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Landcare Research

Wetland extent mapping: Tauranga Water Management Area

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Summary

Project and Client

- Wetland extent in the Tauranga Water Management Area, Bay of Plenty, was mapped from recent aerial imagery, LiDAR, and existing GIS and field survey data for Bay of Plenty Regional Council.

Objectives

- Delineate wetlands greater than 0.5 ha within the Bay of Plenty Regional Council's Tauranga Water Management Area.
- Estimate wetland attributes such as wetland class and vegetation structure where possible.
- Compare the wetland extent resulting from this work with previous wetland extent data for palustrine wetlands.

Methods

- A Topographic Position Index mask, supplemented with existing wetland spatial data, was used with orthophotos acquired between 2015 and 2017 to map wetlands greater than 0.5 ha in the Tauranga Water Management Area, Bay of Plenty.

Results

- We mapped 687 separate polygons representing 2,854 ha of wetlands in the Tauranga Water Management Area, including 250 polygons (1,734 ha) of estuarine wetlands.
- We mapped 974 ha of freshwater wetlands, excluding wetlands classified as predominantly wet pasture – 93% more than the 505 ha previously mapped.
- We identified 168 ha of forest and treeland wetland, of which 58.5 ha (35%) appears to be exotic (*Salix* spp.) dominated.
- Wetland types excluded from Bay of Plenty Regional Council's Natural Resources Plan and previous wetland inventories (pasture and rush-dominated pasture) totalled 181 ha of the Tauranga WMA.

Conclusions

- There are significant differences between the number and extent of wetlands mapped in this project and the most recent and comprehensive previous wetland mapping in the Tauranga WMA, with only 27% of palustrine wetlands in the new mapping sharing geometries with the previous inventory layer.
- Only three wetlands were not included in the new dataset: one that appears to have been destroyed or was incorrectly identified previously, one that is very small, and one that is indistinct and does not appear to be wetland.

- The current mapping indicates the area of extant palustrine wetland in the Tauranga WMA is at least 90 % more than in previous inventories, but the extent and condition of previously unmapped wetlands need to be assessed by field survey.

Recommendations

- The methods used to map wetlands in the Tauranga Water Management Area should be used in other Water Management Areas in Bay of Plenty,
- Mapped wetlands should be field-checked to refine extent, class, and vegetation structure. An initial survey by helicopter could be an efficient way to rapidly assess many sites, particularly where we have low confidence from aerial images,
- The current wetland mapping could be refined by combining some of the wetland polygons into multipart polygons where these better reflect ecologically coherent wetland units.
- Spatial data derived from this, and future mapping of Bay of Plenty wetlands should be incorporated into a national wetland extent database, as recommended by Newsome (2017).

1 Introduction

Wetland extent in the Tauranga Water Management Area, Bay of Plenty (BOP), was mapped from recent aerial imagery, LiDAR, and existing GIS and field survey data. This report describes the methodology used to identify and delineate these wetlands, and summarises the extent of wetlands derived from this process compared with previous mapping.

2 Background

Loss of wetlands to anthropogenic impacts has historically been high in New Zealand, despite the wide range of environmental and economic benefits they provide, and degradation and loss of wetlands is still occurring (Myers et al. 2013). Based on data from 2003 and earlier, Ausseil et al. (2008) estimated that less than 8% of more than 43,000 ha of historic wetlands remained in the Bay of Plenty region. Nationally, protection of extant wetlands is biased toward larger wetlands, especially in lowland environments where they often occur on private land (Ausseil et al. 2008; Myers et al. 2013), despite the importance of small wetlands for the preservation of rare and threatened plants (Richardson et al. 2014).

Regional and district councils have responsibilities to implement legislation and develop policies and regulations to protect wetlands and prevent their damage and degradation. To achieve this, accurate delineation of wetland extent is needed (Myers et al 2013). Bay of Plenty Regional Council has an ongoing programme of wetland monitoring, and has previously undertaken wetland mapping (Newsome 2017). The most recent previous wetland mapping was based primarily on Regional Digital Aerial Mosaic (RDAM) aerial orthophotos flown in 2003 and 2005. This project aims to produce updated maps of wetlands in the Tauranga Water Management Area of the Bay of Plenty Region from recent aerial orthophotos and other spatial data.

3 Objectives

- Delineate wetlands greater than 0.5 ha within the Bay of Plenty Regional Council's Tauranga Water Management Area.
- Estimate wetland attributes such as wetland class and vegetation structure where possible.
- Compare the wetland extent resulting from this work with Bay of Plenty Regional Council's Wetland Extent geospatial layer.

4 Methods

Wetland mapping was done with ArcMap 10.3 using the New Zealand Transverse Mercator projection and NZ Geodetic Datum 2000.

We attempted to use a random forest model to identify areas of potential wetlands from existing 'Wetland Extent' shapefiles (provided by Bay of Plenty Regional Council) and site attributes. This model predicted wetlands over much of the lowland areas and, although this may reasonably reflect historic or potential wetlands, it did not help refine candidate areas of unmapped extant wetlands and was subsequently not used.

To aid the identification and delineation of wetlands we created a mask to identify areas on the landscape with topography that might contain wetlands. The layer was created using both ArcGIS (ESRI, 2012) and SAGA GIS (Conrad et al, 2015). We used saga GIS (v6.3.0) to develop a Topographic Position Index (TPI; Guisan 1999) surface of the Tauranga water Management Area. This calculates the difference between the elevation of each 5×5 m cell in a raster and the mean elevation of surrounding cells. We used a radius of 100 m and all other values at default settings. Elevation data was taken from a 2-m Digital Elevation model derived from LiDAR acquired in 2015 for BOPLASS Ltd. We used ArcGIS v10.2.1 to create an exclusion mask of areas of slope greater than 3 degrees and TPI greater than 2. This was then added bitwise to create a surface with values from 0 to 3 with zero being the most likely to contain wetlands.

Mask = (Slope > 3) + 2* (TPI > 2)

Wetland extent polygons were digitised against orthophotos acquired between 2015 and 2017 for BOPLASS Ltd. Spatial resolution of these orthophotos is 0.125–0.3 m per pixel, with positional accuracy of 0.3–0.5 m.

Wetlands were mapped in two phases;

1 Remapping of wetlands included in existing datasets – BOP Regional Council 'Wetland Extent', Land Cover Database 4 (Landcare Research 2015), Wetlands of National Importance (WONI) current wetlands with 2015/16 updates (Belliss et al. 2017).

2 Mapping of previously omitted wetlands greater than 0.5 ha.

Delineating wetland boundaries is complicated for several reasons, including diffuse boundaries (ecotones), summer drying, and 'wetland' plants extending onto infertile non-wetland soils (Johnson & Gerbeaux 2004). We primarily used visual cues from aerial images to delineate wetland extent, and this along with plant cover data from wetland field surveys (including wetland monitoring undertaken for BOP Regional Council; Manaaki Whenua – Landcare Research unpublished data) where available to attribute wetland class and structure. Polygons were digitised at screen scales between 1:600 and 1:4000. Wetlands with clearly defined boundaries were digitised more accurately, with closer vertices, than those where there was more uncertainty.

We assessed and assigned each polygon to hydrosystem and wetland class (Johnson & Gerbeaux 2004), vegetation structural classes (Atkinson 1985), and whether the vegetation appears to be dominated by exotic species.

We compared palustrine wetlands mapped in the current project with BOP Regional Council's previous 'Wetland Extent' layer. The 'Wetland Extent' layer is a composite dataset based primarily on Regional Digital Aerial Mosaic (RDAM) aerial orthophotos flown in 2003 and 2005. It includes wetlands from three surveys (Bay of Plenty Wetlands Excluding the Rotorua Lakes Ecological District - final version acquired 24/03/2005, Rotorua Lakes Ecological District Wetlands - final version aquired 24/03/2005, Rotorua Lake Margins Wetlands Extents Only). This dataset is almost exclusively for use in BOP Regional Council's Freshwater Wetland Database, so generally does not include estuarine wetlands, and BOP Regional Council's Maritime Wetlands Database (which does include estuarine wetlands) was not included in this analysis

5 Results

We mapped 687 separate wetland polygons – which can be broadly equated to individual wetlands – covering 2,854 ha in the Tauranga Water Management Area. Estuarine wetlands (which were not consistently included in BOP Regional Council's 'Wetland Extent' dataset) make up over half of the newly mapped area (1,734 ha, 250 polygons).

Although our nominal minimum area to map was 0.5 ha, some smaller areas were included where they were clearly delineated or they were associated with nearby larger areas. In total, 103 polygons <0.5 ha are included in the mapping, covering a total area of 33 ha. The smaller mapped polygons are predominantly palustrine, while the largest polygons tend to be estuarine (Figure 1).

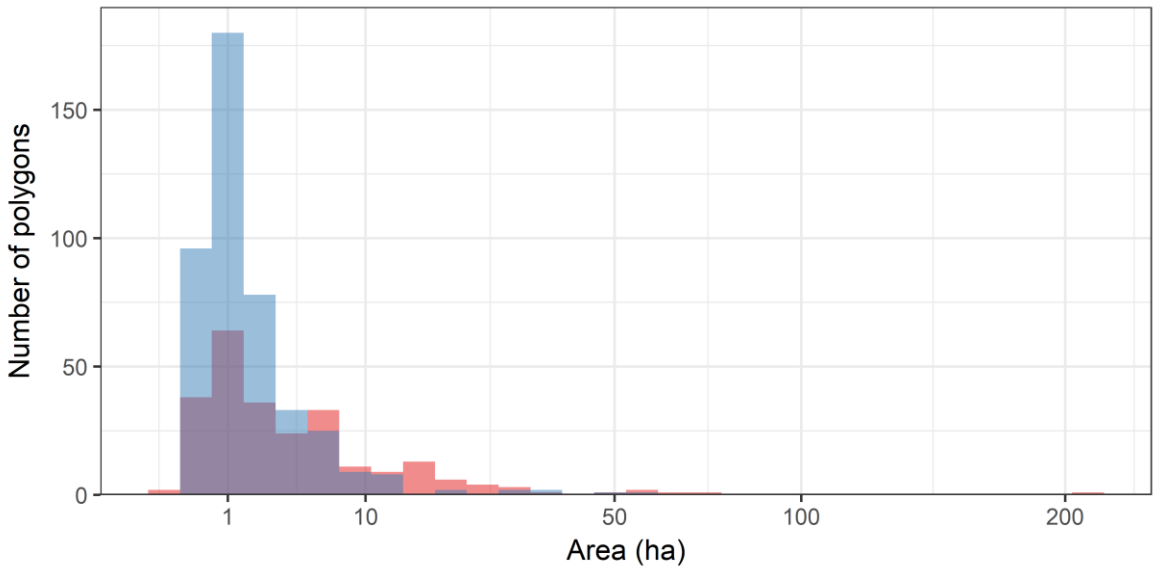

Figure 1 Size distribution, in 0.5 ha bins, of palustrine (blue) and estuarine (pink) wetland polygons in the Tauranga Water Management Area, Bay of Plenty.

For polygons considered to be mixtures of more than one wetland or vegetation structural class, all classes are listed in the polygon attributes, with the dominant class listed first. The most widespread wetland class by area is saltmarsh, and by number of polygons is swamp (Table 1, Figure 2). More than 1,160 ha of the mapped wetlands is dominated by mangrove (*Avicennia marina* subsp*. australasica*) saltmarsh (Table 2, Figure 3). Mangrove saltmarsh was relatively clearly delineated and identifiable. Conversely, herbfield — the second most common vegetation structural class by area — was typically difficult to separate from visually similar types and is likely to have higher misidentification of vegetation structure.

Forest wetlands were generally difficult to separate from surrounding non-wetland forest due to visual similarity. We identified 58.5 ha of forest and treeland wetlands that appear to be dominated by exotic vegetation – 35% of the total area of these vegetation types. Exotic vegetation of this type is likely to be predominantly willow (*Salix* spp. – mainly *S. cinerea* and *S. fragilis*).

We identified 181.4 ha of wet pasture and rush-dominated wet pasture ("Rushland/Wet Pasture"). Wetlands of these types probably do not meet the definition of wetland under Bay of Plenty Regional Council's Natural Resources Plan but are included here to allow further consideration and field-checking.

Table 1 Number of polygons and area of wetlands grouped by the dominant wetland class in the Tauranga Water Management Area

Dominant wetland class	Number of polygons	Area (ha)
Bog	6	16.7
Fen	2	2.2
Marsh	11	29.1
Other	74	193.4
Saltmarsh	249	1,770.5
Swamp	326	827.4
Water	19	14.4

Table 2 Number of polygons and area of wetlands grouped by the dominant vegetation structure, and area of these identified as dominated by exotic vegetation in the Tauranga Water Management Area

Dominant vegetation structure	Total Number of polygons	Total area (ha)	Area of exotic (ha)
Forest	59	149.1	48.5
Grassland	2	2.5	0.7
Herbfield	313	1,064.0	35.4
Mangrove	111	1,162.5	0
Open Water	17	14.0	0
Rushland	2	6.6	
Shrubland	91	207.0	20.1
Treefernland	9	18.9	0
Treeland	13	43.1	10.0
Wet Pasture, and Rushland/Wet Pasture	70	181.4	113.1

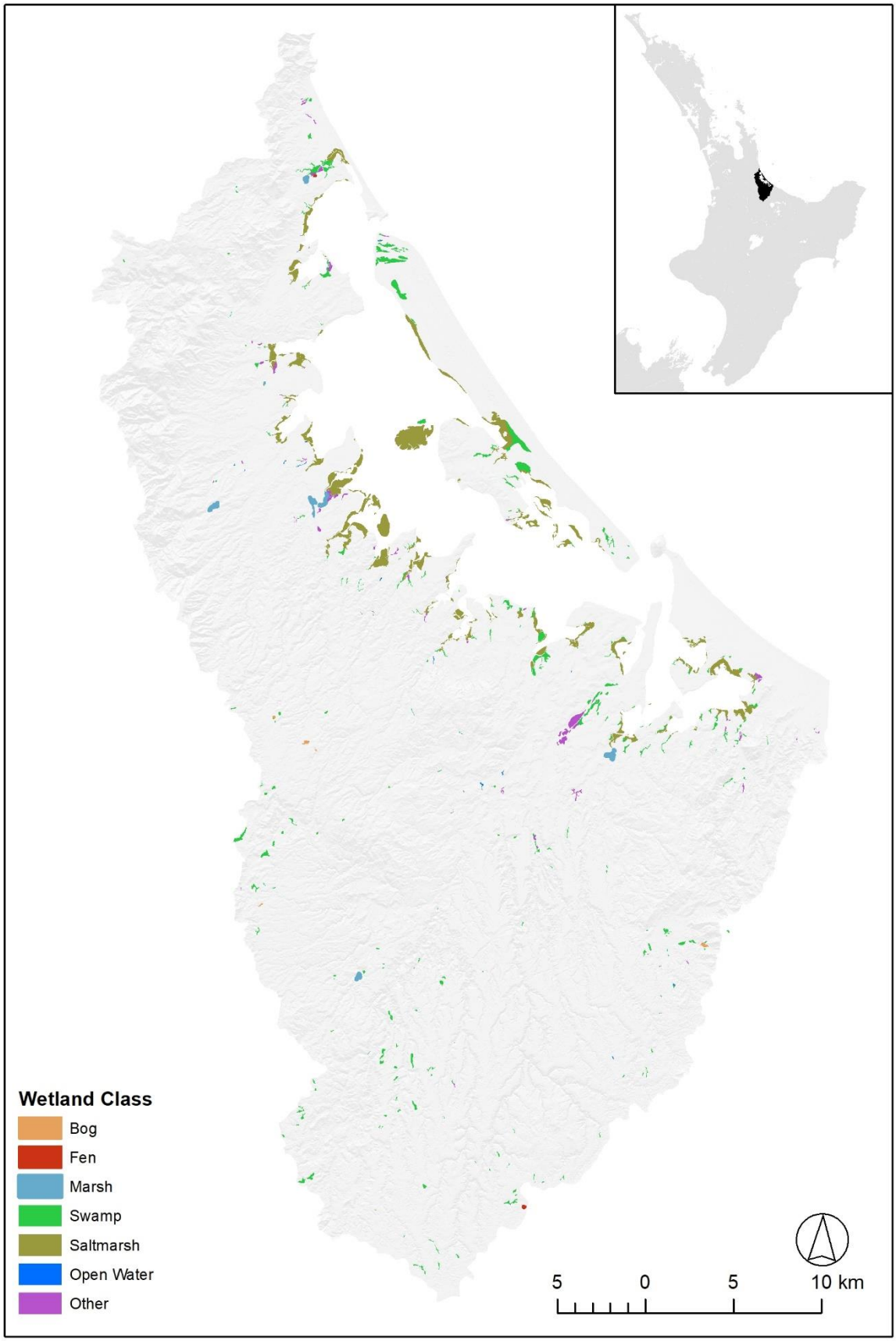

Figure 2 Wetland Class of potential wetlands mapped in the Tauranga Water Management Area, Bay of Plenty.

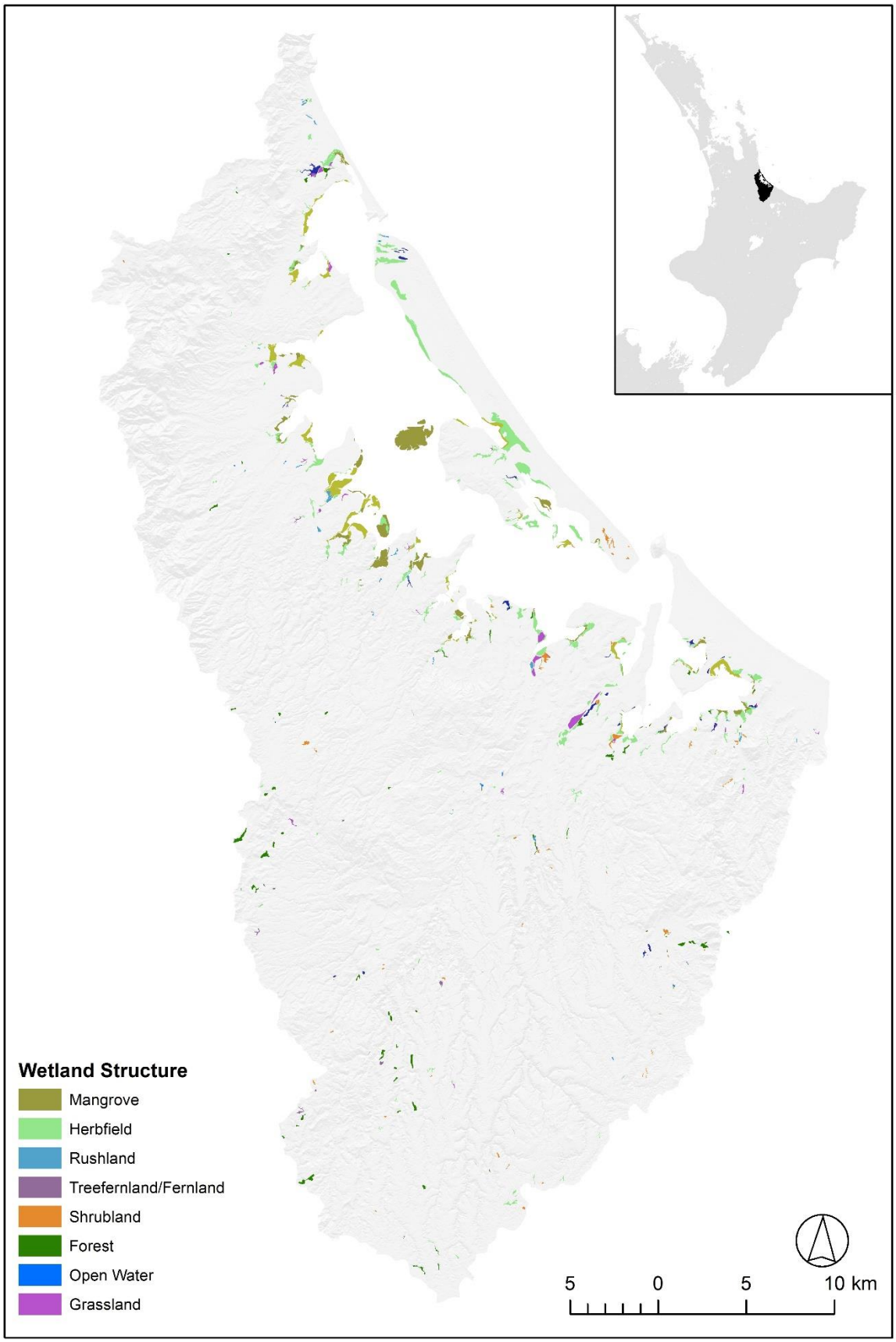

Figure 3 Vegetation Structure of wetlands mapped in the Tauranga Water Management Area, Bay of Plenty.

5.1 Differences between current and previous mapping

Excluding wet pasture (147 ha), we mapped 973 ha of freshwater wetlands in the Tauranga WMA. This is 93% more than the 505 ha in the previous wetland inventory provided by BOP Regional Council.

We compared the extent of current wetlands mapped in this project with the recent mapping by performing a spatial union between the layers to identify intersecting polygons. From this we identified previously mapped wetlands that were entirely omitted from the current mapping exercise, parts of previously mapped wetlands that were retained in the current mapping, parts of previously mapped wetlands that were not retained in the current mapping, and newly mapped wetlands.

Of the current polygons mapped in this project, 173 (25 %) corresponded at least partially with existing wetland mapping, however, all current polygons were newly drawn independent of existing line work, so boundary correlation with existing polygons was generally low. The proportion of intersecting polygons is similar when restricted to those we identified as palustrine, with 115 (27 %) of the 437 new palustrine polygons intersecting previously mapped areas. By area, 69 % (806 ha) of palustrine wetlands mapped in the current dataset are not in the previous inventory, and 141 ha of previously mapped wetlands were not retained in the current mapping.

Three previously mapped polygons were omitted entirely from our current mapping. One of these – 0.16 ha of reedland that makes up part of Honeywood Wetland – now appears to be artificial ponds (Figure 4). Another of these – Wairoa River Wetlands – is very small (approximately 300 m^2) and was not field checked during the previous mapping. We could see no visual cues to suggest the third omitted polygon – at McLaren Lake Wetlands – was in fact wetland. The attributes for the previous mapping note there was very low confidence in the mapping and it was also not field checked.

Figure 4 Changes in mapping of Honeywood Wetland, Bay of Plenty, showing a new area that does not intersect with previous mapping (red), a previously mapped polygon that is omitted entirely from current mapping (purple), previously mapped polygons that are included (and expanded) in current mapping (green), and parts of previously mapped polygons that are now omitted (blue).

6 Conclusions and discussion

There are significant differences between the number and extent of wetlands mapped in this project and BOP Regional Council's 'Wetland Extent' layer (the most recent and comprehensive previous wetland mapping in the Tauranga WMA). Only 27% of palustrine wetlands in the new mapping share geometries with the previous 'Wetland Extent' layer. The remaining 73% of the polygons in the new dataset represent potential wetlands that were not included in previous inventories. This is likely to be due to improvements in aerial imagery now available. We mapped a greater number of new polygons than we anticipated, and more than recent remapping of wetlands in Auckland in which 60% of mapped polygons represented new wetlands (Lawrence & Bishop 2017). In the process of examining all previously mapped wetlands in the project area only three were not included in the new dataset; one which appears to have been destroyed or was incorrectly identified previously, one that is very small, and one that is indistinct and does not appear to be wetland. Overall, it appears there is at least 90% more extant wetland in the Tauranga WMA than previous inventories indicate. However, we make no assessment of wetland condition.

Because of the importance of image quality when delineating wetlands, the use of historic aerial imagery to create new spatial data on historic wetlands (e.g. to investigate change over time) is likely to be problematic, particularly for smaller and less distinct areas.

We did not compare estuarine wetlands with previous mapping, such as the Bay of Plenty Regional Council's Maritime Wetland Database. It would be worthwhile undertaking this comparison in future work.

Unlike some previous inventory layers, we did not create multipart polygons in the current project. Individual wetland polygons mapped in this project could, in future, be combined into multipart polygons where these would better represent ecologically coherent wetland units.

We used a Topographic Position Index mask to aid the identification of potential wetlands, and this was found to accurately match known existing wetlands. However, because the TPI also highlights very large areas of former wetland that have now been destroyed and converted to other landuse, considerable time was still spent visually checking large areas.

Wetland boundaries and vegetation structure were identified predominantly by visual cues from recent aerial photography. This inevitably means there will be some errors in delineation, and likely greater errors with identification of vegetation structure. We attempted to categorise the level of certainty in the mapping to assist with prioritisation of field checking.

7 Recommendations

- The methods used to map wetlands in the Tauranga Water Management Area should be used in other Water Management Areas in Bay of Plenty
- Mapped wetlands should be field-checked to refine extent, class, and vegetation structure. An initial survey by helicopter could be an efficient way to rapidly assess many sites, particularly where we have low confidence from aerial images.
- The current wetland mapping could be refined by combining some of the wetland polygons into multipart polygons where these better reflect ecologically coherent wetland units.
- Spatial data derived from this, and future mapping of Bay of Plenty wetlands should be incorporated into a national wetland extent database, as recommended by Newsome (2017).

8 Acknowledgements

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