greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

Wetland Health State of the Environment monitoring programme

Annual data report, 2016/17

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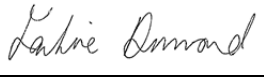
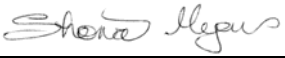
	F Drummond	Environmental Monitoring Officer	
Report reviewed by:	S Myers	External ecologist	
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1. Introduction

This report summarises the results of the Wetland Health State of the Environment (SoE) monitoring programme for the period 1 July 2016 to 30 June 2017 inclusive. The Wetland Health monitoring programme has been designed to survey 150 wetlands across the Wellington Region over a 5 year timeframe. The region has been divided into five whaitua (super-catchment areas) by Greater Wellington Regional Council (GWRC) for the purposes of freshwater planning. Thirty wetlands are surveyed annually, with a whaitua-based approach being taken in the sampling programme. The order in which wetlands are being sampled in each whaitua is as follows:

- Year 1 - Ruamahanga,
- Year 2 - Kapiti,
- Year 3 - Porirua and Hutt/Wellington,
- Year 4 - Eastern Wairarapa
- Year 5 - Ruamahanga and Kapiti remaining wetlands.

In addition to this sampling, three wetlands a year are surveyed in the relevant whaitua for the presence and abundance of fish and indicator wetland bird species. This report details the results of wetland health monitoring undertaken at 30 sites in Year 1 of the programme in 2016/2017.

2. Overview of the Wetland Health SoE monitoring programme

Wetlands are recognised by GWRC as a key ecosystem type that has undergone major decline. Only 2.3% of the original wetland extent is estimated to remain in the Wellington region according to Ausseil et al 2003. The National Policy Statement on freshwater management details that 'The overall quality of fresh water within a region is maintained or improved while … protecting the significant values of wetlands." GWRC's proposed Natural Resources Plan (pNRP) contains policies, rules and methods related to the protection and improvement of wetland health.

GWRC also has a Key Native Ecosystem (KNE) programme which aims to improve ecological outcomes at selected high value ecological sites in the region. The KNE programme includes 30 wetlands. The aim of the Wetland Health SOE monitoring programme is to monitor the state of wetlands in the region to determine the effectiveness of GWRC policies and interventions through the KNE programme. We do this by surveying 30 wetlands per year, with a return time of five years, so that 150 wetlands in total will be assessed.

2.1 Monitoring objectives

The aim of the Wetland health SOE monitoring programme is to measure the state and trend of wetland health across the Wellington region. The work described here aims to monitor:

1. the state and trend of wetland health in the Wellington region,

2. the effectiveness of the proposed Natural Resources Plan (pNRP) policies, rules and methods, and

3. the outcomes of management at selected wetland sites.

2.2 Monitoring network

2.2.1 Wetland health programme

The monitoring network is based on sampling of the 211 wetlands that have been scheduled in the proposed Natural Resources Plan (14 of which have been designated 'Outstanding" and 197 as "Significant). All 14 "Outstanding" wetlands and the 30 wetlands managed under GWRC's KNE programme were included in the sample, along with a randomised selection of the remaining wetlands. Proportional representation of wetlands between whaitua was maintained during the randomisation process. The distribution of the 30 selected wetlands surveyed in 2016/2017 in the Ruamahanga whaitua are shown in Figure 2.1.

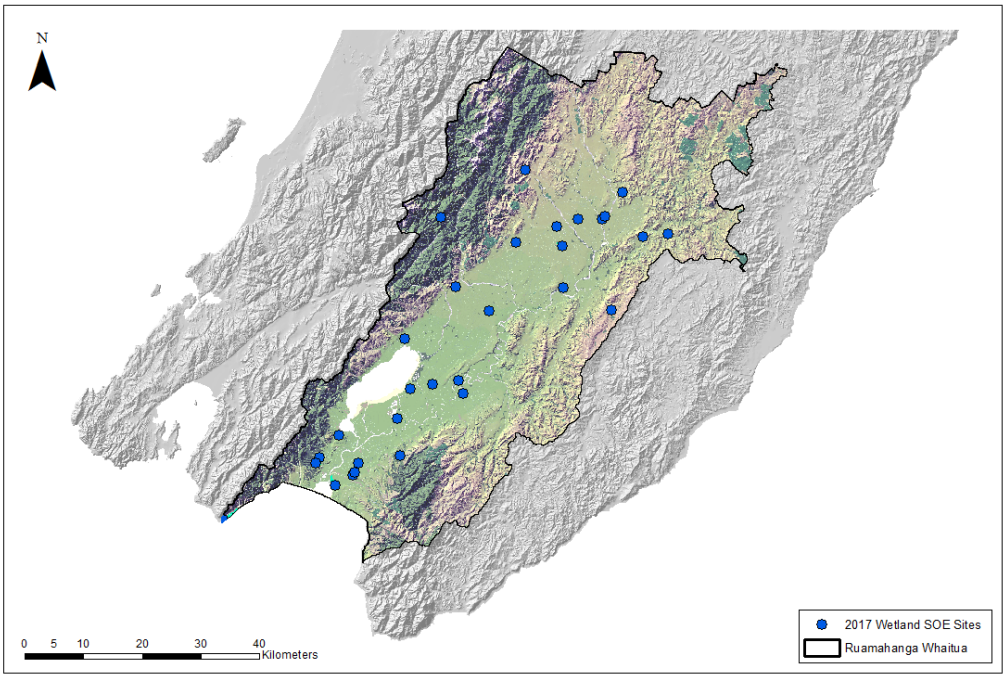

Figure 2.1: Wetlands surveyed in the Ruamahanga whaitua in 2016/2017

2.2.2 Fish and wetland bird sampling

Three of the 30 wetlands were selected for bird and fish surveys in the Ruamahanga whaitua based on their significance and vulnerability to change. Fish and bird survey sites were selected within the wetlands based on habitat and accessibility. The number of sites fished varied between two and four sites per wetland.

2.3 Monitoring variables

2.3.1 Wetland Health programme

Wetland monitoring followed Clarkson et al 2003, with adaptations from Clarkson et al 2013. The following indices/attributes were surveyed:

- Wetland Condition Index
- Wetland Pressure Index
- Vegetation composition
- Soil condition
- Plant nutrient status

The Wetland Condition Index is a compositie index that uses indicators of the following components of wetland health:

- Hydrologic integrity
- Physiochemical parameters
- Ecosystem intactness
- Browsing/predation/harvesting
- Dominance of native plants

Assessments are made at both the wetland scale and at a more detailed plot level. A Wetland Pressure Index is also scored at the landscape scale for each wetland.

The vegetation composition was sampled in 5m x 5m plots randomly located in all plant communities covering > 20% of the terrestrial area of the wetland. Field measurements of water table depth, water conductivity and pH (if water is present) and von Post (if peat is present) were recorded at each plot. Two soil core samples (100mm diameter x 70mm depth) were collected from the plot boundary and analysed in the laboratory for water content, bulk density, pH, conductivity, total C%, total N% and total P. Leaf samples of the two dominant canopy species present were also collected and analysed for %N and %P.

2.3.2 Fish and wetland bird surveys

Sampling of birds and fish was conducted in spring. Gee-minnow traps (3mm mesh) and finemesh fyke nets with exclusion chambers were set overnight and retrieved at first light to minimise hypoxia risk. Up to five fyke nets and 10 Gee-minnow traps were deployed at each site where accessibility allowed. Species, numbers and size classes were recorded for fish. All fish were released alive at their capture location.

Wetland birds were surveyed from the margins of each wetland using play-back calls for spotless and marsh crake. Surveys were conducted between 3pm and midnight, and in the morning starting 1 hour after midnight. Listening for bittern calls took place between 3am and 1 hour after sunrise. Recording devices were also left at each wetland for 4-6 weeks and were pre-set to record bird call for 4 hours at dusk and 2 hours before dawn. Species, number and location were recorded for wetland birds.

3. Results

3.1 Wetland types

Wetlands are classified as a particular wetland class overall, but within a wetland different habitat types can occur, (e.g. an ephemeral wetland on the side of a swamp). Twenty-eight wetlands were classified overall as swamps, with one saltmarsh and one bog also being surveyed. Some of the swamps contained areas of ephemeral wetlands (1), marsh (1) and shallow water (1). Each wetland had between one and five plots established depending on the number of vegetative communities present. A total of 48 plots were established in the 30 surveyed wetlands. Seven vegetation community types were identified as present: flaxland, shrubland, forest, sedgeland, reedland, rushland and grassland. Some wetlands are dominated by one vegetation type, others contain more than one or multiple.

3.2 Wetland Condition Index (WCI)

A range of condition scores were recorded for the 30 wetlands surveyed in the Ruamahanga whaitua in 2016/2017, with the highest WCI score being 23.33 and the lowest 10.33 (see Figure 3.1)

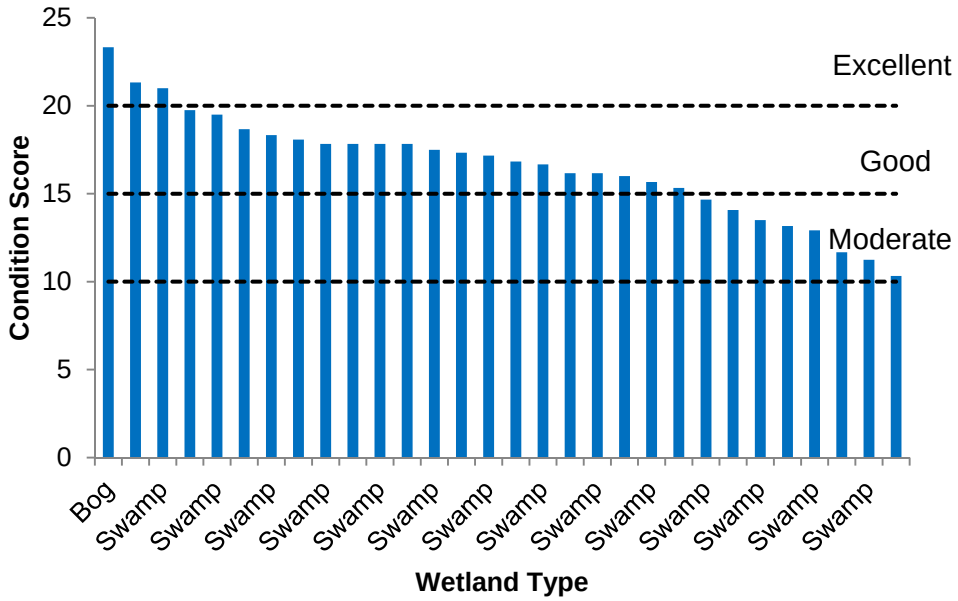

Figure 3.1: Wetland Condition Scores for wetlands surveyed in the Ruamahanga whaitua

Using the scoring system of Clarkson et al 2015:

- 3 sites were classified as being in excellent condition,
- 18 sites were in good condition, and
- 9 sites were in moderate condition.

3.3 Wetland condition components

The scoring for wetland condition is comprised of the following components: hydrological integrity, physiochemical, ecosystem intactness, browsing/predation and dominance of native plants. If separated into these components , the majority of excellent and poor scores were recorded for native plant dominance (see Figure 3.2). This is a reflection of the weediness of many wetlands. It is also of note that around half of the sites had scores in the poor and moderate categories for hydrological integrity and physiochemical condition, while only one third of the sites scored in the lower two categories for ecosystem intactness, browsing/predation and dominance of native plants. Hydrological integrity and physiochemical scores are influenced by catchment level management, while ecosystem intactness, browsing/predation and dominance of native plants are influenced by site-based management.

3.4 Wetland Pressure Scores

The Wetland Pressure scores ranged between 6 and 27 (out of 35). In general, the Wetland Condition Index scores were a reflection of the Wetland Pressure scores with wetland condition being inversely related to pressure scores (see Figure 3.3).

3.5 Soil analyses

The aim of soil analysis was to detect human-derived inputs of nutrients. Total carbon, total nitrogen, total phosphorus were all measured in soil cores at each plot, but understanding how this data will be used to assess wetland health is still in development. This is challenging as N levels are influenced by natural inputs from plants and the reduction of N in the wetland environment. Nitrogen levels do not necessarily reflect the nutrient inputs to a wetland as previously mentioned because nitrogen is a component of wetlands and is bound to carbon in the wetland organic material. Similarly, total phosphorus can reflect the composition of the wetland itself, rather than nutrient inputs. Some analyses of total carbon and bulk density levels are of interest however.

Interim national limits for some soil variables have been developed for swamps and bogs, but not for marsh, saltmarsh, ephemeral or shallow water wetland types at this stage (Clarkson et al 2015). The single bog plot that was measured fell within national limits for all soil variables. The remaining results presented here are for swamps only. It should be noted that the interim national limits have been set for wetlands that have a WCI score of >15 and nine of the sites reported here fell below that score. Nevertheless, all swamp plots are included in the comparison with the national limits (even for wetlands with a WCI below 15).

Organic carbon and total nitrogen are indicators of the organic reserves in the soil derived from healthy plant communities. It can be seen in Figure 3.4 that seven wetlands had low organic carbon levels. Six of the seven sites which were below the lower national critical limit for organic C did not have livestock excluded.

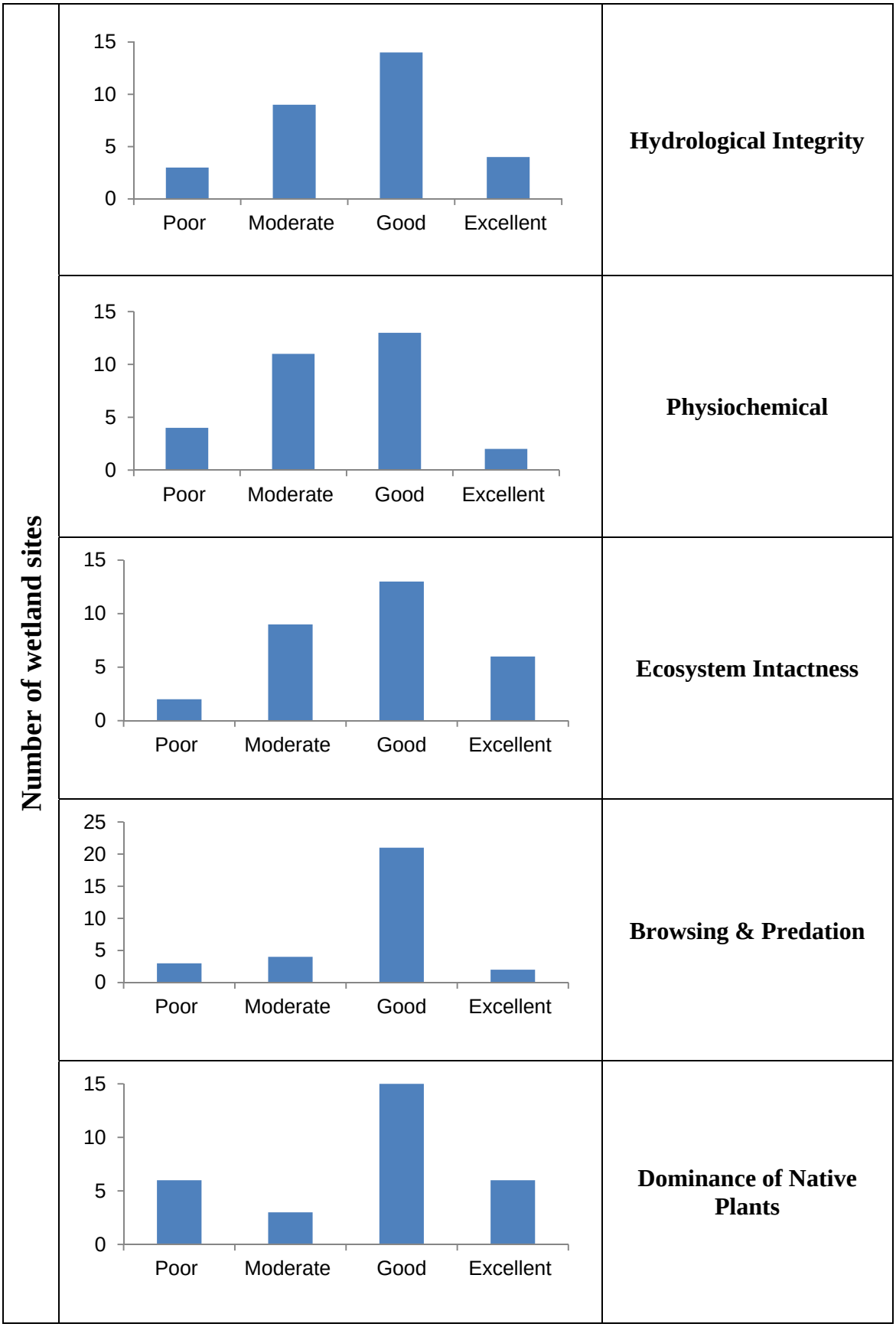

Figure 3.2: Wetland condition component scores

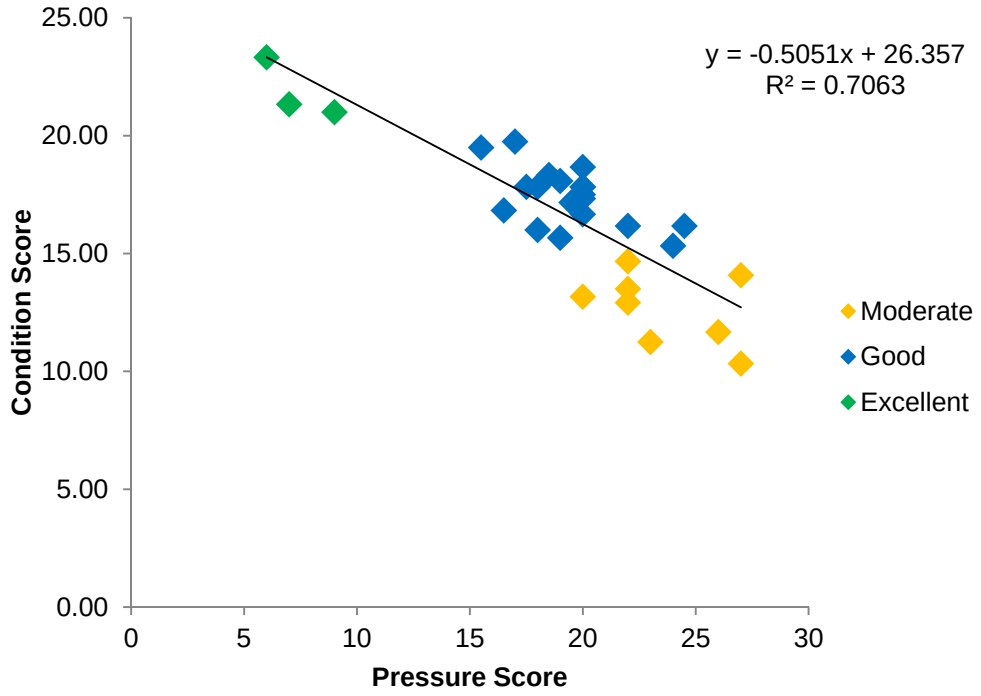

Figure 3.3: Relationship between the Wetland Condition Score and the Wetland Pressure Scores for the surveyed wetlands

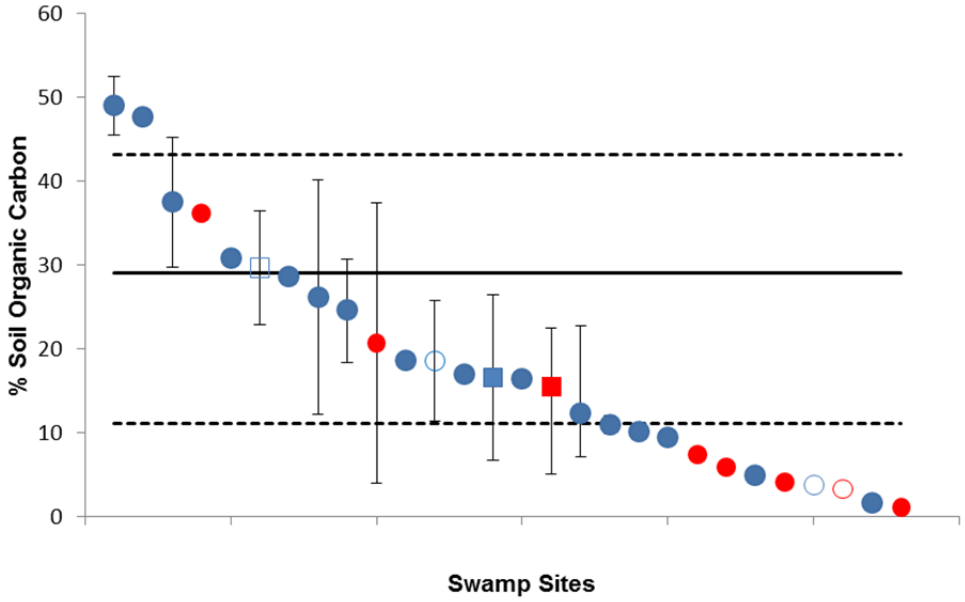

Figure 3.4: Ranked organic carbon levels within swamp sites with national mean (black line) and upper and lower critical limits (dashed lines) (Clarkson et al 2015). Red indicates no livestock exclusion, open symbols are KNEs, circles are significant wetlands and squares are outstanding wetlands

Dry bulk density (a measure of soil compaction) was also highest in plots where livestock were not excluded or where earthmoving machinery had been used to re-construct wetlands (see Figure 3.5).

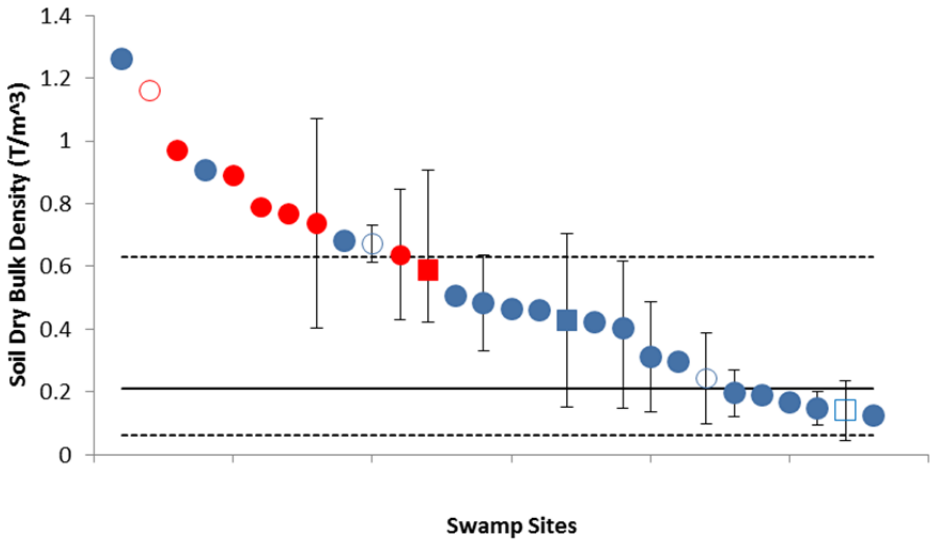

Figure 3.5: Ranked dry bulk density levels in swamp sites with national mean (black line) and upper and lower limits (dashed lines) (Clarkson et al 2015). Red indicates no livestock exclusion, open symbols are KNEs, circles are significant wetlands and squares are outstanding wetlands

3.6 Native species dominance

Native species dominance within the different vegetation community types is shown in Figure 3.6. Grassland had the lowest percentage of native species and cover, while flaxland had high native species dominance. Wetlands with grassland and rushland communities scored the lowest native species dominance, and in lowland areas commonly contained a mix of exotic and native species. Wetland communities with low native species dominance have been impacted by external effects which allow for exotic species to invade and outcompete native wetland species, such as lowering of the water table, altered hydrology, high nutrient levels, or grazing by stock or rabbits. Lower and more open native vegetation communities (such as rushland and sedgeland communities) are also more likely to be invaded by exotic species, particularly if also impacted by lowering of the water table or grazing.

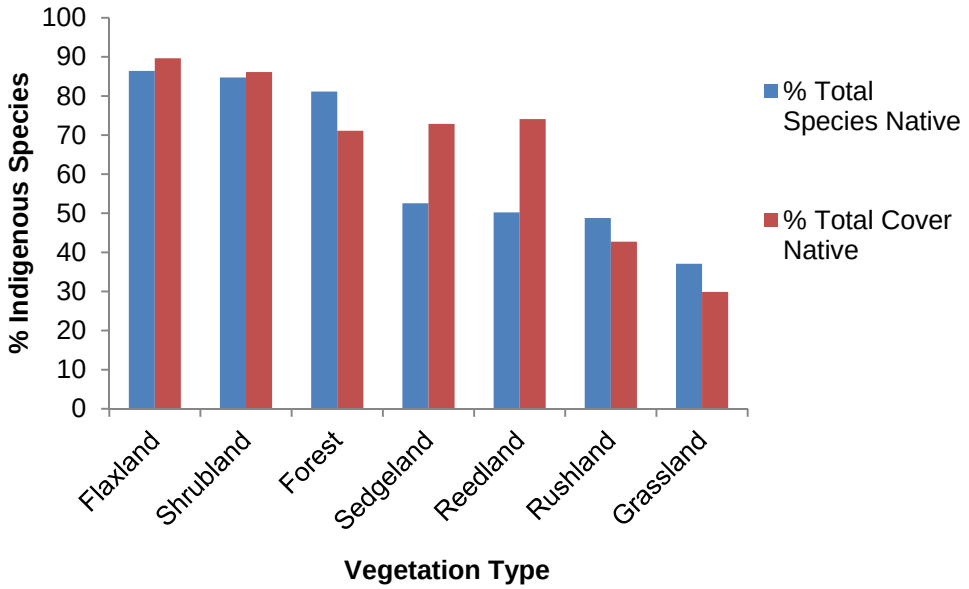

Figure 3.6: Percentage of species and cover composed of native species in each vegetation type

3.7 Spring faunal surveys

The findings from the three selected wetland sites surveyed durng the spring are shown in Table 3.1.

Table 3.1: Wetland bird and fish species identified during spring surveys

Site	Wetland birds	Fish
Wetland 1	1 pair and 2 individual spotless crake	Short-finned eel and koura
Wetland 2	4 pairs spotless crake	Brown mudfish, bullies, shortfinned eel, longfin eel
Wetland 3	No target species detected	Brown mudfish, upland bully, longfin eel

4. Discussion

This is the first year of the wetland health monitoring programme and while this data has provided some interesting information, the strength of the data will be to record change over time. It appears that the wetlands in the Ruamahanga are in a reasonable state given that 70% of wetlands surveyed were in excellent or good condition by national standards. The categories are have been set based on a small sample of wetlands from across New Zealand and may be refined as more data, particularly from wetlands in developed catchments, becomes available. This may, for example, mean that the national bottom line is ultimately set at a higher WCI. Wetlands in developed agricultural landscapes have significantly lower WCI than wetlands in indigenous dominated catchments (Clarkson et al 2013)

The results of the soil sampling have been of interest because of the negative correlation of soil carbon levels with wetlands that do not have stock excluded. This is because grazing stock most likely remove organic material from the wetland. Soil organic carbon is the major component of soil organic matter, which provides essential elements for wetland plant growth by retaining moisture and nutrients and providing good soil structure for water movement and plant growth (Sorenson, 2012). Higher soil organic carbon levels tend to improve mositure and nutrient-holding capacities and decrease nutrient runoff into surface and groundwater, benefitting landscape health.

Similarly, the high bulk densities found in wetlands that had been affected by machinery, such as diggers or by grazing stock indicate the impact that these pressures can have on a wetland. This soil compaction is a concern as it can increase soil erosion through runoff. More work needs to be completed to understand how high nitrogen inputs could be assessed, as most nitrogen in wetland soils is found in the organic matter, meaning that total nitrogen is related to the amount of carbon in the soil. It is possible that a low C:N ratio may provide a good indicator of high levels of human-derived N. Phosphorus levels are also difficult to interpret because of the connection to organic matter in the soil. It has been recommended that Olsen P be tested during the next sampling round to determine if this variable could be useful in assessing P load in a wetland (Faline Drummond pers comm.).

Four Key Native Ecosystem sites were assessed during this sampling. These surveys have been able to point to areas that need attention to improve the WCI in these KNEs and thereby can inform management actions. Changes in the WCI over time will provide data on the outcomes of management. In terms of plan effectiveness, the need for more landscape management to improve the WCI scores has been highlighted through the results detailed in Section 3.3. Changes in wetland health do not occur rapidly, but this monitoring programme has established the baseline condition of wetlands in the Ruamahanga whaitua and will be able to provide an assessment of changes in condition that occur over time. The spring bird and fish surveys have provided good information about the species present in the wetlands sampled and the health of those sites. The presence of spotless crake in the Ruamahanga wetlands is a positive sign, as these species have declined due to wetland drainage and the effects of animal predators.

5. Acknowledgements

The field team who collected this data included Shona Myers, Owen Spearpoint and Faline Drummond. Shona also produced a background report on the survey data, while Faline Drummond completed the analysis of the soils data and provided the figures for this report. Soil analysis was completed by Landcare Research Ltd.

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Appendix A: Data tables

Appendix 1: Wetland protection status in the GWRC Proposed Natural Resources Plan, current state of stock exclusion, and soil mean dry bulk density and percentage organic carbon at each swamp site monitored in the Rumahanga whaitua over summer 2016/2017

Site	No. plots sampled	GWRC protection	Stock excluded	Dry bulk density (t/m²)			% Organic Carbon		
				Mean	Min	Max	Mean	Min	Max
SOE WL01	3	Significant	N	0.64	0.43	0.85	5.90	5.71	6.14
SOE WL02	2	Significant	Y	0.31	0.14	0.49	26.20	12.20	40.20
SOE WL03	1	Significant	Y	0.42	0.42	0.42	18.60	18.60	18.60
SOE WL06	1	Significant	Y	0.19	0.19	0.19	30.80	30.80	30.80
SOE WL08	2	Significant	N	0.74	0.41	1.07	20.70	4.03	37.40
SOE WL09	1	Significant	Y	1.26	1.26	1.26	1.72	1.72	1.72
SOE WL10	1	Not Scheduled	Y	0.91	0.91	0.91	9.44	9.44	9.44
SOE WL11	2	Significant	Y	0.15	0.10	0.20	24.60	18.40	30.70
SOE WL13	3	Significant	Y	0.40	0.15	0.62	12.30	7.10	22.70
SOE WL14	1	Significant	Y	0.17	0.17	0.17	28.60	28.60	28.60
SOE WL15	2	Significant	Y	0.13	0.11	0.14	49.00	45.50	52.50
SOE WL16	1	Significant	N	0.77	0.77	0.77	36.20	36.20	36.20
SOE WL19	2	Significant &KNE	Y	0.67	0.61	0.73	3.80	3.31	4.28
SOE WL20	2	Outstanding & KNE	Y	0.14	0.05	0.24	29.70	22.90	36.50
SOE WL27	2	Significant & KNE	Y	0.24	0.10	0.39	18.60	11.40	25.70
SOE WL28	1	Significant	N	0.97	0.97	0.97	4.07	4.07	4.07
SOE WL32	1	Significant	Y	0.46	0.46	0.46	16.40	16.40	16.40
SOE WL34	2	Outstanding	Y	0.43	0.15	0.71	16.60	6.72	26.50
SOE WL37	1	Significant	Y	0.68	0.68	0.68	5.03	5.03	5.03
SOE WL40	1	Significant	N	0.89	0.89	0.89	7.41	7.41	7.41
SOE WL42	1	Significant	Y	0.47	0.47	0.47	10.20	10.20	10.20
SOE WL43	1	Significant	Y	0.30	0.30	0.30	47.70	47.70	47.70
SOE WL44	1	Significant & KNE	N	1.16	1.16	1.16	3.30	3.30	3.30
SOE WL45	1	Significant	Y	0.51	0.51	0.51	17.00	17.00	17.00
SOE WL46	2	Significant	Y	0.20	0.12	0.27	37.50	29.70	45.20
SOE WL47	5	Outstanding	N	0.59	0.42	0.91	15.50	5.12	22.50
SOE WL48	2	Not scheduled	Y	0.48	0.33	0.64	11.00	9.92	12.10
SOE WL49	1	Significant	N	0.79	0.79	0.79	1.10	1.10	1.10

Appendix 2: Wetland vegetation types and the dominance of native species and native vegetation cover in the 5m x 5m plots sampled at each site monitored across the Rumahanga whaitua over summer 2016/2017. Sites are numbered (e.g. SOE WL01) and plots are listed as letters (i.e. A, B, C, D and E)

Plot	Vegetation type	Native species dominance (%)	Native cover dominance (%)
SOE WL01A	Sedgeland	37	64
SOE WL01B	Reedland	29	64
SOE WL01C	Flaxland	90	91
SOE WL02A	Sedgeland	46	55
SOE WL02B	Reedland	70	87
SOE WL03A	Shrubland	64	60
SOE WL06A	Reedland	50	76
SOE WL08A	Rushland	54	21
SOE WL08B	Grassland	53	20
SOE WL09A	Grassland	14	20
SOE WL10A	Reedland	14	43
SOE WL11A	Shrubland	92	99
SOE WL11B	Sedgeland	90	96
SOE WL13A	Forest	57	5
SOE WL13B	Forest	96	90
SOE WL13C	Shrubland	50	63
SOE WL14A	Shrubland	82	79
SOE WL15A	Flaxland	69	78
SOE WL15B	Shrubland	88	95
SOE WL16A	Reedland	69	89
SOE WL19A	Sedgeland	20	87
SOE WL19B	Shrubland	100	100
SOE WL20A	Forest	100	100
SOE WL20B	Shrubland	100	100
SOE WL27A	Forest	100	100
SOE WL27B	Sedgeland	50	82
SOE WL28A	Grassland	43	36
SOE WL32A	Forest	100	100
SOE WL34A	Reedland	87	78
SOE WL34B	Forest	84	76
SOE WL37A	Forest	100	100
SOE WL38A	Grassland	100	100
SOE WL40A	Forest	0	0
SOE WL41B	Sedgeland	60	75
SOE WL42A	Forest	72	60
SOE WL43A	Forest	94	99
SOE WL44A	Rushland	44	64
SOE WL45A	Forest	91	70
SOE WL46A	Flaxland	100	100

Plot	Vegetation type	Native species dominance (%)	Native cover dominance (%)
SOE WL46B	Forest	80	54
SOE WL47A	Shrubland	73	77
SOE WL47B	Sedgeland	68	67
SOE WL47C	Reedland	69	87
SOE WL47D	Sedgeland	63	65
SOE WL47E	Shrubland	76	86
SOE WL48A	Sedgeland	42	73
SOE WL48B	Grassland	0	0
SOE WL49A	Grassland	13	4

Appendix 3: Wetland type and the condition and pressure scores by component for the 30 wetland sites monitored in the Ruamahanga whaitua over summer 2016/2017. Wetland condition indicators are scored out of 5 and averaged to give a score out of 5 for each component. The five components that make up the Wetland Condition Index are then summed to give a score out of 25 where (<10=poor, 10 ≤ 15=moderate, 15 ≤ 20 =good and >20 =excellent). The pressure index is calculated as the sum of seven indicators, each scored out of 5 to give a score out of 35

Site	Wetland type	Indicator component					Overall condition index	Overall pressure index
		Hydrological integrity	Physiochemical parameters	Ecosystem intactness	Browsing and predation	Dominance of native plants		
SOE WL01	Swamp	2.83	2.00	3.33	2.00	3.00	13.17	20.00
SOE WL02	Swamp	3.17	3.50	3.33	3.67	3.67	17.33	20.00
SOE WL03	Swamp	2.67	3.00	2.67	3.67	2.67	14.67	22.00
SOE WL06	Swamp	3.67	4.00	4.33	2.67	4.00	18.67	20.00
SOE WL08	Swamp	3.33	2.50	3.17	2.50	2.00	13.50	22.00
SOE WL09	Swamp	2.00	2.25	2.00	3.33	1.67	11.25	23.00
SOE WL10	Swamp	2.33	2.25	1.33	3.67	3.33	12.92	22.00
SOE WL11	Swamp	4.33	4.00	4.33	3.67	4.67	21.00	9.00
SOE WL13	Swamp	3.00	3.00	3.00	3.67	3.33	16.00	18.00
SOE WL14	Swamp	3.33	4.00	3.33	3.67	3.17	17.50	20.00
SOE WL15	Swamp	3.33	3.50	3.67	3.67	3.67	17.83	20.00
SOE WL16	Swamp	3.67	3.00	3.17	3.00	3.33	16.17	22.00
SOE WL19	Swamp	4.00	3.75	3.67	4.33	4.00	19.75	17.00
SOE WL20	Swamp	5.00	3.50	4.33	3.83	4.67	21.33	7.00
SOE WL27	Swamp	2.33	3.00	3.33	4.17	4.00	16.83	16.50
SOE WL28	Swamp	4.00	3.00	3.00	2.75	1.33	14.08	27.00
SOE WL32	Swamp	3.67	3.00	3.67	3.67	4.33	18.33	18.50
SOE WL34	Swamp	2.67	4.00	3.33	3.50	2.67	16.17	24.50
SOE WL37	Swamp	2.00	4.00	2.67	3.67	4.33	16.67	20.00
SOE WL38	Bog	5.00	4.67	4.67	4.00	5.00	23.33	6.00

Site	Wetland type	Indicator component					Overall condition index	Overall pressure index
		Hydrological integrity	Physiochemical parameters	Ecosystem intactness	Browsing and predation	Dominance of native plants		
SOE WL40	Swamp	3.00	2.00	3.00	1.67	2.00	11.67	26.00
SOE WL41	Saltmarsh	3.00	3.50	4.33	3.67	3.33	17.83	17.50
SOE WL42	Swamp	3.00	3.50	3.00	3.67	4.00	17.17	19.50
SOE WL43	Swamp	3.33	3.75	3.00	3.67	4.33	18.08	19.00
SOE WL44	Swamp	3.67	3.00	4.00	3.17	4.00	17.83	20.00
SOE WL45	Swamp	3.33	2.00	3.33	3.67	3.33	15.67	19.00
SOE WL46	Swamp	4.33	2.50	4.00	3.67	3.33	17.83	18.00
SOE WL47	Swamp	3.67	4.50	4.33	3.33	3.67	19.50	15.50
SOE WL48	Swamp	3.67	4.00	2.33	3.33	2.00	15.33	24.00
SOE WL49	Swamp	2.00	2.00	2.67	1.67	2.00	10.33	27.00