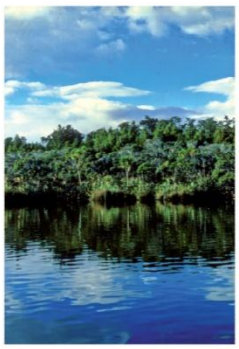

A methodology for monitoring Bay of Plenty wetlands

Landcare Research
Manaaki Whenua

A methodology for monitoring Bay of Plenty wetlands

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Contents

Summary

Project and Client

- Bay of Plenty Regional Council contracted Landcare Research to develop a system for monitoring the ecological state and trend of Bay of Plenty wetlands for high-level reporting purposes under the Natural Environment Regional Monitoring Network (NERM).

Objectives

- Develop and trial a sampling approach and monitoring system applicable to the range of freshwater wetlands in the Bay of Plenty region.
- Provide detailed guidelines for establishing vegetation plots, replication, plot size, and overall wetland condition assessment, incorporating current standard procedures and any potential refinements.

Methods

- Use a monitoring system based on the current wetland handbook monitoring approach with refinements recently developed for Southland wetlands, in a subset of Bay of Plenty wetlands covering a range of wetland classes and vegetation types.
- Trial the Prevalence Index, a weighted average measure of 'dryness' based on plant species fidelity to wetland that was developed for wetland delineation in USA, as a surrogate for monitoring hydrological changes in a wetland, following a pilot study in Southland wetlands.
- Develop a robust approach to wetland sampling in terms of plot replication and location within a wetland.

Results

- A wetland monitoring system together with field sheets (Wetland Record Sheet, Wetland Plot Sheet, Prevalence Index) and guidelines for establishing vegetation plots, plot replication, location, and size, sampling techniques and overall condition assessment were trialled and refined in three Bay of Plenty wetlands covering different wetland classes and vegetation types.
- The Prevalence Index shows promise as a cost-effective and simple surrogate for monitoring hydrological changes in a wetland.

Conclusions and Recommendations

- Analysis of data from the pilot surveys indicate the monitoring system, which is consistent with standard monitoring methods developed for wetlands in both New Zealand (monitoring handbook) and USA, should be suitable for monitoring Bay of Plenty wetlands for NERM and other requirements.

1 Introduction

The extent and condition of wetlands in New Zealand have declined significantly since the arrival of humans. More than 90% of wetland area has been destroyed and many wetland sites continue to degrade because of reduced water, additional nutrients, and/or impacts from many invasive species. Monitoring is important for detecting negative changes in biodiversity and ecosystem properties so that early and effective remedial action can be taken. Regional Councils have responsibilities to maintain indigenous biodiversity under the Resource Management Act 1991 and to monitor the state of the environment, which includes monitoring the state of wetlands. This project aims to assist Bay of Plenty Regional Council (Environment Bay of Plenty) with meeting these requirements.

2 Background

Bay of Plenty Regional Council contracted Landcare Research to develop and implement a system for monitoring the ecological state and trend of a representative set of Bay of Plenty wetlands. The purpose of the monitoring is for various reporting requirements under the Natural Environment Regional Monitoring Network (NERMN), which can be used to assess the efficiency and effectiveness of regional policies and plans.

There are four main parts to the project:

A. Framework for assessment of the priorities for wetland monitoring based on historic vs extant extent of representative wetland types. This includes geographic spread (e.g. Ecological District), and ecological values/ecological integrity. The framework will yield a representative set of priority wetlands for monitoring on a 5-year rotation. Part A has now been completed (Fitzgerald et al. 2013).

B. Development and trialling a sampling approach and monitoring system in a range of wetland classes and vegetation types. Provision of detailed guidelines for establishing vegetation plots, replication, plot size, and overall condition assessment incorporating current standard procedures and any potential refinements.

Note: This monitoring project focusses on monitoring the vegetation, nutrient and some hydrological components of wetlands. Monitoring of faunal components such as bird counts, fish surveys, and pest numbers will be undertaken separately in association with Department of Conservation (N. Willems, Bay of Plenty Regional Council, pers. comm. 2013)

C. Implementing the wetland monitoring system over a 5-year period.

D. Data analysis to establish baselines for monitoring wetland extent and condition.

This report covers Part B.

3 Objectives

- Develop and trial a sampling approach and monitoring system applicable to the range of freshwater wetlands within Bay of Plenty.
- Provide detailed guidelines for establishing vegetation plots, replication, plot size, and overall wetland condition assessment incorporating standard procedures and any subsequent refinements.

4 Methods

- Use a monitoring system based on the current wetland handbook monitoring approach (Clarkson et al. 2004), with refinements developed recently for Southland wetlands, in a subset of Bay of Plenty wetlands covering a range of wetland classes and vegetation types.
- Trial the Prevalence Index, a weighted average measure of 'dryness' based on plant species fidelity to wetland that was developed for wetland delineation in USA, as a surrogate for monitoring hydrological changes in a wetland, following a pilot study in Southland wetlands.
- Develop a robust approach to wetland sampling in terms of plot replication and location within a wetland.

5 Results

5.1 Wetland sites

Three wetlands were selected for the trial: Tumurau (Braemar) Lagoon Wetlands (henceforth Tumurau Wetland) and Kohika Wetlands in Te Teko Ecological District, and Kaituna Sand Dunes Wetlands in Tauranga Ecological District. These wetlands are nationally or regionally significant and are listed in the provisional set of wetlands to be considered for monitoring (Fitzgerald et al. 2013). They cover a range of wetland types (marsh, swamp, and fen) and vegetation types (e.g. grey willow treeland, *Coprosma* shrubland, *Machaerina* sedgeland, *Juncus* rushland, raupo reedland). They also cover various impacts of management, e.g. Tumurau Wetland has recently undergone willow control operations, and there are large areas of native and exotic vegetation dieback. The wetlands were sampled on 18–19 November 2013 and 19–20 December 2013, with a total of 12 plots sampled (Appendix 1).

5.2 Overall approach

The methods follow the Handbook for Monitoring Wetland Condition (Clarkson et al. 2004) http://www.landcareresearch.co.nz/publications/researchpubs/handbook_wetland_condition.pdf with modifications based on the WETMAK: Wetland Monitoring and Assessment Kit (Denyer & Peters 2012) http://www.landcare.org.nz/wetmak and the RECCE method (Hurst & Allen 2007) http://nvs.landcareresearch.co.nz/html/Recce_ExpandedManual.pdf. The approach was further refined after field testing in Southland wetlands by Bev Clarkson

(Landcare Research), Andy Hicks (Environment Southland), and Hugh Robertson (Department of Conservation), and the addition of the Prevalence Index (PI), a wetland indicator used in the USA protocols for wetland delineation (US Army Corps of Engineers: Environmental Laboratory 1987, and subsequent revisions).

The points of difference between the current approach and the Handbook for Monitoring Wetland Condition method and/or background information are summarised in Sections 5.2.1 to 5.2.3 below.

5.2.1 Wetland Sheet

- Removal of Indicator Component Fire Damage: Any nutrient enrichment caused by recent fires can be incorporated in the indicator component 'Nutrient levels' and any vegetation/biota damage can be captured in the new Indicator component 'Recent vegetation damage/clearance'. This follows the WETMAK approach (Denyer & Peters 2012).
- New indicator components 'Native animal species occupancy decline' and 'native plant species occupancy decline' are added to measure the extent of divergence from the expected or typical species composition and/or structure expected for that particular wetland type.

5.2.2 Wetland Plot Sheet

This builds on the WETMAK approach with additional data recorded. For more information and guidance see Field Sampling Protocols (section 5.3.1 below).

5.2.3 Prevalence Index

This is a method for assessing the 'wetness' or, more correctly, 'dryness' of a plot based on plant species composition and cover. It was developed for the USA wetland delineation system (Environmental Laboratory 1987) using individual wetland species indicator status based on typical wetland habitat (OBL: obligate wetland, FACW: facultative wetland, FAC: facultative, FACU: facultative upland (dryland), UPL: upland) to calculate a Prevalence Index (PI). In USA if PI ≤ 3, the vegetation is considered hydrophytic and satisfies the vegetation criterion for delineating wetlands (the other criteria are soils and hydrology). Epiphytes are not included in the assessment because they are not rooted in wetland soils.

In New Zealand we are trialling use of the Prevalence Index as a tool to monitor changes in hydrological regime in permanent plots at a site. The list of indicator status ratings for New Zealand wetland plants is available online at http://www.landcareresearch.co.nz/__data/assets/pdf_file/0014/64400/wetland_rating_species_December_2013.pdf. As plants integrate and reflect the environmental conditions at a site, significant changes in the hydrological regime will be apparent in changes in species composition and cover. For example, influxes of FACU and UPL pasture species may be promoted by the lowering of the water table following drain construction, and will result in increases in Prevalence Index values. Further work is planned with a biometrician on developing significance levels related to the extent of the change of Prevalence Index.

The Prevalence Index for the Bay of Plenty plots sampled (Table 1) indicates that the PI ranged from 1.00 to 3.33, reflecting very wet through to relatively dry hydrological regimes. Following the USA wetland delineation system, Kohika Plot 1 does not satisfy the wetland vegetation criterion (i.e. PI≤3). Kohika Plot 1 had significant proportions of FAC, FACU and UPL species, and the water table was not measurable (deeper than 40 cm). Monitoring in the future will indicate whether the sites are drying out or not.

Table 1 Prevalence Index for wetland plots sampled

Plot	Prevalence Index	Wetland vegetation
Kaituna Sand Dunes Plot 4	1.00	Yes
Tumurau Plot 8	1.03	Yes
Tumurau Plot 7	1.13	Yes
Kaituna Sand Dunes Plot 1	1.25	Yes
Tumurau Plot 9	1.33	Yes
Tumurau Plot 6	1.95	Yes
Kohika Plot 2	2.03	Yes
Tumurau Plot 1	2.19	Yes
Tumurau Plot 5	2.21	Yes
Tumurau Plot 2	2.42	Yes
Tumurau Plot 4	2.98	Yes
Kohika Plot 1	3.33	No

5.3 Field Sampling Protocols

We recommend the protocols outlined below for wetland monitoring. In addition, repeat measurements (inter-annual) should be undertaken at the same time of year to avoid seasonal differences, and under 'normal' conditions to avoid short-term fluctuations caused by abnormal climatic, disturbance or other conditions.

5.3.1 Background references and equipment required

- Fitzgerald et al. (2013) report for list of priority Bay of Plenty wetlands for monitoring.
- This report (Clarkson et al. 2014) for monitoring methodology.
- Handbook for Monitoring Wetland Condition (Clarkson et al. 2004) for assessment of wetland condition in Wetland Record Sheet, soil and foliage sampling protocols, and von Post scoring scale.
- Aerial photos, reports, wetland vegetation maps, other relevant information on wetland.
- GPS points both primary and at least 2 back-up points per major vegetation type (see 5.3.2).

- GPS and spare batteries.
- Field sheets (Appendix 1): Wetland Record Sheets, Wetland Plot Sheets, Prevalence Index Sheets.
- Aluminium poles *c.* 2 m tall for permanent plot corners. Four per plot.
- Small permolat squares or similar for marking plot numbers (use nail or similar to scratch label on – not marker pen as this fades) and compass orientation corners, e.g. SW etc. Beforehand, drill holes in top and bottom of square to slide snugly over aluminium pole. Four per plot.
- Tape measures. Two 30-m tapes for marking out plots.
- Builder's retractable steel tape measure for species heights.
- Steel liner for taking substrate/soil cores, e.g. 10 cm diameter by 7 cm height.
- Knife for cutting out core – one with a serrated edge is recommended.
- Sealable plastic bags for cores. Two per plot.
- Small paper bags (e.g. 15 × 15 cm) or envelopes for foliage samples (not plastic bags, which sweat and the samples may become mouldy). Usually one per plot. However, we recommend that mānuka also be collected if present as this is a standard species for nutrient content.
- Field pH and conductivity (EC) meter.
- Von Post scoring scale (in Handbook for Monitoring Wetland Condition).
- Chilly bin with ice packs for storage of substrate samples in the field. Store in fridge as soon as possible on return from the field.
- Courier samples for analysis at an ISO-accredited laboratory, such as the Landcare Research laboratory at Palmerston North http://www.landcareresearch.co.nz/resources/laboratories/environmental-chemistry-laboratory.

5.3.2 Plot selection

- Delineate in a GIS system the vegetation types at each wetland, based on published and unpublished reports, local knowledge, interpretation of recent aerial photos, and other relevant information. The GIS information will be used to choose sample locations below and forms an important part of the meta-data associated with the sample. It should therefore be documented and the version used should be stored for later analysis and reporting.
- Determine the desired number of sample locations per vegetation type. We recommend at least one plot per vegetation type.
- Using a probability sampling method, choose the desired number of plot locations in each vegetation type. We recommend that the SPAS sampling extension developed by Landcare Research be used to choose spatially balanced samples. This program operates as an extension of ArcView 3.2 or 3.3. SPAS does not require that ArcView be running, but does require the ArcView libraries. If ArcView is not available, then the simple random sampling options available in ArcGIS are suitable. In all cases the area of each vegetation type and the number of samples in that type should be recorded and

maintained with the data to provide information on sampling intensity (inclusion probabilities) required for analysis. The SPAS (Spatial Sampling) program will calculate inclusion probabilities and include them in the output file containing plot locations.

- It is recommended that at least an equal number of alternate back-up locations be generated for each vegetation type in case plots are rejected on the basis of misclassification or recent development/destruction. This can be achieved simply by repeating the above procedure for each vegetation type, using a different random seed.
- If ground truthing of the aerial photographs and/or vegetation maps reveals that a vegetation type has been missed during the sampling process, additional plot(s) may be sampled. To do this, delineate the vegetation type in the field and use random numbers (e.g. X metres towards the centre of the vegetation type) to select the plot origin, ensuring the plot is representative of the target vegetation type. Indicate that this plot is 'additional' to the randomly generated plots.

5.3.3 Field survey: plot establishment and sampling

- Using the GPS random point coordinates as the origin and south-west corner, set up a 5 × 5 m plot due north, east, etc. from that point using tape measures and poles.
- Take 2 photos at the SW corner, the first looking N, and the second looking E, with the poles and tape delineating plot along the edge of the photo if possible (see Figs 1 and 2). Record photo number and time it was taken.
- Fill in page 1 of the Wetland Plot Sheet in the field. Page 2 of the Wetland Plot Sheet can be left until later, when soil/foliage analyses are completed.
- Species cover (Cover % column) is not measured in fixed height (RECCE) or Atkinson variable height (Atkinson 1985) tiers. It is the vertical projection (spread) of the aboveground live biomass for each species measured as % cover of the total area of the plot, irrespective of height or tier, or position of other vegetation. Imagine each species is the only species in the plot and estimate its cover. Individual species cover cannot be more than 100% but total vegetation cover usually will be >100%. This applies to all vascular species and *Sphagnum* moss. Bryophytes and lichens may also be recorded to species level if known, but must also be recorded collectively as Bryophytes or Lichens. Assess the cover of rarely-occurring species down to 0.1% if possible i.e. approximately a 15 × 15 m square in a 5 × 5 m plot (1% cover is equivalent to a 50 × 50 cm square).
- Cover class estimates for each species in the different height tiers is the cover class estimate based on the % cover of that species within the appropriate height tier compared with the total area of the plot.
- Fill in the plot vegetation data table on page 2 of the Wetland Plot Sheet.

Figure 1 Photograph example from SW corner: Tumurau Wetland Plot 1 looking north.

Figure 2 Photograph example from SW corner: Tumurau Wetland Plot 1 looking east.

5.3.4 Wetland Record Sheet

Fill in the wetland record sheet to calculate a Wetland Condition Index for each wetland, based on the Wetland Monitoring Handbook Table 5 (Clarkson et al. 2004) and information therein. For the new indicators of 'Native animal species occupancy decline' and 'Native plant species occupancy decline', assess the extent of divergence from the expected or typical species composition and/or structure expected for that particular wetland type (based on wetland ecological knowledge). Use similar scoring categories used for the other indicators, i.e. 5: none/very low; 4: low; 3: moderate; 2: high; 1: very high; 0: extreme.

5.3.5 Prevalence Index

Calculate the Prevalence Index by filling in the Prevalence Index table using plot percent cover and species indicator group data from the New Zealand wetland species indicator status ratings available on the web (Clarkson et al. 2013: http://www.landcareresearch.co.nz/__data/assets/pdf_file/0014/64400/wetland_rating_species_December_2013.pdf). Populate the Prevalence Summary Worksheet on page 2 of the Wetland Plot Sheet.

5.3.6 Nutrient Analyses

Instructions for collecting foliage and substrate samples are outlined in the Wetland Monitoring Handbook (Clarkson et al. 2004). Soil cores and field water measurements are taken in the south-west corner just within the plot. When substrate and foliage nutrient analyses have been received from the analytical laboratory, fill in the tables on page 2 of the Wetland Plot Sheet.

5.4 Wetland survey data sheets

The Wetland Record Sheet, Wetland Plot Sheet, Prevalence Index, all nutrient and other analyses for Kaituna Sand Dunes, Kohika, and Tumurau Wetlands are provided in Appendices 1–5. These provide examples and guidance for filling in the datasheets.

6 Conclusions

The field protocols as outlined above were relatively quick and easy to follow, provided both quantitative and semi-quantitative data for inter-annual monitoring, and were suitable for the range of wetland types encountered during the pilot survey. Recent work in Southland wetlands (and elsewhere) indicates the protocols are also suitable for other wetland types present in Bay of Plenty but not included during this pilot. We conclude the monitoring data should assist Environment Bay of Plenty in monitoring the state of their wetlands.

7 Recommendations

We recommend keeping protocols as consistent as possible within the region (and nationally) by ensuring the field team is familiar with the standard wetland monitoring approach and/or undertakes training at the start of the project to ensure consistency.

Additionally, field sampling should be undertaken under 'normal' conditions and re-measurements over different time periods should be at similar times of the year (preferably early-midsummer).

8 Acknowledgements

We thank Nancy Willems, Bay of Plenty Regional Council, for organising the project, assistance in the field, and providing on-going feedback. We thank Mark Smale for field assistance and for reviewing the report.

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Appendix 1 – Field record sheets

These comprise:

- Wetland Record Sheet
- Wetland Plot Sheet (pages 1 and 2)
- Prevalence Index worksheet

WETLAND RECORD SHEET

Wetland name: **Date:**

Region: **GPS/Grid Ref.:**

Altitude: **No. of plots sampled:**

Classification: I System	IA Subsystem	II Wetland Class	IIA Wetland Form

Field team:

Indicator	Indicator components	Specify and Comment	Score 0– 5[1]	Mean score
Change in hydrological integrity	Impact of manmade structures			
	Water table depth			
	Dryland plant invasion			
Change in physico-chemical parameters	Degree of sedimentation/erosion			
	Nutrient levels			
	Von Post index			
Change in ecosystem intactness	Loss in area of original wetland			
	Connectivity/fish barriers			
	Recent vegetation damage/clearance			
Change in browsing, predation & harvesting regimes	Damage by stock/feral browsers			
	Introduced predator impacts on wildlife			
	Harvesting levels			
	Native animal species occupancy decline			
Change in dominance of native plants	Introduced plant canopy cover			
	Introduced plant understorey cover			
	Native plant species occupancy decline			
Total wetland condition index /25				

[1] Assign degree of modification as follows: 5=v. low/ none, 4=low, 3=medium, 2=high, 1=v. high, 0=extreme

Main vegetation types:

Native fauna:

Other comments:

Pressure	Score2	Specify and Comment
Modifications to catchment hydrology		
Water quality decline in catchment		
Animal access		
Key undesirable species		
% catchment in introduced vegetation		
Other land-use threats		
Total wetland pressure index /30		

[2] Assign pressure scores as follows: 5=very high, 4=high, 3=medium, 2=low, 1=very low, 0=none

WETLAND PLOT SHEET

Wetland name: **Date:** **Plot no:**

Plot size: **Altitude:** **GPS:**

Recorder: **Veg structure:** **Composition[1]:**

Species (* for exotics)	**Cover** %[2]	**Height m**		**Cover class 1** <1%, **2** 1–5%, **3** 6–25%, **4** 26–50%, **5** 51–75%, **6** 76–100%					**Seed -ling** #[3]	**Notes**
		Max	Avg	<0.3 m	0.3–1 m	1–2 m	2–5 m	>5 m		
Litter (total %)		**Bare Ground** (total %)					**Photo** (SW corner) N:			
Bryophytes (total %)		**Water** (total %)					**Photo** (SW corner) E:			

[1]Atkinson bird's eye view method, i.e. / or – for different or same height; 50–100%, 20–49% (10–19%) [1–9%]
[2]Live shoot biomass for each species; total plot cover usually >100%. Note dead foliage if >20% cover
[3]Woody seedling number: actual count for low numbers, otherwise estimate.

Field measurements:

Water table cm		Water conductivity µS	
Water pH (if present)		Von Post index (peatlands)	
Soil cores collected (√)		Foliage collected (list species)	

Comments/additional species in vicinity in same vegetation type:

Wetland Plot Sheet: Page 2

Wetland Name: **Date:** **Plot No.:**

Plot vegetation (use plot data only: vascular species and *Sphagnum*)	**Total**
A Native species cover: sum of % cover for all native species	
B Total species cover: sum of % cover for all plants	
A/B*100, i.e. % native vegetation cover	
C Native species richness: number of native species	
D Total species richness: total number of species	
C/D*100, i.e. % native species number	

Soil core laboratory analysis (two soil core subsamples):

Water content % dry weight		Total (organic) C %	
Bulk density T/m^3		Total N %	
pH		Total P mg/kg	
Conductivity µS (optional)		Total K % (optional)	

Foliage laboratory analysis (leaf/culm sample of dominant canopy species and wetland target species):

Species	%N	%P	%C	%K optional

Prevalence Index Summary Worksheet

Total % cover of:		Multiply by:	
OBL species		× 1 =	
FACW species		× 2 =	
FAC species		× 3 =	
FACU species		× 4 =	
UPL species		× 5 =	
Column totals:		(A)	(B)
Prevalence Index[1] = B/A =			

[1]In USA if PI ≤ 3, vegetation is hydrophytic (i.e. wetland veg). PI changes over time indicate hydrology changes

Table 1: Prevalence Index

Indicator Group	Species Name	Percent Cover by Species	Total Cover by Group	Weighting Factor	Product
OBL				1	
FACW				2	
FAC				3	
FACU				4	
UPL				5	
	Totals		**(A)**		**(B)**
Hydrophytic Vegetation Determination	Prevalence Index = B/A = _____ Hydrophytic Vegetation by PI Indicator? _____ Yes _____ No				

NB if PI = 3.0 or less site is defined as having hydrophytic vegetation, i.e. satisfying one criterion for delineating wetlands

USA Wetland delineation approach (Environmental Laboratory 1987)

Appendix 2 – Wetland Record Sheet Data

WETLAND RECORD SHEET

Wetland name: Kaituna Sand Dunes **Date:** 20/12/2013
Region: BOP; Tauranga ED **GPS/Grid Ref.:** 1896082 5819308
Altitude: c 5 masl **No. of plots sampled:** 2

Classification: I System	IA Subsystem	II Wetland Class	IIA Wetland Form
Estuarine	Permanent	swamp	Swale

Field team:

Indicator	Indicator components	Specify and Comment	Score 0–5[1]	Mean score
Change in hydrological integrity	Impact of manmade structures	Little impact, minor crossings	4.5	4.43
	Water table depth	Impacted by grey willow, pines on margin	4	
	Dryland plant invasion	Very little	4.8	
Change in physico-chemical parameters	Degree of sedimentation/erosion	None observed	5	4.5
	Nutrient levels	Test drift from pines + market garden (N), agriculture (S)	4	
	Von Post index	N/A.		
Change in ecosystem intactness	Loss in area of original wetland	Mostly intact	4.5	4.67
	Connectivity/fish barriers	Still connected on E side to Kaituna Estuary	4.5	
	Recent vegetation damage/clearance	None observed	5.	
Change in browsing, predation & harvesting regimes	Damage by stock/feral browsers	Fully fenced, possums present.	4.5	2.88
	Introduced predator impacts on wildlife	No barriers, small wetland, v. high urban area on W	1	
	Harvesting levels	None observed.	5	
	Native animal species occupancy decline	Probably high as small size	1	
Change in dominance of native plants	Introduced plant canopy cover	Willows locally, also NW end drier	3.5	3.5
	Introduced plant understorey cover	Some herbaceous exotics	3.5	
	Native plant species occupancy decline	Reasonably intact system.	3.5	
Total wetland condition index /25				19.98

[1] Assign **degree of modification** as follows: 5=v. low/ none, 4=low, 3=medium, 2=high, 1=v. high, 0=extreme

Main vegetation types: ELA sph reedland, Grey willow treeland, JUN bol rushland

Native fauna:

Other comments: Myriophyllum robustum present. Very long + narrow shape susceptible to edge effects

Pressure	Score[2]	Specify and Comment
Modifications to catchment hydrology	4	Drains, farmland, residential dept to West
Water quality decline in catchment	3	Fertiliser on market gardens, farmland, Farm effluent
Animal access	4	Easily accessible over farmland + from houses
Key undesirable species	3	Grey willow, farm-associated exotics
% catchment in introduced vegetation	4.5	Very little native vegetation in catchment
Other landuse threats	3	Urban sprawl, pine harvesting
Total wetland pressure index /30	21.5	

[2] Assign pressure scores as follows: 5=very high, 4=high, 3=medium, 2=low, 1=very low, 0=none

WETLAND RECORD SHEET

Wetland name: Kohika
Region: Bay of Plenty: Te Teko ED
Altitude: 2 masl
Date: 20/12/2013
GPS/Grid Ref.: 1933105 5797959
No. of plots sampled: 2

Classification: I System	IA Subsystem	II Wetland Class	IIA Wetland Form
Palustrine	Permanent	Swamp (modified)	Floodplain / backswamp

Field team: Neil Fitzgerald, Mark Smale

Indicator	Indicator components	Specify and Comment	Score 0–5[1]	Mean score
Change in hydrological integrity	Impact of manmade structures	stopbank on W side, pond sewerage drainage canal on E side, drains	1	1.67
	Water table depth	very dry at time of visit, unnaturally lowered	1	
	Dryland plant invasion	Cal apa, LON jap, PAC sti, PRU vul mainly pasture weeds	3	
Change in physico-chemical parameters	Degree of sedimentation/erosion	Low as / isolated from catchment remnant	3.5	3.5
	Nutrient levels	Slightly elevated - agricultural drift	3.5	
	Von Post index	N/A		
Change in ecosystem intactness	Loss in area of original wetland	Extensive loss of orig. wetland on plains	1	2
	Connectivity/fish barriers	weir on Nend, stopbanks, high impact	1	
	Recent vegetation damage/clearance	Recent development on SE corner	4	
Change in browsing, predation & harvesting regimes	Damage by stock/feral browsers	No stock, probably possums	4	2.5
	Introduced predator impacts on wildlife	Most introd. predators likely present	2	
	Harvesting levels	Duck shooting (includes native birds)	3	
	Native animal species occupancy decline	Highly modified	1	
Change in dominance of native plants	Introduced plant canopy cover	Predom. exotic	1	1
	Introduced plant understorey cover	Mostly exotics	1	
	Native plant species occupancy decline	Highly modified	1	
Total wetland condition index /25				10.67

[1] Assign **degree of modification** as follows: 5=v. low/ none, 4=low, 3=medium, 2=high, 1=v. high, 0=extreme

Main vegetation types: Grey willow treeland, Calystegia sepium vineland

Native fauna:

Other comments: Very dry underfoot, dominated by exotics (grey willow, Chinese privet)

Pressure	Score[2]	Specify and Comment
Modifications to catchment hydrology	4	Highly modified - mostly drained farmland + stopbanked waterways
Water quality decline in catchment	4	Can smell river (Tarawera River) from Kawerau paper mill
Animal access	4	Crossings + many pests/predators can swim
Key undesirable species	4.5	grey willow, Chinese privet, blackberry etc. Abundant
% catchment in introduced vegetation	4.5	Very little native vegetation in immediate catchment
Other landuse threats		
Total wetland pressure index /30	21	

[2] Assign pressure scores as follows: 5=very high, 4=high, 3=medium, 2=low, 1=very low, 0=none

WETLAND RECORD SHEET

Wetland name: Tumurau
Region: BOP: TeTeko ED
Altitude: c. 10m asl
Date: 19/11/2013* – 19/12/2013
GPS/Grid Ref.: 1927793 5790220
No. of plots sampled: 8

Classification: I System	IA Subsystem	II Wetland Class	IIA Wetland Form
Palustrine	Permanent	Swamp	Floodplain/backswamp

Field team: Ben Clarkson, Neil Fitzgerald, Mark Smale — Buffered by size

Indicator	Indicator components	Specify and Comment (road to W stopbank on E)	Score 0–5[1]	Mean score
Change in hydrological integrity	Impact of manmade structures	Weir at N, drain in middle, S	3.5	3.77
	Water table depth	Weir maintains WT, rel. high.	3.8	
	Dryland plant invasion	Mainly on margins	4	
Change in physico-chemical parameters (Damage)	Degree of sedimentation/erosion (Fire?)	None observed, minor sedimentation from road	4.8	4.65
	Nutrient levels	Some fert. drift, overall little impact	4.5	
	Von Post index	N/A.		
Change in ecosystem intactness	Loss in area of original wetland	Extensive loss of wetland	1.5	2.33
	Connectivity/fish barriers	Stopbanks, weir, moderate effect	3	
	Recent vegetation damage/clearance *	Recent willow spraying – affected native spp as well	2.5	
Change in browsing, predation & harvesting regimes	Damage by stock/feral browsers	No stock access, possums seen, pest control programme	4.5	3.75
	Introduced predator impacts on wildlife	Pest control programme, possums noted	3.5	
	Harvesting levels	Duck shooting	3.5	
	Native animal species occupancy decline*		3.5	
Change in dominance of native plants	Introduced plant canopy cover	Willows recently sprayed but some resprouting	4	3.93
	Introduced plant understorey cover	Mostly native	4	
	Native plant species occupancy decline *	EMP prob dieback from spraying	3.8	
Total wetland condition index /25				18.43

[1] Assign **degree of modification** as follows: 5=v. low/ none, 4=low, 3=medium, 2=high, 1=v. high, 0=extreme

Main vegetation types: Grey willow treeland, COPtec shrubland, LEPsco shrubland, RHOten/HOLlan grassland, TYPorirecdland, MACarth-MACrub sedgeland, JUNacu rushland, herbfield, open water

Native fauna: Bittern (booming common), welcome swallow, Tui, fernbird (heard+seen), Silvereye, Paradise duck

Exotics: Possum + baby in dead willow spar, invasive worm Amynthas sp., Canada geese

Other comments: Herbicide by-kill high for some native species, especially EMP prob
Relatively large wetland reserve for lowland BOP.

Pressure	Score[2]	Specify and Comment
Modifications to catchment hydrology	3.5	Hills to W retain some native cover, Otherwise drained farmland
Water quality decline in catchment	2.5	Farmland – fertiliser. Farm effluent
Animal access	3.5	Relatively easy access across farmland + along road
Key undesirable species	3	Grey willow, privet, blackberry
% catchment in introduced vegetation	4	Majority of catchment is exotic vegetation
Other landuse threats		
Total wetland pressure index /30	16.5	

[2] Assign pressure scores as follows: 5=very high, 4=high, 3=medium, 2=low, 1=very low, 0=none

Appendix 3 – Wetland Plot Sheet Page 1 Data

WETLAND PLOT SHEET

Wetland name: Kaituna sand Dunes **Date:** 20-12-13 **Plot no:** 1 (Bac 2)
Plot size: 5x5 **Altitude:** 13 **GPS:** 1896082 5819308
Recorder: N Fitzgerald M Smale **Veg structure:** Reed land **Composition[1]:** Salcin / ELA spp

Species (* for exotics)	Cover %[2]	Height m (M)		Cover class 1<1%, 21-5%, 3 6-25% 4 26-50%, 5 51-75% 6 76-100%					Seed-ling #[3]	IS[4]	Notes
		Max	Avg	<0.3 m	0.3-1 m	1-2 m	2-5 m	>5 m			
ELE spp	70	1.1	0.7	6	6	1					
* SALcin	45	7	7	1	1	3	4	3			
* LUP pol	25	0.3	0.2	3							
* KANfla	2	0.8	0.6	2	2						
* GALpal	5	0.6	0.4	2	1						
* JUNmar	5	0.5	0.1	2	1	1					
MYR robustum	15	0.2	0.1	3							
AZO fil	35	0.05	0.05	4							
LEM min	1	0.01	0.01	1							
CAR vir	1	1.4	1.4	1	1	1					
Litter (total %)	5	**Bare Ground** (total %)				0	**Photo** (SW corner) **N:**				✓
Bryophytes (total %)	0	**Water** (total %)				0	**Photo** (SW corner) **E:**				

[1]Atkinson bird's eye view method, ie /or – for different or same height; 50-100%, 20-49% (10-19%) [1-9%]
[2]Live shoot biomass for each species; total plot cover usually >100%. Note dead foliage if >20% cover
[3]Woody seedling number: actual count for low numbers, otherwise estimate; [4]Indicator Status e.g. OBL (page 2)

Field measurements:

Water table cm	-10 cm	Water conductivity uS	377
Water pH (if present)	5.73	Von Post index (peatlands)	8
Soil cores collected (√)	✓	Foliage collected (list species)	SALcin, ELE spp

Comments/additional species in vicinity in same vegetation type:

17.7° C

Primary plot 1 was LOLper grassland.
Bac plot 1 was SALcin forest

Pussum poo

WETLAND PLOT SHEET

Wetland name: KAITUNA **Date:** 20 – 12 – 13 **Plot no:** 4
Plot size: 5 x 5m sand dunes **Altitude:** 16 M **GPS:** 1896742 5818774
Recorder: M C Smale **Veg structure:** rushland **Composition[1]:** ELAsp2 / Junbul

Species (* for exotics)	Cover %[2]	Height m Max	Height m Avg	Cover class 1<1%, 2 1-5%, 3 6-25% 4 26-50%, 5 51-75% 6 76-100% <0.3 m	0.3-1 m	1-2 m	2-5 m	>5 m	Seed -ling #[3]	IS[4]	Notes
ELE sp2	30	0.7	0.5	4	4						
* JUN bul (C)	60	0.2	0.1	5	5						

Litter (total %) 0		**Bare Ground** (total %) 0		**Photo** (SW corner) **N:**	✓
Bryophytes (total %) 0		**Water** (total %) 10		**Photo** (SW corner) **E:**	✓

[1]Atkinson bird's eye view method, ie /or – for different or same height; 50-100%, 20-49% (10-19%) [1-9%]
[2]Live shoot biomass for each species; total plot cover usually >100%. Note dead foliage if >20% cover
[3]Woody seedling number: actual count for low numbers, otherwise estimate; [4]Indicator Status e.g. OBL (page 2)

Field measurements:

Water table cm	+10	Water conductivity uS	272
Water pH (if present)	5.4	Von Post index (peatlands)	
Soil cores collected (√)	✓	Foliage collected (list species)	ELE sp2

Comments/additional species in vicinity in same vegetation type:

Free-standing water 27.6°C

Litoria frog NZ Monk's nymphs

WETLAND PLOT SHEET

Wetland name: Kohika **Date:** 20-12-2013 **Plot no:** 1
Plot size: 5x5 **Altitude:** 7 **GPS:** 1933105 5797959
Recorder: N Fitzgerald, M Smale **Veg structure:** vineland **Composition[1]:** CALsep vineland.

Species (* for exotics)	Cover %[2]	Height m		Cover class 1<1%, 21-5%, 3 6-25% 4 26-50%, 5 51-75% 6 76-100%					Seed-ling #[3]	IS[4]	Notes
		Max	Avg	<0.3 m	0.3-1 m	1-2 m	2-5 m	>5 m			
CALsep	90	3.5	1.5	3	5	6	2				
Hollan *	5	1.8	1.5	3	3	1					
LIGsin *	20	5	4	2	3	3	3				
RUBfru *	10	1.1	0.7	3	3	3					
LOTped *	2	1.4	1	2	2	1					
GALapa *	2	0.8	0.4	1	2						
CARgem	5	2	1.5	2	2	2					
LONjap *	15	5	1.6	2	3	3	2				
CRAmon *	5	4	2	2	2	2	1				
COPaus	2	8	8	—	—	—	1	2			
RANrep *	2	0.3	0.3	2	2						
MELcam	3	3.2	1	2	2	2	2				
MICsti	0.1	0.7	0.4	1	1						
COPcun	1	1.9	1.5	1	2	2					
POApra *	0.1	0.7	0.7	1	1						
RUMcri *	0.1	1.1	1.1	1	1	1					
PHOten	0.5	1.2	1.2	—	1	1					
OPLimb	0.1	0.3	0.2	1	1						
GENrup	0.1	0.7	0.7	1	1						
COPtec	0.1	1.4	1.4	1	1	1					
PRUvul *	0.1	0.7	0.4	1	1						
GALpal *	0.1	0.9	0.9	1	1						
SCHarv *	0.1	1.7	1.7	1	1	1					
Litter (total %)	50	**Bare Ground** (total %)				0	**Photo** (SW corner) **N:**				✓
Bryophytes (total %)	0	**Water** (total %)				0	**Photo** (SW corner) **E:**				✓

[1]Atkinson bird's eye view method, ie /or – for different or same height; 50-100%, 20-49% (10-19%) [1-9%]
[2]Live shoot biomass for each species; total plot cover usually >100%. Note dead foliage if >20% cover
[3]Woody seedling number: actual count for low numbers, otherwise estimate; [4]Indicator Status e.g. OBL (page 2)

Field measurements:

Water table cm	< – 30 deeper than	Water conductivity uS	NA
Water pH (if present)	NA	Von Post index (peatlands)	NA
Soil cores collected (√)	✓	Foliage collected (list species)	COPtec CALsep

Comments/additional species in vicinity in same vegetation type:

WETLAND PLOT SHEET

Wetland name: KOHICA (2) **Date:** 29-12-13 **Plot no:** 2
Plot size: 5x5-n **Altitude:** ~7 m **GPS:** 1932983 -5798157
Recorder: MCSmale **Veg structure:** Treeland **Composition[1]:** SALCIN / Gly max

Species (* for exotics)	Cover %[2]	Height m		Cover class 1<1%, 21-5%, 3 6-25% 4 26-50%, 5 51-75% 6 76-100%					Seed-ling #[3]	IS[4]	Notes
		Max	Avg	<0.3 m	0.3-1 m	1-2 m	2-5 m	>5 m			
GLY max *	60	2.1	1.3	5	5	4	1				
CAL sep	30	1.8	1.2	3	4	4					
CAR gem	5	1.4	1.2	2	2	2					
SALCIN *	55	6.0	6.0	1	1	1	5	4			
RAN rep *	5	0.4	0.2	2	1						
RVR fru *	3	1.1	0.6	1	2	2					
COP cun	1	1.4	1.4	1	2	2					
GAL pal *	1	1.0	0.7	2	2						
BAU ten	1	1.5	1.5	1	1	1					
HOL lan *	2	1.1	0.7	2	2	1					
CORAUS	1	7.0	7.0	1	2	2	2	2			
PHO ten	3	4.0	4.0	2	2	2	2				
LOTped *	2	1.0	0.3	2	2						
LONjap *	10	4.0	1.2	2	3	3	2				
PYR ele	0.1				1						epiphyte.
MUE aus	1	4.0	4.0	—	—	2	2				
CYPERUS eragrostis *	0.1	0.7	0.7	1	1						
Litter (total %)	20	**Bare Ground** (total %)				0	**Photo** (SW corner) **N:**				✓
Bryophytes (total %)	0	**Water** (total %)				0	**Photo** (SW corner) **E:**				✓

[1]Atkinson bird's eye view method, ie /or – for different or same height; 50-100%, 20-49% (10-19%) [1-9%]
[2]Live shoot biomass for each species; total plot cover usually >100%. Note dead foliage if >20% cover
[3]Woody seedling number: actual count for low numbers, otherwise estimate; [4]Indicator Status e.g. OBL (page 2)

Field measurements:

Water table cm	40 deeper than	Water conductivity uS	NA
Water pH (if present)	NA	Von Post index (peatlands)	NA
Soil cores collected (√)	✓	Foliage collected (list species)	SALCIN PHOten

Comments/additional species in vicinity in same vegetation type:

WETLAND PLOT SHEET

Wetland name: Tumurau **Date:** 19/11/2013 **Plot no:** 1
Plot size: 5x5 **Altitude:** c. 15m **GPS:** 1927976 5789691
Recorder: NW, BRC, NBF **Veg structure:** shrubland **Composition[1]:** Coptec

Species (* for exotics)	Cover %[2]	Height m		Presence ~~/or Absence~~ – cover class					Woody seedling #[3]	IS[4]	Notes
		Max	Avg	Ground <0.3m	0.3-1m	Mid 1-2	Top >2m	>5			
Cop tec	70	1.70	1.0	3	3	3	–	–	15		
SAL cin *	3	2.0	1.4	1	2	2	–	–			
LOT ped *	5	0.70	0.45	2	2	–	–	–			
HOL lan *	1	0.35	0.25	1	1	+	–	–			
TYP ori	dead										
ELE acu	1	0.45	0.30	1	1	–	–	–			
RAN fla *	0.5	0.33	0.18	1	1	–	–	–			
HYD pte	0.5	0.14	0.08	1	–	–	–	–			
PHO ten	1	1.10	0.90	1	1	1	–	–			
Cop pro	0.5	1.10	0.80	1	1	1	–	–			
Bryophyte	2	–	–	2	–	–	–	–	–		
PRA ang	0.5	0.15	0.08	1	–	–	–	–			
CER fon *	0.5	0.10	0.10	1	–	–	–	–			
SON asp *	0.5	0.25	0.25	1	–	–	–	–			
RAN ecb *	0.5	0.12	0.12	1	–	–	–	–			
BAU rub	0.5	1.0	0.7	1	1	1	–	–			
Photos N	34			E 35							
Litter	90	Bryophytes % 2									
Bare Ground/Substrate	5										
Water	2										

[1]Atkinson bird's eye view method, ie /or – for different or same height; 50-100%, 20-49% (10-19%) [1-9%]
[2]Live shoot biomass for each species; total plot cover usually >100%. Note dead foliage if >20% cover
[3]Estimate no if present: <10 (or actual count), 10-50, 50-100, 100-500, >500; [4]Indicator Status eg OBL (page 2)

Field measurements: 17.3°C

Water table cm	– 8 cm	Water conductivity uS	987
Water pH (if present) 6.0 * 1	6.0	Von Post index (peatlands)	N/A
Soil cores collected (√)	✓	Foliage collected (list spp)	Coptec

Comments/additional species in vicinity in same vegetation type:

Coords @ SW corner
Soil plot @ SW corner

WETLAND PLOT SHEET

Wetland name: Tumurau **Date:** 18/11/2013 **Plot no:** 2
Plot size: 5x5 **Altitude:** c. 15m **GPS:** 1927769 5789492
Recorder: BRC NBF **Veg structure:** Litterland **Composition**[1]: [Copfec]

Species (* for exotics)	Cover %[2]	Height m		~~Presence √ or Absence –~~ cover class					Woody seed-ling #[3]	IS[4]	Notes
		Max	Avg	Ground <0.3m	0.3-1	Mid 0.3-2	Top >2m	7.5			
COPfec	3	4.5	1	1	1	1	2	–	~50		
LEPsco	0.5	0.07	0.05	1	–	–	–	–	~10		
SEN min	0.5	0.05	0.04	1	–	–	–	–			
HYDpte	0.5	0.07	0.05	1	–	–	–	–			
PHOten	0.5	0.43	0.43	1	1	–	–	–			
HYPrad *	0.5	0.2	0.2	1	–	–	–	–			
BLE min	0.5	0.18	0.1	1	–	–	–	–			
DICsqu	0.5	0.05	0.05	1	–	–	–	–			
LEOtar *	0.5	0.07	0.07	1	–	–	–	–			
MYOlax *	0.5	0.05	0.05	1	–	–	–	–			
BACjun	0.5	0.15	0.07	1	–	–	–	–			
Moss	0.5	0	0	1	–	–	–	–			
SONole *	0.5	0.05	0.05	1	–	–	–	–			
SCHmas	0.5	0.05	0.05	1	–	–	–	–			
NERsca	0.5	0.01	0.01	1	–	–	–	–			
Litter	100%	dead Lepsco, Copfec, EMProb									
Bare Ground/Substrate	0.5										
Water	—	Bryophytes % 0.5									

[1]Atkinson bird's eye view method, ie /or – for different or same height; 50-100%, 20-49% (10-19%) [1-9%]
[2]Live shoot biomass for each species; total plot cover usually >100%. Note dead foliage if >20% cover
[3]Estimate no if present: <10 (or actual count), 10-50, 50-100, 100-500, >500; [4]Indicator Status eg OBL (page 2)

Field measurements: 15°C

Water table cm	-28	Water conductivity uS	112.5
Water pH (if present)	5.87	Von Post index (peatlands)	–
Soil cores collected (√)	X	Foliage collected (list spp)	not collected

Comments/additional species in vicinity in same vegetation type: Bittern heard booming, possum + baby in dead willow tui

Photos: N = 18 17:30 E = 19 17:31

sandy lens starts @ c.7cm depth

WETLAND PLOT SHEET

Wetland name: Tumurau **Date:** 18.11.2013 **Plot no:** 4
Plot size: 5x5m **Altitude:** c. 15m **GPS:** 1927399 5789468
Recorder: BRC NBF **Veg structure:** Litterland **Composition[1]:** [ISO ret]

Species (* for exotics)	Cover %[2]	Height m Max	Height m Avg	~~Presence~~ ~~√ or Absence~~ cover class Ground <0.3m	0.3-1m	Mid 1-3	Top >2m	75	Woody seedling #[3]	IS[4]	Notes
CON alb *	1	0.6	0.5	1	1	–					
SON asp *	12	1.05	0.8	1	1	1					
SCH mas	2	0.05	0.04	2	–	–					
SEN bip *	1	0.2	0.15	1	–	–					
HOL lan *	3	0.45	0.35	2	2	–					
JUN /om? *	2	0.4	0.25	2	1	–					
PER dec	0.5	0.12	0.1	1	–	–					
VER ana-aquatica *	0.5	0.2	0.2	1	–	–					
ISO ret	5	0.14	0.04	3	–	–					massive seedling growth.
RUB fru *	0.5	0.05	0.05	1	–	–					
DIG pur *	1	0.25	0.15	2	–	–					
STE med *	0.5	0.6	0.3	1	1	–					
CEO tar *	0.5	0.04	0.04	1	–	–					
GNA coa *	0.5	0.05	0.05	1	–	–					
SOL ole *	0.5	0.50	0.35	1	1	–					
HYP rad *	1	0.35	0.25	1	1	–					
MEL ran	0.5	1.2	0.5	1	1	1					
CIG sin *	0.5	0.4	0.15	1	1	–					
TME elo	0.5			–	–	1					epiphyte
MYR aus	0.5	0.6	0.4	1	1	–					
GEN rup	0.5	0.28	0.28	1	–	–					
UNC unc	1	0.28	0.25	1	–	–					
CYA dea	0.5	0.24	0.24	1	–	–					
PYR ele	0.5			1	1	1					epiphyte
JUN bul *	1	0.1	0.05	1	–	–					
COR aus	0.5	0.2	0.2	1	–	–					
COP tec	0.5	0.15	0.1	1	–	–					
EPI cil *	1	0.35	0.3	1	1	–					
moss	2	0.01	0.01	1	–	–					
Photo ; N	16	15.32		Photo ; E			17		15 ; 32		
Litter	85										
Bare Ground/Substrate	5										
Water	3	Bryophytes % 2									

[1]Atkinson bird's eye view method, ie /or – for different or same height; 50-100%, 20-49% (10-19%) [1-9%]
[2]Live shoot biomass for each species; total plot cover usually >100%. Note dead foliage if >20% cover
[3]Estimate no if present: <10 (or actual count), 10-50, 50-100, 100-500, >500; [4]Indicator Status eg OBL (page 2)

Field measurements: Temp = 18.7°C

Water table cm	-2cm	Water conductivity uS	168.6
Water pH (if present)	6.23	Von Post index (peatlands)	N/A
Soil cores collected (√)	✓	Foliage collected (list spp)	Hol lan

Comments/additional species in vicinity in same vegetation type:
Dead Emprob nearby
Coordinates @ SW corner

WETLAND PLOT SHEET

Wetland name: Tumuran **Date:** 1.9.11.2013 **Plot no:** 5
Plot size: 5x5 **Altitude:** c.15m **GPS:** 1927793, 5790220
Recorder: BRL NBF **Veg structure:** grassland **Composition[1]:** Photen/Hollan

Species (* for exotics)	Cover %[2]	Height m		Presence √ or Absence – cover class					Woody seedling #[3]	IS[4]	Notes
		Max	Avg	Ground <0.3m	0.3-1m	Mid 0.3-2	Top >2m	75%			
PHOten	20	1.80	1.00	3	3	3					2-3 dead willow shrubs
HOLlan *	35	1.00	0.7	3	3	3					
LOTped *	15	1.10	0.8	3	3	3					
BAUrub	15	1.45	1.3	3	3	3					
COPtec	2	1.5	1.3	1	1	2					
CARmao	2	0.50	0.4	1	1	–					
CARsec	1	0.9	0.8	1	1	–					
EPIcil *	0.5	0.6	0.5	1	1	–					
GALpal *	1	0.95	0.60	1	1	+					
MAC arthrophylla	0.5	1.0	1.0	1	1	1					
ISAglo	.5	0.75	0.65	2	2	–					
EPIpal	.3	1.3	1.0	2	2	1					
LEPsco	0.5	1.20	1.20	1	1	1					
HYDpte	1	0.35	0.2	1	1	–					
COPxcun	0.5	0.2	0.2	1	–	–					
ELEacu	0.5	70	60	1	1	–					
ANTodo *	0.5	60	50	1	1	–					
LUDpal *	1	20	10	1	–	–					
photo N°. 32	11:36	-	E:	33	11	36					
Litter	2										
Bare Ground/Substrate	0										
Water	0	Bryophytes % 0									

[1]Atkinson bird's eye view method, ie /or – for different or same height; 50-100%, 20-49% (10-19%) [1-9%]
[2]Live shoot biomass for each species; total plot cover usually >100%. Note dead foliage if >20% cover
[3]Estimate no if present: <10 (or actual count), 10-50, 50-100, 100-500, >500; [4]Indicator Status eg OBL (page 2)

Field measurements: 16.4

Water table cm	-11	Water conductivity uS	72.2
Water pH (if present)	5.91	Von Post index (peatlands)	N/A
Soil cores collected (√)	✓	Foliage collected (list spp)	HOLlan, PHOten

Comments/additional species in vicinity in same vegetation type:
Fernbird heard & seen 30m away, Bittern booming in distance. welcome owe plot
Collected worm Amynthas sp (invasive)

WETLAND PLOT SHEET

Wetland name: Tumurau **Date:** 19.11.2013 **Plot no:** 6
Plot size: 5x5m **Altitude:** **GPS:** 1927992 5790120
Recorder: BRC NBF **Veg structure:** Lowland **Composition[1]:** [Cop tec]

Species (* for exotics)	Cover %[2]	Height m		Presence √ or Absence – cover class					Woody seedling #[3]	IS[4]	Notes
		Max	Avg	Ground <0.3m	0.3-1m	Mid 1-2	Top >2m	>5			
COP tec	2	1.6	1.2	/	/	/			40		
PHO ten	1	1.45	1.0	/	/	/					
BID fro *	1	0.65	0.45	/	/	–					
LEM min	1	0	0	/	–	–					
AZO rub	1	0	0	/	–	–					
LOT ped *	1	0.39	0.25	/	/	–					
HYD pte	0.5	0.09	0.07	/							
HOL lan *	0.5	0.1	0.08	/							goose grazed
CAR sec	0.5	0.2	0.2	/							
SEN min	0.5	0.12	0.12	/							
CON alb *	0.5	0.08	0.08	/							
LUD pal *	0.5	0.06	0.04	/							
EPI pal?	0.5	0.1	0.08	/							
Usnea	0-5			–	–	/					epiphyte
other lichen	1			/	–	/					epiphyte
bryophytes	0.5			/							
photo N = 30	10.39	E = 3	1	(100-31)		10:39					
Litter	75										
Bare Ground/Substrate	20										
Water	2	Bryophytes % 0.5									

[1]Atkinson bird's eye view method, ie /or – for different or same height; 50-100%, 20-49% (10-19%) [1-9%]
[2]Live shoot biomass for each species; total plot cover usually >100%. Note dead foliage if >20% cover
[3]Estimate no if present: <10 (or actual count), 10-50, 50-100, 100-500, >500; [4]Indicator Status eg OBL (page 2)

Field measurements: 20.8°C

Water table cm	-1 cm	Water conductivity uS	118.2
Water pH (if present)	6.43	Von Post index (peatlands)	–
Soil cores collected (√)	no - on edge of lagoon too sloppy	Foliage collected (list spp)	COP tec

Comments/additional species in vicinity in same vegetation type: Bittern heard booming
welcome swallow over plot

Sprayed. SALCIN - COPtec/GLY max shrubland.
Soil sampled in NE corner
Lichen cover = 1.5%

WETLAND PLOT SHEET

Wetland name: Tumuran **Date:** 19-12-2013 **Plot no:** 7
Plot size: 5x5m **Altitude:** 20 **GPS:** 1928339, 5790090
Recorder: N Fitzgerald, M Smale **Veg structure:** Rushland **Composition[1]:** JUNacu rushland

Species (* for exotics)	Cover %[2]	Height m		Cover class 1<1%, 2 1-5%, 3 6-25% 4 26-50%, 5 51-75% 6 76-100%					Seed-ling #[3]	IS[4]	Notes
		Max	Avg	<0.3 m	0.3-1 m	1-2 m	2-5 m	>5 m			
*JUNacuminatus	60	0.8	0.6	5	5						
*SALcin	14	15	0.9	3	3	1					
*LUDpal	15	0.2	0.15	3							
MYRpropinquum	20	0.2	0.1	3							
*MOLcae	4										
HYDpte	0.1	0.1	0.05	1							
LYCfol	20	0.8	0.6	3	3						
MACrub	3	0.8	0.7	2	2						
CARMOO	3	0.8	0.6	2	2						
LEPSCO	0.1	0.7	0.7	1	1				1		
ELE ACU	5	0.9	0.5	2	2						
*RANFlo	3	0.7	0.5	2	1						
*GALium pal	0.1	0.1	0.05	1							
PHOten	1	1.1	1.1	1	1	1					
*HOLlan	0.1	1.1	1.1	1	1	1					
Litter (total %)	5	**Bare Ground** (total %)				0	**Photo** (SW corner) **N:**				✓
Bryophytes (total %)	0	**Water** (total %)				5	**Photo** (SW corner) **E:**				✓

[1]Atkinson bird's eye view method, ie /or – for different or same height; 50-100%, 20-49% (10-19%) [1-9%]
[2]Live shoot biomass for each species; total plot cover usually >100%. Note dead foliage if >20% cover
[3]Woody seedling number: actual count for low numbers, otherwise estimate; [4]Indicator Status e.g. OBL (page 2)

Field measurements: Temperature 25.6°C

Water table cm	+4	Water conductivity uS	73.9
Water pH (if present)	5.25	Von Post index (peatlands)	NA
Soil cores collected (√)	✓	Foliage collected (list species)	JUNark

Comments/additional species in vicinity in same vegetation type: SALcin PHOten

25-50

WETLAND PLOT SHEET

Wetland name: Tumurau **Date:** 19/11/2013 **Plot no:** 8
Plot size: 5x5 **Altitude:** c. 15m **GPS:** E 1927950 N 5790509 *new
Recorder: BRC NBF **Veg structure:** reedland **Composition[1]:** raupo

Species (* for exotics)	Cover %[2]	Height m		Presence √ or Absence – cover class					Woody seedling #[3]	IS[4]	Notes
		Max	Avg	Ground <0.3m	0.3-1.9	Mid 0.3-2	Top >2m	>5			
TYPori	50	3.5	2.5	3	3	4	2				
CAR sec	4	1·3	1·0	2	2	2					
CAR mao	0·5	0·8	0·7	1	1	+					
GAL pal *	2	0·8	0·6	1	2	2					
PHO ten	1	1·4	1·0	1	1	1					
LYC eur *	1	0·8	0·6	1	1	+					
PER dec	1	0·7	0·55	1	1	+					
LEM min	10	0	0	3							
AZO fil	12	0	0	3							
AZO pin* ?	13	0	0	3							
LOT ped *	0·5	0·5	0·4	1	1	+					
ISA glo	4	1·0	0·85	2	2	1					
ELE acu	0·5	1·1	1·0	1	1	1					
BLE min	1	0·7	0·55	1	1	+					
HYD pte	0·5	0·35	0·25	1	1	+					
MYR pro	0·5	0	0	1							
Litter	10	Bryophytes % 0									
Bare Ground/Substrate	0	photo (SW corner) N; ✓									
Water	75	photo (SW corner) E; ✓									

[1]Atkinson bird's eye view method, ie /or – for different or same height; 50-100%, 20-49% (10-19%) [1-9%]
[2]Live shoot biomass for each species; total plot cover usually >100%. Note dead foliage if >20% cover
[3]Estimate no if present: <10 (or actual count), 10-50, 50-100, 100-500, >500; [4]Indicator Status eg OBL (page 2)

Field measurements: 15.7°

Water table cm	+25cm	Water conductivity uS	82.2
Water pH (if present)	6.43	Von Post index (peatlands)	–
Soil cores collected (√)	no - edge of lagoon	Foliage collected (list spp)	TYPori ✓

Comments/additional species in vicinity in same vegetation type:
Bittern heard, canada geese, paradise s-duck nearby. silvereye

Photos: N 20 9:39 , E 21 9:40
Random target was island of SALein/CARsec-PHOten-COPtec

WETLAND PLOT SHEET

Wetland name: Tumurau **Date:** 19/11/2015 **Plot no:** 9
Plot size: 5x5 **Altitude:** c. 15m **GPS:** 1927982 5789621
Recorder: NW BRC NBF **Veg structure:** Sedgeland **Composition**[1]: Bau arth (hut) - Bau rub

Species (* for exotics)	Cover %[2]	Height m		Presence √ or Absence – Cover class				Woody seedling #[3]	IS[4]	Notes
		Max	Avg	Ground <0.3m	0.3-1m	Mid 1-2	Top >2m >5			
PHO ten	4	2.08	1.40	2	2	2	1			
BAU arth	55	1.70	1.40	4	4	4	—			
SAL cin *	4	2.0	1.60	1	1	2	1			
ISA glo	1	0.50	0.35	1	1	+	–			
COP tec	15	2.70	1.90	2	2	3	2			
BAU rub	20	1.40	1.10	3	3	3	–			
BAU ten	0.5	0.80	0.80	1	1	+				
HYD pte	0.5	0.25	0.10	1	–	–	–			
BLE min	3	0.60	0.50	1	2	–	-			
LEP sco	1	2.10	1.50	1	1	1	1			
CAR mao	0.5	0.60	0.55	1	1	–	–			
COR aus	0.5	0.60	0.60	1	1	–	–			
~~DRA ang~~	~~0.~~									
HYP rad *	0.05	0.05	0.05	1	–	–	–			
Bryophyte	5			2	–	–	–			
LOT ped *	2	0.80	0.60	1	2	–	–			
COP pro	1	1.80	1.80	1	1	2	–			
USNea (epiph)	0.5			–	–	1	1			epiphyte
Photo: N	✓		E =	✓						
Litter	2	Bryophytes % 5								
Bare Ground/Substrate	2									
Water	0.5									

[1]Atkinson bird's eye view method, ie /or – for different or same height; 50-100%, 20-49% (10-19%) [1-9%]
[2]Live shoot biomass for each species; total plot cover usually >100%. Note dead foliage if >20% cover
[3]Estimate no if present: <10 (or actual count), 10-50, 50-100, 100-500, >500; [4]Indicator Status eg OBL (page 2)

Field measurements: 15.4°C

Water table cm	-10	Water conductivity uS	64.9
Water pH (if present)	4p.5k	Von Post index (peatlands)	N/A
Soil cores collected (√)		Foliage collected (list spp)	Bau arth, Photen, Lep scop

Comments/additional species in vicinity in same vegetation type:

flt 1 -8 water table.

Appendix 4 – Wetland Plot Sheet Page 2 Data

Wetland Plot Sheet: Page 2

Wetland Name: Kaituna Sand Dunes **Date:** 20-12-2013 **Plot No.:** 1

Plot vegetation (use plot data only: vascular species and Sphagnum)	Total
A Native species cover: sum of % cover for all native species	122
B Total species cover: sum of % cover for all plants	204
A/B*100, i.e. % native vegetation cover	60%
C Native species richness: number of native species	5
D Total species richness: total number of species	10
C/D*100, i.e. % native species number	50%

Soil core laboratory analysis (two soil core subsamples):

Water content % dry weight	741	Total (organic) C %	44.0
Bulk density T/m3	0.11	Total N %	2.76
pH	5.38	Total P mg/kg	1040
Conductivity µS (optional)	0.71	Total K % (optional)	0.05

Foliage laboratory analysis (leaf/culm sample of dominant canopy species and wetland target species):

Species	%N	%P	%C	%K optional
Salix cinerea	1.65	0.133	50.0	1.19
Eleocharis sphacelata	2.17	0.138	44.2	1.52

Prevalence Index Summary Worksheet

Total % cover of:		Multiply by:	
OBL species	152	× 1 =	152
FACW species	52	× 2 =	104
FAC species	0	× 3 =	0
FACU species	0	× 4 =	0
UPL species	0	× 5 =	0
Column Totals:	(A) 204		(B) 256
Prevalence Index[1] = B/A = 1.25			

[1]In USA if PI ≤ 3, vegetation is hydrophytic (i.e. wetland veg). PI changes over time indicate hydrology changes

Wetland Plot Sheet: Page 2

Wetland Name: Kaituna Sand Dunes **Date:** 20-12-2013 **Plot No.:** 4

Plot vegetation (use plot data only: vascular species and Sphagnum)	%
A Native species cover: sum of % cover for all native species	30
B Total species cover: sum of % cover for all plants	90
A/B*100, i.e. % native vegetation cover	33.3%
C Native species richness: number of native species	1
D Total species richness: total number of species	1
C/D*100, i.e. % native species number	50%

Soil core laboratory analysis (two soil core subsamples):

Water content % dry weight	452	Total (organic) C %	14.8
Bulk density T/m3	0.20	Total N %	1.00
pH	5.46	Total P mg/kg	560
Conductivity µS (optional)	0.21	Total K % (optional)	0.22

Foliage laboratory analysis (leaf/culm sample of dominant canopy species and wetland target species):

Species	%N	%P	%C	%K optional
Eleocharis sphacelata	1.68	0.069	45.1	1.10

Prevalence Index Summary Worksheet

Total % cover of:		Multiply by:	
OBL species	90	× 1 =	90
FACW species	0	× 2 =	0
FAC species	0	× 3 =	0
FACU species	0	× 4 =	0
UPL species	0	× 5 =	0
Column totals:	(A) 90		(B) 90
Prevalence Index[1] = B/A = 1.00			

[1]In USA if PI ≤ 3, vegetation is hydrophytic (i.e. wetland veg). PI changes over time indicate hydrology changes

Wetland Plot Sheet: Page 2

Wetland Name: Kohika **Date:** 20-12-2013 **Plot No.:** 1

Plot vegetation (use plot data only: vascular species and Sphagnum)	%
A Native species cover: sum of % cover for all native species	101.9
B Total species cover: sum of % cover for all plants	163.4
A/B*100, i.e. % native vegetation cover	62.4%
C Native species richness: number of native species	10
D Total species richness: total number of species	23
C/D*100, i.e. % native species number	43.5%

Soil core laboratory analysis (two soil core subsamples):

Water content % dry weight	74	Total (organic) C %	8.82
Bulk density T/m3	0.45	Total N %	0.79
pH	5.61	Total P mg/kg	900
Conductivity µS (optional)	0.24	Total K % (optional)	0.25

Foliage laboratory analysis (leaf/culm sample of dominant canopy species and wetland target species):

Species	%N	%P	%C	%K optional
Coprosma tenuicaulis	1.92	0.115	47.0	0.86
Calystegia sepium	1.99	0.170	45.8	2.86

Prevalence Index Summary Worksheet

Total % cover of:		Multiply by:	
OBL species	0.1	× 1 =	0.1
FACW species	8.6	× 2 =	17.2
FAC species	99.1	× 3 =	297.6
FACU species	48.5	× 4 =	194
UPL species	7.1	× 5 =	35.5
Column totals:	(A) 163.4		(B) 544.4
Prevalence Index[1] = B/A = 3.33			

[1]In USA if PI ≤ 3, vegetation is hydrophytic (i.e. wetland veg). PI changes over time indicate hydrology changes

Wetland Plot Sheet: Page 2

Wetland Name: Kohika **Date:** 20-12-2013 **Plot No.:** 2

Plot vegetation (use plot data only: vascular species and Sphagnum)	%
A Native species cover: sum of % cover for all native species	42.1
B Total species cover: sum of % cover for all plants	180.2
A/B*100, i.e. % native vegetation cover	23.4%
C Native species richness: number of native species	8
D Total species richness: total number of species	17
C/D*100, i.e. % native species number	47.1%

Soil core laboratory analysis (two soil core subsamples):

Water content % dry weight	269	Total (organic) C %	28.2
Bulk density T/m3	0.20	Total N %	1.75
pH	5.17	Total P mg/kg	1310
Conductivity µS (optional)	0.56	Total K % (optional)	0.29

Foliage laboratory analysis (leaf/culm sample of dominant canopy species and wetland target species):

Species	%N	%P	%C	%K optional
Salix cinerea	2.52	0.439	51.3	0.91
Phormium tenax	1.46	0.107	50.6	0.97

Prevalence Index Summary Worksheet

Total % cover of:		Multiply by:	
OBL species	61	× 1 =	61
FACW species	124.1	× 2 =	248.2
FAC species	39	× 3 =	117
FACU species	14	× 4 =	56
UPL species	0	× 5 =	0
Column totals:	(A) 238.1		(B) 482.2
Prevalence Index[1] = B/A = 2.03			

[1]In USA if PI ≤ 3, vegetation is hydrophytic (i.e. wetland veg). PI changes over time indicate hydrology changes

Wetland Plot Sheet: Page 2

Wetland Name: Tumurau **Date:** 19-11-2013 **Plot No.:** 1

Plot vegetation (use plot data only: vascular species and Sphagnum)	%
A Native species cover: sum of % cover for all native species	24
B Total species cover: sum of % cover for all plants	35
A/B*100, i.e. % native vegetation cover	68.6%
C Native species richness: number of native species	7
D Total species richness: total number of species	7
C/D*100, i.e. % native species number	50%

Soil core laboratory analysis (two soil core subsamples):

Water content % dry weight	1690	Total (organic) C %	42.1
Bulk density T/m3	0.04	Total N %	2.26
pH	5.22	Total P mg/kg	1480
Conductivity µS (optional)	0.44	Total K % (optional)	0.082

Foliage laboratory analysis (leaf/culm sample of dominant canopy species and wetland target species):

Species	%N	%P	%C	%K optional
Coprosma tenuicaulis	2.55	0.195	49.3	0.62

Prevalence Index Summary Worksheet

Total % cover of:		Multiply by:	
OBL species	2.5	× 1 =	2.5
FACW species	24.5	× 2 =	49
FAC species	7	× 3 =	21
FACU species	1	× 4 =	4
UPL species	0	× 5 =	0
Column totals:	(A) 35		(B) 76.5
Prevalence Index[1] = B/A = 2.19			

[1]In USA if PI ≤ 3, vegetation is hydrophytic (i.e. wetland veg). PI changes over time indicate hydrology changes

Wetland Plot Sheet: Page 2

Wetland name: Tumurau **Date:** 19-11-2013 **Plot No.:** 2

Plot vegetation (use plot data only: vascular species and Sphagnum)	%
A Native species cover: sum of % cover for all native species	7.5
B Total species cover: sum of % cover for all plants	9.5
A/B*100, i.e. % native vegetation cover	78.9%
C Native species richness: number of native species	10
D Total species richness: total number of species	14
C/D*100, i.e. % native species number	71.4%

Soil core laboratory analysis (two soil core subsamples):

Water content % dry weight	358	Total (organic) C %	16.3
Bulk density T/m3	0.15	Total N %	1.27
pH	5.25	Total P mg/kg	890
Conductivity µS (optional)	0.23	Total K % (optional)	0.125

Foliage laboratory analysis (leaf/culm sample of dominant canopy species and wetland target species):

Species	%N	%P	%C	%K optional
Coprosma tenuicaulis	1.94	0.100	48.9	0.74

Prevalence Index Summary Worksheet

Total % cover of:		Multiply by:	
OBL species	1.5	× 1 =	1.5
FACW species	5.0	× 2 =	10
FAC species	1	× 3 =	3
FACU species	1.5	× 4 =	6
UPL species	0.5	× 5 =	2.5
Column totals:	(A) 9.5		(B) 23
Prevalence Index[1] = B/A = 2.42			

[1]In USA if PI ≤ 3, vegetation is hydrophytic (i.e. wetland veg). PI changes over time indicate hydrology changes

Wetland Plot Sheet: Page 2

Wetland name: Tumurau **Date:** 18-11-2013 **Plot No.:** 4

Plot vegetation (use plot data only: vascular species and Sphagnum)	%
A Native species cover: sum of % cover for all native species	12.5
B Total species cover: sum of % cover for all plants	29
A/B*100, i.e. % native vegetation cover	43.1%
C Native species richness: number of native species	11
D Total species richness: total number of species	27
C/D*100, i.e. % native species number	40.7%

Soil core laboratory analysis (two soil core subsamples):

Water content % dry weight	520	Total (organic) C %	25.4
Bulk Density T/m3	0.16	Total N %	1.85
pH	5.87	Total P mg/kg	1000
Conductivity µS (optional)	0.18	Total K % (optional)	0.147

Foliage laboratory analysis (leaf/culm sample of dominant canopy species and wetland target species):

Species	%N	%P	%C	%K optional
*Holcus lanatus**	1.95	0.095	44.2	2.53

Prevalence Index Summary Worksheet

Total % cover of:		Multiply by:	
OBL species	2.0	× 1 =	2.0
FACW species	10	× 2 =	20
FAC species	4.5	× 3 =	13.5
FACU species	9.5	× 4 =	38
UPL species	2.0	× 5 =	10
Column totals:	(A) 28		(B) 83.5
Prevalence Index[1] = B/A = 2.98			

[1]In USA if PI ≤ 3, vegetation is hydrophytic (i.e. wetland veg). PI changes over time indicate hydrology changes

Wetland Plot Sheet: Page 2

Wetland Name: Tumurau **Date:** 19-11-2013 **Plot No.:** 5

Plot vegetation (use plot data only: vascular species and Sphagnum)	%
A Native species cover: sum of % cover for all native species	51
B Total species cover: sum of % cover for all plants	104
A/B*100, i.e. % native vegetation cover	49.0%
C Native species richness: number of native species	12
D Total species richness: total number of species	18
C/D*100, i.e. % native species number	66.7%

Soil core laboratory analysis (two soil core subsamples):

Water content % dry weight	1870	Total (organic) C %	38.4
Bulk Density T/m3	0.04	Total N %	2.29
pH	5.75	Total P mg/kg	1510
Conductivity µS (optional)	0.76	Total K % (optional)	0.106

Foliage laboratory analysis (leaf/culm sample of dominant canopy species and wetland target species):

Species	%N	%P	%C	%K optional
*Holcus lanatus**	1.62	0.113	45.4	1.86
Phormium tenax	1.09	0.097	49.1	1.02

Prevalence Index Summary Worksheet

Total % cover of:		Multiply by:	
OBL species	30	× 1 =	30
FACW species	22.5	× 2 =	45
FAC species	51	× 3 =	153
FACU species	0.5	× 4 =	2
UPL species	0	× 5 =	0
Column totals:	(A) 104		(B) 230.0
Prevalence Index[1] = B/A = 2.21			

[1]In USA if PI ≤ 3, vegetation is hydrophytic (i.e. wetland veg). PI changes over time indicate hydrology changes

Wetland Plot Sheet: Page 2

Wetland name: Tumurau **Date:** 19-11-2013 **Plot No.:** 6

Plot vegetation (use plot data only: vascular species and Sphagnum)	%
A Native species cover: sum of % cover for all native species	7
B Total species cover: sum of % cover for all plants	10.5
A/B*100, i.e. % native vegetation cover	66.7%
C Native species richness: number of native species	8
D Total species richness: total number of species	13
C/D*100, i.e. % native species number	61.5%

Soil core laboratory analysis (two soil core subsamples):

Water content % dry weight	1660	Total (organic) C %	45.1
Bulk density T/m3	0.04	Total N %	3.23
pH	5.28	Total P mg/kg	1660
Conductivity µS (optional)	0.46	Total K % (optional)	0.059

Foliage laboratory analysis (leaf/culm sample of dominant canopy species and wetland target species):

Species	%N	%P	%C	%K optional
Coprosma tenuicaulis	2.94	0.284	47.1	1.00

Prevalence Index Summary Worksheet

Total % cover of:		Multiply by:	
OBL species	4	× 1 =	4
FACW species	4	× 2 =	8
FAC species	1.5	× 3 =	4.5
FACU species	1	× 4 =	4
UPL species	0	× 5 =	0
Column totals:	(A) 10.5		(B) 20.5
Prevalence Index[1] = B/A = 1.95			

[1]In USA if PI ≤ 3, vegetation is hydrophytic (i.e. wetland veg). PI changes over time indicate hydrology changes

Wetland Plot Sheet: Page 2

Wetland Name: Tumurau **Date:** 19-12-2013 **Plot No.:** 7

Plot vegetation (use plot data only: vascular species and Sphagnum)	%
A Native species cover: sum of % cover for all native species	52.2
B Total species cover: sum of % cover for all plants	144.4
A/B*100, i.e. % native vegetation cover	36.1%
C Native species richness: number of native species	8
D Total species richness: total number of species	14
C/D*100, i.e. % native species number	57.1%

Soil core laboratory analysis (two soil core subsamples):

Water content % dry weight	2050	Total (organic) C %	39.1
Bulk density T/m3	0.04	Total N %	2.49
pH	5.17	Total P mg/kg	1810
Conductivity µS (optional)	0.72	Total K % (optional)	0.13

Foliage laboratory analysis (leaf/culm sample of dominant canopy species and wetland target species):

Species	%N	%P	%C	%K optional
Juncus acuminatus	0.93	0.086	45.7	2.19
Phormium tenax	1.15	0.091	49.9	1.03
Salix cinerea	1.52	0.133	50.4	0.81

Prevalence Index Summary Worksheet

Total % cover of:		Multiply by:	
OBL species	126.2	× 1 =	126.2
FACW species	18	× 2 =	36
FAC species	0.2	× 3 =	0.6
FACU species	0	× 4 =	0
UPL species	0	× 5 =	0
Column totals:	(A) 144.4		(B) 162.8
Prevalence Index[1] = B/A = 1.13			

[1]In USA if PI ≤ 3, vegetation is hydrophytic (i.e. wetland veg). PI changes over time indicate hydrology changes

Wetland Plot Sheet: Page 2

Wetland Name: Tumurau **Date:** 19-11-2013 **Plot No.:** 8

Plot vegetation (use plot data only: vascular species and Sphagnum)	%
A Native species cover: sum of % cover for all native species	85
B Total species cover: sum of % cover for all plants	101.5
A/B*100, i.e. % native vegetation cover	83.7%
C Native species richness: number of native species	12
D Total species richness: total number of species	16
C/D*100, i.e. % native species number	75%

Soil core laboratory analysis (two soil core subsamples): no soil, standing water

Water content % dry weight		Total (organic) C %	
Bulk density T/m3		Total N %	
pH		Total P mg/kg	
Conductivity µS (optional)		Total K % (optional)	

Foliage laboratory analysis (leaf/culm sample of dominant canopy species and wetland target species):

Species	%N	%P	%C	%K optional
Typha orientalis	2.53	0.200	48.7	1.19

Prevalence Index Summary Worksheet

Total % cover of:		Multiply by:	
OBL species	99	× 1 =	99
FACW species	2	× 2 =	4
FAC species	0.5	× 3 =	1.5
FACU species	0	× 4 =	0
UPL species	0	× 5 =	0
Column totals:	(A) 101.5		(B) 104.5
Prevalence Index[1] = B/A = 1.03			

[1]In USA if PI ≤ 3, vegetation is hydrophytic (i.e. wetland veg). PI changes over time indicate hydrology changes

Wetland Plot Sheet: Page 2

Wetland Name: Tumurau **Date:** 19-11-2013 **Plot No.:** 9

Plot vegetation (use plot data only: vascular species and Sphagnum)	%
A Native species cover: sum of % cover for all native species	102
B Total species cover: sum of % cover for all plants	108.5
A/B*100, i.e. % native vegetation cover	94%
C Native species richness: number of native species	12
D Total species richness: total number of species	15
C/D*100, i.e. % native species number	80%

Soil core laboratory analysis (two soil core subsamples):

Water content % dry weight	969	Total (organic) C %	40.3
Bulk Density T/m3	0.06	Total N %	2.75
pH	5.67	Total P mg/kg	1550
Conductivity µS (optional)	0.44	Total K % (optional)	0.193

Foliage laboratory analysis (leaf/culm sample of dominant canopy species and wetland target species):

Species	%N	%P	%C	%K optional
Machaerina arthrophylla	1.12	0.049	46.3	0.62
Phormium tenax	1.08	0.084	49.9	1.03
Leptospermum scoparium	1.22	0.093	53.1	0.52

Prevalence Index Summary Worksheet

Total % cover of:		Multiply by:	
OBL species	77	× 1 =	77
FACW species	27	× 2 =	54
FAC species	4	× 3 =	12
FACU species	0.5	× 4 =	2
UPL species	0	× 5 =	0
Column totals:	(A) 108.5		(B) 145
Prevalence Index[1] = B/A = 1.33			

[1]In USA if PI ≤ 3, vegetation is hydrophytic (i.e. wetland veg). PI changes over time indicate hydrology changes

Tumurau (Braemar) Lagoon Wetland Plot 3

One vegetation type in which *Empodisma robustum* was a common but local component was not encountered. Three *a priori* GPS points randomly generated within the mapped vegetation type for Plot 3 were subsequently rejected in the field on the following basis:

- Tumurau Primary plot 03
    - Not EMP rob
    - Dead LEP sco–dead SAL cin/MAC rub sedgeland
- Tumurau Backup1 plot 03:
    - Not EMP rob
    - Dead SAL cin–dead LEP sco/litter and occasional Machaerina spp
- Tumurau Backup2 plot 03:
    - Not EMP rob
    - Dead SAL cin/PHO ten/MAC rub-MACarth–MAC ten–ISO ret-COP tec–Senecio sp.–EPI pal
    - The EMP rob vegetation type needs to be delineated in the field and an additional plot sampled (planned)

Appendix 5 – Prevalence Index Data

Prevalence Index – Kaituna Sand Dunes plot 1

Indicator Group	Species Name	Percent Cover by Species	Total Cover by Group	Weighting Factor	Product
OBL	*Eleocharis sphacelata* *Ludwigia palustris** *Galium palustre** *Myriophyllum robustum* *Azolla filiculoides* *Lemna disperma* *Carex virgata*	70 25 5 15 35 1 1	152	1	152
FACW	*Salix cinerea subsp. oleifolia** *Ranunculus flammula** *Juncus articulatus**	45 2 5	52	2	104
FAC			0	3	0
FACU			0	4	0
UPL			0	5	0
	Totals		**(A) 204**		**(B) 256**
Hydrophytic Vegetation Determination	**Prevalence Index = B/A** = 1.25 _ Hydrophytic Vegetation by PI Indicator? ✓ Yes No				

NB if PI = 3.0 or less, site is defined as having hydrophytic vegetation, i.e. satisfying one criterion for delineating wetlands

USA Wetland delineation approach (Environmental Laboratory 1987)

Prevalence Index – Kaituna Sand Dunes plot 4

Indicator Group	Species Name	Percent Cover by Species	Total Cover by Group	Weighting Factor	Product
OBL	*Eleocharis sphacelata* *Juncus bulbosus**	30 60	90	1	90
FACW			0	2	0
FAC			0	3	0
FACU			0	4	0
UPL			0	5	0
	Totals		**(A) 90**		**(B) 90**
Hydrophytic Vegetation Determination	**Prevalence Index = B/A** = 1.0 _ Hydrophytic Vegetation by PI Indicator? ✓ Yes No				

NB if PI = 3.0 or less site is defined as having hydrophytic vegetation, i.e. satisfying one criterion for delineating wetlands

USA Wetland delineation approach (Environmental Laboratory 1987)

Prevalence Index – Kohika plot 1

Indicator Group	Species Name	Percent Cover by Species	Total Cover by Group	Weighting Factor	Product
OBL	*Galium palustre**	0.1	0.1	1	0.1
FACW	*Carex geminata* *Cordyline australis* *Coprosma × cunninghamii* *Phormium tenax* *Coprosma tenuicaulis*	5 2 1 0.5 0.1	8.6	2	17.2
FAC	*Calystegia sepium* *Holcus lanatus** *Lotus pedunculatus** *Ranunculus repens** *Rumex crispus** *Schedonorus arundinaceus**	90 5 2 2 0.1 0.1	99.2	3	297.6
FACU	*Ligustrum sinense** *Rubus fruticosus** *Lonicera japonica** *Melicytus ramiflorus* *Microlaena stipoides* *Poa pratensis** *Oplismenus hirtellus subsp. imbecillis* *Geniostoma rupestre var. ligustrifolium* *Prunella vulgaris**	20 10 15 3 0.1 0.1 0.1 0.1 0.1	48.5	4	194
UPL	*Galium aparine** *Crataegus monogyna**	2 5	7.0	5	35.5
	Totals		**(A) 163.4**		**(B) 544.4**

Hydrophytic Vegetation Determination	**Prevalence Index = B/A =** 3.33 _ Hydrophytic Vegetation by PI Indicator? Yes ✓ No

NB if PI = 3.0 or less site is defined as having hydrophytic vegetation, i.e. satisfying one criterion for delineating wetlands

USA Wetland delineation approach (Environmental Laboratory 1987)

Prevalence Index – Kohika plot 2

Indicator Group	Species Name	Percent Cover by Species	Total Cover by Group	Weighting Factor	Product
OBL	*Glyceria maxima**	60	61	1	61
	*Galium palustre**	1			
FACW	*Salix cinerea**	55	124.1	2	248.2
	Phormium tenax	3			
	Carex geminate	5			
	Salix cinerea subsp. oleifolia	55			
	Coprosma × cunninghamii	1			
	Machaerina tenax	1			
	Cordyline australis	1			
	Phormium tenax	3			
	*Cyperus eragrostis**	0.1			
FAC	*Calystegia sepium*	30	39	3	117
	*Ranunculus repens**	5			
	*Holcus lanatus**	2			
	*Lotus pedunculatus**	2			
FACU	*Rubus fruticosus**	3	14	4	56
	*Lonicera japonica**	10			
	Muehlenbeckia australis	1			
UPL	*Pyrrosia eleagnifolia (epiphyte NA)*	0	0	5	0
	Totals		**(A) 238.1**		**(B) 482.2**
Hydrophytic Vegetation Determination	**Prevalence Index = B/A** = 2.03 _ Hydrophytic Vegetation by PI Indicator? ✓ Yes No				

NB if PI = 3.0 or less site is defined as having hydrophytic vegetation, i.e. satisfying one criterion for delineating wetlands

USA Wetland delineation approach (Environmental Laboratory 1987)

Prevalence Index – Tumurau plot 1

Indicator Group	Species Name	Percent Cover by Species	Total Cover by Group	Weighting Factor	Product
OBL	*Eleocharis acuta* *Hydrocotyle pterocarpa* *Ranunculus sceleratus** *Machaerina rubiginosa*	1 0.5 0.5 0.5	2.5	1	2.5
FACW	*Coprosma tenuicaulis* *Salix cinerea subsp. oleifolia** *Ranunculus flammula** *Phormium tenax*	20 3 0.5 1	24.5	2	49
FAC	*Lotus pedunculatus** *Holcus lanatus** *Coprosma propinqua* *Lobelia angulata*	5 1 0.5 0.5	7	3	21
FACU	*Cerastium fontanum** *Sonchus asper**	0.5 0.5	1	4	4
UPL		0	0	5	0
	Totals		**(A) 35**		**(B) 76.5**
Hydrophytic Vegetation Determination	**Prevalence Index = B/A** = 2.19 _ Hydrophytic Vegetation by PI Indicator? ✓ Yes No				

NB if PI = 3.0 or less site is defined as having hydrophytic vegetation, i.e. satisfying one criterion for delineating wetlands

USA Wetland delineation approach (Environmental Laboratory 1987)

"Bryophytes" also present (2%)

Prevalence Index – Tumurau plot 2

Indicator Group	Species Name	Percent Cover by Species	Total Cover by Group	Weighting Factor	Product
OBL	*Hydrocotyle pterocarpa* *Myosotis laxa subsp. caespitosa* *Nertera scapanioides*	0.5 0.5 0.5	1.5	1	1.5
FACW	*Coprosma tenuicaulis* *Phormium tenax* *Blechnum minus* *Machaerina juncea* *Schoenus maschalinus*	3 0.5 0.5 0.5 0.5	5.0	2	10
FAC	*Leptospermum scoparium* *Leontodon taraxacoides**	0.5 0.5	1	3	3
FACU	*Senecio minimus* *Hypochaeris radicata** *Dicksonia squarrosa*	0.5 0.5 0.5	1.5	4	6
UPL	*Sonchus oleraceus**	0.5	0.5	5	2.5
	Totals		**(A) 9.5**		**(B) 23**
Hydrophytic Vegetation Determination	**Prevalence Index = B/A** = 2.42 _ Hydrophytic Vegetation by PI Indicator? ✓ Yes No				

NB if PI = 3.0 or less site is defined as having hydrophytic vegetation, i.e. satisfying one criterion for delineating wetlands

USA Wetland delineation approach (Environmental Laboratory 1987)

“Bryophytes” also present (0.5%)

Prevalence Index – Tumurau plot 4

Indicator Group	Species Name	Percent Cover by Species	Total Cover by Group	Weighting Factor	Product
OBL	*Persicaria decipiens*	0.5	2.0	1	2.0
	*Juncus bulbosus**	1			
	*Veronica anagallis-aquatica**	0.5			
FACW	*Schoenus maschalinus*	2	10	2	20
	*Juncus lomatophyllus?**	2			
	Isolepis reticularis	5			
	Cordyline australis	0.5			
	Coprosma tenuicaulis	0.5			
FAC	*Holcus lanatus**	3	4.5	3	13.5
	*Leontodon taraxacoides**	0.5			
	*Epilobium ciliatum**	1			
FACU	*Conyza sumatrensis**	1	9.5	4	38
	*Sonchus asper**	2			
	Senecio bipinnatisectus	1			
	*Rubus fruticosus**	0.5			
	*Gamocheta coarctata**	0.5			
	*Sonchus oleraceus**	0.5			
	*Hypochaeris radicata**	1			
	Melicytus ramiflorus	0.5			
	*Ligustrum sinense**	0.5			
	Myrsine australis	0.5			
	Geniostoma rupestre var. ligustrifolium	0.5			
	Uncinia uncinata	1			
UPL	*Digitalis purpurea**	1	2.0	5	10

	*Stellaria media**	0.5			
	Tmesipteris elongata (epiphyte NA)	0			
	Cyathea dealbata	0.5			
	Pyrrosia eleagnifolia (epiphyte NA)	0			
	Totals		**(A) 28**		**(B) 83.5**
Hydrophytic Vegetation Determination	**Prevalence Index = B/A** = 2.98 _ Hydrophytic Vegetation by PI Indicator? ✓ Yes No				

NB if PI = 3.0 or less site is defined as having hydrophytic vegetation, i.e. satisfying one criterion for delineating wetlands

USA Wetland delineation approach (Environmental Laboratory 1987)

"Bryophytes" also present (2%)

Prevalence Index – Tumurau plot 5

Indicator Group	Species Name	Percent Cover by Species	Total Cover by Group	Weighting Factor	Product
OBL	*Machaerina rubiginosa*	15	30	1	30
	Carex maorica	2			
	Carex secta	1			
	*Galium palustre**	1			
	Isachne globosa	5			
	Epilobium pallidiflorum	3			
	Hydrocotyle pterocarpa	1			
	Eleocharis acuta	0.5			
	*Ludwigia palustris**	1			
	Machaerina arthrophylla	0.5			
FACW	*Phormium tenax*	20	22.5	2	45
	Coprosma tenuicaulis	2			
	Coprosma X cunninghamii	0.5			
FAC	*Holcus lanatus**	35	51	3	153
	*Lotus pedunculatus**	15			
	*Epilobium ciliatum**	0.5			
	Leptospermum scoparium	0.5			
FACU	*Anthoxanthum odoratum**	0.5	0.5	4	2
UPL		0	0	5	0
	Totals		**(A) 104**		**(B) 230.0**
Hydrophytic Vegetation Determination	**Prevalence Index = B/A** = 2.21 _ Hydrophytic Vegetation by PI Indicator? ✓ Yes No				

NB if PI = 3.0 or less site is defined as having hydrophytic vegetation, i.e. satisfying one criterion for delineating wetlands

USA Wetland delineation approach (Environmental Laboratory 1987)

"Bryophytes" also present (2%)

Prevalence Index – Tumurau plot 6

Indicator Group	Species Name	Percent Cover by Species	Total Cover by Group	Weighting Factor	Product
OBL	*Carex secta* *Epilobium pallidiflorum* *Lemna disperma* *Azolla filiculoides* *Hydrocotyle pterocarpa* *Ludwigia palustris**	0.5 0.5 1 1 0.5 0.5	4	1	4
FACW	*Coprosma tenuicaulis* *Phormium tenax* *Bidens frondosa**	2 1 1	4	2	8
FAC	*Lotus pedunculatus** *Holcus lanatus**	1 0.5	1.5	3	4.5
FACU	*Senecio minimus* *Conyza sumatrensis**	0.5 0.5	1	4	4
UPL		0	0	5	0
	Totals		**(A) 10.5**		**(B) 20.5**
Hydrophytic Vegetation Determination	**Prevalence Index = B/A** = 1.95 _ Hydrophytic Vegetation by PI Indicator? ✓ Yes No				

NB if PI = 3.0 or less site is defined as having hydrophytic vegetation, i.e. satisfying one criterion for delineating wetlands

USA Wetland delineation approach (Environmental Laboratory 1987)

Bryophytes (Usnea, other lichens and bryo) also present (2%)

Prevalence Index – Tumurau plot 7

Indicator Group	Species Name	Percent Cover by Species	Total Cover by Group	Weighting Factor	Product
OBL	*Juncus acuminatus**	60	126.2	1	126.2
	*Ludwigia palustris**	15			
	Myriophyllum propinquum	20			
	Hydrocotyle pterocarpa	0.1			
	Isachne globosa	20			
	Machaerina rubiginosa	3			
	Carex maorica	3			
	Eleocharis acuta	5			
	*Galium palustre**	0.1			
FACW	*Salix cinerea subsp. oleifolia**	14	18	2	36
	*Ranunculus flammula**	3			
	Phormium tenax	1			
FAC	*Leptospermum scoparium*	0.1	0.2	3	0.6
	Holcus lanatus	0.1			
FACU		0	0	4	0
UPL		0	0	5	0
	Totals		**(A) 144.4**		**(B) 162.8**
Hydrophytic Vegetation Determination	**Prevalence Index = B/A** = 1.13 _				
	Hydrophytic Vegetation by PI Indicator? ✓ Yes No				

NB if PI = 3.0 or less site is defined as having hydrophytic vegetation, i.e. satisfying one criterion for delineating wetlands

USA Wetland delineation approach (Environmental Laboratory 1987)

Prevalence Index – Tumurau plot 8

Indicator Group	Species Name	Percent Cover by Species	Total Cover by Group	Weighting Factor	Product
OBL	*Typha orientalis*	50	99	1	99
	Carex secta	4			
	Carex maorica	0.5			
	*Galium palustre**	2			
	*Lycopus europaeus**	1			
	Persicaria decipiens	1			
	Lemna disperma	10			
	Azolla filiculoides	12			
	*Azolla pinnata**	13			
	Isachne globosa	4			
	Eleocharis acuta	0.5			
	Hydrocotyle pterocarpa	0.5			
	Myriophyllum propinquum	0.5			
FACW	*Phormium tenax*	1	2	2	4
	Blechnum minus	1			
FAC	*Lotus pedunculatus**	0.5	0.5	3	1.5
FACU		0	0	4	0
UPL		0	0	5	0
	Totals		**(A) 101.5**		**(B) 104.5**
Hydrophytic Vegetation Determination	**Prevalence Index =** B/A = 1.03 _ Hydrophytic Vegetation by PI Indicator? ✓ Yes No				

NB if PI = 3.0 or less site is defined as having hydrophytic vegetation, i.e. satisfying one criterion for delineating wetlands

USA Wetland delineation approach (Environmental Laboratory 1987)

Prevalence Index – Tumurau plot 9

Indicator Group	Species Name	Percent Cover by Species	Total Cover by Group	Weighting Factor	Product
OBL	*Machaerina arthrophylla* *Isachne globosa* *Machaerina rubiginosa* *Hydrocotyle pterocarpa* *Carex maorica*	55 1 20 0.5 0.5	77	1	77
FACW	*Phormium tenax* *Salix cinerea subsp. oleifolia** *Coprosma tenuicaulis* *Machaerina tenax* *Blechnum minus* *Cordyline australis*	4 4 15 0.5 3 0.5	27	2	54
FAC	*Leptospermum scoparium* *Lotus pedunculatus* *Coprosma propinqua*	1 2 1	4	3	12
FACU	*Hypochaeris radicata**	0.5	0.5	4	2
UPL			0	5	0
	Totals		**(A) 108.5**		**(B) 145**
Hydrophytic Vegetation Determination	**Prevalence Index = B/A** = 1.33 _ Hydrophytic Vegetation by PI Indicator? ✓ Yes No				

NB if PI = 3.0 or less site is defined as having hydrophytic vegetation, i.e. satisfying one criterion for delineating wetlands

USA Wetland delineation approach (Environmental Laboratory 1987)

"Bryophytes" (5%) and epiphytic Usnea (0.5%) also present