Manaaki Whenua
Landcare Research

Pre-human vegetation of the Pakowhai Wetland QEII National Trust covenant

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Pre-human vegetation of the Pakowhai Wetland QEII National Trust covenant

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1 Introduction

In Dec 2020, QEII Regional Representative Malcolm Rutherford contacted Janet Wilmshurst, Manaaki Whenua – Landcare Research (MWLR) about a recently covenanted wetland near Frasertown, in the Wairoa/Gisborne - Tairāwhiti region. While putting in fence posts to keep stock out of the wetland, and as a requirement of the covenant to protect the wetland, significant organic deposits were discovered beneath the surface. Malcom Rutherford asked if Janet Wilmshurst (MWLR) was interested in analysing spot samples for preserved pollen to potentially reveal the pre-human vegetation of the region.

There is a paucity of wetlands from this region with pollen records leaving a significant data gap in our understanding of the pre-human vegetation of the highly modified landscapes in the area.

In March 2022, Janet Wilmshurst analysed the samples that are reported on here.

2 Background

Pakowhai Wetland (38.950187S, 177.391985E) is situated about 100 m above sea level, less than 2.5 km NNW of Frasertown, in the Wairoa/Gisborne - Tairāwhiti region (Figure 1).

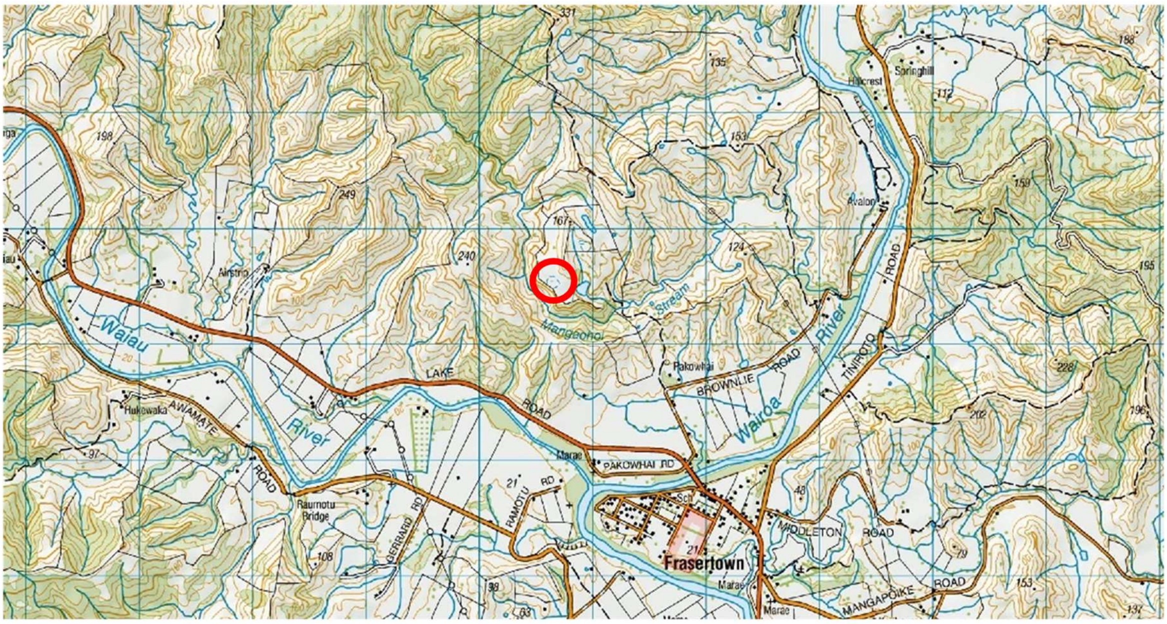

Figure 1. Map showing location of the wetland (red circle). Grid squares = 1 km. (Source: New Zealand Gazetteer 2024, licensed under a CC by Attribution 4.0 International License.)

The covenant is registered to Kings Trustees (2018) Ltd, and landowners Tim and Michelle Brownlie. The wetland (Figure 2) is a constantly wet site despite a century of drainage, and has been covenanted by QEII National Trust. The owners have also fenced the wetland to keep stock from wandering in and getting mired and as a requirement of the covenant.

The current vegetation is dominated by pasture grasses and sedge (*Isolepis* sp.) with a small patch of mānuka (*Leptospermum scoparium*) and *Coprosma rigida*. There are only 11 native species recorded in total (see Table 1).

Table 1. Current native plant taxa recorded at the wetland. (Source: Data provided by M Rutherford 2020).

Taxa	Growth form
Carpodetus serratus	Tree
Coprosma rigida	Shrub
Cyperus ustulatus	Sedge
Drosera binata	Herbaceous forb
Isolepis sp.	Sedge
Leptospermum scoparium	Tree
Lobelia angulata	Herbaceous forb
Myriophyllum propinquum	Aquatic herbaceous forb
Paesia scaberula	Fern
Ranunculus amphitrichus	Herbaceous forb
Sphagnum spp.	Moss

Figure 2. Views of the wetland site. (Left) Catchment area of the wetland showing the *Sphagnum* and patches of mānuka and coprosma; (Right) Aerial view of depression. Red X marks where core sections were collected for pollen analysis (Source: Photos supplied by M. Rutherford.)

3 Objectives

- To analyse the pollen in the sediments sampled from the wetland to reconstruct past vegetation at the site.
- To suggest plant taxa that are appropriate for restoration activities, based on the pollen from this site and similar degraded wetlands in the region.

4 Methods

Sediments and core samples: Malcolm Rutherford (QEII) collected sediments from the wetland and sent them to the author for analysis. He described their collection as follows: A digger dug about 1 m deep at a point along the fenceline through what appeared to be papa and pumice-based soil, and in doing so, exposed an organic layer about 1–1.5 m below paddock level. M Rutherford dug down 40 or 50 cm below paddock level, and pushed an old vacuum cleaner tube as far as was possible into the organic layer below, collecting 60 cm of sediment in four sections, labelled 'Top 30 cm', 'Top', 'Middle' and 'Bottom'.

Figure 3 shows a photograph of the vacuum cleaner core sampling site, while Figure 4 shows M Rutherford's schematic of the set-up.

Figure 3. Sampling site at the wetland, showing culvert and the hole from where the core was sampled (Source: Photo supplied by M Rutherford.)

The four core sections were sent to the Long-Term Ecology Laboratory (LTEL) at MWLR, Lincoln for processing.

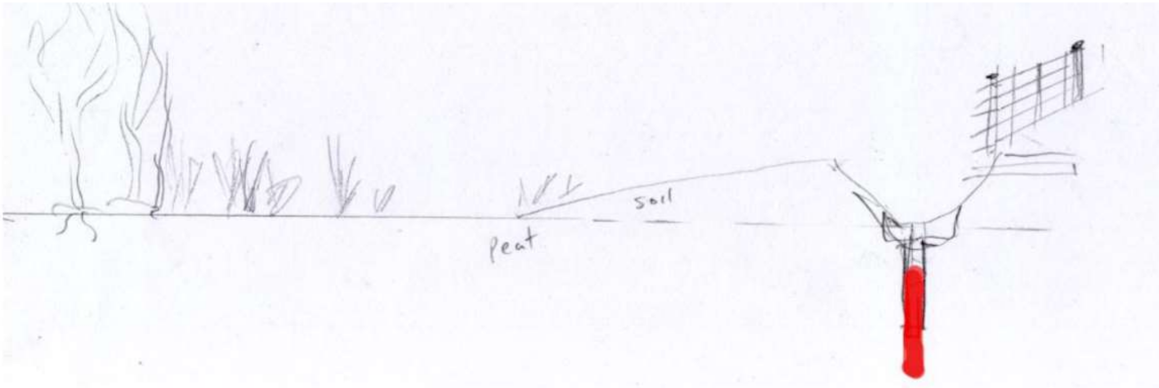

Figure 4. Sketch of coring site relating to Figure 3. The red shading shows where the vacuum pipe was inserted into the culvert to collect the sediment samples. (Source: Original supplied by M Rutherford.)

Pollen and spore analysis: One subsample (c. 5 mL volume) was taken from each of the four core sections described above, labelled 'Top 30 cm', 'Top', 'Middle' and 'Bottom'. The subsamples were prepared for pollen analysis using standard palynological methods (Moore et al. 1991) which removes most of the inorganic and non-polleniferous material and leaves the remaining concentrated pollen and fern spores to be mounted on to microscope slides.

Pollen and fern spores were assessed under a light microscope, under 400 × magnification, using the MWLR LTEL pollen and spore microscope slide reference collection, and the pollen atlas for New Zealand dicotyledonous plants (Moar 1993).

Slides from all four sub-samples (one from each section) were scanned for pollen and fern spore content and all taxa encountered were identified and recorded by Janet Wilmshurst. A standard pollen count (250 terrestrial pollen grains) was undertaken for the 'Bottom' sample to calculate the relative percentage of the pollen composition. Percentages were calculated from a sum of all pollen grains counted (excluding fern spores which can be locally dominant, and that are presented as a percentage of total pollen and spores).

5 Results and discussion

Upon inspection, the core section sediment was found to be highly organic lake mud or gyttja with plant remains, both herbaceous and woody (Figure 5), suggesting the site was formerly a shallow lake rather than a wetland. The catchment area for most of the pollen and fern spores recorded would have been the entire basin surrounding the current depression.

Figure 5. Some of the highly organic lake muds found beneath the surface of the wetland showing preserved leaves, roots and wood. Fingers for scale. (Source: Photo M Rutherford.)

No charcoal was detected in any of the subsamples and the pollen flora was dominated by forest taxa.

The results of the pollen and spore analyses are presented in Figure 6 (grouped into the main forest growth habits) and discussed in Section 5.1.

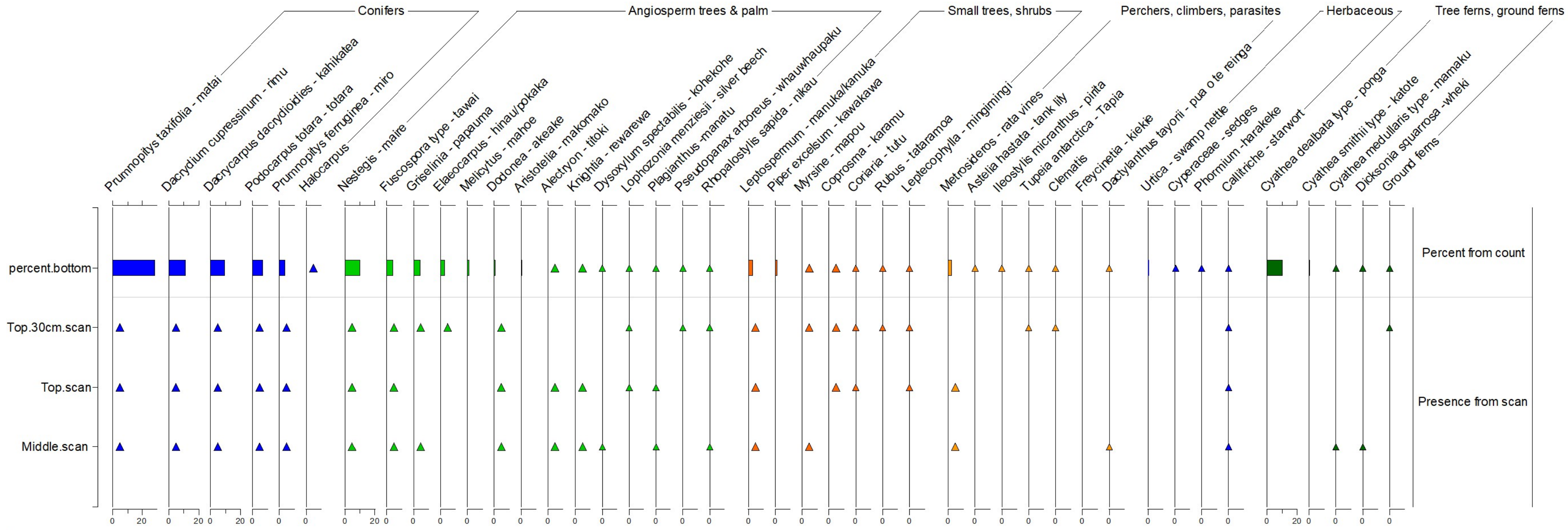

Figure 6. Pollen results (coloured rectangles) from a count of the 'Bottom' sample ('percent.bottom') presented as percentage of the pollen sum (see *x*-axis for values range) including all pollen taxa (excluding fern spores). Coloured triangles show the presence of taxa encountered during a scan of the slides from the different depths).

5.1 Pollen and spore composition

The pollen and spores from all four core sections was diverse and similar in composition. The cores contained at least 43 pollen and spore types, some of which can only be identified to genus (e.g. *Coprosma*) or a 'type' (e.g. *Cyathea dealbata* type) which can represent many or several species. This means that many more species were undoubtedly present in the forest than suggested from the pollen recorded.

Overall, the pollen and spore composition suggest a structurally complex lowland conifer-angiosperm-palm and tree fern–rich forest once grew at the site, with a diverse understorey and abundant perching and climbing plants.

Compared with other pollen and charcoal records from the east coast of the North Island (Wilmshurst et al 1999) the lack of charcoal combined with the pollen types recorded indicate the samples date to the pre-human era when fires were highly infrequent, and probably date within the range of the last 1000–3000 years before present.

The sediment type (gyttja lake mud) and pollen and spore types recorded indicate that the current wetland was not a wetland in the pre-human era, but rather a shallow lake surrounded by dense forest right down to the lake edge.

Dominant conifer taxa included mataī (*Prumnopitys taxifolia*), rimu (*Dacrydium cupressinum*), kahikatea (*Dacrycarpus dacrydioides*), tōtara (*Podocarpus totara*) and miro (*Prumnopitys ferruginea*). This number of podocarps co-occurring is uncommon in local forest fragments today (M Rutherford, QEII, pers. comm. 20 April 2022).

Nīkau (*Rhopalostylis sapida*) pollen was found at most depths (Figure 7). This pollen type does not disperse far from source and is usually under-represented relative to local presence meaning that it could have been locally present and an important component of the canopy.

Figure 7. Nīkau (*Rhopalostylis sapida*) pollen from the 'Bottom' sample. Photo taken under 400 x magnification (Source: Photo J Wilmshurst.)

Tree fern spores were abundant including kātote (*Cyathea smithii*), ponga and mamaku (*Cyathea dealbata* type (includes either or both *C. dealbata and C. medullaris*) and whekī (*Dicksonia squarrosa*). Ground fern spores were present but not abundant.

The angiosperm tree pollen was dominated by *Nestegis* - probably black maire (*N. cunninghamii*), with puka/kāpuka (*Griselinia* spp.), pōkākā/hinau (*Elaeocarpus*), māhoe (*Melicytus*) and many other taxa represented. *Nestegis* trees are not as abundant in local fragments today as suggested by the pollen – suggesting either over-representation of the pollen relative to source, or the climate being different to the present during the period represented in the past.

Tawa (*Beilschmiedia tawa*) may have been locally present, but this insect-pollinated tree is rarely recorded in the pollen rain when known to be present in the vegetation. However, rewarewa (*Knightia excelsa*) pollen is recorded in the sediments and is a tree that commonly co-occurs with tawa today (Vanderhoorn et al. 2024), indicating likely local presence of tawa.

Leptospermum type pollen was recorded in low abundance and can represent either mānuka (*Leptospermum*) or kānuka (*Kunzea*) species which possibly grew with other small trees and small leaved shrubs in an ecotone between the forest edge and lake edge.

The *Metrosideros* pollen type was not identified as northern rātā (*M. robusta*) or pōhutukawa (*M. excelsa*), and probably represents a climbing species in this genus, e.g. white climbing rātā (*M. diffusa*).

Pollen from several perching and climbing plants were recorded including tank lily (*Astelia hastata*), *Clematis* sp., kiekie (*Freycinetia banksii*) and the mistletoes, pirita *(Ileostylus micranthus*) and tupeia (*Tupeia antarctica*). The loss of tall host trees from the catchment and herbivory from introduced mammals will have contributed to their local demise.

Pua o te rēinga / wood rose (*Dactylanthus taylorii*) pollen was a highlight discovery. This distinctive pollen type (Figure 8) is rarely found in the pollen record but has been documented (by J Wilmshurst) in the pre-human sediments from Lake Tūtira, Hawke's Bay. Its pollen occurrence indicates local presence on the forest floor. Interestingly, wood rose is still present in the East Coast/Hawke's Bay conservancy area (Holzapfel 2005).

Figure 8. Distinctive *Dactylanthus taylorii* pollen from the 'Bottom' sample. Taken under 400 x magnification (Source: Photo J Wilmshurst.)

The highly wind-dispersed pollen of beech/tawhai (both *Fuscospora* spp. and *Lophozonia menziesii*) pollen was recorded, but at percentages of below 5% suggesting long-distance dispersal from sources further inland, rather than from locally.

There were virtually no wetland taxa recorded, only one grain of a sedge (Cyperaceae) and one of harakeke (*Phormium tenax*). Starwort (*Callitriche*) pollen, perhaps *Callitriche petriei* subsp. *petriei,* was recorded and was likely to be the dominant herb of wet soaks in the forest. Few herbs were recorded but *Urtica* was the most common recorded, most likely the swamp nettle (*Urtica perconfusa*).

Of the 11 native plant taxa recorded at the site today (Table 1), only *Leptospermum* and *Coprosma* species were recorded in the pollen, showing how transformed the current site is relative to the recent past.

6 Conclusions

- The sediment type (gytta lake mud) and pollen and spore types recorded indicate that the current wetland was not a wetland in the pre-human era, but rather a shallow lake surrounded by dense forest right down to the lake edge. The paucity of herbaceous or wetland taxa suggest it was also not an ephemeral lake or wetland.
- Without a field inspection to examine the stratigraphy, and further sampling of surface sediments it is not possible to determine when the lake transformed into a wetland. The most likely explanations are that it was: a) blocked up with Taupō Tephra 2000 years ago; b) filled in with erosion from deforestation; or c) caused by mass earth movement during a major earthquake.
- Pollen abundances recorded in sediments are not necessarily directly proportional to the abundance of species in the surrounding forest; species vary in their rate of pollen

production, and how far that pollen travels from the plant. However, based on our understanding of these processes the dominant canopy tree species at Pakowhai Wetland are interpreted to have been mataī, rimu, kahikatea, totara, and black maire.

- The pollen composition suggests a structurally complex lowland conifer-angiosperm-palm and tree fern–rich forest, with a diverse understorey and abundant perching and climbing plants.
- More than 43 pollen types were recorded, which undoubtedly represent many more species than this growing in the catchment of the lake.
- The lack of charcoal indicates that frequent fire was not part of a natural disturbance regime in the area (typical of the pre-human era throughout most of NZ; see Perry et al. 2014).
- Compared with the nearest published pollen records from the region, the forest composition recorded from Pakowhai Wetland is most similar to a pollen record from Lake Repongaere (38.596415S, 177.873717E), 15 km north-west of Gisborne (Wilmshurst et al. 1999). The main difference between the two sites is that the Lake Repongaere record had a wetland surrounding the lake throughout its history and did not have any nīkau or wood rose pollen.
- The forest composition inferred from the pollen is also similar to nearby forest fragments, but with many components (including miro, nīkau, maire*,* kohekohe (*Dysoxylum*), the mistletoes and perching plants) often missing from or uncommon in the fragments. Although kohekohe is still present locally, maire is rarely seen but present and nīkau scattered through the region particularly where stock have been excluded; and covenanted forest blocks in the area that have pest control have abundant mistletoes and epiphytes (M Rutherford, QEII, pers. comm. 20 April 2022).

7 Recommendations

- The pollen and spores recorded in the sediment samples from Pakowhai Wetland provide an extensive list of plant taxa present in the catchment before human arrival and can be used to inform local restoration planting if there was a desire to return the surrounding catchment back to forest.
- Although the findings from the few samples taken in this study are reasonably informative, they would be greatly enhanced by collecting a long intact core from the wetland using professional sediment coring equipment and expertise. This would provide a unique opportunity to generate a long-term site-based history of past vegetation and local hydrology of the wetland, showing how it has responded to past disturbances and climate change.
- The fact the wetland has not dried out despite a century of drainage suggests it may be spring fed. Restoring and maintaining the water level may return the site to a permanently shallow lake. However, further examination of the sediment layers in the wetland would be necessary to establish if the wetland has been buried with eroded soil post-deforestation. If this was determined to be the case for example, this overlying cap of eroded soil could be scraped off the surface back to the old lake sediments to potentially assist the recovery to former conditions.

- This report demonstrates how sediments laying beneath the surface of wetlands (even highly degraded ones) are highly valuable archives of local vegetation and landscape change history stretching back thousands of years before present. These sites need protecting from further damage (such as grazing and drying out), so they can generate greater landscape and biodiversity value, and protect valuable information about past ecologies of the region for future generations.
- Other wetlands in the region would benefit from palaeoecological research (such as identifying species from preserved pollen, seeds, invertebrate remains, and ancient DNA from sediments) to inform site-based restoration and conservation plans following natural disasters such as cyclones, fires, erosion and earthquakes. Restoration planting using lists of species known to have been locally present in the recent past under similar climates to today will ensure restoration initiatives are successful, suit the local environmental and climate conditions, and be ecological resilient to disturbances in the future.

8 Acknowledgements

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