Prioritisation of Wetlands of the Rangitikei Catchment

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Abstract

This study aimed to prioritise wetlands of the Rangitikei Catchment. The prioritisation will enable the Manawatu-Wanganui Regional Council to apply its limited resources in an effective way to preserve the biodiversity of the wetlands of the catchment.

A process was designed to achieve the project aim. The first step in the process was the establishment of two conservation goals: 1)Maintain species diversity, 2)Eliminate threats within wetlands.

Secondly, the wetlands of the Rangitikei Catchment were surveyed to collect state and pressure information. 25 wetland sites were surveyed using the REWA survey method.

Data collected was then analysed, first using the complementarity programme Sites V1.0. However, complementarity analysis did not achieve a clarified prioritisation of wetland sites because extreme variability was found among sites. In particular, complementarity analysis did not respond well to having two very different conservation goals of pressure and state.

Therefore, 13 prioritisation criteria were employed based on elements of pressure and state. A method was devised to overcome problems of weighting criteria. True scores were converted to adjusted scores of 1 to 4 using the box and whisker division method. This method also allowed for easier replication and manipulation of data as well as clear visual representation, unlike other methods.

A unique prioritisation framework was then devised which allowed multiple criteria (in this study pressure and state) to be assessed simultaneously. The framework also allowed the large amounts of data involved in the prioritisation process to be presented as a single priority ranking. The prioritisation framework is a relatively simple, repeatable and highly adaptable method. The framework does not compromise the contribution of each criterion to the overall value of the wetland.

This resulted in prioritisation of the surveyed wetland sites of the Rangitikei Catchment and allowed achievement of the study's conservation goals. The box and whisker division method and prioritisation framework presented in the study are two unique methods that may be applied in future prioritisation programmes. Both methods provide simple and visual representations of the complex processes involved in the prioritisation of wetland sites and respond to multiple and opposing conservation goals. The nature of the prioritisation framework allows information to be added as it becomes available as well as accommodating the addition and expansion of conservation goals.

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Thank you also to my supervisor Ian Valentine and the staff and students of NRM for making my year interesting.

Most of all I would like to thank my family for their support, patience and inspiration. In recognition of their contribution I would like to name the prioritisation process devised in this study TAPS (The Amaranathan Prioritisation System).

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Introduction

Cover plate 1. Campion Road Pond. Photograph by Usha Amaranathan.

"Where shall I begin, please your Majesty?" she asked. "Begin at the beginning," the King said, gravely, "and go on till you come to the end: then stop."

-Alice's Adventures in Wonderland, Lewis Carroll

1. Introduction

1.1 STATUS OF NEW ZEALAND'S WETLANDS.

A meagre 10% of New Zealand's wetland area remains (Stephenson 1983). 14.4% of freshwater wetlands in New Zealand were lost in just five years (Anderson, Hogarth et al. 1984).

Wetlands are a valuable resource. They provide many benefits, including food and habitat for wildlife, erosion control, flood protection and water quality improvement. They also provide natural resources, recreational and educational opportunities. Wetlands are highly productive natural ecosystems and have been compared to coral reefs and tropical rainforests in the species diversity they support (U.S. Environmental Protection Agency 1999). Ecological benefits include provision of habitat and food for native fish (eg. Mudfish) and wetland birds (eg. Australasian Bittern, North Island Fernbird, Brown Teal). Wetlands are traditional taonga for tangata whenua, valued for their provision of weaving materials, food and medicinal resources.

Wetlands offer flood protection through storage and slow release of water. This buffering function also protects shorelines against erosion (U.S. Environmental Protection Agency 1999). The retention and slow release of water allows wetlands to improve water quality, as nutrients, organic wastes and sediment are retained and naturally processed before reaching open water (U.S. Environmental Protection Agency 1999).

Although wetlands now cover less than two percent of New Zealand's land area, they are home to 22 percent of our bird species and 30 percent of our native freshwater fish (Waikato Regional Council 2002). This highlights their vital role in maintenance of biodiversity. In a study of Tasman District Council's management of wetlands, the Parliamentary Commissioner for the Environment summarised the state of New Zealand's wetlands:

> Most of New Zealand's wetlands have been drained. Of those remaining, many are small, and their natural character and habitat quality have been lost or degraded by partial drainage, pollution, animal grazing and introduced plants. Lowland wetlands are under-represented and most at risk. Drainage and modification of wetlands continues, New Zealand's wetland area is still in decline, and the valuable services that wetlands offer are being lost (Parliamentary Commissioner for the Environment 2001, p.43).

This status summary of New Zealand's wetlands and wetland management shows that there is a compelling need for evaluation and action so that efficient protection and preservation management plans can be developed.

Scientific demonstrations of the significant economic, ecological and sociological benefits of wetlands have drawn attention to their precious value. There is now an increased desire to protect and enhance the functions of wetlands. The signing of the International Convention on Wetlands (Ramsar Convention) (Ramsar, Iran, 1971) focused global attention on the value of wetlands and directed management processes towards preserving and protecting wetlands. New Zealand, as a signatory to the Ramsar Convention is obligated to monitor and promote wise use of all wetlands (Peck 2001b). Additional to New Zealand's obligations under the Ramsar Convention (1971) wetlands have been granted legislative protection by the Resource Management Act 1991 (RMA) (New Zealand Government 1991). The RMA has established wetland preservation as a matter of national importance and under section 6, Regional Councils and all others exercising functions and powers under the RMA must consider the preservation and protection of wetlands when making management decisions.

1.2 PROBLEM STATEMENT

The Manawatu-Wanganui Regional Council has identified some wetlands within its jurisdiction. However its information on those wetlands is not comprehensive or complete. Some of it dates back to 1977. Due to the dynamic changes in land use and management this information cannot be relied on. The council needs comprehensive and complete information in order to develop a management plan to preserve and protect its precious wetlands.

The Manawatu-Wanganui Regional Council has statutory responsibility for the protection of regionally significant natural areas and values. According to the Manawatu-Wanganui Regional Policy Statement (1998) the extent of wetlands within the region is unknown and while few wetland areas remain (mostly located along the coastal strip) many wetland areas have been modified and some wetland types have become particularly scarce. The Regional Policy Statement (1998) also iterates the role wetlands play in the preservation of our indigenous biota and maintenance of national biodiversity.

The Manawatu-Wanganui Regional Council is in the process of updating its database of regional wetland information. An objective technique of prioritising wetlands so that an efficient strategic plan can be developed and implemented is vital to ensure the Council's limited resources for preserving the remaining wetlands are allocated in the best possible manner.

1.3 PROJECT AIM AND OBJECTIVES

1.3.1 Project Aim

- To prioritise wetlands of the Rangitikei Catchment so that the Manawatu-Wanganui Regional Council has an objective basis for strategic management decisions to preserve its remaining wetlands.

1.3.2 Objectives

- To identify wetland sites in the Rangitikei Catchment.
- Collect information on abiotic and biotic elements of sites.
- To develop a set of conservation goals for wetlands of the Rangitikei Catchment.

- Develop a set of prioritisation criteria examining pressures on and state of wetlands.
- To develop an effective prioritisation method for wetlands of the Rangitikei Catchment.
- To assess the achievement of conservation goals.

1.4 STUDY AREA

There are three major catchments in the Manawatu-Wanganui Region: Manawatu, Wanganui and Rangitikei. This study will concentrate on one catchment – the Rangitikei Catchment as this area had not been comprehensively surveyed and it was the Council's desire to focus on the Rangitikei Catchment.

1.4.1 Location and Boundaries

The Rangitikei Catchment is located in the lower the North Island of New Zealand (Fig. 1.1). The catchment reaches the coast to the south-west and from there arches up towards the central North Island.

The boundaries of the study area are illustrated in figure 1.1. The Rangitikei Catchment is located in the south of the North Island of New Zealand (figure 1.1 (inset)). The Catchment runs from the west coast and arches upward into the central North Island. The Rangitikei River runs through the centre of the catchment. The Catchment is bordered by the other catchments of the Manawatu-Wanganui Region (Wanganui Catchment, Manawatu Catchment and Oroua Catchment) and the Hawkes Bay and Waikato Regions to the east and north east respectively

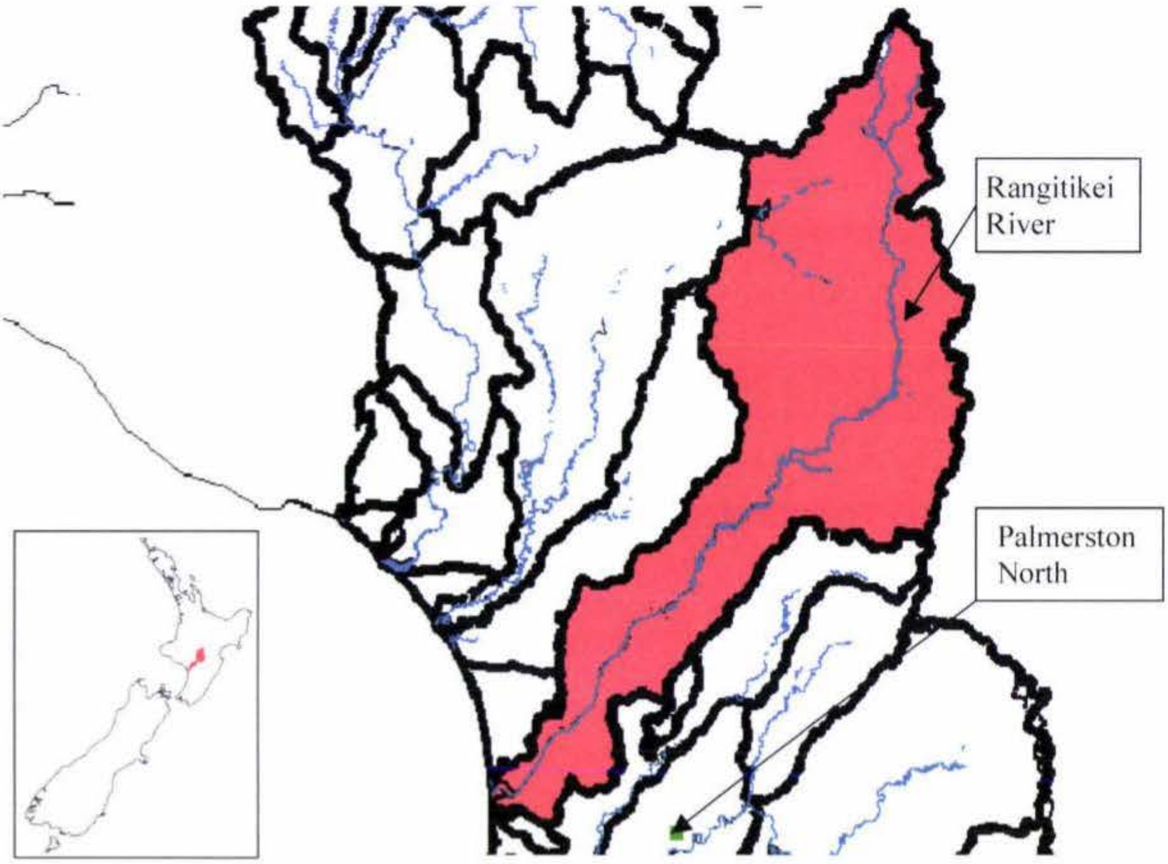

Figure 1.1 The Rangitikei Catchment. Boundaries of the Rangitikei Catchment (catchment shaded in red, rivers shaded blue). Position of Rangitikei Catchment within New Zealand (inset). (maps adapted from Manawatu Wanganui Regional Council 1998, p.13)

1.4.2 Climate

Rainfall in the Rangitikei Catchment is lower than expected in the north as it lies in the rain-shadow of the central volcanoes (New Zealand Meteorological Service 1986). There are distinct temperature differences throughout the Rangitikei and snow falls occur mainly in the north (New Zealand Meteorological Service 1986). Included below is climate information for Palmerston North and Wanganui (table 1.1 and 1.2) – the closest centres to the Rangitikei District for which climate data is available from NIWA (National Institute of Water and Atmospheric Research). The wettest months are May through October (table 1.2). Field surveys were carried out in September and October. This is an ideal time for wetland surveys as they will follow several wet months and will be conducted in wet months also, making the full extent of wetlands more obvious. Surveys at this time are also likely to capture ephemeral wetlands during their inundated stage.

Table 1.1 Summary Climate Information for Wanganui and Palmerston North. Data are mean annual values for the 1971-2000 period. Extreme temperatures are for the full historical record (source National Institute of Water & Atmospheric Research n.d. b).

	Units	PALMERSTON NORTH	WANGANUI
Rainfall	mm	967	882
Wet Days	≥ 1.0 mm	121	115
Sunshine	hours	1733	2043
Mean Temperature	°C	13.3	14
Highest Temperature	°C	33	32.3
Lowest Temperature	°C	-6	-2.3
Ground Frost	days	38	7
Mean Wind Speed	km/h	17	18
Gale Days (Gusts Over 62km/h)	days	1	5

Table 1.2 Mean monthly rainfall (mm) for Palmerston North and Wanganui. Data are mean monthly values for the 1971-2000 period (source National Institute of Water & Atmospheric Research n.d. a).

LOCATION	PALMERSTON NORTH	WANGANUI
JAN	65	62
FEB	62	65
MAR	74	68
APR	76	71
MAY	94	81
JUN	87	82
JUL	94	88
AUG	82	70
SEP	83	72
OCT	90	81
NOV	78	74
DEC	83	70
YEAR	966	882

1.4.3 Landform and Geology

New Zealand's high exposure to physical processes such as storms, earthquakes and ice formation is thought to have contributed to the formation of its wetlands (Cromarty and Scott 1995).

The Rangitikei catchment includes an area of coastal sand dunes, located in an area classified by the Department of Conservation as the Foxton Ecological District (Ravine 1992). The dune system is highly dynamic. Dry sand is constantly blown and shifted, while wet sand is heavier and harder to move. Sand basins and sand plains are, therefore often blown flat down to the water table and will often contain ephemeral wetlands (Ravine 1992). Dune lakes of two types (basin and valley) may also form in these areas. However extensive drainage works have greatly reduced lakes and swamps in the Foxton Ecological District (Ravine 1992). The Foxton Ecological District also contains the Rangitikei River Mouth.

The Rangitikei Ecological Region covers the bulk of the Catchment and contains geology and landforms fairly typical of the entire catchment bar the dune systems of the Foxton Ecological District (Lake and Whaley 1995). The region is made up of rolling hill country and valley systems, greywacke rocks, alluvium deposits and sand and mudstones (Lake and Whaley 1995). Shaped by its hydrology, the Rangitikei Region is home to numerous rivers and streams (Lake and Whaley 1995). Slumps are considered common in the Rangitikei catchment and some slumps may have lead to the formation of swamps via the damming of waterways (Lake and Whaley 1995).

Chapter 2

Literature Review

Cover plate 2. Marton Dam. Photograph by Usha Amaranathan.

"Sometimes I've believed as many as six impossible things before breakfast."

- Lewis Carroll

2. Literature Review

2.1 DEFINING WETLANDS.

'Wetland' is a term that is used often but remains poorly understood. The definition of wetlands is difficult due largely to the fact that wetlands are transitional zones with unclear boundaries. Many authorities and organisations have attempted to define wetlands, however there is no internationally agreed terms of reference (Frost, 1992). Below are just some of the definitions currently used nationally and internationally.

2.1.1 International Definitions.

Ramsar: "Areas of marsh, fen, peatland 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" (Peck 2001a, para. 2).

U.S. Environmental Protection Agency: "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas." (U.S. Environmental Protection Agency 2003, para.2)

2.1.2 National Definitions.

Ministry for the Environment: "Wetlands are areas of shallow water containing specially adapted plant and animal communities. They occur on land-water margins, or on land that is temporarily or permanently wet."(Smith, 1997 p.7.23)

The Regional Policy Statement for Manawatu-Wanganui: "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" (Manawatu Wanganui Regional Council 1998, p.320) this is also the definition used in the Resource Management Act 1991.

New Zealand Wetlands Management Policy, 1986: "A collective term for permanently or intermittently wet land, 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." (Commission for the Environment1986)

There are, therefore, several components often considered important in the formation of a complete definition of wetlands:

- Land-water interface. Perhaps the most important factor to mention in a definition is the wetlands function as a land-water interface. Wetlands do not simply include open water. Land-water margins are integral to the differentiation of wetlands from other water bodies.

- Flora and fauna. The plants and animals of a wetland are highly specialised, thus plants and animals are a good indicator of whether a site is a wetland or not. In order to use the statement that a wetland is characterised by its plants and animals in the definition of a wetland, it must be well understood what constitutes a wetland species. This component of the definition is generally absent from international definitions but is used in all New Zealand examples.
- Water depth. The requirement that wetland areas shall not exceed six metres is generally omitted from New Zealand definitions as this specification is based on Northern Hemisphere tidal ranges (Task Group, 1983 cited in Frost, 1992).
- Chemical parameters: may be excluded in the definition if it is assumed that wetlands may include any chemical type of water (fresh, brackish or saline)

The definition used in this report is a synthesis of the above definitions, which takes into account the points mentioned above. This produces a relatively succinct definition that is practicably applicable. This is also the definition used in the RMA and by the Manawatu-Wanganui Regional Council (1998):

> *"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"*

2.2 CLASSIFICATION.

In the Review Of Wetland Inventory Information in Oceania (Watkins n.d) it is recommended that the wetland classification system used by Ramsar (1971) be used when conducting wetland inventories so that wetland information is standardised to enable nationwide and global assessment of wetland resources. The Ramsar classification system identifies 42 wetland types: 10 man-made, 12 marine/coastal and 20 inland wetland types. However many of the wetland classes identified in the Ramsar system do not apply to New Zealand wetlands.

Classification systems developed for New Zealand were investigated for this report. The Manawatu-Wanganui Regional developed a classification system to be used to classify wetlands in the specific region on which this study is focused.

A fusion of the Ramsar classification system and a New Zealand classification system employed by the Manawatu Wanganui Regional Council was attempted in order to provide some level of standardisation but the two systems were very different. The New Zealand system was, in some ways, more general and often combined several Ramsar types into one. Other types were divided to a finer level in the New Zealand system. Thus the two systems were too different and this synthesis was abandoned. Although the Ramsar classification may be preferable due to its universality, the New Zealand system was developed specifically for New Zealand wetlands and is therefore superior for the purposes of this report and will be used throughout this document (see Appendix 1: Wetland Classification).

2.3 POLICY, LEGISLATION, RULES AND REGULATIONS.

The following section outlines those parties with statutory powers and obligations as well as non-governmental organisations, which have an interest in and may actively pursue wetland protection. The relevant legislation is also covered, providing an understanding of the various forms of protection wetlands may be granted, what this means and who is responsible for the management of such wetlands.

2.3.1 The Convention on Wetlands of International Importance Especially as Waterfowl Habitat (The Ramsar Convention).

The Ramsar Convention 1971 is an intergovernmental treaty adopted on the 2nd of February 1971 in the Iranian City of Ramsar. The original emphasis of the Convention was the conservation and wise use of wetlands, primarily to provide habitat for waterbirds. However, the Convention has broadened its scope to cover all aspects of wetland conservation and wise use.

The Convention entered into force in 1975 and New Zealand became a contracting party in 1976. New Zealand has 5 Ramsar sites (sites designated for the List of Wetlands of International Importance) covering an area of 38,868 hectares (Peck 2002). The 5 listed wetlands are:

- Farewell Spit, Nelson - 11,388 hectares.
- The Firth of Thames Tidal estuary, Waikato - 5,690 hectares.
- Kopuatai Peat dome, Waikato - 9,665 hectares.
- Waituna Wetlands Scientific Reserve, Southland - 3,556 hectares.
- Whangamarino Wetlands, Waikato - 5,690 hectares.

A Ramsar listing obligates the contracting party to ensure the maintenance of the ecological character of the site. The listing will not guarantee a site protection, however being listed as a wetland of international importance is likely to add weight to the importance of preserving such a site when management decisions are made.

2.3.2 Policy and Legislation.

This list is by no means complete but includes those documents of greatest relevance to and impact on wetlands.

2.3.2.1 Resource Management Act 1991 (RMA).

The purpose of the RMA is to promote the sustainable management of natural and physical resources. The RMA provides guidelines and regulations for the management of our environment.

Wetlands are identified in the Act as matters of national importance (section 2.6) and must therefore be addressed in local authority plans and policies. The Act also provides protection for wetlands by allowing protection under water conservation orders and by addressing wetlands under "Other Matters" whereby the intrinsic value of ecosystems must be protected.

2.3.2.2 New Zealand Wetlands Management Policy, 1986.

The wetlands policy identifies a need for immediate and continuing action in order to protect New Zealand's wetlands. The policy also states that the government must act as an advocate for wetland preservation and has an important role in wetland management promoting research and fostering awareness of wetland values (Commission for the Environment1986). The policy has three major objectives:

- Preservation and Protection.
- Wetlands Inventory.
- Public Awareness.

The policy was developed prior to the establishment of the Department of Conservation (1987). The policy anticipated DoC becoming the primary advocate for wetland protection and using the policy in combination with WERI (the national wetlands inventory) to "foster the sensitive management of remaining wetlands (Commission for the Environment1986, p.1). However, the Department of Conservation believes that this document is becoming outdated and a review of this policy is expected (Parliamentary Commissioner for the Environment 2001).

2.3.2.3 Water Conservation Orders.

Water conservation orders are designed to protect water bodies. A water body is "fresh or geothermal water in a lake, river, wetland, stream, pond, aquifer or any part thereof that is not located within the coastal marine area" (Preston 1998a, p.52). A water conservation order may place restrictions on several aspects of a water body such as water quality and quantity and flow levels. Anyone can make an application for a water order. Applications are made to the Minister for the Environment.

A water conservation order alone cannot protect a wetland. The water conservation order will only protect water. Other measures must be taken to protect other parts of a wetland ecosystem eg. Plants, animals, soil.

Within the Manawatu-Wanganui Region there are 3 existing national water conservation orders: for the Manganuioteao River and its main tributaries and the upper catchment of the Rangitikei river (Preston 1998a).

2.3.2.4 Heritage Orders.

These are provisions made in local authority District Plans designed to protect historic and cultural sites. A heritage order may protect a wetland where a water conservation order cannot.

2.3.2.5 The Queen Elizabeth II National Trust Act.

The National Trust was established under the Queen Elizabeth the Second National Trust Act 1977 and is designed to "encourage and promote the provision, protection and enhancement of open space for the benefit and enjoyment of the people of New Zealand" (Queen Elizabeth the Second National Trust n.d., para.1).

The National Trust works with governmental organizations and private landowners to protect land. A private landowner may sell or gift land to the crown or a local authority or they may choose to retain ownership. Ownership may be maintained while placing the land under protection by the use of a Queen Elizabeth II National Trust Open Space Covenant - a legal agreement between the National Trust and a landowner to protect a special open space feature (usually) in perpetuity (Queen Elizabeth the Second National Trust, n.d.). The covenant places certain restrictions on activities that may occur on the site and the National Trust will visit the site annually to discuss management of the site with the landowner. Currently over 1,450 covenants exist, protecting over 54,500 hectares of open space, including many wetlands (Queen Elizabeth the Second National Trust, n.d.).

2.4 GROUPS AND ORGANISATIONS INVOLVED IN WETLAND MANAGEMENT.

2.4.1 Local Authorities (city, district and regional councils).

"Have direct responsibility for the day to day management of resources by ensuring resource users avoid, remedy or mitigate the environmental effects from the use, distribution and development of natural and physical resources." (Preston 1998b, p.6).

Local authorities function under the Local Government Act 1974.

2.4.1.1 Regional Councils.

The powers of regional councils were established under the Local Government Act 1974 but their primary resource management functions are defined under the RMA (Preston 1998b). Regional councils are responsible for the management and protection of physical and natural resources at a regional level.

With regard to wetlands a regional council's responsibilities include:

- Coastal issues. Coastal issues are administered by a regional coastal plan. Regional councils may grant coastal permits. However permits for restricted coastal activities are granted by the Minister of Conservation (Preston 1998b).
- Water and soil management. This includes responsibility for monitoring water quality. The regional council is also responsible for consent of activities likely to affect the water in or near a wetland.

2.4.1.2 Regional Policy Statements.

Regional councils are required under the RMA to prepare policy statements in order to achieve the purpose of the RMA i.e. to promote the sustainable management of natural and physical resources.

2.4.1.3 Manawatu-Wanganui Regional Council.

The key functions of the Regional Council include:

- Natural resource management
- River and drainage engineering
- Land management duties
- Land transport
- Emergency response and civil defence management
-

There are 7 territorial authorities within the Manawatu-Wanganui region. One of these is the Rangitikei District (there are also 3 districts which are partly within the Manawatu-Wanganui Regional Council's boundaries). The Manawatu-Wanganui Regional Council has issued a Regional Policy Statement (Manawatu Wanganui Regional Council 1998) that outlines policies for the management of wetlands and other natural resources.

2.4.1.4 District Councils.

District Councils are responsible for management of land and buildings within their boundaries. The key functions of District Councils are: water supply, sewage and stormwater, waste management, cultural facilities and community services, recreation and leisure, building permits and licensing, community development, economic development and tourism, district planning, roading and carparks, district Civil Defence and the resource consent process (Preston 1998b).

2.4.2 Government Agencies.

2.4.2.1 The Department of Conservation (DoC).

The Department of Conservation is a governmental organization established under the Conservation Act 1987. The departments' mission is "to conserve New Zealand's natural and historic heritage for all to enjoy now and in the future" (Department of Conservation 2002a, para. 2).

DoC designed the National Wetlands Policy for use in combination with the WERI (Wetlands of Ecological and Representative Importance) Database. WERI contains around 3,000 wetlands (Department of Conservation, 2002b). However, it is believed that this database is incomplete (Smith, 1997)

DoC manages wetlands that occur on land administered by the department. The department serves as an advocate for constructive management of wetlands located on private land (Department of Conservation, 1996)

The Department of Conservation is also the administrative authority for the Ramsar Convention 1971 in New Zealand and the manager of most of New Zealand's' Ramsar wetlands of international importance. The Department works closely with Fish and Game in wetland management (Department of Conservation, 2002b).

2.4.2.2 Ministry of Fisheries (Mfish).

The Ministry of Fisheries is responsible for the sustainable utilisation of fisheries. This involves conserving, using, enhancing and developing New Zealand's fisheries resources (Ministry of Fisheries 2002). Mfish is involved in management of fisheries resources including species that reside in wetlands such as eels.

2.4.2.3 Ministry for the Environment (MfE).

The MfE provides advice to the Government on environmental management. The Ministry is responsible for State of the Environment reporting and provides advice on governmental policy and legislation related to the environment, liasing with local government, resource users, resource managers, and others in order to provide information and advice.

2.4.2.4 Fish and Game Councils.

The primary role of the Fish and Game Councils is management of freshwater sportsfish fishing and gamebird hunting (Fish and Game New Zealand 2000a). Fish and Game Councils have purchased areas of wetland throughout New Zealand and continue to stress the importance of wetland conservation to its members. Fish and Game Councils have a strong role in the World Wetlands Day, a day devoted to increasing awareness and celebrating wetlands. They describe themselves as the "lead agency" (Fish and Game New Zealand 2000b, para. 1)

2.4.3 Conservation Organisations.

2.4.3.1 The Royal Forest and Bird Protection Society of New Zealand.

Forest and Bird is a non-governmental organization whose mission is to preserve and protect the native plants and animals and natural features of New Zealand (Royal Forest and Bird Protection Society of New Zealand 2001). One of the primary issues on which Forest and Bird focuses is wetland protection. Forest and Bird is involved in advocacy and lobbying and relies upon its 40,000 members across more than 50 branches, donations and bequests to fund its work (Royal Forest and Bird Protection Society of New Zealand 2001).

2.4.3.2 Ducks Unlimited.

Ducks Unlimited is a non-profit organization dedicated to the conservation and sustainable use of New Zealand's' wetlands. This is achieved through (Ducks Unlimited New Zealand 2002):

- Wetland restoration and development
- Conservation programmes for threatened waterfowl
- Advocacy and education of wetland values

2.5 BIODIVERSITY

Wetlands are a great source of biodiversity. As mentioned in the previous chapter, wetlands are home to 22 percent of our bird species and 30 percent of our native freshwater fish (Waikato Regional Council 2002). However biodiversity is notoriously difficult to define and the question is often asked: why protect biodiversity? The following is an attempt to explains the concept of biodiversity and its relationship to wetland management.

2.5.1 What is Biodiversity?

The terms biological diversity and biodiversity are interchangeable. The words biological diversity have simply been combined and contracted to biodiversity, which has become more frequently used as the issue has risen in profile.

The Convention on Biological Diversity defines biological diversity as "the variability among living organisms from all sources including, *inter alia,* terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems" (Secretariat of the Convention on Biological Diversity n.d., para.2)

The New Zealand Biodiversity Strategy also follows the definition proposed by the Convention on Biological Diversity. One of the strongest criticisms regarding the New Zealand Biodiversity Strategy is that it fails to differentiate between biodiversity and indigenous biodiversity, despite being designed to halt the decline of New Zealand's indigenous biodiversity (New Zealand Central Government Coordinating Group for Biodiversity 2002). This is an important point as although New Zealand's indigenous biodiversity is declining, overall, biodiversity as defined by the Biodiversity Strategy is increasing. The influx of weeds, crop plants, farmed animals and pests has boosted the species count dramatically. In order to effectively convey the sentiments of the Biodiversity Strategy the differentiation between native and overall biodiversity must be made. This will involve a small change in terms of semantics but will convey more correctly the intended meaning of biodiversity in this context:

Biodiversity: the variability among living ***indigenous*** *organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems.*

For this report the above definition of biodiversity is preferred as it is closer to the intended implication of the term biodiversity in that it does not include all living organisms. However, for the purposes of this report, all organisms not considered weeds or pests but benign or beneficial non-indigenous organisms, will be treated as contributing to biodiversity.

2.5.2 Why Protect Biodiversity?

Recent reports such as New Zealand's State of the Environment Report (Smith, 1997) have highlighted the decline in New Zealand's biodiversity. New Zealand's past isolation and high proportion of endemics have created a fragile system, which, now that New Zealand is no longer isolated from global influences and influxes, is at high risk. Many of New Zealand's native bird and reptile species, due to evolution in the absence of mammalian predators, have succumbed in recent times to predators such as stoats. Our native plants are also at risk due to introduced pests such as possums, which consume over 20,000 tonnes of vegetation every night (Smith, 1997).

While it is well understood that many native species are threatened or even extinct, the effect of these losses is less well understood. What is the value of biodiversity? The following points are derived from the New Zealand Biodiversity Strategy (New Zealand Central Government Coordinating Group for Biodiversity 2002).

- The uniqueness of much of New Zealand's indigenous biodiversity means that responsibility for its continued existence is entirely ours; it cannot be conserved in nature elsewhere in the world.
- We base much of our economy on the use of biological resources, and benefit from the services provided by healthy ecosystems. These 'ecosystem services' include producing raw materials (principally food from the sea and fibre from the land), purifying water, decomposing wastes, cycling nutrients, creating and maintaining soils, providing pollination and pest control, and regulating local and global climates.
- Aside from the biological resources we use now, New Zealand's biodiversity represents a pool of untapped opportunities. Scientists believe that most of these have not yet been discovered.

- A 1997 study by economists suggested that the total annual value provided by New Zealand's indigenous biodiversity could be more than twice that of New Zealand's gross domestic product (GDP). The annual value of indigenous biodiversity on land in 1994 was estimated at $46 billion (Patterson and Cole, 1999 cited in New Zealand Central Government Coordinating Group for Biodiversity n. d, para.9).
- In addition to our productive systems being underpinned by healthy ecosystems, our 'clean and green' environment is a major selling point in itself and will reap increasing rewards in the 21st century.
- To many people biodiversity has intrinsic value — the value of the variety of life in itself. The responsibility of humans towards other living things and our obligations to future generations provide a strong moral basis for their conservation and underly the requirements in the Convention on Biological Diversity.

2.5.3 How do we go About Protecting and Enhancing Biodiversity?

There are several documents that require New Zealand to protect biodiversity; this includes the RMA, The Convention on Biological Diversity and the New Zealand Biodiversity Strategy.

The RMA includes several provisions designed to protect biodiversity, all in Part II. These include sections 5, 6(a), 6(b), 6(c) and 7(d). Section 5 centres around the principle of sustainable management of natural resources. Sustainable management by definition will involve preservation of biodiversity – the loss of species is not a sustainable process. Section 6 'Matters of National Importance', subsections a, b, and c, involve the preservation and protection of species and environs. Wetlands are specifically mentioned in this section.

The Convention on Biological Diversity (CBD) was negotiated under the auspices of the United Nations Environment Programme (UNEP). New Zealand ratified the Convention in 1993, one year after its conception. There are three goals of the CBD (Secretariat of the Convention on Biological Diversity n.d.):

- To promote the conservation of biodiversity,
- Sustainable use of the components of biodiversity
- Fair and equitable sharing of benefits arising out of the utilisation of genetic resources.

The New Zealand Biodiversity Strategy has been mentioned several times in this section. It is the most recent of the three documents described here and is designed to achieve the goals of the RMA and the Convention on Biological Diversity. "The purpose of the strategy is to establish a strategic framework for action, to conserve and sustainably use and manage New Zealand's biodiversity." (New Zealand Central Government Coordinating Group for Biodiversity 2002, para.2).

The advice and requirements of these documents provide managers with methods for the preservation of our biodiversity. Initiatives carried out by local authorities and other government authorities are based largely on the achievement of the goals of these three documents and accompanying legislation. Such legislation includes: the Convention in International Trade in Endangered Species of Wild Fauna and Flora (CITES), Convention of the Conservation of Migratory Species of Wild Animals (CMS) and the Ramsar Convention 1971.

2.6 DATABASES AND INFORMATION CURRENTLY AVAILABLE ON THE WETLANDS OF THE RANGITIKEI CATCHMENT.

As described in section 2.4, there are many authorities and organisations with an interest in wetland management. Many of these organisations are required to at least attempt to manage wetlands within their jurisdiction. This involves an awareness of wetland sites. For this reason various authorities and organisations have attempted inventories of the wetlands of the Rangitikei. However, none are complete.

So a complete an up to date inventory of wetlands of the Rangitikei Catchment is an essential step in prioritising them. Prior to undertaking new inventory work a review must be conducted in order to establish the extent and validity of information already acquired. Some information dates back to early last century so it is not considered reliable today. Information contained within these databases may also have been garnered from hearsay. A review and confirmation of all information may be necessary before it is acceptable to include it in a formal inventory of sites.

All known inventories have been collated. All sites previously registered will be reinvestigated and new sites will be noted and surveyed. Thus a combined and complete inventory will be formed.

Sources of information for the updated inventory include Department of Conservation Protected Natural Areas Programme sites (including Recommended Areas for Protection (RAP)), WERI sites, SSWI sites, Threatened Plant Sites, Fish and Game Sites and Manawatu-Wanganui Regional Council databases. These sites are accompanied by information of varying quantity and quality and, as mentioned above, were last surveyed on dates sometimes dating back several decades.

There are very obvious gaps in previous inventories and it is therefore necessary for additional and repeat surveys of wetland sites.

2.7 POSSIBLE SURVEY METHODS.

The application of a wetland survey will provide the bulk of the information required to carry out the prioritisation of the wetlands of the Rangitikei catchment. It is therefore vital that the survey design is sound. The survey also needs to be repeatable so that future assessment of wetland changes can be recorded and the prioritisation status updated. It is important that the survey is designed to obtain the best biodiversity data in order to derive quality information for sound decision processes.

There are several existing wetland inventories in New Zealand. An ecological survey has been undertaken as part of some of these inventories. The methods are reviewed here along with some newly developed methods and a method designed by the American Environmental Protection Agency (EPA).

2.7.1 Protected Natural Areas Programme (PNAP) Survey.

The PNAP survey has been used extensively in the field throughout New Zealand.

The steps involved in a PNAP survey are as follows (Myers, Park et al. 1987):

1. Reconnaissance and field survey
   - Compile and understand ecological information.
   - Develop a field understanding of natural ecosystems of the district.
   - Select study areas.
2. Survey
   - Survey the selected study areas
   - Inform local people about initial survey results and impressions
3. Local analysis and evaluation

- Prepare a list of ecological units and other significant biological values
- Define a set of representative natural areas and assess their ecological and conservation values.
- Compile a summary report of the survey

4. Publication
5. Implementation

The PNAP survey method is based on a framework of increasingly detailed units from Ecological Districts, Ecological Regions and Bioclimatic Zones at the broader end of the continuum to Hydrologic Classes, Land Systems and Vegetation in the mid range of the continuum, down to Special Biological Features of Ecological Significance at the finest level.

Within an ecological district the features present may be divided into ecological classes and ecological units (Fig. 2.1.)

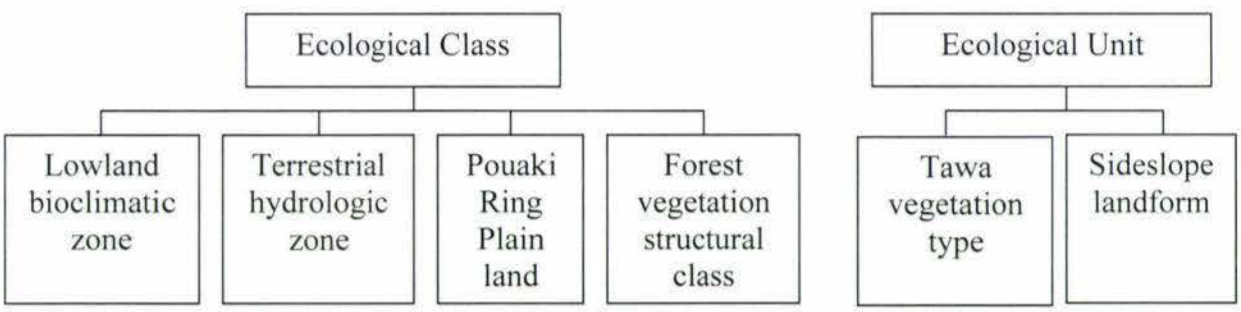

Figure 2.1. Example of the division of ecological classes and units (source Myers, Park et al. 1987, p.10).

Vegetation sampling techniques are based on methods developed by Druce (1959) and Atkinson (1962, 1985). Other units are designed by the Department of Conservation.

As the protected natural areas programme is designed to protect representative examples across ecological sites it is a less specific survey design. However this problem has been addressed in the survey design to some extent by allowing a degree of flexibility within the prescribed technique (Myers, Park et al. 1987). The PNAP surveying technique is a simple sampling method that may be implemented with limited resources and semiskilled personnel (Myers, Park et al. 1987). However, this technique will not provide the level of detail required for the prioritisation of wetlands as it will not provide specific information on every species found at a site or enough detail on the nature and extent of threats.

2.7.2 Wetlands of Ecological and Representative Importance (WERI).

The WERI inventory was designed and conducted by the Department of Conservation. Unlike the previous survey method (PNAP), the WERI survey method is designed specifically for wetlands.

A WERI information sheet contains information such as: tenure, classification, quality (modifiers, immediate threats, buffers), values (wildlife, threatened plant species, ecological character, recreation, educational, historical and landscape) and significance. However the WERI information sheet does not include any detailed information on the range and abundance of species present at a site – this information will be essential for the prioritisation process. Due to the goal of protecting biodiversity, information on all species present at a site is required.

2.7.3 Wellington Fish and Game – Wetlands of the Manawatu Plains.

This is one of a series of surveys carried out in the Wellington Fish and Game Region in order to establish the distribution, magnitude, type and general condition of wetlands (Benn, 1997). This survey was designed to provide information of importance to waterfowl habitat research and resource management purposes (Benn, 1997).

Benn's methodology is based on analysis of aerial photographs and topographic maps. Information gathered is backed up by field surveys. However only a few sample areas were analysed beyond simply locating them. Identification of potential threats to wetlands was based on visual analysis of maps and photographs.

Benn (1997) identifies several sources of error in his methodology, including distortion of aerial photographs, age of data (some dating back more than 30 years prior to the compilation of Benn's report), human elements, financial and temporal constraints which prevented use of computer mapping and satellite imagery analysis.

While Benn's report gives a simple overview of wetlands in his study area, it is a sample. Most sites were identified from photographs and maps. This method may be appropriate for preliminary reports to Fish and Game but it will not yield information to the level of resolution required for the purposes of this study.

2.7.4 Coordinated Monitoring of New Zealand Wetlands: A Ministry for the Environment Sustainable Management Fund (SMF) Funded Project.

The Coordinated Monitoring of New Zealand Wetlands project is aimed at developing a nationally consistent methodology for mapping and monitoring New Zealand's wetlands. The project is divided into two Sustainable Management Fund (SMF) funded phases (Ward and Lambie 1999).

Included within the outputs of phase one are practical tools and guidelines for wetland managers in New Zealand. These tools and guidelines are the basis for effective and coordinated wetlands inventory, monitoring and management, using spatial extent as an indicator of the state of New Zealand's wetlands (Ward and Lambie 1999). Phase one is now complete

It is anticipated that Phase Two of the Wetlands Project will focus on providing indicators and tools for monitoring wetland condition (Ward and Lambie 1999). The indicators will include science based indicators and Matauranga Maori based indicators for wetland condition and trend (Ward and Lambie 1999).

The project is not complete and cannot therefore be used for this study. However, it is important to include information on this project, as it appears to be the largest effort applied (in New Zealand) thus far to developing wetland survey techniques. This project also aims to produce handbooks and guidelines for its techniques, which may provide incentive for The Coordinated Monitoring of New Zealand Wetlands methodology to be adopted as a nationwide assessment method.

The Coordinated Monitoring of New Zealand Wetlands may soon become a highly useful technique and, although not available for use in this study, should be considered in the future by wetland managers.

2.7.5 U.S Environmental Protection Agency Methods for Evaluating Wetland Condition.

The U.S Environmental Protection Agency (EPA) has designed methods for the assessment of wetland health. The EPA techniques involve monitoring biological and nutrient conditions of wetlands.

EPA Biological assessments are based on surveys of the diversity, composition, and functional organization of the community of resident wetland biota including macroinvertebrates, plants, amphibians, birds, and algae. Biological assessments can also be used to help evaluate the performance of restoration, best management practices (eg. buffer strips), and other conservation actions (U.S. Environmental Protection Agency 1999).

The effects of nutrients on a wetland are assessed using ecological and biogeochemical parameters including landscape characterisation, nutrient load estimation, hydrology, and analyses of soil, algae, vegetation, and water quality.

While the sampling methods for both biological and nutrient data may be relatively simple, the analytical techniques involved are time consuming, often expensive and require a moderate level of expertise.

The EPA methodology is designed to provide more of a guideline than a hard and fast set of rules for wetland assessment. It is expected that each state or tribe will develop the methodology, for use in a specific region. Consequently the assessment regimes of many states are still in the development phase.

The EPA methodology would require significant development in order to make it workable in New Zealand conditions. Further, the EPA method could potentially be very costly in terms of both time and analysis costs. The techniques described by the EPA are not so much a methodology but guidelines for the development of a methodology.

2.7.6 Development of a New Method.

An alternative to the methods detailed above is the design of a new method. This study rejects that option for two reasons:

1. Time constraints of this study will not allow for the development and testing of a new method.
2. The development by the Manawatu-Wanganui Regional Council of the Rapid Ecological Wetland Assessment – a methodology designed specifically for wetlands in the Manawatu-Wanganui Region. The reasons for selecting this method are discussed in section 3.7. This specific methodology is described in Chapter 3.

2.8 PRIORITISATION OF NATURAL AREAS.

Investigations into prioritisation techniques for natural areas have featured in the literature over the previous two decades. However the debate over the ideal technique continues and articles are regularly published extolling new and improved techniques.

Articles reviewed as part of this study covers a period of 20 years. These articles describe a variety of techniques, ranging in complexity as well as scope and applied in a range of environments.

This section will examine the various techniques and consider their pitfalls and advantages. The knowledge gained will allow the formulation or adoption of a technique best suited to wetlands, structure the nature of the information to be gathered from wetland sites and set the goals for this specific prioritisation process.

2.8.1 Scoring Techniques and Hot Spots.

A method often used in early research and used recently by Llewellyn, Shaffer et al (1996) and Prendergast, Quin et al (1993) involves collection of ecological data, weighting of attributes and ordering of sites based on scores received for each attribute considered important by the author.

Goldsmith (1987) in Nova Scotia, Canada used the scoring technique. The author established 5 criteria including number of species and area of site. The criteria were then quantified and ranked and a list of prioritised sites established. This is quite a simple method and the resulting priorities may be, for example, the five sites with the most species (richness hotspots). Goldsmith (1987) does compare the number of species protected by each different criterion in order to establish which criterion will yield the best result. However the author is forced to concede that the strategy is flawed.

This method makes the addition of new sites very simple, as they are simply inserted into the ranking. Scoring procedures also allow easy integration of a range of factors such as biological, social and economic concerns (Rodrigues, Gaston et al. 2000). However the potential replication or exclusion of biological units is considered a major drawback of this method (Kirkpatrick 1983), (Rodrigues, Gaston et al. 2000), (Prendergast, Quin et al. 1993). A site may be included in a reserve network based on the presence of attributes considered important. However previously selected sites may also contain these attributes so resources may be awarded to these attributes several times over while other attributes, due to lower rankings, are not protected at all. For this reason the use of hotspots appears to have decreased in popularity.

2.8.2 Iterative Methods and Complementarity Analysis.

An iterative method is a repetitive process. A formula is applied which is designed to select sites containing conservation elements, which have been allocated high weightings or preservation levels. Other factors such as cost of inclusion in the preservation portfolio may also be included. The formula, weightings and preservation levels are ascribed according to the goals of the study. A site is then selected by the formula. This site and the elements within it are considered protected. Next, a second site is selected, taking into account the fact that some elements are already protected and some preservation levels may or may not have been met. This process continues until the goals of the exercise are achieved: (usually) all conservation elements are contained within the portfolio.

Kirkpartrick (1983) explored the use of an iterative method for establishing priorities in Tasmania. Iterative methods are believed to reduce the problem of duplication while maximising the chances of representation (Reyers, Jaarsvelf et al. 1999), (Rodrigues, Gaston et al. 2000), (Kirkpatrick 1983).

Kirkpatrick (1983, p.131) claims that the iterative method "provides for maximum conservation values per unit area preserved" a highly desirable attribute as the prioritisation process is generally employed when resources for protection are limited. Adaptations and extensions of this method have been used throughout the 1990's and continue to present day (Rodrigues, Gaston et al. 2000), (Kreman, Razafimahatratra et al. 1999), (Kershaw, Mace et al. 1995), (Beck and Odeya, 2001), (Polasky, Camm et al. 1999), (Araujo 1999), (Howard, Davenport et al. 2000).

Turpie (1995) agrees that iterative methods are more efficient than scoring techniques. Turpie (1995) conducted an analysis using waterbirds in South African estuaries testing scoring techniques (both single criterion and multiple criteria methods) and complementarity analysis (complementarity analysis is an iterative technique designed to identify sites that will preserve the greatest diversity). Turpie (1995) used presence/absence data to perform a complementarity analysis, which will select the minimum number of sites in which all species will appear at least once. However Turpie (1995) warns that there is a danger of assuming a species is conserved when the site or abundance of the species is inadequate to ensure survivals of the species. To avoid this problem abundance was also taken into account in the analysis. While Turpie (1995) concludes that iterative methods are more efficient the author also notes that scoring systems may provide valuable guidance. Therefore this study concludes that it is wise to include both approaches in a prioritisation exercise.

Araujo (1999) compared the quality of results yielded by various techniques including hotspots (of rarity and richness), random selection of areas and complementarity. Araujo (1999) concluded that complementarity was again the best method and in this case hotspots were in fact no better than selecting areas at random. Iterative methods have become the most popular approach for reserve selection

2.8.3 Selection Criteria.

A range of criteria may be used in any type of prioritisation exercise whether it uses scoring or iterative techniques. Which criteria are the most appropriate for use in prioritisation analyses is another point of debate among researchers. However, most authors seem to agree that before the criteria are decided upon researchers must have a clear understanding of the goals of the exercise, as this will dictate the nature of the selection criteria (Kershaw, Mace et al. 1995), (Turpie, 1995).

Criteria may fall under three broad headings; biological, social and economic. Examples of biological criteria may include presence/absence data on all species or for indicator species (Howard, Davenport et al. 2000), rarity and richness. Other criteria may include land use conflicts (Howard, Davenport et al. 2000) and present protection status.

Presence/absence data are commonly used for complementarity approaches. Polasky, Camm et al (2000) points out that this data is generally incomplete but currently there are no methods which adequately compensate for this.

Several authors, including Howard, Davenport et al (2000), have used indicator species. Howard, Davenport et al (2000) selected indicator organisms based on practical (ease of sampling, availability of resources) and biological criteria (taxonomically different groups).

2.8.4 The Strawman.

While identifying priority marine sites in the Gulf of Mexico, Beck and Odaya (2001) carried out a typical reserve selection procedure involving a computerised iterative technique and using ecosystem, community and species conservation targets. Conservation goals were set for each target (i.e. the amount of the target that must be preserved in order to protect the full range of diversity within an ecoregion) and the mathematical analysis was run on distribution and abundance of targets as well as the set of conservation goals, thus yielding a set of priority sites. However, the prioritisation process did not stop there. The results of the analysis thus far provided a 'stawman'[1] set of sites, which were then evaluated by scientists and managers. The authors point out that there is good congruence between the mathematical analysis results and the suggestions of the scientists and managers and that the additional input may create bias in the priority set. However the premise of including post mathematical checks in the process may be wise due to the large number of variables and potential criteria that may be omitted from mathematical analysis – this reflects Turpie's (1995) conclusions on the relative benefits of iterative methods and scoring techniques.

2.8.5 Prioritisation of wetlands.

Much of the work concerning prioritisation of natural areas is focused on forested sites. This may be a reflection of the paucity of information and awareness worldwide on wetlands. However, several studies have been carried out on the prioritisation of wetlands, including a study by Turpie (1995) on South African Estuaries.

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[1] A 'strawman is defined by Beck and Odeya (p.239, 2001) as "a preliminary set of priority sites".

2.8.6 Reserve selection programmes.

The development of computer-based approaches has allowed reserve selection and prioritisation processes to become faster and more systematic. A major benefit of computer-based approaches is that they are repeatable and allow the addition of new information as it becomes available.

Examples of reserve selection computer programmes available today include CODA (Conservation Options and Decision Analysis), developed by Australian Ecological Consultant Michael Bedward and SPEXAN (Spatially Explicit Annealing), a programme developed by Ian Ball and Hugh Possingham also in Australia (Possingham, Ball et al. 2000). Both of these programmes make use of iterative algorithms to formulate a reserve network, which may then be presented graphically. The SPEXAN programme has also been integrated into the GIS programme ARCVIEW.

2.8.7 Summary.

Throughout the last two decades, the development of prioritisation techniques has progressed from primitive hotspots to scoring techniques and more complex iterative techniques involving algorithms. Iterative techniques have been compared to, and have been found to perform better than, hotspots and scoring techniques.

The identification of appropriate selection criteria is a key step in the development of a reserve network. Criteria may include biological, social or economic factors and indicators may be used.

Computer techniques have allowed faster and easier processing of information and allow for easy addition of new information. However the use of algorithms should only be used as a strawman – a guide for managers who may 'tweak' the results yielded by a given technique.

Chapter 3

Method 1 - Survey Design

Cover plate 3. Omanuka Lagoon. Photograph by Usha Amaranathan.

"Though this be madness, yet there's method in it."

- Shakespare.

3. Method 1 - Survey Design

3.1 INTRODUCTION

While the previous chapters have established the need for a wetland survey, this chapter will explain the methodology and framework of the wetland survey, designed to provide biodiversity information on wetlands.

The survey has been chosen with several aims in mind including a sound scientific basis and repeatability. The survey design aims to be systematic and logical. Periodic field-testing has also been conducted in order to ensure that the design is practicable. Above all, the survey must be designed to address a set of conservation goals described in detail below.

3.2 DEVELOPMENT OF CONSERVATION GOALS

While the previous chapters have made clear the need for an emphasis on wetland protection, it is also clear that resources are limited. The overall goal is maintenance of biodiversity but specific problems and areas must be targeted for action. In order to direct conservation effort a set of clear conservation goals must be established which will give priority to certain areas based on a set of specific criteria.

Once a conservation goal is established a target should be set. While a conservation goal outlines what we wish to achieve, a target addresses how we might achieve the goal with the most efficient expenditure of conservation effort. This is backed up by the rationale – why we wish to achieve the conservation goal and target.

i.e. Goal: What?
Target: How?
Rationale: Why?

3.2.1 Wetland Conservation Goals

1. **Goal:** Maintain species diversity.
   Target: Identify sites which contain high species diversity, placing special emphasis on rare and indicator species.
   Rationale: Protect first those sites with greatest biodiversity value so that maximum biodiversity is maintained within wetland sites.

2. **Goal:** Eliminate threats within wetlands.
   Target: Identify the nature and severity of threats to wetlands, including plant animal and human threats.
   Rationale: Identify sites under threat so that wetland decay/biodiversity loss does not occur.

These goals and targets are related to the two major categories of site characteristics: pressure and state. The concepts of pressure and state and their place in this study are explained further in section 3.4. The two goals seek to protect elements of state and eliminate elements of pressure.

3.3 MANAWATU-WANGANUI REGIONAL COUNCIL RAPID ECOLOGICAL WETLAND ASSESSMENT.

The Rapid Ecological Wetland Assessment (REWA) was been chosen in preference over other methods for several reasons (described further in section 3.7) many of which are related to the specificity of the design. REWA is derived from the Biodiversity Monitoring Toolkit, which was developed by the Manawatu-Wanganui Regional Council. The Biodiversity Monitoring Toolkit was designed to "rapidly assess and compare biodiversity, state, pressure and response indicators as well as ecosystem functions of native habitats" (Janssen 2002, p.1). A set of REWA assessment sheets is provided in Appendix 2.

Four monitoring modules are used to provide biodiversity information in the Biodiversity Monitoring Toolkit: spatial information layers, rapid ecological assessment sheets, distance sampling sheets and quickplot monitoring sheets. The Rapid Ecological Wetland Assessment follows the basic structure of two of these modules:

1. Spatial information layers.
2. Rapid ecological assessment sheets.

Module one consists of information gathered prior to entering the field. Module two involves the use of a series of sheets each of which focuses on a specific aspect of biodiversity structure or function.

The purpose of the Rapid Ecological Wetlands Assessment follows that of the Biodiversity Monitoring Toolkit. That is, REWA focuses on pressure, state and response indicators. A description of this framework follows.

3.4 PRESSURE-STATE-RESPONSE FRAMEWORK

The pressure-state-response (PSR) model states that human activities exert pressures (eg. Drainage) on the environment, which can induce changes in the state of the environment (eg. Species diversity) (OECD. 1993). Society may then respond to changes in pressures or state with, for example, monitoring or policy (OECD. 1993). In order to prioritise wetlands tis study assessed many aspects or 'criteria' were assessed. The criteria fell into two broad groups: threats and biological units.

The PSR model was developed as a framework by the OECD (Organisation for Economic Cooperation and Development) and is also used by the Ministry for the Environment. The format of their State Of New Zealand's Environment report is based on the PSR (pressure, state, response) framework. The framework enables organisation of data and illustrates the connection between threats to wetlands (pressures), the state of wetlands (state) and preservation and mitigation (response) (Fig. 3.1). Thus threats function as 'pressures' while biological units are a measure of 'state'. The survey sheet records indicators of pressures and state.

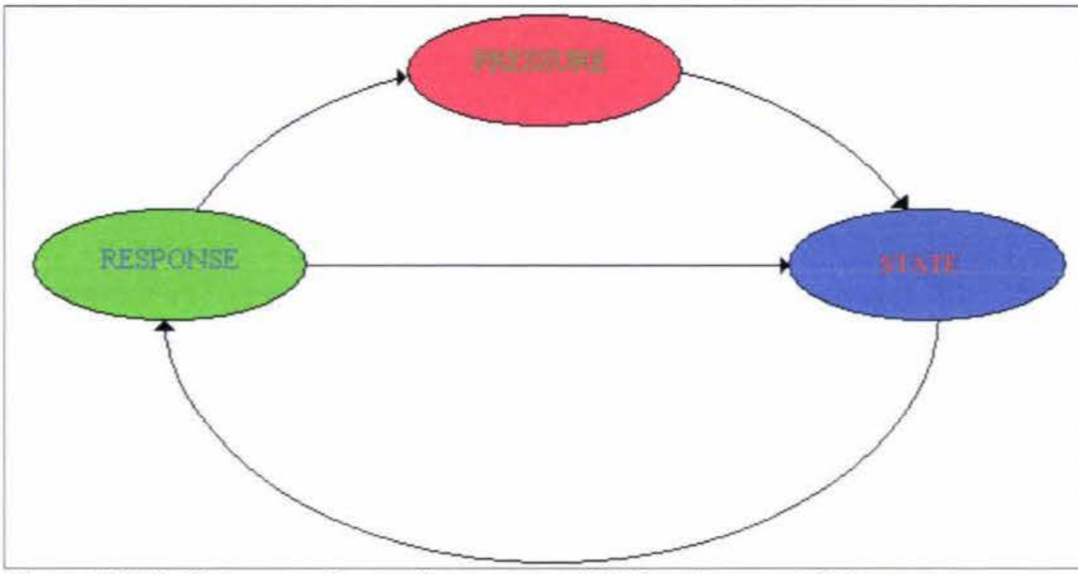

Figure 3.1 The Pressure – State – Response model of environmental change. Source (Smith 1997, p.1.6)

3.5 PRE-FIELD VISIT INFORMATION (REWA MODULE ONE).

The purpose of module one is to bring together all information already known about a site. This includes information from previous inventories, species lists, known threats, monitoring dates, protection status map coordinates, landowner details, topographic maps and aerial photographs.

3.6 DESCRIPTION OF THE RAPID ECOLOGICAL ASSESSMENT SHEETS (REWA MODULE TWO).

Module two of the Rapid Ecological Wetland Assessment consists of the following sections:

- Photopoint Sheet.
- Ecosystem/Habitat
- Habitat Structure and Function
- Wetland Connectivity and Ecotone Intactness

- Fauna Presence Card
- Threats
- Recommended Management Priorities

Each section or 'sheet' is described in detail below and an example can be found in Appendix 2: Rapid Ecological Assessment Sheets.

3.6.1 Photopoint Sheet.

A single photograph or several photographs are taken at the site as a record of features at a specific point in time and space. A series of repeated photos over time are an excellent tool for quantifying the rate, nature, and direction of change of features such as vegetation at an ecological site. In addition, photopoint methods also create a forum for analysing factors in and causes of observed changes and provide a compelling look at historic conditions and trends (MacDonald and Hindley 1998).

Photopoints can be used to monitor factors such as:

- Fencing improvements
- Fire events
- Storm damage
- Weed problems and control
- Feral animal (eg. Goat) problems and control
- Vegetation changes
- Changes in the water table

Photographs can monitor the visual extent of variation, but not the cause of change (MacDonald and Hindley 1998). Photopoint information, when coupled with information from other historical records, provides a more complete picture of previous conditions at a site (MacDonald and Hindley 1998).

Recording the location of the exact photopoint is critical for future replications of the image. For this reason the site is located on an aerial photograph so that future observers can easily identify the photopoint. The location of the photopoint is recorded using a global positioning system (GPS). The compass bearing is also noted. Details of camera settings are recorded so that the photopoint method can be easily and completely replicated. Several photographs may be taken from one photopoint at various compass bearings in order to cover the entire area of interest.

3.6.2 Ecosystem/Habitat Sheet.

On this sheet the habitat type(s) within a site, relative sizes of each habitat type and a habitat area estimate are recorded. There are 6 habitat types: wooded, herbaceous, bare, exotic/artificial, ecotone/edge (links two habitat types) and matrix. Each of these habitat types is indicated by a letter code. Within each habitat type are several categories. For example, in the wooded habitat type categories include Podocarp forest, Broadleaved forest, Wetland Forest, Parkland and others. These categories are indicated by a number code. A habitat area estimate of area covered by abundant species is also recorded as a letter code.

For example, a herbaceous wetland of 1-5ha would be recorded as B20 V. If there were several wetland areas at a site this area would also be named unit 1 or U1.

Habitat Types, Categories and Tiers.

The following is a list of the classes into which vegetation may be divided. As the terms type, category and tier will be used throughout this chapter it is important to understand the meaning of these terms at this point.

Habitat type: habitat types are broad divisions of vegetation form. Each habitat type may include many species but types are broadly divided by appearance or origin (although matrix (M) and ecotone (E) types may combine two or more habitat types).

A=Wooded

B=Herbaceous

C=Bare

D=Exotic/Artificial

E=Ecotone/Edge (links two habitat types)

M=Matrix

Habitat category: habitat categories are more specific divisions within and across habitat types. Habitat categories are named for species and more specific habitat types.

For example within the Wooded habitat type (A), habitat categories include Podocarp Forest, Beech Forest, and Wetland Forest. Within the Bare habitat type, examples of habitat categories include Rocky Coast, Rockland and Sand Coast

Habitat Tier: habitat divisions are based purely on growth form.

3.6.3 Habitat Structure and Function Sheet.

In this assessment sheet, vegetation is divided into:

- Emergent climbers/epiphytes
- Canopy
- Sub-canopy
- Ground

Within each tier of each unit all species are recorded. The average height of the species, and abundance by percentage or by category number (based on number of species) are also recorded.

3.6.4 Wetland Connectivity and Ecotone Intactness Sheet.

This sheet is divided into three sections: Ecotone Intactness – Lakes and Ponds, Ecotone Intactness – Rivers and Streams, and Wetland Connectivity.

The Ecotone Intactness section for lakes and ponds lists several divisions of ecotone intactness (EI) from pristine to exotic plants/pests (scores of 1-6). The habitat type code and area code of each ecotone (as recorded in the Ecosystem/Habitat Sheet) is noted, as is the percent of the circumference of the lake or pond that the specified habitat covers.

For the Ecotone Intactness section for rivers and streams it is riparian cover that is assessed. The habitat type code and area code for riparian vegetation on the left bank (downstream) is recorded. The habitat is given an E.I score (ecotone intactness) ranked from one to six, as for lakes and ponds. The length of the habitat area is also recorded in metres, or as a percentage of the site.

The Wetland Connectivity section describes inflow and outflow. Permanence, substrate and velocity are noted. Barriers to fish migration (waterfalls, dams, weirs, and culverts) are noted and the number and height of each is recorded. Special note is made of any permanent barrier (perched culverts) and GPS coordinates are recorded as these sites will be a priority for attention.

3.6.5 Fauna Presence Card.

A list of terrestrial bird species and wetland bird species is provided. If any of these species is seen or heard, the number observed and comments on habitat type in which they are observed is recorded. A space is also provided for other fauna not specified in the lists.

3.6.6 Threats Sheet.

This sheet is divided into three sections; plant pests, animal threats and human usages.

In the Plant Pests section, the unit in which the pest is found is recorded along with the species causing the threat, the area infested, the distribution of the pest (ranked from 1 - a small patch to 6 - common throughout), the adult to juvenile ratio, how access is gained to the site and any comments.

In the animal threats section, the affected unit is recorded as is the species, the nature of the threat, seriousness of the threat (ranked 1-5), the size of the area affected, weather there is currently any management of this pest, the degree of fencing present and any comments

The human usage section is identical to the animal threats section, bar the exclusion of the details on fencing.

3.6.7 Recommended Management Priorities

The final assessment sheet is a summary of threats and how they may be addressed. The urgency and priority of the threats or management options is recorded and space is allowed for additional comments.

3.7 SURVEY DESIGN SUMMARY.

As mentioned above, the REWA method of ecological assessment has been applied for several reasons. While other assessment methods were rejected due to lack of specificity, poor techniques, incomplete development and time constraints the REWA technique had none of these limitations.

The vegetation assessment method used in the REWA is based on the method developed by Atkinson (1962, 1985). This method has been adopted by many organisations including The Department of Conservation in the PNAP (Protected Natural Area Programme) surveys (Lake and Whaley 1995) and the Ministry for the Environment in the Coordinated Monitoring of New Zealand Wetlands project (Ward and Lambie 1999). As this vegetation assessment method provides a base for many of the assessment sheets included in the REWA, it is important that the method is well developed and well accepted. The fact that Atkinson's method has been used by so many groups and over an extended time period (the PNAP has been running for over 15 years) proves that the use of this method is a sound strategy for the formulation of coherent ecological resource information.

The use of the Pressure-State-Response framework provides a logical and systematic approach to the process of data gathering. Haila and Margules (1996, cited in Austin 1998) argued strongly that a necessary component of any practicable strategy for preserving the biological diversity of the earth is systematic field study. The use of the Pressure-State-Response framework also enables organisation of data and illustrates the connection between various assessments – this framework will be useful in converting data to information and enabling management decisions.

Another vital aspect of an ecological survey design is that it is repeatable. The use of assessment sheets, which are relatively simple and inexpensive techniques, will allow REWA to be repeated. Some aspects of REWA, such as photopoints, will become most useful when repeated. Future photopoint images may be compared to images recorded as a part of the present study to assess changes in vegetation.

The most attractive aspect of the Rapid Ecological Wetland Assessment is that it is specific. REWA is designed for wetlands in the Manawatu-Wanganui region. REWA includes relevant fauna and flora that are threatened within wetlands or threats to wetlands in the Manawatu-Wanganui region. REWA sheets include lists of specific plants and animals under the various headings such as wetland birds and plant pests. This provides specific triggers for field workers, which should reduce time, effort and error in the field. The REWA method requires no further development and will provide the detail necessary for the prioritisation of Wetlands of the Rangitikei Catchment.

REWA also enables a careful and detailed survey that includes aspects such as GPS (Global Positioning System) coordinates and photopoints. This survey may be repeated – an essential step if the effectiveness of a prioritised reserve network is to be updated and validated.

Chapter 4

Method 2 - Prioritisation Procedure

Cover plate 4. Rangitikei Estuary. Photograph by Usha Amaranathan.

"Do not be too timid and squeamish about your actions. All life is an experiment."

- Author Unknown

4. Method 2 - Prioritisation Procedure.

4.1 INTRODUCTION

Two prioritisation methods were employed in this study. The first method was the complementarity analysis using *Sites V1.0*[2]. The second method consisted of a newly devised process, which involves manipulation of prioritisation criteria via a box and whisker division method and the use of a prioritisation framework.

4.2 *SITES V1.0* PROCEEDURE

The mathematical reserve selection programme *Sites V1.0* (Andelman, Ball et al. 1999) was run in order to establish a preliminary set of priority wetlands.

4.2.1 *Sites V1.0* Algorithms

The *Sites V1.0* programme allows use of two prioritisation algorithms known as 'simulated annealing' and 'greedy'. Both algorithms are designed to meet conservation goals with the smallest possible cost. Elements are selected and representation targets (conservation goals) and penalties for not achieving targets are set for each one. Any category of data can be assigned as a cost (for example cost of purchasing a site, number of hours estimated to restore a site) and this cost plus penalty points are the total cost for selection of the portfolio.

The greedy and simulated annealing algorithms are best described by Andelman, Ball et al. (1999):

[2] The site selection programme Sites V1.0 will be printed in italics in order to allow easy differentiation between the word 'sites' (used for wetland areas) and the programme 'Sites V1.0'.

The Greedy algorithm scans each planning unit (wetland site) that is not in the portfolio and selects the one that reduces the total cost by the greatest amount. At each step, the algorithm adds one more site to the portfolio, to the point where adding another site no longer reduces the total cost.

The order in which planning units are added is important because low priority conservation areas will tend to be added toward the end of the procedure. Thus the order of site selection provides a kind of site prioritization scheme.

Simulated annealing begins with a random set, and then at each iteration swaps sites in and out of that set and measures the change in cost. If the change improves the set then the new set is carried forward to the next iteration.

4.2.2 *Sites V1.0* Input

Several files were prepared for each *Sites V1.0* run. These files identified conservation elements, sites and goals:

Species.dat file - this is the file in which elements are identified and representation targets are set. There are several components in a species.dat file:

- Element ID - each element (plant, animal, habitat type) was allocated a unique code number.
- Name - a single word to identify each element.
- Representation goals - each element had a representation goal set to 1 for desirable elements and 0 for undesirable elements.
- Species penalty factors - the *Sites V1.0* programme would try harder to meet representation goals for elements with higher penalty factors (Andelman, Ball et al. 1999).

Cost.dat file - this file related to site boundaries, which were not included in the analysis. Therefore all elements were allocated an equal cost.

Pustat.dat file - recorded the portfolio status of each site. In this study no sites were fixed in the portfolio. Wetland site status was recorded as 0 for all runs i.e. the planning unit is not *guaranteed* to be in the initial or 'seed' portfolio, although it still might be (Andelman, Ball et al. 1999). One site (Neville's) was visited but access to collect data was denied. This site was included in the *Sites V1.0* analysis as a control. All details pertaining to 'Neville's' were included in the *Sites V1.0* input files, but no elements were identified as being present at this site. Therefore, if each run was set up correctly, 'Neville's' should not be selected for inclusion in the portfolio in any of the *Sites V1.0* runs.

Several runs were conducted in the *Sites V1.0* programme - each with different goals (table 4.1). Run 1 was designed to select a portfolio containing all native/naturalised plant species and all animal species at least once. Run 2 placed extra emphasis on indicator/key species by selecting a portfolio which contains all key/indicator species. The penalty factors for key/indicator species were increased in run 3 in order to ensure the complementarity programme achieved targets for key/indicator species. Run5 was conducted as an examination of the sites required simply to represent all native/naturalised plant species. Run 6 was the most comprehensive run as it was designed to select a portfolio which would contain a representation of all native/naturalised plant species, all habitat types and all animal species. Run 7 had the same targets as run6 but was conducted with increased penalty factors in order to ensure the representations targets for all desirable elements were met.

Table 4.1 *Sites V1.0* runs, run descriptions and algorithm type. Run 3 contained errors and was eliminated.

Run Number	Run Description	Algorithm	
		Simulated Annealing	Greedy
1	Represent all native/naturalised plant species and all animals at least once. Penalty factor for all elements set at 1	✓	✓
2	As for 1 but representation goals for key/indicator species (see Appendix 2: Rapid Ecological Wetland Assessment Sheets - Key/Indicator Species) are set at 100%	✓	✓
4	As for 2 but penalty factors for key/indicator species are set at 2	✓	✓
5	Represent all native/naturalised plant species. Representation goals and penalty factors set at 1.	✓	✓
6	Represent all animals, habitat types and native/naturalised plants. All representation goals and penalty factors set at 1.	✓	✓
7	As for 6 but penalty factors set at 2 for all desirable elements. Representation goals set at 0 for exotic habitat types.	✓	✓

4.3 DESIGN OF PRIORITISATION CRITERIA

Two categories of prioritisation criteria were employed, based on the goals and targets described in the previous chapter:

- State prioritisation criteria (based on Goal 1)
- Pressure prioritisation criteria (based on Goal 2)

The site 'Neville's' was retained in the initial *Sites V1.0* procedure as a control and as no data was gathered from this site it was no longer needed. For the scoring procedure the site 'Neville's' was removed from analysis.

13 prioritisation criteria were then selected and placed category 1 or 2 (see table 4.2) A definition, description and rationale for the use of each criterion is presented below. The specific design of each criterion is described and a summary of this information is provided in table 4.2.

4.3.1 Rarity

More value was be assigned to a site because of the presence of rare species. The need to protect a site becomes greater as the need to protect a rare species is more urgent than a species, which has a widespread population. A species should be considered rare if it is uncommon among the portfolio of sampled sites or if it is uncommon in a wider context such as regional or national populations. Similar criteria have been used previously. For example, Howard, Davenport et al (2000) considered small reserves representing vegetation types not found elsewhere in the protected area system of Uganda more important than small forests containing widespread species. In the Rangitikei Catchment, species which occurred only once within the wetland portfolio were considered rare - this criteria was applied to both native/naturalised plant species and birds.

4.3.2 Diversity

Diversity is often measured by richness - a simple representation of the number of species or habitats at a site. Richness appears to be the most commonly used criteria for reserve selection or prioritisation and has been used by a variety of authors in a variety of ecosystems including Goldsmith (1987) for marine reserves, Kershaw, Mace et al (1995) for afrotropical antelopes and Smith, Horning et al (1997) for Madagascan lemurs. In the Rangitikei Catchment richness, was applied to native/naturalised species, bird species and wetland indicator species.

4.3.3 Condition

Condition was a measure of the extent to which a site is affected by undesirable/damaging influences i.e. threats or pressures. In the Rangitikei Catchment, the number of plant, animal or human activity threats and the severity of each threat were used to measure condition. Severity was a subjective measure on a scale of 1 to 3, 3 being most severe. Measures of threats to species or sites are generally based on anthropogenic impacts and are often subjectively measured (eg. visual estimations by Smith, Horning et al (1997)).

4.3.4 External Pressure

The sole indicator of external pressure used in the Rangitikei Catchment was land use. All land use types bordering a wetland site were noted. Land use types that were deemed to be of greatest threat to wetland sustainment were given higher scores than those deemed to be of lesser threat or benign/beneficial. The scores for external pressure ranged from 0 to 2.

The land use types listed in order of greatest to least threat are:

- Intensive pastoralism (dairy) (6)
- Extensive pastoralism (sheep) (5)
- Forestry (4)
- Residential (3)
- Open space and recreation land, garden parkland (2)
- Planted natives, coastal dunes, indigenous forest/scrub (1)

Land use types were ranked according to the level of change from natural habitat which is required for each land use type. Pastoralism, for example, requires extensive, often complete, removal of natural vegetation. Dairy farming was considered the more harmful form of pastoralism due to its intensive nature. Dairy farming was also considered more harmful due to the high level of damage which was observed when cattle have access to wetlands or wetland boundaries.

Forestry was considered a fairly harmful land use type due to the extensive removal of natural vegetation. However, although like pastoralism, forestry alters vegetation, unlike pastoralism there are generally no stock animals kept within areas used for forestry. Therefore forestry was considered less harmful in this context than pastoralism.

Residential land use and open space and recreation land and garden parkland were considered less harmful. These land use types can result in destruction of wetlands, but this usually occurs as these areas are established. These land use types can allow for wetland areas and other natural vegetation to remain.

Planted natives, coastal dunes, indigenous forest/scrub were considered the least harmful land use types due to the persistence of natural vegetation. Such areas were considered more likely to have been unaltered for a significant period of time and might potentially contain undamaged wetlands.

4.3.5 Size

According to the principles of island biogeography, the larger the site the more species it is likely to contain (Goldsmith, 1987). More value was assigned to a site of larger area. In the Rangitikei Catchment sites were placed into one of six categories, the smallest being 5x5m and the largest 25-100 hectares.

4.3.6 Naturalness

Naturalness, as a concept, is an aspect most people would like to preserve. Naturalness is difficult to measure and for this reason some authors recommend avoiding its use. However, in the case of the Rangitikei Catchment naturalness became a simpler concept - a simple measure of the balance between native and introduced plant species (% native species) - a measure perhaps best described as 'nativeness'.

Table 4.2 Summary description, definition and category for all prioritisation criteria.

Type	Definition	Criteria	Category (Goal 1/2)
Diversity	Number of species or habitats at a given site	-Native/ Naturalized species richness -Wetland indicator species richness -Bird species richness -Habitat richness within wetland sites (also type of habitat)	1 1 1 1
Site size	Estimated area of wetland each site	-Estimated area of each wetland site	1
Rarity	Species which occur only once in the sampled set of wetland sites (portfolio)	-Number of plant species at each site which occur only once within the portfolio -Number of animal species at each site which occur only once within the portfolio.	1 1
Condition	Extent to which site is affected by undesirable/damaging influences	-number of plant pest species -severity of plant pest species -number of animal threats -severity of animal threats -number of human activity threats -severity of human activity threats	2 2 2 2 2 2
External pressure		-Land use type	2
Naturalness	Balance between introduced and native species.	-% native species	1

4.4 PRIORITISATION CRITERIA SCORES

True scores for each prioritisation criteria were obtained by applying each criterion to the surveyed sites. For example to establish habitat richness, the number of different habitat types present at each individual site was totalled yielding a habitat richness score for each site.

4.5 MANIPULATION OF PRIORITISATION CRITERIA SCORES

The next step after selection and application of criteria was manipulation. The manipulation of data may initially seem like a simple task - for each site add up the category 1 criteria and take away from this total the category 2 criteria, thus achieving an overall score which, when compared across all sites, will allow a ranking or prioritisation of wetland sites. However, there are flaws in this process due to the high variability among scoring ranges. A method of adjusting the scores or a weighting procedure is needed to avoid this. Other authors have used a complicated weighting procedure or simply not combined criteria. In this study a new method was devised which allowed for multiple criteria but avoided the complexity of weighting procedures.

4.5.1 The Box and Whisker Division Method

"Few researchers agree on the relative importance of different criteria" (Turpie, 1995, p.175). Weighting of criteria can be a problem. For the wetlands of the Rangitikei a box and whisker division method was devised. This allows for easier replication, manipulation of data as well as better visual representation than other methods eg. Goldsmith (1987). The method also allows for multiple criteria and prevents skewing towards a single criterion.

All criteria were given equal weighting. The true scores for each criteria were divided into 4 groups according to minimum value, lower quartile, median, upper quartile and maximum value (Fig. 4.1) thus converting all true scores to a score of 1 to 4 (by using the box and whisker plot). Without this step, criteria such as species richness, which may reach raw scores of eg. 36, would have a far greater weighting than size, which as a raw score may only reach a score of 6. Thus decision making would be skewed towards a single criterion and species rich sites would be catapulted to the top of the priority ranking regardless of other attributes. For adjusted criteria with no lower quartile any true score below the median was given a score of 1.

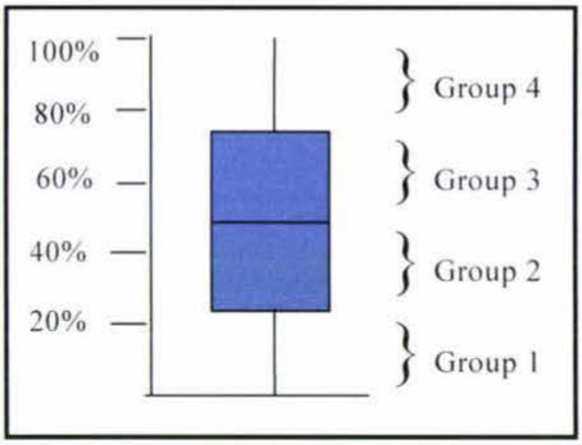

Figure 4.1 Box and whisker division. Illustration of the division of scores into four groups based on the quartiles of a box and whisker plot.

4.6 PRIORITISATION FRAMEWORK

Criteria are often combined to give an overall score. However problems arise when criteria which oppose each other are combined, as they will, in effect, cancel each other out. Thus the information represented by individual scores is lost. Therefore category 1 criteria and category 2 criteria should not be combined in the sense that they are mathematically added. However, the use of a simple framework (table 4.2) will allow the two categories of criteria to be assessed simultaneously without loss of information.

	Category 1	
	High	Low
Category 2 High	H1H2	L1H2
Category 2 Low	H1L2	L1L2

Figure 4.2 The basic prioritisation framework allowing the integration of category 1 and 2 scores. Sites scoring high for both category 1 and 2 criteria are deemed high priority (red square). Sites scoring low for both categories are deemed low priority (green square). Sites scoring low for one category and high for the other are of intermediate priority levels (blue squares).

This framework shows that sites that fall into the H1H2 square, have high biodiversity values, which are at high risk and should therefore go to the top of the priority ranking (under the goals for the Rangitikei Catchment). Sites that fall into the L1L2 square, have low biodiversity values, which are not considered highly threatened and should therefore be considered low priority. Sites that fall into the remaining squares will have intermediate priority and will be ranked higher or lower, relative to each other based on the goals of the exercise. For example, if eliminating risks and preserving all sites is a goal, then those sites which fall into the L1H2 Square, will be ranked higher than the H2L2 sites.

Adjusted scores were totaled for all pressure criteria and all state criteria yielding two scores for each site. These scores were then divided using the box and whisker method - first into two divisions for each category of criteria (divided by the median) (Priority Ranking System One) and then into 4 divisions (based on the divisions as pictured in (fig. 4.1) (Priority Ranking System Two). The framework described as in (fig 4.2) was expanded to allow for 16 priority levels (table 4.3). The two different numbers of divisions illustrate how different levels of resolution within the prioritisation process may be gained.

For the first division of scores into just two groups, each score receives a rating of either very high (shaded red) or very low (shaded dark blue). When the scores were divided into four divisions intermediate ratings of high (yellow)) and low (light blue) were added. Thus each site now has two scores which dictate the coloured squares with which they were marked. The two coloured squares can then be easily matched to the extended framework of table 4.3.

The final step in the prioritisation process is to allocate a priority level. Priority level is based on the combination of coloured squares a site has. An overlay for the extended framework was designed which, when placed over the coloured squares of the extended framework will show the priority level each pair of squares will be allocated. Priority level score proceeds from low numbers (indicating top priority) to high numbers (low priority) from red to yellow to light blue to dark blue (table 4.4). As per the prioritisation framework in figure 4.1 a site with two red squares (indicating high scores for both pressure and state) is a top priority site, while a site with two dark blue squares (low pressure and state) is a very low priority site. Following double red squares is the combination of a red pressure square and a yellow state square. This is followed by yellow pressure and red state squares. Although these two combinations consist of a red and a yellow square, the combination which contains a higher pressure score (red) is considered a higher priority than a site with a yellow pressure score. This decision is based on the goals of the exercise, which places a heavy emphasis on reducing threats, or addressing pressures to prevent the loss or further decay of any site.

Table 4.3 The extended prioritisation framework showing combinations of pressure and state scores with colour coding indicating strength of score (red=very high, yellow=high, light blue=low, dark blue=very low).

Pressure	State: Very High	State: High	State: Low	State: Very Low
Very High	P S	P S	P S	P S
High	P S	P S	P S	P S
Low	P S	P S	P S	P S
Very Low	P S	P S	P S	P S

Table 4.4 Prioritisation overlay displaying single, priority level scores, which correspond to the combination of coloured squares as illustrated by table 4.3.

Pressure	State: Very High	State: High	State: Low	State: Very Low
Very High	1	2	5	10
High	3	4	7	12
Low	6	8	9	14
Very Low	11	13	15	16

4.7 PRIORITISATION PROCEDURE SUMMARY

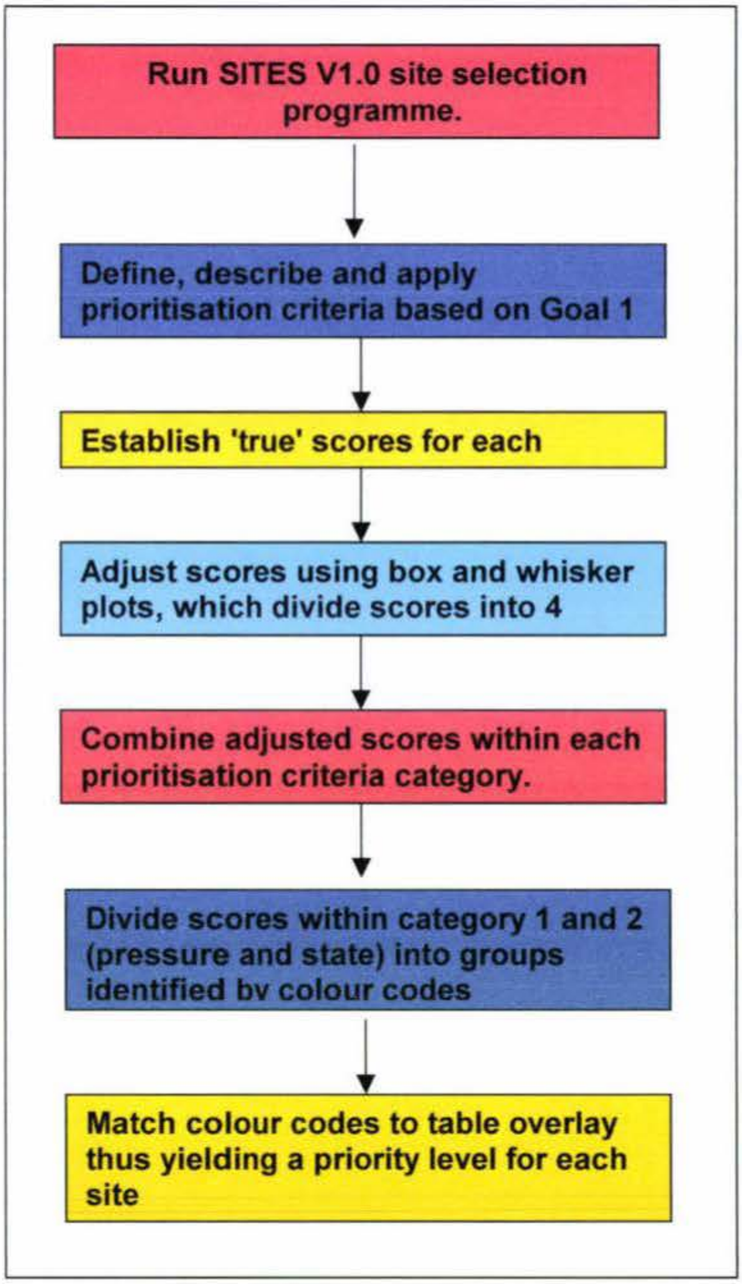

Figure 4.3 Flow chart of the major steps in the prioritisation procedure.

Chapter 5

Results

Cover plate 5. Pryces Rahui Bush Reserve. Photograph by Usha Amaranathan.

"When one tugs at one thing in nature, he finds it attached to the rest of the world."

- John Muir

5. Results

In the following chapter the results of both complementarity analysis and scoring procedures are presented. The results of the application of the prioritisation framework are also described, concluding with tables displaying the final priority rankings of the surveyed wetland sites and a series of graphs representing the achievement of objectives and goals.

5.1 *SITES V1.0* COMPLEMENTARITY ANALYSIS

Run 1 was conducted to achieve the goal of protecting all native/naturalised plant species (including key/indicator species) and all animal species. The results of this run indicated that just 12 (simulated annealing) or 16 (greedy algorithm) sites would be required to achieve this (table 5.1).

In Run 2 representation goals for key/indicator species were set at 100% i.e. every example of those species considered highly important to wetlands should be represented in the chosen portfolio of sites. Again the first aim of this run was the representation of at least one example of each native/naturalised plant species and all animal species. 23 sites were chosen for inclusion in the portfolio (table 5.1).

Run 4 was conducted in order to overcome this shortfall in achievement of representation goals. Penalty factors for not achieving representation goals were increased from 1 to 2 for key/indicator species. This time all representation goals were achieved and 24 sites (every site bar 'Neville's') were selected for inclusion in the portfolio (table 5.1).

Sites V1.0 Run Site Name	Run 7 G	Run 7 A	Run 6 G	Run 6 A	Run 5 G	Run 5 A	Run 4 G	Run 4 A	Run 2 G	Run 2 A	Run 1 G	Run 1 A	Selection %
Tricker's Bush	✓	✓			✓	✓	✓	✓	✓	✓	✓		75
Simpson's Reserve	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100
Campion Road Pond	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		83
Tangimoana Fernbird Area	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100
Omanuka Lagoon	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100
Marton Dam	✓	✓		✓	✓	✓	✓	✓	✓	✓			75
Rangitikei River Country Estate	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100
Vinegar Hill Domain	✓	✓			✓	✓	✓	✓	✓	✓			67
Pryces Rahui Bush Reserve	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100
Pukemarama Lagoon	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100
Westoe A	✓	✓		✓			✓	✓					42
Westoe B	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		83
Reu Reu Road Swamp	✓	✓			✓	✓	✓	✓	✓	✓	✓		75
Inanga Spawning Site 12	✓	✓			✓	✓	✓	✓	✓	✓			67
Flockhouse swamp	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100
Pemberton Farm Dams	✓	✓		✓	✓	✓	✓	✓	✓	✓			75
Wings Line Pond	✓	✓			✓	✓	✓	✓	✓	✓			67
Speedy Road Ponds	✓	✓			✓	✓	✓	✓	✓	✓			67
Pemberton Reserve	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100
Makirikiri Road	✓	✓		✓	✓	✓	✓	✓	✓	✓			75
Neville's													0
Tasngimoana Dump Dunes	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100
Saltmarsh B	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100
Saltmarsh A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100
Marton Water Reservior	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100
Number of Sites Chosen	24	24	12	18	23	23	24	24	23	23	16	12	

Table 5.1 *Sites V1.0* Results. Number of sites selected by each run. Selection of sites as a percentage of *Sites V.10* runs.

Run 5 was conducted in order to establish how many and which sites would be required in order to represent all non weed plant species. All sites were selected except 'Neville's' and 'Westoe A'. The site 'Westoe A' received the least number of selections for inclusion in the portfolio (selected in just 42% of runs) (table 5.1).

Run 6 was conducted to achieve representation of all native/naturalised plant species (including key/indicator species), all animal species and all habitat types. Just 18 (simulated annealing) or 12 (greedy algorithm) sites were selected (table 5.1).

In Run 7, penalty factors for all elements (species and habitat types) were increased to 2 and exotic habitat types were excluded from the portfolio. All sites (except 'Neville's') were required to achieve representation of all desirable elements (table 5.1).

5.2 PRIORITISATION CRITERIA AND MANIPULATION.

5.2.1 True Scores

Table 5.2 True scores for all state prioritisation criteria for all sites.

Criteria	Rarity - Plants	Rarity - Birds	Diversity - Wetland Indicator Richness	Diversity - Native/ Naturalised Plant Richness	Diversity - Habitat Richness	Diversity - Bird Richness	Naturalness	Bird Abundance	Size
Site Name									
Tricker's Bush	1	0	4	4	5	8	25	17	4
Simpson's Reserve	8	2	11	13	6	12	68.42	40	5
Campion Road Pond	0	1	5	6	3	6	50	32	3
Tangimoana Fernbird Area	2	1	5	6	5	8	46.15	21	3
Omanuka Lagoon	2	2	4	6	7	8	54.55	117	5
Marton Dam	0	0	2	2	5	7	28.57	18	3
Rangitikei River Country Estate	7	1	3	4	4	3	25	9	2
Vinegar Hill Domain	0	0	3	3	5	6	27.27	17	5
Pryces Rahui Bush Reserve	9	0	11	11	4	11	78.57	28	3
Pukemarama Lagoon	1	1	4	5	3	7	41.67	15	3
Westoe A	0	0	1	1	4	0	50	0	2
Westoe B	1	0	5	5	3	2	71.43	24	2
Reu Reu Road Swamp	1	0	2	2	3	3	20	4	2
Inanga Spawning Site 12	2	0	2	2	2	6	22.22	42	3
Flockhouse swamp	2	1	7	8	5	7	61.54	13	3
Pemberton Farm Dams	0	0	3	3	6	2	75	4	3
Wings Line Pond	0	0	2	2	4	0	40	0	1
Speedy Road Ponds	0	0	2	2	5	2	28.57	13	1
Pemberton Reserve	5	0	6	6	6	4	75	8	4
Makirikiri Road	0	0	2	2	5	0	40	0	1
Tasngimoana Dump Dunes	5	1	4	5	6	7	41.67	21	6
Saltmarsh B	2	2	4	6	3	6	66.67	15	6
Saltmarsh A	2	0	1	1	4	6	25	14	6
Marton Water Reservior	0	3	2	5	6	14	41.67	44	6

Table 5.3 True scores for all pressure prioritisation criteria for all sites.

Criteria	Non-Pest Weed Species Richness	Pest Weed Species Richness	Pest Severity	External Pressure
Site Name				
Tricker's Bush	6	6	10	9
Simpson's Reserve	5	1	1	5
Campion Road Pond	4	2	4	6
Tangimoana Fernbird Area	4	3	6	9
Omanuka Lagoon	3	2	4	6
Marton Dam	3	2	7	9
Rangitikei River Country Estate	10	2	0	2
Vinegar Hill Domain	5	3	5	6
Pryces Rahui Bush Reserve	1	2	4	11
Pukemarama Lagoon	5	2	3	6
Westoe A	1	0	1	5
Westoe B	1	1	3	5
Reu Reu Road Swamp	5	3	5	5
Inanga Spawning Site 12	5	2	5	2
Flockhouse swamp	2	3	8	6
Pemberton Farm Dams	1	0	2	5
Wings Line Pond	3	0	0	6
Speedy Road Ponds	3	2	2	5
Pemberton Reserve	2	0	4	5
Makirikiri Road	2	1	2	5
Tasngimoana Dump Dunes	4	3	7	5
Saltmarsh B	1	2	5	1
Saltmarsh A	2	1	5	9
Marton Water Reservior	3	4	11	5

The values achieved by each site for category 1 and 2 criteria are displayed in tables 5.2 and 5.3 respectively. The variability within and among sites is clearly visible in table 5.2. For example for the criterion Native/Naturalised species richness, true scores ranged from 13 to as low as 1. While some sites such as Pryce's Rahui Bush and Simpson's Reserve consistently appeared among the higher scoring sites and the site Westoe A consistently scored low for category 1 criteria, the many sites appearing within these extremes exhibited no clear pattern.

The vast differences in the scoring ranges can also be seen in table 5.2 and 5.3. For example, scores for naturalness ranged between 25 to 71.43, scores for abundance ranged from 0 to 117 and scores for rarity-birds ranged from 1 to 3.

5.2.2 Box and Whisker Divisions

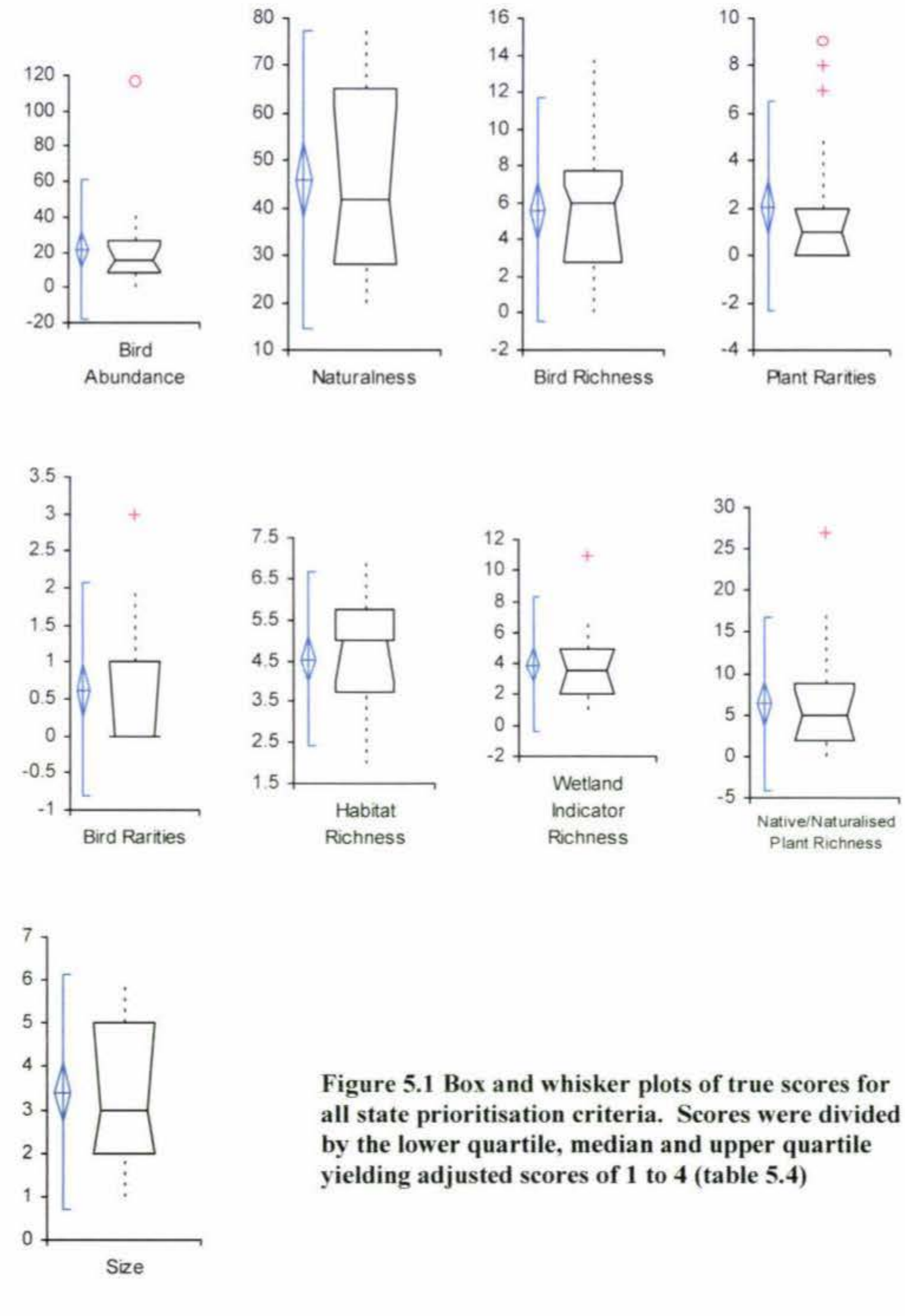

Figure 5.1 Box and whisker plots of true scores for all state prioritisation criteria. Scores were divided by the lower quartile, median and upper quartile yielding adjusted scores of 1 to 4 (table 5.4)

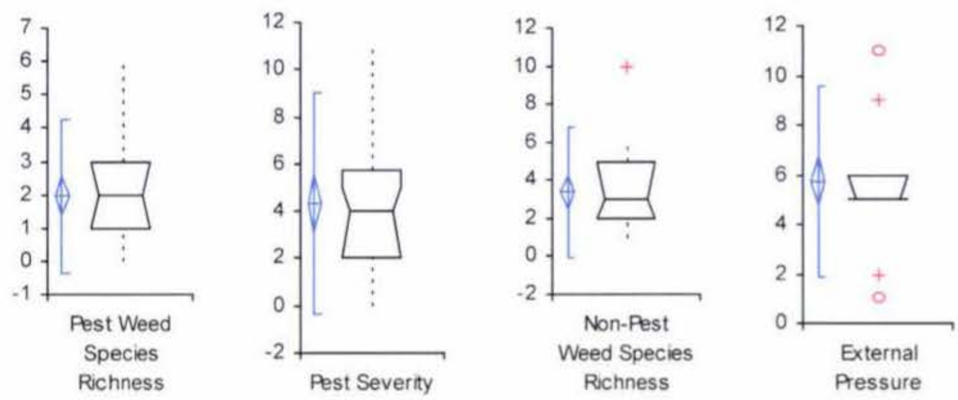

Figure 5.2 Box and whisker plots of true scores for all pressure prioritisation criteria. Scores were divided by the lower quartile, median and upper quartile yielding adjusted scores of 1to 4 (table 5.5).

The box and whisker method as described in Chapter 4 was used to divide scores into 4 groups within each criterion. The box and whisker plots used to divide all true scores into adjusted scores of 1 to 4 are presented above (figure 5.1, figure 5.2).

5.2.3 Adjusted Scores Table.

Table 5.4 Adjusted scores for all state prioritisation criteria for all sites. Scores adjusted using the box and whisker division method to yield scores of 1 to 4.

Criteria	Rarity - Plants	Rarity - Birds	Diversity - Wetland Indicator Richness	Diversity - Native/ Naturalised Plant Richness	Diversity - Habitat Richness	Diversity - Bird Richness	Naturalness	Bird Abundance	Size
Site Name									
Tricker's Bush	2	1	3	2	2	4	1	3	4
Simpson's Reserve	4	4	4	4	4	4	4	4	3
Campion Road Pond	1	3	3	3	1	2	3	4	4
Tangimoana Fernbird Area	3	3	3	3	2	4	3	3	3
Omanuka Lagoon	3	4	3	3	4	4	3	4	3
Marton Dam	1	1	1	1	2	3	2	3	4
Rangitikei River Country Estate	4	3	2	2	2	2	1	2	3
Vinegar Hill Domain	1	1	2	2	2	2	1	3	2
Pryces Rahui Bush Reserve	4	1	4	4	2	4	4	4	4
Pukemarama Lagoon	2	3	3	3	1	3	2	2	3
Westoe A	1	1	1	1	2	1	3	1	3
Westoe B	2	1	3	3	1	1	4	3	2
Reu Reu Road Swamp	2	1	1	1	1	2	1	1	2
Inanga Spawning Site 12	3	1	1	1	1	2	1	4	2
Flockhouse swamp	3	3	4	4	2	3	3	2	3
Pemberton Farm Dams	1	1	2	2	4	1	4	1	3
Wings Line Pond	1	1	1	1	2	1	2	1	1
Speedy Road Ponds	1	1	1	1	2	1	2	2	1
Pemberton Reserve	4	1	4	3	4	2	4	1	3
Makirikiri Road	1	1	1	1	2	1	2	1	1
Tasngimoana Dump Dunes	4	3	3	3	4	3	2	3	4
Saltmarsh B	3	4	3	3	1	2	4	2	4
Saltmarsh A	3	1	1	1	2	2	1	2	4
Marton Water Reservior	1	4	1	3	4	4	2	4	4

Table 5.5 Adjusted scores for all pressure prioritisation criteria for all sites. Scores adjusted using the box and whisker division method to yield scores of 1 to 4.

Criteria	Non-Pest Weed Species Richness	Pest Weed Species Richness	Pest Severity	External Pressure
Site Name				
Tricker's Bush	4	4	4	4
Simpson's Reserve	3	1	1	3
Campion Road Pond	3	2	2	4
Tangimoana fernbird Area	3	3	4	4
Omanuka Lagoon	2	2	2	4
Marton Dam	2	2	4	4
Rangitikei River Country Estate	4	2	1	1
Vinegar Hill Domain	3	3	3	4
Pryces Rahui Bush Reserve	1	2	2	4
Pukemarama Lagoon	3	2	2	4
Westoe A	1	1	1	3
Westoe B	1	1	2	3
Reu Reu Road Swamp	3	3	3	3
Inanga Spawning Site 12	3	2	3	1
Flockhouse swamp	1	3	4	4
Pemberton Farm Dams	1	1	1	3
Wings Line Pond	2	1	1	4
Speedy Road Ponds	2	2	1	3
Pemberton Reserve	1	1	2	3
Makirikiri Road	1	1	1	3
Tasngimoana dump dunes	3	3	4	3
Saltmarsh B	1	2	3	1
Saltmarsh A	1	1	3	4
Marton Water Reservior	2	4	4	3

Sites which evidenced high adjusted state prioritisation criteria include Simpson's Reserve, Pryce's Rahui Bush Reserve and Omanuka Lagoon (table 5.4). Low state scoring sites included Wings Line Pond, Speedy Road Ponds, Westoe A, Markirikiri road and Reu Reu Road Swamp. No site had the highest possible state scores across all criteria or the lowest possible state scores across all criteria. Scores were highly variable within sites.

High pressure scoring sites included Tricker's Bush, Vinegar Hill Domain and Reu Reu road Swamp (table 5.5). Low scoring sites included Westoe A and B, Pemberton Farm Dams, Markirikiri Road and Wings Line Pond (table 5.5). Only Reu Reu Road Swamp received the same adjusted pressure scores for all criteria (table 5.5).

5.3 PRIORITY RANKINGS

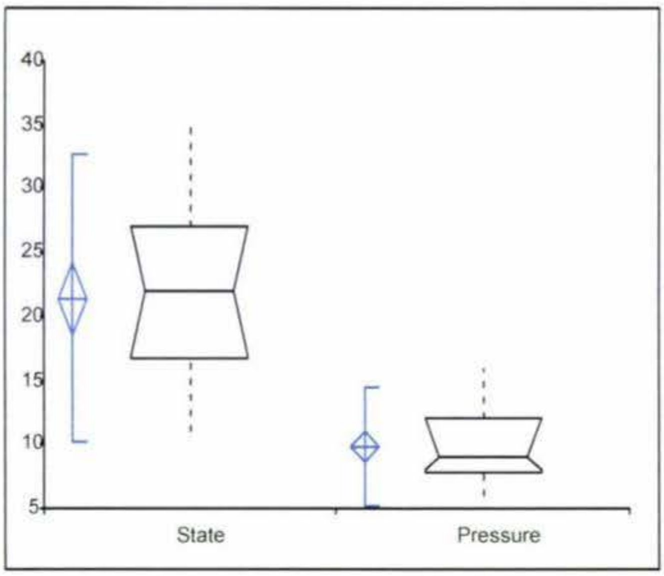

Figure 5.3 Division of totalled adjusted scores for both pressure and state categories using the box and whisker division method. Scores were divided by the lower quartile, median and upper quartile (figures provided in the table).

The box and whisker plot of figure 5.3 divides the totalled scores within each category for each site into four groups once again. This plot was also used to separate scores into just two divisions in order to establish the simpler priority ranking displayed in table 5.7. At this step in the prioritisation process sites were not given scores of 1 to 4 based on the final box plot but instead were colour coded into 2 (table 5.7) or 4 (table 5.8) groups.

Under Priority Ranking System One (table 5.6) sites were divided into 4 priority rankings (1 to 4) each containing 9, 5, 4, and 6 sites respectively. Under Priority Ranking system Two (table 5.7) sites were divided into priority rankings 1-16. Rankings 9, 12, and 13 did not contain any sites.

Table 5.6 Priority Ranking System One. Total pressure and state scores for each site were listed and overlayed with one of two colour codes indicating either high or low scores. Combinations of colours were used to establish priority rankings according to the framework described in Chapter 4.

	Pressure Total	State Total	Priority Ranking
Site Name			
Tricker's Bush	16	22	1
Pryces Rahui Bush Reserve	9	31	1
Pukemarama Lagoon	11	22	1
Campion Road Pond	11	23	1
Tangimoana fernbird Area	14	25	1
Tasngimoana dump dunes	13	29	1
Flockhouse swamp	12	24	1
Marton Water Reservior	13	28	1
Omanuka Lagoon	10	30	1
Marton Dam	12	18	2
Vinegar Hill Domain	13	16	2
Reu Reu Road Swamp	12	12	2
Inanga Spawning Site 12	9	17	2
Saltmarsh A	9	19	2
Rangitikei River Country Estate	8	23	3
Pemberton Reserve	7	27	3
Simpson's Reserve	8	35	3
Saltmarsh B	7	27	3
Pemberton Farm Dams	6	18	4
Wings Line Pond	8	11	4
Speedy Road Ponds	8	12	4
Makirikiri Road	6	11	4
Westoe A	6	14	4
Westoe B	7	20	4

Key
Very High
Very Low

Table 5.7 Priority Ranking System Two. Total pressure and state scores for each site were listed and overlayed with one of four colour codes indicating either very high, high, low or very low scores. Combinations of colours were used to establish priority rankings according to the framework described in Chapter 4.

	Pressure Total	State Total	Priority Ranking
Site Name			
Tasngimoana dump dunes	13	29	1
Marton Water Reservior	13	28	1
Tangimoana fernbird Area	14	25	2
Flockhouse swamp	12	24	2
Omanuka Lagoon	10	30	3
Pryces Rahui Bush Reserve	9	31	3
Campion Road Pond	11	23	4
Tricker's Bush	16	22	4
Pukemarama Lagoon	11	22	4
Marton Dam	12	18	5
Simpson's Reserve	8	35	6
Inanga Spawning Site 12	9	17	7
Saltmarsh A	9	19	7
Rangitikei River Country Estate	8	23	8
Reu Reu Road Swamp	12	12	10
Vinegar Hill Domain	13	16	10
Pemberton Reserve	7	27	11
Saltmarsh B	7	27	11
Wings Line Pond	8	11	14
Speedy Road Ponds	8	12	14
Westoe B	7	20	15
Pemberton Farm Dams	6	18	15
Westoe A	6	14	16
Makirikiri Road	6	11	16

Key
Very High
High
Low

5.4 WETLAND ELEMENT REPRESENTATION.

5.4.1 Cumulative Representation Of Wetland Elements

According to figure 5.4 some elements ceased to increase before the lowest priority ranking. Addition of new rare bird species to the portfolio ceased at priority level 2 (figure 5.4, II) and addition of plant pest species and non-pest weed species ceased at level 3 (figure 5.4, I). For all other elements, cumulative representation continued to increase through all priority rankings.

Under Priority Ranking System Two (figure 5.5) more elements ceased to increase prior to priority level 16. In fact, only cumulative representation of pest severity, external pressure, naturalness and size continued to increase across all priority rankings.

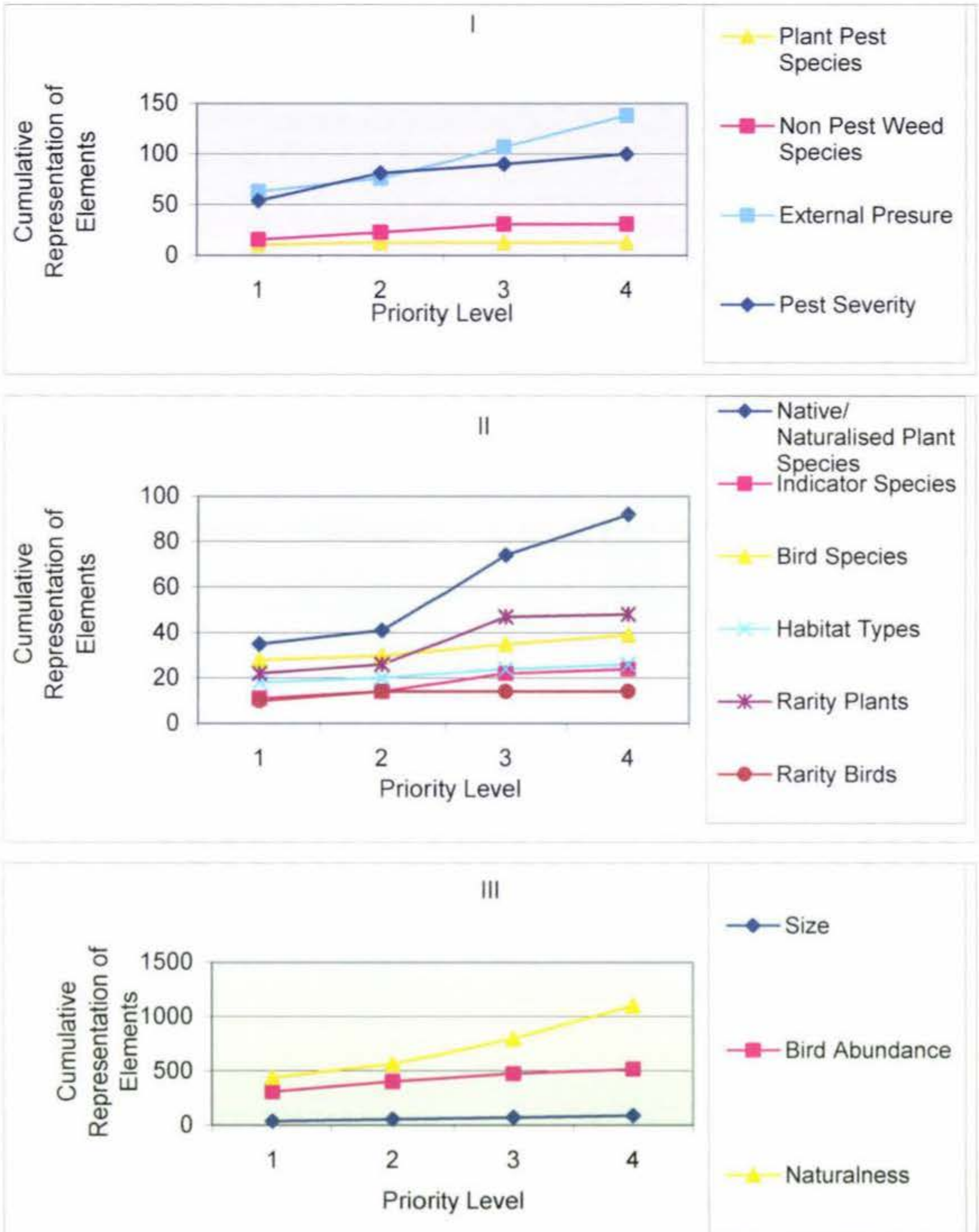

Figure 5.4 Cumulative representation of wetland elements by priority level using Priority Ranking System One. True scores are totalled for each priority level. True score totals for all previous priority levels are added at each level resulting in cumulative scores for those criteria not measuring richness. The cumulative scores for criteria measuring richness (plant pest species, non-pest weed species, native. naturalised plant species, indicator species, bird species, rarities and habitat richness) are based on the total of species (or habitats) found at each priority ranking which have not been recorded in previous priority rankings. Graph I displays pressure scores. Graphs II and III display state scores.

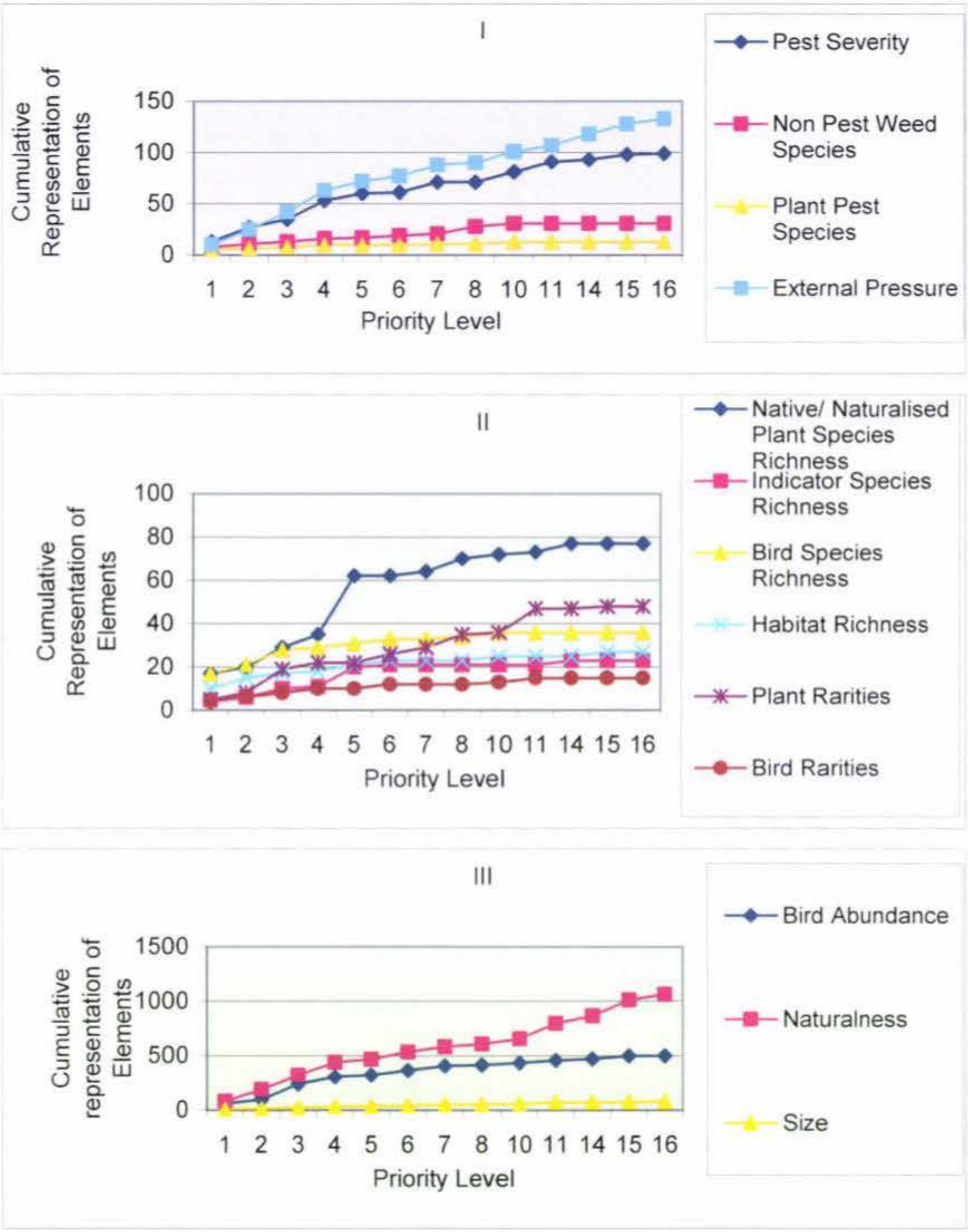

Figure 5.5 Cumulative representation of wetland elements by priority level using Priority Ranking System Two. True scores are totalled for each priority level. True score totals for all previous priority levels are added at each level resulting in cumulative scores for those criteria not measuring richness. The cumulative scores for criteria measuring richness (plant pest species, non-pest weed species, native. naturalised plant species, indicator species, bird species, rarities and habitat richness) are based on the total number of species (or habitats) found at each priority ranking which have not been recorded in previous priority rankings. Graph I displays pressure scores. Graphs II and III display state scores.

5.4.2 Percentage Representation Of Wetland Elements

Using Priority Ranking System One, over 80% of all plant pest weed species may be addressed by sites within priority level 1 (figure 5.6, I). 100% of non-pest weed species are represented by sites under priority rankings 1-3, while sites within all priority rankings contain some elements of external pressure and pest severity (figure 5.6, I). In figure 5.6, II a pattern emerges whereby percentage representations of elements under priority 1 are high, lower for priority 2 and higher again for priority 3 (excluding bird rarity). The other state elements displayed in figure 5.6, III do not exhibit this pattern.

The general pattern observed in figure 5.7 is an undulating rise and fall between consecutive priority rankings. For example, in figure 5.7, I sites under priority ranking 4 all have lower percentage representations of elements than sites under priority ranking 3 or 5. The sites within some priority rankings may represent 0% of a specific element eg priority 6 sites do not represent any plant pest species or any pest severity (figure 5.7, I).

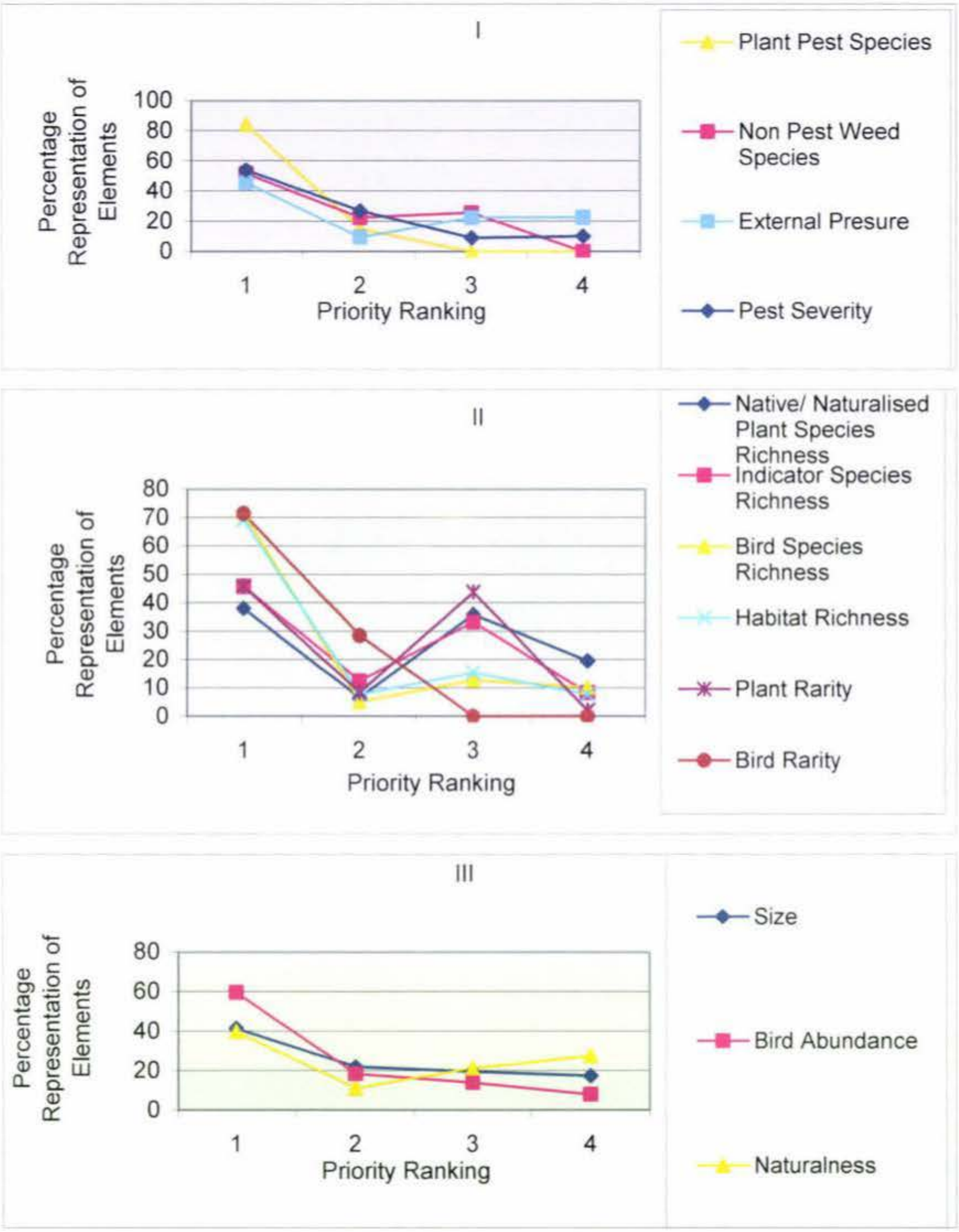

Figure 5.6 Percentage representation of elements by priority level using Priority Ranking System One. For criteria not measuring richness, total true scores for all sites at each priority level are presented as a percentage of totalled true scores for all sites. The percentages for criteria measuring richness (plant pest species, non-pest weed species, native. naturalised plant species, indicator species, bird species, rarities and habitat richness) are based on the total number of species (or habitats) found at each priority ranking which have not been recorded in previous priority rankings. Graph I displays pressure scores. Graphs II and III display state scores.

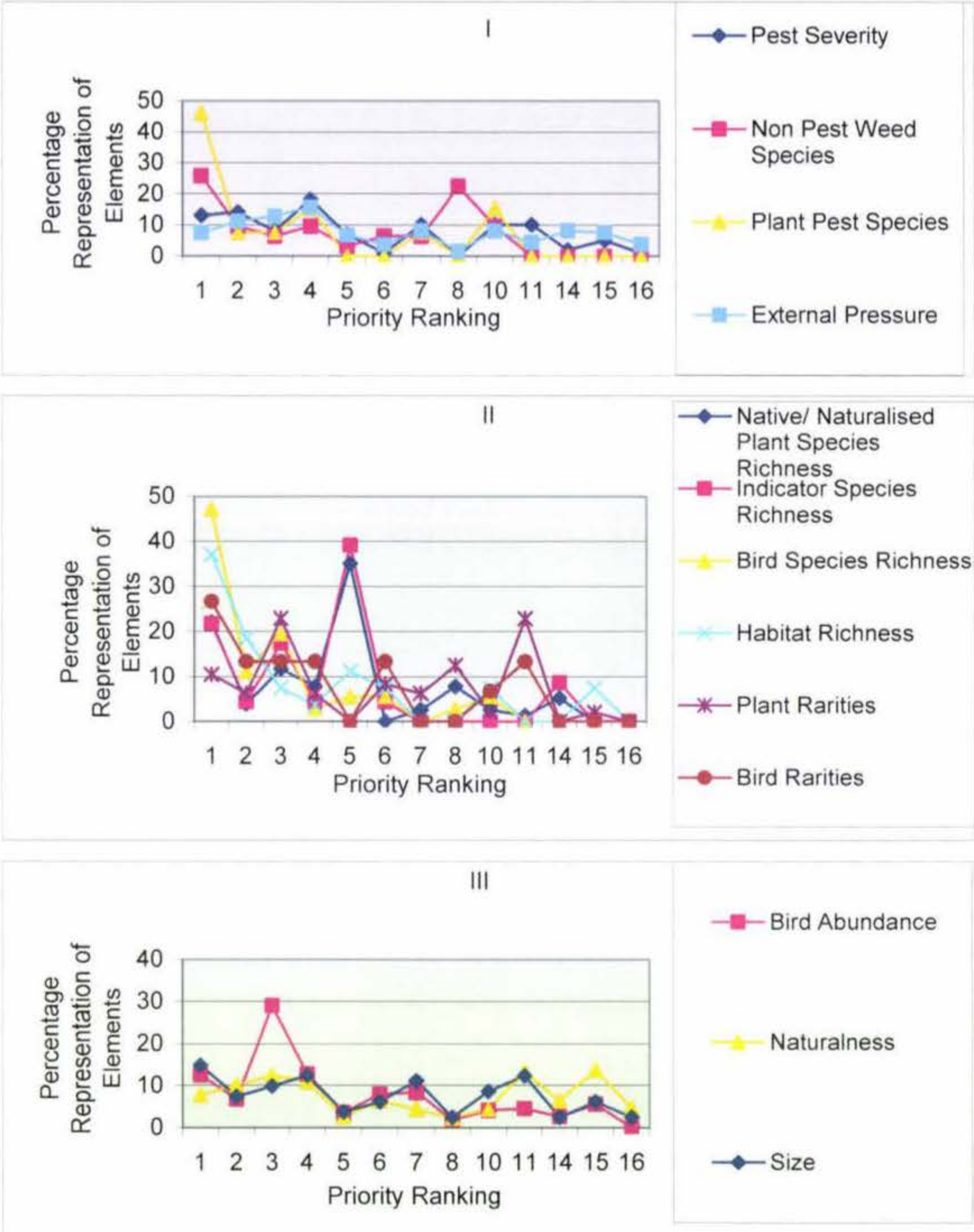

Figure 5.7 Percentage representation of elements by priority level using Priority Ranking System Two. Total true scores for all sites at each priority level are presented as a percentage of totalled true scores for all sites for those criteria not measuring richness. The percentages for criteria measuring richness (plant pest species, non-pest weed species, native. naturalised plant species, indicator species, bird species rarities and habitat richness) are based on the total number of species (or habitat types) found at each priority ranking which have not been recorded in previous priority rankings. Graph I displays pressure scores. Graphs II and III display state scores.

Chapter 6

Discussion

Cover plate 6. Marton Water Reservoir. Photograph by Usha Amaranathan.

"The scientific mind does not so much provide the right answers as ask the right questions."

Claude Levi-Strauss

6. Discussion.

6.1 SURVEY METHOD

The clear advantage of the REWA survey method is the low cost and effort required. One of the aims when designing the survey method was that it would be repeatable. The assessment sheets, which provide relatively simple and inexpensive techniques and the use of photopoints, provide a highly repeatable method. The low cost of this survey method makes it attractive for consequent surveys used to update or add sites to the network of prioritised sites. The REWA vegetation assessment method is also based on an established method (developed by Atkinson 1962, 1985) that has been used by several groups and organisations over an extended period of time. The REWA method was designed for wetlands of the Manawatu-Wanganui Region, of which the Rangitikei Catchment is a part, and required no further development while providing the necessary level of detail required for the prioritisation of wetlands of the Rangitikei Catchment.

This study was limited by time constraints, which restricted surveys to one season - spring. Both plant and bird populations are expected to vary between seasons. Ideally, bird counts and plant surveys should be carried out in all seasons.

There is a risk that some rare species, either plant or animal, may have been missed. A presence/absence database is seldom complete (Polasky, Camm et al. 2000). A solution to this problem may be to apply a degree of effort proportional to the area of the wetland. However, the variation among sites in density and nature of vegetation (eg. Forest wetlands versus low reedlands) means that some wetlands will require more effort (time) to survey due to restricted visibility and manoeuvrability in denser, taller vegetation or difficult terrain.

The sites selected to be included in this survey may affect results. The 25 sites covered by this survey may represent as little as 1/4 of all wetland sites in the Rangitikei catchment. Sites were selected for inclusion in the survey according to factors including accessibility, permitted access and proximity to the area from which this study was based. The sites were also chosen with the aim of representing the range of wetland types within the area. This may explain some of the extreme variability observed among wetland sites. It is expected that with further survey effort this variability may be reduced. As the areas surveyed increases, the number of new species recorded is expected to decrease (Cam, Nichols et al., 2002). Species, in many cases may prove not to be as rare as was initially assumed. However, due to time and cost restraints the upper part of the Rangitikei Catchment was not surveyed. This area however, is known to include several sites, which differ greatly from any site surveyed in the lower part of the catchment such as Reporoa Bog which contains a number of rare plants (Cromarty and Scott 1995). Therefore, extending the survey to include the upper Rangitikei Catchment is, in fact, likely to further increase variability.

6.2 *SITES V1.0* PROCEEDURE

Complementarity analysis revealed that there was extreme variability among wetland sites. This was revealed by the large number of sites required to represent the full range of diversity among wetland sites (table 5.1).

The results (table 5.1) indicated that just 12 (simulated annealing) or 16 (greedy algorithm) sites would be required to achieve the goals of run 1. However the *Sites V1.0* programme did not achieve some representation goals. The number of sites the programme concluded were necessary was lower than would be truly necessary if all representation goals were achieved. This was the case with run 1 - some elements (in this case species) did not achieve their representation goals i.e. some elements would not be represented within the chosen portfolio.

In run 2 more of the representation goals of the first aim were achieved due to the necessary inclusion of more sites to achieve 100% representation of key/indicator species (the second aim). 23 sites were chosen for inclusion in the portfolio (table 5.1). However, all representation goals for the second aim were not yet achieved.

In run 4, all representation goals were achieved and 24 sites (every site bar 'Neville's') were selected for inclusion in the portfolio (table 5.1). Representation goals were achieved because penalty factors were increased. This encouraged the complementarity programme to represent all desired elements. However, habitat was no included.

All sites were selected in run 5 except 'Neville's' and 'Westoe A'. Thus, in order to address the presence of weed species within wetlands, 23 out of 25 sites must be included in the portfolio due to the widespread presence of weed species.

Many representation goals were not achieved in run 6. Just 18 (simulated annealing) or 12 (greedy algorithm) sites were selected for inclusion in the portfolio (table 5.1). Therefore, in run 7, several changes were made. Penalty factors for all elements (species and habitat types) were increased to 2 and exotic habitat types were excluded from the portfolio. In run 7, all sites (except 'Neville's') were required to achieve representation of all desirable elements (table 5.1), however all goals were met.

In summary, the complementarity process did not provide the level of resolution required to separate sites into a prioritised portfolio. For example, to establish a portfolio which will contain representations of all desirable elements 24 out of 25 sites were required to be included. Despite the statements of authors such as Turpie (1995), complementarity analysis may not always be the most efficient method for creating a prioritised network of sites.

The original intended use of the complementarity analysis was as a strawman (as used by Beck and Odeya, 2001), which would provide a guide to the final prioritisation of wetlands of the Rangitikei Catchment. The *Sites V1.0* runs, which have been included in this study, were intended to be preliminary *Sites V1.0* runs upon which further runs could be based which contain altered settings. Instead, due to the high number of sites required to be included in the portfolio, complementarity analysis revealed that further analysis of a different form would be required to examine the elements of pressure and state more deeply in order to separate sites into a clarified priority ranking.

A major criticism of the use of scoring techniques is that they risk duplication of some elements and omission of others (Turpie, 1995). However, complementarity analysis showed that in this case all sites have some importance in representation of diversity elements, another manifestation of the extensive diversity among the 25 wetland sites. When conservation goals were met by complementarity analysis, 23-24 sites were required to be included in the portfolio. No site may be ignored entirely (excluding Neville's), as each site contains an important and unique combination of attributes not found elsewhere in the network (table 5.2, 5.3). Therefore, the selection and elimination of sites that occurs during complementarity analysis was of little use. Instead, inclusion of all sites, prioritisation criteria and a relative priority ranking process were used.

6.3 PRIORITISATION CRITERIA

The prioritisation of wetland sites of the Rangitikei Catchment involved the use of 13 prioritisation criteria divided into 2 categories measuring pressure and state, which reflect the goals of this study. The primary criticism of scoring techniques expressed by authors such as Turpie (1995) is that scoring may replicate some elements while excluding others. Turpie (1995, p.182) states that "an iterative approach is more efficient in selecting a network of reserves which conserves all target species". However, Turpie (1995) does concede that a scoring and ranking exercise may be of use in combination with an iterative method.

The true scores results tables (5.2, 5.3) clearly illustrate the vast differences in the scoring ranges of each criterion and, therefore, the need for manipulation in order to create uniformity in scoring ranges in order to combine and compare criteria. There is extreme variability within and among the 13 prioritisation criteria. Therefore scores were adjusted using the box and whisker division method which overcomes extreme variability by converting all true scores to a narrower range of scores of 1 to 4.

All 13 criteria were based on physical attributes of the wetland sites. A future extension of the prioritisation criteria could include economic and social criteria used by authors such as Kreman, Razafimahatratra et al (1999) to assess ecological viability in the Masoala Peninsula of Northern Madagascar. Social and economic criteria could be used to assess or avoid conflict between commercial or community use such as harvesting processes and the preservation of diversity elements.

Another criterion, which could be added to future surveys, is an assessment of edge to interior ratios. A circular reserve is often thought to be better than a thin reserve of equal area (Llewellyn, Shaffer et al. 1995). However, examining this would decrease the rapidity of the survey process. Due to the difficult nature of interior:edge measurement, this was assessed by a simpler but less accurate measurement of size. A larger reserve is often considered better but a simple assessment of size does not indicate that the site will have a lower ratio of edge:interior. This is dictated by shape. It is recommended that interior to edge ratios are calculated and included if resources are available.

Subjectivity may be an issue with the use of some criteria. While most of the prioritisation criteria used were objective, pest severity is a more subjective measure based on the nature, extent and number of animal, plant and human threats. A more accurate, but again more time consuming, assessment of pest severity may be to calculate area affected (Margoluis and Salafsky et al. 2001). Affected area would provide a numerical representation of extent; number of threats is also a numerical measure. However, the measurement of pest severity based on pest nature remains subjective.

A further criticism of prioritisation of sites using presence/absence data is that a species may be considered protected at a site when the population at that site may not be sustainable (Turpie, 1995, Rodrigues, Gaston et al. 2000). This is the problem of persistence. It has been suggested that this problem may be overcome by the use of abundance and permanence data. Rodrigues, Gaston et al (2000) who found reserve selection based on permanence rate to be a more robust method than one based purely on presence/absence data explored this option. However, obtaining the required information will incur additional costs. Also, due to the nature of permanence data several years of survey effort will be required before adequate data is collected for decisions based on permanence data. These factors make the use of permeance data unsuitable for use in a rapid survey of the nature used in this study.

In this study scores were adjusted using the box and whisker method and presented in tables 5.5 and 5.6 where all scores ranged between 1 and four. This allowed criteria to be combined without any single criteria outweighing all others. The downside of the box and whisker method is that in reducing the range of scores that a site may receive for a single criterion, some information and a degree of resolution is lost. However, the relative rankings of sites is not compromised and the combination of criteria within category 1 and 2 allows the synthesis of many variable and sometimes conflicting scores into a single priority ranking.

In summary, the use and manipulation of scoring (prioritisation) criteria in this study overcomes the shortfalls of complementarity analysis. While authors such as Turpie (1995) and Howard, Davenport et al (2000) suggest that scoring procedures are inefficient and lead to replication of some elements and exclusion of others, the high variability observed in this study rendered complementarity ineffective. The box and whisker division method allowed variability of scores to be reduced as all scores were adjusted to fall within a range of 1 to 4. The box and whisker division method enables the synthesis of multiple criteria - a process some authors, such as Kershaw, Mace et al (1995), have approached with the use of complicated weighting procedures. Others have simply avoided the problem by not combing criteria (eg. Goldsmith, 1987). The use and manipulation of criteria in this study also allows for expansion of the portfolio and prioritisation criteria - a key element in the development of a repeatable process.

6.4 PRIORITISATION FRAMEWORK

There is some level of agreement between the two priority ranking systems developed in this study. The 8 priority 1 sites selected in table 5.7 also constitute the top 4 priority levels of table 5.8. Sites ranked priority 4 in table 5.7 (6 sites) also agree with the final 7 sites selected in table 5.8 as priority 14, 15 and 16. However, the intermediate sites do not show a lot of agreement between the two ranking systems. The site Simpsons Reserve appears further up the priority rankings using System Two, while Vinegar Hill appears further down the priority rankings. The differences in rankings is likely be due to the finer division of scores in Ranking System Two. This shows that by extending the framework a finer division of scores may be achieved.

The processing of prioritisation criteria by way of the prioritisation framework developed in this study allows large amounts of data to be represented by one value, which is easy to understand and easy to explain in management decisions. One concern raised regarding the reduction of criteria to a single number is the loss of information. This concern was raised by Turpie (1995, p.179) who stated " the proximate cause of a site's position in the hierarchy is hidden in a complex formula". Authors such as Goldsmith (1987) discourage addition of criteria while others suggest criteria should be assessed both separately and together (Klopatek et al. 1991 cited in Turpie, 1995). Turpie (1995, p.179) states that "the factors contributing to a site's importance need to be explicit to decision-makers". To make this explicit both the table of true scores and final prioritisation rankings be are made available to decision-makers. All scores for criteria are tabulated in their raw or 'true' form, thus allowing managers to refer back to the criteria, which have lead to the final prioritisation ranking of a particular site. This means the information leading to the ranking of sites is not lost because both raw score tables and prioritised rankings are presented to managers. This information is represented by rankings determined by the prioritisation framework.

The process of prioritisation in this study was, inevitably, somewhat biased. The use of some subjective criteria and processes in the prioritisation of wetland sites was biased by value judgements. However, this bias was explained and was consistently geared toward achievement of the goals of this study (eg. higher ranking of high pressure sites over high state sites).

Despite some level of subjectivity, it is believed that the use of the prioritisation framework is a robust method which is relatively simple, repeatable and highly adaptable. The adaptability of the prioritisation framework means that criteria, as discussed previously, may be easily added. The framework may also be altered to suit the goals of the project. For example, if sites found to be under high pressure are considered unworthy of limited conservation effort the ranking of scores within the framework may be altered to favour sites of high state value but under low pressure. Alternatively, the number of priority ranking levels may be increased or decreased, as illustrated by the two priority ranking systems. The use of the prioritisation framework allows all sites within the surveyed portfolio to be ranked - a necessary feature due to the high variability among sites which manifested itself in the complementarity analysis which yielded little resolution of the relative priority value of wetland sites.

To summarise, two different priority ranking systems have been created, providing two different levels of resolution, one of which may be more appropriate than the other under specific conditions. The development of two priority ranking systems based on the prioritisation framework demonstrates the adaptability of the prioritisation procedure. The prioritisation framework allows large amounts of data to be displayed as one value, which is easy to interpret. The presence of bias in the system is acknowledged. However, as it occurs due to attempts to meet conservation goals and is consistently transparent, the presence of bias is not believed to compromise the validity of the prioritisation process. The prioritisation procedure designed in this study provides visual representation of results via the use of box and whisker plots and colour coded priority rankings. The manner in which the priority rankings are presented also allows for interpretation of the relative ranking of sites at a glance.

6.5 OBJECTIVES AND GOALS

The methodology of this study was designed around the achievement of the objectives and goals described in chapter 1. The achievement of objectives and the targets of goals 1 and 2 validates the suitability and validity of this method.

The importance of setting clear goals is often expressed in the literature: (Turpie, 1995, p.175) "the method of site evaluation also depends on the primary objectives and the nature of information available". This opinion is echoed by the Natural Research Council, (1992 cited in Kershner 1997, p.15) "successful restorations require clear goals and objectives to succeed". Also Kershaw, Mace et al. (1995, p.333) "it is necessary to be explicit about the aim of conservation area networks because the aim may have a significant influence on the which sites are chosen and which attributes will be represented".

6.5.1 Achievement of Objectives.

The objectives of this study were explicit. Each objective was a single step in the prioritisation process from identifying sites to the final ranking process. The achievement of targets is indicated in table 6.1.

Table 6.1 Study objectives, achievement and notes on means of achievement.

Objective	Achievement	Notes
To identify wetland sites in the Rangitikei Catchment.	-	Achieved via module one of the rapid ecological wetland assessment. See 6.5.1.1.
Collect information on abiotic and biotic elements of sites.	✓	Achieved via module two of the rapid ecological wetland assessment.
Develop a set of conservation goals for wetlands of the Rangitikei Catchment.	✓	Designed to protect elements of state and eliminate pressures on wetlands.
Identify prioritisation criteria examining pressure on and state of wetlands.	✓	Based on the goals developed under the previous objective.
Develop an effective prioritisation method for wetlands of the Rangitikei Catchment.	✓	Based on the box and whisker division method, complementarity analysis and the prioritisation framework.
To assess the achievement of conservation goals.		See section 6.5.2.

6.5.1.1 Identification of Wetland Sites

While a number of wetland sites within the Rangitikei Catchment were identified, a complete survey of all wetland sites was not conducted. A sample of 25 sites were visited and although many more were identified as part of module one of REWA, these were not included in this study due to a number of constraints such as time and cost. Although only 25 sites were visited the prioritisation procedure appears to be robust and allows easy addition of further sites as they can be simply inserted in to the ranking by application of the prioritisation framework.

6.5.2 Conservation Goals

The two goals led to the establishment of corresponding targets, which were to identify sites of high diversity, and under high pressure. The achievement of these targets were assessed by examining the way in which the priority ranking systems allow conservation effort to be directed towards sites with the greatest biodiversity and under the greatest threat. This was done via the examination of cumulative and percentage representation graphs (figures 5.7, 5.8, 5.9, and 5.10).

The high variability of elements among wetlands sites is again displayed in figures 5.7 and 5.8. These results help to explain why complementarity analysis was unsuccessful. In order to represent an example of all elements, sites at all priority levels (based on Priority Ranking System One or Two) must be included in the portfolio. This is illustrated by the cumulative representation graphs, which continue to rise with every priority level i.e. with the addition of each priority level to the portfolio, new and as yet unrepresented, elements are added to the portfolio. This is the general pattern for both Priority Ranking Systems One and Two. In order to achieve full representation of all known biodiversity, all priority levels must be addressed. The same applies if all threats to wetlands are to be addressed.

The percentage representation graphs (figures 5.9, 5.10) depict the achievement of goals. For example, using Priority Ranking System One over 80% of all pest weed species may be addressed by addressing sites within priority level 1 (figure 5.9). Under both ranking systems the vast majority of pressure elements are identified within priority 1 (figure 5.9) or within the highest priority rankings of Priority Ranking System Two (figure 5.10).

The general pattern of percentage representation of wetland elements is best illustrated by figure 5.10, B which rises and falls with each priority level. This is due to the preferential placement among sites with equal state scores, of the site with the highest pressure score. Thus, both pressure and state scores are alternately high and low. The state score for a site scoring high for pressure is likely to be lower than the state score at the following priority level. However, this pattern is not apparent for all criteria due to high variability.

The sites ranked in the higher priority levels do represent a high proportion of both state and pressure elements. Thus, by focusing conservation effort on high priority sites, a larger proportion of diversity will be protected and sites likely to undergo severe decay may be protected from decline. The system of prioritisation allows conservation effort to be directed to protecting maximum diversity (target 1, goal 1) while identifying and eliminating threats to wetland persistence (target 2, goal 2).

6.5.2.1 Qualifier

The objectives and goals of this study have, to a large degree, been achieved. However, it must be noted that the results of this study are based on a sample of Rangitikei Catchment wetland sites. For this reason the results of this study cannot be unconditionally ascribed to the entire Rangitikei Catchment. As noted previously, further sites can be added to the portfolio with ease.

6.6 CONTRIBUTION

"There is no generally accepted way to design a protected area network" (Howard, Davenport et al. 2000, p.866). This is due to the many and varied goals and issues which must be addressed in any prioritisation process. The only legitimate course of action when approaching this problem, which has been described as a "hard and wicked problem" (Andelman, Ball et al. 1999, p.4), is to assess the issues specific to the area in question and design a method based on these issues.

The achievement of conservation targets supports the selection of the prioritisation framework used in this study and suggests that, if the prioritisation method was to be applied and followed up with action, the attainment of conservation goals is achievable.

The results also suggest that the application of the framework can be altered to suit specific goals and the level of resolution required (cf. tables 5.6 and 5.7). It is a system, which allows criteria to be added or updated. The system permits addition of new sites, which can be surveyed and inserted into the ranking system. The prioritisation process allows all sites to be assessed and ranked. No site is discarded from the portfolio. Every site is ranked, thus allowing managers to view the current status of a site and determine the degree of effort, which must be applied in order to preserve its value.

The results of this study have also demonstrated that the high variability among wetland sites may mean that complementarity analysis is not always the most efficient method. This is contrary to the opinion espoused by authors such as Araujo (1999).

Further studies could include an evaluation of the impact of prioritised conservation action on the wetland network. If the described process is functionally efficient, state values would be expected to remain stable or even increase while pressure scores should decrease and in some cases should be eliminated. The technique could also be refined with the use of additional criteria, or the incorporation of more detailed inventories as they become available.

The prioritisation process presented in this study provides an alternative to the methods described by other authors. For example, Goldsmith (1987) employed a set of selection criteria in creating a prioritised list of forest sites. Goldsmith (1987) did not manipulate or add any criteria, consequently the prioritised list of sites is presented in a table with each individual criteria score. Unlike the method used in the prioritisation of wetlands of the Rangitikei Catchment, this prioritised list can not be interpreted at a glance. The fact that criteria are not combined reduces the simplicity of the prioritised list of sites. Turpie (1995) used both single and multiple criteria indices. Turpie (1995) did not combine single criteria and consequently, produced a large and complex table, illustrating multiple priority rankings, which was not resolved to a single priority list. Again this method fails to produce the clarity of the procedure employed in this study and lacks the visual element, which plays a major role in the methods used in this prioritisation of wetlands of the Rangitikei Catchment.

Other authors such as Araujo (1999) have placed considerable emphasis on the effectiveness of complementarity analysis. This study has shown that complementarity analysis is not always appropriate for use in a prioritisation process. Complementarity, when employed by Turpie (1995) provided a list of priority sites but sites not considered a priority are simply excluded from the list. Therefore, only the top priority sites are prioritised - all other sites are essentially disregarded. In the study of the wetlands of the Rangitikei, complementarity analysis failed to provide a clarified prioritisation of sites due to the extreme variability among them. Other steps (prioritisation criteria, box and whisker division, the prioritisation framework) were necessarily and effectively employed to overcome the shortfalls of complementarity analysis.

Overall, the prioritisation procedure presents itself as an effective framework, which would be suitable for application or adaptation for other networks.

• • •

Heaven

Rupert Brooke

One may not doubt that, somehow, good
Shall come out of water and mud:
And, sure, the reverent eye must see
A purpose in liquidity.

But somewhere, beyond space and time,
Is wetter water, slimier slime.

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Cover plate 7. Rangitikei Estuary Saltmarsh. Photograph by Usha Amaranathan.

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Appendices

Cover plate 8. Pryces Rahui Bush Reserve. Photograph by Usha Amaranathan.

Appendix 1 - Wetland Classification

Presented below is the wetland classification employed in this study.

Refer to section 2.2 Classification.

Wetland Class	Definition
Lacustrine	Standing open water
Palustrine	Vegetation emergent
Marine	Saline open water
Estuarine	Saline + freshwater
Riverine	Flowing open water

Appendix 2 - REWA Assessment Sheets

Presented in Appendix 2 is a completed set of REWA assessment sheets.

Refer to section 3.3 Manawatu-Wanganui Regional Council Rapid Ecological Wetland Assessment, and Table 4.1 *Sites V1.0* runs, run descriptions and algorithm type.

Rapid Ecological Wetland Assessment[3]

Wetland	☐ ☐	Permanent Seasonal Days per season: Variability (ha): Variability (m):	Inundation state: water surface (m^2): water depth (m):
Fencing	4 3 2 1	No fencing Some fencing (one side, large breaks) % Mostly fenced (areas where stock access is likely) % Secure, intact fencing around entire perimeter %	Notes: Compare field assessment !
Animal/ Plant pest problems	☐ ☐	Plant Pests: Animal Pests:	Notes:
Tenure:	4 3 2 1	Public property Maori land Private property Leased	Date of occupancy:
Protection status	9 8 7 6 5 4 3 2 1	No legal - no managed protection (pest control) Reserve (TLA) - no managed protection Covenant (QEII) - no managed protection Reserve (DoC) - no managed protection No legal protection, but fenced and/ or pest controlled Agreement, contract (RC) and managed protection Reserve (TLA) managed protection Covenant (QEII) and managed protection Reserve (DoC) and managed protection	Year protected: Area legally protected: Protection measures:
Matrix land-use	9 8 7 6 5 4 3 2 1	Dairying / Cropping Sheep and Beef Urban subdivisions Garden; Parkland Open space; Bare land; Recreation land Fire climax forestry (Pinaceae; Myrtaceae) Coastal Dunes Permaculture tree lands; sustainable shelterwood forestry, planted natives Indigenous forest / scrub	Production method: Organic / Conventional
Drainage	☐ ☐ ☐ ☐	Open drains Tile, mole drains Bores Irrigation	Notes: Compare field assessment !
Artificial constr. around in-outflow	☐ ☐ ☐	Dams Weirs Culverts	Notes: Compare field assessment !
Site visit	☐ ☐ ☐ ☐	Free access granted Access permit required Call again for exact appointment No access granted!	Alternative action:
Owner's comments: e.g. Efforts being made		☐ feedback wished by owner	

[3] Preparatory assignment. Query GIS, ecosat, agribase, cadastral information, phone / email landowner.
Obtain aerial photocopy, topographic sitemap.

ECOSYSTEM / HABITAT

Wetland Site type :	☐ Coastal	☐ Estuarine	☐ Riverine	☐ Lacustrine	☐ Palustrine	☐ Artificial

Code	Wooded / treefern habitat category A (80/20)	Code	Grass, herb, moss habitats B	Code	Bare habitats C
1	Podocarp forest	20	Herbaceous wetland	40	Rocky coast
2	Broadleaved forest	21	Flaxland (*Phormiaceae, Liliaceae, Iridaceae*)	41	Sand coast, Dunes
3	Beech forest	22	Reedland (*Typha sp*)	42	Lagoon
4	Podocarp-broadl. forest	23	Sedgeland (*Uncinia, Carex*)	43	Marsh
5	Pod.-broadl.-beech forest	24	Rushland (*Restionaceae, Juncaceae, Cyperaceae, Pingao*)	44	River, Riverbed
6	Kanuka forest (*Kunzea ericoides*)	25	Native grassland (Bush rice grass, *Poaceae, Trisetum, Cockaynea, Hierochloe*)	45	Lake
7D	Fire climax **W**ildings / **P**lantation	26	Tall grasses>1m(*Cortaderia*)	46	Pond
8D	Exotic deciduous Woodland **P / W**	27	Tussock (*Chinochloa*)	47	Stream
9	Parkland (spaced plants)	28D	Exotic grassland (*Lolium, Festuca, Poa, Phleum*)	48	Cliff, Bluff, Gorge
10	Wetland Forest	30	Herbfield	49	Rockland
11	Shrubland (*Leptospermum, Olearia, Hebe*)	31	Cushionfield	50	estuary
12	Scrub (regen.)	32	Fernfield (*Pteridium esculentum*)	51	Peatland
13	Treefern land (*Cyathea, Dicksonia*)	33	Moss and Clubmossfield	52	Island
D	**Artificial / Exotic / Planted habitats**	34	Lichenfield	60	Other types (specify)
				E	**Ecotone / Edge**

Ecological Context

Unit	Category: A,...E[4],M	Code	Habitat area estimate[5]

[4] Tessellated habitat types within site 'S' = $\Sigma(U_i, E_i)$:
U_{1-1}, U_{1-2}, U_{1-3} : subunits of unit 1

[5] Estimate habitat area and/or area covered by abundant species: **Z** > l km² (>*100 ha or1000x1000m*); **Y** 100 ha-25ha (*500x500m*); **X** 25ha-10ha(*200x500m); **W** 10 ha-5ha (100x500m*); **V** 5 ha-1ha(*100x100m*); **U** 1ha-1acre(=0,4ha or *40x100m*);
T 1acre-1/4acre(*20x50m*); **S** 1/4 acre-town house (10x10m); **R** town house-dining room (5x5m);**Q** (< 5x5m).

CLIMATIC CONDITIONS DURING THE VISIT

Humidity	Dry Moist Mist Fog Rain	☐ ☐ ☐ ☐ ☐	**Clouds**	Clear -1/3 Cumulus -2/3 Cumulus Cirrus Alto stratus Stratus N-stratus	☐ ☐ ☐ ☐ ☐ ☐ ☐	**Winds**	Calm Light breeze (leaves) Breeze (twigs) Windy (branches) Storm (trees sway)	☐ ☐ ☐ ☐ ☐	**Temp**	Hot > 25 ^{c} Very warm 20-25^{c} Warm 15-20^{c} Cool 10 - 15^{c} Cold 1 - 10 ^{c} Frost < 0 ^{c}	☐ ☐ ☐ ☐ ☐ ☐

PHOTOPOINTS

Mark photopoints on Aerial photo by cross. **Peg placed at site:** ☐ Yes ☐ No	**Indicate direction of photographs taken by arrow.** **Photo of setup taken** ☐ Yes ☐ No

GPS ID	Photo				
	No	Description	GPS E / N	Compass Bearing	Zoom

Description of the site :

Comments

HABITAT STRUCTURE AND FUNCTION

Estimate Species Abundance (Cat: by area[6] or number[7]; or as % cover).

List most common and key species (see attached list)

	Emergent Climbers / Epiphytes			Canopy				Sub-canopy				Ground			
Unit	Species	H (m)	Cat	Species	H (m)	Cat	%	Species	H (m)	Cat	%	Species	H (m)	Cat	%

[6] Estimate habitat area and/or area covered by abundant species: **Z** > I km^2 (*>100 ha or1000x1000m*); **Y** 100 ha-25ha (*500x500m*); **X** 25ha-10ha(*200x500m);* **W** 10 ha-5ha (100x500m); **V** 5 ha-1ha(*100x100m*); **U** 1ha-1acre(=0,4ha or *40x100m*);
T 1acre-1/4acre(*20x50m*); **S** 1/4 acre-town house (10x10m); **R** town house-dining room (5x5m);**Q** (< 5x5m).

[7] Estimate abundance category by number: ⑤=> 50; ④=20-50; ③=10-20; ②=5-10; ①= <5 specimen.

WETLAND CONNECTIVITY (SURFACE WATER)

	Permanence[8]	Substrate[9]	Velocity[10]	Waterfall	Dams	Weirs	Culverts	Barriers at low flow	Perched Culverts	Barriers to fish migration
Inflow				YES / NO nb : H (m) :	YES / NO nb : H (m) :	YES / NO nb : H (m) :	YES / NO nb : H (m) :	YES / NO nb : H (m) :	YES[11] / NO nb : H (m) :	YES / NO nb :
Comments :										

	Permanence[6]	Substrate[7]	Velocity[8]	Waterfall	Dams	Weirs	Culverts	Barriers at low flow	Perched Culverts	Barriers to fish migration
outflow				YES / NO no : H (m) :	YES / NO no : H (m) :	YES / NO no : H (m) :	YES / NO no : H (m) :	YES / NO no : H (m) :	YES[9] / NO nb : H (m) :	YES / NO no : H (m) :
Comments :										

ECOTONE INTACTNESS

Lakes and ponds

Habitat code	% of circumference	E.I. Score (1-6)

E.I scores :

Pristine (water to >100m native veg)	6
Natural (water to <100 m native veg)	5
Mainly native (water - native veg – exotics)	4
Intersected native (Water – exotics – native veg)	3
Mainly exotic (water – native veg and exotics / pest exotics)	2
Exotic plant/ pests (water –exotics)	1

Rivers and streams

Left Bank (facing downstream)			Left Bank (facing downstream)		
Habitat code	**% of circumference**	**E.I. Score (1-6)**	**Habitat code**	**% of circumference**	**E.I. Score (1-6)**

[8] 1 = permanent ; 2 = frequent ; 3 = infrequent.

[9] Name most to least common substrate type: **R**ocks, **P**ebbles, **SA**nd, **S**ilt; **M**ud

[10] **Fast** <3 sec/m. **Med**ium 3-5sec/m ; **Slow** >5 sec/m

[11] Note GPS coordinates below

FAUNA PRESENCE CARD

Tide Level (for estuaries):

Birds (record native and exotic species within the habitat patch) give number or tick

Terrestrial Species	Seen	Heard)	Other reports[12]	Unit(s)	Wetland Species	Seen	Heard	Other reports	Unit(s)
Bellbird					Tui				
Blackbird					Turkey				
Banded dotterel					Paradise shelduck				
Black backed gull					Pied shag				
Black billed gull					Pied stilt				
Black shag					Pukeko				
Black swan					Red billed gull				
California quail					Rock (domest) Pigeon				
Canadia Goose					Royal Spoonbill				
Caspian tern					Scaup				
Cattle Egret					Shoveller duck				
Chaffinch					Variable oystercatcher				
Coot					Welcome swallow				
Dabchick					White Faced Heron				
Eastern rosella					White-fronted tern				
Fantail					Whitehead				
Goldfinch					White Heron				
Greenfinch					Yellowhammer				
Grey duck									
Gey Teal					Australasian Gannet				
Grey warbler					Banded rail				
Harrier hawk					Bar-tailed Godwit				
Hedge sparrow					Black-fronted Dotterel				
House sparrow					Bittern				
Kereru					Cuckoo spp				
Kingfisher					Falcon				
Little black shag					Fernbird				
Little shag					Knot				
Magpie					Marsh crake				
Mallard duck					Morepork				
Masked Lapwing					NZ dotterel				
Mute swan					Robin				
Peacock					Shining cuckoo				
Pheasant					Spotless crake				
Pipit					Turnstone				
Red poll					Wrybill				
Rook									
Silver eye					Others :				
Skylark									
Song thrush									
Starling									
Tomtit									

Other Fauna

Species Name	Heard (tick)	Seen (tick)	Sign Observed (describe)	Other reports	Habitat type

[12] Owner's observations (or other people). Try and report only reliable observations.

THREATS

Plant Pests (See attached list)

Unit	Species	Height (m)	Area Cat	Area %	Distri bution[13]	Adult / juv ratio	Access to the site[14]	Description / comments
						% juv % ad		
						% juv % ad		
						% juv % ad		
						% juv % ad		

Animal threats (stock and / or wild pests)

Unit	Species	Impact				Current Management	Fencing[15]	Comments
		Nature of damage / threat	Seriousness[16]	area				
				ha	%			
						Yes /no Nature :		
						Yes /no Nature :		
						Yes /no Nature :		
						Yes /no Nature :		

Human Usages

Unit	Activity[17]	Impact				Current Management	Comments
		Nature of damage / threat[18]	Seriousness[14]	area			
				ha	%		
						Yes /no Nature :	
						Yes /no Nature :	

[13] **1** = One small patch ; **2** = Locally scattered ; **3** = Local patches ; **4** = Scattered throughout ; **5** = Patches throughout ; **6** = Common throughout

[14] **1** = Difficult access, several kilometers from roads, no easy helicopter landing sites ; **2** = Several kilometers to road, but good helicopter landing site ; **3** = Short walk from 4WD access ; **4** = Short walk from road suitable for two-wheel drive ; **5** = Vehicle access right to the site

[15] **1** = Secure intact fencing around entire perimeter ; **2** = Mostly fenced (all areas where stock access is likely; some small recent breaks) % ; **3** = Some fencing (one side, poorly maintained or large breaks) % ; **4**= no fencing

[16] **1** = No evidence ; **2** = signs ; **3** = moderate ; **4** = High ; **5** = Major

[17] Examples : earthworks ; rubbish dumping ; waterways works ; clearing ; drainage ; tramping, shooting, recreational vehicles…

[18] Examples : erosion, trees chopped, destruction of riparian cover, barriers to fish migration, birds disturbed on nesting sites….

RECOMMENDED MANAGEMENT PRIORITIES

Threats, Impacts				Management		
	Minor	Moderate	Major	Urgency[19]t	Priority[16]	Comments
Cattle	☐	☐	☐			
Sheep	☐	☐	☐			
Rabbit, Hare	☐	☐	☐			
Deer	☐	☐	☐			
Goat	☐	☐	☐			
Predators (specify)	☐	☐	☐			
Possum	☐	☐	☐			
Human visitor impacts	☐	☐	☐			
Weeds herbs / grasses	☐	☐	☐			
Weeds shrubs, trees	☐	☐	☐			
Weeds vines	☐	☐	☐			
Other (specify)	☐	☐	☐			

Management Needs	No	Yes	If Yes, give urgency	If Yes, give priority	Comments
Environmental education	☐	☐			
Fencing	☐	☐			
Farm plan	☐	☐			
Catchment plan	☐	☐			
Visitor Management	☐	☐			
Other:	☐	☐			
Monitoring Needs					
Rapid assessment of ecological context (Baseline)	☐	☐			
Distance monitoring (Ecosystem function)	☐	☐			
Plot monitoring (Change)	☐	☐			

OWNER COMMENTS

Environmental Awareness (EA) and Attitude (AT)	5 4 3 2 1	No EA, Confronting AT (Plan to clear bush; drain site) Some EA / Indifferent AT Some EA / Co-operative AT Good EA / Co-operative AT (interested in native ecosystem functions and sustainable farm production) Good EA / positive AT (efforts already made and keen to enhance further)	Recommendation[17] / Comments:
	☐	Confidentiality wished by the owner	

[19] **1** = low urgency ; **2** = moderate urgency ; **3** = high urgency
[16] **1** = low priority ; **2** = moderate priority ; **3** = high priority ;
[17] f.e. Environmental Award, Environmental Grants, Environmental Education Regulation

KEY Species

Emergent Climbers / Epiphytes

Kahikatea
Matai
Miro
N. Rata
Rimu
Totara
Perched lilies
Met ful
Supplejack

Canopy

Species (m)
Cordyline
Fuchsia
Hinau
Kohekohe
Miro
Hed arb
Pse arb
Titoki
Not spp.

Sub-canopy

Cop gra
Fuchsia
Kowhai
Lancewood
Marbleleaf
Miro
Pit eug
Pit cras
Pse col

Ground

Cop gra
Cop rob
Pit ten

WETLAND INDICATOR species

Emergent

Kahikatea - *Dacrycarpus dacrydioides*
Pukatea - *Laurelia novae-zelandiae*
Swamp Maire - *Syzygium maire*
Silver podocarp - *Lagarostrobos colensoi*

Mountain cedar - *Libocedrus bidwillii*
Kawaka - *Libocedrus plumosa*
Yellow podocarp - *Halocarpus biformis*
Yellow silver podocarp - *Lepidothamnus intermedius*
Twiggy tree daisy - *Olearia virgata*
Manuka - *Leptospermum scoparium*
Cabbage tree - *Cordyline australis*
Mountain cabbage tree - *Cordyline indivisa*
Dwarf cabbage tree - *Cordyline pumilo*

Climbers / Epiphytes

Kowharawhara - *Astelia spp*
Kahakaha – *Collospermum spp*

Sub canopy

Kotukutuku (tree fuschia) – *Fuschia excorticata*

Coprosma rotundifolia

Grass and Herb swamps

Emergent

Carex secta
Cortaderia toetoe

Canopy

Phormium tenax
Typha spp.
Carex virgata

Scirpus lacustris
Eleocharis sphacelata
Juncus pallidus
Carex geminata
Hierochloe redolens
Nertera balfouriana

Ground Floating / Submerged

Thelymitra venosa

Vegetated Peatlands

Canopy

Myriophyllum pedunculatum
Arbotanella caespitosa
Celmisia graminifolia
Oxalis lactea
Nertera balfouriana

Ground Floating / Submerged

Empodisma minus
Leptocarpus similis
Chinocloa rubra
Droscera spathulata
Droscera binata
Droscera arcturi
Droscera stenopetala
Corybas unguiculatus
Donatia Novae-zealandiae
Gleichnia dicarpa
SphagnumLycopodium

Plant Pest List

Status	Species		Status	Species	
	Common name	Scientific name		Common name	Scientific name
RCP	African Love Grass	Eragrostis curvula	CONT	Australian Sedge	Carex longebrachiata
RCP	Alligator weed	Alternanthera philoxeroides	CONT	Blackberry	Rubus fruticosus
RCP	Californian. Bullrush	Scheonoplectus californicus	CONT	Boneseed	Chrysanthemoides monilifera
RCP	Cathedral bells	Cobaea scandens	CONT	Broom	Cytisus scoparius
RCP	Chinese pennisetum	Pennisetum alopecuroides	CONT	Californian Thistle	Cirsium arvense
RCP	Dysophylla	Buddleja dysophyla	CONT	Gorse	Ulex europeaus
RCP	Evergreen Buckthorn	Rhamnus alaternus	CONT	Heather	Calluna vulgaris
RCP	Nassella Tussock	Nassella (or Stipa) trichotoma	CONT	Nodding Thistle	Carduus nutans
RCP	Purple Loosestrife	Lythrum salicaria	CONT	Old man's beard	Clematis vitalba
RCP	Pyp Grass	Ehrarta villosa	CONT	Perennial Nettle	Urtica dioica
RCP	Sagittaria	Sagittaria graminea ssp platiphylla	CONT	Plumeless Thistle	Carduus aconthoides
RCP	Senegal tea	Gymnocoronis spilanthoides	CONT	Ragwort	Senecio Jacoaea
			CONT	Variegated Thistle	Sylibum marianum
DCP	Spartina	Spartina spp	CONT	Wild ginger species:	
DCP	White Bryony	Bryonia cretica ssp dioica	CONT	Kahili Ginger	Hedychium gardnerianum
			CONT	Yellow Ginger	Hedychium flavescens
OCP	African Feather Grass	Pennisetum macrourum			
OCP	Pinus contorta	Pinus contorta	SURV	Banana passionfruit	Passiflora mollissima
OCP	Darwins Barberry	Berberis darwinii	SURV	Blue Morning Glory	Ipomoea indica
OCP	Woolly nightshade	Solanum mauritianum	SURV	Chilean Flame Creeper	Tropaelum speciosum
			SURV	Chilean Rhubarb	Gunnera tinctoria
SSP	Barberry	Berberis glaucocarpa	SURV	Climbing asparagus	Asparagus scandens
SSP	Bl.passion flower	Passoflora caerulea	SURV	Climbing spindleberry	Celastrus orbiculatus
SSP	Boxthorn	Lycium ferocissimus	SURV	Coastal Wattle / Sydney Golden Wattle	Acacia sophorae/ longifolia
SSP	Brush wattle	Paraserianthes lophantha	SURV	Egeria	Egeria Densa
SSP	Elder	Sambucus nigra	SURV	Grey Willow	Salix cinerea
SSP	Ivy	Hedera helix	SURV	Hornwort	Ceratophyllum demersum
SSP	Jap. Hon.suckle	Lonicera japonica	SURV	Japanes Walnut	Juglans ailantifolia
SSP	Jasmine	Jasminum polyanthum	SURV	Lagarosiphon	Lagarosiphon major
SSP	Pink Ragwort	Senecio glastifolius	SURV	Madeira vine	Anredera codifolia
SSP	Sycamore	Acer pseudoplatanus	SURV	Moth plant	Araujia sericifera
SSP	Wandering jew	Tradescantia fluminensis	SURV	Mugwort	Artemisia verlotiorum
			SURV	Nut Grass/Purple nutsedge	Cyperus rotondus
			SURV	Pampas & Purple Pamp.	Cortaderia selloana, C. jubata
			SURV	Parrot's Feather	Myriophyllum aquaticum

RCP.= Regional (Horizons.mw) Control Pest;
DCP = DoC Control Pest;
OCP = Occupier Control Pest;
SSP = Significant site pest;
CONT = Containment Pest;
SURV = Regional and National Surveillance Pest.
All plant pests in grey cells must be reported to Plant Pest Management Officers.