eddy covariance tower has recently been installed in the centre of the bog, and a long-term hydrological monitoring network is in the process of being installed. Key research

questions to be addressed by new PhD student, Joss Ratcliffe (starting October 2015), will be focussed on the impact of the lowered water table on the peatland's carbon balance over annual to decadal timescales, and whether peat is still accumulating. Restoration options will then be explored, hopefully in parallel with improved marginal farmland management.



360 degree panorama during research equipment installation at Moanatuatua bog. Photo C. Morcom

Recce to Moanatuatua bog: John Gumbley, Keith Thompson, Bev Clarkson, Elyn Humphreys. Photo D. Campbell

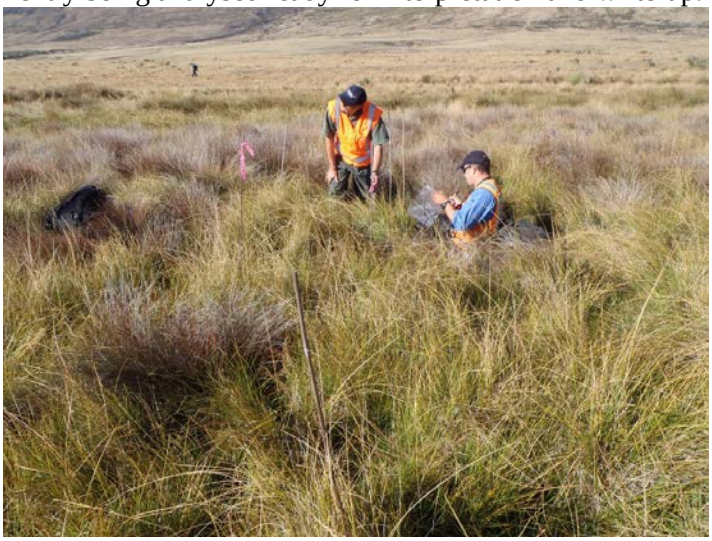
Waikato-Tainui-led restoration of Maurea Islands

Maurea Islands, two islands on the Waikato River close to Maurea Marae and totalling 16 ha, have been returned to Waikato-Tainui. However, they are dominated by troublesome exotic species, such as yellow flag iris, reed sweet grass, alder, and gorse. Waikato-Tainui received Waikato River Authority funding for 2 years, up until June 2015, to develop new techniques for eradicating invasive pest plants. On one island standard herbicides have been used, and on the other native plants have been trialled to out-compete the pest plants. While this is just the start of the goal of restoration of the whole of both islands, there was widespread support at the end-of-project hui in June 2014 to continue with the restoration. The project has featured as an episode of Project Whenua on Maori TV. http://www.sciencelearn.org.nz/Contexts/Toku-Awa-Koiora/Sci-Media/Video/Maurea-Islands

Snippets

- The 3-year fertiliser experiment at O Tu Wharekai (Ashburton Lakes) on the resilience of the O Tu Wharekai (Lake Clearwater) to N and P enrichment was completed in March 2014. This was a major plant harvesting and sampling operation involving several staff from NIWA,

Landcare Research and Department of Conservation. Biomass data and peat and foliage samples are currently being analysed ready for interpretation and write-up.



James Sukias and Scott Bartlam take substrate samples at O tu Wharekai. Photo: B. Clarkson

- Research on restoration of invertebrate communities in mined peat bog showed restoration of plant communities after peat extraction resulted in only partial recovery of invertebrate (beetle) assemblages. Small, native, and poorly dispersing taxa were not well represented in different-aged restoration plantings, and may require help to migrate to restore ecosystem functionality in the longer term.
- The first national estimation of carbon stocks in New Zealand freshwater wetlands has been published, based on soil data in the Landcare Research wetland database. The project showed the extensive conversion to agriculture since European settlement (90% wetland loss) threatens not only wetland biodiversity but also the stability of global climates through releasing significant amounts of CO_2 to the atmosphere each year.
- Fulbright scholar Sophie Burke, from the University of New Hampshire, USA, has been hosted at the University of Waikato and is researching the causes of delayed recovery of methane emissions following drought at Kopuatai bog.

Sophie Burke sampling water for dissolved methane concentration at Kopuatai. Photo D. Campbell

- Associate Professor Elyn Humphreys, from Carlton University, Canada, spent 3 months of her sabbatical at the University of Waikato in late 2014. Elyn has an extensive research and publication record in Canadian temperate and arctic peatland carbon and climate research, so she was fascinated by the distinctly different Waikato restiad bogs.

- The wetland programme hosted two international student interns during the year: Laura Meinecke, from Germany, whose main focus was to help the National Wetland Trust with restoration of Lake Serpentine wetland, site of the proposed National Wetland Centre; and Sergio Heynes, from Mexico, who focussed on wetland ecology in New Zealand wetlands.

Papers/theses (selection)

Amesbury MJ, Charman DJ, Newnham RM, Loader NJ, Goodrich JP, Royles J, Campbell DI, Roland TP, Gallego-Sala A 2015. Carbon stable isotopes as a palaeoclimate proxy in vascular plant dominated peatlands. Geochimica et Cosmochimica Acta 164: 161–174. DOI: 10.1016/j.gca.2015.05.011.

Ausseil A-GE, Jamali H, Clarkson BR, Golubiewski NE 2015. Soil carbon stocks in wetlands of New Zealand and impact of land conversion since European settlement. Wetlands Ecology and Management. DOI:10.1007/s11273-015-9432-4.

Goodrich JP 2015. Magnitude and controls on the net carbon balance of a New Zealand raised bog. Unpublished PhD thesis, University of Waikato, Hamilton. http://researchcommons.waikato.ac.nz/handle/10289/9345

Goodrich JP, Campbell DI, Roulet NT, Clearwater MJ, Schipper LA 2015. Overriding control of methane flux temporal variability by water table dynamics in a Southern Hemisphere, raised bog. Accepted article online, Journal of Geophysical Research – Biogeosciences, 120, DOI: 10.1002/2014JG002844.

Goodrich JP, Campbell DI, Clearwater MJ, Rutledge S, Schipper LA 2015. High vapour pressure deficit constrains GPP and the light response of NEE at a southern hemisphere bog. Agricultural and Forest Meteorology 203: 54–63.

Urbankova P, Kulichova J, Kilroy C 2014**.** *Frustulia curvata* and *Frustulia paulii*, two diatom species new to science. *Diatom Research*, http://dx.doi.org/10.1080/0269249X.2014.968625

Watts CH, Mason NWH 2015. If we build – they mostly come: partial functional recovery but persistent compositional differences in wetland beetle community restoration. Restoration Ecology: DOI: 10.1111/rec.12227.

Watts C, Ranson H, Thorpe S, Cave V, Clarkson B, Thornburrow D, Bartlam S, Bodmin K. Accepted. Invertebrate community turnover following control of an invasive weed. Arthropod-Plant Interactions.