Whangamarino Wetland vegetation map methodology

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ABSTRACT

Whangamarino Wetland is 7100 ha in size and situated in the lower Waikato basin, 62 km south of Auckland, North Island, New Zealand. Whangamarino Wetland is a Ramsar site and the second-largest swamp and bog complex in the North Island. The vegetation has undergone major changes as a result of hydrological changes, human-induced fires and the invasion of exotic species. Prior to this report the extent of vegetation change between 1942 and 1993 was quantified from aerial photography using the geographical information system ARC/INFO. Since 1993 the Department of Conservation has undertaken a number of management activities to rehabilitate the native plant communities, including the construction of a weir to raise minimum water levels, and extensive willow control. To monitor the effect of these activities a further vegetation map was commissioned using aerial photographs taken in 2001 and 2002. This report describes the methodology used to interpret the aerial photographs, ground-truth the interpreted images, and produce the final map. Digital ortho-rectified photos at 1:40 000 with excellent resolution (1 m^2) were used to interpret the photos. The key diagnostics used were colour and texture of the images combined with information on the location of wetland types. Ground-truthing was primarily by helicopter and complemented by recent ground-based vegetation survey work. Defining the boundary between vegetation types that had similar colour and texture on the aerial photographs proved the most difficult task. This could be mitigated in the future by using stereoscopic aerial photographs to view height of vegetation, a useful diagnostic feature for distinguishing between vegetation types in a wetland with tall invasive species.

Keywords: Whangamarino Wetland, vegetation mapping, aerial photos, GIS, New Zealand.

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1. Introduction

Whangamarino Wetland is 7100 ha in size and situated in the lower Waikato basin, 62 km south of Auckland. Whangamarino Wetland is a Ramsar site and the second largest swamp and bog complex in the North Island. The vegetation has undergone major changes as a result of hydrological changes, human-induced fires and the invasion of exotic species. Prior to this report the extent of vegetation change between 1942 and 1993 was quantified from aerial photographs using the geographical information system ARC/INFO. Since 1993 the Waikato Conservancy of the Department of Conservation (DOC) has undertaken a number of management activities to rehabilitate the native plant communities including the construction of a weir and extensive willow control. To monitor the effect of these activities a further vegetation map was commissioned using aerial photographs taken in 2001 and 2002. This report describes the methodology used to produce an updated vegetation map of the Whangamarino Wetland.

The various types of vegetation were mapped from aerial photographs which were supplied by the Waikato Conservancy through their membership of the Waikato Regional Aerial Photography Syndicate (WRAPS). WRAPS commissioned Terralink International Ltd to take colour aerial photographs of the Waikato Region at 1:40 000 and supply them as ortho-rectified images. The aerial photographs were taken over a number of months, with the southern third of the Whangamarino Wetland photographed on 5 November 2001 and the northern two-thirds on 2 February 2002. Resolution of the photographs was 1 m^2.

The revised vegetation map of the Whangamarino Wetland is available from the Waikato Area Office of the Waikato Conservancy.

2. Methodology

The 2001/02 vegetation map is an update of the 1993 vegetation map of the Whangamarino Wetland compiled by Reeves (1994).

The process of developing the map involved three distinct phases:

- Interpretation of vegetation types from aerial photographs
- Ground-truthing (i.e. verifying the interpreted images)
- Map production

2.1 INTERPRETATION OF AERIAL PHOTOGRAPHS

The accuracy of aerial photograph interpretation is dependent on the type and quality of the aerial photography that it is based on. The most important variables for interpreting vegetation types from photographs are scale, colour and height.

The aerial photographs used were taken at a scale of 1:40 000 and had excellent resolution (1 m^2). At this scale it was possible to distinguish individual willow trees with canopies greater than about 10 m^2, but it was not possible to distinguish between small patches of the different small herbaceous species that comprise large areas of the wetland. Colour aerial photography is the preferred medium for distinguishing between wetland vegetation types (Ward & Lambie 1999) and colour was one of the key diagnostic features used by us for interpretation of the photographs to produce the map.

The aerial photographs were used to identify the present-day boundaries of the vegetation classes identified in the 1993 vegetation map of the Whangamarino Wetland (Reeves 1994). Several other sub-classes of vegetation were also mapped to assist DOC in assessing vegetation changes that are likely to be the result of restoration activities in the Wetland (e.g. installing a weir to raise minimum water levels and willow control). These sub-classes can be aggregated back to one of the main vegetation classes for analysing changes over time. A description of the vegetation classes appears in Appendix 1.

The key that was developed for interpreting the 1993 photographs could not be used for this study as it was designed specifically for interpreting black and white aerial photographs in stereoscopic pairs. Instead, a set of guidelines using key diagnostic features was developed for interpreting the non-stereoscopic colour aerial photographs taken in 2001/02. These guidelines are presented in Table 1.

Automated image analysis using ARC/INFO software was investigated to see whether it could accurately distinguish between vegetation types. This did not prove successful due to some vegetation classes appearing very similar in colour in the photographs (e.g. both grey willow and crack willow appear light-medium green).

As indicated in Table 1, some of the vegetation classes couldn't be distinguished from other vegetation types on the aerial photographs because of scale (most of the patches were too small or had colours that overlapped with the seasonal adventives and grasses vegetation type). These patches were mapped by estimating their extent and taking GPS co-ordinates when ground-truthing from a helicopter.

We also had some difficulties determining the boundaries between vegetation types that have similar colours. This problem can be overcome using stereoscopic photo pairs (where images appear 3-dimensional when viewed using a stereoscope) if the vegetation types are different heights. Height differentiation was a key diagnostic analysis used to produce the 1993 map. However, stereoscopic photo pairs were not commissioned by WRAPS, so the only practical means of defining boundaries was by ground-truthing from a helicopter, a time-consuming task given the large size of the Whangamarino

Wetland (c. 7000 ha). Two long flights were undertaken to carry out sufficient ground-truthing to define the boundaries with accuracy comparable to that in the 1993 map. Accuracy is important, as it ensures that time-related changes in vegetation can be assessed (between this and the 1993 map, and between this and any subsequent maps).

TABLE 1. GUIDELINES FOR DETERMINING VEGETATION CLASSES FROM THE COLOUR AERIAL PHOTOGRAPHS SUPPLIED IN 2001/02 (ORIGINAL CONTACT PRINTS WERE AT 1:40 000). *Note that the guidelines are specific to the photographs supplied (the degree of flooding at the time the photographs were taken can alter the colour of vegetation types).*

	DIAGNOSTIC FEATURES		
VEGETATION CLASS	COLOUR	TEXTURE	LOCATION
Peat bog			
Sedges and rushes	pale green, light brown, red & grey	Smooth with occasional low coarseness	peat bogs (i.e. away from the influence of the rivers)
Semi-mineralised swamp			
manuka	dark brown, dark green	medium coarseness	edges of peat bogs, semi-mineralised soils
manuka with royal fern*	very light grey	medium coarseness	grey willow control area south of the Whangamarino River
grey willow	light–medium green	very coarse, dense circular crowns	mostly on semi-mineralised soils
Mineralised swamp			
crack willow	light–medium green	very coarse, circular crowns	mineralised soils, adjacent to waterways
seasonal adventives and grasses	bright green, patches of brown, red, white, yellowish green, muddy brown	smooth	mineralised soils
kahikatea	medium green	medium coarse, conical crowns	mineralised soils
flax*	medium–bright green	low–medium coarseness	mineralised soils
Carex sedgeland	reddish green†	smooth†	mineralised soils
Eleocharis reedland*	dark green†	smooth†	mineralised soils
raupo reedland*	green and white†	smooth†	mineralised soils
Bolboschoenus reedland*	yellowish green†	smooth†	mineralised soils
Other			
marginal vegetation	medium–dark green	medium–very coarse, crowns usually discernable	

* vegetation sub-classes † undistinguishable from seasonal adventives and grasses

2.2 GROUND-TRUTHING

Ground-truthing involves verifying, by field inspection, the vegetation classes and boundaries interpreted from the photographs. Most of the ground-truthing was done by helicopter on 8 and 29 May, 2003. Other information, obtained from recent surveys undertaken on foot and annotated onto maps and aerial photographs, was also used to ground-truth the vegetation classes and boundaries marked on the photographs.

2.3 MAP PRODUCTION

The boundaries of vegetation types were transferred from photos printed out for ground-truthing into ARC/MAP (version 8.2) using on-screen digitising. Roads, railway lines, water bodies and drains were all added in as digital layers from the NZ Topographic Dataset (LINZ). The positional accuracy of this data is ± 20 m.

3. Recommendations

Some of the most interesting vegetation changes occurring in the Whangamarino Wetland as a result of raising minimum water levels were very difficult to detect at the 1:40 000 scale of the photography provided. These changes include the regeneration of native sedgeland and reedland communities in the mineralised swamps. Future mapping of the Wetland to detect these changes would require larger-scale aerial photography (1:5000 scale) over these key areas.

The 1:40 000 scale of aerial photography had sufficient resolution to capture the changes in vegetation types; however, defining the boundaries between vegetation types required careful ground-truthing, which was time-intensive. Time associated with ground-truthing could be reduced in future if the survey used stereoscopic aerial photographs (which would allow differences in vegetation height to be observed).

4. Acknowledgements

Andrea Brandon (DOC) and Rachel Kelleher (DOC) who assisted in the interpretation of aerial photographs and ground-truthing.

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Appendix 1

DESCRIPTIONS OF VEGETATION CLASSES

Sedges and wirerush This encompasses the vegetation of the peat bogs: wirerush (*Empodisma minus*), umbrella fern (*Gleichenia dicarpa*), *Baumea teretifolia, Schoenus brevifolius*, bladderworts, orchids and sundews. In places, this vegetation type may also include stunted manuka (*Leptospermum scoparium*), and flax (*Phormium tenax*). Figure 1 shows typical sedge and wirerush bog vegetation.

Figure 1. A view across the Reao Arm peat bog showing the sedges and wirerush vegetation type in the foreground.

Manuka This vegetation type includes all of the semi-mineralised swamp where manuka makes up over 50% of the canopy species. Key species associated with this vegetation type include grey willow (*Salix cinerea*), swamp coprosma (*Coprosma tenuicaulis*), *Blechnum novae-zelandiae,* cabbage tree (*Cordyline australis*), royal fern (*Osmunda regalis*), *Baumea* spp., wirerush, flax and umbrella fern.

Manuka with royal fern This is a sub-class of manuka and includes only the area south of the Whangamarino Wetland where willow control was carried out. It currently appears on the aerial photographs as dead grey willow. However, a reconnaissance survey undertaken in 2001 (Reeves 2001) in this area found that the living vegetation under the dead grey willow canopy was dominated by manuka and royal fern, which were present in densities not seen elsewhere in the Whangamarino Wetland (Fig. 2). Other key species associated with this vegetation class include those listed above for the 'manuka' vegetation class.

Grey willow This vegetation type includes all of the areas of the wetland where grey willow makes up over 50% of the canopy species. Grey willow is mostly found in semi-mineralised swamp but is encroaching onto the peat bogs. It is also found in the mineralised swamp, although crack willow (*Salix fragilis*) normally

Figure 2. Royal fern (darkest patches) and manuka amongst dead grey willow.

dominates closer to the river channels. Other key species associated with this vegetation type include royal fern, manuka, swamp coprosma, flax, marsh bedstraw (*Galium palustre*), crack willow, *Persicaria*, *Carex* and *Baumea* species. It appears that grey willow is still invading other semi-mineralised wetland types. Figure 3 shows grey willow colonisation of manuka scrub.

Figure 3. Grey willow invading manuka along the eastern edge of the central peat bog.

Crack willow This vegetation type includes all of the areas of the wetland where crack willow makes up over 50% of the canopy species. Crack willow is only found in the mineralised swamp. Key species associated with this vegetation type include *Carex gaudichaudiana, Carex subdola*, reed canary grass (*Phalaris arundinacea*), water purslane (*Ludwigia palustre*), *Persicaria* species and beggars' ticks (*Bidens frondosa*).

Seasonal adventives and grasses This vegetation type includes all of the areas of the wetland where at least 80% of the canopy species are seasonal adventives and grasses. This vegetation type occurs on mineralised soils. The most common seasonal adventives include *Persicaria* species, water plantain (*Alisma plantago-aquatica*), water purslane, water primrose (*Ludwigia peploides* subsp. *montevidensis*), parrot's feather (*Myriophyllum aquaticum*) and beggars' ticks. Grass species include reed sweet grass (*Glyceria maxima*), reed canary grass, Mercer grass (*Paspalum distichum*) and creeping bent (*Agrostis stolonifera*). Figure 4 illustrates typical seasonal adventive herbs that dominate this vegetation type.

Figure 4. Water plantain and *Persicaria* species in the floodplain between the Whangamarino River and the Reao Stream.

Photo: Paul Champion

Kahikatea Only a few small remnants of kahikatea (*Dacrycarpus dacrydioides*) remain in the wetland (see Fig. 5). Associated species include *Baumea* spp., swamp coprosma, *Blechnum novae-zelandiae,* cabbage tree, flax, *Carex virgata* and, sometimes, kowhai (*Sophora microphylla*).

Flax This was identified as marginal vegetation on the 1993 vegetation map as it occurs on drier areas that typify the habitat of marginal vegetation. It has been mapped as a separate layer this time as it has conservation values much greater than all the other types of marginal vegetation. It occurs mostly with cabbage trees, some kahikatea and blackberry (*Rubus fruticosus*).

***Carex* sedgeland** This vegetation type includes the areas of the wetland where swards of *Carex gaudichaudiana* and *C. subdola* collectively make up more than 50% of the canopy (Fig. 6). Other native species occurring with this vegetation type include *Eleocharis sphacelata, E. acuta, Baumea articulata, Persicaria decipiens, Myriophyllum propinquum* and *Bolboschoenus fluviatilis*. Introduced species include marsh bedstraw, *Persicaria* species, water plantain, water purslane, Mercer grass, reed canary grass and creeping bent.

***Eleocharis* sedgeland** This vegetation type, dominated by tall spike sedge (*Eleocharis sphacelata*), was a sub-set of *Carex* sedgeland occurring as small patches in deeper water amongst *Carex* swards. However, with the increase in

Figure 5. A small kahikatea stand with adjacent flax vegetation to the left, where the Maramarua River enters the Whangamarino Wetland.

Figure 6. An area of *Carex* sedgeland (middle–top of photo) and *Bolboschoenus* reedland (in the very foreground) in an old willow control area adjacent to the Maramarua River. The low dark-coloured vegetation is *Persicaria* (seasonal adventives and grasses).

water levels as a result of the installation of the rock weir, it is forming large-enough patches (Fig. 7) to enable it to be mapped as a separate vegetation type.

Raupo reedland This vegetation type, dominated by raupo (*Typha orientalis*), was a sub-set of *Carex* sedgeland on the 1993 map. It occurred as very small patches in some of the semi-mineralised swamp, but the patches were not large enough to be distinguished as a separate vegetation class. The present (2001/02) map shows it mostly occurring on mineralised soils with other sedges (*Carex, Bolboschoenus, Baumea* and *Eleocharis* spp.) and in very fertile areas adjacent to roads or pasture in the semi-mineralised swamp.

Figure 7. *Eleocharis* sedgeland next to the causeway near the downstream end of the Reao Stream.

***Bolboschoenus* reedland** This vegetation was also a sub-set of *Carex* sedgeland on the 1993 map. It occurred as very small patches of *Bolboschoenus fluviatilis* along the banks of the Whangamarino Wetland and other parts of the mineralised swamp where there was no crack willow. It has only appeared in detectable patches since 2002; this change is likely to be the result of the increase in water levels.

Marginal vegetation This vegetation type is a broad category encompassing a range of terrestrial vegetation types that occur on elevated land within the wetlands. The most common species are pine (*Pinus radiata*), wattle (*Racosperma mearnsii*), gorse (*Ulex europaeus*), mahoe (*Melicytus ramiflorus*), pampas (*Cortaderia* species), blackberry and Chinese privet (*Ligustrum sinense*) (Fig. 8).

Figure 8. Marginal vegetation, mostly gorse and blackberry along the old causeway connecting Kokopu Coal Mine with the now non-operational Meremere power station.