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HAWKE'S BAY REGIONAL COUNCIL

SAFEGUARDING YOUR ENVIRONMENT + KAITIAKI TUKU IHO

Wetland Monitoring Review

A Review of Hawke Bay Regional Council's Wetland Monitoring

October 2008
EMT 08/09
HBRC Plan No. 4076

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Environmental Management Group
Technical Report

Environmental Science

Wetland Monitoring Review

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EXECUTIVE SUMMARY

Regional Councils have are required by the RMA to sustainably manage wetlands through rules and policies in their Regional Plans.

The Hawke's Bay Regional Council has set out clear direction in its policy statement, Regional Resource Management Plan and Proposed Coastal Environment Plan to improve the environmental conditions of priority wetlands and prevent the further loss of ecologically significant wetlands. As a result of this and to measure the effectiveness of its policies the Regional Council undertakes bi-annual ecological monitoring of wetlands previously selected by the Department of Conservation as the 'best' wetlands in Hawke Bay that would benefit from restoration and enhancement works (Lake Hatuma, Lake Oingo, Lake Runanaga, Pekapeka Swamp, Tukituki Estuary, Waitangi Estuary, Whakaki Lagoon and Whakamahia Lagoon).

To build an inventory of wetlands in Hawkes Bay, a wetland database was adopted from Environment Bay of Plenty which aimed to document wetlands in Hawke's Bay larger than 0.5ha as identified by Council Land Management Officers, Department of Conservation and Fish and Game representatives.

This document is the result of a review of our current wetland monitoring and enhancement programme and aims to;

- assess how well the current programme addresses out objectives and policies in the RRMP & RCEP;
- look at how well our programme fits with national protocols; and
- address how the current programme can be developed to provide a more comprehensive and representative monitoring programme that will report on the state of Hawke's Bay wetlands

Conclusions drawn from the review are that the current monitoring undertaken by the Regional Council does not effectively measure the policies set out in the RPS, RRMP, PCEP. This is due to the subset of wetlands selected for inclusion in the programme, survey techniques and the timescales for monitoring. Data obtained from the ecological surveys limits the possibilities of data analysis and does not provide Council with a way to measure the effectiveness of restoration efforts or isolate areas of concern.

The Ministry for the Environment along with a steering group of wetland experts have developed a useful tool to monitor the state of New Zealand's wetland ecosystems. It provides end users with a consistent, national protocol to enable comparisons to be made with other regions using the methodology. Using this approach would provide the Regional Council with a robust, semi-quantitative methodology to actively score the condition of the wetland to detect changes in wetland condition and effectively detect trends, both at the landscape scale and regional scale. This will prove to be an invaluable tool to drive management practices and mitigate against adverse affects.

Contents

1.0 INTRODUCTION

Wetlands are diverse ecosystems that support a range of aquatic and terrestrial species and so have high species diversity. The most widely used definition of a wetland appears in the Resource Management Act (R.M.A, 1991) and states;

"Wetlands include permanently or intermittently wet areas, shallow water and land water margins that support a natural ecosystem of plants and animals that are adapted to wetland conditions"

The vast majority of New Zealand's wetlands have been drained or irretrievably modified for coastal land reclamation, farmland, flood control, and the creation of hydro-electricity reservoirs. This occurred mostly between 1920 and 1980 but still continues to a limited degree in some areas (MfE, 1997).

Regional Councils are required by the RMA to sustainably manage these areas through rules and policies in their Regional Plans. The Hawke's Bay Regional Council's Regional Resource Management Plan (RRMP) addresses these obligations through Objective 15 which states;

"The preservation and enhancement of remaining areas of significant indigenous vegetation, significant habitats of indigenous fauna and ecologically significant wetlands"

The Department of Conservation prepared a report (Adams, 1995) which aimed at highlighting the ten "best" wetlands in Hawke Bay that would benefit from restoration and enhancement work. The list was prepared by taking into consideration existing threats to the wetlands, cultural values and the suitability of the areas for enhancement. The recommendations provided by the Department of Conservation prompted the initiation of the Wetland Monitoring and Enhancement programme, which has been running from 1995 to the present day. To date this is the only wetland monitoring that the regional council has undertaken

In 2003 a National protocol was developed to provide a more consistent way of monitoring wetland extent and condition. Phase I of the Ministry for the Environment SMF funded project aimed to develop a nationally consistent methodology for mapping and monitoring New Zealand's wetlands (Ward & Lambie, 1999). Phase 2 of the project builds on Phase 1 and consists of three main parts;

- developing science-based indicators for wetland condition, and producing a handbook for managers (Clarkson et al, 2003)
- developing a generic set of matauranga Maori-based indicators for wetland condition and trend; and
- producing an illustrated field guide and key to national wetland classification developed in Phase 1

The wetland monitoring and enhancement programme has been running for twelve years now and in light of the development of national protocols it seems appropriate to review our current programme to;

- assess how well the current programme addresses out objectives and policies in the RRMP & RCEP;
- look at how well our programme fits with national protocols; and
- address how the current programme can be developed to provide a more comprehensive and representative monitoring programme that will report on the state of Hawkes Bay wetlands

2.0 STATUTORY REQUIREMENTS

New Zealand is obliged to monitor the health and condition of wetlands as a signatory to two international conventions. As one of the first nations to sign up to the RAMSAR convention and to also be a signatory of the Convention on Biological Diversity, New Zealand must, as a nation, show a coordinated approach to how it monitors wetland extent and condition. The responsibility of meeting these obligations is shared between the Department of Conservation and The Ministry for the Environment. Local Authorities also have an obligation under the Resource Management Act 1991 (RMA91) to monitor the state of the environment "*to the extent that is appropriate to enable the local authority to effectively carry out its function under this Act*" S 35 2 (a).

2.1 Regional Policy

The Hawkes Bay Regional Policy Statement (2006) addresses the need to protect indigenous vegetation and wetlands (Objective 15), and identifies the maintenance and enhancement of wetland water quality (Objective 27) as being of regional significance. The Regional Council is committed to achieving these objectives and has set clear direction in its policy statement to improve the environmental conditions of priority wetlands and prevent the further loss of ecologically significant wetlands, (Table 2.1)

Table 2.1, Anticipated Environmental Results, HBRC (2006)

Anticipated Environmental Result	*Indicator*	*Data Source*
No further loss of ecologically significant wetlands	Extent of wetlands in the region	Council GIS data
Improvements in environmental conditions of priority wetlands	Condition of priority wetlands in the region	Site monitoring

Wetlands are usually part of a larger system, recharging groundwater and buffering surface water systems. The Hawkes Bay Regional Resource Management Plan (RRMP) became operative in 2006 which details the policy framework for protecting surface water quality (Policy 71), quantity (Policy 77) and groundwater quality (Policy 75) and quantity (Policy 76).

The Hawkes Bay Proposed Coastal Environment Plan (2008) provides another mechanism for the protection of wetlands within the 'Coastal Margin' (area from MHWS to the landward boundary). The plan set out a framework to promote the restoration and rehabilitation of the coastal environment's natural character (policy 2-10) and to protect the indigenous species and habitats within the coastal environment by protecting the ecological values of existing wetlands (policy 4-3)

The Regional Council also encourages non regulatory measures to enhance and protect wetland ecosystems through liaison with appropriate territorial authorities for establishment of mechanisms within their district plans.

3.0 THE HAWKES BAY REGIONAL COUNCIL'S WETLAND MONITORING AND ENHANCEMENT PROGRAMME.

The wetland monitoring and enhancement programme has been running since 1995 after the report by the East Coast conservancy highlighted the ten wetlands within Hawke Bay that would most benefit from enhancement works. Wetlands were chosen by rating each of the wetlands in terms of their ecological values by interrogation of the Sites of Special Wildlife Interest (SSWI) and Wetlands of Ecological and Representative Importance (W.E.R.I) databases (Appendix II). Of these wetlands, eight were included in the monitoring and enhancement programme.

Figure 3.1: Prioritised wetlands and their locations

3.1 Whakaki Lagoon

Whakaki Lagoon is situated South-East of Wairoa township adjacent to state highway 2. This wetland remains an area of significant ecological importance in the Hawke's Bay region and as such has been the recipient of substantial restoration efforts using both public and private resources. It provides habitat for regionally important waterfowl and wader species such as the Australasian Bittern *Botaurus poiciloptilus* and also provides habitat for the secretive Marsh Crake *Porzana pusilla* and Spotless Crake *Porzana tabuensis* and provides roosting for a small population of Royal Spoonbill *Platalea regia* found in Hawkes Bay. Due to the high ecological values associated with the lake it has been listed by the Department of Conservation as a Recommended Area for Protection under the Protected Natural Areas Programme.

The lagoon has undergone considerable historical modifications through burning, mechanical clearance and the impact of farm stock which have all altered the natural vegetation patterns (HBRC, 2009). Since monitoring began in 1999 the impact of these modifications has been reduced. The exclusion of stock from the majority of the wetland edges has enabled regrowth of the turf communities and the restoration efforts through planting of regionally significant native species and pest control has enabled the wetland to be restored to a more natural state.

The lake is managed by the Lake Whakaki Trust, a local Maori community involvement group who carry out essential pest control of rabbits, cats, hares and possums and restoration planting on and around the lake margins. This has shown a vast improvement in the ecological values of the lake (HBRC, 2005, 2007).

Figure 3.1.1: Royal spoonbill on eastern channel at Whakaki Lagoon (Cameron, 2007)

3.2 Pekapeka swamp

Pekapeka swamp is located approximately 12km south-west of the city of Hastings. This is a palustrine wetland with inputs of groundwater, and surface water from Poukawa Stream. It is a remnant of a much larger system covering most of the Poukawa basin.

This wetland has undergone hydrological modifications caused by drainage in the upper catchment. This has provided a habitat for the fast growing dry-land plants to invade, as has been seen through the infestation of crack willow which has altered the hydrological integrity of the wetland through evapotranspiration (Williams, 2001). Reduced water levels and associated fish passage have been a problem for diadromous fish species such as inanga *Galaxius maculatus* and both the longfinned and shortfinned eels *Anguilla spp*

Since monitoring began in 1998, and with the development of a management plan for restoration of the swamp, the wetland has improved considerably. By installing a weir and increasing the water levels in the wetland, and through aerial spraying, the willow infestation has been mostly controlled. The restoration of the hydrological integrity of the wetland has seen eel numbers increase in 2007 (Cameron, 2008). Fencing to exclude stock animals has helped restoration efforts. A management plan is still in place for this wetland which envisages the enhancement of the wetland through further pest control and restoration plantings of regionally significant species. Pathways and educational material are to be constructed at the swamp to provide members of the public with an educational and recreational resource.

Figure 3.2.1: Regeneration of Raupo and open water areas at Pekapeka Swamp (Cameron, 2008)

3.3 Lake Hatuma

Lake Hatuma is located on the southern edges of the township of Waipukarau. It is a shallow, oval-shaped, low lying lake situated in a shallow basin amongst flat to undulating pasture. The lake has a surface area of about 150 hectares (HBRC, 2000) and adjacent wetland margins of an additional 76 hectares.

The lake has high ecological value as it supports a wide range of wader and waterfowl species, most notably Bittern, which has been present in the adjacent swamps since the 1950's (Wilson 1950 in HBRC, 2000), the Marsh crake and Spotless crake. The 'threatened' NZ Dabchick is reported to accumulate on the lake in the winter months (Adams et al.1998 in HBRC 2000). As a result of its high ecological values the lake is listed by the Department of Conservation under the Protected Natural Areas Programme to be a Recommended Area for Protection (Maxwell et al, 1993).

Maori have strong cultural values associate with the lake, using it as a food source. There are numerous archaeological remains of middens, pits and tools used by local Maori and it is believed to once have been a considerable population of Maori around Hatuma.

The lake is privately owned by a number of owners. The Hawkes Bay Regional Council developed a management plan aimed at restoration and rehabilitation of the lake through plantings and raising the water level in the lake (HBRC, 2000). This was met with contention by some of the local landowners and as such was not realised. Currently there is no management plan for Lake Hatuma.

Figure 3.3.1: Waterfowl and wader accumulations on Lake Hatuma (Cameron, 2008)

3.4 Lake Oingo

Lake Oingo is a shallow lake located close to Fernhill in the Heretaunga ecological district. It has an approximate surface area of 80 hectares and adjacent wetland margins of about 78 hectares. (Cairns, 2002). The lake is privately owned and there is no public access.

The lake supports both introduced waterfowl species (black Swan, mallard) and native waterfowl (NZ scaub, grey teal, pukeko, paradise shellduck). There is also a strong eel population and commercial eel fishing occurs. The Department of Conservation have listed it as a Recommended Area for Protection under its Protected Natural Areas Programme (Lee, 1994).

Historically the lake has received high nitrogen and phosphorous loadings, due to the predominantly pastoral land use associated with the catchment. The lack of fencing from stock in the 80's and lack of riparian vegetation has led to the lake being in a highly eutrophic state. (Hooper 1987 in Cairns, 2002).

The lake has strong cultural values associated with it and as a result is described in the Hastings district plan (HDC, 2008) as being 'Waihi Tapu' due to the potential burial sites along the lake and margin.

A management plan was developed by the Hawkes Bay Regional Council in 2002 to be used as a guide to the long term management of the lake. The period of this plan ended in 2006 and to date there is no management plan for Lake Oingo.

The conclusion drawn from the ecological surveys, initiated in 2002 and repeated bi-annually, is that the lake is in a moderately natural state but is neither improving nor deteriorating overall at this stage. There are concerns that uncontrolled commercial eeling operations have reduced eel numbers considerably and may also be contributing to the presence of the aquatic weed, water net (Lamason, 2006)

Figure 3.4.1: Surrounding vegetation and land use at Lake Oingo (Lamason, 2006)

3.5 Lake Runanga

Lake Runaga is a small, shallow lake located 4km west of Fernhill in the Heretaunga ecological district. It has an approximate surface area of 95 hectares and a catchment of 856 hectares. The lake is privately owned and there is no public access to the lake.

Due to its proximity to Lake Oingo, Runanga demonstrates the same issues with water quality as its neighbour (Cairns, 2001). It also demonstrates the same ecological values as Lake Oingo and supports a wide range of both introduced and native waterfowl. Spotless crake and Bittern are also present. The lake supports a large eel population and commercial eel fishing occurs.

As with Lake Oingo, the lake has strong cultural values associated with it and as a result is described in the Hasting district plan (HDC, 2008) as being 'Waihi Tapu' due to the potential burial sites along the lake and margin.

A management plan was developed by Hawkes Bay Regional Council in 2001 (Cairns, 2001) aimed to direct restoration and management practices for the lake. The period of this plan ended in 2006 and to date there has not been an updated management strategy.

The conclusion drawn from the ecological surveys, initiated in 2002 and repeated bi-annually, is that the lake is in a moderately natural state but is neither improving nor deteriorating overall. Unlike Lake Oingo, eeling operations are controlled as is evident by the differing size classes of eels caught in the surveys (Lamason, 2006).

Figure 3.5.1: Surrounding vegetation and land use at Lake Runanga (Lamason, 2006)

3.6 Tukituki Estuary

Tukituki Estuary is located approximately 9km south of Napier at the point where the Tukituki River flows into the sea. The Tukituki Estuary has undergone considerable works to control storm water which has had a deleterious effect on the ecology of the estuary. The Tukituki once joined with two other major rivers in the region; the Tutaekuri and the Ngaruroro forming a complex of coastal lagoons which are now all engineered to prevent surface flooding.

The estuary still supports a wide array of both native and introduced species of waders and waterfowl as well as being an important spawning ground for the native galaxid species. Due to the ecological values associated with the species of fish and birds that it supports it has been recognised and selected as a Recommended Area for Protection under the Department of Conservations Protected Natural Areas Programme (Lee, 1994).

A management plan was developed in 2002 (Walls, 2002) to direct restoration and management techniques for the estuary. The term of this plan ended in 2007 and there is no update available to date.

The conclusion drawn from the ecological surveys, initiated in 2002 and repeated bi-annually, is that the Tukituki Estuary is in a low-moderate natural state and is stable or improving in most key aspects.

Figure 3.6.1: Vegetation characteristics of the Tukituki Estuary (Lamason, 2006)

3.7 Waitangi Estuary

The Waitangi Estuary is located approximately 5km south of Napier. It is formed where two rivers, the Tutaekuri and the Ngaruroro, meet at their mouths before flowing out to sea. This would also have been part of the wider coastal lagoon complex before engineering works began.

As is the same with the Tukituki Estuary, The Waitangi Estuary has undergone considerable harmful ecological changes due to the channelling of the rivers and artificial stop bank construction to control floodwaters and protect nearby pasture (Walls, 2000).

The estuary still supports a wide array of both native and introduced species of waders and waterfowl as well as being an important spawning ground for the native galaxid species. Due to the ecological values associated with the species of fish and birds that it supports it has been recognised and selected as a Recommended Area for Protection under the Department of Conservations Protected Natural Areas Programme (Lee, 1994). It has been given the highest ecological ranking in the Heretaunga District and has become an example of successful protection of whitebait spawning sites (Rook, 1994 in Walls, 2000).

A management plan was developed by Regional Council in 2002, designed to direct and aid restoration efforts for the estuary. The plan ended in 2007 and to date there is no update available.

The conclusion drawn from the ecological surveys, initiated in 2000 and repeated bi-annually, is that the Waitangi Estuary is in a low-moderate natural state. The engineering of whitebait spawning areas has improved fish populations and the area is highly significant for native freshwater and estuarine fish species (Lamason, 2006)

Figure 3.7.1: Riparian vegetation and waterfowl accumulations at Waitangi Estuary (Lamason, 2006)

3.8 Whakamahi/ia Lagoon Complex

Whakamahi Lagoon is situated just North of the Wairoa township. It is part of a complex system of lagoons that would once have extended north up the coast to Whakaki Lagoon. Maori history confirms that Whakamahia is the deeper lagoon by Pilot point and Whakamahi the shallower water body to the west (Cheyne & Addenbrook, 2002). The lagoons, associated sandspit and tidal flats are connected to the Wairoa River. The bar is highly mobile and as such the outlet changes considerably (Walls 2005, Cameron, 2008)

The lagoons support a wide range of introduced and native waders and waterfowl and are ranked highly by both the Department of Conservation and the Hawkes Bay Regional Council for its biodiversity values (Cheyne & Addenbrook, 2002). The entire Wairoa Estuary area including the lagoons, sandspit and mudflats is a Wildlife management reserve managed by the Department of Conservation pursuant to the Reserves Act 1977 and Conservation Act 1987.

A management plan was developed by Hawkes Bay Regional Council in 2002, aimed at directing management of the Lagoon areas. The plan term ended in 2007 and to date there is no update available.

The conclusion drawn from the ecological surveys, initiated in 2003 and repeated bi-annually, is that the wetland is not in a natural state but has a stable trend in condition of key aspects. Human disturbance along the spit bar has proved to be problem for ground nesting birds and as such the condition indication for bird species is low (Cameron, 2008). There is no significant difference in condition of this wetland from the initiation of monitoring.

Figure 3.8.1: Whakamahi and Whakamahia lagoons (Cameron, 2008)

4.0 MONITORING METHOD

The monitoring programme was designed by a consultant Ecologist to encompass a wide range of monitoring techniques aimed to provide a detailed baseline of the ecological condition of the wetland. Each wetland was assigned a series of permanent photo points which aimed to ensure a complete coverage of the entire wetland. These were used to provide a visual representation of the temporal change in vegetation patterns. At each of these photo points a brief description of the vegetation was provided. Transects were initially included in the monitoring to provide detailed data on the structure of the vegetation through important vegetation zones. In addition, permanent vegetation plots were established. In 2007 a decision was made to abandon this component of the monitoring programme due to time constraints and difficulty of access.

To monitor the aquatic fauna, aquatic sampling sites were set up to record the fish and macro-invertebrate species present in the wetland. Fish were sampled by setting up hinaki and minnow traps which were baited and left overnight to trap the fish species and fish numbers were recorded. At these sites macro-invertebrates were sampled using the protocol for soft bottomed streams (Stark et al, 2001).

Terrestrial species were recorded as part of the monitoring programme. Bird counts provided data on the presence of waterfowl and wader species present as well as non specialised species using the terrestrial vegetation zones. At present there is no method for the identification of terrestrial invertebrates or lizards. Pest species were also monitored and noted in the monitoring.

The monitoring enables recommendations to be made to provide managers with direction in restoration and enhancement of the ecological values in the wetland through management practices such as fencing to exclude stock, pest control, invasive species management through spraying/removal, etc.

4.1 Monitoring Frequency

The monitoring programme was first established in Pekapeka swamp in 1998. Monitoring was repeated yearly until 2001, when the frequency was changed to bi-annual monitoring. In 1999 Whakaki lagoon and Lake Hatuma were included in the bi-annual monitoring, Waitangi Estuary in 2000, Runanga Lake in 2001, Oingo Lake and Tukituki Estuary in 2002 and Whakamahi/mahia Lagoon complex finally in 2003.

4.2 State of the Environment (SOE) Reporting

Data obtained from the monitoring programme is used to report on the State of the Environment of Hawkes Bay wetlands. The primary purpose of state of the environment reporting is to communicate accurate information about the condition of the New Zealand environment to people who make decisions about natural resource use and management. State of the environment reporting aims to provide information that can answer the following questions:

- What is happening to the environment?
- Why is it happening?
- Are policies and actions having the desired effect?

The wetland monitoring programme has formed a basis for SOE reporting on wetlands. Reports are produced detailing the findings from the monitoring and comparisons given to previous years surveys. The format is a qualitative assessment of the vegetation at each of the photo points, transects and vegetation plots. Semi-quantitative assessments of the aquatic flora and fauna are reported. It is on this basis that a basic assessment of the status and condition of each of the parameters monitored is reached and an overall condition and trend rating is concluded. The status or condition scores are rated as Low to High and the trend scores rated as improving stable or deteriorating (Table 4.1).

Table 4.1: State of the Environment (SOE) monitoring and reporting table, Walls (2005)

Indicator	Status/Condition (**H**igh, **M**edium, **L**ow	Trend (**I**mproving, **S**table, **D**eteriorating)
Native vegetation	M	I
Native flora	M	S
Native birds	H	S-I
Native fish	L-M	S
Native macroinvertebrates	M	S
Water levels	M	S
Water flows	M	S
Water quality parameters	?	?
Overall ecology	**M**	**S-I**

5.0 WETLAND DATABASE

An in house wetland database was adopted from Environment Bay of Plenty (EBOP) by council to provide an inventory of the extent and state of wetlands in Hawkes Bay. The database was originally designed and commissioned by EBOP in 2000 (Stuart, 2000) and a later updated edition was adopted by council in 2003/04.

The aim of the inventory was to document wetlands in Hawke's Bay larger than 0.5ha as identified by Council Land Management Officers, Department of Conservation and Fish and Game representatives.

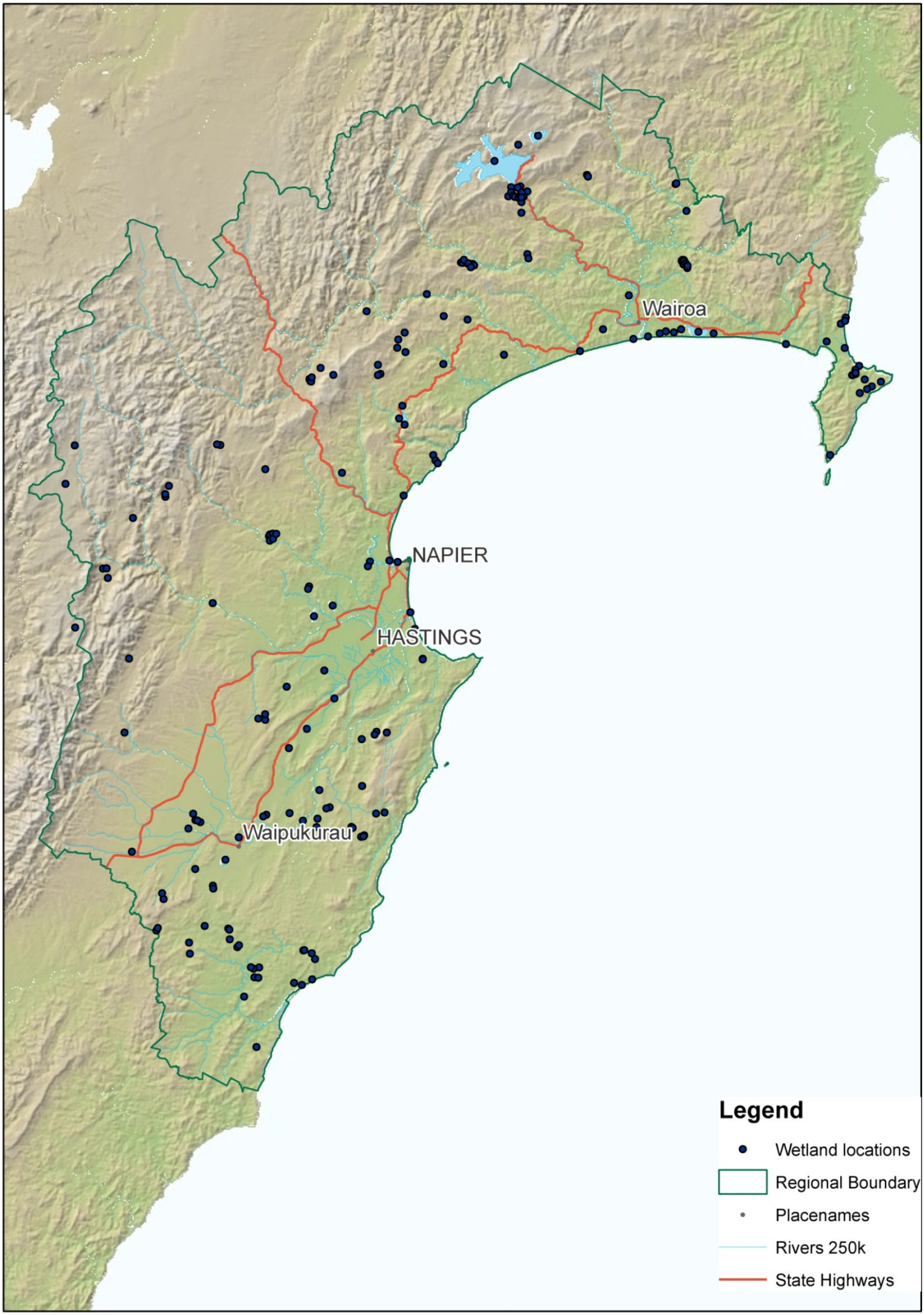
5.1 Wetland Information

The database holds information on 174 regional wetlands (Map 5.1). The database's main table holds information on the wetland name, geographical location, ecological district, catchment, game bird district and district council whose jurisdiction it falls. From the main table there are links to other tables that hold information on the wetlands ecological and hydrological characteristics, location and threats or pressures on the wetland.

Ecological information sources range from surveys conducted from the Protected Natural Areas Programme (Lee, 1994, Maxwell et al. 1993 and Whaley et al. 2001) as well as surveys undertaken by Regional Council staff. The Protected Natural Areas Programme identified 35 wetlands to be Recommended Areas for Protection; 21 within the Tiniroto, Waihua, Mahia and Matawai ecological district, 5 within the Eastern Hawke's Bay ecological district and 9 within the Heretaunga ecological district.

In 2004 a "ground truthing" exercise was carried out by staff to record the vegetation patterns present in each of the remaining wetlands and record the pressures and threats associated with these. This phase of data collection was due for completion in 2006.

To date the wetland database is incomplete and the information it holds, in an inconsistent format. Surveys conducted as part of the Department of Conservation's Protected Natural Areas Programme have the results stored in a qualitative and conversational format. The results of surveys from the staff at the Regional Council conducted in 2004 have been stored in the format of Atkinson's Structural Classification. Due to this, and the overall structure of the database, it has become redundant with no information being updated and no access to external interested parties has meant that the information has not been disseminated.



Map 5.1 Wetland locations extracted from the Wetlands Database

6.0 MFE'S WETLAND EXTENT AND CONDITION PROJECT

MfE, along with a steering group of wetland experts in New Zealand have developed a protocol to monitor wetland extent regionally and locally and together they have developed a set of science-based indicators to enable the coordinated monitoring of wetland condition. The indicators have been developed and a handbook designed aimed at managers, landowners, community groups and anyone else with a need to monitor the condition of wetlands. This section gives a summary of the monitoring handbook detailing the indicators and the methods involved in monitoring.

6.1 The Wetland Record Sheet

Five indicators were identified with each indicator being made up of a number of components and scored on a 0-5 scale, with 5 representing the least modified or best condition. The scores are based on the information obtained in the field and guidance has been provided in the handbook on the allocation of scores for each of the components (Appendix I).

6.1.1 The Indicators

The indicators are scored on the record sheet (appendix II) and the indicator score averaged to produce a sub-index indicator score, which is totalled to provide an overall index that represents the condition of the wetland. The indictors are scored for the wetland as a whole and are listed below:

1. Change in hydrological Integrity
2. Change in physiochemical parameters
3. Change in ecosystem intactness
4. Change in browsing, predation and harvesting regimes
5. Change in dominance of native plants.

As indicated in the handbook the changes are estimated against baselines that would have existed before heavy modification, hence pre-European settlement.

1. Change in Hydrological integrity

As indicated in the handbook the hydrological integrity of the wetland is important in determining the degree of modification that has occurred. Indicator components to measure this are included on the record sheet and are listed below. Each of these components is to be scored on the 0-5 levels to determine the wetland condition index for this indicator.

a) The impact of manmade structures
b) Water table depth
c) Dryland plant invasion

This is the hardest of the indicators to measure and determine any trends from just one site visit so repeated monitoring is recommended to obtain results that can be used to analyse hydrological integrity over time. Season fluctuations in water table depth can affect the results but long term monitoring of the indicator will enable these spikes and fluctuations to be smoothed to build up an overall picture of the wetland hydrological integrity and condition. A cost effective way of measuring the water table in the wetland would be to install staff gauges. The equipment itself is not very expensive and staff installation time would be minimal.

As discussed in the handbook the presence or absence of dry land species can be used as an indicator of the changes in the hydrology of a wetland. If there is an invasion of Willow

species as has been seen in Lake Hatuma and Peka peka wetland (Walls 2005, Cameron 2008) this can be a very good indication of a drop in the water table.

2. Change in Physiochemical Parameters

Changes in physiochemical parameters can indicate the degree of modification of the wetland by fire damage, erosion of sedimentation, increase or decrease in nutrient levels and peat accumulation.

Fires can occur naturally in a wetland and some wetland plant species are tolerant to fire and rhizomatous species can be early to regenerate after a fire event (Timmins, 1992). Other plants will use the burnt areas to recolonise (ibid). Most of the fires in wetlands however are anthropogenic and can cause a great amount of damage to the plants and animals that live there (Clarkson et al. 2003).

Sedimentation in a wetland can occur from direct run off from surrounding land and this can also lead to an increase in nutrients. As has been discussed in the handbook there will be some overlap and interdependence of some of the indicator components but this will further emphasise the issues that are most serious threats to the wetland system.

3. Change in Ecosystem Intactness

Changes in the ecosystem can be determined by mapping the original wetland extent to determine the loss in area of the original wetland. This will enable any changes to be detected and scored accordingly. This indicator does not include species composition changes but only the loss or gain of the area of the wetland.

The connectivity of the wetland to wildlife corridors for the distribution and migration of species between ecological patches will determine the species that will be present in the wetland. In addition to these corridors the presence or absence of rivers and streams which act as natural migratory pathways for fish species will determine the fish species. An absence of these connective pathways will result in the reduction of species and as stated in the handbook small fragmented populations are vulnerable to extinction, especially through habitat loss and disruption of life support systems. Fragmentation will also affect the areal or overland dispersal of species with low dispersal capabilities.

4. Change in Browsing, Predation and Harvesting Regimes

As stated in the handbook, the presence of introduced animals can cause damage that results in changes in community structure, and species composition and abundance, which facilitate invasion of weeds and pests, and loss of intolerant species.

Large animals such as cattle and sheep can cause a huge amount of damage to a wetland through the browsing of the vegetation and the trampling of the plants and wetland soils. They are however easy to recognise in the wetland monitoring and the threat can be managed through appropriate fencing to exclude them.

Other smaller animals can be much more difficult to detect due to them being shy, wary or nocturnal. The presence of their droppings can be a good indication that they are there and liaison with bio security expects will enable the more detailed numbers that are expected to be found in the wetland of interest.

5. Change in Dominance of Native Plants

Changes in species composition in a wetland can affect the plants that grow there. Larger canopy species will cause shading of the wetland which may change the ground flora to more shade tolerant species which are not typically a wetland species. As discussed in the

handbook palustrine wetlands of relatively high fertility, e.g. swamps and fens, are particularly vulnerable to invasion by fast growing deciduous trees such as Willow because they are exploiting an 'empty niche'. Introduced plants can modify a wetland considerably altering light levels and adding to the humus layer by their deciduous nature. As a consequence native flora and fauna adapted to the evergreen system, may decline in abundance and become extinct.

This indicator assesses the introduced species and to what degree they are invading the natural flora of the wetland.

6.1.2 Wetland pressures

Wetland pressures are scored separately on the record sheet with a value 0 (very low) to 5 (extreme). Methods for scoring the pressures as adapted from the handbook are included in Appendix I. The pressures identified are;

1. Modifications to the catchment hydrology
2. Water quality within the catchment
3. Animal access
4. Key undesirable species
5. % catchment in introduced vegetation
6. Other pressures

6.2 The Wetland Plot Sheet.

Two wetland plots are recommended in the handbook for each vegetation type within the wetland. Each plot is suggested to be 2m by 2m ($4m^2$) as this "satisfies minimal sample area requirements for relatively short and/or homogenous wetland vegetation". Plots are selected to represent the typical plant communities within the vegetation type.

The first component of the plot sheet (appendix II) records the species composition by using the Atkinson system (Appendix III). The presence and percentage cover of each of the species within the canopy, subcanopy and groundcover are recorded and their maximum heights stated. Introduced species are identified by an asterix beside the species name. In addition, species found outside of the plot but that are in the same vegetation type are recorded.

The second component of the plots sheet determines the indicators scores;

1. Canopy: % cover introduced species
2. Understorey: % cover introduced species
3. Total species: % number introduced species
4. Total species: overall stress/dieback

These indicators are again scored on a 0-5 scale and a total plot condition index is calculated.

The third component of the wetland plot sheet is where the physical and chemical parameters measured either in the field or from laboratory analysis are recorded. For each of the plots two intact soils cores are to be collected and sent to the laboratory for analysis of the following parameters;

1. % water
2. Bulk density
3. pH
4. Conductivity
5. Total Carbon
6. Total Nitrogen
7. Total Phosphorous

In addition a sample of the tips of the foliage for each plot is to be collected of the dominant canopy species and analysed for total nitrogen and phosphorous.

In some instances, where the vegetation is taller and more diverse the size of the plot may need to be reassessed as the $4m^2$ plot may not adequately represent the community species. This will not affect any comparisons between plots as the vegetation indicators are based on relative measures.

The wetland plots provide a robust and concise way of monitoring the changes in condition of the wetland at specific locations and result in providing qualitative data on the biotic, physical and chemical parameters. Other aspects of monitoring can be included at these plot sites through bird counts, invertebrate sampling, etc.

This section has been included to give a brief summary of the theories and methods involved in the MFE's wetland monitoring and condition project but the handbook will provide you with detailed reasons behind choosing each of the indicators and the methods involved in the monitoring.

7.0 CONCLUSION AND RECOMMENDATIONS

The Hawkes Bay Regional Council has set out clear direction in its policy statement towards the management of wetlands (Table 2.1)

The RPS anticipates:

1. No further loss of ecologically significant wetlands
2. The improvement in environmental conditions of priority wetlands.

Current wetland monitoring carried out by the Regional Council has limitations in addressing these key issues. At present the Regional Council is reporting on the state of the wetlands regionally by monitoring a targeted set of wetlands benefiting from active management through either management plans or community involvement. As a result the perception of Hawke's Bay wetlands is that they are in a stable to improving state (HBRC, 2009). This is not giving a true representation of state of Hawke Bay wetlands and does not enable the council to accurately report how well our wetlands are functioning on a regional scale.

Monitoring provides Council with information on the state of its wetlands which have been identified as priority in 1995. These wetlands were selected due to their recreational, ecological, cultural and amenity values and were identified by council as the wetlands which would benefit most from restoration works. The reporting style follows the photo point monitoring structure of the field surveys and also gives information on birds, aquatic invertebrates, terrestrial fauna and pest species within the wetland. To date the information gathered from the monitoring has provided Regional Council with qualitative information on the ecological functions of priority wetlands in our region. The qualitative way in which the information is reported limits the possibilities of data analysis and does not provide council with a way to measure the effectiveness of restoration efforts or isolate areas of concern.

Current monitoring is repeated on a two yearly rotation which is not a long timescale in ecological terms and does not enable for council to report in a coherent way on any changes at either the landscape or plot scales. As a result, the extent of changes to the composition of wetland vegetation, populations of species and the detection of processes driving these changes are ambiguous. The tight timescale between monitoring does not enable council to use its resources efficiently and puts limitations on the number of wetlands included in the monitoring programme.

To enable the council to fulfil its objectives set out in the RPS, RRMP and RCEP a completed inventory of wetlands must be produced and mapped to enable council to detect the loss of the extent of ecologically significant wetlands. Taranaki Regional Council have produced a detailed inventory of their wetlands, highlighting wetlands that need protection from further degradation. This has proved to be an invaluable resource and has enabled them to manage their wetland ecosystems more effectively through the Proposed Regional Freshwater Plan for Taranaki (Taranaki Regional Council, 2001).

The Hawkes Bay Regional Council's wetland database holds valuable information on the locations of our Hawkes Bay wetlands as well as some important historical information dating back to 1980's for some wetlands, valuable in identifying temporal changes. The database would benefit from an update of information for the wetlands that were not field surveyed during the 2004 exercise. Alterations to better align the database structure toward national protocols would provide a consistent approach to how we display and report on wetland information.

In the past it has been expressly requested by DOC and Fish and Game to have access to the wetlands database. This would be an invaluable source of information to these organisations and should be made a priority. With the creation of over 200 private wetlands in 2007 (Cheyne, 2008), Fish and Game are actively working towards wetland creation and restoration. These created wetlands are important for biodiversity; providing additional

habitat for species and creating important connective pathways to ecological corridors as well as to surface water and groundwater systems. It is important to include this information in the database to enable the true areal extent of wetlands in the Hawke Bay. Hawke's Bay Regional Council's management of the database would work on the same principles as the Freshwater Fish database managed by NIWA, where a form can be downloaded from the website and then e-mailed to the database administrator for inclusion to the database.

The approach to classifying wetlands differs according to the management practices and the priorities for classification. Johnson and Gerbeaux (2004) classify wetland systems by their hydroclasses as is the accepted classification by wetland experts in the country. (Clarkson, 2003). This separates wetland types into nine categories. This can be further refined for Hawkes Bay which only has four types of wetlands in the region; Lacustrine, Palustrine, Riverine and Estuarine.

The Regional Council monitors lakes in the region by using the Lakes SPI management tool which uses Submerged Plant Indicators (SPI) for assessing the ecological condition of New Zealand lakes and for monitoring trends occurring within them (Winton & Champion, 2007). This project involves monitoring surface water quality and ecology of 8 lakes (Waikaremoana, Waikareiti, Rotonuiaha, Tutira, Opouahi, Runanga, Oingo and Kaweka) within our region for the purposes of state of the environment monitoring. The project involves monthly sampling for water chemistry and once every four years for aquatic ecology (Stansfield, pers. Comm.).

Estuaries are monitored by the Regional Council in accordance with the Estuarine Environmental Assessment and Monitoring National Protocol and the Coastal Monitoring Strategy (Madarasz, 2006). Estuaries included in this monitoring are Ahuriri and Porangahau Estuaries and the Maungawhio Lagoon is recommended. At present the Wairoa Estuary and coastal wetlands have not been included in the project.

To classify wetlands with a view to setting priorities for conservation or management a framework must be developed to classify wetlands in the Regional Councils Wetlands database to provide an accurate depiction of the extent of wetland classes as described by Johnson & Gerbeaux (2004) and Ward & Lambie (1999).

Landcare Research has developed a framework for rapid classification of wetlands. The Wetlands of National Importance (WONI) report has got an objective ranking rationale using biogeographic units (not regional council boundaries). This methodology can be refined and adapted to fit within the regional council boundaries. Horizons Regional Council has adapted the methodology of the WONI project to rapidly classify wetlands in the Manawatu-Wanganui region. This rapid classification took six weeks to provide Horizons Regional Council with a complete inventory of wetlands within their region and enabled them to be ranked in order for priority for management using a range of landscape indicators (representativeness, area, connectivity and surrounding naturalness).

To enable the Hawkes Bay Regional Council to accurately report on the true state of Hawke's Bay wetlands it needs to provide an unbiased representative sample of wetlands for inclusion in the monitoring programme. On completion of the database it will enable the wetlands to be mapped and then classified by using the rapid methodology approach adopted by Horizons Regional Council.

Of the wetlands historically selected for inclusion to the wetland monitoring and enhancement programme, only one of these (Pekapeka) has an up to date management plan. This proves problematic in directing management efforts as there is no framework in place. It is recommended that the wetlands that do not have management plans in place are removed from this programme and that ecological surveys for Pekapeka swamp continue on a contract basis to the Operations Group. As there is no active management of the other wetlands by Regional Council the ecological surveys are not providing any useful information to Council and they should be removed from the programme and included in the classification and ranking process to select a new sample of wetlands in the region. Due to

their high ecological values associated with these wetlands it is expected that they will be ranked high using the new process and will still be monitored. If this is not the case, then they should be revisited on a ten year rotation to continue the long record of ecological information that is available for these wetlands.

Once the wetlands have been selected for inclusion in the monitoring programme, monitoring should commence on a five yearly rotation using a quantitative method to enable council to score wetlands on their condition which can then be used as a tool to measure the effectiveness of their policies.

The monitoring condition handbook (Clarkson et al. 2008) is a very useful tool to monitor the state of New Zealand's wetland ecosystems. It provides end users with a consistent, national protocol to enable comparisons to be made with other regions using the methodology. Using this approach would provide the Regional council with a robust, semi quantitative methodology to actively score the condition of the wetland to detect changes in wetland condition and effectively detect trends, both at the landscape scale and regional scale. By moving from a two to five yearly monitoring timescale it will enable better detection of these changes and for state of the environment reporting purposes seems adequate (Clarkson, 2008). This will prove to be an invaluable tool to drive management practices and mitigate against adverse affects.

8.0 PROPOSAL FOR WETLAND MONITORING

A project proposal for a new wetland monitoring strategy is included below. It seems appropriate to split project goals into action steps to enable the effective measurement of project goals and performance.

- Phase One
    1. Identify and map the extent of wetlands regionally
    2. Classify and rank wetlands in order of priority for inclusion in the monitoring programme
    3. Realign wetland database structure toward national protocols (Wetland Condition Monitoring Handbook)
    4. Report on the extent of wetland types in Hawkes Bay
    5. Provide external access to the wetlands database to interested parties (Fish & Game, DOC).
- Phase Two
    1. Monitor wetlands identified in Phase I by adopting the Wetland Condition Monitoring protocols (Clarkson et al, 2003)
    2. Conduct bird monitoring at each of the wetlands identified in Phase I
    3. Monitor aquatic species at each of the wetlands identified in Phase I
    4. Update database with new wetland information on completion of field surveys
    5. Monitor wetlands on a five yearly rotation to enable trend detection both at regional and local scale.
    6. Report on wetland condition of Hawke's Bay wetlands

8.1 Resource Requirements

It is proposed that the mapping and prioritisation of wetlands could be funded by a medium advice envirolink grant. ($20,000)

Phase One

Internal Expenditure code	Reason	Budgeted weeks	Expenditure
790 – Data Analyst	Reporting on wetland extent	2	
758 – Information services	Database structure alignment	2	
830 – Strategic Development	Wetland database on internet	2	

- Phase Two

Internal Expenditure code	Reason	Budgeted weeks
790 – Data Analyst	Field work, data collection & reporting	8
758 – Information services	Database	0.2
Total		**8.2**

External expenditure code	Reason	Expenditure
908 - Consultant	Bird surveys	$1000.00
920 – laboratory costs	Sample analysis	$7340.40
Total		**$8340.40**

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APPENDIX I: WETLAND INDICATORS

Indicator	Type of indicator (P/S/R)	What does the indicator measure?	Collection	Analysis	Reporting
Change in wetland extent.	**State Indicator.**	**This indicator describes changes to the spatial extent of wetlands throughout the region.**	**Changes to wetland extent can be quantified using the Land Cover Database (LCDB)**	**Changes to wetland extent can be quantified using the Land Cover Database (LCDB)**	**Will be reported in 5-yearly in the SOE report.**
Change in wetland condition:					
-Change in hydrological integrity **o Impact of man-made structures that alter hydrology** **o Change in water table depth** **o Dryland plant invasion**	**State Indicator.**	**Water is inarguable essential for wetland persistence, this indicator measures those activities that can affect water quantity in wetlands.**	**Number/ size/ depth/ effectiveness/ coverage of man-made structures (drains, stopbanks, tide gates, etc.) within wetland and in catchment.**	**Indicator at time [1] compared to indicator at time [2].**	**At the end of each wetland studied.**
-Change in physicochemical parameters **o Fire damage** **o Degree of sedimentation/erosion** **o Nutrient levels** **o Von Post index (peat bogs only)**	**State Indicator.**	**This indicator can reflect changes to water quality including nutrient levels.**	**Changes in soil/water N, P & pH, foliage N:P ratio (from plot data), loss/decline of species adapted to oligotrophic conditions (especially slow-growing stress tolerant plants), change in phytoplankton composition, e.g., from diatoms to large filamentous Cyanobacteria**	**Indicator at time [1] compared to indicator at time [2].**	**At the end of each wetland studied.**
-Change in ecosystem intactness **o Loss in area of original wetland** **o Connectivity barriers**	**State Indicator.**	**Capacity for faunal migration, seed dispersal, habitat diversity etc.**	**Monitored in relation to changes in wetland extent, and in field identifying connectivity barriers.**	**Indicator at time [1] compared to indicator at time [2].**	**At the end of each wetland studied.**
-Change in browsing, predation, and harvesting regimes **o Damage by domestic/feral animals** **o Introduced predator impacts on wildlife** **o Harvesting of biota**	**State Indicator.**	**Pests and predation can affect wildlife values and species diversity.**	**5 min bird counts, fish trapping, predator investigations e.g. track tunnels. Presence of senstive species such as fernbird, bittern, banded rail.**	**Indicator at time [1] compared to indicator at time [2].**	**At the end of each wetland studied.**
-Change in dominance of native plants **o Introduced plant canopy cover** **o Introduced plant understorey cover.**	**State Indicator.**	**Reflects ecosystems values, and restoration capacity.**	**Plot data.**	**Indicator at time [1] compared to indicator at time [2].**	**At the end of each wetland studied.**

APPENDIX II: WETLAND RECORD AND PLOT SHEETS

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 physio-chemical parameters	Fire damage			
	Degree of sedimentation/erosion			
	Nutrient levels			
	Von Post index			
Change in ecosystem intactness	Loss of area of original wetland			
	Connectivity barriers			
Change in browsing, predation and harvesting regimes	Damage by domestic or feral animals			
	Introduced predator impacts on wildlife			
	Harvesting levels			
Change in dominance of native plants	Introduced plant canopy cover			
	Introduced plant understorey cover			
Total wetland condition index /25				

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

Main vegetation types:

Native fauna:

Other comments:

Pressure	Rating[2]	Specify and Comment
Modifications to catchment hydrology		
Water quality within the catchment		
Animal access		
Key undesirable species		
% catchment in introduced vegetation		
Other pressures		
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 (2m x 2m default)**:** **Altitude:** **GPS/GR:**
Field leader: **Structure:** **Composition:**

Canopy (bird's eye view)			**Subcanopy**			**Groundcover**		
Species[1] (or Substrate)	**%**	**H**	**Species**	**%**	**H**	**Species**	**%**	**H**

[1] % = % cover: total canopy % cover = 100%; H = maximum height in m; indicate introduced species by *

Additional species in vicinity in same vegetation type:

Comments:

Indicator (use plot data only)	**%**	**Score 0–5**[2]	**Specify & Comment**
Canopy: % cover introduced species			
Understorey: % cover introduced spp[3]			
Total species: % number introduced spp			
Total species: overall stress/dieback	NA		
Total plot condition index /20	NA		

[2]5=0%: none, 4=1–24%: very low, 3=25–49%; low, 2=50–75%: medium, 1=76–99%: high, 0=100%; very high
[3]Add subcanopy and groundcover % cover for introduced species

Field measurements:

Water table cm		Water conductivity uS (if present)	
Water pH (if present)		von Post peat decomposition index	

Soil core laboratory analysis (2 soil core subsamples)**:**

Water content % dry weight		Total C %	
Bulk Density T/m3		Total N %	
pH		Total P mg/kg	
Conductivity uS			

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

Species		%N		%P	

APPENDIX III: ATKINSON'S STRUCTURAL CLASSIFICATION

(adapted from Clarkson, 2003)

Structural class	Diagnostic criteria for structural classes and definitions of growth forms
1. FOREST	Woody vegetation in which the cover of trees and shrubs in the canopy is >80% and in which tree cover exceeds that of shrubs. Trees are woody plants ≥10cm dbh. Tree ferns ≥10cm dbh are treated as trees.
2. TREELAND	Vegetation in which the cover of trees in the canopy is 20–80%, with tree cover exceeding that of any other growth form, and in which the trees form a discontinuous upper canopy above either a lower canopy of predominantly non-woody vegetation or bare ground, e.g., mahoe/bracken treeland. (Note: Vegetation consisting of trees above shrubs is classified as either forest or scrub depending on the proportion of trees and shrubs in the canopy).
3. VINELAND	Vegetation in which the cover of *unsupported* (or artificially supported) woody vines in the canopy is 20–100%, and in which the cover of these vines exceeds that of any other growth form or bare ground. Vegetation containing woody vines that are supported by trees or shrubs is classified as forest, scrub or shrubland. Examples of woody vines occur in the genera *Actinidia , Clematis, Lonicera, Metrosideros, Muehlenbeckia, Ripogonum, Vitis* and others.
4. SCRUB	Woody vegetation in which the cover of shrubs and trees in the canopy is >80% and in which shrub cover exceeds that of trees (cf. FOREST). Shrubs are woody plants <10cm dbh.
5. SHRUBLAND (including tussock-shrubland)	Vegetation in which the cover of shrubs in the canopy is 20–80% and in which the shrub cover exceeds that of any other growth form or bare ground. It is sometimes useful to separate tussock-shrublands as a sub-class for areas where tussocks are >–20% but less than shrubs. (Note: The term scrubland is not used in this classification).
6. TUSSOCKLAND (including flaxland*)	Vegetation in which the cover of tussocks in the canopy is 20–100%, and in which tussock cover exceeds that of any other growth form or bare ground. Tussocks include all grasses, sedges, rushes, and other herbaceious plants with linear leaves (or linear non-woody stems) that are densely clumped and >10cm height. Examples of the growth form occur in all species of *Cortaderia, Gahnia,* and *Phormium,* and in some species of *Chionochloa, Poa, Festucs, Rytidosperma, Cyperus, Carex, Uncinia, Juncus, Astelia, Aciphylla,* and *Celmisia.* It is sometimes useful to separate *flaxland** as a subclass for areas where species of *Phormium* are dominant.
7. FERNLAND	Vegetation in which the cover of ferns in the canopy is 20–100%, and in which the fern cover exceeds that of any other growth form or bare ground. Tree ferns ≥10cm dbh are excluded as trees (cf. FOREST).
8. GRASSLAND	Vegetation in which the cover of grass in the canopy is 20–100%, and in which the grass cover exceeds that of any other growth form or bare ground. Tussock-grasses are excluded from the grass growth-form.

* The term "flaxland" could not be used outside New Zealand because elsewhere the name flax is widely applied to species of *Linum*

Structural[2] class	Diagnostic criteria for structural classes and definitions of growth forms
9. SEDGELAND	Vegetation in which the cover of sedges in the canopy is 20–100%, and in which the sedge cover exceeds that of any other growth form or bare ground. Included in the sedge growth form are many species of *Carex, Uncinia,* and *Scirpus.* Tussock-sedges and reed-forming sedges (cf. REEDLAND) are excluded.
10. RUSHLAND	Vegetation in which the cover of rushes in the canopy is 20–100% and in which the rush cover exceeds that of any other growth form or bare ground. Included in the rush growth form are some species of *Juncus* and all species of *Sporadanthus, Leptocarpus,* and *Empodisma*[3]. Tussock-rushes are excluded.
11. REEDLAND	Vegetation in which the cover of reeds in the canopy is 20–100%, and in which the reed cover exceeds that of any other growth form or open water. Reeds are herbaceous plants growing in standing or slowly-running water that have tall, slender, erect, unbranched leaves or culms that are either hollow or have a very spongy pith. Examples include *Typha, Bolboschoenus, Scirpus lacustris, Eleocharis sphacelata,* and *Baumea articulata.*
12. CUSHIONFIELD	Vegetation in which the cover of cushion plants in the canopy is 20–100%, and in which the cushion-plant cover exceeds that of any other growth form or bare ground. Cushion plants include herbaceous, semi-woody and woody plants with short densely packed branches and closely spaced leaves that together form dense hemispherical cushions. The growth form occurs in all species of *Donatia, Gaimardia, Hectorella, Oreobolus,* and *Phyllachne* as well as in some species of *Aciphylla, Celmisia, Centrolepis, Chionohebe, Colobanthus, Dracophyllum, Drapetes, Haastia, Leucogenes, Luzula, Myosotis, Poa, Raoulia,* and *Scleranthus.*
13. HERBFIELD	Vegetation in which the cover of herbs in the canopy is 20–100%, and in which the herb cover exceeds that of any other growth form or bare ground. Herbs include all herbaceous and low-growing semi-woody plants that are not separated as ferns, tussocks, grasses, sedges, rushes, reeds, cushion plants, mosses or lichens.
14. MOSSFIELD	Vegetation in which the cover of mosses in the canopy is 20–100%, and in which the moss cover exceeds that of any other growth form or bare ground.
15. LICHENFIELD	Vegetation in which the cover of lichens in the canopy is 20–100%, and in which the lichen cover exceeds that of any other growth form or bare ground.
16. ROCKLAND	Land in which the area of residual bare rock exceeds the area covered by any one class of plant growth-form. Cliff vegetation often includes rocklands. They are named from the leading plant species when plant cover ≥1%, e.g., [koromiko] rockland.
17. BOULDERFIELD	Land in which the area of unconsolidated bare boulders (>200mm diam.) exceeds the area covered by any one class of plant growth-form. Boulderfields are named from the leading plant species when plant cover ≥1%.
18. STONEFIELD/ GRAVEFIELD	Land in which the area of unconsolidated bare stones (20–200mm diam.) and/or gravel (2–20mm diam.) exceeds the area covered by any one class of plant growth-form. The appropriate name is given depending on whether stones or gravel form the greater area of ground surface. Stonefields and gravelfields are named from the leading plant species when plant cover ≥1%.
19. SANDFIELD	Land in which the area of bare sand (0.02–2mm diam.) exceeds the area covered by any one class of plant growth-form. Dune vegetation often includes sandfields that are named from the leading plant species when plant cover ≥1%.
20. LOAMFIELD/ PEATFIELD	Land in which the area of loam and/or peat exceeds the area covered by any one class of plant growth-form. The appropriate name is given depending on whether loam or peat forms the greater area of ground surface. Loamfields and peatfields are named from the leading plant species when plant cover ≥1%.

[2] Additional structural classes appropriate to wetlands may be added, e.g., mudfield
[3] The term wirerushland may be used for wetland habitats dominated by *Empodisma.*