



Manaaki Whenua  
Landcare Research

# **A framework for monitoring Northland wetlands**

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# A framework for monitoring Northland wetlands

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# Summary

## Project and Client

- Northland Regional Council contracted Manaaki Whenua – Landcare Research to develop a framework for monitoring ecological state and trend of freshwater wetlands, and to provide a set of priority monitoring sites representative of Northland wetlands.

## Objectives

- Compile information on historic and current wetland extent to assess degree of loss, geographic distribution, and representativeness.
- Hold a workshop with a small group of wetland experts to collate information on current wetlands.
- Classify wetlands in the Northland region by wetland classification hierarchical levels (Johnson & Gerbeaux 2004).
- Assess ecological values of current wetlands using available information and local expert knowledge.
- Develop a framework for assessing regional wetland priorities for monitoring.
- Provide a minimum set of representative wetlands and a timeline for monitoring.

## Methods

- Historic (c. 1840) and current wetland comparisons were based on the Wetlands of National Importance (WONI) database of New Zealand wetlands.
- Current wetlands were classified according to hydrosystem, wetland class, form, vegetation structure, and dominant species composition.
- The ecological values were assessed, and wetlands listed in approximate order of importance using the Northland 'Top Wetlands' ranking system (Wildland Consultants 2011, revised 2015), Protected Natural Area Programme reports, and local expert knowledge. The order of assessment was: first: wetlands of national and high regional importance; second: lower condition wetlands within developed landscapes; and third: wetlands having additional special characteristics, features or geographic distribution.
- A representative set of wetlands of priority for monitoring was selected using the following criteria: rarity, current extent, distribution (Ecological District), ecological importance, catchment land use pressures and current monitoring programmes.

## Results

- The current extent of wetlands is estimated to be 14,291 ha, or about 3.2% of historic extent (453,251 ha).
- Of the wetland classes, the highest proportion remaining is for bogs (5.4%) and the lowest is for fens (0.5%).
- The degree of wetland loss varied across Ecological Districts, ranging from almost 0% remaining for Puketi to 39.3% remaining for Ahipara.

- A draft set of 61 representative wetlands was provided for monitoring on a 5-yearly rolling basis. This includes all wetlands ranked in the Top 30, all wetlands currently being monitored by NRC (including smaller, lower condition wetlands) and/or DOC, and additional wetlands to fill gaps identified, i.e. having unique or uncommon features, poorly represented attributes, or rare and threatened species.

### **Conclusions**

- The provisional set of priority wetlands covers a range of wetland classes, vegetation types, ecological condition, regional distribution, and historic extent, and should be appropriate for monitoring the ecological state and trend of representative wetlands in Northland region.

### **Recommendations**

- Refine and update information on wetlands, e.g. vegetation type areal extent, preferably in a GIS wetlands database.
- The next phase is to develop the methodology for monitoring wetlands, i.e. establishing permanent vegetation plots, sampling design including replication and plot size, and overall condition assessment.

## 1 Introduction

Regional councils are required to develop work programmes to give effect to the suite of new freshwater reforms released by the Government in 2020 under its Essential Freshwater work programme. The reforms include the National Policy Statement for Freshwater 2020 (NPS-FM), the National Environmental Standards for Freshwater 2020 (NES-F), and the Stock Exclusion Regulations 2020. These rules and regulations have a strong focus on protecting and restoring wetlands and require councils to develop and undertake a wetland monitoring plan.

Northland Regional Council (NRC) has an outcome-based monitoring programme that tracks the condition of c. 28 wetland sites using the Wetland Condition Index (WCI: Clarkson et al. 2004). However, these wetlands were selected to assess the effects of council-assisted fencing on wetland condition and are not representative of the full range of different wetland classes, sizes, geographic distribution, and biodiversity across Northland.

Northland Regional Council is currently developing an overall wetland programme that incorporates four strands of work: mapping, monitoring, restoration, and compliance, that will meet the requirements of the NES and NPS. To help satisfy these requirements, NRC contracted Manaaki Whenua – Landcare Research (MWLR) to develop an environmental monitoring framework, and a set of priority wetlands that is representative of Northland wetlands.

## 2 Background

The following information sources are available for Northland wetlands:

- Waters of National Importance (WONI) maps of historic and current wetlands (Ausseil et al. 2008). Metadata and subsequent updates are available from MWLR (data layer files dated 2012)
- Northland Protected Natural Area Programme (PNAP) reports for the 19 Ecological Districts of mainland Northland and published between 1998 and 2012 are available on the Department of Conservation (DOC) website: <https://www.doc.govt.nz/about-us/science-publications/conservation-publications/land-and-freshwater/land/northland-conservancy-ecological-districts-survey-reports/>
- Wildland Consultants (2011) report on the 255 top-ranked freshwater wetlands in Northland (revised in 2015). Their ranking system used PNAP criteria (e.g. representativeness, diversity and pattern, size, rarity, and special features) as a basis to assess ecological importance, with additional criteria from other wetland ranking systems to develop a bespoke ecological ranking system for Northland wetlands. This was mainly a desktop exercise collating the PNAP reports of Northland Ecological Districts, aerial imagery, and local knowledge
- Department of Conservation monitoring programme data for DOC-administered priority wetlands

- Northland Regional Council outcome-based wetland monitoring programme data ('WCI' wetlands). These mostly represented smaller wetlands of relatively low ecological condition and situated within agricultural or otherwise modified catchments
- Data from the MWLR wetland database sampled between 2007 and 2015
- Wetland expert knowledge both in-house (NRC) and other organisations including DOC, National Institute of Water and Atmospheric Research (NIWA), and MWLR
- High quality colour aerial photographs taken in 2021 by Biospatial Ltd.

### **3 Objectives**

- Compile information on historic and current wetland extent to assess degree of loss, geographic distribution, and representativeness
- Hold a workshop with a small group of wetland experts to collate information on current wetlands
- Classify wetlands in the Northland region by hierarchical levels (Johnson & Gerbeaux 2004), e.g. wetland class, form, vegetation structure and dominant species composition
- Assess ecological values of current wetlands using available information and local expert knowledge
- Develop a framework for assessing regional wetland priorities for monitoring based on representativeness, regional distribution, historic extent, ecological importance, vegetation types, adjacent land use, and a range of ecological condition
- Provide a minimum set of representative wetlands and a timeline for monitoring.

## **4 Methods**

### **4.1 WONI historic and current wetland comparisons**

Historic (c. 1840) and current wetland mapping was based on the predicted extent of New Zealand wetlands (Ausseil et al. 2008) using the 2012 WONI data layers held by MWLR. WONI was derived by modelling topographical and soil attributes to estimate the probability that a given area falls within a particular wetland class.

The WONI polygon data were clipped to the Northland Region and analyses conducted on historic and current areas by wetland class, Ecological District, and proportion of area remaining to assess representativeness of current wetlands and inform priorities.

### **4.2 Ecological assessment of current wetlands**

A workshop was held 20–21 April 2022 at Northland Regional Council to collate ecological data on current wetlands. Wetland experts attending were Paul Champion (NIWA),

Dave West (DOC), Andrew Townsend (DOC), Lisa Forester (NRC), Katrina Hansen (NRC), Anya Duxfield (NRC GIS expert), and Bev Clarkson (MWLR).

To enable the assessment, Northland Regional Council compiled an Excel spreadsheet of freshwater wetlands previously ranked in order from 1 to 255 (by Wildland Consultants 2011, revised 2015). This was prepopulated with relevant wetland ecological data and information.

Column categories in the spreadsheet followed the hierarchical levels of the wetland classification of Johnson & Gerbeaux (2004). These included hydrosystem, wetland class, wetland form, vegetation structure, species composition, and area, with one row of the spreadsheet for each unique vegetation structure and species composition combination.

Workshop participants systematically worked through the 30 top-ranked wetlands by adding rows and information using the NRC GIS wetland database, recent Biospatial Ltd colour aerial photographs, Wildland Consultants (2011, revised 2015), PNAP reports, other reports, and expert local knowledge. Where available, area (ha) was assigned to each vegetation type (vegetation structure plus species composition). If not available, areas were assigned pro rata according to the total area of wetland and the number of vegetation types.

The Top 30 wetlands were considered to be of national importance or else of very high regional importance, and as such, would be of greatest priority for monitoring. We then added similar information for c. 40 wetlands (mostly post-workshop) to fill gaps in representativeness. First, the wetlands being monitored by DOC were added as these were also of national or regional importance. Second, the WCI wetlands being monitored by NRC were added to capture a range of smaller wetlands of lower ecological condition and located within more modified landscapes. Finally, those wetlands ranked lower than 30 having special characteristics, features or geographic distributions that were not captured in the draft list of priority wetlands were included.

### **4.3 Selection criteria for a representative set of wetlands for monitoring**

The selection of a representative set of priority wetlands for Northland region used the following criteria:

- **Rarity.** This is based on the magnitude of the loss of a particular wetland class (compared with historic extent) relative to other wetland classes
- **Current extent**
- **Distribution.** Ecological Districts with the greatest wetland losses and/or largest extent of wetlands remaining are higher priorities for targeting wetlands for monitoring
- **Ecological importance ranking.** Top-ranked wetlands are higher priorities for monitoring than lower ranked wetlands
- **Catchment land uses and pressures**
- **Current monitoring programmes.** These provide invaluable longer-term monitoring data and include smaller, more modified wetlands to encompass a greater range of class, size, ecological condition, and vegetation type.



## 5 Results

### 5.1 WONI historic and current wetland comparisons

The current extent of wetlands in Northland is estimated to be 14,291 ha, or about 3.2% of historic extent (Table 1). This proportion is much lower than the estimated national figure of c. 10% remaining (Ausseil et al. 2008, 2011). Within wetland classes, the highest proportion remaining is for bogs, (5.4%), and lowest is for fen (0.5%). However, all wetland classes are well below the 10% national figure, therefore all wetland classes can be considered of high priority. This also means that all remaining wetlands are important for protection and management.

The following caveats apply:

- The seepage wetland class was not included in the historic extent, so current/historic proportions are not available. Seepages are typically small wetlands or components within other larger wetland classes (Johnson & Gerbeaux 2004), and are difficult to map at broad scales
- Ephemeral wetlands are included the marsh class following McGlone (2009)
- Shallow water was not classified in the historic or current WONI data as depth of standing water was not available. Areas of shallow water were incorporated into other wetland classes (Ausseil 2008)
- The pakihi & gumland wetland class is almost entirely made up of gumlands, of which Northland is the national stronghold
- The fen wetland class is likely to be under-represented in the WONI layer, in Northland. This is because field verification of wetlands in Otago showed that many of the bogs identified by GIS rules were fens (Ausseil et al. 2008, 2011). Although the regions are quite different climatically, the GIS rules were based on topography and soils, which would also be relevant to regions elsewhere in New Zealand.

However, although there are issues associated with the broad scale of the mapping and the rules-based approach for historic data, general trends should still be applicable for assessing representativeness and informing priorities.

**Table 1. Wetland classes of historic (c. 1840) and current wetlands of Northland Region**

Wetland Class	Total area (ha)		Proportion remaining
	Historic	Current	%
Bog	16,253.5	881.5	5.4
Fen	8,463.6	43.4	0.5
Marsh	34,988.4	1,045.8	3.0
Pakihi & Gumland	133,622.9	2,774.4	2.1
Seepage	0.0	25.8	–
Swamp	259,922.1	9,520.4	3.7
<b>Total</b>	<b>453,250.6</b>	<b>1,4291.2</b>	<b>3.2</b>

Current and historic wetlands were assigned to Ecological Districts (EDs; Table 2) and mapped (Figs 1, 2). There were no historic or current wetland data for Poor Knights and Taranga EDs, so they will not be considered further. Kaipara, Otamatea, and Rodney EDs extend southwards into the Auckland Conservancy/region, therefore only those parts that are in the Northland region have been included in the analysis.

**Table 2 Historic (c. 1840) and current area of wetlands in Ecological Districts of Northland Region**

Ecological District	Total area (ha)		Proportion remaining
	Historic	Current	%
Ahipara	3,658.9	1,439.5	39.3
Aupouri	44,517.9	5,879.7	13.2
Hokianga	37,062.6	472.4	1.3
Kaikohe	34,237.2	649.8	1.9
Kaipara (part)	58,870.8	2,706.3	4.6
Kerikeri	22,737.0	531.4	2.3
Manaia	1,297.9	28.4	2.2
Maungataniwha	13,761.7	79.9	0.6
Otamatea (part)	16,576.9	2.4	0.0
Poor Knights	0.0	0.0	
Puketi	8,926.1	2.6	0.0
Rodney (part)	9,180.1	156.8	1.7
Tangihua	43,287.8	69.2	0.2
Taranga	0.0	0.0	
Te Paki	13,011.9	1,033.9	7.9
Tokatoka	21,377.3	286.4	1.3
Tutamoe	13,438.4	103.9	0.8
Waipu	17,060.9	24.3	0.1
Whangarei	30,067.5	453.9	1.5
Whangaroa	6,484.8	56.2	0.9
Whangaruru	57,694.8	314.1	0.5
<b>Total</b>	<b>453,250.6</b>	<b>14,291.2</b>	<b>3.2</b>

The degree of wetland loss varied across Ecological Districts, with the greatest losses in Puketi (virtually none remaining), Otamatea (part) (virtually 0%), Waipu (0.1%), Tangihua (0.2%), Whangaruru (0.5%), Mangataniwha (0.6%), Tutamoe (0.8%), and Whangaroa (0.9%). Ahipara had the highest proportion remaining (39.3% of historic wetlands), and Aupouri had the largest area of current wetlands (5879.7 ha: 13.2% remaining).

Note that there may be minor discrepancies in current wetland area between the WONI and the more up to date NRC spreadsheet data used for this project. Such refinement of information will be ongoing as more information becomes available. However, this should not change the overall patterns summarised in Table 2.



Figure 1. Historic wetlands (c. 1840) of Northland Region Ecological Districts.



**Figure 2. Current wetlands of Northland Region Ecological Districts.**

## 5.2 Draft list of wetlands for monitoring

Sixty-one wetlands were listed on the draft wetland priority list (Table 3), together with the reasons for inclusion, i.e.

- All wetlands in the Top 30 rankings of Wildlands (2011, revised 2015). These wetlands are considered to be nationally and/or regionally significant
- Other important wetlands currently being monitored by DOC ( $n=11$ ) and/or by NRC in programmes other than 'WCI' ( $n=3$ ). Note that these monitored wetlands included some overlaps with Top 30 wetlands

- Wetlands currently being monitored by NRC within the WCI ( $n=21$ ). This provides a detailed monitoring data set of smaller, and/or more modified wetlands
- Gap filling criteria, such as including unique or uncommon features, poorly represented attributes, and rare and threatened species ( $n=8$ ).

In total, the area of priority wetlands is 10,944 ha, which represents 7.7% of the current areal extent of wetlands based on WONI (Ausseil 2008). The wetlands cover a good range of wetland classes, geographic distribution, historic losses, current extent, ecological values (including threatened or rare species), ecological condition, and vegetation types. Note that this analysis covers only those parts of Rodney, Otamatea, and Kaipara Ecological Districts located within the Northland Region. For more information on wetland class, vegetation structure, main species composition, and threatened species see Appendix 1, section 5.2.2 below, and the NRC Excel spreadsheet.

**Table 3. Draft list of priority wetlands by Ecological District and reason for inclusion**

Wetland Name	Ecological District	Area ha	Ranking	Monitored	Reason
Ahipara Massif & Epikauri	Ahipara	1,549.7	9	DOC	Top 30
Whakakoro	Ahipara	98	151	NRC	WCI
Kaimaumau/Motutangi	Aupouri	1,870	2	DOC	Top 30
Lake Ohia	Aupouri	800	4	DOC	Top 30
Lake Rotokawau, Puwheke	Aupouri	97.9	15		Top 30
Lake Waiparera	Aupouri	186.5	20		Top 30
Te Arai Sandfields	Aupouri	13	24		Top 30
Te Paki Stream	Aupouri	43	22		Top 30
Tapuwae 1–5	Hokianga	4.5		NRC	WCI
Aratoro Stream Bush	Kaikohe	7.2			Gap
Kaipeha Swamp	Kaikohe	317.6	10		Top 30
Lake Omapere & Environs	Kaikohe	1,213.8	11		Top 30
Ngawha Geothermal Field	Kaikohe	181	14		Top 30
Stone/Waingaruru	Kaikohe	7.5	71		WCI
Lake Humuhumu W&F	Kaipara	268	17	NRC	Top 30
Maitahi Wetland Sci Res	Kaipara	280	6		Top 30
Pouto Dune System	Kaipara	638	1	NRC DOC	Top 30
Punahaere Creek Fen	Kaipara	16		DOC	DOC
Gillanders	Kerikeri	6		NRC	WCI
Guleray	Kerikeri	2.24		NRC	WCI
Kerikeri Airport Gumland	Kerikeri	67.6	19	DOC	Top 30
Opuia Forest	Kerikeri	31.9	25		Top 30
Waitangi Wetland Complex	Kerikeri	114.7	27	DOC	Top 30
Duffy	Manaia	0.2		NRC	WCI

Wetland Name	Ecological District	Area ha	Ranking	Monitored	Reason
Paranui Stream Swamp	Maungataniwha	45.3	23		Top 30
Hautakima South Forest	Otamatea	2	188		Gap
Puketi Forest Gumland	Puketi	9	44		Gap
King Road Saltmarsh	Rodney	39			Gap
Awakino & Flaxmill Swamps	Tangihua	69.8	39	DOC	DOC
Taikirau Swamp	Tangihua	481.6	7		Top 30
Taikirau Wetland	Tangihua	144.2	28		Top 30
Tarakihi Fen & Environs	Tangihua	153.3	18		Top 30
North Cape Scientific Reserve	Te Paki	52.2	49		Gap
Paranoa & Waitahora	Te Paki	269.6	3	DOC	Top 30
Shenstone Block	Te Paki	7.7	29		Top 30
Te Hapua Wetland	Te Paki	25.2	149		Gap
Te Paki Shrublands/Forests	Te Paki	100	51		Gap
Te Werahi Wetland	Te Paki	495.4	21		Top 30
Waiwhero Stream Wetland	Te Paki	7.7	26		Top 30
Manganui River Complex	Tokatoka	338.4	8		Top 30
Kaihu Forest	Tutamoe	205.8	5		Top 30
Muriwai Stream Swamp	Tutamoe	97.4	16		Top 30
Curtis	Waipu	19.6	170	NRC	WCI
Hansen	Waipu	0.7	55	NRC	WCI
Matheson	Waipu	1.45		NRC	WCI
Pirihi	Waipu	2		NRC	WCI
Sime Rd	Waipu	0.5	57	NRC	WCI
Andries	Whangarei	1.12		NRC	WCI
Gatenby	Whangarei	0.2		NRC	WCI
Otakairangi Peat Bog	Whangarei	250	13	DOC	Top 30
Putt/Bell	Whangarei	0.9		NRC	WCI
Wairua River WMR	Whangarei	160.9	11	DOC	Top 30
Waterhouse 1,2	Whangarei	2		NRC	WCI
Komutu Swamp	Whangaroa	29	38		Gap
Whyte 1abc,2,3ab	Whangaroa	9.9		NRC	WCI
Cox	Whangaruru	0.6		NRC	WCI
Harman	Whangaruru	3.8		NRC	WCI
Hawken	Whangaruru	1.9		NRC	WCI
Kippenberger	Whangaruru	1		NRC	WCI
Russell Forest	Whangaruru	100	30		Top 30
Tāika /Mount Tiger	Whangaruru	0.5		NRC	WCI
<b>Total</b>		<b>10944.0</b>			

## 5.2.1 Wetland class vegetation types

Thirty-four structural vegetation classes were identified in the draft priority list of wetlands (Table 4). For each vegetation class, the total area is provided, together with the number of different wetlands in which it is represented (count). Additional vegetation classes may be present in wetlands not on the priority list, and, as information comes to hand, those of ecological and conservation importance, e.g. new indigenous vegetation types, should be added to the matrix.

For the analysis of hydrosystems, all were treated as palustrine. This was because the majority of wetlands were palustrine, and the very few cases of lacustrine, riverine, and geothermal wetlands did not contain any unique indigenous vegetation types (vegetation structure and main species composition).

**Table 4. Vegetation structure by wetland class, and areal extent, of current wetlands in draft priority list of Northland Region. Counts represent the number of wetlands in which each wetland class/vegetation structure combination is present. Most wetlands have more than one vegetation structure. Areas are indicative only (see Recommendations)**

Wetland class	Structure	Total area (ha)	Count
Bog	Fernland	62.5	1
	Restiadland	550.8	3
	Scrub	62.5	1
	Sedgeland	114.3	1
	Shrubland	62.5	1
Fen	Fernland	146.6	5
	Flaxland	253.4	2
	Scrub	32.4	4
	Sedgeland	0.9	2
	Shrubland	394.4	9
Marsh	Herbfield	898.5	10
	Restiadland	672.1	4
	Sandfield	172.2	1
	Sedgeland	257.0	5
	Treeland	0.3	1
Pakihi & Gumland	Fernland	73.0	2
	Mossfield	172.2	1
	Reedland	114.3	1
	Restiadland	1.9	1
	Scrub	632.1	5
	Sedgeland	310.9	4
	Shrubland	603.4	10

Wetland class	Structure	Total area (ha)	Count
Swamp	Fernland	3.8	1
	Flaxland	33.8	3
	Forest	714.3	8
	Grassland	50.9	13
	Herbfield	47.4	3
	Reedland	463.7	9
	Restiadland	84.4	3
	Rushland	7.3	1
	Scrub	242.3	8
	Sedgeland	1606.8	42
	Shrubland	393.9	16
	Treeland	287.5	9

The characteristic species for the different wetland classes in Northland (derived from available information and expert knowledge) are summarised in Table 5. The vegetation compositional differences reflect the distinctive hydrological and nutrient regimes of the classes, e.g. low nutrient gumlands and bogs with relatively small hydrological regime fluctuations, and higher nutrient swamps with larger hydrological regime fluctuations. For details on the main species composition of each vegetation type combination, including presence of rare and threatened species, see Appendix 1 and the full NRC Excel spreadsheet.

**Table 5. Characteristic species of the wetland classes in Northland. \* = introduced**

Wetland Class	Characteristic Species for Northland
Bog	<i>Empodisma robustum</i> , <i>Gleichenia dicarpa</i> , <i>Leptospermum scoparium</i> , <i>Machaerina teretifolia</i> , <i>Schoenus brevifolius</i>
Fen	<i>Coprosma tenuicaulis</i> , <i>Gleichenia dicarpa</i> , <i>Isachne globosa</i> , <i>Leptospermum scoparium</i> , <i>Machaerina arthrophylla</i> , <i>Machaerina complanata</i> , <i>Machaerina rubiginosa</i> , <i>Machaerina teretifolia</i> , <i>Phormium tenax</i> , <i>Schoenus brevifolius</i>
Marsh	<i>Alternanthera philoxeroides*</i> , <i>Apodasmia similis</i> , <i>Carex pumila</i> , <i>Carex subdola</i> , <i>Cyperus ustulatus</i> , <i>Eleocharis neozelandica</i> , <i>Glossostigma elatinooides</i> , <i>Gunnera arenaria</i> , <i>Lilaeopsis novae-zelandiae</i> , <i>Machaerina juncea</i> , <i>Myriophyllum votschii</i> , <i>Persicaria hydropiper*</i> , <i>Persicaria strigosa*</i> , <i>Sparganium subglobosum</i> , <i>Triglochin striata</i> , Other introduced species*
Pakihi & Gumland	<i>Campylopus introflexus</i> , <i>Dianella haemataca</i> , <i>Dracophyllum lessonianum</i> , <i>Epacris pauciflora</i> , <i>Gleichenia dicarpa</i> , <i>Hakea gibbosa*</i> , <i>Hakea sericea*</i> , <i>Kunzea linearis</i> , <i>Lepidosperma neozelandicum</i> , <i>Leptospermum scoparium</i> , <i>Leucopogon fasciculatus</i> , <i>Machaerina teretifolia</i> , <i>Pomaderris kumeraho</i> , <i>Schoenus brevifolius</i> , <i>Ulex europaeus*</i>
Swamp	<i>Apodasmia similis</i> , <i>Carex gaudichaudiana</i> , <i>Carex subdola</i> , <i>Coprosma tenuicaulis</i> , <i>Cordyline australis</i> , <i>Dacrycarpus dacrydioides</i> , <i>Eleocharis sphacelata</i> , <i>Isachne globosa</i> , <i>Isolepis prolifera</i> , <i>Laurelia novae-zelandiae</i> , <i>Leptospermum scoparium</i> , <i>Machaerina articulata</i> , <i>Machaerina arthrophylla</i> , <i>Phormium tenax</i> , <i>Salix babylonica*</i> , <i>Salix xfragilis*</i> , <i>Schoenoplectus tabernaemontani</i> , <i>Syzygium maire</i> , <i>Typha orientalis</i> , Other introduced species*
Shallow Water (included within Swamp class)	<i>Azolla pinnata*</i> , <i>Bolboschoenus fluviatilis</i> , <i>Eleocharis sphacelata</i> , <i>Lemna disperma</i> , <i>Machaerina articulata</i> , <i>Schoenoplectus tabernaemontani</i> , <i>Typha orientalis</i>



### **5.2.2 Monitoring and timelines**

The full draft list of 61 wetlands would require around 12 wetlands to be monitored per year on a rolling 5-year cycle. However, as many of the wetlands are very large and complex, this target may take several years to achieve, and is also dependent on the ability of NRC to increase wetland capacity and funding. Some of the monitoring could be undertaken in partnership with DOC, as 11 of these wetlands are in the DOC monitoring programme.

In the interim, a monitoring programme should focus on incorporating the higher priority wetlands according to the selection criteria, and on minimising as much duplication (e.g. in wetland class, vegetation type) as possible. For example, a wetland monitoring subset could comprise the top-ranked wetland in each Ecological District ( $n=19$ ), and additional wetlands with a Top 10 ranking ( $n=3$ ), which totals 22. Wetlands can be added from the Table 3 list according to the number of wetlands required and covering as great a range of wetland characteristics and/or gaps as possible.

A timeline for monitoring wetlands based on geographic proximity should be considered to minimise costs and increase efficiencies. For example, wetlands could be grouped according to Ecological Districts on a 1–5 yearly monitoring basis from north to south. However, this timeline may be adjusted by other considerations such as obtaining permission from landowners for access, or changes in priority as more information on conservation values becomes available. The preferred sampling season is spring–autumn, during periods of active plant growth. Re-measurement of each wetland should be undertaken at a similar time of year to minimise extraneous variables.

## **6 Conclusions**

A provisional set of 61 wetlands covering the range of wetland classes, vegetation types, regional distribution and historic extent is provided for monitoring the ecological state and trend of representative wetlands in the region. A suggested 5-year rolling system is recommended, with wetlands allocated each year based on geographic proximity, e.g. from north to south. This monitoring framework should be sufficient to enable NRC to monitor wetland condition and trend, and to identify any losses in wetland extent or values.

## **7 Recommendations**

Accurate mapping of the areas of vegetation types within the set of priority wetlands using high quality aerial photos and expert knowledge is recommended, along with incorporation of polygons as separate layers within a GIS database. Currently, most vegetation types were allocated pro rata, i.e. the area of the wetland divided by the number of vegetation types. The area and number of vegetation types are important in informing the monitoring framework to avoid duplication, i.e. which vegetation types within which wetlands should be monitored.

The next phase in the monitoring programme is to develop and refine the methodology for monitoring wetlands, i.e. establishing permanent vegetation plots, sampling design including replication and plot size, and overall condition assessment. A monitoring methodology was developed, and field tested for Bay of Plenty wetlands (Clarkson et al. 2014), which may be largely applicable to Northland wetlands.

## **8 Acknowledgements**

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## Appendix 1 – Ecological values of priority wetlands in Northland

Threatened species not listed in the vegetation type as main species are indicated in brackets. Unless otherwise known, the area of the vegetation type is allocated pro rata.

Rank	Wetland Name	Class	Structure	Main Species	ED	Area ha
1	Pouto Dune System	Swamp	Sedgeland	MACart-ELEsph	Kaipara	106.3
		Marsh	Herbfield	GUNare	Kaipara	106.3
		Marsh	Restiadland	APOsim	Kaipara	106.3
		Swamp	Reedland	TYPori	Kaipara	106.3
		Swamp	Scrub	LEPsco	Kaipara	106.3
		Marsh	Herbfield	ELEneo-TRIstr	Kaipara	106.3
2	Kaimaumu/Motutangi	Gumland	Scrub	LEPsco	Aupouri	374.0
		Bog	Restiadland	EMProb-GLEdic	Aupouri	374.0
		Fen	Sedgeland	MACter-SCHbre	Aupouri	374.0
		Swamp	Reedland	TYPori-PHOten	Aupouri	374.0
		Marsh	Restiadland	APOsim	Aupouri	374.0
3	Paranoa & Waitahora	Swamp	Reedland	TYPori	Te Paki	38.5
		Swamp	Sedgeland	MACrub-ELEacu	Te Paki	38.5
		Swamp	Shrubland	LEPsco	Te Paki	38.5
		Swamp	Sedgeland	MACart	Te Paki	38.5
		Swamp	Restiadland	APOsim	Te Paki	38.5
		Swamp	Shrubland	HIBdiv	Te Paki	38.5
		Swamp	Herbfield	THYrep	Te Paki	38.5

Rank	Wetland Name	Class	Structure	Main Species	ED	Area ha
4	Lake Ohia	Gumland	Shrubland	LEPSCO	Aupouri	114.3
		Gumland	Reedland	TYPori	Aupouri	114.3
		Gumland	Shrubland	LEPSCO	Aupouri	114.3
		Gumland	Sedgeland	LEPneo	Aupouri	114.3
		Bog	Sedgeland	SCHbre-GLEdic	Aupouri	114.3
		Bog	Restiadland	EMProb	Aupouri	114.3
		Fen	Sedgeland	MACrub	Aupouri	114.3
5	Kaihu Forest	Swamp	Forest	DACCup/SYZmai	Tutamoe	205.8
6	Maitahi Wetland Sci Res	Gumland	Shrubland	LEPSCO	Kaipara	70.0
		Gumland	Fernland	GLEdic	Kaipara	70.0
		Fen	Sedgeland	MACrub	Kaipara	70.0
		Swamp	Reedland	TYPori	Kaipara	70.0
7	Taikirau Swamp	Swamp	Forest	DACdac	Tangihua	96.3
		Swamp	Reedland	TYPori	Tangihua	96.3
		Swamp	Sedgeland	MACart	Tangihua	96.3
		Swamp	Treeland	CORaus	Tangihua	96.3
		Swamp	Forest	SALxfra	Tangihua	96.3
8	Manganui River Complex	Swamp	Forest	DACdac	Tokatoka	56.4
		Swamp	Treeland	DACdac-CORaus	Tokatoka	56.4
		Swamp	Sedgeland	CARsub-CARGau	Tokatoka	56.4
		Swamp	Sedgeland	MACart	Tokatoka	56.4
		Swamp	Reedland	TYPori	Tokatoka	56.4
		Marsh	Herbfield	PERstr-LUDpep	Tokatoka	56.4

Rank	Wetland Name	Class	Structure	Main Species	ED	Area ha
9	Ahipara Massif & Epikauri	Gumland	Scrub	LEPsco	Ahipara	172.2
		Gumland	Shrubland	LEPsco	Ahipara	172.2
		Gumland	Sedgeland	MACter-SCHbre	Ahipara	172.2
		Gumland	Mossfield	CAMint	Ahipara	172.2
		Swamp	Sedgeland	MACart-TYPori	Ahipara	172.2
		Marsh	Herbfield	TRIstr-MYRvot	Ahipara	172.2
		Marsh	Sedgeland	CARpum	Ahipara	172.2
		Marsh	Sandfield	ELNeo	Ahipara	172.2
Marsh	Restiadland	APOsim	Ahipara	172.2		
10	Kaipeha Swamp	Swamp	Reedland	TYPori	Kaikohe	79.4
		Swamp	Scrub	LEPsco	Kaikohe	79.4
		Swamp	Sedgeland	MACart	Kaikohe	79.4
		Fen	Shrubland	LEPsco/MACter	Kaikohe	79.4
11	Wairua River WMR	Marsh	Sedgeland	CARsub-CARlon	Whangarei	26.8
		Swamp	Sedgeland	ISOpro	Whangarei	26.8
		Swamp	Scrub	LEPsco	Whangarei	26.8
		Swamp	Shrubland	LEPsco	Whangarei	26.8
		Marsh	Herbfield	SPAsub-PERstr	Whangarei	26.8
		Swamp	Sedgeland	MACart	Whangarei	26.8
11	Lake Omapere & Environs	Swamp	Sedgeland	MACart-SCHtab	Kaikohe	202.3
		Marsh	Herbfield	LILnov-GLOela	Kaikohe	202.3
		Marsh	Herbfield	ALTphi	Kaikohe	202.3
		Fen	Shrubland	LEPsco	Kaikohe	202.3

Rank	Wetland Name	Class	Structure	Main Species	ED	Area ha
11	Lake Omapere & Environs	Fen	Flaxland	PHOten	Kaikohe	202.3
		Swamp	Forest	DACdac	Kaikohe	202.3
13	Otakairangi Peat Bog	Bog	Restiadland	EMProb	Whangarei	62.5
		Bog	Fernland	GLEdic	Whangarei	62.5
		Bog	Shrubland	LEPsco	Whangarei	62.5
		Bog	Scrub	LEPsco	Whangarei	62.5
14	Ngawha Geothermal Field	Gumland	Scrub	LEPsco	Kaikohe	60.3
		Fen	Fernland	GLEdic	Kaikohe	60.3
		Fen	Shrubland	LEPsco/MACcom	Kaikohe	60.3
15	Lake Rotokawau, Puwheke	Marsh	Herbfield	ALTphi	Aupouri	19.6
		Fen	Shrubland	LEPsco-PHOten	Aupouri	19.6
		Swamp	Reedland	TYPori	Aupouri	19.6
		Marsh	Restiadland	APOsim	Aupouri	19.6
		Fen	Shrubland	COPtec-LEPsco	Aupouri	19.6
16	Muriwai Stream Swamp	Swamp	Sedgeland	MACHut	Tutamoe	24.4
		Swamp	Scrub	LEPsco	Tutamoe	24.4
		Swamp	Reedland	TYPori	Tutamoe	24.4
		Swamp	Flaxland	PHOten	Tutamoe	24.4
17	Lake Humuhumu W&F	Swamp	Sedgeland	SCHtab	Kaipara	67.0
		Swamp	Sedgeland	ELEacu	Kaipara	67.0
		Swamp	Reedland	TYPori	Kaipara	67.0
		Swamp	Shrubland	LEPsco	Kaipara	67.0
18	Tarakihi Fen & Environs	Swamp	Sedgeland	MACHut	Tangihua	51.1

<b>Rank</b>	<b>Wetland Name</b>	<b>Class</b>	<b>Structure</b>	<b>Main Species</b>	<b>ED</b>	<b>Area ha</b>
18	Tarakihi Fen & Environs	Fen	Flaxland	PHOten	Tangihua	51.1
		Swamp	Sedgeland	ELEsph	Tangihua	51.1
19	Kerikeri Airport Gumland	Gumland	Sedgeland	MACter-GLEdic	Kerikeri	22.5
		Gumland	Shrubland	LEPsco	Kerikeri	22.5
		Gumland	Scrub	LEPsco	Kerikeri	22.5
20	Lake Waiparera	Swamp	Sedgeland	ELEsph	Aupouri	37.3
		Swamp	Reedland	TYPori	Aupouri	37.3
		Swamp	Restiadland	APOsim	Aupouri	37.3
		Swamp	Sedgeland	ELEsph-MACart	Aupouri	37.3
		Swamp	Shrubland	LEPsco	Aupouri	37.3
21	Te Werahi Wetland	Swamp	Reedland	TYPori	Te Paki	61.9
		Swamp	Sedgeland	MACart	Te Paki	61.9
		Swamp	Sedgeland	ELEsph	Te Paki	61.9
		Swamp	Shrubland	LEPsco	Te Paki	61.9
		Swamp	Treeland	CORaus	Te Paki	61.9
		Swamp	Reedland	TYPori	Te Paki	61.9
		Swamp	Sedgeland	MACart	Te Paki	61.9
		Fen	Sedgeland	MACHut-MACspp	Te Paki	61.9
22	Te Paki Stream	Swamp	Reedland	TYPori	Aupouri	8.6
		Swamp	Sedgeland	ELEsph-MACart	Aupouri	8.6
		Swamp	Restiadland	APOsim(OPHped)	Aupouri	8.6
		Swamp	Herbfield	LILnov-LIMlin	Aupouri	8.6
		Swamp	Reedland	TYPori	Aupouri	8.6



Rank	Wetland Name	Class	Structure	Main Species	ED	Area ha
23	Paranui Stream Swamp	Swamp	Forest	DACdac/CORaus(SYZmai)-ASTgra	Maungataniwha	9.1
		Swamp	Treeland	CORaus/PHOten-TYPori	Maungataniwha	9.1
		Swamp	Reedland	TYPori	Maungataniwha	9.1
		Swamp	Flaxland	PHOten	Maungataniwha	9.1
		Swamp	Treeland	SALbab	Maungataniwha	9.1
24	Te Arai Sandfields	Swamp	Reedland	TYPori-ELEsph-MACHut	Aupouri	3.3
		Marsh	Herbfield	GLOela(CENmin)	Aupouri	3.3
		Swamp	Scrub	LEPsco/(MAZhir)	Aupouri	3.3
		Marsh	Sedgeland	SCHtab-MACspp-APOsim(TODbar,OPHpet,CYCint,THEcon)	Aupouri	3.3
25	Opua Forest	Swamp	Reedland	TYPori	Kerikeri	10.6
		Swamp	Shrubland	LEPsco/PHOten	Kerikeri	10.6
		Swamp	Sedgeland	LEPsco/MACspp-GLEdic	Kerikeri	10.6
26	Waiwhero Stream Wetland	Swamp	Reedland	TYPori	Te Paki	2.6
		Swamp	Sedgeland	MACspp	Te Paki	2.6
		Marsh	Sedgeland	MACjun-CYPust-FICnod	Te Paki	2.6
27	Waitangi Wetland Complex	Swamp	Sedgeland	MACrub-MACspp	Kerikeri	22.9
		Swamp	Sedgeland	ELEsph-MACart	Kerikeri	22.9
		Swamp	Reedland	TYPori	Kerikeri	22.9
		Swamp	Treeland	SYZmai/TYPori	Kerikeri	22.9
		Swamp	Shrubland	LEPsco-COPtec/MACspp(KORSal)	Kerikeri	22.9
28	Taikirau Wetland	Swamp	Forest	DACdac	Tangihua	24.0
		Swamp	Treeland	DACdac/TYPori-PERspp	Tangihua	24.0
		Swamp	Forest	SALxfra	Tangihua	24.0

Rank	Wetland Name	Class	Structure	Main Species	ED	Area ha
28	Taikirau Wetland	Swamp	Reedland	TYPori-PHOten	Tangihua	24.0
		Swamp	Shrubland	COPpro-LEPsco-PHOten	Tangihua	24.0
		Swamp	Sedgeland	MACspp	Tangihua	24.0
29	Shenstone Block	Swamp	Sedgeland	MACart-ELEsph(UTRaus)	Te Paki	1.9
		Gumland	Restiadland	EMProb	Te Paki	1.9
		Gumland	Shrubland	LEPsco/MACter-GLEdic(SPInov,orchids,MACcom,TODbar)	Te Paki	1.9
		Gumland	Sedgeland	MACrub	Te Paki	1.9
30	Russell Forest	Swamp	Reedland	TYPori-PHOten	Whangaruru	33.3
		Swamp	Shrubland	LEPsco	Whangaruru	33.3
		Swamp	Sedgeland	MACspp	Whangaruru	33.3
38	Komutu Swamp	Swamp	Reedland	TYPori-PHOten	Whangaroa	7.3
		Swamp	Shrubland	LEPsco	Whangaroa	7.3
		Swamp	Treeland	CORaus/CYPust-COPspp-PHOten	Whangaroa	7.3
		Swamp	Rushland	JUNacutus	Whangaroa	7.3
44	Puketi Forest Gumland	Gumland	Shrubland	LEPsco-DRAles/GLEdic	Puketi	3.0
		Gumland	Scrub	LEPsco	Puketi	3.0
		Gumland	Fernland	GLEdic-SCHbre-MACter	Puketi	3.0
39	Awakino & Flaxmill Swamps	Swamp	Sedgeland	MACart	Tangihua	11.6
		Swamp	Sedgeland	MACart-(MACcom)	Tangihua	11.6
		Swamp	Sedgeland	BOLflu	Tangihua	11.6
		Swamp	Reedland	TYPori	Tangihua	11.6
		Swamp	Shrubland	LEPsco-PHOten-MACart-TYPori	Tangihua	11.6
		Swamp	Reedland	TYPori	Tangihua	11.6

Rank	Wetland Name	Class	Structure	Main Species	ED	Area ha
	Aratoro Stream Bush	Gumland	Shrubland	LEP <sub>sco</sub> -COP <sub>pro</sub> -DRA <sub>les</sub> -GLE <sub>dic</sub>	Kaikohe	7.2
	Punahaere Creek Fen	Fen	Fernland	LEP <sub>sco</sub> /GLE <sub>dic</sub> (SCH <sub>car</sub> )	Kaipara	16.0
	Andries	Swamp	Sedgeland	SCH <sub>tab</sub> /LOT <sub>ped</sub>	Whangarei	0.6
		Fen	Sedgeland	CAR <sub>Ing</sub> /ISA <sub>glo</sub>	Whangarei	0.6
	Putt/Bell	Swamp	Sedgeland	MAC <sub>rub</sub>	Whangarei	0.3
		Marsh	Treeland	POD <sub>tot</sub> /BLE <sub>nov</sub>	Whangarei	0.3
		Swamp	Reedland	TYP <sub>ori</sub> -ISA <sub>glo</sub>	Whangarei	0.3
	Duffy	Swamp	Scrub	LEP <sub>sco</sub>	Manaia	0.1
		Swamp	Sedgeland	MAC <sub>art</sub>	Manaia	0.1
	Gatenby	Swamp	Grassland	PAS <sub>spp</sub> -JUN <sub>eff</sub>	Whangarei	0.2
	Guleray	Fen	Shrubland	LEP <sub>sco</sub> -COP <sub>tec</sub>	Kerikeri	0.7
		Fen	Shrubland	LEP <sub>sco</sub> /BLE <sub>nov</sub>	Kerikeri	0.7
		Fen	Scrub	LEP <sub>sco</sub> -GLE <sub>dic</sub>	Kerikeri	0.7
55	Hansen	Fen	Sedgeland	CAR <sub>Ing</sub> -ELE <sub>sph</sub>	Waipu	0.4
		Fen	Scrub	LEP <sub>sco</sub> (SPH <sub>sp</sub> )	Waipu	0.4
	Harman	Swamp	Reedland	TYP <sub>ori</sub> -SCH <sub>tab</sub> /AGE <sub>eade</sub>	Whangaruru	0.8
		Swamp	Grassland	ISA <sub>glo</sub> /LOT <sub>ped</sub>	Whangaruru	0.8
		Swamp	Grassland	ISA <sub>glo</sub> -PAS <sub>urv</sub>	Whangaruru	0.8
		Swamp	Grassland	ISA <sub>glo</sub> -SCH <sub>tab</sub> -AGE <sub>eade</sub>	Whangaruru	0.8
		Swamp	Grassland	ISA <sub>glo</sub> -SCH <sub>tab</sub>	Whangaruru	0.8
	Hawken	Swamp	Grassland	PAS <sub>dis</sub>	Whangaruru	1.0
		Swamp	Sedgeland	ELE <sub>acu</sub> -ISO <sub>glo</sub>	Whangarei	1.0
170	Curtis	Swamp	Reedland	TYP <sub>ori</sub> -BOL <sub>flu</sub>	Waipu	19.6

Rank	Wetland Name	Class	Structure	Main Species	ED	Area ha
	Kippenberger	Swamp	Shrubland	LEPsco/ISAglo	Whangaruru	0.5
		Swamp	Treeland	(SYZmai)/LEPsco	Whangaruru	0.5
	Matheson	Swamp	Grassland	PASdis-LOTped	Waipu	0.4
		Swamp	Sedgeland	MACrub-ISAglo-SCHtab	Waipu	0.4
		Swamp	Reedland	TYPori	Waipu	0.4
		Swamp	Flaxland	PHOten-MACrub-PAEscala	Waipu	0.4
	Pirihi	Swamp	Scrub	(KUNrob)	Waipu	1.0
		Swamp	Scrub	LEPsco	Waipu	1.0
	Cox	Swamp	Sedgeland	MACrub	Whangaruru	0.3
		Swamp	Sedgeland	ELEacu	Whangaruru	0.3
57	Sime Rd	Swamp	Sedgeland	ELEsph	Waipu	0.5
71	Stone	Swamp	Grassland	IASglo-TYPori	Kaikohe	3.8
		Swamp	Fernland	PTEesc-LAUnea-MACrub	Kaikohe	3.8
	Tapuwae 1	Swamp	Shrubland	LEPsco/APOsim	Hokianga	4.5
	Tapuwae 2	Swamp	Shrubland	COPpro-LEPsco	Hokianga	4.5
	Tapuwae 3	Swamp	Reedland	TYPori	Hokianga	4.5
	Tapuwae 4	Swamp	Shrubland	LEPsco/TYPori	Hokianga	4.5
	Tapuwae 5	Swamp	Reedland	TYPori	Hokianga	4.5
	Waterhouse	Swamp	Sedgeland	CARsec-TYPori	Whangarei	0.8
		Swamp	Reedland	TYPori-PERhyd	Whangarei	1.2
	Whyte 1a	Swamp	Grassland	ISAglo	Whangaroa	9.9
	Whyte 1b	Swamp	Grassland	ISAglo-MACrub	Whangaroa	9.9
	Whyte 1c	Swamp	Grassland	ISAglo-ELEacu	Whangaroa	9.9

Rank	Wetland Name	Class	Structure	Main Species	ED	Area ha
	Whyte 2	Swamp	Sedgeland	MACrub-ISAglo	Whangaroa	9.9
	Whyte 3a	Swamp	Grassland	ISAglo	Whangaroa	9.9
	Whyte 3b	Swamp	Sedgeland	MACrub-ISAglo	Whangaroa	9.9
151	Whakakoro	Gumland	Shrubland	LEPsco	Ahipara	49.0
		Gumland	Shrubland	LEPsco	Ahipara	49.0
	Gillanders	Marsh	Herbfield	PERhyd-PASdis	Kerikeri	3.0
		Swamp	Grassland	ISAglo-ELEacu	Kerikeri	3.0
	Tāika /Mount Tiger	Swamp	Reedland	TYPori	Whangaruru	0.3
		Swamp	Herbfield	AGEade-TYPori-ISAglo	Whangaruru	0.3
	King Road Saltmarsh	Fen	Fernland	GLEdic-MACspp	Rodney	39.0
188	Hautakima South Forest	Swamp	Reedland	TYPori	Otamatea	2.0
49	North Cape Scientific Res.	Marsh	Sedgeland	LEPneo-GLEdic-SCHbre ((PTEpub), (TODbar), rare orchids)	Te Paki	52.2
51	Te Paki Shrublands/Forests	Fen	Scrub	LEPsco	Te Paki	25.0
		Fen	Shrubland	LEPsco	Te Paki	25.0
		Fen	Fernland	GLEdic	Te Paki	25.0
		Fen	Sedgeland	MACspp (LEPneo)	Te Paki	25.0
149	Te Hapua Wetland	Fen	Scrub	LEPsco	Te Paki	6.3
		Fen	Shrubland	LEPsco	Te Paki	6.3
		Fen	Fernland	GLEdic	Te Paki	6.3
		Fen	Sedgeland	MACspp (LEPneo)	Te Paki	6.3