The Status of Wetlands in the Manawatu

A THESIS

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Abstract

Wetlands have been severely degraded throughout history, particularly by agricultural activities. In addition, legislation has played a role in the sustainability of this resource. The purpose of this study was to determine the status of wetlands within the Manawatu, requiring an assessment of the physical attributes of the wetland, as well as reviewing the legislation, policies and plans governing how these areas are managed.

The objectives were to determine whether wetlands should be protected, and if so are they adequately preserved within a sample group. The sample group was determined by a number of factors including site access, landowner permission, and time restrictions. If it is shown that these wetlands are not in acceptable environmental condition, then details of what should be done to improve their status are included.

To achieve these objectives a wetland field assessment sheet that could be used by someone not familiar with the various plant and animal species found around wetlands, was designed. This field assessment sheet assessed the surrounding land use, threats, functions (of the wetland), and assessment of other attributes such as bank stability, water quality, and the effects of humans in the area. This field assessment sheet was necessary in order to determine whether the wetlands in the selected group were adequately preserved.

Relevant wetland legislation and planning documents were also assessed. These were used to determine whether wetlands are given adequate protection under current laws such as the Resource Management Act (1991).

Aerial photographs at a scale of 1:27 500 were used to identify the changes in numbers of wetlands between the 1940s and 1990s, and to measure the change in size of the sampled wetlands between the same time period. A main result showed that wetlands are generally increasing in number within four random aerial photo transects. The wetlands that were selected for field assessment proved to be in reasonable environmental condition. Zones within the wetlands that need improvement lie within the amount and composition of bank vegetation

surrounding the wetland. In almost all cases, the average width of the surrounding riparian margin was less than five metres.

Analysis of the legislation and planning documents showed that great emphasis is placed on those wetlands that are identified as being of national or regional significance. Those wetlands that are not classified as such are left to the maintenance of the landowner. Ultimately the status of these wetlands, not identified as being of regional or national significance, lies in the good will of the landowners. In most case studies, landowners were aware and mindful of the wetlands on their property. It is this attitude that must not change if the desired outcome is a continuation of wetlands throughout the region.

It is concluded that a regional wetland plan or strategy should be designed in order to give greater importance to those wetlands not identified in the Regional Policy Statement (1998), so their status is more likely to be preserved. This plan should contain encouragement for landowners to provide a more suitable buffer zone around their wetlands – not only for the provision of suitable habitat for wildlife, but also to act as a filter for nutrients entering the wetland system.

To Gran'ma

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1 Introduction

1.1 Statement of Problem

Wetlands are among the world's most productive environments, they provide for both plants and animals, by offering water, habitat, roosts and breeding areas for migratory species and generally improving the biological diversity of the region. As a result, wetlands support high concentrations of birds, mammals, reptiles, amphibians, fish and invertebrate species. Wetlands are also important banks of plant genetic material and provide valuable buffers during periods of flood and drought (Woodward-Clyde, 1995; Ramsar Information Paper No.1, 1999; DoC Web Site, 1999). These functions, values and attributes can only be maintained if the ecological processes of wetlands are allowed to continue functioning. Unfortunately, wetlands continue to be among the world's most threatened ecosystems, owing mainly to ongoing drainage, conversion, pollution, and over-exploitation of their resources (Ramsar Information Paper No. 1, 1999).

Globally, wetlands have been degraded an estimated 50 per cent, and New Zealand estimates suggest that prior to the arrival of Maori, about eight per cent of the total land area was made up of dry lands, lakes and swamps. There were extensive wetlands in the Manawatu before European settlement. Swamp covered large areas of plains both to the east and west of the Manawatu gorge. As the land was developed for agriculture, the bush was removed and the wetland area reduced through drainage, construction of flood protection schemes, reclamation works, dune stabilisation and forestry development. Former wetlands are now largely prime agricultural land used particularly for dairy farming (Manawatu-Wanganui Regional Council, 1998a).

Changes to vegetation cover occurred for a variety of reasons. Swamps were often regarded as unsightly areas, whose best use were as receptacles for the waste products of communities, or as areas to be tided up by reclamation for roads, recreational areas, and industrial land. In rural areas, wetlands were seen as cheap sources of additional land, as the soils that lay beneath the water are usually very fertile (Handford, 1983). Urban development has also changed the land, and pasture development has meant that many swamps and coastal wetlands have been drained (Statistics New Zealand 1993; Spencer et al., 1998). The response has been the adoption of a variety of measures to slow the rate of habitat loss and increase the protection of remaining natural wetland (Adam, 1995). Thompson (1983) stated that both public and scientific interest in wetland values has increased enormously. He went on to say that wetlands are no longer regarded as 'wastelands' that must be drained and converted into something useful.

1.2 Reasons to Justify Investigation

Jones et al., (1995) noted that Simpson (1985) claimed, "the phase of necessity is over, yet the ethic remains". The necessity to drain wetlands comes from the thinking that wetlands were regarded as wastelands, whose value could only be realised through conversion to some other use, usually agriculture. If this ethic is to be removed, then a major shift away from traditional thought is going to be needed. In addition, the Wellington Fish and Game Council is concerned that the relevant authorities and landowners are not protecting the Manawatu's wetlands. Benn (1997), who identifies that drainage is the most significant threat to Manawatu wetlands, and "lenient" resource consent requirements by Horizons.MW (Appendix 21.1) support their viewpoint. Therefore the aim of this research was to determine whether legislation and practise adequately protect and preserve wetlands in the Manawatu region. This aim was achieved by following four objectives:

1. Determine whether wetlands should be protected;
2. If so, determine whether they are being adequately preserved (measure their current status, both physically and institutionally);
3. If not, determine what should be done to correct this;
4. Describe the methods of how improvements in wetland management should be carried out.

For the purpose of this research, protected is defined in context as a wetland that is kept from harm or degradation. A wetland that is protected for example, may have a rule in the Regional Policy Statement that does not allow activities that may result adverse affects on the wetlands natural character. In contrast, a wetland that is preserved, is defined as one that is kept in existence. An example of a wetland that is being preserved, may be a situation where the landowner is taking active measures to enhance or maintain the natural character of the wetland. Therefore, a wetland may be either preserved, protected, or both.

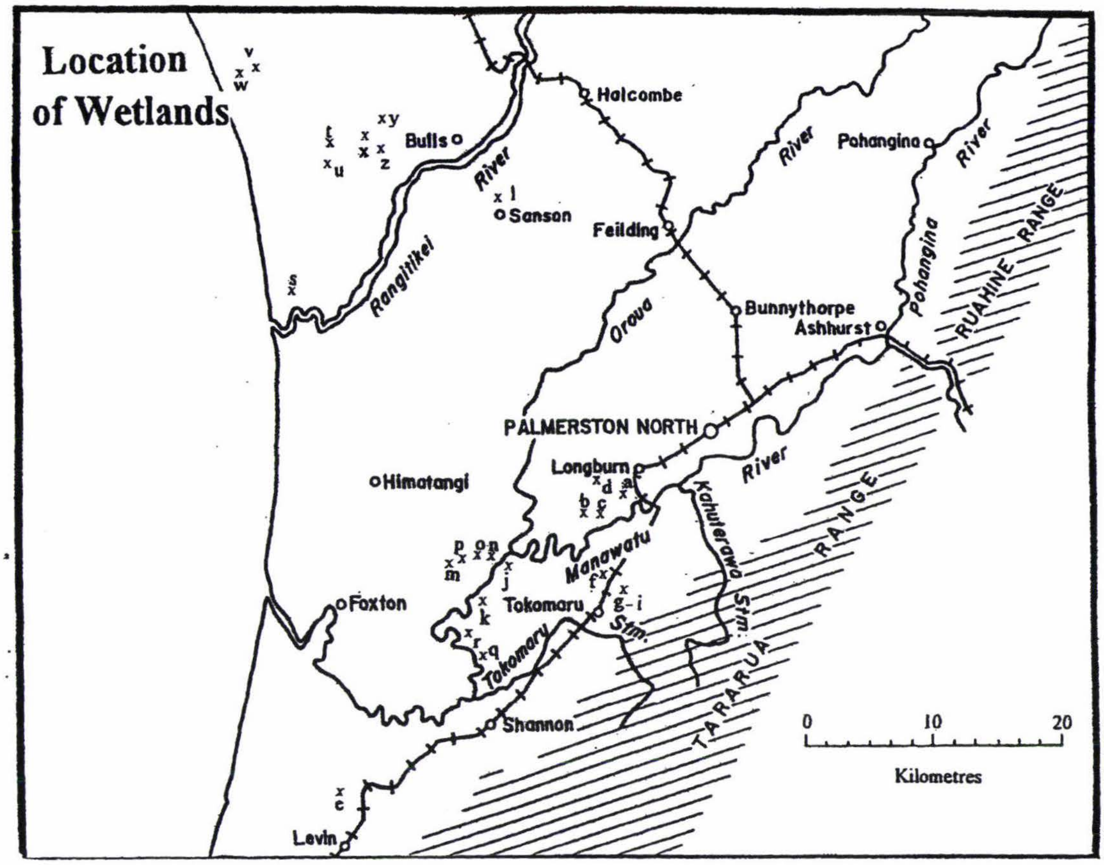
1.3 Indications of Recent Research

Recent research into wetlands in New Zealand is very minimal. The most relevant literature to this study is that of Benn (1997), and Partridge et al. (1999). Benn looked at the size and abundance of wetlands throughout the Manawatu Ecological District. He concluded that wetlands in the district are generally small (less than two hectares), and are mostly threatened by drainage activities. The work by Partridge et al., attempted to design a workable wetland classification scheme that could be applied to a New Zealand setting.

1.4 What Was Examined and Where

The research area included wetlands of the Manawatu as far north as Marton, and south as far as Levin (Figure One). The wetlands that were included in this study included dune lakes, oxbow lakes, artificial ponds, natural ponds, and swamps.

Figure 1: Study Area and Location of Sampled Wetlands



A = Karere Lagoon	H = Fielding Property (2)	O = Himatangi (2)	V = Koitiata (2)
B = Off Dampneys Road	I = Fielding Property (3)	P = Himatangi (3)	W = Lake Koitiata
C = Voss Property	J = Candy Project	Q= Douglas Property	X = McDonald Property (1)
D = Off No. One Line	K = Tannock Property	R = Seymour Property	Y = Lake Alice
E = Near Levin	L = Collier Property	S = Crawshaw Property	Z = McDonald Property (2)
F = Manderson Property	M = West Property	T = Frecklinton (1)	
G = Fielding Property (1)	N = Himatangi (1)	U = Frecklinton Property (2)	

1.5 Methods

A thorough literature review was carried out in order to determine what previous work had been undertaken in this field. This was necessary to gather formation for all aspects of this thesis. This review provided the information necessary to determine the functions and values of wetlands as detailed in the following chapters. Also, the review was required to compile and design the field assessment sheet.

No literature was found regarding wetland assessment in New Zealand. As a result, many documents were sourced from overseas and New Zealand, in order to create a 'patchwork' field assessment sheet. Wetland assessment literature was utilised along with literature designed for other natural resource assessment, stream quality for example. From this literature, indicators were extracted on a basis of what had been previously used, and those that may provide useful information to the status of the wetland being assessed. Additional data was added to the field sheet for general information purposes – grid references for example.

Institutional assessment was carried out by reviewing documents such as the Resource Management Act (1991), the Manawatu-Wanganui Regional Policy Statement (1998), the Regional Monitoring Strategy (1998), the Proposed Regional Plan for Beds of Rivers and Lakes and Associated Activities (1997), the Proposed Land and Water Regional Plan (1999), and the Regional Coastal Plan. (1997). The Manawatu and Horowhenua District plans were also looked at. For this part of the research, relevant information was reviewed relating to the protection and preservation of wetlands throughout the region.

The next step in the process was the observation of aerial photo transects. The transects (Figure 12) were selected on a basis of data availability, and distribution throughout the Manawatu, from north to south. Ideally it would have been better to examine more than four transects, but many of the earlier photo transects were incomplete, and did not offer useful data. The observation and recording of wetlands from these photos was extremely time consuming, therefore limiting time available for fieldwork.

Wetlands were identified on the photos using a magnifying glass, stereoscope, and the naked eye. Once a wetland was located on the aerial photo, its location was plotted onto a 1:50 000 topographical map and recorded. This was quite a difficult task on the earlier photos (1942/49), as landmarks such as roads and buildings had changed markedly over the years. This process was repeated for the later 1995/6 photos.

Originally field assessments were going to be carried out at wetlands identified in the aerial photo transects. Finding these sites on the ground was a lot more difficult than expected. Some wetlands were reached, however most were not. Reasons for this included, not being able to contact landowner, landowner not aware that a wetland existed on their property, and permission to visit declined. To overcome this, the author asked the Wellington Fish and Game Council and Ducks Unlimited representatives to help identify wetlands that could be used in this assessment. This method proved to be most fruitful, with a range of wetland sizes, types, and conditions.

The actual field assessment was relatively easy (once the wetland was found on the property). The field assessment sheets was designed so that the researcher could stand at the waters edge, with movement needed only for taking temperature and pH levels at different locations around the wetland. These different locations were the points of a compass (north, south, east, and west). Most wetlands allowed access to these points, but some areas were inaccessible due to vegetation and/or boggy underfoot conditions.

The data from the field assessments were then added into a spreadsheet for storage and assessment. Data analysis was undertaken in the form of correlations, averages and cumulative scores.

1.6 Key Findings

The key findings were that the abundance of wetlands in the Manawatu has increased within the four aerial photo transects, however the Levin transect registered a decrease in numbers. Overwhelmingly, the surrounding land use of the sampled wetlands was that of pastoral/grazing areas. Not surprising given the Manawatu's agricultural focus. What was unusual was the high proportion of wetlands that were used as a sanctuary or for scenic purposes. Both these ranked above hunting as the main wetland purpose. Regarding the threats to wetlands, the results presented in this thesis show that invasive plant species and eutrophication were most dominant. Oxbow wetlands were on average, the largest of wetlands sampled. The size of swamps and their water temperature are related, as swamps were recorded as having the smallest size overall, along with the highest temperatures. This is due to the small water body (in swamps) being more easily heated by the sun, compared to the larger wetlands.

The bank stability of the wetlands sampled were in excellent condition, possibly a result of the lack of pugmarks recorded per wetland. Regarding widths of riparian margins, lakes had the greatest average width (15.5 metres). This result did not affect the overall scores however, as most of the wetlands visited had riparian margins less than five metres wide. Lakes also tallied the best score for composition of bank vegetation, meaning that these wetlands were the most biodiverse, in terms of vegetation.

Results from the cover of aquatic vegetation show that in seventy three percent of sampled wetlands had less than 20 percent surface coverage. Under the water produced different results, with the majority of wetlands showing moderate amounts of algae. Underwater clarity showed that natural ponds were the clearest, with swamps containing the murkiest water. Oxbow lakes recorded the highest recordings for conductivity. It is not known why these oxbows were much different to other similar sized wetlands. Overall, the wetlands tested for conductivity fitted nicely with the categories of Spencer et al. (1998). Their study defined a reading of 292-833 µSiemens/cm as "good". None of the wetlands sampled in the Manawatu exceeded 600 µSiemens/cm.

Results from invertebrates and bird life were very similar when comparing across wetland classifications.

The results from looking at the anthropocentric effects on wetlands showed that most wetlands have some form of drainage, which is interesting when comparing to the dominant land use at the wetland results, that show that 59 percent of the sampled wetlands were a part of a reserve. When assessing the availability of the wetland to the amount of fencing, it can be seen that the most common scenario was that wetlands were entirely fenced, and the total number of occurrences of stock at the wetland was zero. However, there were situations where wetlands were completely fenced, but stock still had access to the wetland (via gates and holes in fences).

1.7 Limitations to Research/Assumptions

The limitations of this research are linked to the field assessment sheet that was used to determine the status of each wetland. The design and implementation of the field assessment sheet was necessary in order to determine whether the wetlands were adequately protected and preserved. Very little previous work had been done in this area, and many sources of information had to be drawn from. In some instances, assessment criteria designed for stream assessment was adapted for wetlands. This produced some results that may have distorted the true situation of the status of the wetlands sampled, and is discussed fully in a later chapter.

A major drawback to this research is the fact that a random sample was not taken, as originally anticipated. If this could have been carried out, the results could be used to paint a more representative depiction of the status of Manawatu's wetlands. In addition, a greater number of wetlands should have been sampled for field assessment.

In almost all cases the field assessment was left to the author, without the help of the landowner or land occupier. This meant that certain assumptions had to be made regarding the primary function of the wetland. These assumptions were typically easy to make, as it was relatively straightforward as to what the wetland was mainly used for.

1.8 Contribution to Knowledge

This research's contribution to knowledge is important for the future management of wetlands throughout the country. It is important because it is the first attempt to create and test wetland criteria to assess the physical status of wetlands. In addition, this report identifies what legislation is available to the management of wetlands in the Manawatu, and exposes the shortcomings of those plans to cater for wetlands not recognised as being of regional significance.

1.9 Layout of Thesis

The layout of this thesis follows a conventional format. The following chapter describes what is a wetland, where a definition is presented based on a number of literature sources. A classification of wetlands is then detailed, outlined the differences between the different types of wetlands. The wetlands that are distinguished here are coastal wetlands, bogs, ponds, swamps, river margins, oxbows, and ephemeral wetlands.

Chapter Three provides information about wetland features, and is divided into three main sections; buffer zones and riparian margins, wetland communities, and habitats. The buffer zone section begins with an outline of the nutrient and sediment removal ability of these areas. It then accounts for the erosion control ability of riparian margins, followed by a short note about some other uses the margins provide.

The second section discusses the different communities found in and around wetlands, which leads to the third section that reviews the habitats provided, and the various animals that live in those areas. Birds that are mentioned are waterfowl (ducks), diving birds (scaup), wading birds (herons), coastal birds (gulls), and marsh birds (bitterns).

Chapter Four describes the history of wetlands in New Zealand, past wetland vegetation, the management problems associated with wetlands, and the situation with wetlands today in New Zealand. The history section gives detail to what the Manawatu must have looked like in the pioneering years, with an emphasis to drain wetlands for agricultural purposes. Past wetland vegetation was very difficult to find information on, and thus this section is very brief. Wetland management problems are then outlined, in particular, is the continuing threat of drainage to the remaining wetlands. The last section is that of wetlands today in New Zealand. This section gives a brief account of New Zealand's geography, past wetland surveys, the reduction of wetlands, and drainage schemes.

Chapter Five follows by detailing the geology and climate of the Manawatu. The first section of this chapter provides some rainfall data for the region, the second section details some of the more common soil types. The drainage section highlights the major drainage schemes in the Manawatu, some of which influence the next section, Manawatu wetlands. In this section, the region's significant wetlands are discussed.

The management of wetlands is covered in Chapter Six. Here local authorities, regional policy statements, water conservation orders, heritage orders, and the Treaty of Waitangi are dealt with.

The organisations associated with this management are covered in Chapter Seven. Here, the roles and responsibilities of Horizons.MW, District Councils, the Department of Conservation, the Ministry of Agriculture and Fisheries, Fish and Game Councils, the Royal Forest and Bird Protection Society, Ducks Unlimited, other non-governmental organisations, and RAMSAR, are detailed.

Chapter Eight provides a brief description about some of the techniques available for the valuation of wetland areas. Related with this, is Chapter Nine, which talks about some of the non-monetary values associated with wetlands.

Chapter Ten describes the functions that wetlands can perform. The sections include; the functions of agricultural wetlands, water, erosion protection, recreation, tourism and education, Maori culture, historic records, habitats, plants and animals, and productivity. The water section is further divided into three sub-sections. The first is water quality, which outlines the various processes that can occur within a wetland. For example, the ability of wetlands to act as natural filter systems to remove pollutants. The second sub-section discusses the ability of wetlands to absorb water during high flood events, and slowly release this water downstream. The third sub-section briefly talks about the aquifer recharge ability of some wetlands.

Threats to wetlands are detailed in Chapter 11. Threats include; drainage, damming and diverting, fire, grazing, invasive plant species, rubbish dumping, pollution, reclamation, recreation, other land uses, and indirect threats. The pollution section is made up of three sub-sections. The first is that of the effects of sewage and wastewater, particularly from agricultural sources. The second sub-section mentions the threat that toxic substances can be passed through the food chain to humans. The third sub-section is accidental spillages, which can have both short and long term effects on the environment.

Chapter 12 uses the information presented earlier to determine whether wetlands should be protected and preserved.

Chapter 13 discusses the legislation and planning documents associated with wetlands. This chapter covers four Acts of government; the Resource Management Act (1991), the Conservation Act (1987), the Wildlife Act (1953), and the Fisheries Act (1983). Four local authority plans are also presented; the New Zealand Wetland Management Policy, the Manawatu Catchment Water

Quality Regional Plan, the Proposed Regional Plan for Beds of Rivers and Lakes and Associated Activities, and the Proposed Manawatu District Plan.

These documents, along with the Manawatu-Wanganui Regional Policy Statement, Manawatu-Wanganui Regional Council By Law, the Proposed Land and Water Regional Plan, the Horowhenua District Plan, the Rangitikei District Plan, and resource consents, are reviewed in Chapter 14, to determine whether wetlands are being adequately protected.

The Methodology Chapter is follows. This chapter is composed of two main sections; Aerial Photo Analysis, and Wetland Status Assessment. The latter section is made up of five sub-sections. The first is a review of the wetland classification schemes used for this assessment. The second describes how the wetland field assessment sheet was put together. The third sub-section outlines the particular indicators to be used in the assessment. Fourthly, the assessment of the anthropocentric effects is given. The fifth sub-section outlines the methods used to select wetlands for the aerial and field assessments.

Chapter 16 is the Results and Discussion chapter. The results from the following sections are detailed in this chapter. First, are the results from the legislation and planning documents, then the results from the aerial photo analysis. The results from the wetland assessment are then presented. Finally, some general comments are made.

Recommendations are presented in Chapter 17. This chapter contains useful information regarding the ways in which to improve the management of wetlands, including monitoring, a regional plan for wetlands, riparian margins, fencing, and other activities. There are also sections devoted to the restoration and construction of wetlands. The chapter concludes by highlighting some obstacles to improvement.

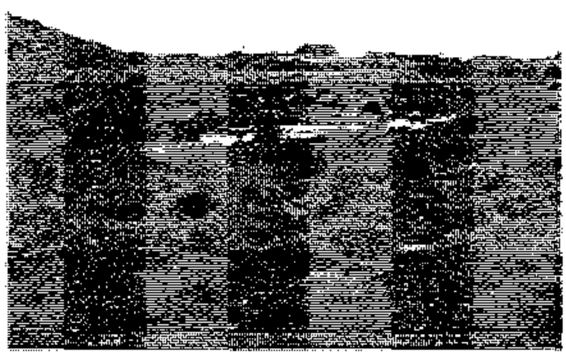
The Conclusion makes up Chapter 18. Here, a summation is presented that discusses some attitudes to wetlands, from a societal to a landowner perspective. Recreational attitudes are also mentioned. The last section gives a mention to the future of artificial wetlands.

Chapter 19 and 20 are the References and Bibliography, with Chapter 21 containing the Appendices.

2 What is a Wetland?

Wetlands represent various intermediate stages in the process of change from a lake to dry land (Figure Two). This process is known as succession, and is often accelerated by human use of wetlands and of the surrounding land. Also, river control work, sand stabilisation schemes and other activities have prevented new wetlands from forming naturally. The development of artificial lakes (including hydro lakes), reservoirs and ponds does provide new sites for wetlands, but they can never replace the diversity of a natural wetland (Buxton, 1991).

Figure 2: Wetland in Final Stages of Succession



Wetlands occur on land-water margins, or on land that is temporarily or permanently wet. They can be found on a variety of altitudes from alpine tarns to coastal estuaries, however the majority of wetlands can be found in valley floors and on flood plains, often in association with past river courses, ponding areas, lake margins and dune hollows (Smith, 1997). This is particularly evident in the Manawatu, with numerous oxbow lagoons present.

The most dominating feature about a wetland is its high water table. Where a single wetland is subjected to many land uses, it must be remembered that a single adjoining water table still links all parts of the wetland. Water table management activities in one part of the wetland will influence wetland functioning everywhere else (Thompson, 1983).

It is important to remember that wetlands are short-lived features on a geological time scale. They can disappear by one of two processes, or both. First, lakes that have stream outlets (such as Lake Horowhenua) will be gradually drained as the outlets are eroded to lower levels. Where a strong bedrock threshold underlies the outlet, erosion will be slow, but certain. Secondly, lakes accumulate inorganic material carried by stream entering the lake and organic matter produced by plants within the lake. Sediment comes down the inflowing waterways, transported by wind, from adjacent land runoff, and from erosion of the shoreline. Plants and animals, by their decomposition, contribute to the infilling and provide the materials for further plant and animal growth. Eventually these materials fill the lake up, forming a boggy wetland with little or no free water surface. After further decomposition of the sediments and organic matter, a soil develops and the wetland is transformed into increasingly solid and dry ground. They can also disappear when climate changes. For example, if precipitation is reduced within a region, or temperature and net radiation increases, evaporation can exceed input and the wetland will dry up. The consequence of this process is that animals and plants of the open water are replaced by those tolerant of wet swamp conditions. They in turn give way to species that prefer dryer ground (Vant, 1987a; Williams, 1983; Strahler and Strahler, 1994). In order for management organisations to determine what is a wetland, definitions have had to be devised which cover the attributes that are discussed above.

2.1 Wetland Definitions

The word wetland encompasses many different types of landform, and covers a range of ecosystems with very different properties. Because wetlands occur in many different climatic zones, in many different locations and have many different soil and sediment characteristics, they have become an integral part of the landscape and the economy since earliest times. Some of these names include; coastal estuary or lagoon, a braided river, dams fens, marshes, bogs, swamps and mires. The distinguishing feature about all these types of wetland is the interaction between the land and the water. The influx of water can be caused by the periodic overflowing of river valleys, the rise and fall of tides, tectonic movements, climatic events, deposition of sediments, and the rising of the water table above the surface (Williams, 1990; Buxton, 1991; Adam, 1995).

As a result, many definitions have been attempted. The most notable ones are presented below:

The Commission for the Environment (NZ) defined wetlands as:
"A collective term for permanently or intermittently wetland, shallow water and land-water margins. Wetlands may be fresh, brackish or saline, and are characterised in their natural state by plants or animals that are adapted to living in wet conditions".

The World Conservation Union (IUCN) definition is quoted in Williams (1983), as:
"Wetlands are areas of marsh, fen, peat land, or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish, or salt, including areas of marine water the depth of which at low tide does not exceed six metres."

The Ramsar Convention defines wetlands as; "*areas of marsh, fen peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres*". In addition, the Convention provides that wetlands; "*may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands*" (Ramsar Information Paper No. 1, 1999; Department of Conservation (DoC), 1996a).

Frost (1992) states that because land and water legislation were administered separately, and as a result, they were left in a state of "limbo" – with no one organisation responsible for them. Frost (1992) and Benn (1998a) quotes the Resource Management Act (1991) (RMA) which defines wetlands as "*...permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions*". Frost notes that this is the first time a definition has been included in New Zealand legislation. Although this definition is general enough to describe wetlands for policy and legislative purposes, Cooke (1991) believes that it is worth emphasising that the main characteristic of wetlands that differentiates them from other types of water bodies – such as lakes- is the association between land and water. Even though lakes and rivers may have wetland margins, mainly aquatic processes determine their response to wastewater inputs. In wetlands, a fine balance between terrestrial and aquatic processes determines response to wastewater inputs. Cooke does not go on to describe these processes.

The RMA states that wetlands are recognised as matters of national importance in Part II, Section 6 of the RMA, which states that people exercising functions or powers under the Act:[1]

"... shall recognise and provide for the following matters of importance:

(a) The preservation of the natural character of the coastal environment... wetlands and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use and development...

(c) The protection of areas of significant indigenous vegetation and significant habitat of indigenous fauna... "

These definitions have been combined to give a definition that shall be used in this report and will be used for the selection of wetlands to be evaluated;

'An area of land that is permanently or intermittently wet, consists of shallow water that is fresh, brackish or saline and less than six metres deep, has land-water margins, and provides habitat for plant and animal species that are adapted to living in wet conditions.'

2.2 Classification of Wetlands

Wetlands can be generally categorised into the following types:[2]

1. coastal wetlands;
2. bogs;
3. ponds[3], swamps, or river margins;
4. oxbows;
5. ephemeral wetlands.

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[1] Quote taken from Benn (1998a).
[2] Buxton (1991).
[3] Both artificial and natural - for example, a farm dam could be classified as an artificial wetland pond.

2.2.1 Coastal Wetlands

This category includes harbours, estuaries, lagoons and dune lakes. At the upper limit of tidal influence are salt meadow communities, affected by salt spray, but rarely covered by seawater. Lower down on the shore are species such as eelgrass *Zostera* species, that can be completely covered by a high tide. Between the two zones of vegetation are plants adapted to varying amounts of seawater. Near the seaward boundary, mangroves (not found in the Manawatu, however) partially submerged by each incoming tide and left dry at low tide. Closer to land, areas of rushes, sedges and other plants can be found (Crisp, 1986).

Estuaries are partially enclosed by land, but open to the sea and subject to regular flow and tidal fluctuations. They water may be salty or brackish. These are generally the most productive of all wetlands, with a rich animal life. Many coastal fisheries depend on this type of estuary for spawning and the early stages of their development. In the north of the North Island, the mangrove is the most dominant estuarine plant, with rushes and herbs tending to be more prevalent further south. There are only about 300 estuaries in New Zealand, of which two thirds being less than 500 hectares in area, and 90 per cent are less than 1700 hectares; in total they cover little more the 100 000 hectares (0.35 per cent of the New Zealand land area) (Williams, 1983).

Lagoons are shallow, contain brackish water, and are separated from the sea by a sand bar or narrow strip of land. The vegetation can be very lush, which attracts a great variety of bird life (Buxton 1991). A description of coastal wetlands is given in Adkin (1948), where he states that they lie within "fortuitous" depressions and hollows among the dunes, deriving their supply from ground water. They can fluctuate considerably depending on conditions, and may vary individually from extensive sheets of open water, to raupo-choked swamps, and may even dry up completely.

2.2.1.1 Dune lakes

Dune lakes are associated with wind-blown sand. These come in two main types; the dammed valley and dune-contact. Dammed valley lakes are formed when dunes block a valley draining towards the coast. Dune contact lakes occur in depressions between two or more dunes, or between dune belts (Soons and Selby, 1992).

2.2.1.2 Deflation Lakes

These are hollows produced by excavation by wind erosion, uneven accretion or both. These types are always associated with dune sand deposits. Again, two major variations are recognised; perched dune lakes, and water table-window lakes. In perched dune lakes, the water is held by an aquaclude that may be formed in various ways such as organic accumulation. In watertable-window lakes there is no impermeable layer, and a wetland forms when the groundwater levels are high enough to be exposed in the deflation basin (Soons and Selby, 1991).

Both types of lakes are vulnerable to the effects from contaminants from surrounding catchments. They are small and shallow, and many do not have direct outlets, which means that they rely on groundwater exchange during the summer. The coastal dune lakes trophic status varies throughout the region, ranging from mesotrophic to hypertrophic (Horizons.MW, 1999a).

2.2.2 Bogs

These wetlands are those that are fed by rainfall only. They are formed by a blockage of drainage and the build up of vegetation that is specialised to live in those conditions. An example of this is moss, which creates its own reservoir of moisture. Bogs have low fertility due to a lack of inflow from other sources besides rain, and are acidic. Peat is formed by the slow decomposition of plant and animals. Drier bogs support a variety of plants species, including sedges, rushes, umbrella fern and sphagnum moss. Tree and shrub species may also be found, often manuka or bog pine. There are few aquatic animals found here, but insects and spiders use vegetation, along with birds (Buxton, 1991).

This type of wetland covers about 166 000 hectares, or 0.6 per cent of the New Zealand land area, or about the same size of Stewart Island (Williams, 1983). There are five bogs that have been identified by the recent inventory of wetlands conducted by Horizons.MW (Phillips, pers. comm., 2000). They are:

- Taringamoutu Bog;
- Erua Bog;
- Ngawakaakuae Bogs;

- Reporoa Bog;
- Hokio Beach Road Bogs.

2.2.3 Ponds, Swamps and River Margins

Swamps and river margins are periodically or permanently flooded from through-flowing waters. They contain varying amounts of organic matter, silt, minerals and other materials carried in the water. As a result, the soils are less acidic, and more fertile, with decomposition being quicker than in bogs. Plant species are usually annuals. For example, raupo dies during the winter. The organic matter in these environments supports large numbers of aquatic invertebrates and vertebrates. Spiders and insects are also seasonally abundant.

Ponds and freshwater lagoons, either naturally or artificially made, are permanent impoundments of freshwater with less seasonal fluctuation in water levels. They are characterised by deep (more than two metres) open water areas with marshland vegetation around shallower margins. It is these conditions that provide important waterfowl habitat.

In New Zealand they total about 145 000 hectares or 0.5 per cent of New Zealand's land area (Williams, 1983). Within the Manawatu region, oxbows account for nearly three per cent of the total wetland area, and approximately 0.12 per cent of the total land area (Benn, 1997).

2.2.4 Oxbows

The cutting off of meander loops of rivers forms oxbows during peak flow events (Soons and Selby, 1991). In Benn's (1997) study, oxbow lakes accounted for 5.5 per cent of the Manawatu area surveyed.

2.2.5 Ephemeral Wetlands

Although many wetlands do have surface water, many only do so during flooding, which may occur frequently or for short periods and are known as ephemeral wetlands. These types of wetlands encompass a wide range of plant communities, depending on such factors as altitude, rainfall, parent rock material, and history of disturbance. What they have in common is alternating periods, of greater or lesser length, in which water is present or absent from the surface. Many wetlands have surface water only when water is most available because of recent high rainfall, large volumes of melting snow, or because plants have not had time to expire the water vapour into the atmosphere (Johnson, 1987). Ogle (1994) states that it is this periodic absence of water that is responsible for the disproportionate loss of ephemeral wetlands compared with permanent waters.

The variability of surface water supply does not limit wetland functions, but actually increases them (Robinson, 1995). It allows them to create temporarily wet habitats in normally dry regions, to absorb pollutants, to provide refuge for fish and other animals during high water levels, and to perform other functions such as those described in Chapter 10.0.

There is a major lack of appreciation of ephemeral wetlands, of their ecological importance, their national rarity, their great range of type, and of the dynamics of such systems, including the vulnerability of many types to disturbance. Nature conservation tends to fare badly in competing interests for use of wetlands that are not permanently wet (Ogle, 1990). This is further emphasised in an article taken from the Environmental News Network, which quotes a wetland scientist as saying, " (ephemeral wetlands)...are much harder to appreciate than vast marsh areas. But without these smaller wetlands, it is very possible that much of the animal and plant life that make wetlands rich, productive habitats would not survive. We need to worry about the conservation of smaller wetlands as well as the larger ones."

Robinson (1995) claims that the value of smaller and temporary wetlands for maintaining biodiversity and wildlife is widely recognised, but judging by the lack of publications relating to ephemeral wetlands in New Zealand, it could be argued that these types of wetlands are not given the respect that they deserve.

Ephemeral wetlands are not poor quality versions of permanent wetlands, they are a distinctly different type of habitat, used by species that are adapted to the changing conditions that they face. It is important that landowners, planners, resource managers, and the public recognise ephemeral wetlands for their dynamic nature and specialised biota (Ogle, 1994).

Robinson (1995) shows that there is an inverse relationship between the size of a wetland and the degree of water permanence, and the proportion of time waterfowl spend there. The information presented in her paper is summarised in Table One.

Table 1: Density of breeding pairs for five species of ducks of wetland of various sizes in North and South Dakota, and Montana.

Wetland Size (hectare)	Pairs/Hectare
0.04	8.28
0.20	3.74
0.41	2.67
0.81	1.89
2.02	1.22
4.05	0.87

Thompson (1983) first attempted to produce some sort of classification system for wetlands in New Zealand, but it is well known that any sort of classification system can be troubled by controversy and problems, due to the large variety of wetland types and their dynamic nature. Further difficulties arise due to the attempts to define wetland boundaries (Finlayson and Moser, 1991).

3 Wetland Features

3.1 Buffer Zones and Riparian Margins

Buffer zones can be described as vegetated zones, either partially cleared or undisturbed, located between natural resources, and areas where human activity has altered the natural environment (Castelle et al., 1994). They differ from riparian margins in that they usually cover an area much greater than that of the narrow vegetative strip around the wetland or water body known as a riparian margin. In many cases, riparian margins are the only protection given to wetlands from the surrounding land use activities.

Buffers that are undersize may not effectively remove pollutants from entering the wetland, but if a buffer is too big, it may reduce the amount of land that is available for the landowner to utilise in a more economically efficient way (Castelle et al., 1994).

These areas are can be useful methods for reducing the input of pollutants and nutrients into wetland systems. They may fall under one of two categories; fixed width or variable width. Fixed width buffers are most often based on a single parameter, such as functional value. These are more easily enforced, as they do not require regulatory experts in wetland ecology, allow for greater predictability, and require smaller expenditures of both time and money to administer. However, they do have their flaws. Fixed width buffers do not consider site-specific conditions, and may not provide adequate protection to wetland ecosystems (Castelle et al., 1994).

Variable width buffer requirements consider site-specific conditions and may be adjusted accordingly to adequately protect valuable resources. These require a greater expenditure of resources and a higher level of training for monitoring staff, while offering less predictability for land use planning (Castelle et al., 1994).

In order to assess the effectiveness of a buffer zone, it is useful to look at the existing vegetation. If it consists of dense native vegetation, then the size of the strip may be smaller than that consisting of disturbed vegetation. Small riparian margins are also useful to protect areas that are of low functional value, and adjacent land use has low impact potential. Conversely, large buffers are required for wetlands that are of high value, and are surrounded by intense land use activities. (Castelle et al., 1994). Obviously the area of contention is the valuation of the wetland. The issues that must be kept in mind are; who values the wetland, and what indicators do they use to value it? For example, a wildlife society will have contrasting opinions and expectations to those of a landowner wanting to use the wetland for wastewater disposal.

3.1.1 Nutrient and Sediment Removal

Vegetated margins can remove metals and nutrients by both filtering water and via plant uptake (Castelle et al., 1994). It is not within the scope of this report to detail the ways in which these processes take place.

Castelle et al., (1994) stated that small buffers were able to remove small amounts of sediments, but disproportionately large buffer widths are required to remove incrementally larger amounts of sediment. They provide an example that if the sediment removal design criteria were increased from 90 to 95 per cent on a two degree slope, then the buffer widths would have to be doubled from 30.5 to 61 metres.

3.1.2 Erosion Control

Vegetated riparian margins control erosion by three main ways:

- Restricting the flow of sediment and debris;
- Stabilising shore banks and wetland edges; and
- Promoting infiltration.

The vegetation forms a physical barrier that slows surface flow rates and physically traps sediment and debris. The roots of the vegetation sustain the soil structure, and hold together otherwise erodible soil. Further, vegetation resists the formation of water channels which means that the water flowing over the surface of the ground will be much slower, resulting in a higher absorption of water and nutrients as well as allowing more time for the settling of sediments (Castelle et al., 1994).

3.1.3 Other Uses

Forested riparian margins adjacent to wetlands provide cover, helping to maintain lower water temperatures in summer and lessen temperature decreases in winter (Castelle et al., 1994).

Buffers protect wetlands from direct human impact through limiting easy access to the wetland and by blocking or attenuating the conveyance of noise, light, odours, and debris (Castelle et al., 1994).

3.2 Wetland Communities

Wetlands are areas of shallow water containing specially adapted plant and animal communities. These communities are made up of species such as rushes, sedges, reeds, flax, waterfowl, eels, mudfish, aquatic invertebrates and a host of other species. Plants can be used to identify the various types of wetland, as certain plants indicate the fertility and acidity of the soil and water. New Zealand wetlands frequently stand out prominently in the landscape, with their outlines marked by a dramatic change of plants. This contrasts with other countries where wetlands merge gently into their surroundings (Buxton, 1991).

Within constructed wetlands, plants have two important functions according to Osborne and Adcock (1995):

1. In the water column, stems and leaves significantly increase surface area for the attachment of microbial populations; and
2. Wetland plants transport atmospheric gases, including oxygen, down into the roots and the sediments that surround them.

Further, the plants also require nutrients and trace elements and therefore play a direct role in pollutant removal. However this role may not be sustained unless plant harvesting is carried out. Aquatic plants also act as filters and reduce suspended solid loads as well as physically stabilising the sediments through root development.

The proper functioning of wetlands is dependent on the establishment and maintenance of a dense cover of emergent wetland plants. The plants perform a variety of roles (Tanner and Kloosterman, 1997) including:

- Promoting the settling of suspended solids;
- Providing surfaces for the development of biofilms;
- Shading the water surface to reduce algal growth;
- Releasing oxygen into their root zone;
- Taking up and cycling nutrients; and
- Improving wildlife and aesthetic values.

3.3 Habitats

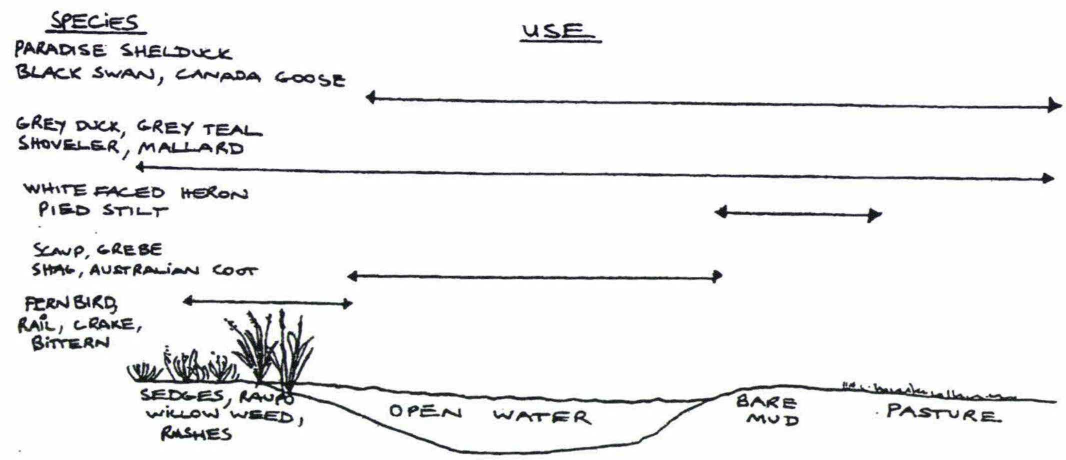
Small remnant habitats such as wetlands provide refuge and need protection and enhancement to help maintain genetic diversity and wildlife corridors between significant habitats. They help to ensure that the indigenous species remains part of the regional biodiversity (Manawatu-Wanganui Regional Council, 1998b).

3.3.1 Waterfowl

Ducks, swans, geese and paradise shelduck generally favour shallow water bodies. Emergent, floating or submergent vegetation is important as food and cover, and as the habitat for aquatic invertebrates on which the young birds depend on. Rough upland vegetation adjoining the wetland provides important shelter for nesting. Ducks require ponds or streams with densely vegetated margins to afford protection from disturbance during their annual moult. Large open expanses of water, open riverbeds or streams are favoured by geese and paradise shelduck for moulting. Some waterfowl species such as blue duck and grey duck have special habitat needs, including wild river environments (NWASCO, 1982) (Figure Three).

Figure 3: Wetland Bird Habitat Zones

Figure 3: Wetland Bird Habitat Zones



Source: Buxton, 1991

Temporary and seasonal wetlands allow breeding waterfowl to isolate themselves from others. This provides more distinct territories, and helps limit the impact of diseases that can cause damage if animals are not spread out (Robinson, 1995).

Additionally, waterfowl require water levels of different depths. Some ducks dive in deeper waters, but others can only dabble and cannot feed at water depths deeper than their extended neck lengths (Robinson, 1995).

3.3.2 Diving Birds

The New Zealand scaup, grebes and shags obtain their food by diving and require standing or flowing water of sufficient depth for this (NWASCO, 1982).

3.3.3 Wading Birds

Herons, oystercatchers, stilts, godwits, plovers and other waders prefer shallow lakes, margins of lagoons, estuaries, and rivers and wet or boggy soils. They like open expanses relatively free of vegetation for feeding and resting (NWASCO, 1982).

3.3.4 Coastal Birds

Gulls and terns feed in shallow coastal waters, lagoons, lake and rivers, and generally breed on sand spits and shingle bars devoid of vegetation (NWASCO, 1982).

3.3.5 Marsh Birds

Bitterns, crakes, rails and fernbirds live almost entirely in dense thickets of aquatic emergent vegetation or in rush and shrub associations on waterlogged soils (NWASCO, 1982).

4 Wetlands in New Zealand

4.1 History

Wetlands have always had an important role within Maori communities. They provided food, material for clothing, weaving, dyes, landing sites, places to season timber, and to store taonga. Increasing recognition of and respect of rights and traditions of Maori, bring some new responsibilities and a bicultural perspective on conservation (DoC, 1996a).

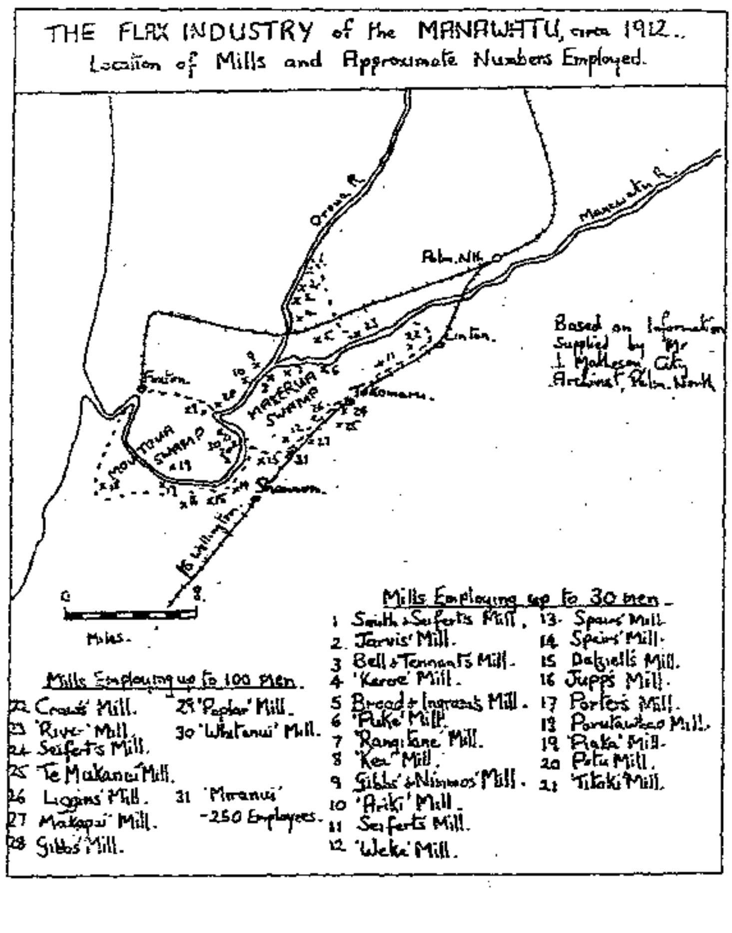
The history of wetland conversion and modification often relates to phases in New Zealand's history when native lands were being converted to land suitable for pasture. This was due to two factors. First there was the recognition that if the wetlands could be drained, the area could become prime productive land, with examples already being proved in other parts of the country (Holcroft, 1977). Secondly there was "overwhelming" economic incentives to convert as much land as possible to productive commercial use, even the clearance of natural riverbank vegetation, which protects waterways, soils, forest, and aquatic biodiversity. Consequently, it is estimated that approximately eight per cent of original wetlands now remain (Jones et al., 1995; DoC, 1996a; Smith, 1997; DoC Web Site, 1999).

Much of the Manawatu Plains consisted of swamp, with areas of kahikatea and related species in forest, but even more extensive areas of flax and raupo. To the west, the flats were covered by dense rainforest containing extensive stands of timber dominated by totara, matai, rimu, and kahikatea (Peterson, 1973). This vegetative cover led to the beginnings of the local economies, for example, Foxton's early growth was based on flaxmilling (Figures Four and Five). A port was developed to export commodities such as flax, timber, and agricultural products from the Manawatu (Manawatu-Wanganui Regional Council, 1998b).

Figure 4: Flaxmills Isolated by Flood Waters from the Manawatu River in 1904

Source: Holcroft, 1977

Figure 5: The Flax Industry of the Manawatu 1912.



Source: Fitzgerald 1970

Peterson (1973) goes on to describe what the Manawatu must have looked like through the eyes of the pioneer.

> *"This forested area almost covered the Upper Manawatu or Ahuaturanga block, a mysterious appearing unknown land, an untamed wilderness. The deep sluggish creeks that wound through the forest, the riverside lagoons and flax choked swamps swarmed with eel and waterfowl, the groves of karaka and hinau were in season laden with fruit, and the dense bush gave shelter to myriads of pigeons, kakas, tuis, wekas and kiwis which frequented the forest and river margins where the moa had once stalked. But this great territory was uninhabited by man, except for the pas and kaingas of the Rangitane along the riverbanks was valued by the Maori only as a source of food or place of refuge from the enemy. It lay remote from any greatly used line of communication and was traversed only by a few intermittently used forest tracks."*

In the swampiest parts of the region, stopbanks and water pumping were needed to keep the land dry, because when these rivers experienced seasonal floods, the water would flow into the flats, and fill low swampy areas, making even foot travel impossible. The one of the least attractive features of the Manawatu was the flood-prone swamplands near the lower course of the Manawatu River near Shannon (now in the locality of the Motua floodgates). This area was drained in 1901 by the Wellington-Manawatu Railway company (Craig, 1968). In many cases, travel was best made by travelling up the Manawatu and Oroua Rivers which meandered their way across the floodplains, and allowed a means of penetrating the swampy lowland without which exploration would have been nearly impossible (Peterson, 1973).

Preparing the swampy land for pasture was not an easy task. As the surface sank under the process of drainage, outcrops of logs and stumps appeared and had to be extracted and removed or burnt. In many places a further outcrop of old timer emerged the following year and the process of stumping and up-rooting the logs had to be repeated two or three times (Peterson, 1973). The demise of these areas is summarised by Holcroft (1977), who noted that native birds were retreating to the hills, streams where the Maori had fished for eels had become congested by the debris of fallen trees, and swamps that were once abundant sources of waterfowl, were silent and empty.

Wetlands continue to be subject to change throughout the country through the extension of urban settlements on to wetlands; sand and gravel extraction, drainage, and weed encroachment (DoC, 1996a).

4.1.1 Past Vegetation

Remnants suggest that kahikatea grew near the western margin of the Makerua swamp on land that was occasionally flooded by the Manawatu River (Elser, 1978).

In the lower parts of the Manawatu River below its junction with the Oroua River, semi-swamp forest tended to occupy higher ground, with the lower parts occupied by wetlands (Elser, 1978). Where surface water is present throughout the year, raupo was dominant. When the summer reduced the water table, Phormium (flax), toetoe and cabbage trees were present (Hannigan, 1982).

4.2 Wetland Management Problems

Draining and developing these extensive wetlands was seen in the pioneering era as a necessary step towards national prosperity. That was the view that most people generally accepted then, and perhaps by some people today (Pike, 1991).

There are two main reasons for the lack of transfer of scientific and monitoring data into wetland conservation action. The first being those managers often do not have much time to spend on lengthy and detailed ecosystem monitoring. Secondly, most wetlands occur on private land, where landowners do not have simple and reliable monitoring tools available to assess the influence of their land management actions on the wetlands (Spencer et al., 1998)

Of relevance to this thesis is the fact that government policy in respect of land development hastened the destruction of wetlands. Grants and loans to landowners for the development of agriculture and forestry are accountable for wetland loss and that of other natural habitats throughout the country. This has been the result of a lack of a clear national statement regarding wetlands according to Jones et al., (1995). In Britain, the process of land drainage was largely implemented and managed by agricultural interests, which were aided by grants of up 50 per cent of total costs (Carter, 1988). An example of this is taken from Pike (1991), where he recalls that as late as 1987, the Rivers Control Council understood the issues that were arising from wetland drainage and destruction (by lobbying from the Wildlife Service), but had a statutory duty to assist in the drainage of wetlands when owners or occupiers wanted to 'improve' it. Furthermore, the legislation did not deny any landowner the right to drain any wetland, no matter how valuable to flora and fauna or what other natural resource values it had. This was aided further by government grants that subsidised up to 80 per cent for farm development and drainage schemes.

4.3 Wetlands Today in New Zealand

Wetland ecosystems are characteristic of New Zealand, being due to the fact that New Zealand experiences a lot of storms, earthquakes and ice, the factors which contribute to the formation of wetlands. The various forms of wetland found in New Zealand show the linkage between physical processes with physical features. For example, rivers and bogs from frequent rain, swamps from the deposition of erosion products by rivers and the sea, and estuaries and lagoons from tidal flooding of old river valleys. These features provide habitats for species that form the uniqueness of the New Zealand biogeographic region. Examples of these are; flax swamps, waterfowl habitats, high country bogs, tarns, reed estuaries, and kahikatea (*Dacrycarpus dacrydioides*) swamp forest (DoC, 1996a).

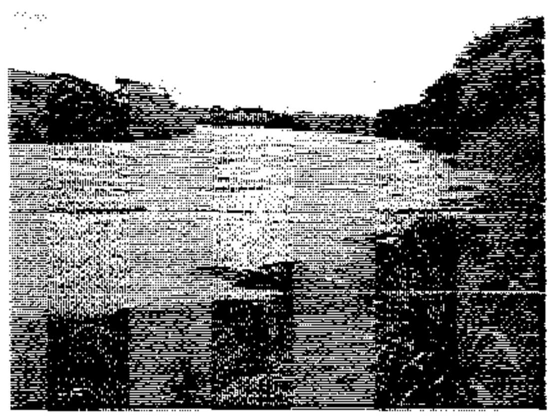
New Zealand's wetlands are as varied as the terrain that shapes them, but they can be broadly grouped into three categories reflecting their water quality and typical vegetation. The first group is Eutrophic mires. These have high nutrient levels and are dominated by the native weed, raupo (*Typha orientalis*). Mesotrophic wetlands have moderate nutrient levels and are dominated by rushes, sedges, and the native flax harakeke (*Phormium tenax*). Oligotrophic bogs have very low nutrient levels and are dominated by spaghnum moss, rush-like sedges (such as *Schoenis*, *Baumea*, and *Tetraia* species) and restiad rushes (*Empodisma* and *Sporodanthus* for example). The oligotrophic wetlands often have no significant surface water (Smith, 1997).

Between 1954 and 1976, surveys by the former Wildlife Service found that 263,000 hectares were lost at a rate of nearly 12,000 hectares per year. Surveying stopped when the Wildlife Service was integrated into the Department of Conservation (DoC). DoC has since then set up a wetland inventory (WERI), which lists about 3,000 wetlands. WERI is based on ecological and regionally significant trends, and is not systematically updated The WERI database contains all the important wetlands (Smith, 1997).

Wetland areas have been reduced by about 85 per cent in the last century and a half, from nearly 700,000 hectares to about 100,000 hectares. Several thousand wetlands remain, including more than 70, which are deemed to be of international importance. Drainage, pollution, animal grazing and introduced plants have degraded many of the surviving wetlands. Some of the most depleted wetlands in New Zealand are ephemeral wetlands. This may be due to many people thinking that land that is not permanently submerged is not wetland, and therefore has less conservation value than a 'real wetland' (Ogle, 1994; Smith, 1997).

The drainage schemes currently installed do not allow for the natural seepage and ponding of rainwater. Instead, it is directed to rivers and streams and transported swiftly away. Cattle have access to areas suitable for waterfowl, weeds, eutrophication (Figure Six) and pollution have all reduced the biodiversity of many surviving wetlands (Smith, 1997).

Figure 6: Wetland with High Level of Eutrophication



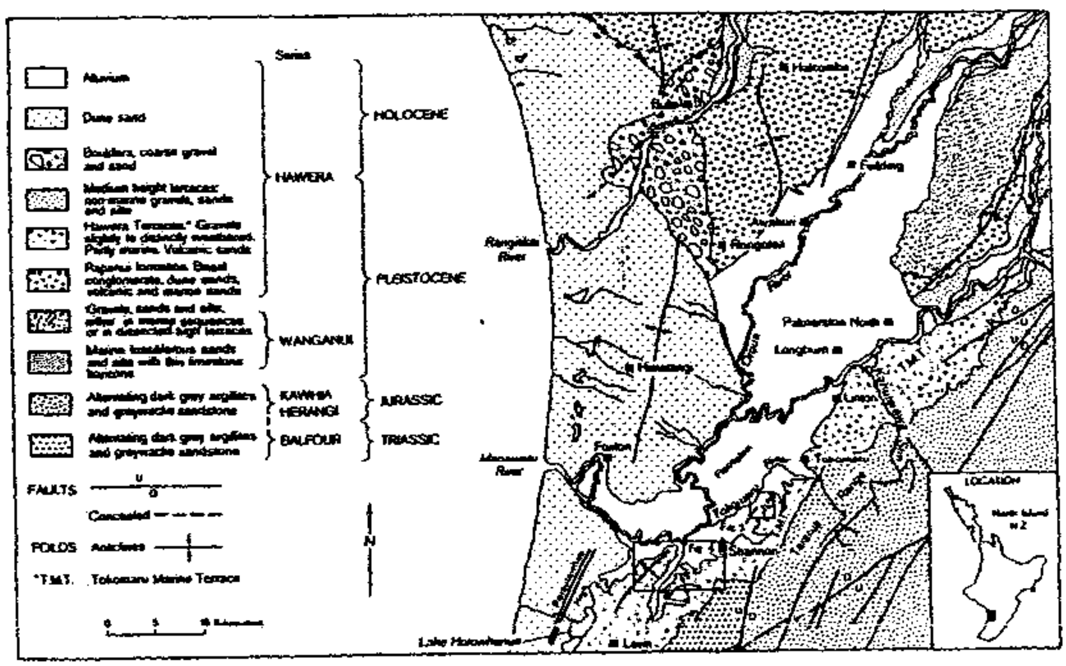
Several attempts have been made to estimate the extent of the wetland decline in New Zealand. Landcare scientists have used soil maps to estimate that the original area of freshwater wetland was about 672,000 hectares. Earlier estimates including saltwater wetlands and salt marshes put the original wetland area at over one million hectares (Smith, 1997).

Although some wetlands span thousands of hectares, most are only a few hectares. These are made up of about 900 mountain tarns and small lakes, coastal lagoons, small dune lakes, several peat wetlands, numerous swampy valleys, saltmarshes, mangrove estuaries, and braided rivers. In addition to this list should be added; constructed wetlands (for example, wastewater disposal), hydro lake margins (Smith, 1997).

5 Manawatu Region

During the last glaciation (about 6000 BP), a major estuary existed in the present Manawatu flood plain, while many valleys within the Tokomaru Marine Terrace became branches of the estuary. Subsequent filling with estuarine and fluvial sediment led to the formation of the flood plain and nearby valleys (Hesp and Shepherd, 1978). This study showed that the Himitangi Anticline and the Poroutawhao High formed barriers behind which the present dune lakes can now be found (Figure Seven).

Figure 7: Geology of the Manawatu



Source: Hesp and Shepherd, 1978

When one or more parabolic sand dunes moves across an older sandplain, it can restrict water runoff from that sandplain, and form a dune lake. Sometimes a chain of lakes results, the most obvious example can be found the along Rangitikei and Manawatu rivers (Ravine, 1992).

Major drainage works carried out over the last 100 years have had drastic effects on the dune lakes. Even where a lake has not been drained directly, its level may have been lowered as a result of drainage of swamps or lakes nearby (Ravine, 1992). In the southwestern part of the Manawatu the coastal environment has experienced degradation of its native vegetation, with only local areas of scrub and wetland remaining (Manawatu-Wanganui Regional Council, 1998b). Much of this destructive work on the environment was carried out prior to the first run of aerial photographs that were used in this study, therefore limiting the ability to be able to assess the full effect of humans on the natural environment. Even so, the region has more than 40 named lakes. Twenty-five of these are coastal dune lakes that are spread along the length of the coastline, and up to 20 kilometres inland (Horizons.MW, 1999a).

Almost all of the oxbow lakes and swamps that were once prevalent in the flood plain of the Manawatu have been drained and converted to pasture. The ones that are left are nutrient enriched, and some are seasonally dry. However they remain very important sources of habitat for wildlife (Horizons.MW, 1999a).

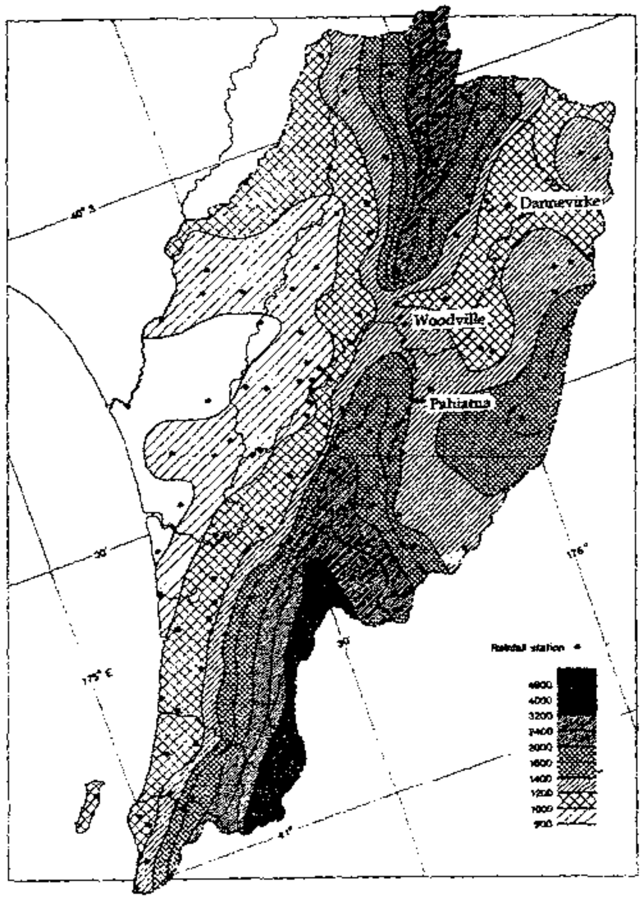
Benn's (1997) study of wetlands in the Manawatu identified 2136 wetland sites within an area of 6130 hectares. The average size of the wetlands was 2.87 hectares, with the majority being small, artificial, or modified. More than half had no fencing. Benn concluded that the overall condition of wetlands in the Manawatu Plains was poor.

5.1 Rainfall

The coastal and lowland area of Manawatu, is one of the driest areas in the North Island, with rainfall providing enough moisture for agricultural needs, except during the exceptionally dry summer months of January and February. Although summer rainfall is relatively low in some areas, extended dry spells of very dry weather is infrequent (Burgess, 1983).

Annual rainfall is evenly spread over coastal and lowland areas of Horowhenua and Manawatu, and amounts range from under 900 millimetres near the coast on the Rangitikei Plains between Bulls and Foxton, to 1200 millimetres or more in the more elevated areas. These elevated areas, that is those areas of the Tararua and Ruahine Ranges, can have rainfall twice as great (Burgess, 1983) as those that are recorded on the coastal lowlands (Figure Eight).

Figure 8: Mean Annual Rainfall in the Manawatu (1951-80)



Source: Burgess, 1983

June, July and August are usually the wettest periods of the year, rainfall totals can also be quite high during December, especially inland, and north of the Manawatu Gorge. This is probably due to enhanced convectional activity in moist airstreams due to strong surface heating (Burgess, 1983).

5.2 Manawatu Wetland Soils

The Manawatu is an area composed of almost entirely sedimentary rocks, varying in age from 150-180 million years, to present-day alluvial and marine deposits (Heerdegen and Shepherd, 1992). The soils of wetlands are formed from the alluvium brought down by rivers and streams and deposited during periods of flooding. The differences between the soils are largely due to the frequency of flood deposition, the texture of the alluvium, and natural drainage (Carpenter, 1992).

Where flooding is more frequent, and the material is coarser, the soils (Rangiteiki soils) are sandy and stony with little soil profile development. They have rapid drainage, causing drying out during the summer. They are also liable to river erosion or burial from fresh flood deposits (Carpenter, 1992).

On the higher and more drained river and stream levees where flooding is less frequent, the soils (Manawatu soils) are deeper and consist of dark brown silt or sandy loams overlying olive brown silty or sandy subsoils which grade down to gravels or sand. These soils are fertile and are now mainly used for dairying or horticulture (Carpenter, 1992).

In the low lying swamps where the water table was originally near the surface for most of the year, the soils grade into peaty Makerua and Opiki soils. In these soils, decomposition of dead plant material has been slowed down by a lack of oxygen and has accumulated as peat either as thick surface deposits or layers within the alluvium. The original vegetation in these areas was mainly rushes, sedges, and flax. However the remnant logs and stumps suggest that forest too had been present. These peats are mature and non-acidic. Once drained, can be used for dairying and horticulture (Carpenter, 1992).

5.3 Drainage

The Koputaroa, Motua and Makerua areas (Figure Five) are former swamps that are subject to drainage by drainage schemes. These schemes and following upgrades allowed farmers to intensify their production as demand increased. The Makerua Drainage Scheme has recently had its resource consents extended in order to meet the drainage requirements of local farmers. This has not been without its controversy (Appendix 21.1).

5.4 Manawatu Wetlands

In 1997, the Wellington branch of the Fish and Game Council commissioned a survey of wetlands in the Manawatu ecological district. The study looked at 2136 sites, within 6130 hectares. Most of the wetlands surveyed were artificial or greatly modified in some way.
The most common modification features of these wetlands were some form of water level control structure. These structures were found on about two thirds of the selected wetlands, with about 50 percent having some form of associated drainage.

In terms of the threats identified by this study, Benn (1997) stated that eutrophication, infilling and drainage are the major threats. He also pointed out that these threats are exacerbated by the fact that most of the wetlands studied had little or no fencing to keep out grazing stock. Additionally, apart from Lake Horowhenua, the coastal dune lakes have not been monitored since a survey during a period lasting from 1977 to 1982. But anecdotal evidence in a Horizons.MW (1999) report suggests that the condition of some of these lakes is continuing to deteriorate.

Benn concluded that the overall condition of wetlands on the Manawatu plains is poor. It must be kept in mind at this point however, that this report was commissioned by the Fish and Game Council, and that other organisations may have differing opinions as to what determines a wetland to be in poor condition.

Many wetlands can be found within the dune country between Foxton and Tangimoana, with a concentration in a line three to four kilometres inland near the junction of the western side of the Himitangi Anticline with the Holocene coastal plain. According to Heerdegen and Shepherd (1992), these wetlands are of recent age, and probably formed after the Motuiti dune building phase when water tables were likely to have risen in response to continued progradation of the coastal plain. At nearby coastal zones, lakes are concentrated at the inner margin of the dunefield where the valleys of small streams issuing from the Last Interglacial marine terrace were blocked by migrating dunes. These wetlands contain a much thicker infill of sediment and some may formed as early as the final stages of the postglacial marine transgression (Heerdegen and Shepherd, 1992).

5.4.1 Wetland Areas

Horizons.MW believes that some habitats in the region are more significant than others, depending on their rarity, distinctiveness, and their ability to regenerate. For example the Manawatu River Estuary is a rare habitat, which is also nationally important.

5.4.1.1 Regionally Significant Wetlands

A study between 1977-82 was undertaken by the Rangitikei-Wanganui Catchment Board, and tested a number of coastal lakes for trophic status using Chlorophyll-*a*. The results show that Lake Alice (a lake that has been included in this study) had a Chlorophyll-*a* score of 190 milligrams per cubic metre (Horizons.MW, 1999a). This meant that Lake Alice was in a significantly trophic state, as Lake Dudding nearby had a reading of 2.7 milligrams per cubic metre. Secchi visibility tests where also used for these surveys, as was used for the research in this report.

Pukepuke Lagoon

Pukepuke Lagoon is a coastal dune lake located inland between Tangimoana Beach and Himatangi Beach, and is administered by the DoC (Manawatu-Wanganui Regional Council 1997a). The area includes 82 hectares of wetland with 15 hectares being open water (Armstrong, 1997).

The lagoon provides a valuable habitat for some rare bird species including the banded rail and the marsh crake. However it is not a wetland of international importance, as it has already been highly modified by drainage and the introduction of foreign plants and species. It is also affected by livestock, rabbits, weeds, and by the lowering of the water table by adjacent pine plantations. In 1870, the wetland was around 480 hectares. This consisted of a lagoon of about 160 hectares and swampland of around 320 hectares. Today, the total area is no more than 100 hectares, with a 15 hectare lagoon. Even with this kind of modification, the wetland is perhaps one of the largest and least modified dune lake in the Manawatu coastal region (Manawatu-Wanganui Regional Council, 1997a; Smith, 1997).

Pukepuke Lagoon is included in the Regional Policy Statement list of regionally significant natural features and landscapes. The values and attributes of this wetland to be protected from inappropriate subdivision, use and development are:

- Its scenic quality as a prominent coastal wetland;
- Its ecological importance as a habitat for rare bird species; and
- Its value as a wildlife management reserve.

Manawatu River Estuary

The largest estuary in the Manawatu is the Manawatu River estuary. It was initially formed when the lower part of the valley, was inundated during the postglacial marine transgression. At this time (about 6500 years ago), the estuary extended east to Shannon and north to Opiki, with extensions into the lower parts of the tributary valleys that cross, or rise within the adjacent Tokomaru Marine Terrace. Today little of the original estuary remains, due to infilling of estuarine sediment, followed by fluvial and wetland deposits. This infilling was most likely increased by the introduction of the exotic marsh grass, *Spartina x townsedii,* in 1913 (Heerdegen and Shepherd, 1992).

The DoC considers that the Manawatu River estuary has national importance as a nursery for freshwater and estuarine species. It is an internationally important site for migratory bird species and provides the habitat for rare and threatened bird species. It is also an important roosting and feeding are for wading birds, as well as containing regionally significant plant species (Manawatu-Wanganui Regional Council, 1997b).

The estuary provides regionally important examples of estuarine landforms, with its extensive tidal mudflats and a series of sand dunes. The area includes a 100-hectare saltmarsh on the north bank along the loop edge and two smaller saltmarshes totalling about 40 hectares on the south bank of the river. Much of the area is in a relatively natural state (Manawatu-Wanganui Regional Council, 1997b).

Lake Horowhenua

Lake Horowhenua is a shallow freshwater dune lake between the west coast and Levin. The lake catchment extends back to the Tararua Ranges. Hokio Stream is the only outlet that drains it to the sea. The surface area of the lake is 2.9 square kilometres, with a maximum depth of less than two metres. Both ground and surface water feed the lake (Manawatu-Wanganui Regional Council, 1997c).

The Reserves and Other Land Dispersal Act 1956 specified that the lake level be kept at 9.14 metres above the mean low water springs at Foxton Heads. To help achieve this, a weir has been constructed at the junction of where the lake drains into Hokio Stream. The stream flows through five kilometres of rural farmland before it reaches the coast (Manawatu-Wanganui Regional Council, 1997c).

Lake Horowhenua has historical significance, particularly as a plentiful food source of eels, fish, and shellfish. It also provides habitat for carp, ducks and swans, as well as being recognised as a breeding ground for the banded kokupu (Manawatu-Wanganui Regional Council, 1997c).

The values that the lake holds are mainly in the form of scenic and recreational values. Recreation at the lake is limited due to the lake being unsuitable for contact recreation, however sailing and rowing do take place on the water. The water is unsuitable for contact recreation because treated sewage effluent was discharged into the lake between 1952 and 1987. The water quality of the lake is said to be improving since then (Manawatu-Wanganui Regional Council, 1997c).

The Regional Policy Statement list of regionally significant natural features and landscapes includes Lake Horowhenua and its margin. The values and attributes of the lake to be protected from inappropriate subdivision, use and development are (Manawatu-Wanganui Regional Council, 1997c):

- Its ecological importance as a wildlife habitat and as a breeding habitat for the banded kokopu;
- Its importance to tangata whenua; and
- Its recreational value for water sports

Lake Papaitonga

Lake Papaitonga is another shallow freshwater coastal dune lake, situated south west of Levin. Wetland and coastal forest surround one side of the lake, with a wetland that merges into farmland on the other (Manawatu-Wanganui Regional Council, 1997c).

The DoC administers the land surrounding the lake, and the land is managed as a recreational reserve containing walking tracks (Manawatu-Wanganui Regional Council, 1997c).

Tangata whenua regard the lake as being significant because Mua Upoko (the local iwi) once had pa sites in the area and it is thought that the lakeshores contain midden sites and sunken canoes. The tribe still uses the lake and the reserve around the lake as a source of food and craft material (Manawatu-Wanganui Regional Council, 1997c).

The Regional Policy Statement list of regionally significant natural features and landscapes includes Lake Papaitonga and the recreational reserve next to it. The values and attributes of the lake to be protected from inappropriate subdivision, use and development are (Manawatu-Wanganui Regional Council, 1997c):

- Its value as a recreational reserve;
- Its ecological importance as a habitat for wildfowl, whitebait and land snails;
- Its importance to tangata whenua; and
- Its scenic qualities provided by its forested margin

In the southwestern part of the Manawatu, the coastal environment (including areas of wetlands, lakes and the sand dune system) has almost been stripped of native vegetation, though local areas of low forest and scrub on dunes and around wetlands remain (Manawatu-Wanganui Regional Council, 1998b).

6 Wetland Management

The high water table of a wetland means that wetlands are more susceptible to management activities outside the wetland than is the case for dryland areas. Scientific and environmental impact studies must often extend beyond the visible wetland boundaries in order to be able to understand wetland functioning. These boundaries are often difficult to define. This is because there is a gradual transition from wetland to dryland. Wetland area varies seasonally too, which makes scientific analysis difficult (Thompson, 1983).

Managing wetlands by a policy of simply allowing wetlands to develop or change without direct management is an option, however it is unlikely for two main reasons (Adam, 1995):

1. There may be features of wetlands (either species or functions) whose survival is of importance to society.
2. Local authorities seek instant solutions. A condition of a resource consent may be that a certain wetland type exist on a site within a short period, while the natural process of colonisation and development occurs over many years.

Actions undertaken by the DoC at certain wetland sites have included statutory advocacy (submissions), reservation, covenanting, investigation of potential Ramsar sites, preparation of management plans, survey and monitoring, research, threatened species management, restoration, plant and animal pest control, water level management, publicity and educational work (DoC, 1996a).

The Regional Coastal Policy Statement (1997) for the Manawatu-Wanganui Region, states that the objectives for all protected areas will be no loss of habitats or significant ecological values, including natural character. It goes on to state that there will be limits on the use of the area, recognising the value and sensitivity of the estuaries in the protected area. Neighbouring areas will also be managed so that the protected area is not compromised. Rules relating specifically to the protected area have been developed recognising the significant ecological values of these areas, and their importance to the region (Manawatu-Wanganui Regional Council, 1997b).

6.1 Regional Councils

Regional Councils have played a big part in the destruction of wetland habitat over the last 100 years. Their predecessors, the Catchment Boards, provided engineering expertise to farmers and others for drains, diversions, ditches, dams and other means of removing water from the land (Fish and Game New Zealand, 1999).

Regional Councils' responsibilities in relation to wetlands can be separated into two broad areas – those within the coastal marine area, and those outside it. The coastal marine area is administered by a regional coastal plan, and is the area below the mean high water springs out to the 12-mile territorial limit at sea. Regional Councils have a responsibility under the RMA for monitoring the quality of water within each region, they are also responsible for the issuing resource consents under the RMA. Any action likely to affect the water in or near a wetland will require the consent of the local regional council. The Minister of Conservation has a role in consents for Restricted Coastal Activities under the RMA. The Minister also approves Regional Council's Regional Coastal Plans (Frost, 1992; DoC, 1996b).

Regional Councils can affect the use and management of wetlands through their functions as a consent granting authority. They are given the responsibility to grant permits relating to water, discharges, and the coastal environment (Jones et al., 1995).

6.2 Local Authorities

Territorial local authorities (districts and cities) have primary responsibility for managing the effects of land use. They are given control over land use and subdivision, for which they are able to issue consents. Through their control over land use, local authorities have a direct influence over the development of wetlands. Local authorities are required to prepare a district plan detailing resource management policies and objectives, and methods of achieving the stated objectives. The RMA requires that a district plan must "have regard to" the respective regional policy statements and plans. Local authorities are also required to take out heritage orders prescribing the protection of areas of cultural, architectural, historical, scientific, or ecological interest (Frost, 1992; Jones et al., 1995).

6.3 Regional Policy Statements

The purpose of the Regional Policy Statement (RPS) is to achieve the purpose of the RMA, which is to promote the sustainable management of natural and physical resources by setting out the significant resource management issues and a statement of methods to be used to implement the policies. In doing so, the RPS must provide an overview of the resource management issues of the region, and provide for the integrated management of its natural and physical resources (Jones et al., 1995; Manawatu-Wanganui Regional Council, 1998).

The RPS must look at the issue relating to resources, such as land, water, air, and the coast, that are of importance to the region. These issues must be addressed in a way that promotes the sustainable and integrated management of resources (Manawatu-Wanganui Regional Council, 1998).

6.3.1 District Plans

Every territorial authority is required to prepare a district plan to assist it carrying out its functions under the RMA, and these must not be inconsistent with the regional policy statement or any other plans that are produced for the region. District plans contain rules restricting certain use and development of land, and can designate land for particular uses where the use can cause adverse significant effects on the environment (Horizons.MW, 1999a).

6.4 Water Conservation Orders

These are intended to recognise and sustain outstanding amenity or intrinsic values that water in its natural state presents. Under Section 201 of the RMA, anyone can make an application for a water conservation order (WCO) to the Minister for the Environment. A WCO offers an avenue for protection of water, by allowing the protection of a water body in its natural state. WCO's also allow for the protection of characteristics such as wildlife habitat, scenic, scientific, historical, spiritual, cultural, ecological, and recreational features.

Under the RMA, WCO's are designed to protect "water bodies" or outstanding value. The term 'water body' is defined as including "fresh water or geothermal water in a river, lake, stream, pond, wetland, or aquifer, or any part thereof, that is not located within the coastal marine area". (Lile, 1993). The RMA provides for WCO's to preserve water already partially modified, and can be used to set rules or guidelines to protect water quality in water bodies.

Between 1981 and 1992, 23 WCO's were finalised and granted (Mosley 1992).

WCO's frequently have a "no dams" clause to safeguard trout and salmon fisheries. This provision also allows for the preservation in their natural state of wild and scenic sections of rivers that have outstanding values for recreational uses such as canoeing (Mosley 1992).

It should be noted here that WCO's only protect 'water'. It should be realised that if a wetland is in need of protection (that is, including its soil, water, and biotic features), then a WCO would not be as effective as a Heritage Order. Further, WCO's do not restrict or affect water rights before the Order was made. Therefore it is evident that the main value of WCO provisions is the opportunities they provide for individuals, with no statutory power to protect water values (Lile, 1993).

6.5 Heritage Orders

These expand on water conservation orders to include cultural and historic sites not covered by water conservation orders. These are aimed at providing a means by which special interest parties can ensure the conservation or preservation of places of special interest (Frost, 1992).

6.6 Treaty of Waitangi

The Treaty of Waitangi was signed in 1840, and was a contract between Maori tribes and the Crown. In this deal, Maori exchanged legal sovereignty for the guarantee of chiefly authority over their lands, resources, and treasures, and to have all the rights and privileges of citizenship (Fish and Game New Zealand, 1997a).

The principles of the Treaty have been developed and it is these rather than the Treaty itself which are referred to in law. These principles emphasise the concept of partnerships and the Crowns obligation to protect iwi interests including the requirement to consult on all matters that potentially impact their interest. For example, Section Four of the Conservation Act requires Fish and Game to give effect to the principles of the Treaty of Waitangi (Fish and Game New Zealand, 1997a).

7 Organisations Involved with Wetlands

7.1 Horizons.MW

The RMA details the Regional Council's functions, including:

- Control over activities, structures, excavations, drilling, planting drainage and reclamation of any lake or river bed (s.13); and
- Control of the use of land for purposes including the maintenance and enhancement of the quality and quantity of water in water bodies (s.30(1)(c); and
- Control of the taking, use, damming, and diversion of water; and the quantity level, and flow of water in any water body (s.14 an s.30(1)(e)); and
- Control of discharges of contaminants and water into or onto land or water; and discharges of water into water (s.15 and s.30(1)(f)).

During monitoring, routine measures are taken of temperature, dissolved oxygen, pH, conductivity, turbidity, nitrate, dissolved phosphorus, biochemical oxygen demand, and faecal coliform bacteria. The results are then converted into a water quality index using a score between zero to 100:

- 0 – 20 Totally unsuitable for general use
- 21 – 40 Unsuitable
- 41 – 60 Doubtful
- 61 – 80 Suitable
- 81 – 100 Eminently suitable for general use

Horizons.MW (Manawatu-Wanganui Regional Council) is directly involved in environmental resource management projects by providing economic incentives (regional grants and rate relief), pest control and provision of public information. The Lake Horowhenua restoration project is a recent example of co-operation between public agencies and the community. The project was initiated and organised by the local community, in particular Muaupoko who own the lake bed (Horowhenua Lake Trustees, 1996; Ramsar Convention on Wetlands, 1999).

7.2 District Councils

It is important to note that regional councils have direct control over issues relating to water quality and flow in water bodies. The district council has a complementary role in controlling the effects of activities that may adversely effect the natural, ecological, spiritual, and landscape values of natural features and areas (Rangitikei District Council, 1999). The District Councils functions include:

- Control of any actual or potential effects of the use, development, or protection of land (s.9 and s. 31(1)(b)); and
- Control of any actual or potential effects of activities in relation to the surface of water in rivers and lakes (s.31(1)(e)).

7.3 Department of Conservation

The Department of Conservation was established under the Conservation Act (1987). The Department is responsible for the conservation of New Zealand's natural and historic resources. The Department manages those wetlands, that occur on land managed and administered by the Department, and has a statutory role in advocating and advising on conservation of other wetlands. Collectively, the Department has specialists in the fields of botany, zoology, ecology, and wildlife and fisheries management, wetland management, landscape architecture and nursery aspects. The Department also funds some research into specific wetland related issues such as the response of various wetland species to habitat restoration and control of threats (Frost, 1992; DoC, 1996b).

The Department holds inventories on wetlands: WERI database (Wetlands of Ecological and Regional Importance), Coastal Resource Inventory (including wetlands such as mangroves) and

SSBI (Sites of Special Biological Interest). These inventories form an important basis for the Department's advocacy of appropriate management of wetlands by private landowners (DoC, 1996b).

WERI is a computer database that contains about 3,000 wetlands throughout New Zealand. It includes information about wetland size, location, land ownership, classification, modifiers and threats, wildlife and vegetation types, cultural and ecological values, and other sources of information (DoC, 1996b).

The Fauna Survey Unit of the former New Zealand Wildlife Service developed the SSWI wildlife habitat ranking system. The Unit surveyed the whole of New Zealand between 1977 and 1985 on a regional basis to identify all "Sites of Special Wildlife Interest". All natural or semi-natural areas important as habitat for one or more species of wildlife were evaluated and each site ranked into five groups (outstanding, high, moderate-high, moderate, and potential) on the basis of their value to wildlife (DoC, 1996b).

7.4 Ministry of Agriculture and Fisheries (MAF)

MAF is responsible for research on freshwater fisheries and provides advice on the identification, habitat requirements and management of fish that inhabit wetlands. The Aquatic Plant Section of MAF Tech can advise on the types, requirements and management of aquatic and marginal wetland plants (DoC, 1996b).

7.5 Fish and Game Councils

Fish and Game Councils replaced the Acclimatisation Societies under Section 17 of the Conservation Law Reform Act (1990). The main statutory role of the Fish and Game Councils is to manage, maintain, and enhance sports fish and gamebirds in New Zealand, and as such, are advocates for the conservation of wetlands. To meet these objectives, the Council is required to (Fish and Game New Zealand, 1997a):

- Assess and monitor sportfish and game populations, habitats, and harvest;
- Assess and monitor angler and hunter satisfaction;
- Maintain and improve the sportfish and game resource;
- Provide information and promote angling and hunting; and
- Represent the interests of anglers and hunters in the statutory planning process.

They represent the interests of anglers and hunters, and provide management and enhancement of sportfish and game. In order to achieve their aims, Fish and Game Councils have bought and continue to purchase areas of wetland throughout New Zealand (DoC, 1996a).

7.5.1 Game Bird Stamps

The Game Bird Habitat Trust Board is a charitable trust set up in 1993 to receive and to distribute the proceeds of the Game Bird Habitat stamp programme, which is administered by the Fish and Game New Zealand. Annually, Fish and Game New Zealand consider applications and grant funds for habitat development that will primarily benefit game birds, and secondarily enhance other wildlife habitat. So far the Board has supported 24 projects with funding of about $300 000 for the development of new game bird habitat (New Zealand Stamps Web Site, 1999).

7.6 Royal Forest and Bird Protection Society Inc.

The society is a broad-based conservation organisation, which concerns itself with advocacy and protection of natural habitats. The society actively seeks protection for natural wetlands and in some cases, seeks voluntary and financial assistance for wetland protection (DoC, 1996a).

7.7 Ducks Unlimited Inc.

Is a non-profit organisation that is dedicated to the preservation, restoration and maintenance of wetland habitat both in New Zealand and around the world. The organisation is also involved in the propagation of the rare indigenous Anatidae and to liase with other interest groups. Ducks Unlimited have undertaken a number of projects to assist waterfowl such as the brown teal, grey teal, blue duck, and Canada goose. They have also provided finance for purchasing, restoring and maintaining wetlands (DoC, 1996a) (Appendix 21.2).

7.8 Other Non-Governmental Organisations

The Ecological Society, Botanical Society, Limnological Society and Orthinological Society all have a general interest in the scientific and management aspects of wetland issues both at a local and national level. Other groups with an interest in wetland values include farmers, industries that use water or take resources and community groups (DoC, 1996a).

7.8.1 Queen Elizabeth II National Trust

The Queen Elizabeth II National Trust is an independent organisation established to protect open space (including wetlands) on private land, without jeopardising the rights of ownership. This is achieved by covenants that are initiated by the landowner (Department of Conservation Web Site, 1999).

Currently the Trust has 1000 open space covenants, protecting more than 40,00 hectares of wetlands, streams, lakes, forests, forest remnants, tussock grassland, and other natural features.

The covenants are legal agreements between the National Trust and a landowner. The land under the covenant does not become the property of the trust. The covenants are binding on both present and future landowners for ever.

The covenant defines the area to be protected, states the purpose of protection, and states the activities that can and cannot be carried out within the protected area.

The Trust offers suggestions for management, and a representative of the Trust visits the site annually, to discuss the management of the site with the landowner.

7.9 Ramsar

The Convention on Wetlands is an intergovernmental treaty adopted on 2 February 1971 in the Iranian city of Ramsar. The official name of the treaty is "*The Convention on Wetlands of International Importance Especially as Waterfowl Habitat*". This title reflects its original emphasis on the conservation and wise use of wetlands chiefly to provide habitat for waterbirds. Since inception, the Convention has broadened its scope to cover all aspects of wetland conservation and "wise use", recognising wetlands as ecosystems that are important for biodiversity conservation and for the well being of human communities. Since then it has become known as the "Ramsar Convention". Ramsar was one of the first modern global intergovernmental treaties on conservation and wise use of natural resources. From its inception, the main decision making body of the Convention (the Conference of Contracting Parties) has been further developed and interprets the basic vision of the treaty. Additionally (and by its own admission), the Convention has succeeded in keeping abreast of changing world awareness, priorities, and trends in environmental thinking. The Convention now has more than 110 Contracting Parties in all parts of the world, with about 950 wetlands scheduled to be included in the List of Wetlands of International Importance, covering some 70 million hectares (Ramsar Web Site, 1999).

The criteria used in the selection process are those developed for the identification of wetlands of international importance for designation under Article Two of the Ramsar Convention. A wetland is suitable for inclusion in this directory if it meets any one of the criteria listed by DoC (1996a) and the Australian Government website below:

(1) Criteria for representative or unique wetlands. A wetland should be considered internationally important if:

a) It is a particularly good representative example of a natural or near-natural wetland, characteristic of the surrounding biogeographical region; or
b) It is a particularly good representative of a natural or near-natural wetland, common to more than one biogeographical region; or
c) It is a particularly good representative example of a wetland which plays a substantial hydrological, biological or ecological role in the natural functioning

of a major river basin or coastal system, especially where it is located in a cross-border position; or

d) It is an example of a specific type of wetland, rare or unusual in the appropriate biogeographical region.

(2) General criteria based on plants or animals. A wetland should be considered internationally important if:

a) It supports an amount of rare, vulnerable, or endangered species or sub species of plant or animal, or a number of individuals of any one or more of these species; or

b) It is of special value for maintaining the genetic and ecological diversity of a region because of the quality and peculiarities of its flora and fauna; or

c) It is of special value as the habitat of plants or animals at a critical stage of their biological cycle; or

d) It is of special value for one or more endemic plant or animal species or communities.

(3) Specific criteria based on waterfowl. A wetland should be considered internationally important if:

(a) It regularly supports 20,000 or more waterfowl; or

(b) It regularly supports substantial numbers of individuals from particular groups of waterfowl, indicative of wetland values, productivity or diversity; or

(c) Where the data on populations are available, it regularly supports one per cent of the individuals in a population of one species or sub species of waterfowl.

(4) Specific criteria based on fish. A wetland should be considered internationally important if:

(a) It supports a significant proportion of indigenous fish subspecies or families, life history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity; or

(b) It is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.

Five of the largest surviving wetlands have been designated as wetlands of international importance under Ramsar in New Zealand. New Zealand ratified the convention in 1976. The five listed wetlands are mostly under DoC protection or stewardship. They are:

- The Firth of Thames tidal estuary (Waikato) – 7,800 hectares
- Whangamarino Wetland (Waikato) – 5,690 hectares
- Kopuatai Peat Dome (Waikato) – 9,665 hectares
- Farewell Spit (Nelson) – 11,388 hectares
- Waituna Wetlands Scientific Reserve (Southland) – 3,556 hectares

A Ramsar listing does not mean that the wetland will be guarded from destruction, but it does raise its significance when government and local authorities make decisions affecting the (Smith, 1997).

Many wetlands including parts of the identified Ramsar ones, are privately owned or are grazed by livestock from adjacent farmland. Any protective measures require co-operative support from surrounding landowners (Smith, 1997).

Any changes in the management of a Ramsar site which results in deterioration of the ecological characteristics for which the site was recognised means that the wetland can be listed on the Montreux Record. This listing can stimulate rehabilitation and policies to reverse degradation (Morrison and Kingsford, 1997).

8 Valuation

The term 'value' places an anthropocentric angle on the discussion of wetlands. The term is usually used in an ecological sense to refer to functional processes. For example, the value of primary production in providing the food energy that drives the ecosystem (Mitsch and Gosselink, 1993).

Environmental valuation involves estimating monetary values for wetland resources (Morrison and Kingsford, 1997). Increasingly economists and scientists are working in the field of the valuation of ecosystem services. This is proving to be a difficult task, with many uncertainties. There is now a growing awareness that most wetlands are valuable economic resources, even when retained in their natural or semi-natural state. Recent studies have shown that ecosystems provide at least US$33 trillion worth of services annually, of which US$4.9 trillion are attributed to wetlands (Turner and Jones, 1990; Ramsar Information Paper No. 1, 1999).

While it is important to gather information about the ecological impacts of alternative uses for water and land resources, these impacts also need to be translated into a language which allows for the comparison of the benefits to the human community of different uses. Valuation enables decision-makers to weigh the benefits from wetland functions against the opportunity cost of other uses of wetlands or their inputs. This helps determine which option has the greatest net benefits for the community (Morrison and Kingsford, 1997).

Techniques such as cost-benefit analysis (CBA) provide a mean of comparing the value of wetland preservation with competing uses of wetlands or wetland inputs. CBA is a framework for comparing the community wide benefits and costs of different resource use options across an entire catchment. These include benefits or costs from wetland services as well as costs or benefits from consumptive use of resources. Cost benefit analyses provide information to decision makers about how to use scarce resources; options with higher net benefits are likely to be more socially beneficial (Morrison and Kingsford, 1997).

Environmental valuation should improve communication about the benefits of maintaining wetland quality, will enable more direct comparisons of the benefits with the foregone opportunity cost of consumptive use of wetland resources, and will increase the transparency of decisions made about land use activities (Morrison and Kingsford, 1997).

Social inefficiency in wetland use is connected to the fact that wetlands are usually under heavy pressure, involving multiple use conflicts. The inefficiency results from the fact that not all uses are properly accounted for. This is particularly true for what Turner and Jones (1990) term "natural" services such as ground water storage, and food web support. They also go on to state that this inefficiency is also found within the services provided by wetlands to humans, such as recreation, hunting and education.

The full costs of developing wetlands (including the full cost of losing the benefits of natural wetlands) are never calculated according to Thompson (1983). He goes on to quote Odum (1978) by stating that the market value of wetlands is based on its saleable products such as game birds and fish, and agricultural products.

Fish and Game Councils can value their wetlands in terms of the total amount of money spent by anglers and hunters. A wetland with a flood control function can be valued in terms of the human-made structures it protects (Thompson, 1983).

9 Values

Disputes about the values of particular wetlands can arise because the term 'wetlands' covers such a wide range of plant and animal communities, and some do not fit into people's perception of wetlands. They have been limited primarily to recreation, flood protection, fisheries and other direct use benefits (Ogle, 1994; Breaux et al., 1995).

Wetlands yield things that can be termed non-use values (or existence values). This is when individuals benefit from knowing that certain natural resources are protected. These are values that are not derived from direct or indirect uses of the wetland. This means that wetland habitats, flora and fauna that these habitats support, may be valued by people living far away from the wetland. Even if these people never actually visit the wetland, they may nevertheless feel a sense of loss if such natural places cease to exist. This loss would reduce their option, or that of their descendants, to visit such sites (option value). It would also reduce their ability to pass on undegraded wetlands to future generations (bequest value) (Turner and Jones, 1990; Frost, 1992).

Wetlands provide huge economic benefits in terms of water supply, fisheries, agriculture, timber production, tourism, and recreation activities. Wetlands have also special attributes in that they are part of the cultural heritage of many communities. They are related to religious and cosmological beliefs, constitute a source of aesthetic inspiration, provide wildlife sanctuaries, and form the basis of important local traditions (Ramsar Information Paper No. 1, 1999).

Both use and non-use values are associated with wetlands. Use values include those resulting from direct use, such as production of timber and fish supplies, and indirect use, such as flood control, and water quality. Studies by Krutilla (1967), and Brown (1993) as mentioned in Streever et al., (1998), state that non-use values, such as intrinsic values and bequest values can exist either on or off site, and can be considerably higher than use values.

The two values considered by landowners in Jones et al., (1995) study, was that of the role that wetlands played in maintaining water quality, and as a habitat for species.

10 Functions

Wetlands function like natural sponges, storing water and slowly releasing it. Trees and other wetland vegetation help slow floodwaters, which, when combined with storage, can reduce the water's erosive potential. Other functions that the wetland performs are shoreline stabilisation, groundwater recharge/discharge, and water purification (Frost, 1992; Ramsar Information Paper No. 1, 1999; EPA Web Site, 1999).

Thompson (1983) briefly describes five main functions that wetlands carry out:

1. Wetland vegetation traps sediment and minimises soil erosion and evaporation losses.
2. Wetlands act as nutrient traps, particularly where a wetland separates a water body from an area of agricultural activity or sewage outfalls.
3. Wetlands exercise control over water regimes and protect against flash flooding and acting as ponding areas and sponges.
4. The wetland/open water interface is one of the most biologically richest zones in the world. It is here that many fish and waterfowl feed, breed and shelter.
5. Importance for recreation, landscape diversity, education and science.

On a more global scale, wetlands contribute to the stability of available nitrogen, atmospheric sulphur, carbon dioxide, and methane (Mitsch and Gosselink, 1993).

The functions and values of wetlands depends on their extent and their location, but does not need to be ponded on the land's surface to provide many of their functions. If the wetland lies along a river, it probably plays a greater functional role in stream water quality and downstream flooding, than if it were isolated from the stream. If situated at the headwaters of a stream, a wetland would function in ways different from those located near a stream's mouth (Mitsch and Gosselink, 1993; Robinson, 1995).

Robinson (1995), states that there is research to suggest that small wetlands scattered around the landscape can play an important role in filtering sediments, nutrients and pesticides.

10.1 Functions of Agricultural Wetlands

Wetlands in agricultural settings, as found in the Manawatu, have the same range of natural function as wetlands elsewhere do. Additionally, they often receive sediment, nitrate, phosphate, organic matter, and pesticides associated with the agricultural practise on surrounding land.

There has been considerable research on the ability of wetlands in agricultural settings to serve as sinks for fertilisers such as phosphates and nitrates, as well as studies showing the potential for wetlands to absorb agricultural pesticides. The water quality improvement function is often well developed in these types of systems, although pollutants can cause stress (National Research Council, 1995).

Wetlands that act as sinks for sediments, organic matter and nutrients, must exhibit the following:[4]

- Low water flow velocities; this favours sedimentation
- Contact between water, sediment and micro-organisms
- High plant productivity

Because many former wetlands were drained for crop and animal production, the periods for which water remains on or near agricultural land have been altered and floodwater retention functions are diminished accordingly. This means that the wetlands are potentially valuable for maintenance of water quality, they can be significantly disturbed and can show reduced functional capacity. As a result, the National Research Council (1995) point out a study that argued that wetlands in agricultural settings should not be used as sinks for processing non-point source pollutants because they have already been greatly reduced, and should therefore be preserved for their habitat and recreational values. Also these wetlands in many cases already receive significant amounts of agricultural runoff (National Research Council, 1995). Obviously this is intended to mean only natural wetlands, and ignores that some wetlands are designed and constructed for the sole purpose of processing contaminated water.

[4] Clark et al. (1997).

10.2 Water

10.2.1 Water Quality

Biological, chemical and physical processes all affect the quality of water as it flows through a wetland. The slow flow rate of water as it moves through a wetland, allows particles to settle out. Plant surfaces provide attachment sites for microbial activity, provide filtration, process organic wastes, absorption of solids, and add oxygen to the water. Growing plants remove nutrients, such as nitrogen and phosphorus. This cleansing role of wetlands protects downstream environments (Buxton, 1991; DoC Web Site, 1999; EPA Web Site, 1999).

Wetlands can reduce suspended matter, bacterial contamination and the biochemical oxygen demand of water flowing through them. These nutrients may pass through unchanged, but are usually processed in two main ways; released into the atmosphere or stored, either temporarily or permanently in the biomass, or sediments. However it must be assumed that these wetland systems have a finite capacity to carry out this function (Osborne and Adcock, 1995).

The ability of wetlands to act as natural filter systems for nutrients and other pollutants is the reason for their use in waste management systems. Artificial wetlands can remove sediment from stormwater by a mixture of settling and filtration (Cooke, 1991; Griffiths, 1995). The use of wetlands for wastewater treatment has several advantages. First, existing treatment levels can be provided at low cost. Secondly, the discharge of effluents into wetlands can actually enhance the wetland ecosystem. Third, natural wetlands have the potential for higher levels of treatment than can be achieved under reasonable cost traditional methods. Fourthly, using wetlands to receive discharges would enhance the quality of those waters that had previously been receiving these discharges (Breaux et al., 1995).

Wetlands have several attributes that cause them to exert major influences on chemicals that flow through them. These attributes are taken from Mitsch and Gosselink (1993):

- A reduction in water velocity as streams enter wetlands, causing sediments and chemicals to be absorbed, and drop out of the water column;

- A variety of anaerobic processes in close proximity, promoting denitrification[5], chemical precipitation, and other chemical reactions that remove certain chemicals from the water;
- The high rate or productivity of many wetlands that can lead to high rates of mineral uptake by vegetation and burial in sediments when the plants die;
- A diversity of decomposers and decompositions processes in wetland sediments;
- A high amount of contact of water with sediments because of the shallow water, leading to significant sediment-water exchange; and
- The accumulation of organic peat in many wetlands, which causes the permanent burial of chemicals.

Freshwater wetlands can vary in their pH due to natural causes and human influences such as increased nutrient runoff from farmlands (Ministry for the Environment, 1997a).

The change in water quality flowing through a wetland may not necessarily be a visible change, but rather a change in its nature. Many harmful substances entering a wetland are absorbed by wetland organisms, whereas substances in the outflow consist of natural wetland products (Buxton, 1991).

A potential indicator of water quality could be the amount of fishing done in a particular stretch of river. The reasons for fishing are many and varied, and not necessarily related to fish being present. It is also dependent upon the perception of the cleanliness of the water. For example, a high weed content is not favoured and a high sediment load in particular will put anglers off an area (Woodward-Clyde, 1994).

The volume of water contained in wetlands also creates a groundwater pressure that can prevent saltwater into public water supplies. This is important especially in coastal holiday communities where freshwater wetlands interface with an estuarine environment (Cooke, 1991).

A lack of reliable design formulae is holding the engineering profession back from great cost savings achievable with wetland treatment. The missing factor is how much sewage an area of wetland can purify without the life in it being killed and the system failing (Manning, 1991)

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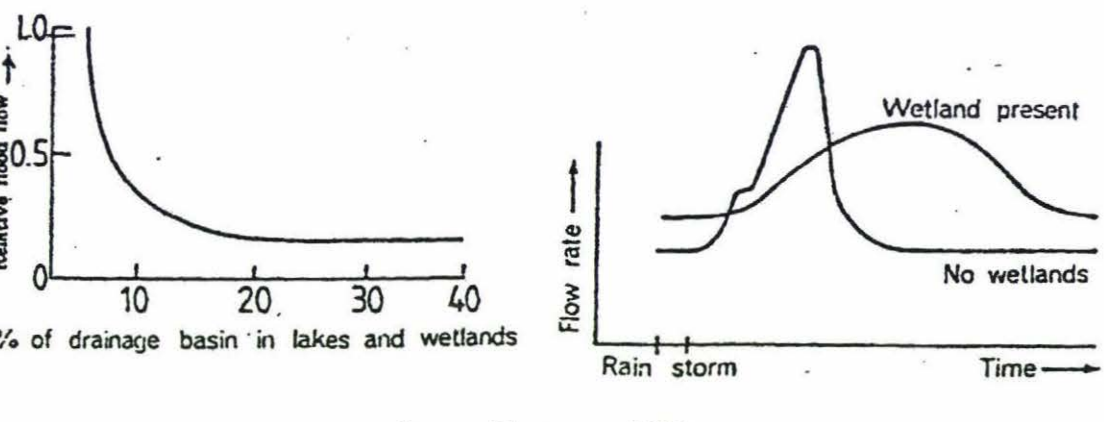
[5] According to Van Oostrom (1993), denitrification is the main nitrogen removal process in wetlands that are formed over a gravel bed.

10.2.2 Water Storage and Flow Regulation

Wetlands absorb water during heavy rain, releasing water gradually so flooding is reduced. Downstream water flows and ground water levels are also maintained during periods of low rainfall. Wetlands also help stabilise shorelines and riverbanks (Frost, 1992; Robinson, 1995; DoC Web Site). Kirkland (1988) estimated that this function has an estimated value of $1500 per hectare in New Zealand.

Wetlands can reduce peak water levels during flood events, by acting like a giant sponge during wet periods. The storage capacity of a wetland will detain floodwater, with the peak flows and water levels downstream evening out (Figure Nine). For example, a wetland about 40 hectares could reduce a major flood (18-year return period) by 70 per cent, from a catchment of about 30 square kilometres (Buxton, 1991; Cooke, 1991; Mitsch and Gosselink, 1993).

Figure 9: Flood Peak Events and Wetland Responses



Source: Thompson, 1983

No studies suggest that wetlands are the complete answer to flood control, but they all support that wetlands help alleviate the severity of the floods (Robinson, 1995).

There are risks however, the location of wetlands in a river basin can complicate the response downstream. For example, detained water in a downstream wetland of one tributary, can combine with the flows from another tributary to increase the flood peak rather than desynchronise flows (Mitsch and Gosselink, 1993).

10.2.3 Aquifer Recharge

For a function that has such massive implications, this function has not been well documented. Some hydrologists believe that although some wetlands recharge groundwater systems, most wetlands do not. The reason for the absence of recharge is that the soils under most wetlands are impermeable. In the few studies noted by Mitsch and Gosselink (1993), recharge occurred primarily around the edges of wetlands and was related to edge:volume ratio of the wetland. This means that aquifer recharge is relatively more important in small wetlands, than in large ones (Mitsch and Gosselink, 1993). This feature could also be another important feature of ephemeral wetlands, whose soils are much more permeable than those of permanent wetlands.

10.3 Erosion Protection

Because wetland plants have adapted to survive in the areas between dryland and water, they can play an important role in protecting these areas from erosion (Buxton, 1991).

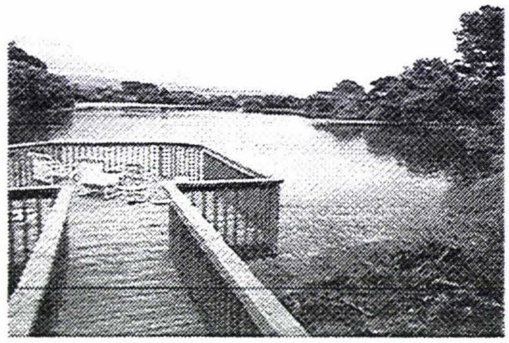
10.4 Recreation

Wetlands offer a wide variety of recreation activities including boating, fishing, swimming, bird watching, whitebaiting and hunting. Wetland areas are the habitats of many waterfowl, such as the mallard, and paradise shelduck. At least 60,000 people a year use wetlands for game bird hunting, while in the United States, game bird hunters spend over $600 million annually to hunt (Buxton, 1991; DoC Web Site, 1999; EPA Web Site, 1999). In New Zealand, Kirkland (1988), estimated that the fishing value alone is about $4 per hectare.

Hunting can have an adverse impact on waterfowl numbers, and appropriate management systems are required to ensure that problems are avoided or mitigated. For example, hunting and fishing can alter population structure, affect endangered species, contaminate water with lead from shot, and affect habitat through associated activities such as camping and boating (Frost, 1992).

Wetlands not only allow for hunting and fishing, but also that of pure scenic value (Figure Ten).

Figure 10: Wetland Used for Scenic Values



10.5 Tourism and Education

Wetlands are attractive to visitors because of the large numbers and diversity of plants and animals they support. They are an essential part of the wide range of scenery which gives New Zealand its distinctive character. Water can be the main element within a landscape, with wetlands adding a special feature to the land. In particular, the scenic value of farmland can be improved by the presence of wetlands (Buxton, 1991).

The fact that wetlands are wet does restrict access, and makes them very sensitive to trampling and other damage, thus limiting the development of tourism. However the construction of boardwalks and hides for birdwatching overcomes many problems (Buxton, 1991).

Wetlands contain a wealth of information. Some wetlands contain records of the past in the form of pollen, plant fragments and preserved wood, skeletons or bones. Pollen, once buried in wetlands, is preserved in oxygen-starved conditions, and is buried by sediment over time. It is then possible to reconstruct the vegetation and the climate of the area over the past several thousand years (Buxton, 1991).

Wetlands also offer many exciting education opportunities. Wetlands represent a wide range of unique habitats, which can be used to demonstrate food webs, nutrient cycles and other natural systems. These systems are usually easy to study because the basic species are few in number and the physical characteristics are widespread, making the habitats fairly simple to understand. Further, what makes these areas more appealing is that they are generally accessible in all weather conditions (Crisp, 1986; Buxton, 1991; Frost, 1992; DoC Web Site, 1999).

10.6 Maori Culture

Wetlands have always provided an important role within Maori communities, not just being a food source, but providing materials for medicines, dyes, timber, and the preservation of artefacts (Buxton, 1991; Cooke, 1991).

Estuaries and wetland areas have high value for the Maori people, they provided fish, shellfish, birds, flax and other traditional items. Many coastal areas have cultural and historic significance, which should be protected along with the ecosystem (Crisp, 1986).

10.7 Historic Records

Early settlement of both Maori and Europeans were often based around wetlands, especially estuaries, as they were a rich source of food, water and close access to the sea (Frost, 1992).

The airless conditions that wetlands provide allow for the preservation of historic artefacts. Wooden artefacts, bones and pollen samples are commonly discovered. Wetlands and streams were also significant areas for early Maori for food and other resources, such as eels, koura, waterfowl and vegetables. Flax was also harvested for many purposes, and waterways provided transport links (Frost, 1992; DoC Web Site, 1999).

10.8 Habitats

The most visible function that wetlands provide is as habitat for waterfowl. They do this by acting as nurseries and feeding grounds for crustaceans, fish and birds (Carter, 1988). The productivity of wetlands far exceeds that of forests and agricultural systems (Thompson, 1983). Wetlands provide habitats for both native and non-native bird species. These species include; fernbirds, crake, bittern, dabchick, pukeko, mallard, grey duck, paradise shelduck, black swan, shags, and the white faced heron. Fish species include many of the galaxiids, bullies and eels. Plant species include sphagnum moss, sedges, raupo, flaxes, toetoe, ti kouka, and kapungawha and other reeds.

10.9 Plants and Animals

Wetlands provide home to a huge range of plants and animals. The plants and animals of a wetland either produce, consume or decompose organic matter. Green plants, both the microscopic phytoplankton and the larger macrophytes, use the sun's energy to convert carbon dioxide and water into carbohydrates and oxygen gas. This primary productivity forms the basis of the food web in a wetland, and is the one source of the oxygen required by most aquatic organisms (Vant, 1987b).

10.9.1 Plants

Wetland plants include 47 species of rush and 72 species of native sedge. Many of these plants have very specific environmental needs, and are vulnerable to change. A number of New Zealand's endangered plant species depend totally on wetlands. Wetlands in New Zealand also support the largest concentrations of bird life of any habitat. Migratory species depend on chains of suitable wetlands. The survival of threatened species such as the Australasian bittern, brown teal, fern bird, marsh crake and white heron relies on New Zealand's remnant wetlands. Native fish also rely on the availability of wetlands. Of the birds that are regular visitors to New Zealand or are permanently resident or breeding, 22 per cent have wetlands as their primary habitat, and a further five per cent have wetlands as an important secondary habitat. No other major habitat type supports as many bird species (Williams, 1983; DoC Web Site, 1999).

To survive in a wetland, a plant needs very special adaptations. For example, to overcome low fertility in some wetlands, two groups of native plants have adapted to catch insects for nutrients. Some plants have overcome waterlogging by having hollow or nearly hollow stems which transport air to the roots, other plants have aerial breathing roots. The kahikatea, grows on damp ground on the edges of rivers or lakes, or in swamps, and tolerates waterlogging by having some feeding roots at the top of the water table. Very few stands of kahikatea are found today, due to the loss of lowland wetlands (Buxton, 1991).

10.9.2 Animals

Although birds are the most visible component of wetlands, invertebrates, amphibians, and reptiles may also be found.

It has already been stated that wetlands support the greatest concentration of bird species in such small area. Many birds have specialised adaptations for surviving in the wetland habitat, and are therefore vulnerable if this habitat were to be lost or altered. For example, the black swan requires open water, as they graze plants that are completely submerged. The grey duck uses shallow water margins of large areas of water, where they feed on semi-aquatic or aquatic plants, seeds and invertebrates. Pukeko can be found as the wetland increasingly becomes drier, as they feed on semi-aquatic and terrestrial vegetation (Buxton, 1991).

10.9.3 Fish

Eight of New Zealand's 27 fish species including inanga, short finned eels, kokopu and bullies are found in wetlands while the whitebait fishery depends on the spawning habitat offered by freshwater wetlands. New Zealand's best runs are found on the east coast of the South Island, where extensive areas of forestry and swamp remain. The decline in native fish populations is directly related to massive reductions in freshwater habitat (DoC Web Site, 1999).

Wetlands and estuaries are important habitats for feeding, nursery, and spawning for many fish species taken for human food, either commercially or recreationally. While many of these species are not found within the wetland habitat, except at high tide, they are reliant on the habitat to varying degrees (Handford 1983, 1999).

The importance of wetlands to most fish species comes from three main features:

1. The high productivity of wetlands which forms the basis of the harbour/estuarine food web, and contributes to the coastal food web;

2. The rich invertebrate fauna which is an important food source for many coastal demersal fish species, especially juveniles; and
3. The presence of protected waters for spawning, growth of juveniles.

While destruction of marine wetlands is unlikely to result in the disappearance of a species, population numbers would be drastically reduced, disrupting the complex food webs of the estuarine ecosystems (Handford, 1983).

The disproportionately large number of plants and animals associated with wetlands is due to the great diversity of niches available in the wetland environment. Wetlands offer the opportunity for plants and animals to live under, in, on, or over the open water. For those that can live at the water's edge, can tolerate seasonal or tidal inundation and exposure, and for those plants demanding both wet and almost dry soil. Wetlands also provide for animals to exploit resources beyond the wetland margin, but who still require a safe wetland retreat (Williams, 1983).

10.10 Productivity

It is the immense diversity of plant and animal life, and the fact that wetlands trap nutrients that gives wetlands their outstanding productivity.

Intertidal flats, mangroves and salt marshes have the highest rates of productivity, and have a net primary productivity equal to that of a tropical rain forest and up to fours time that of ryegrass pasture. Studies in New Zealand have shown that a raupo stand can produce more than 2.5 kilograms dry weight of plant material per year. This is equal to about 250 tonnes wet weight per hectare. This makes raupo the second most productive plant recorded in New Zealand, second only to *Pinus radiata* on the very best and most heavily fertilised sites (Williams, 1983; Crisp, 1986).

10.10.1 Food Production

Wetlands, especially artificial ones, can provide a range of habitats for growing plants and raising animals. Productive habitats range from dryland, permanently moist soils, to wet soils, and to totally submerged soils. Plants that can be grown within the wetland environment may include kahikatea, (timber, food for birds), karaka (bird food), and avocados in the drier land; blueberries, asparagus and taro in the permanently moist soil; water spinach, watercress and iris in the wet soil; and water chestnuts, lotus and waterlillies in areas that are always under water. This last group could also support fish, while other areas could be seen to provide food for animals elsewhere (Buxton, 1991; DoC Web Site, 1999). However, a commercial grower would not likely to favour 'pests' eating away at the potentially profitable crops.

At least 30 commercially important species of fish use estuaries at some stage of their life cycles. These include flounder, mullet, rockfish, sole, kahawai, trevally, parore, red cod, and gurnard. Freshwater eels, salmon, and whitebait migrate through wetlands at least twice in their life cycle. Beds of shellfish, including pipis and cockles, are exploited in many estuaries, and oysters are cultivated in many bays and inlets throughout the country (Crisp, 1986).

10.10.2 Peat

Many wetlands produce peat by the decomposition of dead plant material that has incompletely decomposed due to a lack of oxygen within the wetland. In New Zealand the most common peat-producing plant is the lesser-jointed rush (*Empodisma minus*) (Buxton, 1991).

Peat is a valuable soil conditioner and is used in horticulture (potting mix). It has a high water-holding and insulating capacity and a high nutrient retention additionally, peat is high in fibre, which improves soil structure, and has a high organic content. Its use in horticulture is considered non-sustainable (Buxton, 1991).

11 Threats

Holding the line against further wetland loss is clearly essential, but many existing wetlands are degraded with increased sedimentation, modified hydrology, change water quality and invasion by feral plants and animals all impairing wetland function (Adam, 1995). Because many species depend on wetlands, whatever harms the wetland harms the species. For example, the well-being of gamebird populations is directly related to the status and abundance of wetland habitats, not to mention climatic conditions (EPA Web Site, 1999).

In a survey carried out by Jones et al., (1995), results showed that the major causes of wetland disturbance are agriculture, and land drainage. Flood control and other activities affecting water level were also mentioned in the study. Further, waste water treatment, discharges, forestry, mining, rubbish disposal, infilling and subdivision were also described.

The expansion of urban areas, pollution, runoff, reclamation of lake shores, and the encroachment of weeds have also contributed to the disturbance of wetlands (Jones et al., 1995). A further list of threats to New Zealand's remaining wetlands is mostly the result of human activities including:[6]

- Sand and gravel extraction, causing changes in water level and access for weeds or damage to existing vegetation.
- Badly planned subdivision and residential development.
- Roading and bridging.
- Nutrient eutrophication.
- Mismanagement of fish and shellfish resources.
- Thermal addition through use of water for cooling purposes.
- Reclamation of lake and river margins, lagoons and estuaries and draining of farm swamps, which reduce wetland area.
- Excess runoff of sediment and nutrients, which can pollute wetlands.
- Plant and animal pest invasion.

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6 List taken from Handford (1983), the DoC Web Site (1999), and from Stricker (1995).

- Stock grazing in surrounding catchments and wetlands themselves. This damages vegetation, decreases soil stability and contributes to pollution.
- Loss of natural character – the natural appearance of wetlands in the landscape.
- Careless recreation practices including mis-uses of jet skiing, hunting, kayaking, power boating and whitebaiting. Carelessness disturbs plant and animal life and may destroy parts of the physical wetland environment.
- Forest harvesting close to wetlands may damage wetland vegetation and cause erosion.
- Loss of vegetation, which allows excess sediment to run directly into wetlands.
- Inappropriate use of surrounding land in a catchments, for example pine forests draw so much water away from ground water systems that wetlands can be left depleted of water supply, or poorly managed farming practices such as sediment and/or fertiliser runoff.
- Drainage of wetlands for urban development.
- Altered flow regime, too much, too soon, too fresh.
- Siltation.
- Cultural eutrophication.
- Chemical or organic contamination of surface and groundwaters.

The above are common causes of degradation. While many of these activities not actually destroy wetland areas, they always reduce the productivity and value of them as a buffer zone. Often it is only a small change that is the trigger for degradation. Table Two shows the resulting impacts from varying pollutants. For example, a small change in the catchment drainage that diverts runoff from a new development to a wetland. Within a short time this change amplifies into further degradation, as levels of silt, nutrients and other contaminants, as well as weeds build up in the wetland. When the tolerance of the wetland to these inputs is surpassed, changes in the processes with the wetland occur and functions become impaired. Ultimately fisheries will be affected (Handford, 1983; Stricker, 1995).

Table 2: Impact Pollutants on Water Quality

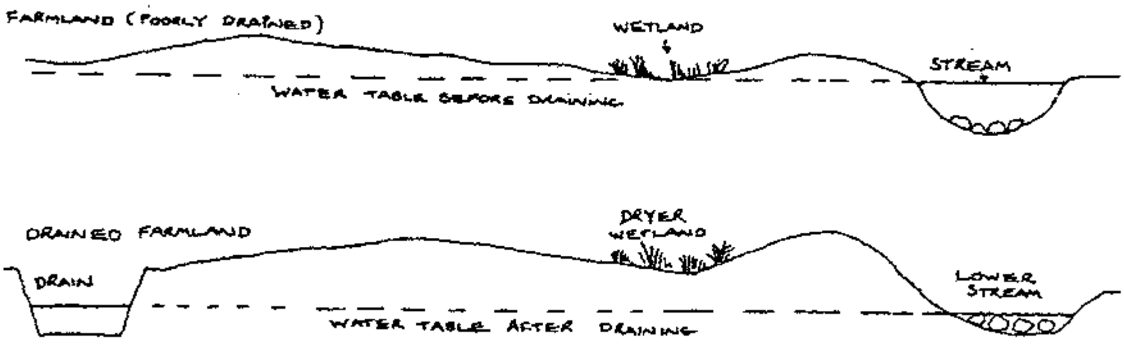
Source: Statistics New Zealand (1993).

Pollutant and Source	Impact
Biodegradable organic material from agricultural industry and human sewage	Oxygen depletion of aquatic habitat, foul odours
Nitrate and phosphate from agriculture, industry and urban wastes	Eutrophication, oxygen depletion
Suspended and deposited sediments and solids from solid erosion, industry and urban wastes	Siltation, degradation of aquatic habitat
Toxic substances	Chronic and acute toxicity to aquatic organisms, foul odour and taste, domestic water not usable
Metazoa, protozoa, bacteria viruses from human and animal wastes	Infectious diseases
Heating from industrial cooling	Oxygen depletion, change in aquatic habitat

11.1 Drainage

In urban areas, perhaps the most common disturbance is alteration of the natural flow of water through the system to aid stormwater disposal. In other cases waterflow has been channelled. This reduces the area that is inundated for a period long enough to support wetland organisms (Osborne and Adcock, 1995) (Figure 11).

Figure 11: Effects of Drainage on Groundwater Systems



Source: Buxton, 1991

Drainage has been identified as one of the main contributors to wetland loss. It effects New Zealand's wetlands, rivers, lakes, and groundwaters. The main reasons for drainage of low-lying land has been to increase the area of pasture and for flood control, and to provide favourable growing conditions in the root zone for high-producing plants. Another reason why drainage is carried out is with the emphasis on providing a healthy work place. Farm drainage is a very important way of making work on the land more attractive by removing the unpleasantness of muddy, wet conditions (Bowler, 1980). Most drainage occurred in New Zealand between 1920 and 1980, but is still continuing in some areas (Jones et al., 1995; Smith, 1997).

These drainage schemes have removed most of the nation's wetlands and have altered the natural character of some rivers and shallow lakes. These changes came in the form of stopbanks and river straightening. The straightening and diversion of water via drains have also lead to an increase in the erosion of river beds and banks, due to the increase amounts of water flowing through them, and increased water velocities (Smith, 1997).

Eutrophication is often associated with drainage improvements and agricultural fertiliser use in surrounding catchment. Such enrichment may lead to algal blooms and deoxygenation. The presence of think algal mats along the shore and across tidal wetlands further reduces the ability of the ecosystem's productivity (Carter, 1988).

Changes in groundwater level, often due to groundwater extraction for human use and/or consumption, are having disastrous effects on the world's wetlands, and on attempts to restore them (Middleton, 1999).

11.2 Damming and Diverting

Many of the drains of the region have been installed to improve drainage from what would otherwise be "swampy or poorly drained land". The damming of these drains can increase the risk of flooding or reduce the suitability of the surrounding land for human uses (Horizons.MW, 1999a).

The adverse effects associated with diverting water in within drains relate to changes in the drainage patterns of inundated land. Water diverted from one drain to another can increase the flow of the receiving drain to a level greater than its carrying capacity. This can then lead to potential problems such as the further lowering of the water table upstream, and the submersion of land downstream (Horizons.MW, 1999a).

11.3 Fire

Many wetlands are seasonally dry enough to burn. Fire damages not only the plants, but also the other organisms that reply on those plants for habitat. Fire can alter or increase the nutrient status in the wetland. For example, fires have been shown to result in an increased availability of nutrients particularly; nitrogen, phosphorus, magnesium, and potassium. Fire can also lead to increased light levels to fledgling vegetation. The increased fertility is generally short lived as second generation growth readily absorbs available nutrients (Buxton, 1991; Clarkson and Stanway, 1994; Middleton, 1999).

11.4 Grazing

Grazing in wetlands is a problem found the world over, and can damage wetlands in several ways. While wetlands can often recover after grazing ceases, even low levels of grazing have a significant impact, due to trampling, manure deposition, and grazing. These impacts can result in the stunted growth or damage to branches and seedlings of trees and shrubs. Soil trampling prevents the settling of seedlings and natural regeneration to replace dead plants. As a result, wildlife tends to avoid grazed areas where habitat is poor, especially ground feeding birds. Trampling can also destroy the margins of rivers and wetlands, along with bird breeding and roosting sits and fish spawning sites (Crisp 1986; Middleton, 1999). Grazing animals can also disturb and enrich the ground, making it unstable and more prone to infestation by weeds (Buxton, 1991).

Grazing around wetland margins has several disadvantages and advantages. The disadvantages are:

- Erosion at the water's edge;
- The trampling and pugging of soft ground;
- The discharge of high concentrations of nutrients in urine and faeces;
- The eating and trampling of important plants;
- The trampling of whitebait spawning areas;
- The disturbance of wildlife;
- The introduction of unwanted plants;
- The removal of desirable vegetation (that is, vegetation providing habitats for wildlife, nesting sites and cover for birds, and spawning sites for fish).

The advantages are:

- The maintenance of open areas for waterfowl, waders, and human access;
- The (possible) control of unwanted or dominating plants.

11.5 Invasive Species

Changes in surrounding vegetation, water quality, water levels or nutrient levels in a wetland can allow the invasion of foreign plants. Invasive species may be aquatic or terrestrial. Aggressive introduced plants represent a threat to native plant communities because of their ability to replace the natives (Buxton, 1991).

Pest populations are often the most severe threat to indigenous ecosystems. Invasive introduced plant pests such as old mans beard (*Clematis vitalba*), wilding pine (*Pinus* spp.), and *Heiracium* species threaten indigenous vegetation. Possums, rabbits, deer and other grazing animals threaten vegetation and native fauna indirectly, through competition; while mustelids, rats and feral cats threaten native fauna directly, through predation. Exotic plant invasion and pest damage to vegetation is disrupting revegetation and successional processes in many ecosystems (Ingle and Hilton, 1997).

11.6 Rubbish Dumping

The disposal of litter into wetlands, or surrounding areas, destroys the ecological and scenic value, and can affect neighbouring areas through run off and leachates (Crisp, 1986).

11.7 Pollution

The sediment of wetlands is made up of, and traps nutrients and chemicals, making the sediment much richer in organic matter and nutrients than the surrounding hinterland. However this function of wetlands, means that they are susceptible to becoming pollution sinks (Crisp, 1986). These pollutants can come from:

11.7.1 Sewage and Wastewater

Sewage harms natural ecosystems in a number of ways:

- The suspended solids of sludge smother the thin, biologically productive surface;
- The biochemical oxygen demand (BOD) from decaying matter leads to depletion of dissolved oxygen, with a devastating effect on aquatic animals;
- Secondary treatment reduces the BOD, but leaves excessive amounts of nitrate and phosphates, that can lead to a bloom of algal species.

In many water bodies, high nutrient concentration can result in rapid phytoplankton growth, producing high densities of plant cells (biomass). These increases in biomass are called phytoplankton blooms or algal blooms (Vant, 1997).

11.7.2 Toxic Substances

Toxic substances entering wetlands can be passed on through the food chains. For example, oysters that filter their food, may take in pollutants such as heavy metals or bacteria. Oysters in particular retain these poisons, and build up concentrations much greater than in the surrounding water, which makes them a dangerous food when taken from a contaminated area (Crisp, 1986).

11.7.3 Accidental Spillages

Spills of toxic substances can have both an immediate and a short-term effect.

11.8 Reclamation

Reclamation of land from the sea for roads, landfills, sports grounds, industrial development and farmland has destroyed thousands of hectares of wetlands. Once reclaimed, these areas are gone forever, leaving a ecologically poorer and less diverse region. Reclamations in tidal areas result in a complete loss of the habitats and lowers the reoxygenation capacity of estuaries, reducing intertidal areas, and the amount of water reoxygenated on each tide (Crisp, 1986).

11.9 Recreation

Recreational pressure is increasing at all areas of the natural environment.

11.10 Other Land Use Activities

Land use activities that can lead to increased rates of erosion, subsidence, excavation or sedimentation can have adverse effects on the quality of water within a wetland. These effects include discolouration and smothering of habitat by fine sediments (Manawatu-Wanganui Regional Council, 1998b).

Increased concentrations of nutrients and suspended solids can occur from activities such as cultivation, tracking, and excavation, or from inappropriate stocking rates. Agricultural activities also have their effects in terms of increased animal and plant wastes, along with fertilisers and chemicals that can runoff the farm during heavy periods of rainfall. These factors contribute to the accelerated growth of algae and fungus that can suffocate habitats and reduce the visual amenity or waterways (Manawatu-Wanganui Regional Council, 1998b).

The runoff from intensive agriculture land can also result in bacterial contamination of the waterways and reduce their value for contact recreation. The effects of pesticides and herbicides on waterways have not been fully investigated because the effects are very difficult to detect and the effects may be subtle and cumulative (Manawatu-Wanganui Regional Council, 1998b).

The removal of vegetation from a wetland can result in an increase in the amount of nitrogen and phosphorus entering the waterways. This may lead to algal blooms, who when decay, use up large amounts of oxygen, depriving fish and other aquatic organisms (EPA Web Site, 1999).

The planting and growth of exotic trees can be detrimental to a wetland, due to the moisture absorption of the trees. This results in drying and other changes in its character (Jones et al., 1995). If exotics trees are planted to reduce run-off from pasture, it is interesting to note that there is little effect on run-off from pasture in the years immediately following the plantation. As the canopy extends, run-off is reduced significantly (Marshall, 1995).

There are instances where the introduction of dairy cows and cattle to wetland areas has caused significant degradation to what was once ideal duck breeding and rearing habitat. Conversely, there are areas which under previous crop or sheep grazing management that were considered marginal for farm viability, and so were left mostly in a natural state (Fish and Game New Zealand, 1998).

Loss of permanent wetlands and shallow ponds has contributed to the decline in shoveler duck populations throughout many regions. Being a true dabbling duck, the species prefers expanses of water about 15-20 centimetres deep. Shoveler are quite shy and do not readily adjust to the pressures and disturbances associated with the modern farming world (Fish and Game New Zealand, 1998).

Gradual reductions in the size of individual wetlands, resulting from the activities of grazing cattle, could potentially have more impact on the overall extent of wetlands than the effects of continued land drainage (Fish and Game New Zealand, 1999).

11.11 Indirect Threats

Farm development, forestry, road building, residential development, and other activities in the hinterland can have serious impacts on wetlands by altering the inputs of water, nutrients and sediment.

11.11.1 Freshwater Flow Reduction

By damming and water abstraction changes in water circulation, flushing rate, salinity, sediment transport and the natural flow of nutrients, can greatly disrupt a wetland ecosystem (Crisp, 1986).

11.11.2 Roading

Roads across wetlands can destroy plant and animal communities, by cutting them off from the natural forces that they might otherwise experience and need for survival (Crisp, 1986).

11.11.3 Residential Development

Subdivision brings threats of reclamation, increased sediment runoff, domestic effluent, erosion and stormwater runoff (Crisp, 1986).

11.11.4 Sediment

Increased amounts of sediment from bush clearing, land development and exotic afforestation can smother wetland plant and animal communities (Crisp, 1986).

11.11.5 Wave Action

Wave action, through its effect on the bed and shoreline profile, affects the plant communities that grow in these areas. This effect is most noticeable in wetlands with large areas of open water (Buxton, 1991).

12 Should Wetlands Be Protected?

The evidence provided here, shows that wetlands indeed are valuable natural resources that deserve to be preserved and protected. The following chapter describes the methods and materials used to achieve the first objective to determine whether wetlands are being adequately preserved in the sample group.

12.1 Should They Be Preserved?

This is best answered from the following notes, taken from McCoomb and Lake (1988):

- Samples of wetlands should be maintained as part of a general conservation policy for the preservation of genetic and biotic biodiversity.
- Wetlands should be seen as an important component of the biosphere. An example is given as a wetland being a part of the hydrological cycle, where the wetland traps, immobilises and recycles nutrients and other chemicals.
- Their continued existence adds to the variety of ecosystems that humans can visit and enjoy. Where people can escape from the pressures of modern life to experience natural, relatively undisturbed ecosystems.
- Conserved wetlands are a valuable source for scientific and educational study.

Wetlands have an important role in controlling water flow. Wetlands slow the flow of water into downstream catchments, protecting the land from erosion.

Many wetlands contain valuable records of plant communities that once surrounded them, and events in their catchments. This information provides clues to the impact of humans and the change of climate. This information may be important for predicting the future effects of climatic change.

13 Wetland Legislation and Planning

13.1 Introduction

The institutional framework for environmental management in New Zealand underwent important changes during the period of 1985-1991. This restructuring was influenced by national and international factors such as the Ramsar Convention. In practical terms, the major considerations were that many government agencies had conflicting mandates - both the protection of, and development of natural resources. Some agencies had overlapping responsibilities, with numerous laws, which resulted in an incremental and often ad hoc approach to environmental management (Jones et al., 1995).

This inability to effectively manage natural resources can be illustrated by the management and protection of wetlands. Before this restructuring period, there were about 30 different statutes that had relevance to the development, use, protection and management of wetlands. Individual statutes often referred to several different functions, while at the same time, other statutes referred to similar functions. This meant that duties and responsibilities of government bodies often overlapped and some were mandated to carry out conflicting functions. For example, the Ministry of Agriculture and Fisheries was required to provide advice on wetland development and drainage, but also on wetland retention for the protection of fish breeding habitats (Jones et al., 1995).

13.2 Resource Management Act (1991)

In the late 1980s, the Ministry for the Environment undertook a comprehensive review of the major laws governing natural and physical resources in New Zealand. Discussion papers were published, submissions were received, and regional discussion meetings and huis were held. The resulting Resource Management Act (RMA), consolidated the previously fragmented and often ad hoc legislative framework dealing with the use of natural resources. The Act repealed more than 75 statutes and amended more than 150 others (Ministry for the Environment, 1997a).

The RMA affects virtually all aspects of resources and environmental management in New Zealand (with minerals being excluded). The purpose of the Act is "sustainable management of natural and physical resources". This has been defined as "the use, development, and protection of natural and physical resources in a way or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety" (Jones et al., 1995).

The RMA defines the roles and responsibilities in respect of resource management for the three levels of government in New Zealand – central, regional, and local. At the central government level, the Minister for the Environment is assigned various powers that may be used for decisions relating to the management of wetland areas. These include the power to recommend the issuing of national policy statements, the power to impose regulations specifying national environmental standards relating to water quality, level, or flow. The Minister may also call for a review of any proposed plan for development or policy statement (Jones et al., 1995). The emphasis of the Act is on effects rather than activities.

The purpose of the Act is set out in Section Five:

(1) The purpose of this Act is to promote the sustainable management of natural and physical resources.

(2) In this Act, "sustainable management" means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide social, economic, and cultural well-being and for their health and safety while –

- *(a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and*
- *(b) Safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and*
- (c) *Avoiding, remedying, or mitigating any adverse effects of activities on the environment.*

Section Six states that wetlands are a matter of national importance in that "*all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall recognise and provide for the following matters of national importance:*

(a) *The preservation of the natural character[7] of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development.*

Development activities require resource consents from local authorities under the RMA. The consent process includes provisions for consultation with affected landowners and public consultation, which can be costly and drawn out. The Department of Conservation and other interested parties such as the Fish and Game Council, can lobby for protection for wetlands and for appropriate activities on wetlands and surrounding land.

The mid-1980s Government decision to end funding of irrigation, flood control and drainage schemes may have slowed some pressures on wetlands. However, small-scale drainage continues to occur in a number of small areas, especially in areas where dairy farming is expanding or intensifying (Smith, 1997).

13.2.1 Classes of Activities

For each zone identified in the various regional and district plans, there are a set of rules influencing the type and extent of activities that are allowed to take place. Activities are described by the following classes of activity, which are scaled according to the expected adverse effects that the activity has on the environment. The following descriptions of the various activity classifications are taken from Horowhenua District Council's District Plan (1999).

Permitted These activities are allowed without the need for a resource consent if they comply in all respects with the performance conditions that are specified for them.

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[7] The natural character includes the landform, water, wetland plants and animals and the margin as defined by the extent of seasonal inundation and wetland plants. An important factor of the natural integrity of

Controlled These activities require a resource consent. They shall be granted consent provided the application complies with the standards and terms specified for them. They will be assessed according to the specific matters listed in the various Plans over which a local authority has reserved control. The authority may impose conditions in respect of those matters over that it reserves it control.

Limited Discretionary These activities require a resource consent. They may be granted or refused consent. The local authority will restrict the activity at its discretion, in granting or refusing such applications, to a specified range of matters. The authority can limit its consideration of the merits of such activities to the restricted matters specified in regional and district plans. The authority may also impose conditions in respect of the matters to which it has restricted it discretion.

Discretionary These activities require a resource consent. They may be granted or refused consent. There is no restriction on the authority's discretion to grant or refuse or to impose conditions of consent. The objectives, policies, and rules of the regional and district plans, and the requirements of the RMA in considering and deciding on any application, guide the local authority.

Prohibited These are activities that a plan specifically prohibits and describes as an activity for which no resource consent may be issued.

13.3 Conservation Act 1987

This act established the Department of Conservation (DoC), which seeks to promote the conservation of New Zealand's natural and historic resources. The statute gives the Minister of Conservation the power to declare land under the Act for conservation purposes. Categories of protected areas include conservation parks, wilderness areas, ecological areas, and sanctuary

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water bodies is the management of activities within the riparian margins, as these are important both as natural areas and in protecting water quality (Rangitikei District Council, 1999).

areas. Restriction can be placed on access (by humans, livestock, vehicles, aircraft) and construction. The DoC may also negotiate agreements with landowners over the use and management of areas of natural habitat on their property (Jones et al., 1995; DoC, 1996a).

13.4 Other Acts

Other Acts include the National Parks Act (1980), which provides for the creation and management of national parks. The Marine Reserves Act (1977), for the identification of marine habitats, the Wildlife Act (1953), Freshwater Fisheries Regulation (1983), Whitebait Fishing Regulations (1993).

13.4.1 Wildlife Act 1953

This Act provides for the establishment and taking of gamebird species, the appointment and powers of rangers and the maximum penalties for breaches of the Act and associated regulatory notices.

13.4.2 Fisheries Act 1983

Part Five of the Act, governs the taking of sportfish while Section 90 and 90 set out special provision in relation to freshwater fisheries including the establishment and operation of freshwater fish farms.

Regulation controlling the licensing of anglers, the taking of sportfish and the storage, smoking and canning of acclimatised fish are included in the Freshwater Fisheries Regulations 1983. Part Eleven of those regulation deals with offences and penalties relating to sportfish angling. The anglers Notice prepared each year under the provisions of Section 70 of the Fisheries Act provides detail as to the prohibitions, restrictions, offences, and penalties relating to the taking of sportfish species (Fish and Game New Zealand, 1997b).

13.5 New Zealand Wetlands Management Policy

The government in 1986, to preserve and protect important wetlands that are of international, national and regional importance adopted this policy. The policy also aimed to maintain an inventory of wetlands (WERI database), and the promotion of public awareness of wetland values (DoC, 1996a).

13.6 Manawatu Catchment Water Quality Regional Plan

This document sets out all the rules and policies for water quality within the Manawatu catchment. It was designed to address the adverse environmental effects caused by the degradation of water quality within the Manawatu Catchment. The plan is divided into five parts; Part One explains why there is a need for such a regional plan, and its associated statutory framework. Part Two describes the Manawatu River catchment, as well as the values associated with it, and a description of the indicators that are used to assess water quality. The third section discusses the issues associated with water degradation and includes the management procedures that have been adopted to address those issues. Part Four describes the environmental monitoring of the resource and the review timetable for the Plan. Part Five describes the processes and requirements for the application of resource consents (Manawatu-Wanganui Regional Council, 1998d).

13.7 Proposed Regional Plan for Beds of Rivers and Lakes and Associated Activities

This document tries to establish a framework in which to consider all perspectives of use and development in order to manage the different and sometimes conflicting demands on the region's river and lake beds. The document sets out to establish this framework by stating effects-based rules for activities that may affect these natural features (Manawatu-Wanganui Regional Council, 1997a).

13.8 Proposed Manawatu District Plan (1998)

Within this document, the Manawatu District Council acknowledges that wetlands make a significant contribution to the quality of the landscape. The District Plan also recognises that the Rangitikei River estuary is a regionally significant wetland and wildlife habitat. It states that other important wetlands include the interdunal lakes and oxbows from the Manawatu and Oroua Rivers. Full details of these regionally significant wetlands are given in Appendix 21.3.

14 Review of Legislation and Planning Documents

14.1 Resource Management Act (1991)

This Act identifies wetlands as being of national importance that must be taken into account when local authorities are making decisions under the Act. More generally, the Act's "additional matters" cover wetlands by providing protection of the intrinsic value of ecosystems, the protection of heritage and amenity values, the maintenance and enhancement of the natural quality of the environment, the recognition of any finite characteristic of natural and physical resources, and the protection of trout and salmon spawning habitat. The Act also provides for wetlands to be covered by water conservation orders, which previously only offered protection if a river flowed through a wetland (DoC, 1996a).

The RMA requires local authorities such as the Manawatu-Wanganui Regional Council to draw up regional and district plans. During the public consultation process of these plans, interested parties are able to identify wetlands, including coastal and estuarine areas, for special protection under these plans.

The New Zealand Coastal Policy Statement, requires Regional Coastal Plans to identify Areas of Significant Conservation Value. Examples from the Manawatu Wanganui Regional Coastal Plan are the protection areas of the Rangitikei and Manawatu River Estuaries. The plan protects these areas by giving them special status as Coastal Protection Areas, which also includes parts of the foreshore containing breeding and roosting areas for birds.

14.2 Manawatu-Wanganui Regional Policy Statement (1998)

The Regional Policy Statement (RPS) seeks to integrate the use of natural resources at a regional and local level through the application of policies for the management of lakes, rivers and wetlands of the Manawatu region (Horowhenua District Council, 1999). This section will identify the issues, objectives, policies and methods from the regional policy statement that have particular reference to wetlands and the sustainable management of them.

Objective 11A *To avoid, remedy or mitigate the adverse effects of land use on water quality in lakes, rivers and streams.*

Although the objective does not implicitly state, it is presumed that adverse effects on wetlands is also considered. This is proven in the following policy.

Policy 11A.1 *To protect and enhance the existing vegetation along riparian margins of rivers, lakes, wetlands and the coast, except where this will increase risk from flooding or where action is needed to control plant pests.*

This policy only protects the wetland vegetation from the adverse effects of plant pests and does not take into consideration the effects that other influences may have on the wetland.

Method 11A.1 *Promote the protection and planting of riparian margins through education and advocacy to landowners and to other organisations or agencies acting under other legislation.*

Method 11A.2 *Promote the retirement and planting of riparian margins by offering technical advice and assistance, and preparing riparian management plans in conjunction with landowners.*

The regional council has produced information booklets relating to this subject. The "Poplars and Willows" document outlines the varieties of poplar and willow poles that may be purchased from the Regional Council for the purpose of soil conservation. The other document entitled "The

Good Plant Guide" identifies that various plant species that may be used by planters to ensure that the species they buy are not invasive or poisonous.

Issue LRW2 *The need to recognise Maori spiritual and cultural values in the development and activities in lakes, rivers, wetland and their margins.*

This is to provide for the relationship that Maori have with the natural environment, and to provide for the special historic values that are held to these places.

Issue LRW3 *Loss of wetland habitat.*

This issue acknowledges that there has been a extensive loss of wetland habitat within the region as a result of the want to develop land for agriculture. There is also acknowledgement that other activities have contributed to this loss, including drainage, flood protection schemes, reclamation works, dune stabilisation, and forestry.

Even with the publication of Benn's report (1997), the regional council cannot be sure of the extent of wetlands under its jurisdiction. But what is known is that there still are wetlands in areas that are not suitable for farming. Examples of these areas are given in the RPS and include the volcanic plateau and along the coastal dune area. The RPS states that for these reasons, it is important for these remaining wetlands to be identified and protected.

Objective 15 *To preserve the natural character of lakes, rivers and wetlands and their margins and protect their ecological, cultural, intrinsic and amenity values from inappropriate subdivision, use and development.*

This is a self-explanatory objective that the regional council has set itself. This objective is to provide for Section Six (a) of the RMA, which caters for the preservation of the natural character, including wetlands.

Policy 15.1 *To provide for the preservation of the natural character of lakes, rivers and wetlands and their margins. In determining natural character of lakes, rivers and wetlands matters to be considered shall include:*

(a) the existing degree of human modification

(b) *the presence of areas of significant flora and habitats of indigenous fauna; and*

(c) *the diversity of species, communities or habitats; and*

(d) *amenity values; and*

(e) *the degree to which the area provides for the continued functioning of ecological and physical processes.*

This policy sets out the criteria for determining whether a wetland shall be protected under the RPS. Obviously if a wetland has been modified by a great deal, contains little "significant" flora, fauna or habitats, then it is not going to gain very much protection by the local authorities. The fifth point here will be very difficult to assess. No where in the RPS are there details of how the regional council is going to carry this assessment out to determine how well the wetland provides for continuing ecological and physical processes.

Policy 15.2 *To provide for the protection of the ecological, cultural, intrinsic and amenity values and attributes of lakes, rivers and wetlands and their margins from inappropriate subdivision, use and development. In determining inappropriate subdivision, use and development matters to be considered shall include:*

(a) *actual or potential effects on:*

i. *natural character*

ii. *areas of significant indigenous vegetation or habitat or indigenous fauna; and*

iii. *amenity values; and*

iv. *cultural values; and*

v. *the life-supporting capacity of ecosystems; and*

vi. *the habitats of trout; and*

vii. *frequency and magnitude of occurrence of natural hazards such as flooding and erosion;*

and, where activity may result in adverse effects, the degree to which it is required to:

(b) *mitigate the effects of natural hazards; or*

(c) provide for the development or maintenance of utilities and services to the public; or

(d) provide for the social and economic well-being of communities;

provided that, in all cases, adverse effects of any activity on these features and attributes can be avoided, remedied or mitigated.

This policy provides for the protection of wetlands by stating that any effects of use, subdivision, or development shall not have any adverse effects on the stated values. If the activity is to have adverse effects, then the RPS requires the consent applicant to prove that the activity will provide some form of compensatory benefit as identified in (b) through (d) above.

Policy 15.4 *In considering applications for regional plans to protect inland water bodies not protected by existing Local Water Conservation Notices or National Water Conservation Orders, the Council will have regard to whether the water body has regionally significant values that require protection, in particular whether it:*

(a) has wild, scenic or other natural characters; or

(b) provides a habitat for rare aquatic biota; or

(c) is of cultural or spiritual significance to tangata whenua; or

(d) contains special or important amenity or intrinsic value, including scientific, ecological, recreational, fisheries, historical, spiritual or cultural values; and

will also consider the needs of primary and secondary industry and the community.

This policy states that if an applicant where to ask for protection of a wetland, the regional council would consider whether the wetland was worth protecting under the aforementioned policy, and they will also take into consideration any effects this protection will have on local industry. The author believes that although effects on locals from protection should be taken into consideration, the other aspects of the policy should be disregarded. If a landowner where to ask for protection of a wetland on his/her property, then the regional council would have to determine whether the wetland has those significant attributes that are stated in Policy 15.4. It follows that a wetland may not fall into those categories of the policy, but may still provide adequate functioning of wetland properties. For example, the area may protect a few areas from flood events, and provide adequate habitat for game hunters. Both of which can be argued that are not "regionally significant", but nonetheless significant at a local level.

Method 15.3 *Prepare a regional plan for lakes, rivers and wetlands to control activities in these areas.*

The regional council trading as Horizons.MW has prepared a "Background Report on the Proposed Land and Water Regional Plan". This document will be discussed later.

Method 15.4 *Request the Department of Conservation, Fish and Game Councils, iwi and other appropriate agencies and interested parties to help identify the attributes and values of lakes, rivers and wetlands that may merit protection.*

The Department of Conservation was included in a programme with the regional council that identified some of the more 'significant' wetlands throughout the region (Ravine, pers. comm., 1999).

Issue L3 *Adverse effects of land use activities on surface water quality and biota.*

This is recognition that land based activities lead to accelerated erosion, subsidence, excavation and sedimentation. These activities include cultivation, roading, excavation and stocking, all of which have adverse effects on water and habitat quality. These adverse effects come from; sedimentation, plant and animal wastes, agricultural fertilisers and chemicals. They promote the growth of algae and fungi that in turn smother aquatic habitats. Discolouration and silting of the waterways (including wetlands) is also another effect of increased sedimentation from these land-based activities. (Manawatu-Wanganui Regional Council, 1998b).

Environmental Results Anticipated

The following is a brief list of what the regional council expects to be environmental results within the scope of this report, as a result of the implementation of the regional policy statement.

(a) *Attributes of lakes, rivers, wetland and their margins that are highly valued for their cultural, ecological or intrinsic values will be identified and protected.*

(b) *The natural character of wetlands, lakes and rivers will be preserved.*

Out of a possible six anticipated results, two were related to wetlands, the others were solely focussed on rivers and lakes. Again point (a) refers to the protection of already highly values wetlands, and the vague term 'natural character' is added to cover the requirements of the RMA. The term is vague because there is no description of what the natural character of a wetland consists of. The glossary of the RPS states that natural character is:

"The qualities of the environment that give it recognisable character. These qualities may be ecological, physical, spiritual, cultural or aesthetic in nature. They include modified and managed environs."

All these terms can be applied to a wide range of wetlands throughout the region, including those designed for functional use (a hunting spot for example), to those that are protected and remain largely unmodified. So to state that it is hoped the wetlands will retain their natural character seems to be a way of saying that wetlands will remain in their present state – even if the wetland has been highly modified and altered from its original form.

14.3 Manawatu-Wanganui Regional Council Bylaw 1991

This bylaw contains a rule stating:

"No person shall connect a private drain to any water course under the control of the (Regional) *Council, or alter or enlarge any private drain connection to a watercourse under the control of the Council, without the prior written consent of the Council."*

This law has good intentions, but it would be quite conceivable that if a farmer wanted to drain or alter a drain on the property, then unless the work was quite significant, it is unlikely that the farmer would seek written approval.

14.4 Manawatu Catchment Water Quality Regional Plan

There is no mention within this document of the need to improve or preserve wetlands, as the emphasis is on river water quality and the effects of discharges to waterways.

14.5 Proposed Land and Water Regional Plan

This proposed plan sets up a framework to manage discharges of contaminants to land and water, and abstractions and uses of surface water and groundwater (Horizons.MW, 1999b).

The following is a description of the objectives, rules, and issues that are addressed in this document.

DL Objective 3 *Improving surface water quality*

To reduce sediment, bacteria and nutrient runoff to lakes, rivers and streams.

This is a reasonably straightforward objective, however wetlands have not been implicitly stated. This means that either Horizons.MW has no objective towards reducing sediment into wetlands, or that wetlands somehow fit into the categories of the objective.

DL Rule 4 *Discharges of agricultural effluent*

4.1 Any discharge onto or into land, except in the Manawatu catchment of,

a. wastewater and/or sludge from dairy sheds, piggeries, or feedlots; or

b. sludge from agricultural wastewater treatment ponds; or

c. poultry farm litter or wastewater

*is a **Controlled Activity***

This rule means that the above activities are classified as controlled activities as long as they occur outside the catchment of the Manawatu River. Controlled activities are those that require resource consents, as long as the consent holder complies with the conditions of the consent, and the various regional and district plans.

4.2 The activity shall comply with the following standards:

a. subject to clause 4.2.b[8]*, there shall be a buffer zone of at least 20 metres width between the disposal area and the coastal marine area, the nearest river, lake, natural wetland, artificial watercourse, public road, residence and neighbouring properties.*

Riparian margins need to be at least 10-30 metres wide (Polglase and Death, 1998, Spencer et al., 1998) to be effective. To state that disposal areas need to have at least 20 metres buffer zone, is a significant step towards protecting and preserving the quality of the wetland environment.

4.3 The Council will exercise control in relation to these activities over the following matters:

b. *the distance of the discharge to the nearest river, lake, natural wetland, artificial water course, public road, neighbouring properties, residence, marae, public hall, church, school, and public recreation area.*

This rule was put in place to regulate rule 4.2a (above), to ensure that there are adequate riparian margins between waste disposal areas and places for human activity and waterways – including wetlands.

It is stated in this proposed plan that the nutrient enrichment of the coastal dune lakes will be reduced. Some of these coastal dune wetland were included in the field work research of this report and it will be interesting to see whether these wetlands do have a high trophic level.

DSW Rule 3 *Discharges to lakes and natural wetlands*

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[8] There shall be a buffer zone of about 150 metres between a piggery waste disposal area and any settlements or recreational sites.

3.1 Except as provided for by DWS Rule 4 and 6[9] and within the Manawatu catchment, any discharge of a contaminant to a lake or natural wetland

is a **Non-Complying Activity.**

This rule applies to all discharges to natural wetlands, except those discharges that are of stormwater. This rule does not apply to artificially constructed wetlands – they are covered by a separate rule (DSW Rule 7).

If an applicant wishes to apply for consent in the area described in DSW Rule 3, then that person must follow the guidelines that are reproduced from Horizons.MW (1999b) below.

DSW Rule 3 *Discharges to lakes and natural wetlands*

Pursuant to Section 88 of the Act, applications for non-complying activities described in DSW Rule 3 of this plan shall include the following information-

a. *a statement specifying all other resource consents that the applicant may require from the regional council or the district council in respect of the activity, and whether or not the applicant had applied for such consents; and*

b. *a description of the site of the proposed activity, including the map reference from NZMS map, scale 1:50,000, and plans of the site showing the location of the point of discharge, drains, watercourses and neighbouring properties; and*

c. *a description of the receiving environment including:*

- *i.* *existing water quality, including trophic status;*
- *ii.* *aquatic ecosystems;*
- *iii.* *indigenous flora and fauna;*
- *iv.* *other values, such as recreation and amenity; and*
- *v.* *the sensitivity of the receiving environment to adverse effects; and*

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[9] These are rules relating to the discharges of stormwater (Rule 4), and the discharge of water to water (Rule 6).

d. *a description of the effects of the discharge on the receiving environment; and*

e. *the types of non-biological or persistent contaminant in the discharge, and whether the contaminant is likely to accumulate in the lake or wetland environment; and*

f. *the measure that will be taken to avoid, remedy or mitigate any adverse effects on:*

- *i.* *matters of concern to tangata whenua*
- *ii.* *aquatic ecosystems;*
- *iii.* *human health and amenity values; and*
- *iv.* *any specified value associated with any feature of regional significance identified in the Regional Policy Statement for Manawatu-Wanganui; and*

g. *a description of any alternative methods of discharge, including discharge into any other receiving environment; and*

h. *a description of the consultation undertaken with parties interested in or affected by the proposal, and the applicant's response to the views of those consulted.*

These guidelines do not provide for any buffer zone that the applicant may wish to use as some form of a filter system, before the waste enters the water body of the wetland. This could be used in conjunction with DL Rule 4 (above), as a way to remove excess nutrients, and help to lower the trophic state of many of the wetlands in the Manawatu.

SW Policy 7: *Protection of wetlands*

This policy is designed to mitigate, or remedy the effects of the diversion or taking of water that would result in the lowering of the water level in any wetland.

The applicant would have to have regard for:

a. *the degree of modification from its natural state; and*
b. *the biological diversity or uniqueness of aquatic or terrestrial species or habitats; and*
c. *its significance as an area of indigenous vegetation; and*

d. *its hydrological or biological relationship with a river or lake in terms of river flows, lake levels or water quality; and*

e. *its significance in terms of scientific, educational, recreational, aesthetic or intrinsic values; and*

f. *its cultural or spiritual significance to Maori; and*

g. *the cumulative loss of wetlands in the local area.*

All of these are straightforward enough for an applicant to follow. However, point (d) may be very difficult for an applicant to assess. The proposed plan does not have any instructions on how to interpret the relationship with the wetland and a nearby river or lake. If this relationship is not clear to the applicant, does this mean that a professional scientist needs to be brought in to inspect the wetland and surrounds, at a cost to the applicant? Probably not, but this needs to be elaborated on further by Horizons.MW, to avoid any confusion.

This policy also allows for the mitigation, remedying, or offsetting of adverse effects on wetlands associated with taking or diverting water. This means that the council may require the establishment of a wetland, similar to one that will be adversely affected by the granting of a consent that allows diversion or taking of water. Horizons.MW (1999b) go on to state that this policy goes towards recognising that it is a matter of national importance to preserve the natural character of wetlands and protect them from inappropriate use.

SW Policy 8: *Protection of regionally significant wetlands*

This again, is further protection of those wetlands that have been identified in the regional policy statement as being of significant regional value.

SW Rule 9: *Diverting water from wetlands*

9.1 Any diversion of water from

- *a. Kutaroa and Otahupitara Swamps (Irirangi Swamp);*
- *b. Markirikiri Tarns; or*
- *c. Reporoa Bog*

*is a **Non-Complying** activity.*

This rule only applies to the water in wetlands, and not to the diversion of water in rivers, lakes, or drains. The three wetlands acknowledged in the rule have been identified in the regional policy statement as having values significant at a regional level.

SW Rule 10: *Diverting water except from wetlands, lakes or rivers*

Subject to SW Rule 9 any diversion of surface water in an artificial watercourse

*is a **Permitted Activity** subject to the following*

a. *the diversion does not cause lowering of the water levels in any lake, river or wetland; and*

b. *the diversion does not cause adverse effects on groundwater levels on neighbouring properties; and*

c. *the diversion does not cause any erosion of flooding on neighbouring properties.*

This rule caters for those instances not covered by SW Rule 9, or by a rule in the Regional Plan for Beds of Rivers and Lakes and Associated Activities. An example where this rule may come into affect is given by Horizons.MW (199b) of a farm drain being diverted to a roadside drain or river.

Horizons.MW does not only rely on rules and regulations to achieve its objectives, there are also non-regulatory methods in which the management of wetlands in the Manawatu can be undertaken. For example;

SW Method 1: *Wetland Inventory*

The regional council has just started a wetland inventory as part of a Land and Riparian Management Strategy. This inventory hopes to assess the location and types of wetlands that exist within the Manawatu region. The council hopes that an assessment of the values of the wetlands could then be undertaken in order to design management practices to address the adverse effects that activities have on them.

The document by Horizons.MW (1999b), was designed in order to protect the existing character of wetlands in the region from the effects of drainage. This proposed plan goes a lot further than the other plans. It does this by providing not only for those wetlands that are identified as having regionally significant values, but also those that are not in that list.

14.6 Proposed Regional Plan for Beds of Rivers and Lakes and Associated Activities

The scope of this document is determined by the RMA[10]. They are listed below:

- Restrictions on activities in the beds of rivers and lakes (s.13);
- The damming and diversion of water (s.14(1)) and associated discharge of excess water (part s15.(1));
- Restrictions on land use (s.9); and
- The functions and responsibilities of regional and district councils (s.30 and s.31).

The following are rules and explanations that are in this proposed plan, and that relate to the status of wetlands in the Manawatu.

BRL 25: *Lawfully established reclamation and drainage – all rivers and lakes.*

Any reclamation and drainage of the bed, or part of the bed, and any directly associated structures or diversion of water for drainage or reclamation, in any river or lake in the Region, lawfully established at the time of notification of this Proposed Plan

*is a **Permitted Activity** subject to the continued adherence to all conditions attached to the resource consent or other permission which established the activity (irrespective of whether that consent is still operative).*

This rule means that as long as the resource consent holder is carrying out any drainage and reclamation with structures and diversion of water, then that activity is allowed to continue. This is on the condition that the activity is within the provisions of the consent. The document states that any further or new drainage or reclamation activity will need to be considered under the following rules 26 and 27. The proposed plan states that this particular rule is consistent with the provisions of the Soil Conservation and Rivers Control Act (1941), and the General Authorisation of these activities under Section 22 of the Water and Soil Conservation Act (1967) (Manawatu-Wanganui Regional Council, 1997a).

BRL Rule 26: *New or further reclamation or drainage – protected lakes.*

Any new or further reclamation or drainage of the bed, or part of the bed (including extension of existing reclamation or drainage) and any directly associated activities and structures for drainage or reclamation in, on, under or over the bed, and any directly associated diversion of water.

*Is a **Non-complying activity** in the following lakes:*

- *i. Lake Horowhenua;*
- *ii. Lake Papaitonga; and*
- *iii. Pukepuke Lagoon.*

These lake and wetland areas have been identified under the Regional Policy Statement as having significant features that are of value to the region, and that any new or further reclamation or drainage is a non-complying activity (Manawatu-Wanganui Regional Council, 1997a). The document stops short by allowing the continuance of existing drainage schemes and reclamation sites, and does not require these to be removed. If an application was received for further or new drainage or reclamation, then the applicant would have to meet the requirements of section 105 2(b) of the RMA. This section states that any activity being undertaken would have minor adverse effects on the environment, and that the granting of the consent would not be contrary to the objectives and policies of any plan (RMA, 1991; Manawatu-Wanganui Regional Council, 1997a). However, the proposed plan states that any further reclamation or drainage of the aforementioned wetlands is considered to have potentially "significantly adverse effects" on the environment.

BRL Rule 27: *Reclamation and drainage – all other lakes and rivers*

27.1 Except as provided for by BRL Rule 25 and subject to BRL Rule 26, and reclamation or drainage of the bed, or part of the bed of any lake or river (including extension of existing reclamation or drainage) and any directly associated activities and structures

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[10] These notes have been taken from Manawatu-Wanganui Regional Council (1997a)

for drainage or reclamation in, on, under or over the bed, and any directly associated diversion of water

is a ***Discretionary Activity.***

This rule is to provide for any other new or further drainage or reclamation of the bed of any river or lake, and it is presumed that this can be extended to include those wetland areas that are not identified as being of regional significance. This is not stated however. It could be as easily assumed that those wetlands not identified as significant have no such protection under this proposed plan.

Under these rules, the proposed plan states that the following information must be provided when applying for a resource consent:

BRL Rules 26 and 27

a. *A description of:*

- *i.* *depth of the area to be reclaimed or drained;*
- *ii.* *the volume of the reclamation;*
- *iii.* *the materials to be used as fill and its source including sediment characteristics;*
- *iv.* *whether the reclamation is to be vested in the applicant;*
- *v.* *any provisions made for an esplanade or reserve strip, or the reasons why an exemption is necessary;*
- *vi.* *a description of existing flora and fauna and an assessment of effects on existing flora and fauna.*

Obviously more details are required, but these descriptions are the ones that relate directly to the scope of this report. The consent review people would then use this information to determine whether the proposed reclamation or drainage would be suitable under the framework of the regional policy statement.

14.7 Proposed Manawatu District Plan (1998)

The following is some objectives, policies, and methods from the Proposed Manawatu District Plan, specifically dealing with the management of wetlands.

Objectives

HV1) *To protect significant heritage places and items so as to maintain the cultural, historic, architectural, education or natural values associated with the place concerned, and to protect any rare or outstanding features associated with them;*

HV2) *To ensure special recognition for natural features and places valued by the Tangata Whenua, and to make provision for protection, preservation or use of such places, in consultation with the groups concerned;*

HV5) *To promote the sustainable management of those areas of indigenous vegetation and habitats which have not been identified as significant.*

Clearly these objectives are not specifically designed to promote the protection of wetlands, however they do provide for the protection of those wetlands that have been identified as having a regionally important role in the region. These generally objectives are again shown in the policies:

4.4 (b) *To ensure that those natural features and ecosystems which are important parts of the District's environment are protected and enhanced.*

The next chapter of the proposed plan is slightly more focussed, but stops short of identifying what habitats and ecosystems will be protected under these strategies. It is assumed that all natural features will be protected. For example from Chapter Five;

Objectives

LU1) *To recognise the potential adverse effects of activities upon the natural environment, land and ecosystems and to avoid, remedy or mitigate these effects.*

Polices

5.2(a) *To ensure that adverse effects on the natural environment, land and ecosystems are avoided, remedied or mitigated.*

5.2(b) *To take potential impacts on future owners of an affected property into account when managing land use effects.*

This second policy (5.2(b)), is of interest, as in other parts of this document and other regional and district plans, the effects of future landowners is disregarded with emphasis on the sustainability of the natural resources a focal issue.

The District Plan names certain natural features within the district that the Plan will seek to protect. The only wetland specified in this document is Pukepuke Lagoon;

LU 7) *To protect the quality of the District's outstanding landscapes, namely:*

(e) Pukepuke Lagoon

Again it is the same issue of only protecting those wetlands that are of regional significance, and those that already happen to be protected by other means. In this example Pukepuke Lagoon is under the protection of the Department of Conservation by means of a management plan and a reserve status. Access to the area is limited, with anyone wanting to visit the wetland, having to apply for a permit issued by the Department.

Another area of interest within this document is an objective that deals with potential conflict between rural land users.

Objective

LU 9) *To minimise conflict between primary production and potentially incompatible activities in the rural zone.*

Policies

5.3.4 (a) *To recognise that rural residents will need to accept that some adverse effects may result from normal primary production activities from time to time.*

5.3.4 (b) *To reduce the adverse effects of high impact land uses as far as practical.*

5.3.4 (f) *To mitigate the adverse effects of intensive farming activities.*

These policies and objective allow for the effects of farm activities on the natural environment. This relates particularly well with farm activities impacting on wetlands.

Related to this, are the issues of water supply, stormwater and farm drainagé. The District Plan states that:

Objective

S 4) *To ensure that water supply, stormwater disposal and farm drainage needs are taken into account at the subdivision stage.*

Policy

6.3.4 (c) *To preserve legal access for drainage from new allotments where appropriate, as well as practical access for drain clearance.*

Obviously these only relate to circumstances where the property is being subdivided, but it shows that wetland drainage is not a very restricted activity, and that the development of new or ephemeral wetlands is severely limited in areas that subdivision may occur (or is occurring).

This issue is dealt with in the next chapter, mainly a section entitled "Fragmentation of Natural Areas and River Channels".

Objective

S 11) *To avoid adverse effects on the natural values of streams, lakes, wetlands and indigenous forest areas arising from fragmentation of land ownership.*

Policies

6.3.11 (a) *To ensure that the natural values of indigenous forest areas, lakes and significant wetlands are not adversely affected by fragmentation of ownership arising from subdivision.*

The District Plan explains that wetlands that are owned by more than one party can be more difficult to manage as one entity, as each landowner has their own ideas about activities on their land. For example, one landowner may wish to drain the wetland to convert the land into pasture, while the neighbour may wish to raise the water level to promote a better habitat for game birds.

The plan allows for the fragmentation of areas containing wetlands, as long as those wetlands are then subject to be protected by a legal covenant. It is hoped that subdivision in the district does not adversely affect the natural, heritage, and amenity values of wetlands.

Chapter Seven is dedicated to esplanade management, and the areas that relate to wetlands are described below.

Objective

EM 3) *To preserve the natural character of the coast, wetlands, lakes and rivers and their margins.*

EM 4) *To protect areas of significant indigenous vegetation, wetlands and aquatic habitats.*

Policy

7.2 (b) *To use esplanade management to protect the significant conservation values and to enhance the water quality of Lake Kaikokopu, Lake Momanuka, Karere Lagoon and Hamilton's Bend Lagoon. Public access for these places will not be sought.*

These by themselves provide adequate coverage for the protection and preservation of wetlands in the district. The provision not to allow public access to the sites is commended, as this could have a detrimental effect on the natural habitats and wildlife within the areas. The Plan states that wetlands over eight hectares are important bird habitats, and that these fall into the matters of national importance clause in the Resource Management Act.

The Manawatu District Council envisages that areas of significant indigenous vegetation and wetlands will be protected, and that the conservation vales of Lakes Kaikokopu, Omanuka, Karere Lagoon, and Hamilton's Bend Lagoon are protected, with improvements to water quality.

The Plan has rules for the activities within its jurisdiction, and those that are related to wetlands are identified below.

Permitted Activities

A) *The following shall be permitted activities in all zones:*

i) *Management of the water level of areas listed in Appendix 1A*[11] *(wetlands etc) if approved by the **Regional Council**.*

ii) *Any activities in respect of a place listed in Appendices 1A, 1B or 1C(Wetlands etc, Significant Indigenous Forest/Vegetation and Outstanding Natural Features) which are consistent with a **legal covenant** applying to that place.*

These rules cover the already protected wetlands, and do not apply to others that have not been classified as 'significant'.

Discretionary Activities

A) *The following shall be permitted activities in all zones:*

i) *Clearing, spraying, felling or burning vegetation (except **plant pests**) in Category A or B places listed in Appendix 1A (wetlands etc).*

ii) *Drainage, reclamation or excavation of Category B places listed in Appendix 1A. This rule shall not apply to water level management*

iii) *Constructing permanent structures for birdwatching etc within Category A or B places listed in Appendix 1A.*

Non-Complying Activities

A) *The following shall be permitted activities in all zone:*

i) *Drainage, reclamation or excavation of Category A places listed in Appendix 1A (Wetlands etc). This rule shall not apply to water level management permitted by Rule A2 2.3.1 A (i).*

With these two rules, it can be seen the continuing importance given to areas that have already been designated as significant and important.

[11] Reproduced as Appendix 21.3.

14.8 Horowhenua District Plan

This section follows the same format as above, with the identification of the issues, objectives, methods and rules from the Plan that relate to the management of wetland areas.

Issue 4: *Outstanding landscapes and significant natural features contribute to the natural character and quality of the environment, and should be protected from inappropriate subdivision, use and development, in order to meet the needs of present and further generations.*

Here reference is given to the outstanding and significant natural features that are found within the Horowhenua district. This is a common trend as the various local authorities are sticking to what is required of them by the RMA, but not taking that a step further by investigating the protection or preservation of other features, that do not fall in to the 'significant' classification.

The Horowhenua District Plan identifies three wetlands that are of outstanding regional or district significance:

- Manawatu River Estuary
- Lake Horowhenua
- Lake Papaitonga

Obviously there are many more wetlands within the Horowhenua District Council as these are the only ones which the Council has decided have warranted the protected through this Plan.

Objective 4: *To avoid, remedy or mitigate the adverse effects of activities on landscapes, natural habitats, indigenous vegetation, and wetlands or ecological, recreation and visual significance to the District.*

To achieve this objective, the District Council hopes to:

Policy 4.1 *To have regard to intrinsic values of ecosystems.*

Policy 4.2 *To maintain and enhance views to and from significant landscapes and natural features of visual importance.*

Policy 4.3 *To protect identified areas of significant indigenous vegetation, and significant habitats of indigenous fauna.*

Policy 4.4 *To ensure that development within the vicinity of significant natural features does not lead to a loss of environmental character and quality.*

Policy 4.5 *To encourage the protection of outstanding natural features and landscapes of visual and regional significance from inappropriate subdivision, use and development.*

Policy 4.6 *To recognise and provide for the protection of outstanding natural landscapes of significance to Tangata Whenua.*

These policies are continuing the trend for the protection of outstanding natural features, at the expense of everything that falls outside the significant classification.

Issue 26: *Water pollution and the problems caused by discharges of wastes or untreated stormwater to waterways and to land; and activities which give rise to land disturbance, soil erosion, and downstream siltation and adverse water quality effects.*

Although indirectly related to wetland status, the Plan provides for the land use effects of activities within its district. This is due to the regional council having control over discharges through resource consents. However not all discharges require consent from the regional council. For example, grazing stock and its associated manure entering the environment is a permitted activity (Horowhenua District Council, 1999). The District Council becomes involved with the cumulative effects of a series of indirect or minor effects. Examples taken from the District Plan include:

- The effects of clearing vegetation and exposing soil to the elements with flow-on effects of silt in waterways.
- The risks of accidental spillages from activities taking place on the surface of water or immediately next to waterways.
- The adverse effects that might be caused by certain activities adjacent to a water body on the spiritual and cultural importance of that water body to local tangata whenua.

The district council then uses these considerations to assess the effects of different land use activities, as well as trying to accomplish the following objective;

Objective 20: *The maintenance or enhancement of the quality of water in surface water and groundwater bodies.*

The policies with which the council will attempt to achieve this objective are:

Policy 20.1 *To avoid, remedy, or mitigate any adverse effects of land use activities on water quality.*

Policy 20.2 *Promote sustainable land management and riparian management practices to improve water quality.*

As mentioned previously, these are not implicitly related to wetland protection or preservation, but the promotion of riparian management practices will certainly help reduce the amount of harmful substances entering the wetland environment, as well as providing suitable cover and habitat for wetland animals.

14.9 Resource Consents

The Horowhenua District Plan gives instructions on what is to be included with resource consent for subdivision. The areas of these instructions that relate to this report are reproduced below:

Information Required to Accompany Applications for Subdivision Consent

Vegetation and Habitat:	*the location, nature and extent of any significant trees or areas of vegetation and habitat for indigenous fauna within the site.*
Waterways:	*the location and width of any streams and the limits of any tidal influence.*
Drainage:	*the location and dimensions of any piped or open drains.*
Wetlands:	*the location and extent of any wetland areas or swamps.*

Flooding: *any areas subject to inundation by any waterway or the sea.*

The Horowhenua District Council acknowledges the contribution to the regional by providing for the identification and description of all wetland areas that may be affected by the subdivision of land. However it is likely that if the wetland is not of significant value to the district, region, or nation, that subdivision will take precedence.

The other district council within the scope of this report is the Rangitikei District Council. The following section follows the same format as previous sections.

14.10 Rangitikei District Plan

Policy 14.1 *In particular, recognise and protect the unique cultural, spiritual, ecological, and natural values associated with the following significant features and landscapes.*

- *Mount Aorangi, the Reporoa Bog, Makirikiri Tarns, red tussock grasslands, and forest remnants;*
- *Kutaroa and Otahupitara Swamps;*
- *Lakes Koitiata, Waipu, Vipan, Dudding, Heaton, Alice, and Lake Ngaruru;*

This policy provides for the significant natural features that have been identified in the regional policy statement, district plans, the Department of Conservation, iwi, and other interested organisations. Lake Koitiata and Lake Alice have been surveyed as part of the research of this report.

Issue 15 *The importance of the natural character of wetlands, lakes, rivers, and their margins and the potentially adverse effects of inappropriate management of water bodies and riparian margins.*

Objective 15 *Protection of the natural character of wetlands, lakes, rivers, and their margins; from inappropriate subdivision use and development and;*

Appropriate management of riparian margins of waterways to protect the in-stream values, water quality, natural habitat values, and landscape values of water bodies.

Policy 15.1 *Promote responsible care of the riparian margins including land management practices which improve the quality and natural functioning of water bodies.*

Policy 15.2 *Avoid, remedy, or mitigate the adverse effects of vegetation clearance in important riparian margin areas.*

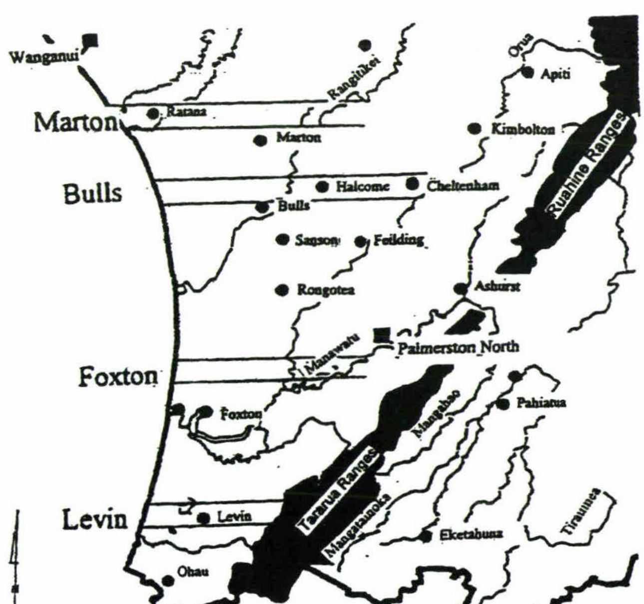
This objective goes a long way to protecting and preserving the status of wetlands within the Rangitikei District. It does this by stating that it is hoped that the natural character of the wetland will be protected. It is assumed that this will in turn promote the preservation of the wetland as well. The two policies designed to achieve this objective are focussed not on the wetland or water body itself, but on the protection of the riparian margin around the wetland. This means that the Rangitikei District Council is hoping that the effects of activities outside the wetland are absorbed by the riparian margin, and that any impacts on the actual wetland will be minimal.

15 Methodology

15.1 Aerial Photo Analysis

Important measures of wetland status are the abundance of wetlands in the region, and their area. The earliest available data were a series of aerial photographs that were flown during the 1940s. The photographs that were used in this report were taken during 1942 and 1949 (at an approximate scale of 1:27 500). These were compared to another series of aerial pictures that were taken during 1995 and 1996 at a scale of 1:27 500. Four transects (Figure 12) were selected and the number of wetland pond sites were counted using a stereoscope across the transects from the coastline to the foothills of the Ruahine Ranges. The transects were selected on a basis of data availability, location distribution within the Manawatu. It was felt that the four transect locations would offer a generalisation of the Manawatu's wetlands, from north to south. Obviously it would have been ideal to examine more than four transects, but many of the earlier photo transects were incomplete, and did not offer useful data. The observation and recording of wetlands from these photos was extremely time consuming, therefore limiting time available for field work.

Figure 12: Location and Extent of Aerial Photograph Transects



A note was made of areas that may have supported wetland plants and animals, but could not be clearly identified as being a wetland. These areas included deflation basins within dune fields and dry riverbeds. These areas were not included in the count as it was decided that the boundaries of these areas were too difficult to determine, and that no accurate comparison could be made.

As each wetland was found within an aerial photograph, its position was determined by estimating its grid reference on a 1:50 000 topographical map. This was particularly difficult with the 1940s pictures, as many of the landmarks and human features had changed markedly between the two dates.

Only open water wetlands were recorded, and no attempt was made to classify these wetlands from this technique. The lists of grid references were then recorded to help map the extent of wetlands and the change in numbers between the 1940s and the 1990s. This data can be seen in Appendix 21.4.

15.2 Wetland Status Assessment

15.2.1 Review of Wetland Classification Scheme

The classification system currently being devised by Partridge et al. (1999) (Appendix 21.5) was intended to be used in this study. Several factors influenced the researcher's decision in order to abandon this form of classification. First, the template that was made available to the researcher was only in its draft form and that the final report had not yet been submitted to the funding organisation for approval. Secondly, studies that had already been published such as Benn (1997, 1998a, 1998b) had opted for a classification system that was based on the wetland's physical form. This meant that for the purpose of this study, wetlands would be classified into one of the following forms; lake, oxbow, artificial pond, natural pond, and swamp. Dairy shed effluent ponds and sewage oxidation ponds were not included in this study as the status of these was irrelevant to providing examples of the inadequate management and use of wetlands in the Manawatu. These were not included because it was felt that these wetlands would distort the data needed to determine the status of Manawatu wetlands. Finally thoughts from Phillips (pers comm., 1999) suggested that a more readily understood classification system would be one similar to that of Benn (1997), rather than the complex one of Partridge et al. (1999).

15.2.2 Field Assessment Sheet

Rapid wetland survey methodologies have been used in Australia to identify wetlands of conservation value, but have not been developed or tested for assessing wetland condition (Spencer et al., 1998). It is not known whether (or to what success), rapid wetland appraisal techniques for wetlands have been used in New Zealand.

The field assessment sheet used for this study was composed from the work of Town (1982), Moore, Ogle and Moynihan (1984), the Department of Conservation (1996a), Benn (1997), Spencer et al. (1998), Polglase and Death (1998), NIWA (1998), and the Ministry for the Environment's web site (1999). So many sources had to be drawn upon, as there was not a suitably comprehensive or adequate field assessment sheet available. In fact, only the Department of Conservation, Benn, and Spencer et al. were specifically designed for wetland analysis. The others where aimed at the assessment of other waterways such as stream assessment.

A replica of the survey form can be found in Appendix 21.6. The field assessment sheet is basically divided into three parts; the first is a general section regarding the name of the wetland, the date of assessment, and the approximate size of the wetland. The next section contains boxes that were ticked to determine how the wetland is fed with water, and identification of the type of wetland being surveyed. The third section was for recording information about the physical attributes of the wetland. For example, information on surrounding land use and water temperature.

15.2.3 Indicators

An indicator can be defined as a measure against some aspects of the environment that can be assessed (Ministry for the Environment, 1998a). For this report, they are used to summarise the issues of the particular wetland, and to indicate the current status of that site.

There is no single indicator that will provide an accurate assessment of the health of a wetland ecosystem. Ecosystem structure and function has to be monitored using a number of indices. Further, there are some additional matters that need to be addressed.

A wetland that is constructed for enhancement of water quality will need to be assessed on its nutrient removal performance and whether this function can be maintained (Osborne and Adcock, 1995).

The trophic status of a wetland, as an index of nutrient enrichment, is a key indicator of overall productivity according to Miller (1995). The observed differences in the amount and consequences of biological production in wetlands can be classified into three levels of eutrophication. In oligotrophic or infertile waters that have a low concentration of plant nutrients, biological production is low, while in eutrophic, fertile water, it is high. Turbid waters and high dissolved oxygen depletion rates accompany high production. Studies shown in Miller (1995), conclude that increasing productivity leads to an increase in the abundance of invertebrates, with a shift in community composition. This means that wetlands that have the most enriched trophic status, have the greatest abundance of macrofaunal communities, but the lowest species richness. Communities from less enriched wetlands are likely to have more even species richness and abundance (Miller, 1995). It should be noted that the use of trophic terms should not be used in terms of the wetland's suitability for a defined use. It is not sufficient to observe that a lake is unsatisfactory because it is eutrophic as done in Horizons.MW (1999). Rather the effect of the condition on desired uses must be described. For example, excessive phytoplankton growth contributes to poor water appearance and reduced suitability for recreational uses, and restricts the habitat for desirable fish (Vant, 1987b).

15.2.3.1 Water Inflow

The variables for assessing how the wetland was being fed included; direct stream flow, seepage (from watertable), drains, overland flow, or other. Direct stream flow and drains are relatively straightforward, as if either of these fed into the wetland, then that particular box was given a tick. If these features were not present, then judgements had to be made regarding how the wetland came to be wet. In those cases, the surveyor had to judge how water would enter the wetland, and this was done by observing the surrounding area to assess where possible sources of water could come from.

Climatic conditions were also recorded. This included the measurement of sunlight, and wind direction and strength. The temperature of the water was also taken.

15.2.3.2 Temperature

As a consequence of the clearance of riparian and other vegetation, many wetlands have high temperatures that may affect the health of aquatic organisms. An indicator of temperature might be expressed as the amount of time that temperature lies above a maximum accepted value for that wetland (Ministry for the Environment, 1997a). The water temperature was recorded at four or more sites (usually the four compass points) around the wetland and averaged to give an overall temperature of the water. The temperature was taken at depths of one metre.

The next section looked at external factors that may affect and influence the wetland. These included assessing the surrounding land use, the main function or usage of the wetland, and the threats that endanger the wetland.

The extent to which the vegetation has been modified can limit the range of wildlife species likely to be present, and thus lower the value of the wetland as wildlife habitat. It is possible to assess subjectively the degree of wetland condition modification as slight, medium, or heavy. This is done by considering the extent of wetland vegetation that has been grazed, the presence and effect of drainage ditches, the presence of roads and fences, and the range of human activity in the area (Ogle and Williams, 1987). This was modified slightly so that these factors had associated indicators that were ranked on a scale of zero to five, with five having an extreme impact or magnitude.

15.2.3.3 Assessment of General Status of Wetlands

Surrounding Land Use

Estimating the magnitudes of the following to a limit of about 50 metres in all directions from the wetland assessed the surrounding land use or habitat. The indicators used were; pastoral/grass, heavy grazing, cropping, forestry, native bush, exotic bush, human construction works, earthworks/bare ground/ploughed land, and roads. The difference between pastoral grasses and heavy grazing was dependent on the length of the grass in question. If the length was short and regularly grazed, then it was assessed to be in the pastoral/grass category. If it were long and irregularly grazed then it was placed into the grazing category. Human construction included buildings such as houses, woolsheds, and water tanks.

Wetland Function

The main wetland usage/function of the wetland was difficult to assess as this was completed generally without the landowner or land occupier present, and certain assumptions had to be made. However the main function of the wetland was generally obvious, with minor functions less apparent. The components of this factor included; water supply, hunting, fishing, boating, scenic, recreation (other than those previously mentioned), wastewater treatment, tourism, education, Maori values and usage, historic values and usage, flood control, peat production, flax production, erosion protection, and plant and animal nursery/sanctuary.

Threats

Threats were also assessed on a scale of zero to five. Again some assumptions had to be made, but in most instances the threats were plainly visible. The threats that were assessed included; drainage, eutrophication, fire, flow reduction, grazing, invasive species, reclamation, recreation, residential development, roading, rubbish dumping, sediment influxes, sewage, wastewater, and other toxic substances. Flow reduction was assessed according to how the wetland was fed (if at all) with water. If this flow was being reduced or if it were possible that this were to occur, then a mark was given based on the severity of the threat. Monitoring the change in the abundance and distribution of pest species can indicate pressures on an ecosystem and in conjunction with other measurements, can point to cause and effect relationships (Ingle and Hilton, 1997). This type of monitoring and assessment is out of the context of this particular report, but is worth noting for further research opportunities.

Invasive species included both plant and animal species that were identified as being of a threat to the native wetland flora and fauna. Reclamation was the direct threat by humans wanting to reclaim the submerged land, by means of active drainage, or infilling. Active drainage is intended to mean drainage of such intensity, that the water in and around the wetland will not remain for very long. Rubbish dumping is included to assess not only deliberate acts of placing rubbish in the wetland, but also those instances where careless disposal of rubbish has occurred within the boundaries of the wetland. Rubbish here is defined as being all litter not classified by the other waste forms such as sewage and wastewater. Sediment was assessed as a threat when there was signs of excessive amounts of sediment flowing into the wetland environment. Sewage assessed the threat both human and animal wastes had on the wetland. Toxic substances included those materials that were entering the system from an unnatural source, such as chemical dumping. All other types of waste were assessed as being wastewater.

The third part of the assessment sheet assessed the following variables, each with their own indicators; soil attributes, terrestrial vegetation, aquatic vegetation, water, fauna, and anthropocentric effects.

15.2.3.4 Assessment of the Physical Status of Wetlands

Soil Attributes

The category of soil attributes included two indicators. They were bank stability, and the degree of pugging. Both indicators were assessed on a scale of one to five. A score of one pointed out that that particular indicator was in a poor state, meaning that the indicator had suffered severe degradation.

Soil Stability

The bank stability indicator's scale ranged from very unstable to very stable. A very unstable score meant that there was extensive erosion, with bare, steep banks. The next score (two) was classified as being unstable. Its definition is that of significant erosion, with little vegetation. Score three was classified as being moderately stable, with moderate erosion. A score of four is a stable bank, with good stability, and minor spot erosion. A score of five meant that the bank is very stable, with an adequate vegetative cover.

Pugging

Sampling random areas around the wetland with a one metre square quadrate assessed the degree of pugging. This sampling was undertaken at four or more sites per wetland. The lowest score of one was given to those sites where 20 or more pug marks where counted on average. A score of two meant that 13-19 pug marks were recorded, with 7-12 pug marks recording a score of three. Scores of four and five where those instances where six or less pug marks where noted.

Terrestrial Vegetation

The types of plant community colonising a wetland depends on a number of factors; water table, substrate, rainfall, sunshine hours, altitude and latitude and sometimes aeolian sand and salt transportation rates (NWASCO, 1982). In documenting the flora of an area it is useful to note abundance of each plant species (Johnson, 1987).

Some form of vegetation survey is necessary because much of the existing or potential value of the wetland to wildlife lies in the diversity and abundance of habitats present. For some species the preferred habitat covers a very small range of vegetation types (Ogle and Williams, 1987).

Ecosystem health and stability may be estimated through measures of vegetation diversity and abundance, or percentage cover of zone by aquatic plants. However, a low species diversity does not necessarily mean that the system is unstable or lacks resilience, but a loss of diversity over time can be taken as an indication of ecosystem decline (Ingle and Hilton, 1997; Ministry for the Environment, 1997b).

Riparian habitat is important to the functioning of ecosystems, by helping to stabilise the shorelines of wetlands, and by providing organic matter and food to wetland systems. Riparian indicators can be expressed as the percentage of wetland margin in a particular condition such as pristine, good or poor condition (Ministry for the Environment, 1997b). In the assessment sheet used for this report, indicators used are riparian width, and the diversity and composition of bank vegetation.

Riparian Margins

Riparian margins can reduce erosion and provide habitats for plants and animals. Inappropriate management of these areas can result in soil run off to waterways and contamination of water quality. Control of weeds is also a problem in some riparian zones (Rangitikei District Council, 1999).

Observing four different points around the wetland (usually the four compass points), and estimating the width of the buffer zone in metres assessed the width of the riparian margin (or buffer zone). These measurements where then averaged to give a overall measurement of the width of the buffer zone. The recommended width of riparian margins is about 16 metres or more

(Castelle et al., 1994). The wider the buffer zone, the higher the score allotted to the wetland. Any width of five or less metres received a score of one. Between six and ten metres was given a score of two. A score of three was given to those wetlands with an average width between 11 and 15 metres. Any width that was greater than 20 metres scored a mark of five.

Composition of Bank Vegetation

The composition of bank vegetation did not require the identification of every plant species found in the surrounding riparian margins. Rather it allowed the researcher to focus on those species that were either native or exotic. The scoring of this indicator is completely different to that of the other indicators. Each vegetation type is given a predetermined score, and it is up to the researcher to establish what percentage of the bank vegetation is composed of that type. The most preferred vegetative species have the highest scores, and as this vegetative cover is degraded, the scores decline. The various vegetation types with their associated scores in brackets are as follows; Native Trees (10), Wetland Vegetation (10), Tall Tussock Grassland (8), Introduced Trees (willow, poplar) (8), Other Introduced Trees (conifers) (5), Scrub (5), Pasture Grasses and Weeds (3), Bare Ground, Roads, and/or Buildings (-10). These scores are then multiplied by the estimated percentage of area that this particular vegetation type takes up, and then divided by 100, to give a score out of ten. For example, the researcher determines that the wetland being sampled has bank vegetation that is composed of 90 per cent tall grass, and 10 per cent wetland vegetation ((90*10)/100)+((10*8)/100 = 9.8. This score indicates that this site would have a very good composition of bank vegetation. This scoring system has been modified slightly from NIWA (1998) for the purpose of stream monitoring, and it may prove that this form of scoring would be useful in future assessments of wetlands after undergoing some adjustments (see Discussion chapter).

Aquatic Vegetation

The assessment of aquatic vegetation also used two indicators. The indicators used were the percentage of surface water that was covered by aquatic vegetation and the amount of attached algae that was submerged beneath the surface of the water.

Coverage of Aquatic Vegetation

The cover of aquatic vegetation on the water surface was scored depending on what percentage of the surface water was covered by floating vegetation. The five scoring categories were broken into 20 percentiles. The worst condition was that of water coverage from 81-100 per cent. The second worst condition was that between 61-80 per cent. The highest score that could be achieved was that of water coverage between 0-20 per cent.

Attached Algae

Periphyton (attached algae) is an important indicator of the life-supporting capacity of wetlands, as it forms the basis of the food chain, and helps purify the water. It occurs naturally in waterways and thrives on nutrients that are contained in organic wastes. Although algae increases dissolved oxygen by photosynthesis during the day, excessive growths can cause severe oxygen depletion at night. This in turn can affect fish and invertebrate habitats and reduce light penetration effecting large aquatic plants, and aesthetic degradation. (Ministry for the Environment, 1997b; Manawatu Wanganui Regional Council, 1999c). Studies shown in Armstrong (1997) indicate that nitrate concentrations between 0.004 and 0.1 gm^{-3} are sufficient to promote "nuisance" growth.

The assessment of attached algae was difficult to assess in some cases as the vegetation floating at the surface, hid what was growing below the water's surface. The assessor had to determine the abundance of submerged vegetation growing within the wetland. This assessment did not attempt to score for every type of underwater flora, but those that grow upward from the floor of the wetland. This is meant to include all those multi-cellular plants that are deemed to be of nuisance value by NIWA (1998). The lowest possible score were those sites that had greater than one third of the wetland's floor covered in vegetation. The other categories used in order from worst to best condition were, with the relating score in brackets; Many Clumps (2), Clumps (3), Small Patches Present (4), and No Obvious Signs (5). It is important to note at this point that this indicator was developed for the purpose of assessing the quality of streams (NIWA, 1998). No information regarding what the preferred level of growth should be within wetlands could be found. Obviously if wetlands are to support life and assimilate nutrients, then a diverse amount of plant life would be necessary. Additionally, as the wetland naturally progresses from water to land, more and more pioneer species will inhabit the wetland to aid this conversion to dry land. These points need to be remembered when analysing and discussing the results.

Water

The quality of the water was assessed using three indicators; water clarity, water conductivity, and water pH.

Water Clarity

Soil, silt, organic matter and pollution all contribute to the level of suspended solids within the water body of a wetland. These solids increase the water's turbidity, which is an indicator of how much light is scattered or absorbed by particles in the water. Reduced light penetration caused by suspended solids adversely affects aquatic communities and also affects the colour and clarity of the water.

For this research, water clarity was measured using a metre-long, 50-millimetre diameter clear acrylic tube, graduated along its length in centimetres. One end is clear (for viewing), the other end is open but has a plug that stops water from escaping. A 20 millimetre black semi-circle if fixed to a magnet so that it is in the centre of the tube. This can be slid along the inside of the tube using another magnet on the outside (NIWA, 1998). The clearer the water, the further the magnets can be slid along the tube and thus the higher a measurement and corresponding score.

The clarity of the water was measured at four or more points around the edge (or as far out from the edge as practicable) of the wetland. The corresponding measurement was then read off the side of the tube and recorded on the field survey sheet.

Water Conductivity

One quantity that can be measured to give an indication of the pollution level of water is its electrical conductivity. The ability of water to conduct electric current increases with the amount of inorganic salts dissolved in it. The higher the concentration of these salts (the products of bacterial action of waste), the higher the water conductivity.

Water conductivity was measured at four or more points around each wetland. It was measured using a hand-held conductivity meter. These measurements were then averaged to give an overall figure for that particular wetland. Again the scoring range was based on that of NIWA (1998). The scoring parameters were as follows; a score of one was given to those sites with a reading at equal to, or greater than 400 ųSiemens/cm. A score of two was given to those sites that 250-399 ųSiemens/cm. Scores of three meant that the average reading was between 150-249 ųSiemens/cm, and a score of four meant that the recording was between 51-149 ųSiemens/cm. A score of five would be those wetlands where the average reading was at or less than 50 ųSiemens/cm.

pH

The third water quality indicator was that of water pH. Litmus paper was used to sample the water at four or more points around the wetland site. These readings were then averaged to give an overall result. Here the scoring was based on three possible scores; one, three, and five. A score of one meant that the pH was less than 5.5, or greater than 9.5. A score of three was attributed to the pH ranges of 5.5-6.5 or 7.5-9.5. Finally, score five was those readings that were between the range of 6.5-7.5.

Fauna

The fauna attributes were assessed using the indicators of invertebrates and bird life. These indicators measured only the abundance of each indicator, as no attempt was made to try and identify either the invertebrates caught, or the birds observed.

Invertebrates

There are several water parameters that can be measured to assess ecosystem health, with many regional councils already having freshwater monitoring strategies in place. The most cost-effective method involves "rapid assessment" of invertebrate communities (Ingle and Hilton, 1997).

The invertebrates were collected at the four compass points (north, south, east, west) around the wetland, and their numbers counted. They were collected by swabbing the water and wetland floor with a net and emptying the contents into an ice cream container. It was decided that the scoring category of NIWA (1998) would be the most effective manner in which to assess each wetland. Accordingly, the scaling system for this indicator was on a scale from one to five. Scores one, two, and three indicated that the abundance of invertebrates ranged from nothing, to small numbers, and to only a few numbers found respectively. Scores of four and five meant that there were significant to abundant numbers of invertebrates.

Birds

To assess the wildlife value of a wetland, four sets of information are required according to Ogle and Williams (1987); a list of wildlife present and its abundance, an estimate of the area of the wetland, a semi-quantitative description of the vegetation, and a subject assessment of the wetland's condition.

Any wildlife observations are best made at dusk, or the early morning (Ogle and Williams, 1987). Birds are high on the food chain, and have been used previously as indicators of the health of aquatic ecosystems. Indicators that are useful to this study are numbers and presence or absence (Ministry for the Environment, 1997b). This basic form of indicator has the benefit of not having to be an expert in the field of avian fauna to identify all bird species that are present at the time if the site assessment. The weakness of this indicator is that the time of visit may influence what (if any) species are present. For example, a majority of birds may only visit the wetland at certain time of the day, and if the site assessment does not correspond to this time, then the results from the assessment will be inaccurate. This means that site assessments are taken during the times when it is expected that the most number of birds and species can be recorded, usually at dusk or dawn (Ogle and Williams, 1987).

Birds were assessed according to their abundance at the time of the wetland assessment. A score of one meant that no birds where seen or heard in and around the wetland environment. A score of two indicated that birds where heard, but could not be seen as they were hidden within any surrounding vegetation. If some birds were seen around the wetland site, then the score recorded would be three. If there were a moderate of birds seen and heard, then four points were allocated. If the wetland was home to a great abundance of birds, and they were seen flourishing in and around the wetland, then five points were allocated.

No attempt was made to identify the plant, animal or invertebrate species found at each site. This would have required the services of people who are trained in those various fields, and it was thought that if too much time was spent trying to identify the various species, then that would detract from the original purpose of this research.

15.2.4 Assessment of Anthropocentric Effects

The effects humans had on the wetland sites were assessed using four indicators. These included the intensity of drainage systems that were in operation at the site, the dominant land use of the land immediately surrounding the wetland, the area of wetland stock had access to, and the percentage of the wetland that is fenced.

15.2.4.1 Drainage

The intensity of drainage systems at the wetland was determined by the assessor. The scoring categories with their corresponding score in brackets were; Extensive Drainage (1), Significant Drainage (2), Moderate Drainage (3), Limited Drainage (4), and No Drainage (5). Any score that would be recorded lower than three, meant that there was more than three drains entering or leaving the wetland.

15.2.4.2 Dominant Land Use

The dominant land use indicator assessed what the land immediately surrounding the wetland was. It is not to be confused with the surrounding land use analysis that measured the land use to a distance of 50 metres from the wetland. The scoring categories presented with score of one being the first, and a score of five the last; Intensive Farming and/or Cropping, Exotic Forestry, extensive farming, Disturbed Native Forest, Reserve. The scores from these were then used to give overall score for a particular wetland.

15.2.4.3 Stock

Assessing how much access stock had to the wetland was often based using clues such as pug marks, but in most cases it was more than obvious how much of the wetland was open to stock. If stock had access to the entire wetland, then a score of one was given. Where stock could get to about 75 per cent of the wetland, a score of two was accredited. Where stock could get to about half of the wetland, then a score of three was certified. Scores of four and five where only given when it could be seen that stock had access to 25 per cent or less of the wetland.

15.2.4.4 Fencing

Perhaps the most obvious threat to native habitat is domestic stock grazing. Fencing off significant indigenous vegetation remnants on private land should be a high priority for local authorities and landowners that wish to provide protection for significant areas (Ingle and Hilton, 1997).

The fencing scoring system was almost identical to that of stock access, in terms of scoring to percentages. For example if the wetland was not fenced at all, then a score of one was allocated. At the other end of the scale, if the site was completely fenced, then that site recorded a score of five. Obviously if the site only had half of it fenced off, then the score was three.

15.2.5 Selection of Wetlands

Initially it was presumed that the wetlands that would be selected in this study would be those which were identified in the aerial photo analysis. This method was unsuitable, as many of the wetlands that were located with aerial photos could not be assessed. The reasons why are detailed in the "Limitations of Research" section. It was then decided that examples of wetlands would be selected to test the hypothesis that legislation and practice inadequately preserve the status of wetlands in the Manawatu. Limitations of time, property access, and money meant that only 27 wetland sites were chosen for further investigation.

Only the following types of wetlands were selected for assessment; natural ponds, oxbows, lakes, swamps and artificial ponds. Artificial ponds where those that were constructed to look similar to that of a natural pond system. The other wetlands as classified by Benn (1997), stream channels, drains, oxidation ponds, and sewage oxidation ponds were not included in this study. This decision was made because they would score very poorly on the field assessment and therefore not present an accurate assessment on the status of wetlands. Stream channels where not included due to their definition of wetlands as previously discussed.

The researcher then went to various sources in order to gain the location of wetlands and to gain the appropriate permission of landowners. This involved meeting with representatives of the Wellington Fish and Game Council, the Department of Conservation, and Ducks Unlimited. It was then necessary to contact the landowners and arrange a suitable time to visit the wetland.

Once at the wetland site, each landowner was asked whether they knew of any other wetlands in neighbouring properties, that may also be included in this study. For each wetland sampled, a field assessment sheet was filled out to record the various scores and attributes of the wetland.

Those wetlands that were selected for assessment were then located and measured using a digital planimeter and aerial photographs. In many cases these aerial photos had to be magnified by several times so that the planimeter could accurately record the open water area of these wetlands.

16 Results and Discussion

16.1 Introduction

The results and their discussion are presented in this chapter. As discussed in the Chapter 15 information and data for this study was collected using aerial photographs and field assessments. The results are summarised into five broad sections.

16.2 Legislation and Planning

Jones et al. (1995) discovered in their New Zealand study, that there is a weak understanding and appreciation of wetlands within resource management agencies, as very few of the agencies reviewed could not provide detailed information on the extent of wetland habitats within their jurisdiction. Some agencies acknowledged that there is a lack of technical expertise to support wetland management and protection. This indeed has proven to be correct today with local authorities having very limited knowledge of wetlands in their regions (Dahm, pers. comm., 1999). This is however being addressed in the Manawatu region with the undertaking of a wetland inventory, which is intended to account for all wetland types within the Manawatu-Wanganui Regional Council's boundaries.

In the United States, destruction of wetlands is mitigated by the creation of new wetlands. Guidelines for this practice vary between states, with the most severe in California, where developers must produce four units of equal or greater productive wetland for every one unit they destroy. If no suitable sites for new wetlands are available, then money or land is then transferred to the State Government. In most States, mitigation proposals must be lodged before development permits are issued (Carter, 1988). In the Manawatu, no such requirement is necessary. Developers are required to take into account whether the wetland is of regional or national significant value. If so, then the activity may be deemed restricted or prohibited. For example, new or further reclamation or drainage of the beds of lakes, particularly a protected lake[12] is a non-complying activity (Manawatu-Wanganui Regional Council, 1997a). This policy protects large wetlands with open water, but the swampy, marshy land, which is also classified as wetland, is not so fortunate, and it is up to the discretion of the landowner as to the most appropriate management. In some cases, if the landowner feels that local authorities would not approve of an activity such as wetland drainage, then they may go ahead with the drainage, without notifying anyone (Dalyrmple, pers comm., 1999). This would be very easy to do to wetlands that are not protected by current local authority policy.

Some of the lakes and rivers covered by Water Conservation Orders include significant wetlands. But the main responsibility for protecting wetlands lies with the Department of Conservation and Regional Councils. Wetland protection can be achieved through rules in District Plans limiting harmful activities, voluntary arrangements with users, and outright purchase from owners (Smith, 1997).

The reasons behind these policies as stated in the RPS are due to the protection given to areas under the RMA that are considered to be matters of national importance. The RPS acknowledges that the region has undergone drastic human modification and considers that any further drainage of wetland should be "constrained". By this it is presumed that wetland drainage may take place on areas that do not have any significant values on a regional scale, at a controlled rate. This may seem a practical way of dealing with case by case issues. However on a regional scale the drainage of what may be termed 'insignificant' wetlands may eventuate to cause very significant environmental and ecological problems in the future. This means that the gradual decline of 'insignificant' wetlands throughout the Manawatu will probably lead to a small number of well preserved wetlands with a good diversity of plant and animal species. However on a regional scale, the diversity and abundance of those same species will be far less than what was once a prolific and diverse wetland environment.

16.2.1 Review of Regional Policy Statement

It is applauded that not only are land based activity effects considered in the regional policy statement, but also the possible adverse effects of plant and animal pests. However, some

[12] Some wetlands are included under this protection, Pukepuke Lagoon for example – which was not sampled in this study.

representative samples of wetlands in varying ecological conditions should be maintained as part of a general conservation policy for the preservation of genetic and biotic biodiversity (McCoomb and Lake, 1988). This seems to be catered for in the documents that were assessed for this study. The problem with this approach however is that the region is likely to be left with a very small number of "significant" wetlands and not much else. It has already been mentioned that plants and animal species require a vast range of wetland types or succession stages, so that if these (therefore) insignificant wetlands are not preserved, then the plants and animals that rely on such habitats will also diminish.

16.3 Results of an Analysis of Aerial Photographs

Wetlands were identified in original (1942/49) and recent (1995/96) photographs (Table 3). The results of this analysis showed an overall increase of 32 per cent in the number of wetlands between 1942 to 1996. This increase was to be expected, as many landowners have been installing artificial ponds for a number of purposes (Taylor, pers comm., 1999), and also concurs with the work of Benn (1997), who recorded that artificial wetlands were much more prevalent than natural wetlands, outnumbering them by 40 per cent.

Table 3: Numbers of Wetlands Identified on Aerial Photographs Taken in 1942/49 and 1995/96.

Transect Location	Original (1942/49)	Recent (1995/96)	Percentage Change
Marton	57	65	+14
Bulls	34	59	+74
Foxton	24	36	+50
Levin	12	8	-30

The Bulls and Foxton transects recorded substantial increase in wetland numbers, while Marton showed a smaller increase. The Levin transect indicated a reduction in numbers.

16.4 Results of Wetland Assessment

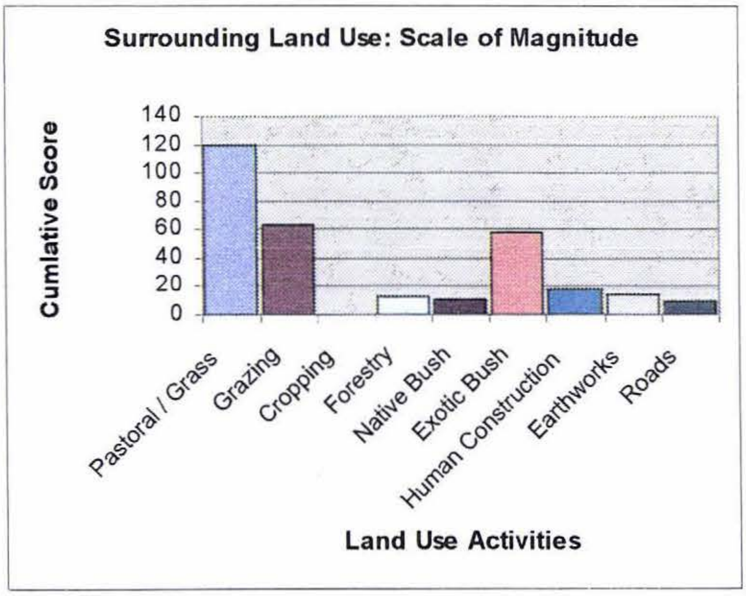
16.4.1 General Status of Sampled Wetlands

The raw data taken from field assessments of the sampled wetlands can be seen in Appendix 21.7.

16.4.1.1 Surrounding Land Use

As can be seen from Figure 13, cultivated pastoral grass is the most common land use. Rough grazing is the second most common land use. Cropping was not recorded at any of the sites that were selected.

Figure 13: Surrounding Land Usages



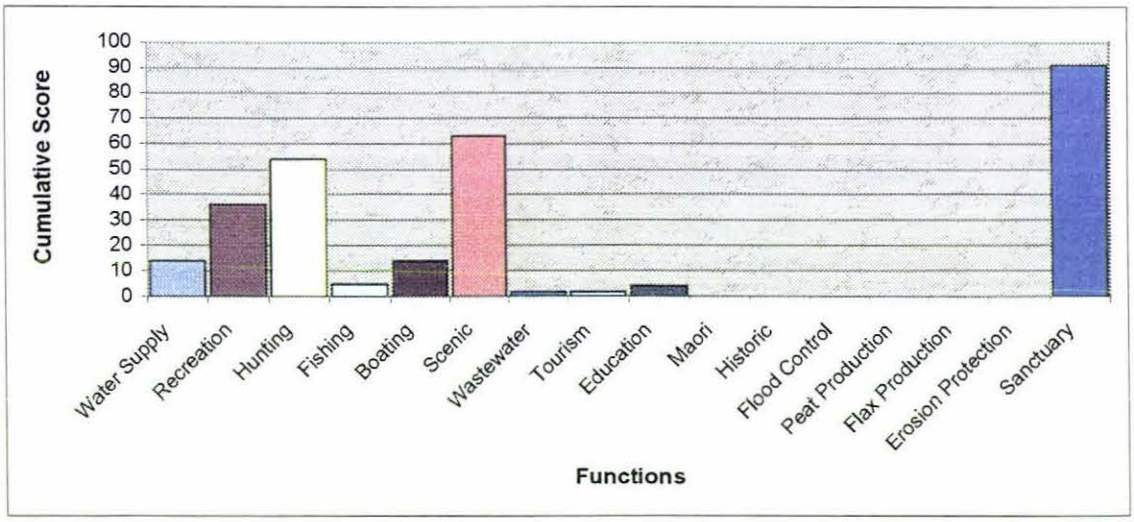
Jones (et al., 1995) states that a factor that contributes to wetland degradation has been the perception that wetlands are "wastelands". The results show that the land surrounding the wetland[13] to a limit of 50 metres is primarily pasture grasses and heavy grazing, combining to take up 60 per cent of the total surrounding land use. This would indicate that the wetlands are situated in the middle of agricultural land, where the land is utilised to create an economic return.

[13] Beyond the definable boundaries of the wetland itself.

16.4.1.2 Primary Wetland Function

The results here have been accumulated to provide an overall view of the functions of wetlands in the sample group (Figure 14). The most significant function of the sample group is for the provision of a plant or animal sanctuary (81 per cent)[14]. The second most important function was that of providing a scenic area for humans to enjoy. Of the wetlands surveyed 46 per cent were maintained for the purpose of game bird hunting. Recreation was noted as being of importance at 10 wetlands (39 per cent of total number sampled). Maori and historic values were not identified for any of the wetlands surveyed. Similarly, flood control, peat and flax production (for a commercial use), and erosion protection were not recorded at any site.

Figure 14: Primary Wetland Function



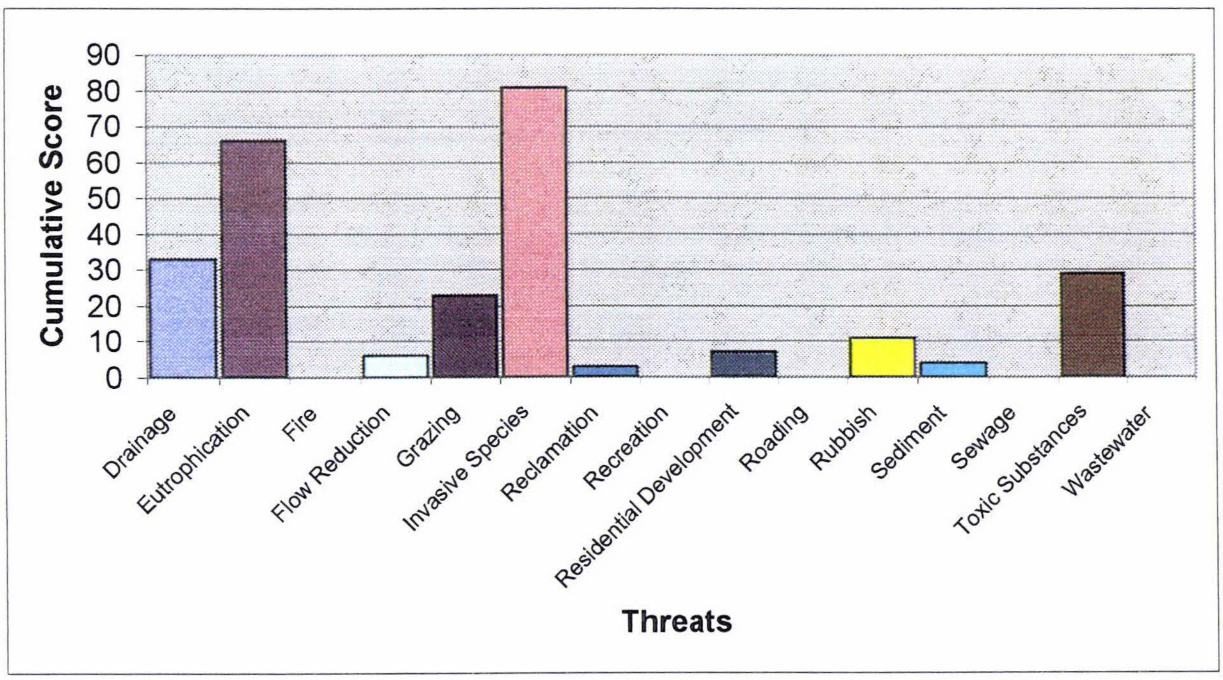
Providing a sanctuary for plants and animals was the most common function registered (32 per cent) of the total cumulative score for all functions. The second most important function was that of providing a scenic area for humans to enjoy. Hunting and other recreation registered 19 and 13 per cent each. The supply of water and the provision for boating were equal on five per cent. Wastewater treatment, tourism, and education functions all tallied one per cent each.

[14] This percentage is given on a basis of each score per wetland is at a level three or above, which implies that there is significant importance given to that function.

16.4.1.3 Threats

This scale, very similar to the previous two, was designed to identify the major threats to wetlands in the sample group. The most significant threat to wetlands is that of invasive plant species (Figure 15), with over 81 per cent of wetlands threatened by it. The second most significant threat was that of eutrophication (63 per cent). Drainage is the third most significant threat (37 per cent). Toxic substances, and grazing (both registering 22 per cent) were the fourth and fifth most significant threats respectively. Threats that did not register an impact included; fire, recreation, roading, human sewage, and wastewater.

Figure 15: Threats to Wetlands Sampled



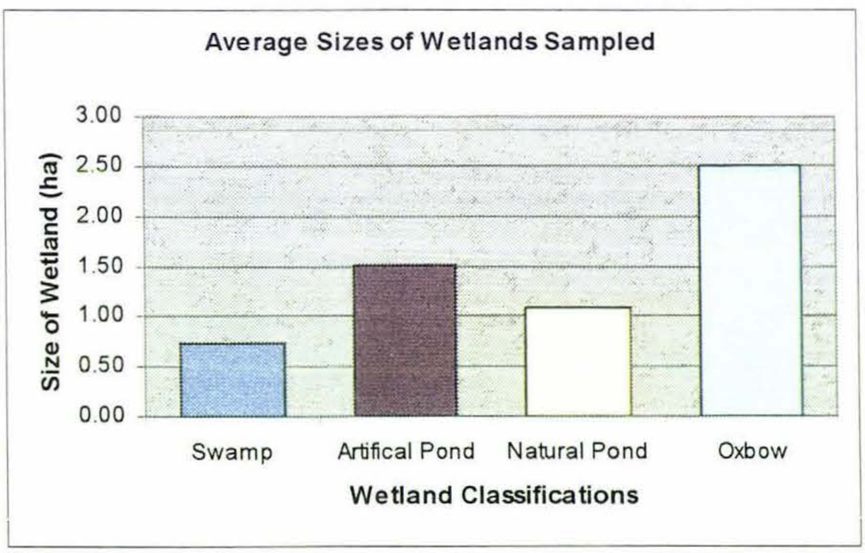
In support of Horizons.MW (1999a), the indirect or non-point source threats such as eutrophication and invasive species accounted for a considerable proportion (56 per cent) of the total cumulative score. The threat of grazing was noted in Benn (1997) as being "a real threat". The result of this analysis showed that grazing only accounted for nine per cent of the total threats to the wetlands assessed and therefore cannot be considered a significant threat.

16.4.2 Physical Status of Sampled Wetlands

16.4.2.1 Sampled Wetland Size

Benn (1997) estimated that the total area of wetlands in the Manawatu was around 7 000 hectares. The total wetland area that was surveyed in this research totalled about 66 hectares. This equates to less than one per cent of the total wetland area of the Manawatu. The wetlands that were surveyed ranged from 0.08 of a hectare to 13.99 hectares. The average size of the wetlands was 2.28 hectares. This figure is distorted slightly by the presence of the two lakes; Lake Alice (13.11 hectares), and Lake Koitiata (13.99 hectares). If these lakes were removed, the average size of the wetlands is 1.34 hectares. Also, the median would be 0.875 hectares, and the mode 0.08 hectares (Figure 16).

Figure 16: Average Size of Wetlands Sampled



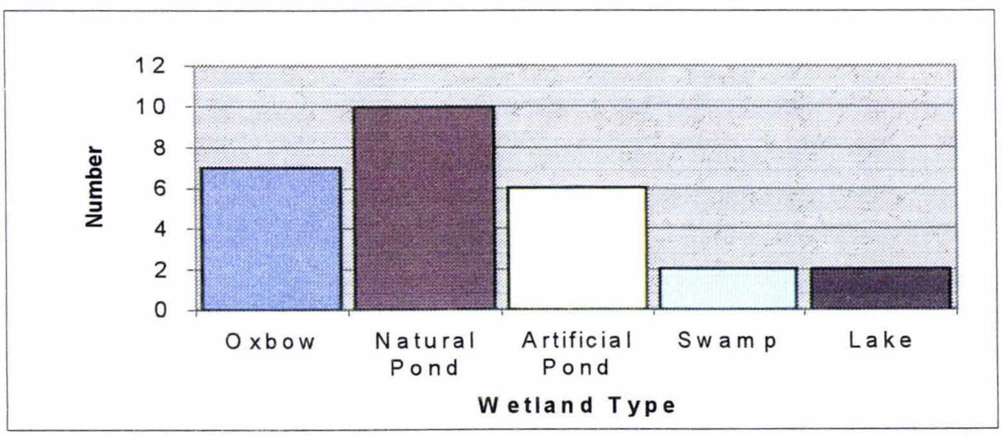
The measurements of the wetlands sampled and how their sizes have varied over time can be seen Appendix 21.8. Six of the 26 wetlands decreased in size from the 1940s to the 1990s. The range of wetland decreases ranged from –0.55 to –6.17 hectares. The average area of decrease within these six wetlands was 2.27 hectares. The wetland which experienced the greatest decrease was Lake Koitiata (wetland "W"), which shrunk in size from 20.16 hectares in 1942, to 13.99 hectares in 1995. In only one instance, the most up to date aerial photo did not include a wetland that was sampled. This was because the wetland was created after 1995. Wetlands that grew in size ranged from an increase of 0.10 hectares to 3.23 hectares. This was an average of increase of 1.05 hectares. The wetlands that experienced the greatest growth between 1940s and 1990s was Lake Alice (wetland "Y") and wetland "B".

Attitudes towards wetlands are changing as discussed in Jones et al. (1995), but at a slow rate. The authors state that it has only been since the late 1960s that wetlands have attracted the attention of researchers, who have made efforts to study them. They go on to state that the reason why wetlands do not attract much attention is due to the fact that they rarely cover large areas, and go mostly unnoticed. The results that are presented in this report show that the average size of wetlands sampled was 2.28 hectares. If the outlying lakes (Lake Alice and Lake Koitiata) are removed, then this average size is reduced to 1.34 hectares. Even with this reduction, more than 86 per cent of wetlands sampled are greater than one hectare. Those wetlands less than one hectare, total about 11 and 14 per cent (with and without the lakes respectively), are most likely to be overlooked by local authorities and disregarded by landowners and land occupiers.

16.4.2.2 Wetland Type

Figure 16 shows how many of the various wetland classifications were included in this investigation.

Figure 17: Numbers & Types of Wetlands



16.4.2.3 How Wetlands are Fed with Water

Only two wetlands (2.8 per cent of total number sampled) were fed by one source only. These particular sites were fed solely by drainage systems (Table 4).

Table 4: How Wetland is Fed with Water

Wetland Inflow	Total Number of Recordings
Direct Stream	19
Seepage	16
Drainage System	20
Overland Flow	17

The percentage of wetlands that were fed by all possible variables was 13 per cent. The percentage that represented wetlands being fed by natural means only, that is, by means other than drainage systems, was 72 per cent.

Most wetlands sampled in this study were fed by a number of sources. Only two recordings were made of a wetland being fed by only one source (drains). Seventy two per cent of all the wetlands sampled were fed by natural means only. These natural means included; direct stream input, seepage from the underlying watertable, and overland flow. Interpretation of the results show that 55 per cent of wetlands sampled had drainage feeding the wetland. Thirty six per cent of wetlands were fed by drains and determined to be threatened by drainage. Finally nine per cent of wetlands had no water input via drains, but were threatened by drainage leaving the wetland system. These results are somewhat in agreement with Benn (1997), who stated that about 42 per cent of the wetlands he sampled had some form of associated drainage threat.

16.4.2.4 Water Temperature

Water temperature ranged from 10.0 to 19.5 degrees Celsius (°C). The average water temperature in the selected wetlands was 14.2°C.

Table 5: Average Temperatures of Wetland Classifications (September – November, 1999)

Wetland Classification	Average Temperature °C
Artificial	12.3
Natural	14.5
Oxbow	14.0
Lake	14.3
Swamp	17.0

The recommended range for water temperature was between 15-19.9°C. Out of the 26 wetlands that were surveyed, 10 (38 per cent) were within this specified range and 16 (62 per cent) were below the range. No measurements where taken that were above the preferred range.

The Ministry for the Environment (1997b) states that as a consequence of the clearance of riparian and other vegetation, many wetlands have high temperatures that may affect the health of aquatic organisms. The results here show that even though there was very little riparian vegetation around the wetlands sampled, the affect on water temperature was not noticeable. However the higher average temperature for swamps may be attributed to the smaller waterbody that is found within swamps, owing to the fact that water is more likely to fluctuate in smaller waterbodies than larger ones.

16.4.3 Assessment Indicators

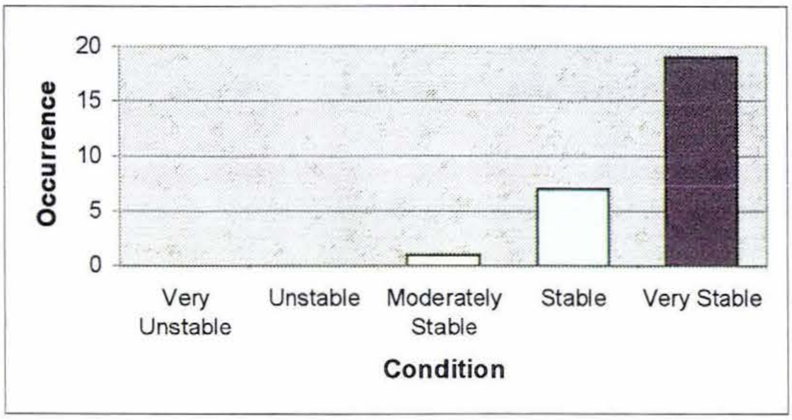
16.4.3.1 Soil Attributes

This section looked at two key indicators that were likely to indicate the condition of the soil surrounding the wetland.

Bank Stability

The scores for this indicator ranged from 3.25 to (the maximum) five. Just over 70 per cent of wetlands had a score of five, and 25.93 per cent had an average score of 4 or lower (Figure 19).

Figure 18: Bank Stability Condition of Sampled Wetlands

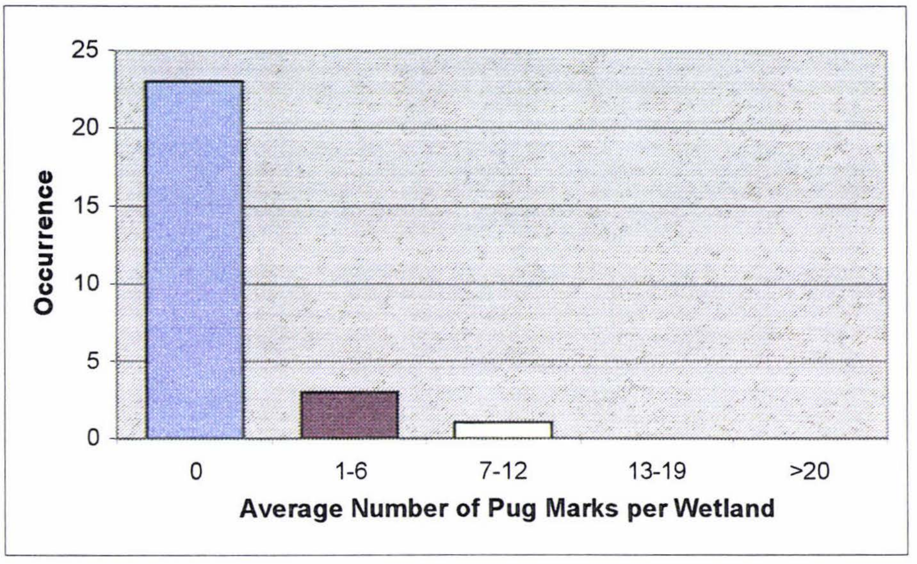


If bank stability is determined to be unstable then this may cause detrimental effects to the fringing vegetation and the water quality (Spencer et al., 1998). The overall bank stability condition of wetlands sampled is excellent, with 70 per cent of all wetlands sampled having very stable banks. No wetlands were recorded as having very unstable or unstable banks. The assessment of the bank stability indicator is the only indicator in this assessment that may be influenced by different assessors. This was because this indicator was the more subjective of the two indicators for soil condition.

Pugging

Pugging scores ranged from three to five. The average score per wetland was 4.79. Of data collected, 81.48 per cent of all wetlands had a score of five, only 11.11 per cent had a score at or below four (Figure 19).

Figure 19: Pugging Condition of Sampled Wetlands



Pugging caused by stock leads to soil compaction, erosion, and lowers the water infiltration rates. (Spencer, et al., 1998). The pugging assessment generally scored very well. Eighty-five per cent of all surveyed wetlands had an average of zero pugmarks.

16.4.3.2 Terrestrial Vegetation

This part of the survey sheet collected data from two indicators; the width of the fringing vegetation (or riparian margin/buffer zone), and the composition of the bank vegetation.

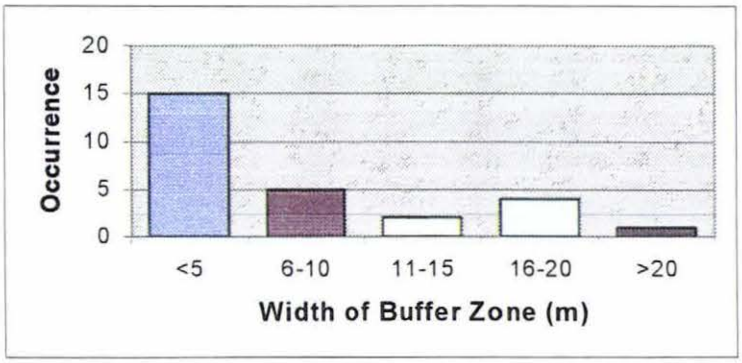
Riparian Margin

The ranges of the widths of riparian margins were from just under five metres to over 20 metres. The average width of all buffer zone measurements was 7.54 (Table Six, and Figure 20).

Table 6: Widths of Riparian margins by Classifications

Wetland Classification	Average Width of Buffer Zone(m)
Artificial	5.2
Natural	8.7
Oxbow	5.9
Lake	15.5
Swamp	3.5

Figure 20: Categorical Results of Riparian Margin Widths



Castelle (et al., 1998) suggests that 16 or more metres may provide adequate protection to the wetland from surrounding non-point source contamination. At the minimal end, Spencer (et al., 1998) states that riparian margins less than five metres provides the minimal protection to aquatic resources under most conditions. The results from this study show that 56 per cent of the wetlands sampled have less than five metres of average riparian margin width. Only 19 per cent of the sampled wetlands were at or above the recommended 16-metre width. This means that the majority of the wetlands that were sampled are not getting enough protection from non-point source pollution.

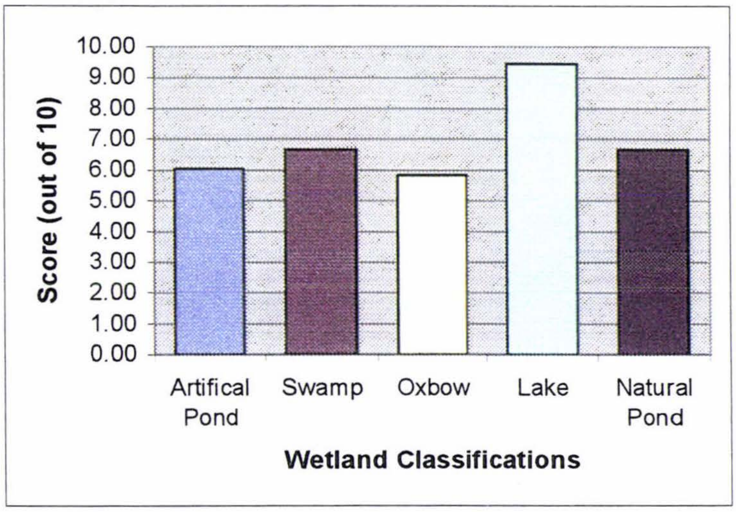
The poor condition of coastal lakes and other wetlands may be attributed to non-point sources of sediment and nutrients from agricultural activity (especially dairy farm waste) being discharged to land, enhanced by the removal of riparian margins (Horizons.MW, 1999a).

The average widths of riparian margins were very low for swamps and were due to the adjacent land use. In almost all cases the land was agricultural land right to the water's edge.

Composition of Bank Vegetation

As mentioned previously, the scoring system for this indicator is different from that employed for other indicators. The scores ranged from three to 9.8. The maximum possible score is ten. The average score was 6.5. Sixty three per cent of sites had scores of six or more indicating a diverse plant community, while only 24 per cent of sites scored five or less, indicating a very poor composition or monoculture (Figure 21).

Figure 21: Bank Vegetation Scores of Sampled Wetlands



The results presented here show that about 67 per cent of the scores for this indicator where five or above, with 26 per cent falling within the range of 7.0 to 7.9, on a range of 0-10, with 10 being an ideal situation – consisting of native and wetland vegetation.

Thirty per cent of the wetlands had a score of 8.0- 9.9. No wetlands gained 10 points. However 33 per cent of wetlands did not score more than 4.9. This may be interpreted to indicate that most of the wetlands that were sampled did have a reasonable vegetation composition. When compared to the widths of riparian margins, it can now be stated that the wetlands that were sampled did not have much width, but the composition of this remnant vegetation was satisfactory.

This scoring is useful, but as mentioned earlier, needs to be modified to more accurately portray what would be suitable compositions of vegetation. This is because some wetlands (particularly dune lakes) have a naturally low fertility, and have vegetation that is adapted to living in such conditions. Fertiliser runoff from surrounding farmland increases nutrient levels in these wetlands and can alter the types of vegetation living there. For example, raupo (*Typha orientallis*) occupies nutrient rich environments, while herbs and sedges are adapted to less fertile conditions (DoC, 1999). Furthermore, a situation where a wetland is surrounded by 90 per cent tall grass, and 10 per cent wetland vegetation, would score 9.8 (out of ten). Obviously a wetland with such limited adapted vegetation should not be classified with such a high score.

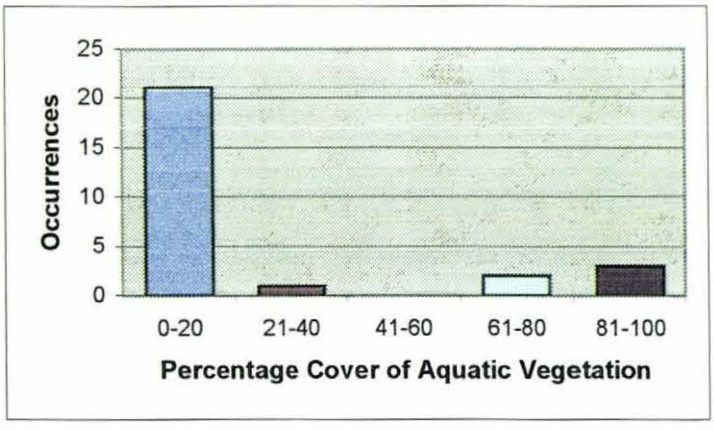
16.4.3.3 Aquatic Vegetation

The work by Horizons.MW (1999a) states that the high eutrophication levels of the regions wetlands is the result of the inputs of nutrients from agricultural activity. The indicators of eutrophication are the coverage of aquatic vegetation, and the amount of attached algae that is present submerged within the wetland and attached to the floor of the wetland.

Surface Cover of Aquatic Vegetation

The surface area of aquatic vegetation is estimated in relation to the remaining open water surface area of the wetland (Figure 22). Seventy three per cent of all wetlands surveyed have less than 20 per cent surface coverage by aquatic vegetation but 15 per cent of wetlands have between 81 and 100 per cent surface coverage.

Figure 22: Surface Water Coverage of Sampled Wetlands



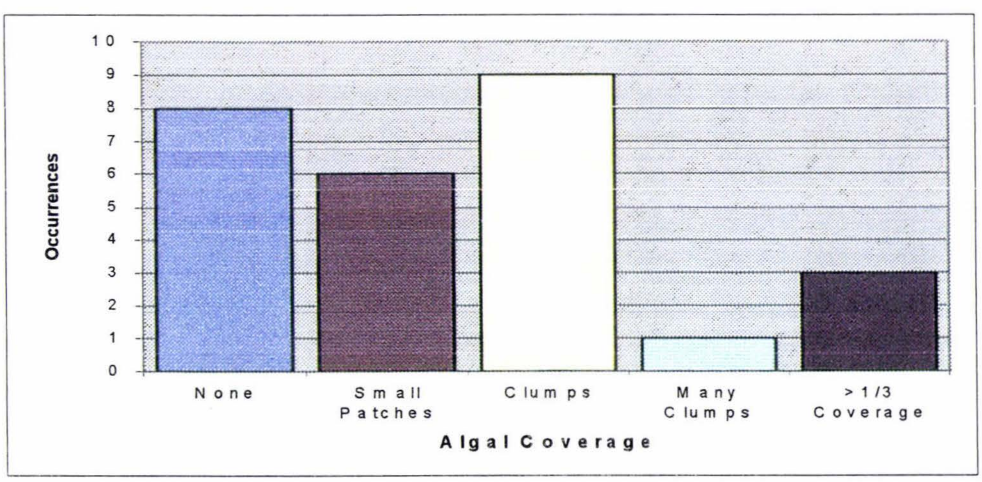
A wetland that is totally covered by aquatic vegetation may be the result of nutrient enrichment, or over growths of exotic species (Spencer, et al., 1998). These authors go on to state that such wetlands are considered to be in poor condition, and therefore are allocated a low score. Benn (1997) thought that one of the major threats to wetlands on the Manawatu plains was that of eutrophication, due to the area's intensive farming and forestry industries. The results from this study show that 73 per cent of the wetlands sampled had less than 20 per cent surface water coverage. Fifteen per cent had aquatic vegetation covering somewhere between 81-100 per cent of the water surface. Noting the information provided about surrounding land use, it may be concluded that the agricultural land use does not affect the water surface of the wetlands sampled.

The results showed the opposite of what was expected after reviewing Benn (1997) and Horizons.MW (1999a), with 73 per cent of sampled wetlands having less than 20 per cent surface water coverage. Nevertheless, the threat of eutrophication registered 25 per cent of the total cumulative, second only to the threat of invasive species.

Attached Algae

This indicator was assessed by observations of the underwater floor of the wetland. The average score for all wetlands is 3.56 out of five (Figure 23).

Figure 23: Amount of Attached Algae Found within Sampled Wetlands



It is unsure what level of abundance would indicate an optimal wetland condition, but Spencer et al., (1998) implies that the more attached algae present, the poorer condition of the wetland. The results showed that the majority of the sampled wetlands had a medium to little abundance of algae. Thirty per cent of sampled wetlands had no signs, 22 per cent has some small areas and 33 per cent registered a medium amount of attached algae. This information further supports the statement that the input of nutrients from the surrounding land use has not affected the trophic status of the wetlands that were included in this sample.

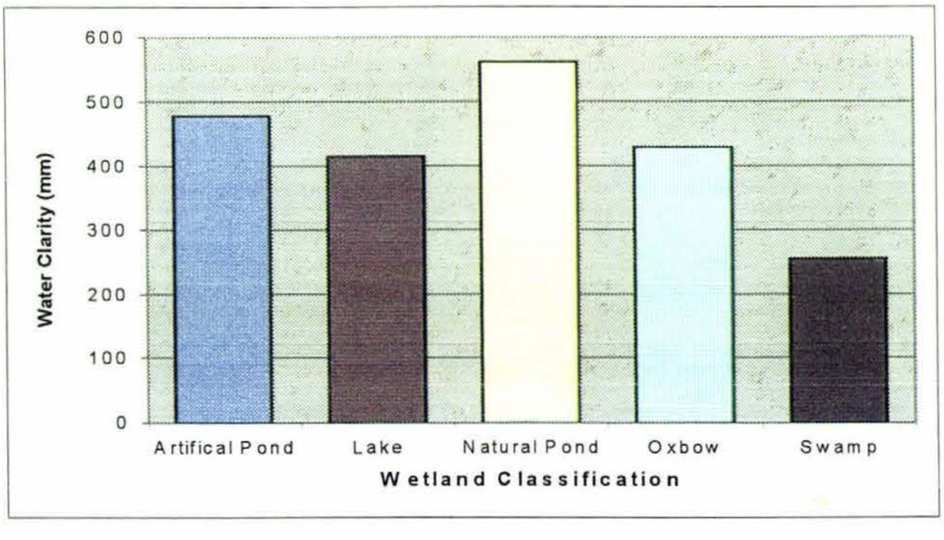
Complications with this scoring system are related to the source of the information – NIWA (1998). As this information was based on the assessment and monitoring of streams, then the ideal situation would be one of very little to no attached algae. However in a wetland situation, attached algae and wetland plants are necessary in order for the system to support the vast of array life and the processing of nutrients. These processes would simply not have operated in a wetland with no aquatic plant life (Miller, 1995).

16.4.3.4 Water Quality

Water Clarity

The depths ranged from 120 millimetres to 890 millimetres. The average depth for all wetlands sampled was 474 millimetres (Figure 24).

Figure 24: Water Clarity by Wetland Classification



As for water temperatures an indicator, there is no information regarding what should be the most appropriate measurement for this indicator and water clarity. Therefore it is assumed for this study that the clearer the water, the better status that wetland has. The maximum depth that the clarity tube measured to was 1000 millimetres. Thirty per cent of sampled wetlands were below 300 millimetres, with 46 per cent measuring 500 millimetres or above.

Protection from non-point sources comes directly from the buffer zone surrounding the wetland. The recommended width for riparian margins is about 16 metres or more (Castelle et al., 1994). The results from the sampled wetlands show that 56 per cent of all sampled wetlands have less than a five-metre buffer zone width on average surrounding the wetland. This may account for the very poor water clarity results, which averaged, to about 474 millimetres of the entire sample population. So it may be argued that the poor water clarity of the wetlands is a result of the minimal width of the buffer zone. However, when these two scores are correlated, the result is 0.06[15], which indicates that there is no such relationship. Compared with other studies (Horizons.MW, 1999a), the use of water clarity tests shows that visibility of less than one metre usually occur in eutrophic water. For example Kaitoke Lake had a Secchi visibility distance of 0.3 metres (300 millimetres), which means that it was in a hypertrophic state when the survey was carried out. Lake Alice, which also had a very high chlorophyll-a reading in 1982, continues to be in a high trophic state, with a visibility reading of 260 millimetres (Horizons.MW, 1999a). One would expect wetlands to be in some eutrophic stage, but if we use the results of the Horizons.MW study as a guide, then the results of this study show that eight (30 per cent) of all sampled wetlands are in a state of hypertrophism. Basing the trophic level on water clarity alone is misleading, the clarity of the water may be influenced by the sediment influx created by recent rainfall, the disturbance of the water by wind of animals, and other factors.

The work by Horizons.MW (1999a) stated that waterbodies with a visibility of less than 300 millimetres were in a state of hypertrophism, and those that are under 1000 millimetres are eutrophic. This means that all the wetlands that were sampled are eutrophic, and 30 per cent are in a state of hypereutrophism. This scale is hampered by the fact that is relies on the amount of suspended sediment in the sample tubes. If there happens to be a recent influx of sediment or a stirring of the wetland floor, then the clarity of the water will be significantly reduced (Valentine,

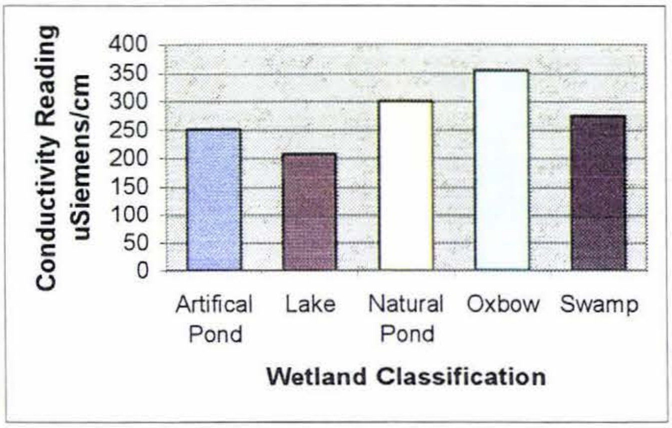
[15] Appendix 21.9

pers comm., 2000). Therefore it can be concluded that the measurement of water clarity alone does not provide sufficient information as to the trophic status of wetlands.

Water Conductivity

The readings ranged from 120 to 600 uSiemens/cm. The average reading for all wetlands was 297 uSiemens/cm (Figure 25).

Figure 25: Water Conductivity of Sampled Wetlands



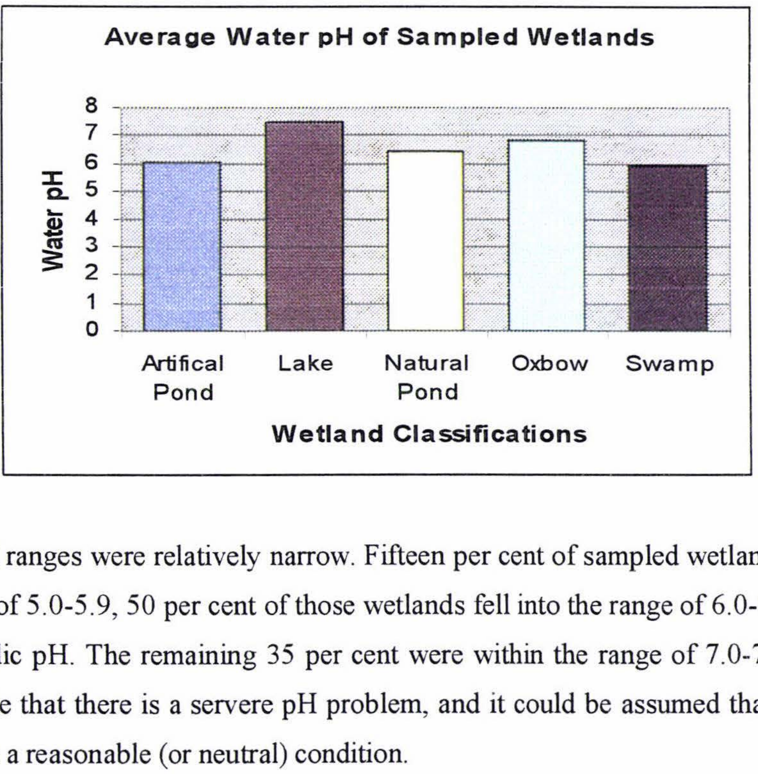
Spencer et al., (1998) also measured water conductivity. Their scale was based on an Australian soil conservation policy document, which used much greater scoring classifications than those that were used in the assessment sheet used for this research. In this study, the lower the conductivity, the higher the score that was allocated to that particular wetland. Sixteen per cent of the sampled wetlands had a conductivity level of greater than 400 uSiemens/cm. Fifty two per cent were in the range of 250-399 uSiemens/cm, and 32 per cent were in the range of 150-249 uSiemens/cm. No wetlands recorded a measurement of 149 uSiemens/cm or less. This information cannot be compared with other data, as it does not exist. Spencer et al., (1998) gives an example of one of the wetlands that were sampled in their study, with a conductivity result of 75 uSiemens/cm, which indicates low conductivity, and in good condition.

The results from this study indicate that the water in the sampled wetlands contains relatively high amounts of dissolved salts, and other materials. Even comparing the maximum recording taken in this research, none surpassed the category of Spencer et al., (1998) of "Good". This category required a measurement of somewhere between 292-833 цSiemens/cm. The highest measurement taken for this report was 600 цSiemens/cm.

Water pH

The pH of the selected wetlands ranged from 5.5 to 7.5, with the average pH being 6.5. The median pH was 6.5, and the mode pH was 6.0 (Figure 26).

Figure 26: Average Water pH of Sampled Wetlands



The water pH ranges were relatively narrow. Fifteen per cent of sampled wetlands where between the pH range of 5.0-5.9, 50 per cent of those wetlands fell into the range of 6.0-6.9. This indicates a slightly acidic pH. The remaining 35 per cent were within the range of 7.0-7.9. None of these results indicate that there is a servere pH problem, and it could be assumed that the status of the water pH is in a reasonable (or neutral) condition.

16.4.3.5 **Fauna**

Invertebrates

The scores for this indicator ranged from one to five, with an average score of 3.19 (Table 7).

Table 7 : Abundance of Invertebrates

Wetland Classification	Total Invertebrate Score	Average Invertebrate Score per Wetland
Artificial Pond	16	2.7
Lake	8	4.0
Natural Pond	34	3.4
Oxbow	23	3.3
Swamp	5	2.5

The results showed that in 44 per cent of the wetlands only moderate amounts of invertebrates were found. A total of 37 per cent was recorded for the categories of moderate to abundant numbers. Nineteen per cent made up the categories of small numbers to zero. This data has shown that the wetlands provide only minimally adequate habitat for invertebrates. It would be expected that a pristine wetland would be home to a vast array and number of invertebrates. This may be related to the width of the buffer zone (56 per cent less than five metres in width) not being able to support many species, and the surrounding land use. However when these indicators were correlated (Appendix 21.9), the resulting figure was 0.36. This number shows a reasonable relationship, but may not give an entirely accurate indication of the situation. As to the status of wetlands regarding the abundance of invertebrates, it is shown here that although many wetlands do support an acceptable number of invertebrate life, there is room for improvement.

Birds

The scores for the bird indicator ranged from two to five, with an average of 3.52 (Table 8).

Table 8: Abundance of Birds Observed at Sampled Wetlands

Wetland Classification	Total Bird Abundance Score	Average Abundance Score per Wetland
Artificial Pond	18	3.00
Lake	9	4.50
Natural Pond	37	3.70
Oxbow	24	3.43
Swamp	7	3.50

The largest category was that of "Some birds around wetland", recording 41 per cent of all sampled wetlands. The category of a "moderate amount' tallied 33 per cent, and the highest category "many birds", 15 per cent. In 11 per cent of the total number of sites, birds where heard around the wetland, but could not be located. These results may seem to be rather pleasing, however as for the invertebrate indicator, an improvement in the widths of the buffer zone, as well as the composition of the surrounding vegetation, may lead to improved bird numbers. The time of visiting each wetland may have affected these results. To minimise this anomaly, most of the fieldwork was carried out in the early to mid morning or late afternoon.

16.4.3.6 Anthropocentric Effects

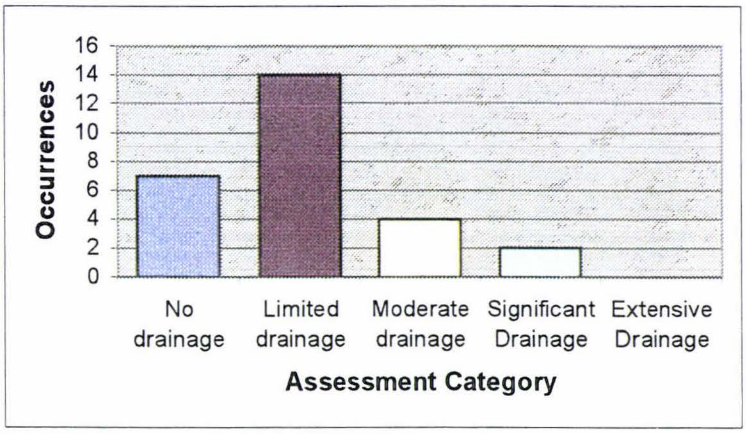
This part of the study attempted to give relevance to the impact humans had on wetlands. The four indicators that were used were; drainage of the wetland, the dominant land use at the wetland site, the accessibility stock have to the wetland, and the amount of fencing that is surrounding the wetland.

Drainage of Wetland

The scoring of this indicator was based on observations made at the time of the field survey. The scoring was based on a scale of one to five, with five being a wetland with no drainage schemes.

The scores ranged from two to five, with an average score per wetland of 3.96. The mode and median scores were both four (Figure 27).

Figure 27: Drainage of Wetlands at Sampled Sites



Streever et al., (1998) noted that respondents of a survey in New South Wales, Australia, stated that they considered wetland drainage, filling or other destruction is either "very serious" or "somewhat serious" problem. This paper went on to state that Australians in their survey were willing to pay A$33 and A$39[16] per household per year for wetland protection in Western Australia and South Australia respectively. Kirkland (1988) used the contingent valuation method to determine that households in New Zealand are willing to pay about $14 per household per year.

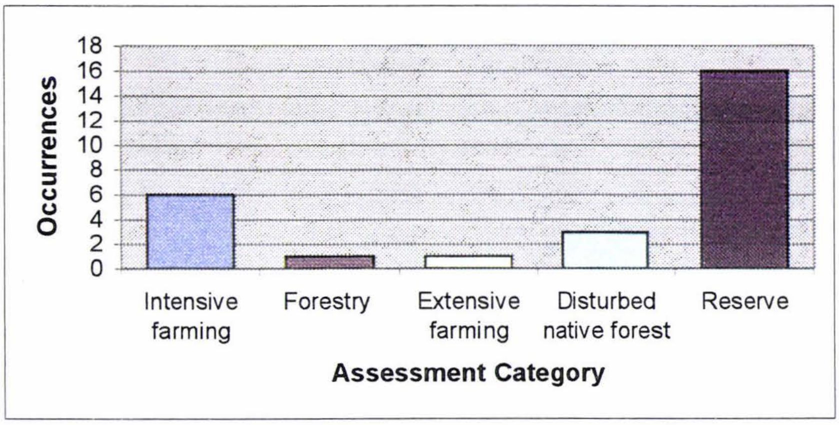
An indicator of this concern may be see in the results of the threat and drainage indicators. As can be seen in Figure 15, drainage accounted for 13 per cent of the total cumulative score. This however was the third highest score. When compared to Figure 27, it can be seen that 52 per cent of all wetlands are influenced by "Limited Drainage". Further, Table Four shows that about 72 per cent of all wetlands sampled are fed by natural means only. These results indicate that landowners and land occupiers are not actively trying to drain wetlands on their property, which they are entitled to do, as long as the wetland is not regarded as having significant regional or national importance, as identified in the Regional Policy Statement.

[16] $44 and $54 New Zealand dollars respectively as at 9 September 2000.

Dominant Land Use at Wetland

This indicator categorised the landowner's activities around the site of the wetland. If the land is surrounded by high commercially productive land, then the score will be considerably lower than a situation where a wetland is in a natural setting. The scores ranged from one to five, with the average score being 3.83 (Figure 28).

Figure 28: Dominant Land Use at Sampled Wetland Sites

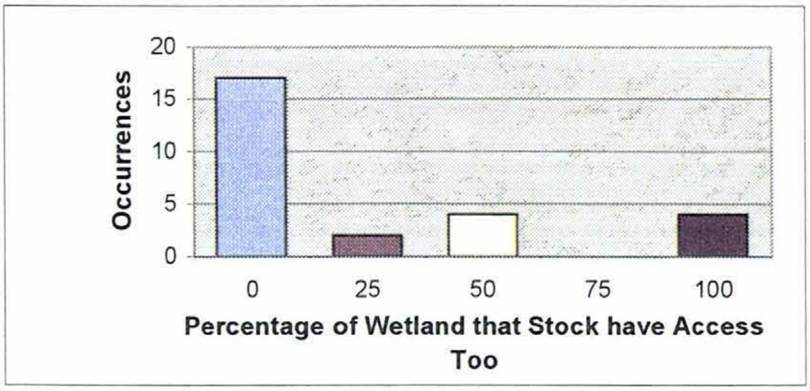


This differed from the surrounding land use indicators, as it looked at what was the land use at the wetland site itself. The results show that in 59 per cent of the sites surveyed, the wetland was, or was part of, some form of reserve or ungrazed area. Not much as been found in the literature regarding the land use at the wetland site, but documents such as Benn (1997) and Horizons.MW (1999a) do mention that the wetlands are located within and surrounded by intensive pastoral farming, dairying and forestry. For the wetlands sampled here, those that were located in some form of agricultural or forestry activity, comprised 30 per cent of the total number of wetlands sampled. This is still quite a significant number, considering that 22 per cent of these where situated within intensive farming practices. The status of the wetlands that were sampled would have be in relatively satisfactory condition, as the bulk of the wetlands are located within a reserve-like area.

Stock Access

Judging how much of the wetland stock had access to gave the scores for this indicator. A low score meant that stock has access to all or almost all shorelines of the wetland. The scores ranged from one to five, with an average score of 4.04 (Figure 29).

Figure 29: Availability of Stock Access at Sampled Wetland Sites

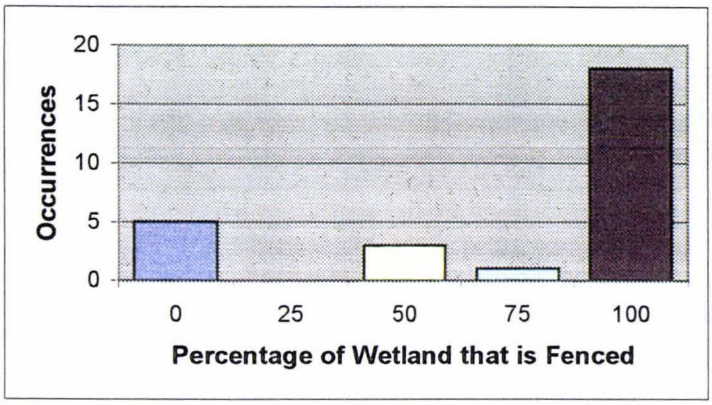


The results of stock access to the selected sites showed that about 63 per cent of all wetlands had no stock access. Seven per cent of wetlands allowed stock into about one quarter of the wetland, with 15 per cent of the total number of wetlands allowing stock to half of the wetland area. In a further 15 per cent, stock was allowed to roam over all of the wetland down to the water's edge. With regards to the status of wetlands, it must me said that with so many wetlands having no access to stock, then the protection of these sites is improved.

Fencing

Actual percentages of how much of the wetland is fenced was measured. The percentages ranged from five to 100 per cent, with an average of 78 per cent (Figure 30).

Figure 30: Wetland Fencing Percentages of Sampled Wetland Sites



The results show that about 67 per cent of all wetlands that were sampled had complete fencing around the entire wetland. Those that did not have any fencing accounted for 19 per cent, while those with 50 per cent and 75 per cent fencing made up 11 and four per cent respectively. Even though a very large percentage of wetlands had 100 per cent fencing surrounding the wetland, this does not imply that the wetland is completely safe from stock grazing. As Benn (1997) states "Some sites were 100% fenced but still grazed, whilst at the other extreme, others were 0% fenced and not grazed at all." This was true also for this report. In many instances, the wetland would be fenced off, but the landowner/land occupier would allow stock access to the wetland through gates.

Overseas studies have shown that the fencing and planting of at least part of wetland margins can significantly improve their waterfowl breeding and carrying capacity (Fish and Game New Zealand, 1999). The improved cover also enhances opportunities for recreational hunting (Fish and Game New Zealand, 1999). The data from the sampled wetlands shows that 79 per cent had fencing somewhere between 76 – 100 per cent of the wetland. The width of the riparian margins in 56 per cent of sampled wetlands was less than five metres. Accompanying this data is the results of the total bird scores. These show that 41 per cent of all sampled wetlands had some bird life around it, with 33 and 15 per cent registering on wetlands with a moderate to ample bird numbers respectively. These results show that the bird life recorded are those that thrive in the open countryside (Valentine, pers. comm., 2000), rather than those native bird species that would be expected in a pristine environmental condition.

16.4.3.7 Relationships Between Indicators used for Assessment

Correlation analysis on pairs of measured attributes was undertaken to identify any relationships between the indicators. The full results of this correlation analysis can be found in Appendix 21.9. The results that are presented here are those which have produced a correlation of at least +/- 0.5 (Lindley and Scott, 1984) (Table 9).

Of all indicators used, not one stood out to be of significance for future use in wetland assessment. This indicates that any future work will have to take a number various indicators, not rely on one key indicator such as water clarity (Valentine, pers. comm., 2000). The size and temperature correlation was greatly affected by the inclusion of Lake Koitiata and Lake Alice.

The indicators of drainage scores and temperature produced a result that one may have expected. This is predictable, as drains bring fresh water into the wetland system, the temperature of the water is likely to decrease. This is proven by the results presented here, which showed that as the drainage intensity decreased, the water temperature increased.

The correlation between bank stability and fencing is another that one may have predicted. As the percentage of the wetland was fenced, the more stable the banks of the wetland. A result that may not have been predicted was the correlation between the amount of pug marks and invertebrate life. Here the abundance of invertebrate life increased as the amount of pugging (stock) decreased. This was unexpected, as it was assumed that high stocks numbers and therefore pugmarks would lead to an increase in the amount of invertebrate life found.

The final correlating relationship was that of the dominant land use scale and the stock scale. Again the results were not surprising. As the dominant land use changed from agricultural to reserve status, the amount of stock entering the wetland area was reduced.

Table 9: Correlation Table

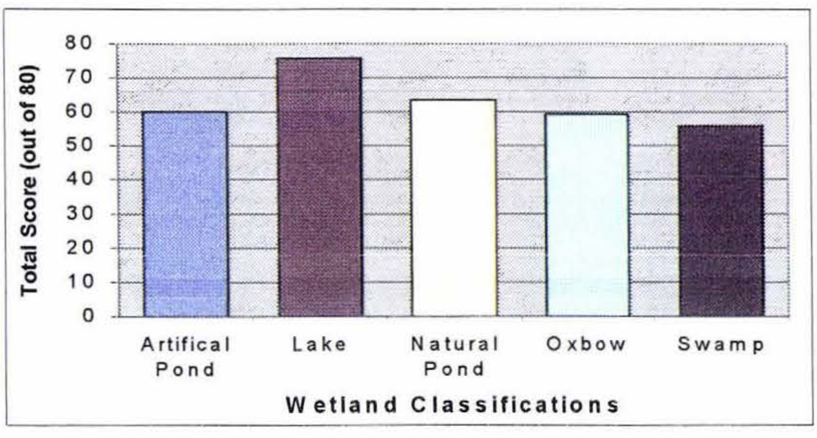
Indicators	Correlation (R^2)
Size & pH	0.57
Temp & Drainage	0.57
Pugging & Invertebrates	0.56
Land Use & Stock	0.64

The positive relationship between the size of the wetland and the actual pH of the water was significantly affected by the sizes of the lakes Koitiata and Lake Alice. If these lakes are removed from the calculation, the resulting correlation would be 0.41 – falling below the chosen threshold.

16.4.4 Overall Scoring

The overall scores of the physical attributes was summed and related to wetland type (Figure 31). The range of overall scoring was from 39 to 77 out of a possible score of 80. The average score over the entire population was 62.

Figure 31: Overall Scores of Wetlands Sampled



Interpretation of these results showed that 56 per cent of the wetlands recorded a score between the range of 61-70. This would indicate that these wetlands are in relatively good condition. Eight per cent were in the lower ranges of 31-50, and seven per cent rated between 71-80. These figures must be looked upon with caution. As frequently mentioned, most of the assessing was based on the stream assessment module of NIWA (1998). In some instances their requirements were not suitable to be used with wetland assessment. Examples of these are the bank composition and the attached alga indices.

In terms of wetland classification, lakes had the highest overall scoring. This is probably due to the lake's regionally significant status within the region. Swamps were in the worst overall condition. This may be due to the landowners and local authorities not regarding these areas as significant wetland areas (Thompson, 1983). The attitude towards swampy areas may be attributed to these areas being very small (0.73ha), and not providing sufficient habitat to large amounts of wetland vegetation and animals. It can now be stated that the overall status of wetlands within the sample group is relatively good.

16.5 General Comments

16.5.1 Limitations of Research

16.5.1.1 The Selection of Wetlands

The most obvious limitation of this research was that if the wetlands were selected on a random basis, then the results could be used to present a representative sample of the status of wetlands throughout the Manawatu. To gain more complete overview of wetlands in the Manawatu, a greater sample population would have also needed to be assessed.

16.5.1.2 Aerial Photo Analysis

To spot and identify wetlands from aerial photos is relatively simple. Getting to the site proved to be very difficult. Simply driving along the same line as the transects of the aerial photos was time consuming, and a very inefficient means of gaining access to wetlands. Therefore if further research is to be carried out in this field it is important that the researcher identify and communicate with the landowner or land occupier to agree on what would be the most suitable time and means of visiting the wetland. People who have wetlands on their properties are generally very busy, so it was imperative that prior arrangements are made before arriving at the property. In many cases after giving directions to the wetland, the farmer had to leave on other business, which left the assessor to draw conclusions about certain aspects of the survey sheet.

This means that a person who interacts with the wetland more than the assessor may have more accurately judged the assessment of the primary function and the threats to the wetland.

On reflection, it may have been useful to count and classify wetlands from the aerial pictures as Benn (1997) did. This would have provided more useful information regarding the abundance of the various classifications.

16.5.1.3 Field Assessment Sheet

Weaknesses in this form of assessment come from the assessments of soil stability, and visual assessments of vegetation. However the evaluation is useful for site comparisons, as long as natural seasonal changes are accounted for. Another important point is to find what Spencer et al. (1998), refers to as 'reference' wetlands. These are wetlands in the same region, which are of relatively pristine condition. These reference wetlands are used to ensure that the scoring of indicator data reflects regional variation within the wetlands (Spencer et al., 1998).

16.5.2 Landowner Responses

In some instances, the landowner had been treated unfairly or had "underhanded tactics" used against them by local authorities. The names of these organisations were not disclosed. This made it very difficult to gain the trust of the landowners who were initially suspicious about the reason the assessor wanted access to their land. However this was not the case in the majority of the situations and once the landowner was informed as to the purpose of the assessment, they were more than happy to accommodate.

Finally, this research is only a snapshot of the status of the selected wetlands in the Manawatu. It does not account for those wetlands that have been degraded or drained to the point of non-existence, which would have to be included in a more complex and detailed study at a later date.

17 Recommendations

17.1 The Ways in Which to Improve Management of Wetlands

In order to reverse the trend of wetland degradation, the problem must be tackled from two fronts according to Osborne and Adcock (1995). First, efforts must continue towards conserving the wetlands that remain. Secondly, those involved in wetland management, encourage a more pro-active role in the fields of wetland rehabilitation and creation. Osborne and Adcock (1995) go on to state that environmental impact statements should not demonstrate the minimal environmental effects, but rather show how the environment is affected by the development.

The drive of the local authorities must encourage this push forward, with voluntary organisations such as Fish and Game, and Ducks Unlimited being called upon for their expertise in various fields of knowledge. Other organisations such as universities, schools, botanical, zoological, research stations, and other groups all have specialised knowledge and information that should provide invaluable data. Landowners and land-occupiers should not be forgotten either. Often it is of their interest to exploit wetlands for economic return, however there may be a reversing trend that suggests that landowners are aware of the values of wetlands and that these people have a far greater knowledge than outside 'experts' may have (Cox et al., 1995).

The next stage of the process is to transform these goals into objectives. In order to restore or rehabilitate a wetland, the factors and processes by which a wetland becomes degraded must be identified (Stricker 1995).

17.2 Monitoring

Monitoring changes in biodiversity and soil productivity is perhaps the most useful indicators available for rapid assessment of ecological health. Areas most at risk may be identified through monitoring the impact of exotic species, the absence of keystone indigenous plants and animals, or the absence of indigenous species (Ingle and Hilton, 1993; Ministry for the Environment, 1997b). Horizons.MW and other local authorities must continue and expand their monitoring of wetland environments throughout the region.

17.3 Regional Plan for Wetlands

Local authorities must concentrate on protecting and preserving wetlands that do not fall into the 'significant' classification. There are enough rules and strategies for dealing with these wetlands, and a fresh perspective must be taken if the preservation of the remaining wetlands is a desired outcome.

The RMA's Section 65 defines the protocols that regional councils should consider the desirability of preparing a regional plan whenever any of the following circumstances or considerations arise or are likely to arise:[17]

> *(a)* *Any significant conflict between the use, development, or protection of natural and physical resources or the avoidance or mitigation of such conflict;*
>
> *(b)* *Any significant need or demand for the protection of the natural and physical resources of any site, feature, place, or area of regional significance;*
>
> *(d)* *Any foreseeable demand for or on natural and physical resources;*
>
> *(f)* *The restoration or enhancement of any natural and physical resources in a deteriorated state or the avoidance or mitigation of any such deterioration;*

or

> *(h)* *Any use of land or water that has actual or potential adverse effects on soil conservation or air quality or water quality.* (Section 65 (3)).

For these reasons, despite their apparent lack of significance in terms of their size and vegetation, the present scarcity of wetlands in the region gives significance in terms of their contribution to maintaining indigenous habitats (Horizons.MW, 1999a). This, in conjunction with the results of this project, point in strong favour of Horizons.MW drawing up some form of Regional Plan or Regional Strategy which is solely focussed on addressing the issues of wetlands in the Manawatu.

However this may not be such an easy task and Horizons.MW will have to overcome several obstacles in order to effectively improve the management of wetlands within the Manawatu. These obstacles are discussed in a later section.

Cox et al., (1995), produced a five step chart for the preparation of a national wetland strategy (in Britain). It has been reformatted and presented below to show how a similar process could take place to prepare a regional plan or strategy for wetlands in the Manawatu.

Figure 32: Step Chart for Regional Wetland Plan

Step One: **Identification of Valued and Threatened Wetlands**

Identify wetlands that are of most value, and that are under threat, or are likely to be under threat, and take immediate action to ensure their conservation and sustainable management. Reassess this list periodically.

Step Two: **Wetland Classification**

Classify all wetlands[18] according to an agreed procedure.

Step Three: **National Wetland Inventory**

Identify all wetland resources for each wetland type, and design an inventory of their values and special features to develop an accessible, user friendly database.

Step Four: **Sustainability Index**

For each wetland type in the wetland classification, and using data from the wetland inventory, order the wetlands according to the importance of their values. Allocate a sustainability index for each wetland in one of three classes:

1) Natural Capital Stock

---

[17] Taken from Manawatu-Wanganui Regional Council (1998b), and Horizons.MW (1999a).

[18] The term "all wetlands" is not defined in Cox, Straker and Taylor (1995), but for the purpose of constructing a regional plan for wetlands, it is assumed that "all wetlands" means all wetlands within the Manawatu region.

These are the most valued and vulnerable wetlands; wetlands that cannot be exploited.

2) Natural Exploitable Stock

These wetlands are those which can be sustainably used and managed.

3) Natural Replaceable Stock

Wetlands that have very little conservation value and can be degraded or destroyed as long as the equivalent area of wetland is recreated – no net loss principle.

Step Five: Regional Wetlands Conservation Strategy

Using the inventory database, formulate a regional wetland conservation strategy. Set policies and targets for no further loss, restoration, reclamation, rehabilitation, and recreation schemes. It is envisaged that this document will take a form very similar to that of the Regional Coastal Plan.

Explanation of Steps

Step One: Identification of Valued and Threatened Wetlands

This stage has already been completed in the Manawatu, as the most regionally significant wetlands are identified in the regional policy statement. More work is needed identifying those wetlands that are under threat, and ensuring that these wetlands have adequate protection.

Step Two: Wetland Classification

At the moment there are no satisfactory classification methods available either within New Zealand or from overseas. Studies such as Benn (1997) have shown that simple classification systems work well. A more complicated and detailed classification system is being developed by Partridge et al., (1999) (Appendix 21.1), and developed further (Ward and Lambie, 1999) and may be the way in which wetland classifications are structured in the future.

Step Three: National Wetland Inventory

New Zealand already has a national wetland inventory held by the Department of Conservation. This inventory contains only those wetlands that are of significant value as determined by the Resource Management Act, 1991. This needs to be expanded to include those wetlands identified in Step One. Horizons.MW is currently undertaking a wetland inventory of the region.

Step Four: Sustainability Index

The RMA sets out the guidelines for what should be deemed a significant wetland – those wetlands are then added to the Natural Capital Stock category. Assessments of each of the wetlands should then be undertaken in order to determine what wetlands shall fit into what category. The assessment should take into account the carrying capacity of the wetland to assimilate increased nutrient and chemical intakes, as well as taking account of the wetland values that are identified in the wetland inventory. The index should reflect all values, identifying the particular values for each wetland and ensuring that these are given appropriate weighting.

Most wetlands may fall into the Natural Exploitable Stock category. These are wetlands that are used extensively and may provide socio-economic value. Examples of these uses include flood management, agricultural practices, and eco-tourism. These sites may be exploited and developed as long as their values are retained.

The lowest class of wetlands is that of Natural Replaceable Stock. These wetlands are of minimum value both to the ecosystem and to the local human community. Wetlands in this category may be developed for residential areas or roading, as long as an equal area of wetland is restored elsewhere.

Step Five: Regional Wetlands Conservation Strategy

In 1986 the Commission for the Environment published a document entitled "New Zealand wetlands management policy". This was an eight-page booklet describing the policies that were to be used to manage wetlands throughout New Zealand. This has now been replaced by the RMA, which sets out the means, by which Regional Policy Statements and Plans may be published. The RMA allows the publication of a regional document as discussed earlier, and such a document can now be drafted. It is important to note that any wetland plan or strategy must be integrated with the other areas that the regional council has jurisdiction over. An example where a wetland regional strategy may be integrated with is with the recently devised Land and Water Regional Plan.

In summary, any wetland management plan/strategy should take into consideration:

- The carrying capacity of the wetland;
- Pressures and threats both real and potential on the wetlands;
- The most valued wetlands and their associated values, and to protect these values;
- Assessing and monitoring both the wetlands themselves and the strategies implemented within the strategy or plan.
- The ability of the strategy or plan to change as circumstances require;
- The principles of sustainable development.

17.4 Riparian Margins

Where there is runoff from land that will affect the quality of the natural environment, the effects can be reduced by the implementation of riparian strips. This usually means the planting of trees and shrubs, and the restriction of stock to waterways. The vegetation acts as an interceptor of sediments and nutrients, trapping them and slowing the flow into the water. The results of this study shows that there is need for improvement in this area. The costs of riparian management comes in the form of where productive land is taken out of use, and the time and money involved with fencing, planting and the construction of alternative stock crossings. Restricting stock access to waterways can also protect the stability of the shores (of the wetland) and the existing vegetation along those margins. Restriction of stock also avoids the direct input of animal waste into the waterway (Manawatu-Wanganui Regional Council 1998a).

Guidelines developed for riparian buffer systems recommend three zones; a grass buffer zone for spreading water and sediments, an upland riparian forest zone for maximum plant growth and uptake of nutrients, and a streamside forested area that is maintained to protect stream banks and provide shading (Hubbard et al., 1995).

Fish and Game New Zealand (1999) outline the following as to the most beneficial way to plant in and around wetlands. They state that trees and shrubs should be suited to the locality of the wetland, and be chosen from locally sourced plants. Additional notes highlight that planting a mix of trees and shrubs is better than a ring around the wetland, as this will impede the flight paths of birds. Any planting should follow the natural contours of the land, as the planting should take place along gullies and ridges – not across them. The planting of low growing species near the water's edge with the odd overhanging tree will provide cover and escape routes for animals. There are also notes regarding the planting of vegetation so that there is year-round fruiting, and avoiding the planting of vegetation that will act as cover for animal pests.

Grass buffer strips as vegetative filters for non-point source pollution from animal waste can be sufficient enough to reduce animal waste concentrations by 90 to 100 per cent. (Castelle et al., 1994). The implication here though is that the grass buffer strip must be on a 1:1 ratio, that is the ratio of buffer area to waste area. In farming practices in the Manawatu, this form of buffer zone would be highly impractical, as it would require vast amounts of pasture to be fenced from stock, causing significant economic impacts.

An article from the Envirolink website, stated that a north American city is looking at developing riparian margins around wetlands, starting at about seven and a half metres, and increasing that to 15 metres in the future. Those wetlands that are deemed to be given special protection, are to be given riparian margins of about 23 metres.

A literature review in Castelle et al., (1994) noted that buffers less than five to ten metres provide little protection of aquatic resources under most conditions. They state that riparian margins should be between 15 to 30 metres in width under most circumstances. The lower range provides for the maintenance of the natural physical and chemical characteristics of aquatic resources. The upper range provides for the minimum necessary for the maintenance of the biological components of many wetlands. It must be remembered that that site-specific conditions may indicate the need for substantially larger buffer or for smaller buffers than those presented here (Castelle et al., 1994).

Riparian management can reduce the amount of hazardous substances entering into a wetland. Obviously this involves the planting of a vegetative boundary around the wetland, but also restricting the access stock have to it as well. Vegetation along these margins traps sediment and nutrients that will in turn slow the processes of sedimentation and algae growth (Manawatu-Wanganui Regional Council, 1998b).

Further, protection should be extended beyond the immediate confines of the wetland in question, perhaps to include a buffer zone along the water ways feeding into the wetlands (Williams, 1983).

17.5 Fencing

While fencing is generally recommended, in some cases it can be detrimental (particularly for paradise shelduck). Fencing about half of the wetland margin is generally a "good rule of thumb" (Fish and Game New Zealand, 1999).

17.6 Other

The major problem for local authorities to overcome is to improve the relationship with the landowners. Not only does this mean improving communication lines with them, but studies completed by Jones et al., (1995) showed that there is a preference for incentives and voluntary mechanisms relating to private property rights. Also, landowners are concerned about the costs involved with protecting wetlands.

Bowen et al., (1995) notes three points that may be used to mitigate the impacts of development on wetlands:

1. The control of adverse effects by design, construction and management features so that development is limited in area, and the spread of disturbance to the wetland is contained.
2. Off setting the loss of wetlands by contributing to corresponding wetland values either on-site or nearby. Proposals could incorporate protective management of parts of a wetland outside the area directly affected by the development. For example, fencing to control the access of stock.

3. The establishment of new wetland habitats nearby to provide extra wetland values to offset the loss of the wetland. This is taken to mean the rehabilitation of degraded wetlands.

17.7 Restoration

Wetland restoration is a balancing act between community perceptions, and what is achievable and sustainable. Stricker (1995) notes three points that may be followed to improve the condition of wetlands:

1. Identify current and potential values
2. Understand how the condition of the wetland has changed over time
3. Take consideration of community perception and current or potential use by the community

In many cases, reversing the trend of degradation can achieve both an enhancement of downstream water quality and the provision of attractive wetland habitats (Osborne and Adcock, 1995).

Fish and Game New Zealand (1999b), note the key design features that restored wetlands must have. These features are presented below:

Size:

- Small sized ponds provide nesting and feeding areas for birds within a wetland network extending to other parts of the (Manawatu-Wanganui) region.
- The larger the size of the wetland, the greater the diversity of wildlife that may exist. It is noted that developers should aim for at least 0.5 hectares of open water, with a ratio of 1:1 open water to dry land/swampy margin. This is provide a greater range of habitats for bird life.

Shelving Margins

- Avoid steep sides and high banks when restoring or constructing wetlands. Shelves should be contoured to allow easy access for birds, as ducks prefer to walk out of ponds, rather than fly.

Depth

- The maximum depth should be about one metre. This may not prove to be the most affective advice. Manderson (pers. comm., 1999) suggests that a deeper water column is necessary to promote the circulation of water within the wetland. But there is no doubt that for the provision of bird life, some parts of the wetland should be around the depth of one metre.

Site Selection

The factors that need to be considered are the:

- Amount of earthworks to be carried out;
- Size of the catchment;
- Availability and consistency of the water supply;
- Ability of the area to hold water;
- Areas to which excess earth will be stored; and
- Enhancement of existing natural values or features.

Islands

- Irregular shaped islands provides wildlife with areas to rest and nest. These islands should remain open especially in sunny locations, and be at a 1:3 ratio of open water to number of islands.

Shape

- An irregular edge of the wetland provides an increased feeding area for birds.
- A gentle-sloping bottom provides different habitat zones for plants and wildlife.

Spillway

- Avoid spillways that have the outlet running over the top of the dam wall. This scouring accounts for most of restoration and construction failures. These spillways should be sited next to the wetland, and be large enough to cope with extreme flood events.

Resource Consents

- Horizons.MW will be able to determine whether a resource consent is necessary for such work.

Osborne and Adcock (1995) recommend that wetlands be planted with at least 18 different (preferably native) species. Not only do these species serve to enhance the biodiversity, they also create a system more responsive to change. For example some species maintain active growth throughout the year, while others are more seasonal.

The Auckland/Waikato Fish and Game Council distributes about 15 000 to 20 000 trees annually for habitat improvement. Priority is given to high visibility projects adjoining public hunting areas. Both native and exotic plants are used, with the exotics providing food for game during times when the natives are unable too. Specially selected exotics often fulfil a role that natives cannot. For example, the swamp cypress provides very good cover and will grow in standing water year round and will not spread like willow (Fish and Game New Zealand, 1999). However, according to Atkinson (1981), constructed wetland soils lack appropriate organic matter content to provide nutrient reducing conditions, to be of much use for water treatment. The Environmental News Network web site (1999) supports this claim, by stating that attempting to restore a seriously degraded wetland, reveals that even though it may look like the original, its not necessarily the same as the real thing, because wetlands cannot be restored on any soil. This is because the soils underlying wetlands have developed over many years, unlike the poor quality soils often used in restoration projects.

The restoration of wetlands may begin by means of placing a covenant on the area. This allows the landowner to protect the site, while continuing to own the land. Financial assistance may be available from the New Zealand Gamebird Habitat Trust Board, Queen Elizabeth II Trust, the Department of Conservation, Fish and Game Councils, and Horizons.MW. District councils may also be able to offer some form of rate relief if approached (DoC, 1999). The pamphlet produced by DoC (1999) also notes that the following are useful when restoring wetlands:

- Partially or totally fence out stock
- Establish plant species that are specific to the wetland area
- Create permanent water, with an irregular shoreline and islands

The following figures from Adamus and Stockwell (1983), show the various possibilities to landowners wishing to restore or create wetlands.

Figure 33: An Example of a Wetland that may Provide Good Fishery Habitat

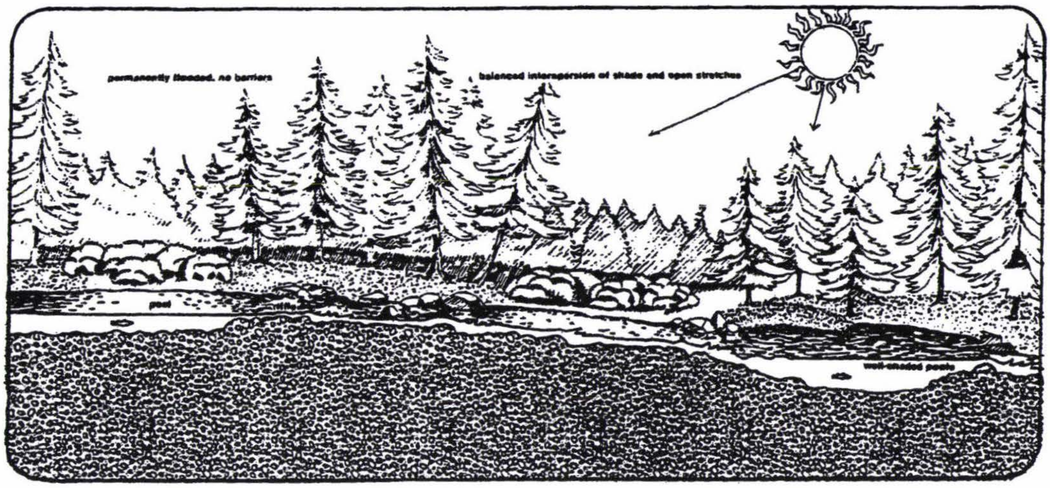


Figure 34: An Example of a Wetland that may Provide Good Wildlife Habitat

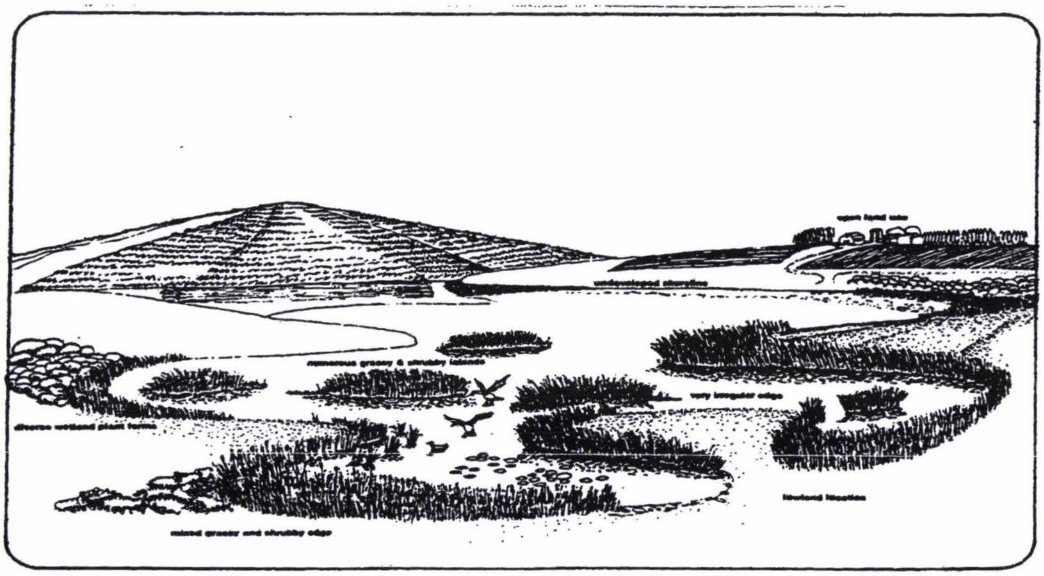


Figure 35: An Example of a Wetland that may Provide Good Active Recreation Opportunities

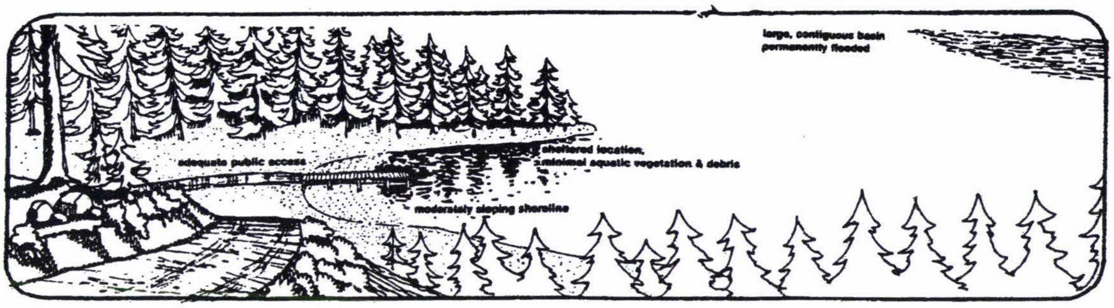
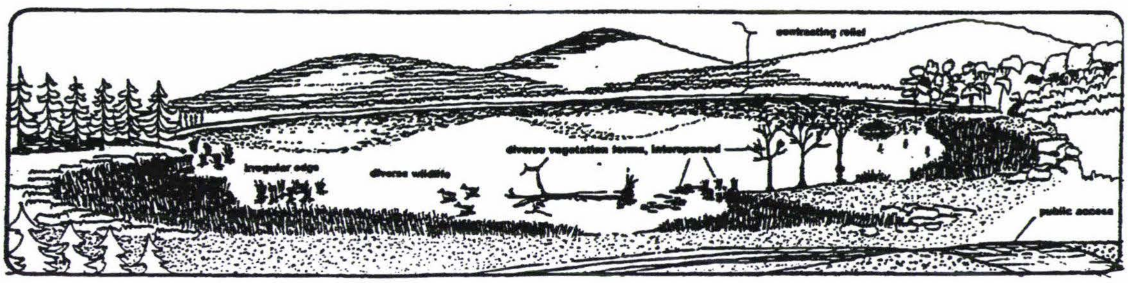


Figure 36: An Example of a Wetland that may Provide Good Passive Recreation Opportunities



17.8 Constructed wetlands

Creation of new wetlands may be a way of mitigating effects, but there is now great interest in using wetlands for water quality control measures. Wetlands have been performing this function throughout history, by design, and more by accidental consequence of the siting of the discharges. It is much more recently that wetlands have been chosen over more traditional engineering solutions (Adam, 1995).

Fish and Game New Zealand (2000b), make the following observations regarding the construction of new ponds:

The larger the pond, the better, as larger wetland encourage more diversity of wildlife. However, ponds of about 0.5 hectares can be good brood-rearing areas.

Other features that are required for the construction of wetlands are identical to those features detailed above in the Restoration section.

Increasingly, wetlands on farms are seen as improving the aesthetic appeal of a farm (Manderson, pers. comm., 1999). However as many wetlands in New Zealand have been lost through drainage, conservation of the remaining wetlands should be a high priority, and the use of vulnerable wetlands for wastewater treatment should be avoided (Tanner and Sukias, 1999). Ideal sites for artificial wetlands can be found in old river oxbows that are now partially filled in with invading willows, or even farmed. Other areas in which good ponds can be made at relatively low costs are gently-sloping gullies with a small water supply – just enough to overcome evaporative losses, but not so much that storm water flows risk damaging the dam wall (Rodway, 1996).

Constructed wetlands also help address cultural concerns about protecting waterways. In addition, they achieve a significant reduction in levels of suspended solids and nutrient enriched water, through the potential to provide additional treatment of dairy shed pond discharges. This wastewater is treated by percolation through either shoots (surface flow), or at the root zone (subsurface flow) of wetland plants growing in channels or beds (Clark et. al., 1997, Horizons.MW, 1999a).

17.9 Obstacles to Improvement

From Jones et al., (1995), four main obstacles to the protection of habitats were identified:

- Attitudes of landowners towards private property rights;
- Attitudes of landowners towards conservation;
- The costs to the agencies of conservation activities, combined with the limits on financial resources; and
- A lack of information and expertise within local authority bodies. This was exposed at Horizons.MW with the undertaking of the wetland inventory, where there was no suitably skilled people to deal with the task. The task fell upon the water scientist, who was already laden with other work.

From a landowner perspective, the introduction of a suitable riparian management scheme that eliminates stock from around a wetland and introduces vegetation to the margins incurs costs to the individual landowner. Conservation requires a direct expenditure of fencing and planting, has an opportunity cost (loss of productive land), and is perceived by landowners to offer little in the way of financial compensation (Jones et al., 1995). Other costs may come from the construction of alternative stock crossings (Manawatu-Wanganui Regional Council, 1998b).

While undertaking the fieldwork for this project, it became clear that landowners do not have a particularly favourable attitude towards some local authorities and those who work there. However in many examples studied in this report, the landowner was conscience about the conservation values associated with their wetlands. Unfortunately with one situation, the landowner kept procrastinating over placing legal protection over the wetland, to the point that the water quality and the surrounding vegetation had become severely degraded.

In order to prepare a practical Regional Plan or strategy on wetlands, Horizons.MW will have to overcome this problem. Further, one landowner was weary on anybody on his land as he had been the victim of some "underhand" dealings with people from local authorities before. Therefore it is absolutely imperative that Horizons.MW build up a trust and working relationship with those landowners that are less than co-operative with them.

Another hurdle for the development of a regional plan on wetlands is the definition of wetlands. The RMA provides a rather suitable one, with a suggested addition of making a clear distinction between other wet areas such as lakes and rivers. Perhaps a more suitable definition may include information on how deep the water is (that is, to differentiate between a lake and a wetland), and a mention of the water flow within the wetland – to distinguish between a river/stream and wetland. The difficult areas to distinguish are those where the easily defined rivers and lakes finish, and the wetlands begin. There is no simple answer for this obstacle, but some form of boundary may be negotiated with the landowners or local communities.

While it is generally accepted that conservation of wetlands is important, landowners do not readily accept that all conversion of wetlands must be stopped, particularly if this might infringe on individual property rights (Jones et al., 1995). This point is important if Horizons.MW did want to prepare a regional plan on wetlands, as by definition, a wetland could be a small section of a paddock that becomes waterlogged and boggy after periods heavy rain. If the landowner wanted to place a small drain to provide consistent grazing land, then the plan would need to account for that particular situation. It is suggested that such events be dealt with on a case by case basis.

Conservation of wetlands is often a matter of resolving the difficult problem of the needs of different groups of users. According to McComb and Lake (1988), local authorities are paying insufficient attention to the resolution of multiple user pressures. Even though this data may be quite dated now, there may be some instances where the resolution of multiple user problems does not please all groups. An example of this was published in the local newspaper. In this example the local Fish and Game Council was against the extension of resource consents involving maintenance of drainage scheme (Appendix 21.2). Nevertheless, McComb and Lake go on to state that local authorities should resist meeting the needs of a well organised lobby group without considering the effects to other potential users.

Future conflicts over management may arise with wetlands created for wastewater absorption. These wetlands may have multiple functions, providing habitat for a range of colonists, water for irrigation and aesthetic values. However, maintenance of the waste assimilation function may demand drastic management including the removal and replacement of large amounts of vegetation. This may cause disturbance to local residents (Adam, 1995).

18 Conclusion

It is clear from studies that wetlands need to have high levels of biodiversity, aesthetically pleasing, and a reasonable capacity for nutrient or pollutant removal (Osborne and Adcock, 1995). The results from this research show that those wetlands sampled do not have vast amounts of bird and invertebrate life. These results also show that the surrounding vegetation is minimal, therefore it is relatively safe to conclude that the wetlands sampled do not have a high biodiversity level.

In the New Zealand context, it is important to recognise the experimental nature of wetland management, and to ensure the full documentation of properly designed monitoring programmes so that in the future we may be able to predict the outcome of management with much greater certainty (Adam, 1995).

Natural wetlands can provide habitat for a large variety of indigenous flora and fauna but there are no appropriate water quality classifications for wetlands in the Third Schedule of the RMA (Manawatu-Wanganui Regional Council, 1998d). While it may be inappropriate to have water quality standards for wetlands, it is hoped that an easy to use, and agreeable classification system is devised to help establish an effective inventory of New Zealand wetlands.

The Manawatu-Wanganui Regional Council (1998d) acknowledge that the relatively few lakes and natural wetlands that remain after many years of draining are also very sensitive receiving environments compared to rivers, sea, or land.

This study is the most extensive investigation of a group of wetlands ever carried out in the Manawatu, and perhaps New Zealand. This report takes a closer step towards understanding the condition and assessment of wetlands than previous publications such as Benn (1997), as it actually assesses various indicators rather than the size of open water, and factors that influence game birds.

For the purpose of data analysis, some indicators were best described using their actual measurements, rather than the score allocated to them. This means that more significant data can be discussed. For example, it was more relevant to discuss the actual temperatures rather than the scores that this indicator received.

From observations made from the 1940 series of aerial photos, it was clear that a lot of drainage had already been carried out (Taylor, pers comm., 1999). The key findings of this research were that the wetlands sampled were in relatively good environmental condition according to the assessment criteria. However there is room for improvement. The main areas that need improvement around the wetland are the width and composition of the riparian margin (buffer zone). This means that the width of the riparian margin needs to be extended, and more wetland vegetation needs to be included in the area immediately around the wetland. Additionally, the most imminent threat to the selected wetlands was that of invasive plant species. Regular maintenance and weeding is needed to minimise this threat.

18.1 Summation

The results of this research have shown that the institutional side is failing those wetlands that do not fall into the criteria of significant wetlands as identified in the Regional Policy Statement. This means that those wetlands that are identified as being either nationally or regionally significant are given protection under the local policies, statements and plans.

Legislation protects those wetlands that are of national and regional significance, but not those that do not fall into that category. In addition, continued management practices of drainage maintenance, dune stabilisation, forestry and high intensity farming are severely limiting the chances of new wetlands forming. In other words, the natural decline of wetlands is being accelerated while the natural formation of new wetlands is being suppressed, which is supported by Osborne and Adcock (1995) who stated that the alteration of the natural flow of water by means of drainage, reduces the area that is inundated for a long enough period to support wetland organisms.

The results of the surrounding land use indicate that the wetlands are located in agricultural land. However when analysing the primary wetland function, it is seen that the wetlands sampled were not simply found in the middle of a paddock, but nearly 100 percent fenced off, and treated as some form of sanctuary or reserve. Protection of this type, has meant that indicators such as bank stability and pugging produced very acceptable results. However as with all reserves, maintenance needs to be carried out to reduce the wetland's biggest threat – invasive plant species, which was an unexpected result, as Benn (1997) had observed that drainage was the biggest threat. Other areas that need to be improved are those of increasing the width of the riparian margins around the wetland. In most cases the average width was less than five metres, when ideally it should be at least 16 metres (Castelle et al., 1998). The abundance of invertebrate and birdlife was disappointing. It was expected that the wetlands would provide habitat to a great number of organisms. This result may have been due to the lack of a riparian margin, but also may have been a consequence of the lack of aquatic vegetation – both at the surface and submerged at the sites.

The areas of this study that need improvement and modification where the scoring system for the composition of bank vegetation. Adjustment is needed to give a greater weighting to native and wetland plant species. Other indicators that need to be researched further are those of determining what measurements or recordings are the ideal for water clarity and water conductivity. However the highest recording within this sample did not surpass the category of "Good" (Spencer et al., 1998), which was between 292-833 ηSiemens/cm. It would be interesting to investigate why this high range of categories is necessary in Australia, when the range in this sample was from only 120 to 600 ηSiemens/cm, with an average of 296 ηSiemens/cm.

The higher the trophic level, the higher the biological production - usually occurring in murky waters, with a high dissolved oxygen rate. Miller (1995) stated that increased productivity and therefore eutrophication resulted in an abundance of invertebrate life. The results of this study have shown that there are not huge amounts of invertebrate life, and that most wetlands sampled had less than 20 per cent surface water coverage. The results also show that most wetlands had very little attached algae.

18.1.1 Attitudes Towards Wetlands

Recently, there has been a growth of interest in wetlands, and an accompanying change in attitude towards them, as some people are retaining or installing wetlands as a personal choice of recreational interests or landscape design. In some countries, the rate of wetland loss is slowing. This growing interest can be seen in the number of international governmental and non-governmental organisations set up to provide for wetland restoration, rehabilitation, and management. Examples of these are the Ramsar Convention, "EnviroLink", and the Society of Wetland Scientists (Jones et al., 1995). In New Zealand, these types of groups are represented by organisations such as the Department of Conservation, Fish and Game, Ducks Unlimited, and the Forest and Bird Protection Society. This interest in preserving wetlands is reflected in the results of primary wetland function, dominant land use, fencing percentages, and stock access. Results from the primary wetland function show that 32 per cent of the sampled wetlands have some component as a plant or animal sanctuary. A further 22 per cent of wetlands are used for their scenic values. This data indicates that the wetlands sampled are being preserved because their values of providing a sanctuary for plants and animals, and for providing scenic views. This is supported by the data relating to the dominant land use, which shows that 59 per cent of wetlands sampled are a part of some form of reserve.

Attitudes towards wetlands is also reflected in the amount of fencing that surrounds the wetland, with 79 per cent of wetlands sampled, being between 76 to 100 per cent fenced. This may point towards the landowner or land occupier acknowledging the fact that wetlands are endangered and that they need protection, particularly from stock. This is supported further by the stock access data, here about 63 per cent of the sampled wetlands allowed no access to stock of any part of the wetland.

18.1.2 Recreational Activities and Attitudes

Further results from Jones et al., (1995) show that the proportion of income earned from the land and landholding size appear to have a relationship with attitudes about the importance and appropriate use of wetlands. This finding is consistent with other studies that have established relationships between affluence and the level of dependence upon the land, or some other resource base. Additionally, landowners who use the land for recreational activities may hold a more practical view of wetland areas. All recreational activities surveyed for this study totalled a maximum of 39 per cent of the total primary wetland function. This means that 39 per cent of all wetlands sampled have some function as a recreational zone. No measurement of the level of income was made to determine a link between affluence and attitudes towards wetlands. However working backward from the data provided by Jones et al. (1995), it may be stated that because 32 per cent of wetland's primary function is to provide some form of plant or animal sanctuary, and a further 39 per cent are used for some form of recreation, then a significant proportion of the sampled wetlands are located on land where there is sufficient land and/or income generated by the agricultural section, and these wetlands are not seen as wastelands.

18.1.3 Artificial Ponds

Comparisons between North America and European practices have shown that the North Americans have been promoting the establishment of new wetlands. Meanwhile the Europeans have been promoting eradication techniques to halt their establishment (Carter, 1988). In the Manawatu, this study has shown that there has been a 32 per cent increase in the number of wetlands between 1942/49 to 1995/96, and this comes as no surprise as landowners have been installing artificial wetlands (Taylor, pers. comm., 1999). From the assessment data, it can be seen that natural ponds and oxbows are still very prevalent within the sample group, however artificial ponds are only outnumbered by one in this study.

This study attempted to investigate and report as to the status of wetlands within a selected population, and link this with the overriding influences of the RMA, the Regional Policy Statement, district plans, and other planning documents. This level of research has not been attempted before. The previous most comprehensive study was that of Benn (1997), who looked at the range, extent and numbers of wetland in the Manawatu region. He also tried to assess the level of threats to these wetlands, but this was limited, as most of his research was done from a desktop.

This report plays an important role in the fact that it provides a worked template of how wetlands should be assessed in the future. It has outlined the major indicators that should be used in such analysis, and highlights those indicators that need further modification to be of future use to wetland assessors. This report is relevant as regional councils seek to gain a greater understanding and appreciation of wetlands within their respective boundaries (Dahm, pers. comm., 1999). In particular, this report should be of some assistance to Horizons.MW, who are currently undertaking a wetland inventory.

It should be acknowledged here that complete cessation of wetland destruction is an impossible task. There will be circumstances where the economic or social benefits of development will be perceived as outweighing the loss of environmental values associated with a particular wetland (Adam, 1995).

The overwhelming evidence provided in this report points out that there is a need to 'preserve' wetlands in the Manawatu, and not simply 'protect' them. The documents provided by Horizons.MW, and the various District Councils in the region suggest that adequate protection is given to those wetlands that are of regionally or nationally significance, but not to those that are not classified as such.

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21 Appendices

21.1 Possible Wetland Classification System

Hydrosystem	Sub-System	Wetland Class	Wetland Form	Structure class (examples)	Cover type(dominance)
Estuarine	Intertidal	Saltmarsh	*(hydrogeomorphic*	*{Atkinson plus submerged classes}*	*{canopy/habitat forming sp}*
(Saline+freshwater)	*(incl supratidal)*	Seagrass meadows	*categories yet to*	eg herbfield	eg. Cotula
		Algalbed	*be agreed upon,*	eg. Algal flatsstonefield	
		Fresh seep	*pending discussions*	eg. (wire)rushland	eg. Leptocarpus
			with NIWA)	eg. algal flats	eg. Gracilaria
				eg. forest	eg. Avicennia
	Subtidal	Mudflat		eg. wormfield	eg. polychaete
		Sandflat		eg. musselreef	eg. Perna
		Cobbleflat		eg. gravelfield	eg. diatomfelt
		Rock/Reef		eg. algalbed	eg. Ulva
	Inter-dunal	Ephemeral/intermittent		eg. shrubland	eg. Lupin
	{dune swale}	Permanent		eg. rushland	eg. Juncus
	Lagoonal	Saline			
	{non-tidal}	Brackish			
		Freshpatch			
Marine	Supratidal	eg. splashzone	eg. exposed coast	eg. barnacle field	eg. Elmius
(saline open water)	Intertidal	eg. sandflat	eg. embayment	eg. eelgrass meadow	eg. Zostera
	Subtidal	eg. rocky reef	eg. tidal bore	eg. kelpforest/urchin barren	eg Ecklonia
		eg. coral reef	eg. bombie	eg. staghorn	
		{marine wetland classes	*{hydrogeomorphic*		
		not yet completed}	*classes not complete}*		

Hydrosystem	**SubSystem**	**Wetland Class**	**Wetland Form**	**Structure classes (eg. or picklist)**	**Cover type (dominance)**
Palustrine	Permanent	Marsh	{basin}	*(Atkinson plus submerged classes)*	*{canopy/habitat forming sp}*
(Vegetation emergent		Swamp	{channel}	eg. reedland	eg. raupo
over freshwater)		Fen	{flat}	eg. shrubland	eg. manuka
		Bog	{slope}	eg cushionfield	eg Donatia
		Flush	{shore}		
		Seep	{Artificial}		
	Ephemeral	Swamp		eg. rushland	eg. Schoenus
		Seep		eg. rockfield	eg. Nostoc
		Vernal pool		eg. algalbed	eg. Spirogyra
Lacustrine	Permanent	Oligotrophic monomictic	{Marginal}	{Low mixed community}	eg. Isoetes
(standing open water)		Oligotrophic amictic	{Littoral}	{Mound community}	eg. Glossostigma
		Mesotrophic monomictic	{Sublittoral}	{Tall mixed community}	eg. Myriophyllum
		Mesotrophic amictic	{Profundal}	{Characean meadow}	eg. Nitella
		Eutrophic monomictic	{Pelagic}	{Byrophyte bed}	eg. Drepanocladus
		Eutrophic amictic		{Algal bed}	eg. Zygnemopsis
		Eutrophic polymictic			
		Dystrophic monomictic			
		Dystrophic amictic			
		Dystrophic polymictic			
	Seasonal	Mesotrophic amictic			
		Eutrophic amictic			
	Ephemeral	Mesotrophic amictic			
		Eutrophic amictic			

Hydrosystem	**SubSystem**	**Wetland Class**(*flow/grad*)	**Wetland Form**	**Structure class {picklist}**	**Cover type (dominance)**
Riverine	Perennial	Stable steepland	{Incised channel}	{Fall/cascade}	{Bedrock}
(flowing open water)		Stable lowland	{Alluvial-channel}	{Rapid}	{Rubble}
		Variable steepland	{Braided channel}	{Riffle}	{Unconsolidated}
		Variable lowland	{Unincised shelf}	{Run/glide}	{Vegetated}
		Flashy steepland		{Pool}	
		Flashy lowland		{Spring}	
	Tidal	Variable		{Saltwedge?}	
		Flashy		{Bore?}	
	Ephemeral	Steepland headwater		{intermittent channel}	
		Lowland floodplain		{floodpool}	
		{simplified categorisation of 2x3 determinants of distinctive difference}			
Frozen	Permanent	Glacier	*{geormorphic*		
			categories not yet		
	Ephemeral	Snowfield	*determined}*		

Hydrosystem	**SubSystem**	**Wetland Class**	**Wetland Form**	**Structure class**	**Cover type (dominance)**
Geothermal	Permanent	Marsh	Basin	*{Atkinson plus submerged classes}*	
(over 35 degrees C)		Swamp	Channel		
		Fen			
		Pool	Terrace		
		Lake			
	PermaFlow	Spring			
		Stream			
	Seep	Flush	Slope		
			Geoterrace		
	SplashZone		Fumerole		
	SteamZone		Basin		
	Reservoir		Aquifer		
Plutonic	Aquifer	*{wetland classes not yet*			
(underground with	Karstpool	*determined}*			
no photosynthesis)	Karststream				

Regional council 'too lenient'

y Jo Myers

ORIZONS.MW is being too le-
·ent toward farmers over the
·ainage of wetlands, says Wel-
·ngton Fish and Game Council.

It has just approved three 15-
·ar resource consents for the
ıintenance of a network of 24
·ainage schemes.

The artificially-excavated
·ains are designed to prevent
rmland from reverting to wet-
nd. Many have been in existence
ıce the turn of the century.

Fish and Game Council senior
'icer Peter Taylor said it was not
posed to the drains being main-
ned, but believed the term of
: consents was too long.

"he 15-year term allowed ser-
ıs environmental damage to
ıtinue.

"It is very disheartening, given the nationally-important status of wetlands under the Resource Management Act, that these most threatened habitats continue to receive wholly inadequate practical recognition by key decision-makers."

Fish and Game wanted a consent term of three or five years.

Horizons.mw regional operations manager Peter Davies, who made the consent application, said because of the costs, a three-to-five-year term would be unreasonable and unrealistic.

The costs were met by ratepayers who were part of the council's drainage schemes.

He said because the regional council was in the "strange" position of applying for, as well as issuing consents, two independent commissioners were appointed to hear the case.

Mr Davies said some resource consents issued by the council were for 35 years, and in this instance he had been seeking consents of 15-to-25 years.

"The commissioners decided to limit all three consents to 15 years, so they obviously took into account some of the comments from Fish and Game."

Many of the drainage schemes had been in operation for more than 90 years and many communities depended on them, Mr Davies said.

Mr Taylor said the Fish and Game Council did not want to turn the clock back, as some landowners seemed to think, and it was ridiculous to suggest that any of the former wetlands should be allowed to revert to wetlands against the wishes of the landowner.

"That is not what the issue is about. (It's about) the proper care of the wetlands we have left, now and in the future, how that is to be achieved and who should pay."

Mr Taylor said it was time the people who had benefited from the destruction of the wetlands began contributing to the well-being of the remaining wetlands.

"The Resource Management Act acknowledges that some adverse effects cannot be avoided or remedied. That is why it also provides for the mitigation of adverse effects."

He said the regional council accepted there had been significant adverse effects caused by its drainage systems, and it had the opportunity to tackle the issue during the consent hearing process.

"I am bitterly disappointed that the RMA has again been applied very leniently to the farming community."

Mr Davies said he did not believe the effects were significant. The applicants had been happy to agree to some conditions being imposed which had been raised during the consent hearings.

"Fish and Game were concerned about the duck habitat, on behalf of recreational hunters and I believe the commissioners decided that communities which depended on these drainage schemes have precedence over recreational hunters.

"I would have to agree with that."

21.3 Ducks Unlimited Newspaper Clipping

Ducks Unlimited NZ

THE GUARDIAN INVITES CLUBS & COMMUNITY ORGANISATIONS TO WRITE ABOUT THEMSELVES IN THIS WEEKLY COLUMN

Ducks Unlimited New Zealand orporated is a charitable, non-profit, ..servation organisation.

It is dedicated to the preservation, restoration, development and management of wetland habitat in New Zealand, the conservation of the country's threatened waterfowl and the advocacy of wetlands as a valuable natural resource.

Ducks Unlimited was founded in New Zealand in 1974 and affiliated to a worldwide group of organisations committed to wetland and waterfowl conservation.

In North America, Ducks Unlimited Canada, Ducks Unlimited Inc and Ducks Unlimited Mexico combine to form the largest conservation organisations in the world with over 700,000 members and annual budgets in excess of US$80 million.

Ducks Unlimited Australia was launched in 1992 and in Europe a group of organisations have combined to form EuroDuck. Within this international network DUNZ is fully autonomous, self-funded, and solely concerned with wetland and waterfowl conservation in New Zealand.

We are the only national charity that is solely committed to the conservation of New Zealand's wetland habitat and our threatened species of native waterfowl.

Membership subscriptions cover ALL administration costs plus publication of the quarterly magazine "Flight", which is distributed to all members and used for promotional purposes.

Regional chapters hold fund raising events such as charity dinner/auctions, sporting clay shoots and open days, the profits from which are added to income derived from sales items, raffles, donations and special grants. This money is then channelled into conservation projects around New Zealand.

We also receive annual income from the New Zealand Waterfowl and Wetlands Trust, a charitable trust established in 1990 to produce income specifically for our conservation projects. All donations to the trust are invested and only this income is available to DUNZ.

When you join, you will have access to a wide knowledge base including wetland site selection, construction, planting (what to and where to), predator control and feeding programmes.

This advice will come from people who have carried out a lot of trials (and errors) and can thus save you considerable effort and money, and lower those frustration levels. DUNZ members can apply for wetland development subsidies, be it for construction, planting, fencing, or further work on existing wetlands.

Contact your local chapter through Neil Candy 353 6132.

• See related article this on page 10.

(Editor's note – the Guardian has run out of Who We Ares. If you want to promote your club, organisation or non-profit group please feel to submit up to 300 words, or 250 words plus a good quality photograph, for publication. This is a free service. Call editor Peter Bartlett with any inquiries on 357 5053 or fax 356 5058.)

21.4 Regionally Significant Wetlands and WERI Classification System

HERITAGE PLACES

WETLANDS, LAKES, RIVERS AND THEIR MARGINS

Refer Rules A2 2.3 and C2 2.4.1 K) (Pages 93 and 147)

W1) Lake Kaikokopu and the Kaikokopu Stream, Himatangi Map Grid Reference S24 024 896 **A**
W2) Karere Lagoon S24 245 860 **A**
W3) Tangimoana Dump Dunes and Fernbird Area S24 993 977 **A**
W4) Lake Omanuka S24 076 948 **A**
W5) Edwards Lagoon, Oroua Road S24 232 967 **A**
W6) Boss Lake (near Lake Omanuka) S24 045 959 **B**
W7) Hamilton's Bend Lagoon, Hamilton's Line S24 215 843 **B**
W8) Voss Lagoon, Hamilton's Line S24 217 850 **B**
W9) Willow Island, Karere Road S24 253 860 **B**
W10) Shaw's Lake (north of Campion Road) S23 100 023 **B**
W11) Broadlands Wetland, Awahou South Road, T23 467 032 **A**
W12) Foxtangi Dunes S24 992 893 **B**

Supplementary List

1) South Conspicuous Road Wetlands T22 632 364 and 627 367.
2) Main Drain Road S24 166 888.
3) Jackeytown Road S24 222 866.
4) Southwest Edwards Lagoon S24 223 965.
5) North Raumai T23 464 075.
6) Lake Road S24 042 908.
7) Raumai Swamp Oxbow T23 466 067.
8) Taikorea Road S24 131 900.
9) South East Mangawhata Oxbow S24 183 869.
10) East Hokerua Trig S24 238 977.
11) Tangimoana Road S24 054 990.
12) Tangimoana Forest S24 026 916.
13) North Highden Oxbow S24 225 005.
14) Wylies Road S24 039 876.
15) South Highway 56 S24 100 854.
16) North Lake Kaikokopu S24 024 908.
17) South No. 1 Line Oxbow S24 225 877.
18) East PukePuke Lagoon S24 083 942.
19) Tangimoana Forest S24 015 970.
20) Valley Road T23 436 076.
21) Bainesse Road S24 134 893.
22) Tangimoana Forest S24 015 933.
23) Cole Road S24 185 986.
24) Midland Road T23 426 059.
25) Whale Road S24 070 959.
26) Tangimoana Forest S24 023 914.
27) Tangimoana Road S24 037 980.
28) Downs Road S24 088 894.
29) East Tangimoana Oxbow S24 016 987.
30) Eden Park Oxbow S24 232 850.
31) Sandon Road S23 250 063.
32) South Himatangi Beach S24 017 885.
33) Lockwood Road S24 208 900.
34) South Himatangi Beach S24 005 880.
35) Whale Road S24 071 960.
36) South Taylor Road lagoon S23 083 045.
37) South Highway 56 S24 085 860.
38) Tangimoana Forest S24 035 953.
39) Haynes Line T23 380 177.
40) Callesens' Bush S24 252 860.
41) Pukemarama Lagoon S24 075 985.
42) South Highway 56 S24 095 859.
43) Highden Oxbow S24 220 999.
44) South Highway 56 S24 094 864.

			Lakes in the Manawatu-Wanganui Region of Outstanding to Moderate- High SSBI Ranking.			
SSBI no.	Map Reference	Conservancy	District Council	Lake	Classification	SSBI rank
	S25 985 601	Wellington	Horowhenua	Lake Papaitonga	L3 S1 S2 S3 S4 S5 S6	1
	U21 843 664	Hawkes Bay	Rangitikei	Trig U Tarns	L1 B3 B4	1
U21 H001	U21 785 750	Wanganui	Rangitikei	Reporoa Bog	L1 B3 S8	1
	S20 269 942	T/T	Ruapehu	Lake Rotokuru (upper lake)	L2	1
	T20 351 193	T/T	Ruapehu	Tama lakes	L2	1
S24 H009	S24 025 937	Wanganui	Manawatu	Pukepuke Lagoon Conservation Area	L4 S3 S4 S5 S6 S7	1
T20 H003	T20 525 989	Wanganui	Ruapehu	Kaimaikuku Tarn (Moawhango riverhea	L5	1
	U21 812 719	Wanganui	Rangitikei	Makirikiri tarns	L5 B2 B3	1
	U21 791 658	Hawkes Bay	Rangitikei	Lake Colenso	L2 S1 S4 S6	2
S22 H004	S22 955 464	Wanganui	Wanganui	Christie's Lake	L3 B3 S4 S5 S6	2
	S25 005 635	Wellington	Horowhenua	Lake Horowhenua	L3 S1 S2 S4 S6	2
	T23 467 032	Hawkes Bay	Manawatu	Broadlands Wetland	L3 S1 S3 S5 S6	2
	S25 937 521	Wellington	Horowhenua, Ka	Lake Kopureherehere	L3 S1 S4 S5	2
S22 H056	S22 156 363	Wanganui	Rangitikei	Lake Ngaruru	L3 S2 S3 S5	2
S23 H007	S23 025 030	Wanganui	Rangitikei	Forest Road Wetlands	L3 S2 S4	2
	S25 922 535	Wellington	Horowhenua, Ka	Lake Huritini	L3 S2 S4 S5	2
S21 H017	S21 164 605	Wanganui	Wanganui	Taonui wetland complex	L3 S2 S4 S5 S6	2
	S24 987 718	Wellington	Horowhenua	Oturoa Lake No.3	L3 S2 S4 S5 S6	2
S24 H002	S24 020 871	Wanganui	Horowhenua	Lake Koputara	L3 S2 S5 S6	2
S23 H024	S23 047 187	Wanganui	Rangitikei	Lake Bernard	L3 S3	2
S24 H007	S24 020 872	Wanganui	Manawatu	Lake Kaikokopu	L3 S3 S4 S5	2
	S24 982 712	Wellington	Horowhenua	Oturoa Lake No.4	L3 S4 S5	2
S24 H005	S24 010 823	Wanganui	Horowhenua	Foxton Lake No. 2	L3 S5 S6 S11	2
S24 H003	S24 014 844, 01	Wanganui	Horowhenua	Orouakaitawa lakes	L3 S5 S7	2

	S25 946 634	Wellington	Horowhenua	Okotore lagoon	L4 S4 S5	2
S21 H004	S21 913 818	Wanganui	Wanganui	Morikau Ponds	L3	3
S22 H044	S22 141 315	Wanganui	Rangitikei	Marton Water Reservoirs	L3	3
S23 H004	S23 640 269	Wanganui	Rangitikei	Lake Waipu	L3	3
S23 H022	S23 093 099	Wanganui	Rangitikei	Fernwood Lake	L3	3
S23 H025	S23 070 175	Wanganui	Rangitikei	Lake William	L3	3
S23 H038	S23 971 185	Wanganui	Rangitikei	Koitaita Wildlife Management Reserve	L3 L6 S6	3
S22 H058	S22 207 434	Wanganui	Rangitikei	Lake Namunamu	L3 S1 S2 S3 S5	3
S22 H023	S22 159 358	Wanganui	Rangitikei	Ngaruru Lakes A and B	L3 S2 S3 S6	3
S23 H012	S23 025 211	Wanganui	Rangitikei	Lake Vipan & Karamu	L3 S2 S4 S5	3
R22 H035	R22 870 360	Wanganui	Wanganui	Lake Kaitoke	L3 S3	3
S23 H008	S23 063 162	Wanganui	Rangitikei	Lake Herbert	L3 S3 S4	3
	S25 040 670	Wellington	Horowhenua	Heatherlea pond, bush and swamp	L3 S3 S5 S6	3
R22 H024	R22 810 438	Wanganui	Wanganui	Westmere Lake	L3 S3 S6	3
	S25 926 568	Wellington	Horowhenua	Ohau river dune lakes	L3 S4 S5	3
S23 H009	S23 090 163	Wanganui	Rangitikei	Lake Alice	L3 S4 S5 S6	3
	T25 478 486	Wellington	Tararua	Ihuraua dam	L3 S4 S6	3
S21 H022	S21 040 618	Wanganui	Wanganui	Parihauhau dam No.3	L3 S5	3
S22 H033	S22 984 424	Wanganui	Wanganui	Kaukatea Pond #1	L3 S5	3
S22 H061	S22 176 431	Wanganui	Rangitikei	Te Kapu Dam 1	L3 S5	3
S24 H039	S24 230 967	Wanganui	Manawatu	Edward's Lagoon	L3 S5	3
S22 H060	S22 176 431	Wanganui	Rangitikei	Te Kapu Dam 2	L3 S5 S6	3
S24 H004	S24 010 816	Wanganui	Horowhenua	Foxton lake No. 1(Lake Omanu)	L3 S5 S6	3
	S24 004 702	Wellington	Horowhenua	Lake Tangimati	L3 S5 S6	3
R22 H012	R22 658 495	Wanganui	Wanganui	Lake Marahau	L3 S6	3
S20 H002	S20 127 919	Wanganui	Ruapehu	Pakihi Road Dam	L3 S6	3
S21 H003	S21 915 810	Wanganui	Wanganui	Morikau Lakes	L3 S6	3
	S24 997 738	Wellington	Horowhenua	Oturoa Lake No.1	L3 S6	3
	S24 993 729	Wellington	Horowhenua	Oturoa Lake No.2	L3 S6	3
	S24 981 707	Wellington	Horowhenua	Oturoa Lake No.5	L3 S6	3
S24 H006	S24 023 879	Wanganui	Horowhenua	Pine Pond (Pirie Pond)	L4 S2 S4 S5	3
S24 H023	S24 075 950	Wanganui	Manawatu	Omanuka Lagoon	L4 S5	3
	S25 974 668	Wellington	Horowhenua	Moutere Lake 4	L4 S6	3

CLASSIFICATION OF LAKE TYPES (and associated surrounding vegetation)

L1 Tarn - very small, generally high altitude, low-nutrient lakes, usually occupying basins formerly scoured by glacial ice; silt veneered rock bottom, often with *Isoetes.*

L2 Montane Lake - lakes located above 600m altitude, usually of glacial, tectonic or volcanic origin; often large and deep and low in nutrients; often with the macrophytes *Lilaoepsis, Limosella* and *Glossostigma.*

L3 Lowland lake/pond - freshwater lake located below 600m altitude, non-fluctuating, diverse origins, substrates and depths, but frequently with silty bottom, shallow and nutrient-rich; often culturally modified.

L4 Lowland lake - freshwater lake located below 600m altitude, fluctuating, diverse origins, substrates and depths, but frequently with silty bottom, shallow and nutrient-rich; often culturally modified.

L5 Ephemeral montane pool

L6 Ephemeral lowland pool

B1 Forest Bog - freshwater, nutrient poor, acidic wetlands dominated by trees and shrubs of the genera *Halocarpus, Lepidothamnus, Lagarostrobos* (all formally *Dacrydium), Podocarpus, Libocedrus* and *Nothofagus.*

B2 Shrub Bog and Heathland - freshwater, nutrient-poor, acidic wetlands dominated by shrub podocarps (*Phyllocladus* and *Halocarpus*), heaths of the family Epacridaceae, and manuka.

B3 Restiad Bog and Tussockland - freshwater, nutrient-poor, acidic wetlands, variable according to temperature and wetness, including red tussock grassland, *Sphagnum* moss, rushland (restiads and others) and fernland (*Gleichenia*).

B4 Cushion Bog - freshwater, nutrient-poor, acidic montane to alpine wetlands, with vegetation adapted to low temperature consisting of low-growing, dense, cushion-shaped plants such as *Donatia, Gaimardia, Phyllachne* and *Oreobolus.*

S1 Podocarp Swamp - freshwater, nutrient-rich wetlands dominated by podocarp trees (kahikatea and matai).

S2 Shrub Swamp - fresh, nutrient-rich wetlands characterised by the abundance of shrubs, including manuka, *Coprosma* and *Olearia.*

S3 Broadleaved-tree Swamp - freshwater, nutrient-rich wetlands pukatea and swamp maire, willows and cabbage trees.

S4 Flax Swamp - freshwater, nutrient-rich wetlands dominated by flax (*Phormium tenax*), sedge (*Carex Secta)* and toetoe.

S5 Reed Swamp - freshwater, nutrient-rich wetlands, predominantly raupo.

S6 Rush and Sedge Swamp - freshwater, nutrient-rich wetlands consisting of rushes and sedges belonging mainly to the genera *Juncus, Carex* and *Eleocharis.*

S7 Grass Swamp - freshwater, nutrient-rich wetlands dominated by introduced grasses particularly *Glyceri, Phalaris* and *Zizania latifolia*, in floodplain and riparian habitats once dominated by kahikatea, flax and raupo.

S8 Montane Swamp - freshwater, nutrient-rich wetlands fed typically by emerging underground water and supporting a diverse herbaceous vegetation particularly bryophytes, grasses and sedges (*Carpha, schoenus*) and herbs of the genera *Celkmisia. Senecio, Ranunculus* and *Montia.*

S9 Herb/Turf Swamp - freshwater, nutrient-rich wetlands.

S10 Leptocarpus Wetland - non estuarine

S11 Sedge Swamp - mesotrophic bog or swamp dominated by *Baumea* and/or *Schoenus* sedges.

SSBI HABITAT RANKINGS

OUTSTANDING (1)

1. Occurrence of an endangered endemic species.
2. Areas important to nationally vulnerable or internationally uncommon species (breeding and/or migratory).
3. Ecosystem or example of an original habitat type which is nationally rare.
4. Rare national example of a sequence or mosaic.

HIGH (2)

1. Occurrence of a vulnerable endemic species.
2. Important habitat of a nationally rare species or presence of regionally rare endemic species.
3. Example of a nationally uncommon habitat, sequence or mosaic.
4. Vegetation/habitat that is rare in that Ecological Region.

MODERATE-HIGH (3)

1. Occurrence of a rare endemic species, or regionally threatened species, or endemic species of limited abundance throughout the country.
2. A habitat or sequence which is rare in that Ecological District.
3. An area where any particular species is exceptional in terms of say abundance or habitat.
4. Sizeable examples of common vegetation types found within the Ecological District.
5. Forms ecoogical buffers, linkages or corridors to significant habitats of indigenous flora and fauna.
6. Good representative example of a habitat type (including landform) that is common in the Ecological District.

MODERATE (4)

Small sites support good numbers of species which are typical of a widespread habitat within an ecological region/district and which has a full canopy structure.

POTENTIAL (5)

1. Examples of an early secondary succession where the vegetation is dominated by naturally established exotic plants and where better examples exist in the Ecological District.
2. Sites that although containing indigenous vegetation, are essentially human-made and are of recent origin eg. wetlands that were created for farm ponds.

21.5 Aerial Photo Analysis Results

Wetlands Identified by Aerial Pictures on Topographical Map S23 (Marton)

Date	Grid Reference	Name of Wetland	Notes	Extent of Aerial Photo Transect	Transect Details
23/5/49	980184		Approx 32 wetlands in Santoft forest area	955170 Northern Limit	1655 Series
	994138		that is, old dune field	970132 Southern Limit	
	996137				
	003139				
	002143				
	003144				
	994146				
	999169				
	003168				
	007135				
	008133				
	103143				
	013142				
	015136				
	017137				
	016156				
	019133				
	019142				
	022168				
	029170				
	032163				
	034166				
	035167				
	036157				
	040149		Photos jumps in sequence from No. 9 to No. 14		
			No photos from about 050 to 088		
	092161		No. 14		
	088163		Lake Alice		
	105142				
	106162				
	112162				
	112153				
	157149				
			No photos from about grid reference 120 to 130		
	221138				
	227139				
30/8/42	887286		In dunefield north of Whangaehu River	880290 Northern Limit	Series 386
	895283			900260 Southern Limit	Marton Office
	896285				MWRC
	898287				
	894273				
	895274		Approx. 5 wtelands in this area		
	903265				
	907265				
	912263				
	916263				
	918263				
	924262				
	920267				
	940268	Lake Waipu			
	986266				
	022268				
	024263				
	025262				
	042278				
	061291				
	069264				
	072270				
	073268				
	082264				
	085269				
	085267				
	092267				
	095264				
	095272				
	097285				
	100288				
	101292				
	102265				
	105290				
	105271				
	108263				
	119267				
	120260				
	124280				
	124281				
	145281				
	151274				
	161274				
	165272				
	165260				
	187283				
			Jump in photos from No 32 to 35		
	204288				
	208289				
	207267				
	208261				
	221268				
	224268				
	231285				
	249261				
	258270				

These references are only those that are found within the 1942 transect To find the others, go to 3 September in my diary

10/5/96	904276			843 Northern Limit
	940268	Lake Waipu	Also found on 1942 transect	245 Southern Limit
	945263	Lake Oraekomiko		
	932270			
	937274			
	941284			
	950272			
	960273			
	969279			
	273283			
	967273			
	962278			
	975263			
	997263			
	001261			
	004259			
	008259			
	016259			
	072288			
	098285		Also found on 1942 transect	
	097841			
	118271			
	159267		Oxidation pond	
	166283			
	170285			
	169274			
	178273			
	179232			
	181266			
	185266			
	189290			
	191267			
	193272			
	193289			
	203289			
	208262			
	217261			
	221268		Dry	
	225267			
	2442616			
	244267			
	245269			
	251265			
	261275			
	297261			
	299271			
	301274			
		47 wetlands		

Wetlands Identified by Aerial Pictures on Topographical Map S24 (Foxton)

Year	Grid Reference	Name of Wetland	Notes	Extent of Aerial Photo Transect	Transect Details
1942	S24013845		1942 areial photographs on a scale of 1:50000 (?)	988878 Northern Limit	Series 219
	018869	Koputara		984836 Southern Limit	
	033863		At least 40 deflation basins with dunefields that may		
	040864		be permanently or intermittantly wet		
	051857				
	063864				
	068868				
	078855				
	095868				
	[illegible]		Old Orua River bed (ephemeral?)		
	194855				
	209843				
	212843				
	214842				
	. 216850				
	221859		Small wetland at drain intersection		
	229852		Oxbow		
	233852				
	244862	Karere Lagoon	Oxbow		
	253860				
	294844				
1942	S24014845		Approx. 25 dune deflation basins that may contain		
wetland	Koputara		wetlands within dune field		
number	020843				
check	029847				
	148843				
	059843		Approx. 2 wetlands		
	068843		Approx. 5 wetlands in deflation basins (ephemeral?)		
	094863		Deflation basin (ephemeral?)		
	086860		Deflation basin (ephemeral?)		
	096850		Deflation basin (ephemeral?)		
	099865				
	213843		Oxbow near Hamiltons Line		
	213843				
	216851				
	227852				
	Karere Lagoon				
	253851				
	299838				
1965	S24014836		At least 32 deflation basins with dunefields that may	Same as 1942 transect	
	014845		be permanently or intermittantly wet		
	018865	Koputara			
	085870				
	145874				
	148859				
	216843		Recently cut off oxbow		
	217851		Oxbow not yet halved		
	220845				
	227852		Eastern half severely infilled		
	246873				
	254870				
	263868				
	278864				
	293854				
1995	S24009862			905992 Nothern Limit	
	010875			984840 Southern Limit	
	010885		Two deflation basins in dune fields		
	014840				
	014845		Also found on 1942 transect		
	018870	Koputara	Also found on 1942 transect		
	020848				
	023846				
	023854				
	023898				
	026846				
	035843				
	039876				
	077850				
	080880		Bottom left corner of grid box approx. 8 wetlands		
	082846				
	082861				
	082868				
	095857				
	105842		Approx. 6 wetlands in this area		
	148881		Oxidation ponds		
	163876		Oxidation ponds		
	168884		Oxidation ponds		
	171851		Oxidation ponds		
	183869				
	184852				
	195878				
	267889				
	202876				
	204861				
	204865				
	215841		Also found on 1942 transect		
	218850		Near Hamiltons Line		
	244899		Oxidation ponds		
	245864	Karere Lagoon	Also found on 1942 transect		
	246873		Dry, but may be ephemeral		
	252858				
	256884		Oxidation ponds		
	262840				
	263868				
	275894		Old stream bed possibly ephermal		
	277871				
	278842		Oxidation pond		
	281868		Linton sewage pond?		
	294853		Linton wetland		

Wetlands Identified by Aerial Pictures on Topographical Map S25 (Levin)

Date	Grid Reference	Name of Wetland	Notes	Extent of Aerial Photo Transect	Transect Details
11/2/42	942635		Approx. 4 dune deflation basins that may contain	640 Northern Limit	Series 228
	946634		wetlands within dune field	605 Southern Limit	
	951612				
	956607				
	948627	Possible swamp land			
	952632	Possible swamp land			
	959617				
	968636				
	968631				
	609969				
	978606				
			Jump in picture numbers from No. 6 to 10.		
			From longitude 989 to 009 on S25 topographical map		
	012638	Lake Horowhenua			

21.6 Field Assessment Sheet

Field Assessment Sheet for Wetlands

Date of Assessment	
Grid Reference	
Name of Wetland	
Size (Ha) of Wetland	

How Wetland is Fed with Water	Direct Stream Flow	
	Seepage (from watertable)	
	Drains	
	Overland Flow	
	Other	

Wetland Type	Lake	
	Oxbow	
	Natural Pond	
	Artifical Pond	
	Swamp	

Surrounding Land Use or Habitat (within 50m)			Scale of Magnitude
	Pastoral/Grass		1 2 3 4 5
	Grazing		1 2 3 4 5
	Cropping		1 2 3 4 5
	Forestry		1 2 3 4 5
	Native Bush		1 2 3 4 5
	Exotic Bush		1 2 3 4 5
	Human Construction		1 2 3 4 5
	Earthworks		1 2 3 4 5
	Roads		1 2 3 4 5
	Bare Ground		1 2 3 4 5
	Ploughed Land		1 2 3 4 5
	Surface Water		1 2 3 4 5
	Flood Debris		1 2 3 4 5

Main Wetland Function/Usage			Scale of Magnitude
	Water Supply		1 2 3 4 5
	Recreation		1 2 3 4 5
	Hunting		1 2 3 4 5
	Fishing		1 2 3 4 5
	Boating		1 2 3 4 5
	Scenic		1 2 3 4 5
	Wastewater Treatment		1 2 3 4 5
	Tourism		1 2 3 4 5
	Education		1 2 3 4 5
	Maori		1 2 3 4 5
	Historic		1 2 3 4 5
	Flood Control		1 2 3 4 5
	Peat Production		1 2 3 4 5
	Flax Production		1 2 3 4 5
	Erosion Protection		1 2 3 4 5
	Plant or Animal Nursery		1 2 3 4 5
	Animal Sanctuary		1 2 3 4 5

Threats			Scale of Magnitude
	Drainage		1 2 3 4 5
	Eutrophication		1 2 3 4 5
	Fire		1 2 3 4 5
	Flow Reduction		1 2 3 4 5
	Grazing		1 2 3 4 5
	Invasive Species		1 2 3 4 5
	Reclamation		1 2 3 4 5
	Recreation		1 2 3 4 5
	Residential Development		1 2 3 4 5
	Roading		1 2 3 4 5
	Rubbish Dumping		1 2 3 4 5
	Sediment		1 2 3 4 5
	Sewage		1 2 3 4 5
	Toxic Substances		1 2 3 4 5
	Wastewater		1 2 3 4 5
	Wave Action		1 2 3 4 5

Weather Conditions
(at time of visit)

Temperature	C	Score
<5		2
5 - 9.9		4
10 - 14.9		5
15 - 19.9		4
20 - 24.9		2
25 - 29.9		1
>30		0

Sunlight	
Bright	
Overcast	
Dark	
Wind	
Direction;	
North	
East	
South	
West	
Strength;	
Gale	
Strong	
Modeate	
Breezy	
Calm	

	Soil Attributes	North	South	East	West	Definition	Notes
	Bank Stability					1 = Very Unstable	Extensive erosion, bare, steep banks
						2 = Unstable	Significant erosion, little vegetation
						3 = Moderately Stable	Moderate, some erosion
						4 = Stable	Good stability, minor sport erosion
						5 = Very Stable	Very stable, good vegetation cover

		North	South	East	West	Definition	Notes
	Degree of Pugging					1 = >20	Mean number of hoof marks within 1m
						2 = 13-19	square quadrates
						3 = 7-12	
						4 = 1-6	
						5 = 0	

	Terrestrial Vegetation	North	South	East	West	Definition	Notes
	Width of Fringing Vegetation or Riparian Condition					1 = <5 metres	
						2 = 6-10 metres	Minimal protection
						3 = 11-15 metres	
						4 = 16-20 metres	Recommended width
							5 = >20 metres

	Bank Vegetation	Total %	(% x Score)/100	Score	Definition
	Native trees			10	
	Wetland vegetation			10	Percentage cover
	Tall tussock grassland			8	(max score of 20)
	Introduced trees (eg willow, poplar)			8	
	Other introduced trees (eg confiers)			5	
	Scrub			5	
	Pasture grasses and weeds			3	
	Bare ground, roads, and/or buildings			-10	

Aquatic Vegetation		Score
Cover of Aquatic Vegetation		1 = 81-100%
Percentage of water surface that is covered by aquatic vegetation		2 = 61-80%
		3 = 41-60%
		4 = 21-40%
		5 = 0-20%

Attached Algae		1 = Abundant algae over <1/3 of water surface
		2 = Many clumps of algae
		3 = Clumps present
		4 = Small patches present
		5 = No obvious signs

Water	1	2	3	Average	5 = Clear to bottom
Water Clarity					4 = 70 - 100 cm
					3 = 55 - 69 cm
					2 = 35 - 54 cm
					1 = <35 cm

Water Conductivity	Readings	Siemens/cm	Score	
	1			5 = < 50
	2			4 = 50 - 149
	3			3 = 55 -69
	Average			2 = 250 - 399
				1 = > 300

Water pH	Score	
		5 = 6.5 - 7.5
		3 = 5.5 - 6 or 8 - 9
		1 = <5 or >9.5

Fauna	Question No.	North	South	East	West	
Macroinvertebrates						1 = Nothing
						2 = Few
						3 = Moderate
						4 = Significant Amount
						5 = Abundance

Birds		1 = No birds to be seen or heard
		2 = Birds heard, not seen; not interacting with wetland
		3 = Some birds around site
		4 = Moderate amount of birds seen and heard
		5 = Lots of birds heard, seen, and flourishing in and around wetland

Anthropocentric Effects

Drainage at/of Wetland		1 = Extensive drainage networks 2 = Significant drainage 3 = Moderate amount of drainage 4 = Limited drainage 5 = No drainage
Dominant Land Use at Wetland		1 =Intensive farming and/or cropping 2 = Exotic forestry and/or sheep/beef farming 3 = Sustainably managed sheep/beef farms 4 = Disturbed native forest/tussock grasslands 5 = Ungrazed native forest, tussock grassland and/or reserve
Stock Access		100%=Stock have access to entire wetland 75% = Stock have access to most of wetland 50% = Stock have access to half of wetland 25% = Stock only have access to small part 0%= Stock have no access to wetland

21.7 Changes in the Size of Sampled Wetlands 1942/49-1995/96

Changes in Sizes of Sampled Wetlands							
Wetland	Open Water Size (ha)					Changes in Area (ha)	
	1942	1965	1995		1940s-60s	1960s-90s	1940s-1990s
Massey Vet Pond							
Karere Lagoon (one)	5.57	5.83	4.22		0.26	-1.61	-1.35
Off Dampneys Road (off Jackeytown Road) (two)	2.88	2.35	6.10		-0.53	3.76	3.23
Hamiltons Line (Max Voss's property) (three)	0.00	0.00	0.24		0.00	0.24	0.24
Number Four (Off No. 1 Line)	0.40	0.63	0.86		0.23	0.23	0.46
Number Five (near Levin)	1.94						
Manderson Property (Number Six)	0.00	0.00	0.00		0.00	0.00	0.00
Alan Feidling's Property (Number Seven A)	0.00	0.42	0.76		0.42	0.33	0.76
Alan Feidling's Property (Number Seven B)							
Alan Feidling's Property (Number Seven C)							
Number Eight	0.55	0.21	0.00		-0.34	-0.21	-0.55
Andy Tannock's Property (Number Nine)	1.51	1.52	2.77		0.01	1.25	1.27
Frank Collier Property (No 10)							
Dave West Property (Number 11)	0.00	0.00	1.90		0.00	1.90	1.90
Number 12	1.76	1.35	1.37		-0.41	0.02	-0.39
Number 13	0.00	0.00	0.94		0.00	0.94	0.94
Number 14	0.00	0.00	1.25		0.00	1.25	1.25
Number 15	2.26	0.65	0.89		-1.61	0.24	-1.37
Number 16	4.52	2.16	3.03		-2.36	0.87	-1.49
Phillip Crawshaw (Wetland "C")	3.76	0.05	0.13		-3.71	0.07	-3.64
Frecklinton Property (Wetland "F")	0.67	1.82	1.02		1.15	-0.80	0.36
Frecklinton Property (Wetland number 2)	0.00	0.00	0.10		0.00	0.10	0.10
Wetland near Lake Koitiata			0.56		0.00	0.56	0.56
Lake Koitiata (Wetland "H")	20.16	13.50	13.99		-6.66	0.49	-6.17
Jim McDonald Property (one)			0.37		0.00	0.37	0.37
Jim McDonaldProperty (Lake Alice)	9.87		13.11		-9.87	13.11	3.23
Jim McDonald Property (two)	0.00	0.00	0.10		0.00	0.10	0.10

Number of Wetlands

Date	Location*	Number of Wetlands	Difference in Numbers	Percentage Change
30/8/42	S23 (Marton)	57		
10/5/96	S23 (Marton)	65	8	14%
23/5/49	S23 (Bulls)	34		
18/10/95	S23 (Bulls)*	59	25	74%
16/3/42 checked	S24 (Foxton)	24		
15/4/65	S24 (Foxton)	15	(Difference between '42 & '65) -9	-38%
20/6/95	S24 (Foxton)	36	(Difference between '65 & '95) 21	140%
			(Difference between '42 & '95) 12	50%
11/2/42	S25 (Levin)	12		
26/5/95	S25 (Levin)*	8	-4	-33.33%

1942/49 Wetlands	127
1995/96 Wetlands	168
Difference	41
Percentage Change	32

formula = $\frac{\text{difference}}{\text{original number}}$

Wetland			Open Water Size (ha)					Changes in Area (ha)	
	Score	Number	1942	1965	1995		1940s-60s	1960s-90s	1940s-1990s
Massey Vet Pond									
Karere Lagoon (one)	48.1	1	5.57	5.83	4.22		0.26	-1.61	-1.35
Off Dampneys Road (off Jackeytown Road) (two)	54	2	2.88	2.35	6.10		-0.53	3.76	3.23
Hamiltons Line (Max Voss's property) (three)	58.7	3	0.00	0.00	0.24		0.00	0.24	0.24
Number Four (Off No. 1 Line)	52.5	4	0.40	0.63	0.86		0.23	0.23	0.46
Number Five (near Levin)	60.3	5	1.94						
Manderson Property (Number Six)	61.14	6	0.00	0.00	0.00		0.00	0.00	0.00
Alan Feidling's Property (Number Seven A)	61.05	7	0.00	0.42	0.76		0.42	0.33	0.76
Alan Feidling's Property (Number Seven B)	66.8								
Alan Feidling's Property (Number Seven C)	63.86								
Number Eight	60.7	8	0.55	0.21	0.00		-0.34	-0.21	-0.55
Andy Tannock's Property (Number Nine)	59.35	9	1.51	1.52	2.77		0.01	1.25	1.27
Frank Collier Property (No 10)	57.25								
Dave West Property (Number 11)	65.6	11	0.00	0.00	1.90		0.00	1.90	1.90
Number 12	52.5	12	1.76	1.35	1.37		-0.41	0.02	-0.39
Number 13	64.95	13	0.00	0.00	0.94		0.00	0.94	0.94
Number 14	63.7	14	0.00	0.00	1.25		0.00	1.25	1.25
Number 15	52.6	15	2.26	0.65	0.89		-1.61	0.24	-1.37
Number 16	62.6	16	4.52	2.16	3.03		-2.36	0.87	-1.49
Phillip Crawshaw (Wetland "C")			3.76	0.05	0.13		-3.71	0.07	-3.64
Frecklinton Property (Wetland "F")			0.67	1.82	1.02		1.15	-0.80	0.36
Frecklinton Property (Wetland number 2)			0.00	0.00	0.10		0.00	0.10	0.10
Wetland near Lake Koitiata					0.56		0.00	0.56	0.56
Lake Koitiata (Wetland "H")			20.16	13.50	13.99		-6.66	0.49	-6.17
Jim McDonald Property (one)					0.37		0.00	0.37	0.37
Jim McDonaldProperty (Lake Alice)			9.87		13.11		-9.87	13.11	3.23
Jim McDonald Property (two)			0.00	0.00	0.10		0.00	0.10	0.10

21.8 Raw Data from Field Assessments

		Wetland Identification	of Wetland (	of Wetland (	ubstrate Typ	Type
		Perfect Pond				
	1	Massey Vet Pond	7.50	75000.00	Muddy / Silty	Artifical Pond
One	2	Karere Lagoon (one)	4.22	42240.00	Muddy / Silty	Oxbow
Two	3	Off Dampneys Road (off Jackeytown Road) (tw	6.10	61048.10	Muddy / Silty	Oxbow
Three	4	Hamiltons Line (Max Voss's property) (three)	0.24	2363.28	Muddy / Silty	Oxbow
Four	5	Number Four (Off No. 1 Line)	0.86	8560.90	Muddy / Silty	Oxbow
Five	6	Number Five (near Levin)	5.00	50000.00	Muddy / Silty	Enhanced Natural Pond
Six	7	Manderson Property (Number Six)	0.08	800.00	Muddy / Silty	Artifical Pond
Seven (a)	8	Alan Feidling's Property (Number Seven A)	0.50	2000.00	Muddy / Silty	Enhanced Natural Pond
Seven (b)	9	Alan Feidling's Property (Number Seven B)	0.20	2000.00	Muddy / Silty	Enhanced Natural Pond
Seven (c)	10	Alan Feidling's Property (Number Seven C)	0.10	1000.00	Muddy / Silty	Artifical Pond
Eight	11	Neil Candy's project	0.20	2000.00	Muddy / Silty	Oxbow
Nine	12	Andy Tannock's Property (Number Nine)	2.77	27729.20	Muddy / Silty	Oxbow
Ten	13	Frank Collier Property (No 10)	0.16	1600.00	Muddy / Silty	Artifical Pond
Eleven	14	Dave West Property (Number 11)	1.90	19030.75	Muddy / Silty	Enhanced Natural Pond
Twelve	15	Himatangi (1)	1.37	13678.35	Muddy / Silty	Swamp
Thirteen	16	Himatangi (2)	0.94	9360.00	Muddy / Silty	Natural Pond
Fourteen	17	Himatangi (3)	1.25	12488.93	Muddy / Silty	Artifical Pond
Fifteen	18	Douglas Property	0.89	8904.60	Muddy / Silty	Natural Pond
Sixteen	19	Seymore Property	3.03	30250.00	Muddy / Silty	Oxbow
C	20	Phillip Crawshaw (Wetland "C")	0.13	1279.10	Muddy / Silty	Natural Pond
F	21	Frecklinton Property (Wetland "F")	1.02	10240.90	Muddy / Silty	Natural Pond
F 2	22	Frecklinton Property (Wetland number 2)	0.10	1000.00	Muddy / Silty	Swamp
H 2	23	Wetland near Lake Koitiata	0.20	2000.00	Muddy / Silty	Natural Pond
H	24	Lake Koitiata (Wetland "H")	13.99	139906.00	Muddy / Silty	Lake
McD One	25	Jim McDonald Property (one)	0.08	800.00	Muddy / Silty	Natural Pond
Alice	26	Jim McDonaldProperty (Lake Alice)	13.11	131083.00	Muddy / Silty	Lake
McD Two	27	Jim McDonald Property (two)	0.01	100.00	Muddy / Silty	Artifical Pond

	Weather Conditions		How Wetland is Fed with Water			
Sunlight	Wind Direction	Wind Strength	Direct Stream	Seepage	Drains	Overland Flow
Bright	West	Calm	0	0	1	0
Overcast	West	Calm	1	1	1	1
Overcast	West	Breezy	0	1	0	1
Overcast	South	Breezy	1	1	1	1
Bright		Still	0	0	0	0
Bright		Still	1	0	1	1
Overcast	South	Breezy	0	0	1	0
Overcast	South	Moderate	1	0	1	0
Overcast	South	Breezy	1	0	1	1
Overcast	South	Breezy	1	0	1	0
Overcast	East	Breezy	1	0	1	0
Overcast		Still	1	0	1	0
Overcast		Still	1	0	0	1
Overcast	West	Calm	0	1	0	1
Overcast	West	Breezy	0	1	1	0
Overcast	West	Moderate	1	1	1	1
Overcast	West	Breezy	1	0	1	0
Overcast	West	Calm	0	1	1	0
Overcast	West	Calm	1	1	0	1
Bright	West	Breezy	1	1	1	1
Bright	West	Breezy	1	1	0	1
Bright	West	Breezy	1	1	1	1
Bright	West	Breezy	1	1	1	1
Bright	West	Moderate	1	1	1	1
Bright	West	Breezy	0	1	0	1
Bright	West	Breezy	1	1	1	1
Bright	West	Breezy	1	1	1	1

Surrounding Land Use Scale of Magnitude								
Pastoral / Grass	Grazing	Cropping	Forestry	Native Bush	Exotic Bush	n Construction	Earthworks/B	Roads
4	0	0	0	0	3	4	4	0
5	4	0	0	0	3	0	2	0
5	5	0	0	0	0	0	0	0
5	5	0	0	0	3	0	0	0
5	4	0	0	0	0	3	0	2
5	5	0	0	0	0	3	2	0
5	0	0	0	0	0	0	0	2
4	0	0	0	0	4	0	0	0
4	0	0	0	0	5	0	0	0
3	0	0	0	0	4	2	2	0
5	0	0	0	0	2	0	0	0
5	0	0	0	0	3	2	0	0
5	5	0	0	0	3	0	0	0
3	0	0	3	0	5	0	0	2
5	5	0	0	0	0	0	0	1
5	5	0	0	0	0	0	0	2
5	0	0	0	0	0	0	0	0
5	5	0	0	0	3	2	0	0
0	0	0	0	4	5	1	0	0
4	0	0	4	0	0	1	0	1
5	5	0	0	2	2	0	0	0
5	5	0	0	2	3	0	0	0
5	0	0	3	0	0	0	0	0
5	5	0	3	0	0	0	0	0
4	0	0	0	3	4	0	0	0
4	0	0	0	0	5	0	0	0
5	5	0	0	0	0	0	4	0

Wetland Function Scale of Importance															
Water Supply	Recreation	Hunting	Fishing	Boating	Scenic	Wastewater	Tourism	Education	Maori	Historic	Flood Control	Peat	Flax	Erosion Protection	Sanctuary
0	3	0	0	0	4	0	2	4	0	0	0	0	0	0	4
0	3	3	0	2	0	0	0	0	0	0	0	0	0	0	5
0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	2
0	5	4	3	2	4	0	0	0	0	0	0	0	0	0	4
0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2
0	3	3	2	2	4	0	0	0	0	0	0	0	0	0	4
0	0	2	0	2	5	0	0	0	0	0	0	0	0	0	4
0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	5
0	3	0	0	0	4	0	0	0	0	0	0	0	0	0	4
0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	3
0	0	4	0	0	3	0	0	0	0	0	0	0	0	0	4
0	0	4	0	0	4	0	0	0	0	0	0	0	0	0	4
0	0	3	0	0	4	0	0	0	0	0	0	0	0	0	4
0	5	5	0	0	4	0	0	0	0	0	0	0	0	0	3
0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	2
0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	4
0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	3
0	0	3	0	0	3	0	0	0	0	0	0	0	0	0	4
0	4	3	0	3	5	0	0	0	0	0	0	0	0	0	4
0	4		0	0	0	0	0	0	0	0	0	0	0	0	3
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
5	0	0	0	0	3	0	0	0	0	0	0	0	0	0	4
0	3	0	0	0	5	0	0	0	0	0	0	0	0	0	5
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
0	3	0	0	3	5	0	0	0	0	0	0	0	0	0	5
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Threats: Scale of Threat													
Drainage	Eutrophication	Fire	Flow Reduction	Grazing	Invasive Species	Reclamation	Recreation	Development	Roading	Rubbish	Sediment	Sewage	Toxic Substances	Wastewater
0	3	0	2	0	3	0	0	3	0	4	2	0	3	0
3	5	0	0	5	3	3	0	0	0	1	0	0	3	0
0	0	0	0	0	3	0	0	0	0	0	0	0	3	0
0	2	0	0	3	3	0	0	0	0	0	0	0	0	0
0	4	0	2	0	3	0	0	0	0	4	0	0	0	0
0	4	0	0	3	0	0	0	4	0	1	2	0	2	0
0	0	0	0	0	4	0	0	0	0	0	0	0	2	0
0	3	0	0	0	5	0	0	0	0	0	0	0	0	0
0	3	0	0	0	5	0	0	0	0	0	0	0	0	0
3	3	0	0	0	4	0	0	0	0	0	0	0	0	0
0	5	0	0	0	4	0	0	0	0	0	0	0	0	0
0	3	0	0	0	4	0	0	0	0	0	0	0	0	0
0	3	0	0	0	5	0	0	0	0	0	0	0	0	0
0	2	0	0	0	3	0	0	0	0	0	0	0	2	0
0	4	0	0	0	5	0	0	0	0	0	0	0	0	0
0	3	0	0	0	3	0	0	0	0	0	0	0	0	0
0	4	0	0	0	3	0	0	0	0	0	0	0	4	0
0	5	0	0	0	5	0	0	0	0	0	0	0	0	0
0	4	0	0	0	3	0	0	0	0	0	0	0	0	0
2	3	0	2	0	3	0	0	0	0	0	0	0	0	0
3	0	0	0	3	0	0	0	0	0	0	0	0	3	0
3	0	0	0	0	4	0	0	0	0	0	0	0	0	0
4	0	0	0	4	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	3	0	0	0	3	0	0	0	0	0	0	0	0	0
3	0	0	0	0	3	0	0	0	0	1	0	0	2	0
4	0	0	0	5	0	0	0	0	0	0	0	0	5	0

Water			Soil Attributes		Terrestrial Vegetation		
Temperature	Temp Score	Bank Stability	Pugging	Total	Width of Buffer Zones	Bank Vegetation	Total
Celsisus	5	5	5	10	5	10	15
11	5	4	5	9	1	8.3	9.3
12	5	4	5	9	1	4.1	5.1
14	5	5	4	9	1	7	8
13	5	5	5	10	1	6.75	7.75
10	5	4	5	9	1	7.5	8.5
18	4	4	5	9	1	6.3	7.3
12	5	5	5	10	1	3.14	4.14
11	5	5	5	10	1	7.05	8.05
15	5	5	5	10	4	8.8	12.8
11	5	5	5	10	1	8.86	9.86
13	5	5	5	10	1	3.7	4.7
17	4	5	5	10	1	4.35	5.35
13	5	5	5	10	1	5.25	6.25
15.5	4	5	5	10	4.25	4.35	8.6
14.5	5	5	5	10	1	3.5	4.5
15	4	5	5	10	2.75	8.2	10.95
16	4	5	5	10	2	7.7	9.7
14	5	5	5	10	2.25	7.35	9.6
19	4	4.25	5	9.25	3	7.35	10.35
14	5	5	5	10	2.25	9.1	11.35
17	4	5	5	10	1.25	4.3	5.55
19.5	4	4	3	7	2.25	9.8	12.05
14	5	5	4.5	9.5	4	3.45	7.45
15.5	4	5	5	10	3.75	9.8	13.55
11	5	3.5	4.25	7.75	2	7.8	9.8
13	5	5	5	10	4.75	9.1	13.85
11	5	3.25	3.5	6.75	1	3	4

Aquatic Vegetation	•				Water		Birds	Invertebrates
Cover of Aquatic Vegetation	Attached Algae	Total	Water Clarity	Water Conductivity	pH	Total	Score	Score
5		5	5	5	5	15	5	5
5	3	8	5	4	5	14	4	2
1	1	2	4	3	5	12	3	3
5	3	8	1	1	5	7	3	3
5	4	9	2	1	5	8	4	3
2	1	3	2	1	3	6	3	4
5	4	9	4	2	5	11	5	5
5	4	9	4	3	5	12	3	3
5	4	9	1	3	5	9	4	3
5	4	9	4	3	3	10	4	3
5	4	9	3	3	5	11	2	3
5	3	8	3	1	5	9	4	4
5	3	8	1	2	5	8	4	3
4	3	7	1	3	3	7	3	3
5	5	10	4	3	3	10	3	5
1	3	4	1	2	2	5	4	4
5	3	8	1	1	5	7	5	4
5	3	8	2	2	5	9	3	4
2	1	3	2	2	3	7	4	1
5	2	7	1	2	5	8	3	3
5	5	10	4	1	5	10	3	3
5	5	10	3	2	5	10	5	4
1	5	6	1	2	3	6	3	1
5	5	10	3	2	5	10	2	4
5	5	10	3	2	5	10	5	3
5	5	10	1	3	3	7	2	2.25
5	5	10	1	4	5	10	4	5
5	3	8	1	2	3	6	3	1

	Anthropocentric Effects				
Drainage	Land Use	Stock	Fencing	Total	Grand Total
5	**5**	**5**	**5**	**20**	**80**
4	4	5	1	14	65.3
5	1	1	3	10	49.1
5	1	3	5	14	57
5	1	5	5	16	62.75
3	2	5	5	15	53.5
5	1	3	5	14	64.3
4	5	5	5	19	65.14
2	5	5	5	17	65.05
4	5	5	3	17	70.8
3	5	5	5	18	67.86
4	5	5	5	19	63.7
5	5	5	5	20	62.35
4	5	5	5	19	60.25
5	5	5	5	20	70.6
4	5	5	5	19	55.5
4	5	5	5	19	67.95
4	5	5	5	19	66.7
4	4	1	5	14	53.6
5	5	5	5	20	64.6
3	5	4	3	15	67.35
4	4	3	3	14	62.55
4	5	3	5	17	56.05
4	1	1	1	7	54.95
4	5	5	5	19	74.55
3	3.5	4	1	11.5	55.3
4	5	5	5	19	76.85
2	1	1	1	5	38.75

21.9 Table of Relationships Between Indicators

	Size	Temp (actual)	Bank Stability	Pugging	Buffer Zone	Bank Vegetation	Aquatic Vegetation	Clarity (actual)	Conductivity (a	pH (actual)	Birds	Bugs	Drainage	Land Use	Stock	Fencing
SIZE																
TYPE																
TEMP	0.09															
BANK STABILITY	0.04	0.16														
PUGGING	0.15	-0.12	0.67													
BUFFER ZONE	0.43	0.16	0.427 0.22	0.11												
BANK VEG	0.35	0.11	0.01	-0.04	0.19											
AQUATIC VEG	0.13	-0.02	0.23	0.21	0.25	0.05										
CLARITY	0.03	-0.04	0.16	0.24	0.06	-0.12	0.14									
CONDUCTIVITY	0.574 -0.29	0.13	0.14	-0.11	0.21	0.01	0.07	0.23								
PH	[illegible]	0.35	0.38	0.31	0.23	-0.06	0.36	0.18	0.33							
BIRDS	0.39	0.33	0.25	0.355317761	-0.04	0.09	0.09	0.08	0.08	0.28						
BUGS	0.22	0.14	0.40	[illegible]	0.36	-0.17	0.26	0.18	-0.04	0.41631372	0.24					
DRAINAGE	0.26	[illegible]	0.24	0.467 0.22	0.18	-0.13	-0.05	0.19	0.09	0.45211652	0.23	0.32				
LAND USE	0.01	0.23	0.45	0.25	0.16	0.29	0.09	-0.25	-0.33	-0.06	0.15	0.05	-0.13			
STOCK	0.12	-0.01	0.37	0.46680546	0.08	0.30	0.32	-0.05	0.11	0.06	0.19	0.37	0.03	0.64		
FENCING	0.11	0.33	0.61	0.29	-0.14	0.16	-0.16	-0.12	0.03	0.14	0.25642	0.32	0.333126119	0.365466942	0.46513696	