HAWKE'S BAY
REGIONAL COUNCIL

Hawke's Bay Biodiversity Inventory

Current State of Knowledge

August 2014

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Environmental Science - Land Science

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Contents

Tables

Figures

Executive summary

Hawke's Bay Regional Council (HBRC) working in conjunction with the Animal Health Board, Central Hawke's Bay District Council, Dairy NZ, Department of Conservation (DoC), Farm Forestry Committee, Federated Farmers, Fish & Game New Zealand, Forest & Bird, Hastings District Council, Hawke's Bay Forestry Group, Hawke's Bay Fruitgrowers' Association, Mana Ahuriri Iwi Inc., Maori Trustee, Ministry for Primary Industries, Napier City Council, Ngā Whenua Rāhui, Ngati Kahungunu Iwi Incorporated, QE II National Trust, Te Taio Hawke's Bay Environment Forum, and Wairoa District Council have made a commitment to develop a Hawke's Bay Biodiversity Strategy by the end of 2014. As part of the strategy development, a Biodiversity Inventory has been developed. HBRC is coordinating a development of the strategy, the inventory and the production of this report with contributions from experts at other agencies such as DoC and Fish and Game.

The purpose of the Biodiversity Inventory is to summarise existing information on biodiversity in the Hawke's Bay region and to provide a more informed understanding of our current state of regional biodiversity. When combined with understanding of drivers of decline (or enhancement), this information will guide regional priorities and targets for the Regional Biodiversity Strategy. The Inventory is a living document, requiring inputs from key partners undertaking biodiversity initiatives. This report is a supplementary document for the Inventory, summarising information collected in the Inventory to date. In the process of compiling information, knowledge gaps have been identified from which recommendations have been made to improve the Inventory and our understanding of biodiversity.

The approach taken in this report is to use published, nationally available databases, and interpret those national datasets within a regional context.

Published literature and expert opinion have been used to identify the presence, distribution and threat status of species. Detailed habitat mapping was completed for threatened birds by avian experts in the region. This was the only taxonomic group for which there was sufficient knowledge to do so. Many other taxonomic groups, particularly those that are cryptic, which also are often the most diverse, have not been studied in such detail. It is unlikely, if not impossible, that the state of cryptic species in the region can be understood. DoC has recently published a list of indicator species to monitor native species trends across New Zealand. It is recommended that this list is reviewed and DoC's initiatives are complemented with actions that help the region achieve the indigenous species objectives of the Biodiversity Strategy.

Habitats were characterised into one of three classes, terrestrial, freshwater and coastal/marine. Where possible, terrestrial vegetation and river habitat types were classified in a quantitative manner, using national classification systems, while characterisation of other habitat types remained qualitative. The level of threat to each habitat type was also determined, where feasible. Only threat classification to terrestrial vegetation is reported on here. Wetlands, sand dunes and other 'Historically Rare Terrestrial Ecosystems' are deemed vulnerable and afforded national priorities by the Ministry for the Environment and Department of Conservation (2007).

1 Background

HBRC and other stakeholders in Hawke's Bay have made a commitment to create a Hawke's Bay Biodiversity Strategy by the end of 2014. The strategy has two key objectives relating to both native species and native habitats:

- Native species: we have sustainable populations of native species throughout the region.
- Native habitats: we sustain, protect, and improve native habitats and the ecosystem services they provide.

Despite a growing appreciation of the importance of indigenous biodiversity which saw drastic reform of New Zealand's environmental management systems, New Zealand is failing to stop the indigenous species and habitat losses (Brake and Peart, 2013). However there are many initiatives to protect and enhance biodiversity being undertaken by different agencies, community groups and landowners which has brought localised successes in protecting indigenous biodiversity. At present there is no comprehensive understanding of the situation of biodiversity within Hawke's Bay. The biodiversity inventory aims to fill that gap by serving as a central repository of information on native species and habitats that can be shared by all stakeholders involved in biodiversity protection and enhancement.

HBRC is coordinating the development of a biodiversity inventory in conjunction with individual experts and organisations engaged in the biodiversity field. Extensive input has been required from key partners, such as DoC, to help fill knowledge gaps and prioritise the areas of greatest need.

2 Purpose and Structure of the Report

2.1 Purpose of the Biodiversity Inventory

The process of developing the Biodiversity Inventory (the Inventory, hereafter) will clarify the state of our current knowledge on biodiversity and will identify what we do **not** know about the region's biodiversity. From what we know about the region's biodiversity, the Inventory attempts to answer the following questions:

- What was the historical state of biodiversity in the region?
- What is the current state of biodiversity in the region?
- What, where and how has biodiversity been changed?
- What caused the changes?
- What aspects of biodiversity are threatened?
- How big is our knowledge gap?

Identifying knowledge gaps will guide the development of the Hawke's Bay Biodiversity Strategy and set objective and outcomes under the strategy.

The Inventory is intended to be a living database which will be updated and maintained as knowledge and information are gained.

2.2 Structure of the report

To answer the questions outlined above, the inventory intends to capture information on both species and habitat levels.

Species whose status is 'Threatened' or 'At Risk' under the National Threat Classification system administered by the Department of Conservation were examined to understand which threatened species are present, and where they are distributed in the region.

An attempt was made to characterise all indigenous habitats that are characteristic of the Hawke's Bay region. 'Characteristic' includes habitat types that should be present and those that are currently present in the region. Where possible, threat status is assigned to habitat types based on the degree of change in their extent.

Species-level and habitat-level information are complementary, and will help determine where biodiversity protection priorities may lie.

"Where to from here" at the end of each section for vulnerable species and habitat types is a conclusion for each section, summarising findings, knowledge gaps and issues identified and proposing next steps to be taken. "Recommendation" is a list of those proposed actions.

Appendix A of this report summarises the information collected and compiled to date. Given the definition of the term 'inventory' (as a detailed, itemised list of things) Appendix A can be considered as a preliminary form of the Biodiversity Inventory. The rest of the report explains in more detail the process of data collection, contents and interpretation of data. Constraints associated with data are also discussed where necessary. In the process of compiling information, knowledge gaps have been identified from which recommendations have been drawn to improve the Inventory and the understanding of biodiversity.

3 Vulnerable species and their habitats

Having being isolated from the rest of the world for millions of years, New Zealand's flora and fauna has a high degree of endemism, that is they are unique in their ecological traits, behaviour and assemblages, and are found only in New Zealand. The most notable feature of the New Zealand habitat prior to human arrival was the low numbers of predators, and complete lack of mammalian predators and large mammalian herbivores. Introduced mammals are one of the deadliest threats to indigenous flora and fauna, through predation, competition for food and habitats, and modification to habitats through browsing. Habitat loss and modification by land use activities poses an equally significant threat to the species decline.

In the context of these national trends in species, a baseline for the region was determined by noting the occurrence and distribution of 'Threatened' or 'At Risk' species.

3.1 Method

As part of its legislative responsibilities, the Department of Conservation (DoC) has developed the New Zealand Threat Classification System (Townsend et al., 2008). Most of indigenous species in New Zealand are assigned one of the threat statuses listed below (Figure B-1, Appendix B):

- Not threatened
- At risk

- Threatened
- Extinct
- Data deficient

The system is made up of manuals and corresponding taxa status lists. The classification system is reviewed every ten years and the status of each indigenous species group including birds, plants and reptiles lists of species are reviewed every three years. The latest listing was completed in the 2008 – 2011 period at the time of this report being written.

The latest lists of indigenous species assessed by DoC and experts were obtained from DoC. Algae, freshwater invertebrates and marine fish were not reassessed during the 2008-2011 cycle, hence the information is taken from the 2004-2007 listing (Hitchmough, 2013). Each list was reviewed, recording the presence/absence of the species in the region. This was done using published information, including DoC's species database (for bats, reptiles, vascular plants, bryophytes, lichens, and fungi), and expert knowledge. Key information such as location of stronghold[1] sites and population size, if any, was also recorded.

The threatened bird list was reviewed by local avian experts during a workshop held on 17 June 2013. This workshop generated the latest information on habitat requirements and conservation sites as well as presence/absence of species. Following the workshop, the habitat information was digitised using ArcGIS. No expert workshops were held for other taxonomic groups.

Broad habitat type analysis was done where spatial data of species observation existed, for vascular plants, bats, fungi, bryophyte, and amphibians and reptiles. The species observation record was then spatially overlaid with the Land Cover Database (version 3) so that the landcover class acted as a surrogate for a habitat type.

The Department of Conservation uses the term 'taxa' which means any taxonomic entity that has been acknowledged by relevant experts, and may refer to genus, species, subspecies, varieties or forma. The term 'species,' which is more well-known term than 'taxa,' is used throughout this document for all of the taxonomic ranks.

3.2 Key findings

Table 3-1 summarises the current knowledge base for vulnerable species relevant to the region.

Nationally, many species have experienced severe reductions in both population size and distribution. One bird and six invertebrate species were added to the 'Extinct' category during the early 2000s. There are further seventy species that have not been seen for more than two decades, but are currently listed as 'Data Deficient' or 'Nationally Critical' (Hitchmough et al., 2007; Hitchmough, 2013). Where sufficient data exists, some taxonomic groups have a high proportion of species that are threatened, including bats, frogs and reptiles (lizards).

The regional picture is similar to that of national picture, where some of the taxonomic groups have a high proportion of vulnerable species. Several species have been lost from the region (shown as 'Locally Extinct' in Table 3-1), and the region is devoid of indigenous frogs.

[1] 'Stronghold 'is defined as 2 % or more of the national population of a species. '2%' rule has been used by local avian experts for national and international wetland programmes such as identification of nationally and internationally significant wetlands for Ramsar Convention on Wetlands (J. Cheyne, personal communication, 17 July 2014).

3.2.1 Known key habitat types for 'Threatened' or 'At Risk' species

Detailed habitat information is compiled and available only for threatened bird species (Appendix C). For the rest of the taxonomic groups, habitat type information is available in the form of observation records, conservation management plans, published information, and expert opinions. There is no comprehensive delineation of habitats for these taxonomic groups.

Indigenous forest, scrub and grassland are home for many threatened species. Large and intact indigenous forests are now confined to the ranges in Hawke's Bay. Many native species relying on such habitats are also confined as a result. For example the central lesser short-tailed bat known population is confined to the Te Urewera National Park. Many streams run through the intact forests on the ranges, providing environments that support threatened species such as the blue duck (Whio). Three large land snail species known to occur in the Hawke's Bay are restricted to high altitude indigenous forests. Regenerating forest, scrub and shrublands provide habitat for threatened species such as the Wellington green gecko. A combination of tussock grassland and rock outcrops and screes at high altitude is a key habitat for specialised species such as the small-scaled skink.

Braided rivers and freshwater wetlands are key habitat types for many threatened bird species. Many known strongholds of threatened bird species occur in these habitats. A single site can hold significant proportions of the national population, such as Lake Hatuma, which has 1% of the national population of bittern, and predator-free Cape Sanctuary[2], which has 10% of national population of brown teal (Table C-1, Appendix C). Many threatened vascular plants are also found in these habitat types (Walls, 1998).

Sand dunes, coastal cliffs, beaches, estuaries and shallow coastal water (to 30 m deep) normally occur within a few hundred metres of the high tide mark. In this area, indigenous coastal terrestrial habitats are fragmented and limited to smaller patches in the region. However the remaining habitats have highly diverse resident and migratory birds and rare native plants. Hawke's Bay is the southern extent of the distribution of Northern New Zealand dotterel[3]. Portland Island is one of the key breeding sites for vulnerable and non-threatened birds, including Northern New Zealand dotterel and New Zealand shore plover. Cobble and shingle beach along the coastline of the region contains species that are evolved to adapt to specific coastal habitats and some of them become genetically and/or morphologically divergent taxa, such as spotted skink (*Oligosoma lineoocellatum*).

Some of the threatened species may use modified environments as habitats. Exotic plantation forests are known to provide habitats for threatened species such as New Zealand falcon and long-tailed bats (Pawson et al., 2010). Some threatened species thrive in modified habitats if they are free from exotic mammalian predators. Cape Sanctuary has living records of brown teal using farm ponds with very light wetland vegetation, and North Island brown kiwi in the open regenerating manuka and kanuka shrubland (J. McLennan, personal communication, 17 June 2013).

3.2.2 Threats

Introduced mammals have devastated the indigenous flora and fauna of New Zealand and in some cases irreversibly altered ecological processes (Table 3-1). Their impact can be direct or indirect. For example, introduced mammal foraging can impede symbiotic relationship between plants and indigenous pollinators. Browsing by introduced mammals can alter the composition of vegetation communities and cease vegetation succession, resulting in habitat modification and loss.

[2] Cape Sanctuary is a wildlife restoration project established in 2006 by landowners of the Cape Kidnappers peninsula, Hawke's Bay. For more information, refer to http://www.naturespace.org.nz/groups/cape-sanctuary.

[3] New Zealand dotterel is now observed in Wellington region (N. McArthur, personal communication, 18 June 2014)

Habitat loss is an on-going threat, and is clearly reflected in the loss of indigenous vegetation and other ecosystem types (see section 4). There are multiple causes of this, including land conversion to agricultural use, urban development, invasive species, browsing, sedimentation in aquatic environments and the draining of wetlands. Habitat loss has negative effects on population growth, breeding success, and dispersal success, and it alters ecological processes within a habitat (Fahrig, 2003).

Habitat fragmentation, in a strict sense, is not a habitat loss but is a process of a large expanse of habitat being transformed into a number of smaller patches (Wilcove et al., 1986 in Fahrig, 2003). It modifies the habitat configuration, creating isolation between each fragment, and changing the original habitat extent. Loss of connectivity between habitats has a negative effect on indigenous biodiversity, particularly for specialist species with specific habitat requirements and for species that are less mobile.

Table 3-1: Threatened and At Risk native species of Hawke's Bay. 'Regional' shows the proportion of 'Threatened' or 'At Risk' (in brackets) native species currently recorded in Hawke's Bay. The number of species that have disappeared from the region (locally extinct) that still exist elsewhere in New Zealand is also shown. 'National' shows the proportion of 'Threatened' or 'At Risk' (in brackets) species in the total number of native species listed in the latest National Threat Classification. The numbers are indicative, and must not be taken as a complete picture of the threatened species. The numbers with an asterisk (*) indicates that their accuracy is likely to be very low due to limited information. Threats are described in the national context, but deemed to reflect the regional situation.

Taxonomic Group		Regional			National		Threats (including but not limited to)
		Number of species recorded in HB	% 'Threatened' ('At Risk') species recorded in HB	Locally Extinct (present nationally)	% 'Threatened' ('At Risk') species	Nationally Extinct (since 1000 AD)	: National context but also likely to be relevant for the region
Bat		2	50 % (50 %)	0	57 % (14%)	0	Introduced mammals (predation, competition for food such as nectar), habitat loss (particularly large and intact, old-growth indigenous forest), possibly disease. Ship rats and possums feed on significant amounts of nectar from flowers of wood rose (*Dactylanthus taylorii*), making it unavailable to lesser short-tailed bats (O'Donnell et al., 2010).
Bird		95	21 % (29 %)	9 species	20 % (24 %)	51 species[4]	Introduced rats and possums, mice (predation, competition for food), habitat loss (Miskelly et al., 2008)
Bryophyte	Moss	10*	8 % (23 %)*	Unknown	19 % (63 %)	0[5]	Habitat loss through deforestation, forest modification, land reclamation, urbanisation, road and dam construction, mining, wetland drainage and over-grazing. Invasive, introduced vascular plant species can also devastate native bryophyte floras. Pollution (as they lack cuticle, a layer on the outer cell surface that protects the tissue from harmful substances), and drought (because of their structure and low reproduction rates).
	Liverwort	20*	20 % (45 %)*	Unknown	12 % (36 %)	0	
	Hornwort	0*	0 % (0 %)*	Unknown	0 % (0 %)	0	
Freshwater fish		25	0 % (38 %)[6]	1 species	26 % (37 %)	1 species	Land use change (through agricultural and forestry effects), predation and competition by introduced fish, water abstraction, loss of interconnectedness of source and sink of population, habitat modification and construction of barriers (such as waterfalls and rock sections) and subsequent invasion of predatory fish to areas upstream of barrier (Allibone et al., 2010)

[4] The latest bird listing includes extinction since 1800, and there was an error in Hitchmough (2013), which missed pre-1800. Therefore, the data is sourced from TE ARA (http://www.teara.govt.nz).
[5] No bryophyte species are known to be extinct to date, but a few species needs validation for their existence (Glenny et al., 2011).
[6] Three freshwater fish species are considered 'Regionally At Risk' (but 'Not Threatened' under the National Threat Classification) which is not included in this figure. When these are included in the statistics, over 50 % of freshwater fish species in the region are under imminent threat.

Taxonomic Group	Regional			National		Threats (including but not limited to)
	Number of species recorded in HB	% 'Threatened' ('At Risk') species recorded in HB	Locally Extinct (present nationally)	% 'Threatened' ('At Risk') species	Nationally Extinct (since 1000 AD)	: National context but also likely to be relevant for the region
Freshwater invertebrate	Unknown	Unknown	Unknown	10 % (70 %)	0	Land use change (through agricultural effects), habitat modification (in-stream and riparian)
Frog	0	(no native frog species present in the region)	2 species[7]	75 % (25 %)	3 species	Predation from introduced mice and rats. Three species have become extinct in the last 1000 years attributed to the arrival of mice and ship rats. The remaining species are very localised on mainland, or confined to mice/rat free islands.
Fungus	Unknown	Unknown	Unknown	5 % (1 %)[8]	0	There is a lack of understanding of fungal species and host plants, and a general neglect from conservation effort. Habitat loss is presumably a threat for those species that specialise in wetlands, sand dunes, or are parasitic or symbiotic with rare plants.
Land snail	Unknown	Unknown	Unknown	18 % (53 %)	0[9]	The attributes of land snails, i.e. limited escape response and dispersal range, makes them vulnerable to external threats including introduced animals (for their predation and competition for food and habitat), loss or modification of habitat and host species.
Lichen (or Lichenized fungi)	Unknown	Unknown	Unknown	1 % (10 %)	0	Loss of habitat (conversion to agricultural land, wetland drainage). Some of the preferred habitats such as clay and/or salt pans, wetland margin, and closed forests are lost or degraded through agricultural activities and mining.
Macro-algae	Unknown	Unknown	Unknown	2 % (61 %)	0	Competition from introduced species. Pollution. Sedimentation. Trampling effects. Trawling.
Marine fish	Unknown	Unknown	Unknown	0 % (25 %)	0	Removal of biomass by commercial and recreational fishing practices. Habitat degradation from increased sedimentation, nutrient inputs, trawling and climate change. Loss of breeding habitat through modification of region's estuaries.

[7] Worthy (1987)
[8] Note that over 90 % of fungal species assessed are listed as 'Data Deficient' (Hitchmough, 2013).
[9] In the previous listing in 2007, four species were listed as 'Extinct' but their statuses have been changed to 'Data Deficient'. There are few other species in this category which may be extinct but yet to be validated.

Taxonomic Group	Regional			National		Threats (including but not limited to)
	Number of species recorded in HB	% 'Threatened' ('At Risk') species recorded in HB	Locally Extinct (present nationally)	% 'Threatened' ('At Risk') species	Nationally Extinct (since 1000 AD)	: National context but also likely to be relevant for the region
Marine invertebrate	Unknown	Unknown	Unknown	11 % (82 %)	0	Removal of biomass by commercial and recreational fishing practices. Competition from introduced species. Loss and modification of habitat through sedimentation, pollution, vehicle access on beaches, and the modification of the regions estuaries.
Marine mammal	36	19 % (0 %)	Unknown	14 % (0 %)	0	Loss of habitat. Water quality issues. International whaling and sealing[10]. Competition for food resources with fishing industry.
Reptile	10	0 % (70 %)	5 species[11]	30 % (47 %)	2 Species	Introduced mammals and birds (predation, competition for food), habitat loss and fragmentation, agricultural chemicals, exotic reptiles (competition for food and habitat), human collectors (Hitchmough et al., 2010; Anderson et al., 2012).
Terrestrial invertebrate	Unknown	Unknown	Unknown	4 % (21 %)	7 species	Predation particularly from rodents, but also by possums, pigs, thrushes and hedgehogs, habitat or modification through land development and stock damage(McGuiness, 2001; Stringer and Hitchmough, 2012).
Vascular plant	193	16 % (35 %)	10 species[12]	10 % (29 %)	7 species	Loss of key habitat types (particularly cliff and closed forest), loss or degradation of habitats in lowland areas, introduced mammal (browsing and trampling), introduced weeds, human collectors (Walls, 1998; de Lange et al., 2009)

[10] Whaling and sealing continues in some parts of the world, but all marine mammals are protected in New Zealand under the Marine Mammals Protection Act 1978 (DoC website, http://www.doc.govt.nz/conservation/native-animals/marine-mammals/)
[11] Estimated from the Bioweb record
[12] Based on DoC database records and Walls (1998). Where records conflict between these sources, the latest record supercedes the older.

3.3 Knowledge gap

In general, taxonomic groups that consist of smaller organisms have a larger number of species and larger knowledge gaps. These knowledge gaps are attributed to various reasons, including difficulties in finding or identifying the organisms, lesser attractiveness and resulting lack of awareness or interest in the organisms, or a lack of expertise in dealing with them. It may also be due to the lack of knowledge around their ecological roles. This applies particularly for the taxonomic groups listed below:

- Bryophytes: Bryophytes are often neglected from conservation interests worldwide, and New Zealand is no exception. A publication from the International Union for Conservation of Nature (Hallingbaeck et al., 2000) has addressed this issue and the global reduction of bryophyte diversity. DoC has assessed 357 species for its threat classification, and about 40% of the species were classed as 'Data Deficient' (there is not sufficient data to confirm threat status). Reflecting the national state of knowledge base, the region has a very limited record of bryophytes. In 2000 the International Union for Conservation of Nature has published a conservation action plan for bryophytes (Hallingbaeck et al., 2000). It states that the lack of understanding may lead to their being overlooked by conservation initiatives, and at the worst, they could go extinct unnoticed. There is potential for the same outcomes for other cryptic taxa groups listed below.

- Fungi: The 2008-2011 listing of threatened fungi has assessed 1,605 species of which 90% were categorised as 'Data Deficient'. This is a small fraction of the 20,000 fungal species that are estimated to occur in New Zealand (Landcare Research, unpublished). A lack of understanding is clear at the national scale. Not surprisingly, there is very little data on fungi in the region. There are three 'Nationally Critical' species in the region recorded by the DoC's species database. This is far less than the national figure implies.

- Freshwater Invertebrates: Freshwater invertebrates are regarded as useful indicators for health of rivers and streams. The Macroinverbetrate Community Index (MCI) is a nationally accepted measure (Stark and Maxted, 2007) used by most of the local authorities, including HBRC, for their State of the Environment (SoE) monitoring for freshwater water quality and ecology. The MCI quantifies the health of a stream or river with a single number which relates to the species found in the macroinvertebrate community. While HBRC holds a wealth of MCI information, the current sampling protocol samples riffles only. Riffles are considered to be the most sensitive part of the river habitats where it reflects any impairment to the river habitat better or quicker than other parts of the river (pools, runs). Therefore, it is unlikely that a full picture of the state of freshwater invertebrates is available. In addition, the MCI examines the community level (mainly genera), which does not indicate which species are threatened in the region.

- Small land snails: While the large land snails (*Powelliphanta*) are relatively well studied[13], small land snails have been under-studied. On a national level, 30% of the total native species occurring in New Zealand are 'Data Deficient'. There are likely to be species of small land snail yet to be identified and named in New Zealand, where snail diversity is said to be higher than most countries in the world (DoC, 2009). Limited information relevant to the region suggests that there are at least 25 to 30 species of small land snails in Hawke's Bay (DoC, 2009; Kessels et al., 2012). The threat status of these species has not been examined, but most of these species

[13] Hawke's Bay has 3 large land snail (Powelliphanta) species, all of which are either Threatened or 'At Risk' and very localised in their distribution. There are recovery plans for each of these species. While most of the larger Powelliphanta were named, discovery of some of the species were relatively recent. One species (Powelliphanta "Urewera") is one of them, and there is not enough data to determine the population trend, hence their threat status may change once such data is collected (Walker, 2003).

are presumably either 'Threatened' or 'At Risk', given that a majority (60%) of known species in NZ are listed as 'Threatened' or 'At Risk'.

- Terrestrial Invertebrates: There are over 13,000 terrestrial invertebrate species known to occur in New Zealand, of which approximately 26% have been formally described, and assessed in the DoC threat listing. When the rest of taxonomically indeterminate species have been formally described, it is likely that the proportion of 'Threatened' and 'At Risk' species will be higher, because these species are likely to be rarer than those that have already been discovered (Stringer and Hitchmough, 2012).

- Lichens: DoC has attempted for the first time to list the conservation status of lichens indigenous to New Zealand (de Lange et al., 2012). Like the bryophytes, there is a lack of expertise and knowledge around the lichens which contributes to the high number of 'Data Deficient' species (975 out of 1,799 species, 54%). Population trends and habitat requirements are not well studied and it is likely that some of the 'Not Threatened' species are in reality more threatened.

- Marine fish: New Zealand has a diverse fish population. Triplefins (family Tripterygiidae) dominate the coastal fish diversity with twenty-six endemic species (Hickey et al., 2009). Fifteen of these species, along with many other endemic species, have been found on shallow reef systems from Pania Reef to Blackhead in the south (Duffy, 1992). This study is the only survey of reef fish populations in Hawke's Bay. According to Beaumont et al. (2009) the species diversity of rocky reef fish is similar to the rest of the central and southern east coast of the north island. However, at present the only monitoring of fish populations in Hawke's Bay is the MPI commercial catch data, which covers a small number of the species found in Hawke's Bay.

- Marine invertebrates: Marine invertebrates are the most numerous of marine organisms. They can range from microscopic (planktonic) individuals to large species such as crayfish. The Hawke's Bay region is of particular importance nationally in terms of its arthropod (animals with an exoskeleton such as crabs) and echinoderm (starfish) species diversity (Beaumont et al., 2009). There has only been one study of the marine invertebrate communities of Hawke's Bay that was completed more than forty years ago (McKnight, 1969). This study highlighted the community composition of some areas of Hawke's Bay. However whether these communities still exist is unknown. HBRC's invertebrate community monitoring revolves around the intertidal SOE monitoring programme focused on soft and hard shore ecology, but the data is spatially too sparse to understand the presence of all marine invertebrate species in the region.

- Marine mammals: Hawke Bay itself hosts many migratory marine mammals at certain times of year with numerous sightings of Orca and common dolphin. The inshore coastal environment between Napier and Mount Manganui is considered the southern right whale's primary winter calving habitat (Clement, 2009) of which there are believed to only be between 4 and 11 reproductive females left around mainland New Zealand (Patenaude, 2003). The large number of strandings of pregnant Pygmy Sperm Whales and females with calves in Hawke's Bay suggests that the main calving and nursery grounds for this species may be further offshore. There is a large seal haulout area on the northern side of Cape Kidnappers and any of the region's beaches could have individual fur seals, sea lions, elephant seals or leopard seals hauling out occasionally (Walls, 2013). Information on marine mammals in Hawke's Bay waters is currently restricted to individual sightings and strandings data. There have been no dedicated studies of marine mammals in this area, so the distribution and behaviour of individual species is unknown.

While cryptic taxonomic groups listed above may be overlooked by conservation initiatives, understanding of more visible and attractive taxonomic groups may also be problematic because of their already rare or sparse distribution. This includes geckos and skinks, which are now so sparse that it requires labour-intensive ground surveys to monitor them and identify the state and trend of their population and distribution.

Species that migrate, including fish, marine mammals, and birds, require further research, including when, how and to what extent they are distributed throughout the region, and whether the region provides habitats suitable for breeding, feeding or nursery areas.

3.4 Where to from here – Threatened Species

The Department of Conservation approaches have shifted from species-focused to be more habitat- and ecosystem-focused. Most of the major public conservation areas have management plans in which vulnerable species are considered together with a range of other matters. All of the pest control across the region, led by various agencies including DoC, HBRC, QEII, community groups and landowners contributes to species and habitat protection.

While it is not realistic to attempt to understand every single species that is vulnerable, it is important to acknowledge that those taxonomic groups that have been overlooked by conservation efforts have significant roles in ecological processes. Bryophytes, invertebrates (terrestrial, freshwater, marine), lichens, and fungi are some of the most diversified groups, forming the base of biological diversity. Without them, key ecological processes such as soil formation, nutrient and water cycles, and food provision would not function (Hallingbaeck et al., 2000; McGuiness, 2001).

The Department of Conservation has been developing and implementing an 'optimisation' system for species and ecosystems (OAG, 2012) that includes wetlands, rivers and river beds, and terrestrial coastal ecosystems. The species optimisation system was designed to identify the most cost-effective species (i.e. species that optimise the overall benefits of protection works within a budget) whilst ecosystem optimisation extends the species approach to ensure that the full range of ecosystems is captured (Leathwick, 2012). So far management plans for 50 species have been developed, and DoC has a target to manage 225 species by 2015/16. A preliminary list of 1000 ecosystem management areas (or "units") prioritised nationally has been generated and further optimisation has been in progress to select the top 400 ecosystem management units (Leathwick, 2012; OAG, 2012).

In parallel with the species and ecosystem prioritisation system, DoC has also published a list of selected indicator species for measuring trends in native species composition (Monks et al., 2013). The selected indicators include a wide range of taxonomic groups and species of both 'Not Threatened' and 'Threatened' or 'At Risk' classification. Each of them is an indicator for particular pressure(s), including human impact, predation, or habitat modification, in their main habitat types, including terrestrial, freshwater or marine.

3.5 Recommendations – vulnerable species and their habitats

- Identify 'indicator species' for the region for protection and monitoring. Identification should be collaborative process among DoC and other agencies. A framework such as technical criteria and process to select such species needs to be developed. Threat status of species, where known, can be one of the criteria in the framework. DoC's proposed indicator species for measuring species composition trends (Monks et al., 2013) and species prioritisation process can be examined when developing such framework.

- Once indicator species are identified, collect baseline information such as current population size, distribution, and their habitat conditions so that appropriate management plans could be made to achieve objectives and outcomes under the HB Biodiversity Strategy.

4 Representative habitat types

'Habitat type' describes a particular area containing species and environmental conditions such as landform, hydrology, and climate. 'Ecosystem' is defined as a biological community of interacting organisms and their physical environment. In this sense the habitat type is considered interchangeable with the term 'ecosystem,' and can act as an umbrella for associated species, thus a surrogate for biodiversity.

The Inventory should, and intends to capture, the existence and location of ALL indigenous habitat types that are present or expected to be present in the region. By doing so, we should be able to answer the key questions listed in Section 2.1, but within the context of habitat types:

- What kind of habitats used to be or should be present in the region, given the climatic and geological conditions?
- What kind of habitats do we have now?
- What, where or how have habitats been changed from their optimum states?
- What are the drivers of this change?
- As a result, which habitat types are threatened?

Habitats are broadly grouped into terrestrial, freshwater and coastal/marine environments. Historically Rare Terrestrial Ecosystems are defined as those being rare before human colonisation of New Zealand, extending less than 0.5 % (approximately 134,000 ha) of New Zealand's total area (Williams et al., 2007).

	Habitat Types
Terrestrial	Indigenous forest and scrub
Freshwater	Rivers and streams
	Freshwater wetlands
	Lakes
Coastal and Marine	Coastal habitats (intertidal,
	Marine habitats (shallow and deep water)
Historically Rare Terrestrial Ecosystems	Historically Rare Terrestrial Ecosystems defined by indigenous vegetation, associated with freshwater habitats, or identified in the coastal environment

Terrestrial

4.1 Indigenous vegetation

In this section, the geographical extent of various terrestrial habitat types is defined by the type of indigenous vegetation present. 'Vegetation types' are broadly equivalent to 'habitat types', given that different vegetation types will support a different assemblage of species.

4.1.1 Method

Classification of indigenous vegetation types

Terrestrial habitat types associated with vegetation are characterised in this section except for wetlands and sand dunes. Wetlands and sand dunes are covered in 4.5 and 4.9 respectively.

The primary data used here is the **Potential Vegetation of New Zealand** (PVNZ) (Leathwick et al., 2012). It predicts vegetation types (or 'classes') that would be expected in the given environments with the absence of human influence or large-scale natural disturbance. The environmental variables used to construct the model are climate, soil type and landform (Table D-1, Appendix D). The model is built upon vegetation plot (field) data accumulated from the 1960s to the 1990s (Leathwick, 2001). Twenty four classes (twenty forest types, four non-forest vegetation types) and their extents have been predicted by the model. This open-source geospatial data is available at Koordinates.com and was used for the habitat characterisation as described in this document (see Table A-2, Appendix A).

Analysis of the PVNZ data revealed twenty forest types and two scrub or shrubland types are present in the region. Three forest types and one shrubland type were not predicted in the region but predicted to occur elsewhere in New Zealand. A preliminary list of vegetation types present was created based on this analysis.

The preliminary list was reviewed by regional experts, and interpreted to fit the regional context. For example, one of the classes in the PVNZ is 'Kauri/northern broadleaved forest' but the region never had kauri-dominant forest, hence the class was interpreted as 'Podocarp/broadleaved forest' based on expert knowledge and published information including Rogers (1991), Adams and Walls (1993), Lee (1994), and Whaley et al. (2001). The preliminary list was also peer-reviewed by experts. This peer review generated the final set of habitat classifications which is reported in section 4.1.5.

Extent of indigenous vegetation

Spatial data from PVNZ was used to represent the 'original' extent of indigenous vegetation in the region. The current extent of each indigenous vegetation types was estimated using the Land Cover Database (version 3)[14]. By comparing these two datasets, the proportion of loss was calculated.

The proportions of each habitat type in legally protected areas (DoC public conservation areas, Nga Whenua Rahui kawenata areas, QEII covenants, Protected private land under Reserves Act 1977) was calculated.

Combining the information on proportion of loss of each habitat type and proportion of remaining habitat types that were protected, threat categories (see below) were assigned.

[14] Land Cover Database is the national database of land cover and is updated every few years. It includes a range of land cover classes.

Threat status of indigenous habitat types based on remaining extent

Threatened Environment Classification is a national scale system for land (not water) to show how much indigenous vegetation is left (or lost) within the land environments, and how much of them are protected (Walker et al., 2007) .

Table 4-1: Threat categories (from Walker et al, 2007).

Threat Category	Criteria
Acutely Threatened	< 10% indigenous vegetation left
Chronically Threatened	10 – 20% indigenous vegetation left
At Risk	20 – 30% indigenous vegetation left
Critically Underprotected	>30% left, < 10% protected
Underprotected	>30% left, 10 – 20% protected
Less Reduced and Better Protected	>30% left, > 20% protected

The principles of this analysis are that as habitat is lost, each additional habitat loss will remove a larger proportion of the original species that once resided within the habitat (Figure 4-1). At 20% of the original habitat extent the rate of species loss is exponentially accelerated.

When a habitat is fragmented and reduced, the ecological processes of the habitat are altered and may no longer be optimal conditions to support resident species population. For instance, when a large tract of forest is fragmented into smaller patches, the proportion of forest perimeter will increase, which modifies the forest microclimate. One New Zealand study concluded that approximately 50 m from the forest edge is dominated by the climate from outside of the forest patch, and that where forest fragments are less than 1 hectare in area, they do not support forest interior conditions (Young and Mitchell, 1994). Habitat loss leads to the irreplaceable loss of biodiversity and more vulnerable to further loss.

In this report, the Threat Category was determined for the different vegetation types in the region, based on the estimated proportion of vegetation extents remaining.

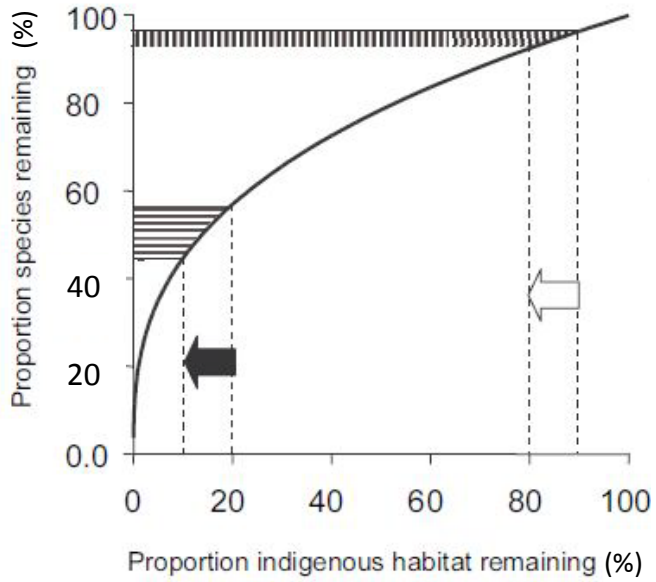

Figure 4-1: A generalised species-area curve (from Walker et al., 2007). When a significant proportion of habitat remains, 10 % of habitat loss leads to a small portion of species loss (white arrow). When a significant proportion of habitat is already lost, a further 10 % of habitat loss will lead to a bigger proportion of species loss (black arrow).

4.1.2 Vegetation-based indigenous habitat types

The interpretation of the PVNZ data has identified sixteen forest types and one scrub type for the region (Table 4-2).

4.1.3 Extent of indigenous vegetation

In the absence of large-scale disturbance, the climate, soil and landforms of 97% of the land environments in the region would support indigenous forest and 1% of the land environments would naturally support non-forest vegetation above the treeline (Figure 4-2). The extensive alluvial plains were once dominated by alluvial forests consisting of swamp species (e.g. kahikatea-pukatea-tawa forest). Podocarp forests extended from coastal region through to the ranges where beech species gradually becomes dominant.

The current extent of indigenous forest is reduced to 23% of its original extent (Figure 4-3). This reduction in indigenous forests has been particularly widespread in those forest types that were found on alluvial plains, coastal and lowland hill country. Most of the remaining habitats are reduced in size and isolated in patches, which makes them highly vulnerable to further loss.

Table 4-2: Vegetation habitat types re-named for Hawke's Bay region. Vegetation Class Names identified by PVNZ (Leathwick et al, 2011) were interpreted and re-named in the regional context. Rimu-matai-miro-totara/kamahi forest and Rimu-miro-totara/kamahi forest was merged into Podocarp/kamahi forest. See **Table D-2** (**Appendix D**) for a full description. Vegetation types related to wetlands and sand dunes are reported in sections 4.5 and 4.9 respectively.

Vegetation Class Name (Leathwick et al., 2011)	Vegetation Type Name for Hawke's Bay
Kauri/taraire-kohekohe-tawa forest	Podocarp/broadleaved forest
Rimu/tawa-kamahi forest	Rimu/tawa-kamahi forest
Kahikatea-pukatea-tawa forest	Kahikatea-pukatea-tawa forest
Matai-kahikatea-totara forest	Podocarp forest
Kahikatea-matai/tawa-mahoe forest	Podocarp/tawa-mahoe forest
Matai-totara-kahikatea-rimu/broadleaf-fuchsia forest	Podocarp/broadleaf-fuchsia forest
Hall's totara/broadleaf forest	Hall's totara/broadleaf forest
Hall's totara/silver-beech-kamahi-southern rata forest	Hall's totara/silver beech-kamahi forest
Rimu-miro/kamahi-red beech-hard beech forest	Podocarp/kamahi-beech forest
Rimu-miro/tawari-red beech-kamahi-tawa forest	Podocarp/red-beech-kamahi-tawa forest
Rimu-matai-miro-totara/kamahi forest	Podocarp/kamahi forest
Rimu-miro-totara/kamahi forest	Podocarp/kamahi forest
Silver beech forest	Silver beech forest
Red beech-silver beech forest	Red beech-silver beech forest
Mountain beech-red beech forest	Mountain beech-red beech forest
Mountain beech forest	Mountain beech forest
Matai-totara/black/mountain beech forest	Podocarp/black/mountain beech forest
Scrub, tussock-grassland and herbfield above treeline	Scrub, tussock-grassland and herbfield above treeline

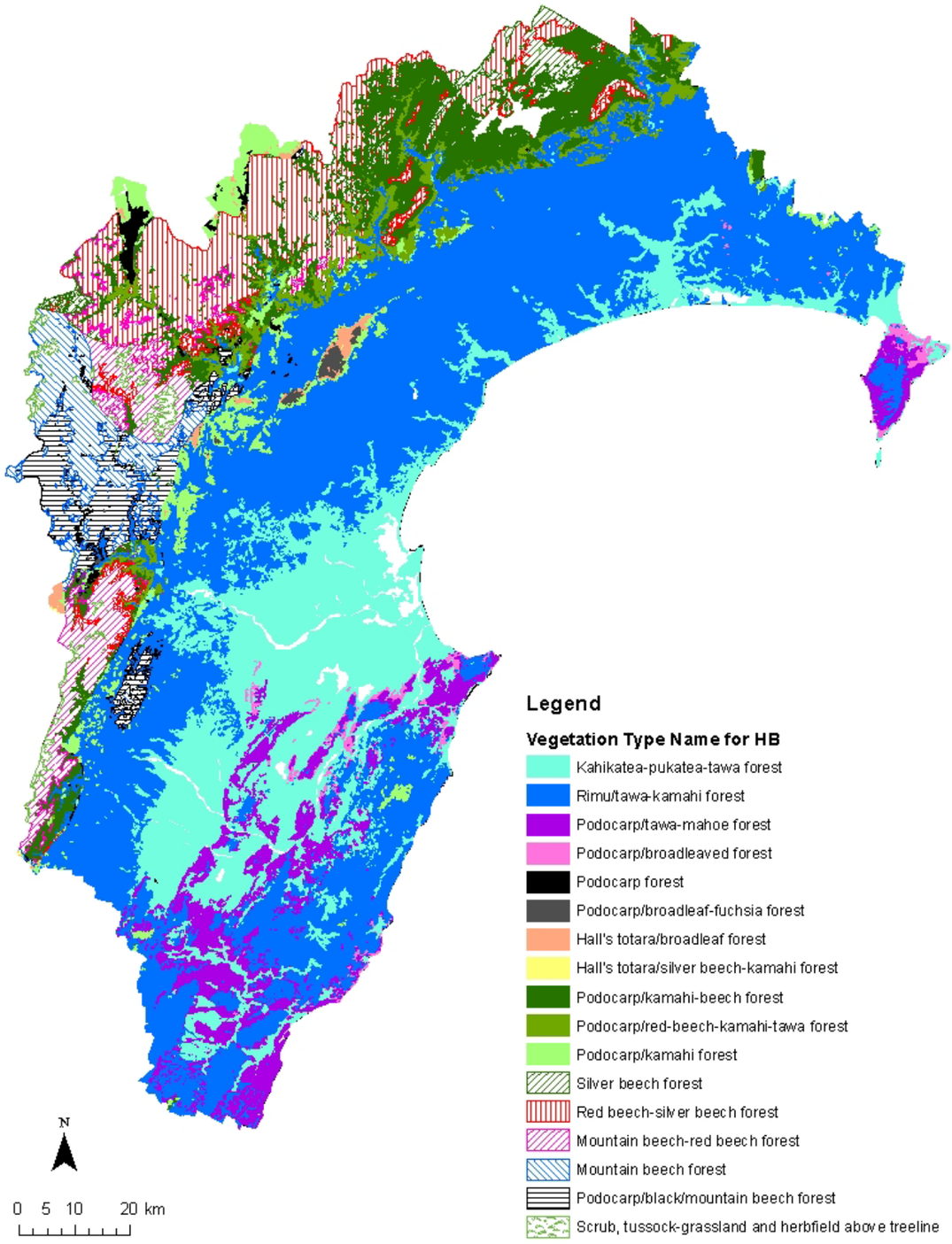

Figure 4-2: The predicted extent of indigenous forest and scrub in the absence of large-scale disturbance in Hawke's Bay. The area without any colour (displayed as white) in this figure is unclassified and consist of open water including lakes and main channel of braided rivers.

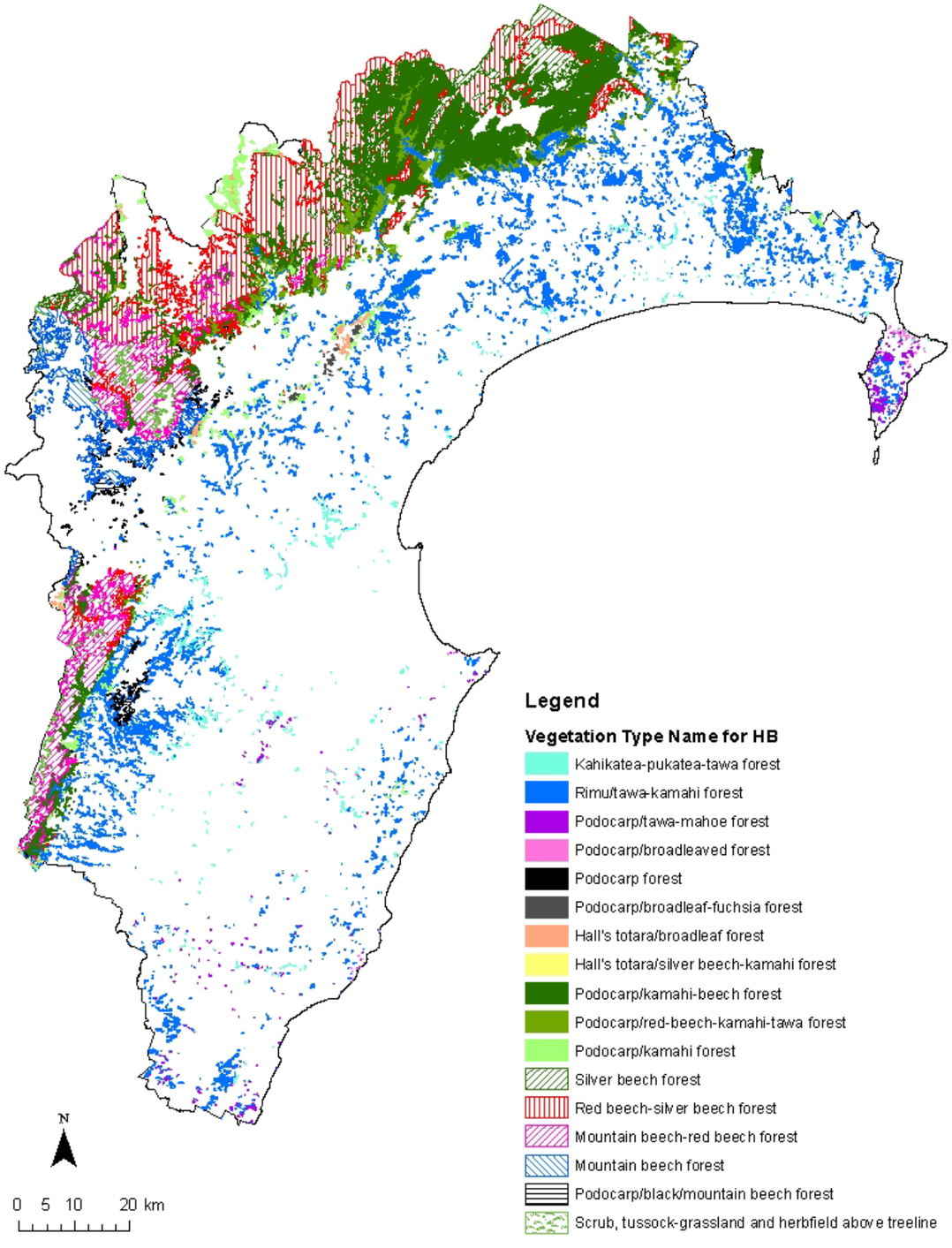

Figure 4-3: The current extent of indigenous forests and scrub in Hawke's Bay. The Land Cover Database (version 3) was used for the current extent of the indigenous forest, and vegetation type names were assigned to the land cover data. Note that manuka/kanuka shrubland and other shrubland are not included in this map. Indigenous forest or scrub is absent from the area with no colour (displayed as white) and dominated by other landcover including pasture, urban, and open water.

4.1.4 Threat status of each habitat type

Of the sixteen forest types, seven types are 'Acutely Threatened', one type is 'Chronically Threatened', and one type is 'At Risk' (Figure 4-4). These are primarily lowland forest types that once dominated an extensive part of the region, including alluvial forests on the region's main alluvial plains (such as the Heretaunga Plains) and podocarp forests from coastal areas to low hill countries, which now accommodate extensive agricultural production (Figure 4-3). Remnants of these threatened forest types are mostly on private land, isolated, fragmented, and subject to modification and eventual loss. Remnants which are legally protected are prone to on-going threat from introduced animals and weeds, and also from encroachments from surrounding land use. Without an adequate management plan, legal protection may not halt the decline of these fragmented remnants (M. Taylor, personal communication, 6 August 2013).

Better preserved forest types tend to occur at higher altitudes in the region, and most of these areas are legally protected. However, it is likely that these large tracts of forest are also under constant pressure from introduced animals and weeds. Therefore, large tracts of forest may lack some of the palatable indicator species such as kamahi (Nugent et al., 2001) (Table D-2, Appendix D).

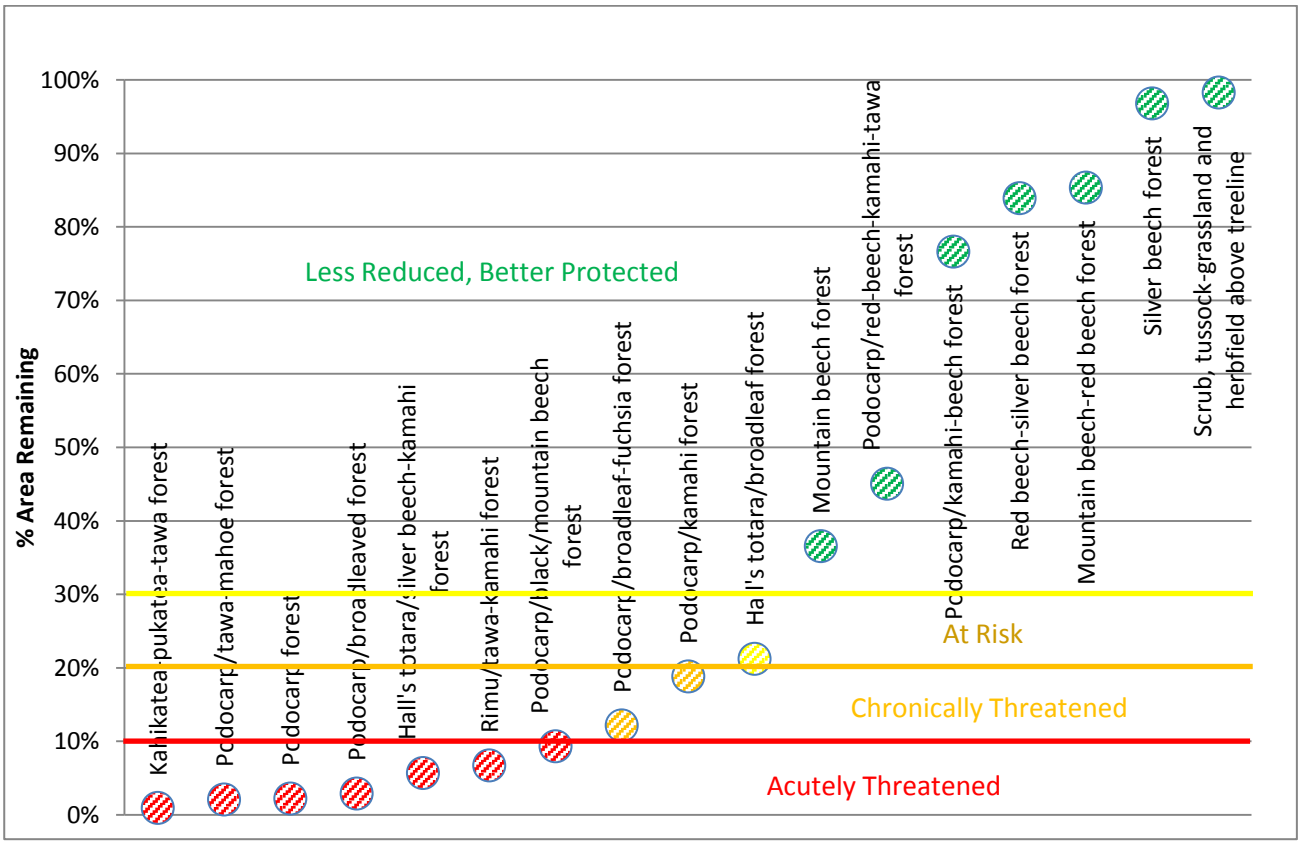

Figure 4-4: Vegetation-based habitat types and the remaining extent of each habitat type expressed as a proportion of the previous extent. Habitat types below the red line are 'Acutely Threatened' (red circle), between the red and orange lines are 'Chronically Threatened' (orange circle), and between the orange and yellow lines are 'At Risk' (yellow circle). Habitat types over 30 % are considered 'Less Reduced, Better Protected' (green circles) (see Table 4-1).

4.1.5 Applications and limitations of the national databases

There are some inherent limitations to these national-scale databases. The accuracy of national databases depends on the intensity of the sampling (plot data) that databases and predictive models are built upon. The most evident limitation is that the PVNZ predicts a vegetation type under optimal conditions with no disturbance by human or nature, such as from natural fires or strong winds. This means that there may be a significant difference between predicted and actual habitats, even with low levels of human disturbance. Consequently it does not predict secondary vegetation types emerging after disturbance.

An alternative approach proposed is to use a more current, field-based knowledge of the region to develop a region-specific vegetation-based habitat type classification (Walls, 2013). There are three key aspects to this approach;

- The classification depicts the current condition of the vegetation. Therefore, it includes many secondary vegetation types resulting from various disturbances such as selective logging, forest clearance and animal browsing.
- It captures the influence of the ecological processes that define the vegetation types, such as riparian vegetation, which is characterised by species adapted to the distinctive environmental conditions.
- Geographical factors such as altitude and landforms are used for the name of the 'Habitat Category' and 'Vegetation Type Name', instead of species.

The resulting classification may be more practical and better recognise the threat status of habitats in the land-scape context such as lowland or montane forest (Table D-3, Appendix D). However, this approach is hampered by a lack of geospatial data covering the entire region. Therefore, Walls' classification can be used only to confirm habitat types predicted spatially by PVNZ.

The PVNZ is useful at the current stage of the Inventory development, because it enables a regional-scale understanding of the state and trend of most indigenous vegetation. Vegetation types and description of the PVNZ provides some indication of the reference conditions of each habitat type.

4.2 Where to from here – indigenous vegetation

Despite the differences between the two classifications presented in this report, the message is consistent and clear. Lowland indigenous vegetation habitats are highly susceptible to irreversible loss. On-going pressure from land-use activities, introduced mammalian browsing and weeds are not only threats to the already reduced vegetation but also to protected areas. For example, fencing of native forest does not halt the deterioration of the forest interior unless the fence is deer- and/or goat-proof.

Threatened habitat types may be very small and fragmented into patches, highly modified, and deteriorated to the extent that many of the characteristic species and ecological processes have been lost. A particular area may be the last remnant of a particular habitat left in the region, and if such remnants are neglected, it will be an irreversible loss and the region may no longer have a full-range of habitat types. There needs to be a framework which allows prioritisation of areas (or sites) for protection and enhancement to achieve the Biodiversity Strategy outcomes for native habitats.

The Department of Conservation's Protected Natural Areas Programme (PNAP) from the 1980s to early 2000s examined many native forest and scrub remnants outside conservation areas. Some of the remnants were listed as Recommended Areas for Protection (RAP), while others were surveyed but not afforded RAP

status[15]. These RAPs are not legally protected, and many of the lowland remnants are presumably deteriorated or at worst already being lost[16]. Although it has not been updated for over a decade, PNAP reports are still some of the best records available for the region.

The PNVZ, though having limitations, is the best potential tool to provide informed understanding of the habitat types and their patterns of distribution in the region. Field data is critical to refine the modelled picture of habitats in the future. If an area is currently dominated by secondary vegetation such as manuka and kanuka shrubland, a better understanding of the potential vegetation cover of the area would provide better prediction of the future vegetation type, which would be useful in formulating a management plan such as selection of species for planting.

The state and trend of indigenous vegetation on private land in the region is largely unknown at this time. There is an initiative by regional councils throughout the country to build a terrestrial biodiversity monitoring framework (Lee and Allen, 2011). The framework will guide regional councils and unitary authorities in measuring and understanding the state and trend of terrestrial biodiversity in a consistent manner. This will also allow the effectiveness of conservation efforts to be monitored. The proposed indicators and measures are summarised in Appendix F.

4.3 Recommendations – indigenous vegetation

- Establish a framework to identify ecologically significant areas of indigenous vegetation that are classified as 'Acutely Threatened' or 'Chronically Threatened' in addition to areas identified by PNAP surveys. Complete the inventory of identified areas. Retain the Wall's habitat type description to supplement the PVNZ.

- Establish a framework for identifying significant secondary vegetation areas (such as regenerating secondary forests and scrub) and complete the inventory of the areas identified[17].

Below are recommendations which may be outside of the scope of this report. However they are likely to be necessary actions subsequent to, or concurrent with the on-going development of the Inventory.

- Establish a programme for monitoring state and trend of terrestrial biodiversity by implementing the terrestrial biodiversity monitoring tool proposed in Appendix F. The development of monitoring network may require consideration of existing monitoring frameworks by other agencies such as DoC's Biodiversity Monitoring and Reporting System as a component of Natural Heritage Management System, and QEII's monitoring framework for the covenants.

- Develop a process to prioritise enhancement efforts to meet the objectives and outcomes of the Biodiversity Strategy. Such a process may generate a list of sites where enhancement funds would be allocated. Suggested criteria for prioritisation include ecological value of a site, which would be informed through a framework proposed above, and social values such as existing community projects and community willingness. As is demonstrated by the FENZ database (see section 4.4.4), DoC has been developing an ecosystem prioritisation tool for their estate, which could be implemented at regional scale.

[15] See Appendix E for distribution of RAPs in the region.

[16] It is of general view among local conservation experts that many RAPs have not been afforded for protection are deteriorating due to on-going grazing and other land-use activities. While re-visiting RAPs are necessary to verify this view, there are obvious cases of RAPs being largely disturbed such as large-scale kanuka and manuka scrub clearance in Opoutama Catchment (RAP WAH 1). Hastings District Council has been considering the need for assessments of all RAPs listed in the District Plan (R. Little, pers. comm. 6 August 2013)

[17] DoC's PNAP programme has identified some of the significant secondary vegetation areas as RAPs. For example, approximately 10 % of the total area of manuka/kanuka scrub in the region is captured as RAPs. Methodology of PNAP programme and areas surveyed can provide basis for the framework for the region.

Freshwater

4.4 Rivers and Streams

In this section, habitat types are defined for the various types of rivers and streams. 'River types' are considered equivalent to 'habitat types', given that different river types are likely to support different species assemblages.

4.4.1 Tools and methods

The Freshwater Ecosystems of New Zealand (FENZ) database consists of a large set of spatial data around freshwater ecosystems such as rivers, streams, lakes and wetlands in New Zealand (Leathwick et al., 2010). The FENZ database enables a range of objective analyses and mapping, including the classification of rivers and streams based on physical characteristics such as substrates, slope, riparian shading and biological characteristics such as macroinvertebrate community, fish community, the distribution of fish and invertebrate communities, and the distribution of human pressures such as impacts from mines, dam, and industrial areas. The FENZ classification was used to show what types of rivers and streams were found in the region (see section 4.4.2).

To assess the degree of changes in river habitat conditions, modelled Macroinverbetrate Community Index (MCI) data[18] developed by Clapcott et al. (2013) was used (see section 4.4.3). The model predicts both current (Observed) and reference (Expected) values for MCI in New Zealand's rivers and streams (Clapcott et al., 2013). The raw data used to build the model was obtained from regional councils and unitary authorities from the period 1998 to 2011. Twenty three predictors considered to affect the macroinvertebrate communities were selected to build the model (Table G-1, Appendix G).

FENZ also allows objective ranking of water bodies for conservation. The FENZ ranking is based on biodiversity conditions that take into account human pressures, and also considers the key conservation principles: connectivity, complementarity, representativeness and vulnerability of a site (Leathwick et al., 2012; West, 2013). Connectivity is critical for riverine habitats to function, and particularly affects New Zealand's diadromous fish, which migrate between streams and the sea at different times in their life cycles. FENZ ranking considers the connectivity of each site. The principle of complementarity ensures that those sites with high ranking will complement those that have already been receiving conservation efforts, or will add unrepresented biodiversity features to an existing set of conservation sites, achieving a full representation of biodiversity features. Vulnerability describes the likelihood of biodiversity loss caused by current or impending threats. Sites that are rare and/or irreplaceable in terms of river habitat types, macroinvertebrate and fish communities also tend to be ranked highly. High value sites modeled by FENZ are shown in section 4.4.4.

River Values Assessment System (RiVAS)[19] is another ranking for rivers incorporating different values including native birdlife, native fish, kayaking, swimming, angling, natural character and irrigation (Hughey et al., 2011). In 2012, a series of expert workshops were held to apply this tool to the Hawke's Bay region, producing lists of rivers and streams which were ranked based on the values listed above. Ranking of rivers and streams based on native birdlife and native fish values are presented in section 4.4.4 (Hughey et al., 2012; Hughey et al., 2012). The ranking of rivers on social and cultural values are not presented in this report.

[18] Usefulness of MCI is defined in section 3.3 (Freshwater Invertebrate).

[19] RiVAS + is an advanced tool which incorporates the effectiveness of intervention to the rivers and stream values. Intervention options include enhancing access, enhancing flow, improving bed and in-stream habitat, removing/mitigating fish barriers, and improving riparian habitat. RiVAS+ was applied to Hawke's Bay rivers, but the results are not shown in this report. RiVAS and RiVAS+ assessment results are reported in a series of reports (see Appendix A).

4.4.2 River habitat types

There are thirty three river habitat types identified in Hawke's Bay (Table 4-3, Figure 4-5). Most rivers and streams (73% of total lengths of all rivers and streams) in the region are represented by six river habitat types, which are A1, A4, C4, C6, C8 and C9 (see Table G-2, Appendix G for detailed descriptions of river types). All of these 6 river types except C9 (Taharua River) are lowland to mid-elevation rivers and streams. C4 is the main class for so-called 'braided river and riverbeds.' HBRC monitors the state and trend of water quality and ecology (periphyton and macroinvertebrate community) of these six river types[20]. Rivers and streams in high elevations are a relatively small proportion of the total length of rivers and streams in the region.

Table 4-3: River types defined by FENZ level 2 classifications for Hawke's Bay. River environment is a broad categorisation of where each river type tends to occur. Number of sites monitored by HBRC's State of the Environment (SoE) programme is shown for each river type. Detailed description of each river type is shown in Table G-2, Appendix G.

River Environment	FENZ Level 2 class	Length of rivers and streams (km)	% of total length in HB	No. of SoE sites
Lowland to mid-elevation rivers and streams	**A1**	1,601	7.36	12
	A2	245	1.13	-
	A3	10	0.04	-
	A4	4,205	19.33	3
	A5	159	0.73	-
	B1	8	0.04	-
	C1	55	0.25	-
	C2	4	0.02	-
	C4	1,032	4.74	17
	C5	1,585	7.28	-
	C6	2,537	11.66	29
	C7	1,628	7.48	-
	C8	6,457	29.68	7
	C9	100	0.46	2
	F1	1	0	-
	F2	1	0.01	-
Mid- to high elevation rivers and streams	**C10**	626	2.88	-
	C11	57	0.26	-
	C12	68	0.31	-
	G1	470	2.16	-
	G2	282	1.3	-
	G5	21	0.1	-
	G7	2	0.01	-
	G8	7	0.03	-
	H1	60	0.28	-

[20] Current SoE programme is not designed for biodiversity but for monitoring changes of water quality. See section 4.7.1 for further discussion.

River Environment	FENZ Level 2 class	Length of rivers and streams (km)	% of total length in HB	No. of SoE sites
	H3	23	0.1	-
	H4	11	0.05	-
	H5	2	0.01	-
	H6	485	2.23	-
	J1	1	0	-
	J6	4	0.02	-
	N2	2	0.01	-
	N5	11	0.05	-
TOTAL		21,760	100.00	70

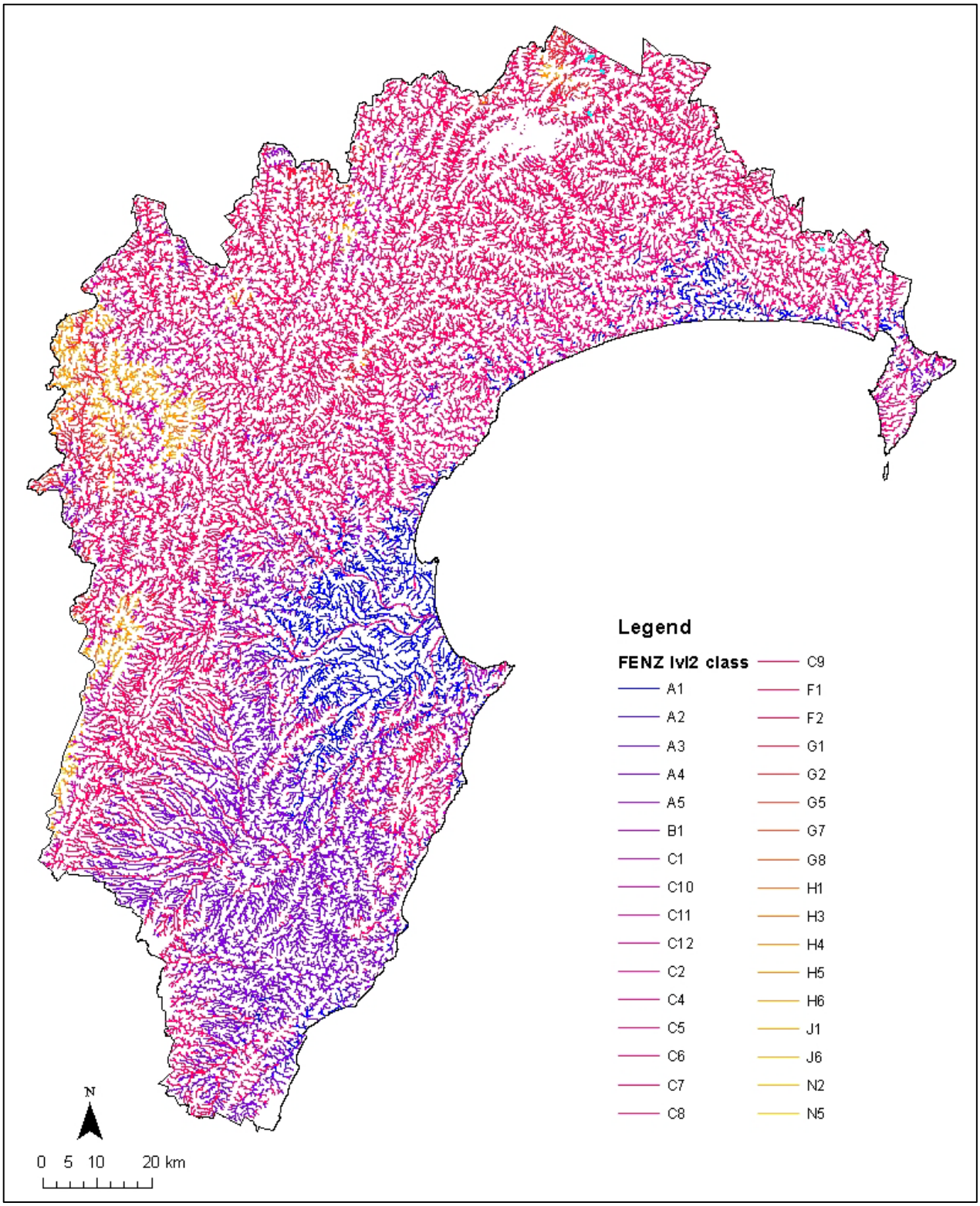

Figure 4-5: River habitat types in Hawke's Bay based on FENZ classification.

4.4.3 Changes in the freshwater macroinvertebrate community

The degree of change in the freshwater macroinvertebrate community from expected to observed conditions is greater in the streams and rivers running from foothills of main ranges to the coast than in those on the mountain ranges (Figure 4-6). This pattern of change is similar to the pattern of indigenous forest loss and modification shown in Figure 4-3. Clapcott et al. (2013) have identified four of the twenty three environmental predictors (or variables) that are the most important in defining macroinvertebrate communities. These four predictors are native vegetation cover, heavy pasture cover, flow stability and summer air temperature (Table G-1, Appendix G). Since indigenous forest loss is related to all four of the predictors, the close association between forest loss and MCI changes is expected.

4.4.4 Identification of significant river habitats using FENZ and RiVAS

FENZ ranks rivers and streams at catchment and sub-catchment levels. Figure 4-7 shows rankings of sites based on biodiversity conditions, connectivity and complementarity. The relative ranking of catchments where 80% or more of the area is legally protected are shown in green. Relative ranking of catchments where majority of the area is not protected are shown in blue. Catchments in the darkest blue are the top 25% of unprotected catchments which have good biodiversity conditions, connectivity, complementarity, representativeness, or high vulnerability (to threats) (see 4.4.1 for definitions of these ranking principles).

The RiVAS method quantifies a range of values for New Zealand rivers from natural (or ecological), recreational, cultural and economic perspectives. Here, the evaluations based on native birdlife and native fish values are summarised.

Through the RiVAS system, the Tukituki River was ranked as of 'National Significance' in terms of native birdlife (Figure 4-8) (Hughey et al., 2012). This ranking is weighted by bird habitat distinctiveness, habitat extent, total bird population, foraging guilds, and 'Threatened' and 'At Risk' species strongholds. The remainder of the region's major rivers and their tributaries were ranked as either of 'Regional Significance' or of 'Local Significance'.

In terms of native fish values, the Ngaruroro, Tukituki, Tutaekuri and Wairoa catchments were ranked as of 'National Significance' through the RiVAS system (Hughey et al., 2012). Native fish values are based on species richness, whitebait spawning sites, migratory species occurrence, the number of 'Declining' species, strongholds, water quality, introduced fauna, physical barriers and riparian shading. The Napier coast was ranked as of 'Local significance' and the remaining catchments being of 'Regional Significance'.

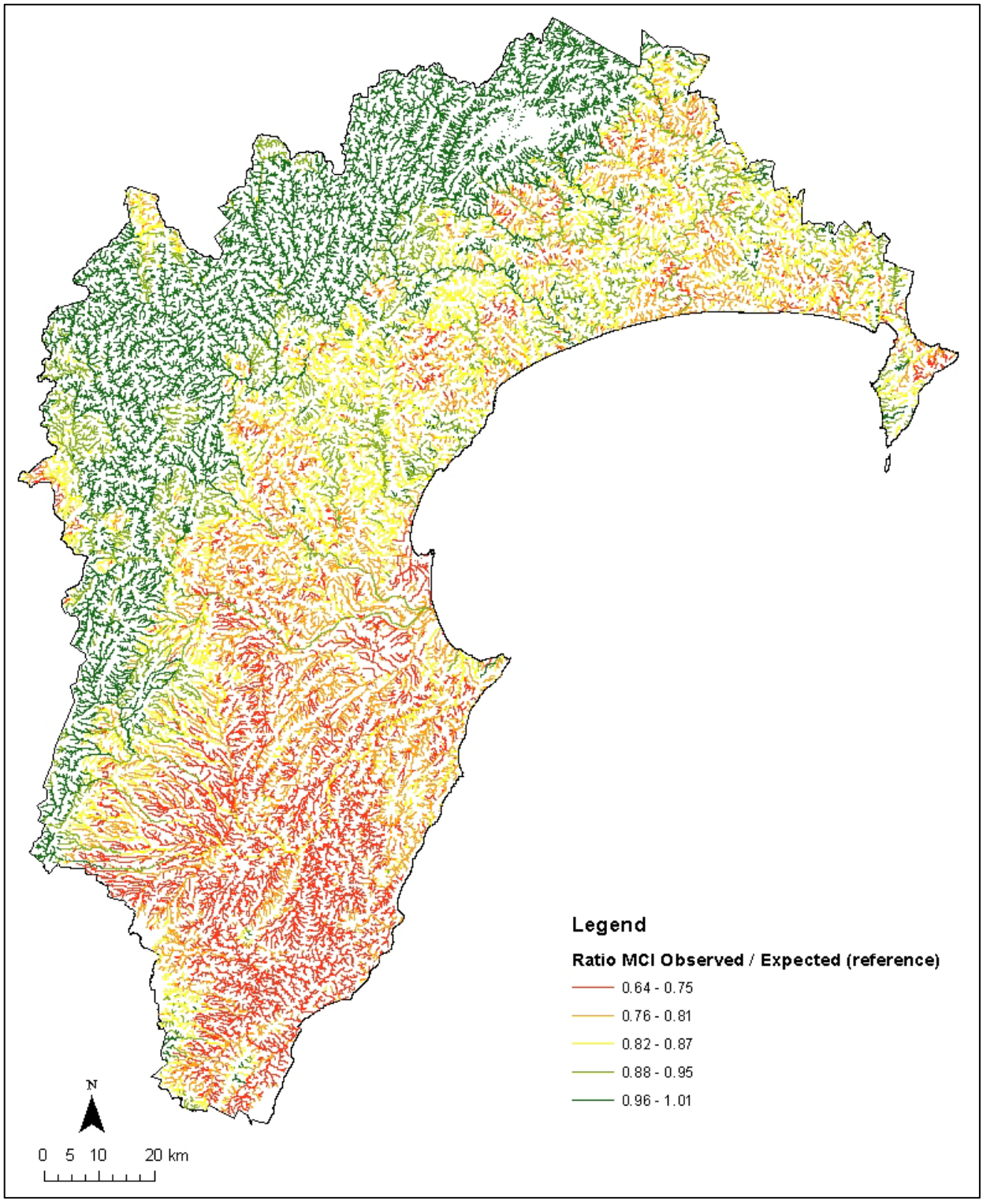

Figure 4-6: The degree of change in the Macroinvertebrate Community Index of rivers and streams in Hawke's Bay. The score is a ratio of Observed (current) and Expected (reference) MCI values. The higher score (e.g. streams shown in green lines) means the current MCI is very close to the reference state. Lower scores (e.g. streams shown in red lines) mean the current MCI is much lower than the reference state. Some sites have higher Observed MCI than Expected MCI because the Observed MCI is also modelled.

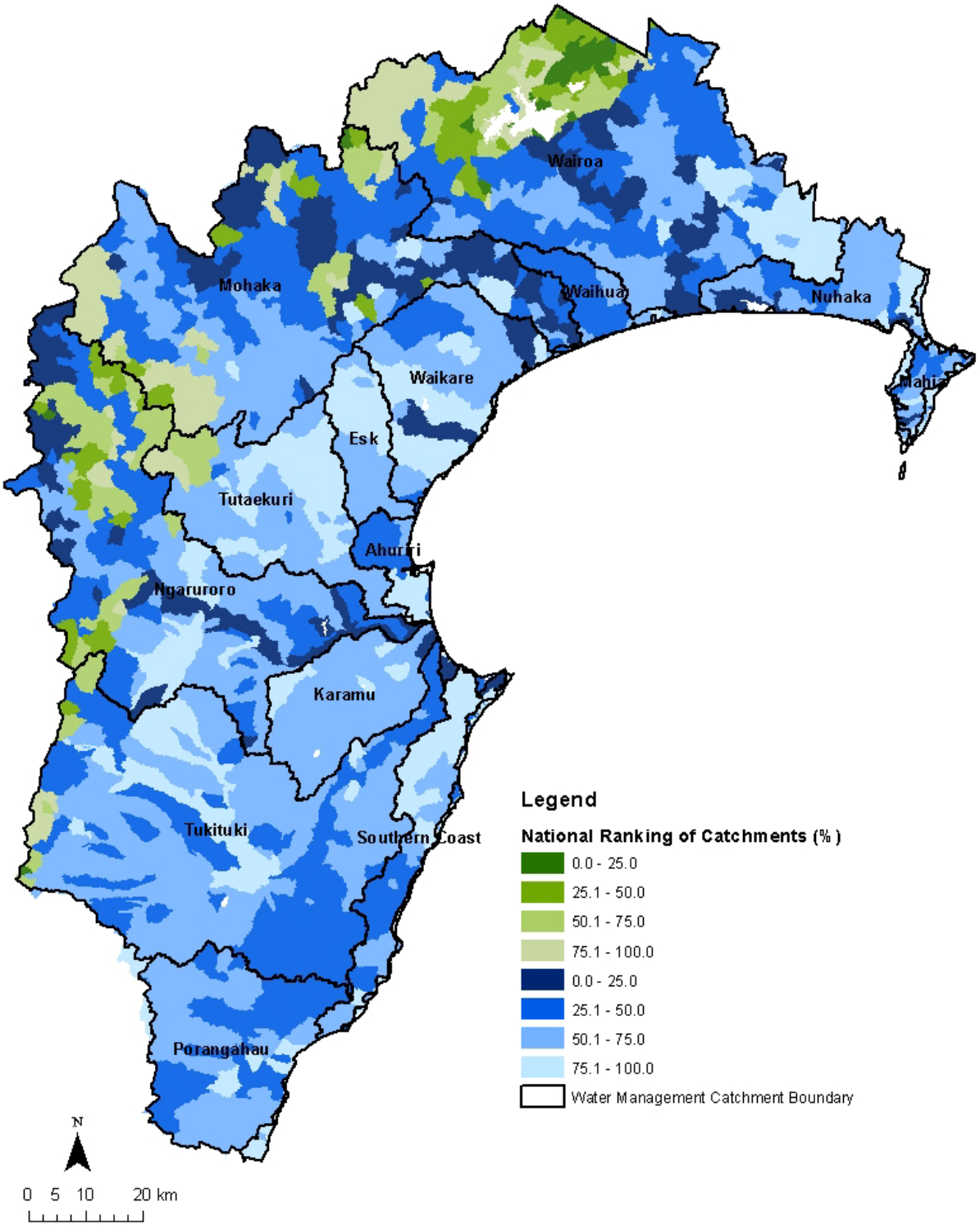

Figure 4-7: The national FENZ rankings of catchments accounting for river conditions, connectivity and complementarity. The ranking system also considers levels of existing protection, i.e. DoC conservation estate, QEII, and Nga Whenua Rahui covenants. Green colours are rankings for catchments whose substantial extents are under existing legal protection. Blue colours are rankings for catchments where majority of their extents are not under existing legal protection.

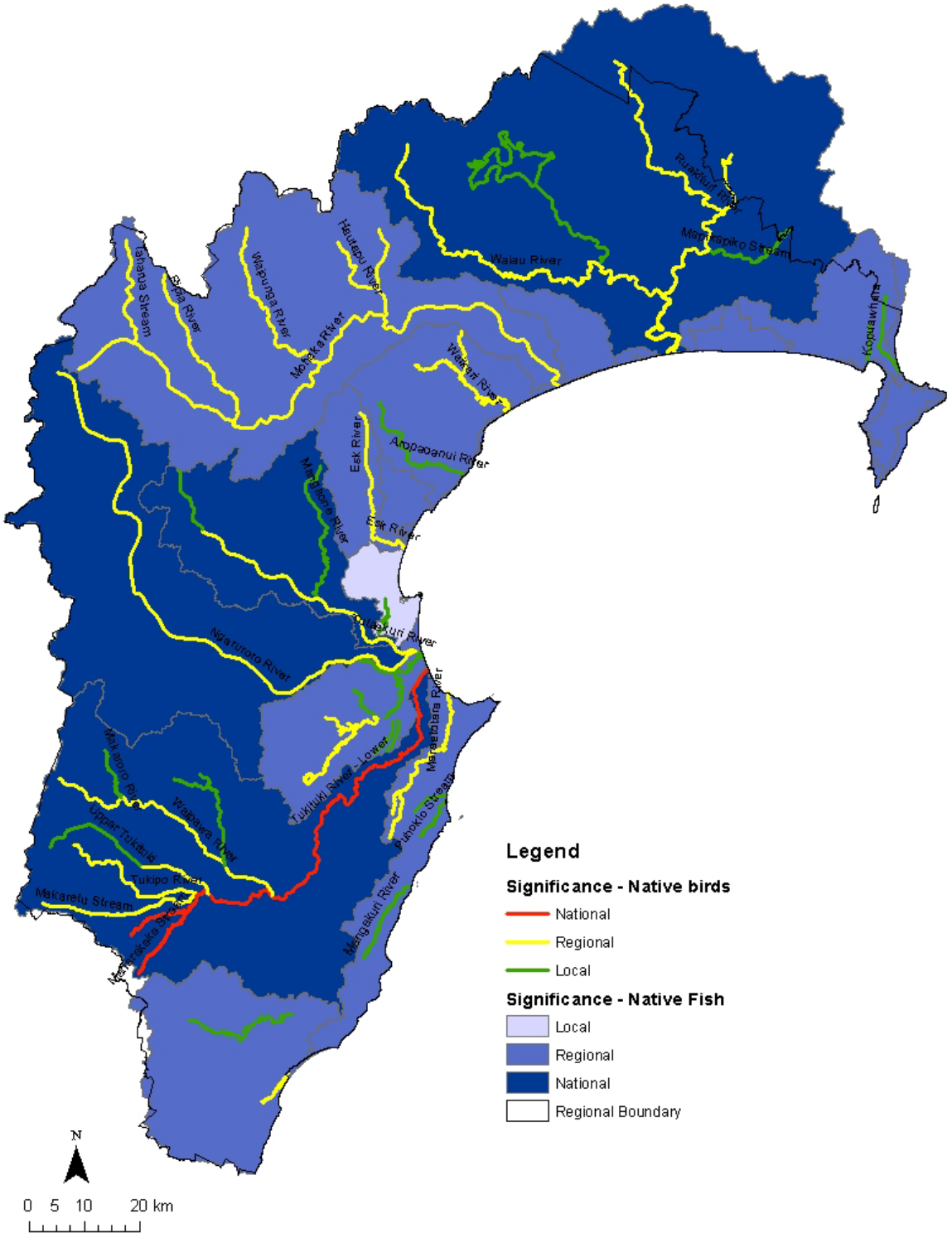

Figure 4-8: RiVAS rankings of rivers based on native birdlife and native fish values (Hughey et al, 2012). The significance level of rivers based on native birdlife value is shown as river lines. The significance level based on native fish value is shown at catchment (derived from FENZ) level as native fish habitat in rivers is usually driven by catchment-scale characteristics such as elevation, distance from coast, and indigenous vegetation cover. Note that the Ruakituri River in the Wairoa Catchment extends beyond the HBRC administrative boundary. HBRC monitors water quality and ecology of Ruakituri River in collaboration with Gisborne District Council (pers. comm. S. Haidekker, 6 August 2014).

Use and interpretation of rankings

There are large differences in the ranking attributed to rivers and streams using FENZ and RiVAS. One of the limitations of the FENZ ranking system is that it does not capture native bird values or threatened species. This limitation contributes to the relatively low ranking of Tukituki River and its tributaries by FENZ although these are considered highly significant by local experts and the wider community particularly for its bird life, fish, and amenity values (Chadderton et al., 2004). RiVAS can complement such shortcomings by assessing the native bird value of rivers. Using this analysis, the Tukituki River is considered the most significant for bird diversity. It is possible to combine the two to provide better selection of sites for freshwater biodiversity enhancement and maintenance.

Braided rivers and riverbeds receive additional attention from a conservation perspective. Braided riverbeds are one of the 'Historically Rare Terrestrial Ecosystems', given priority status by the Ministry for the Environment and Department of Conservation (MfE and DoC, 2007). Therefore, 'Local' or 'Regional Significance' does not necessarily mean braided rivers and riverbeds are any less important than other rivers ranked as having 'National Significance' by RiVAS.

4.5 Freshwater wetlands

This section characterises the freshwater wetlands in the region. The analysis of wetland extent in section 4.5.3 includes both freshwater and coastal wetlands such as estuaries and lagoons, however coastal wetlands are further discussed in the Coastal and Marine chapter. Lakes can be considered a type of wetland, thus the HBRC's wetland monitoring programme used to include both wetlands and lakes until 2006, when the state of the environment monitoring (SoE) programme for lakes was established. Lakes are discussed in section 4.6.

4.5.1 Method

The Freshwater Ecosystems of New Zealand (FENZ, see section 4.4.1) database has a wetland component which captures the historic and current extent and ecological characteristics of all New Zealand wetlands larger than 0.5 ha[21]. The wetland component enables a similar assessment as the river component as explained in section 4.4.1, including broad classification of each wetland and ranking of wetlands based on multiple criteria (Leathwick, 2010). The historic and current extent of wetland data was interrogated to estimate the degree of change in their extent.

HBRC has a monitoring programme for the top eight priority freshwater and coastal wetlands and lakes in the region, as recommended by DoC (Adams, 1995). These are Whakaki Lagoon, Lake Poukawa/Pekapeka Swamp, Lake Hatuma, Lake Oingo, Lake Runanga, Tukituki Estuary, Waitangi Estuary and Whakamahi Lagoon. Ecological data around these priority wetlands is reported every five years[22]. HBRC commenced a lake SoE monitoring in 2006 which includes nine lakes in the region (see section4.6). Recognising there are many more wetlands remaining in the region which deserve attention, HBRC has launched a wetland inventory programme. The inventory will map and classify all wetlands larger than 0.5 ha in the region. The information in the wetland inventory can be used for further assessment of wetland values, such as ecological, cultural, social and economic values, which can form the base for prioritisation of wetlands for various initiatives (HBRC, 2011). The wetland inventory for Hawke's Bay will also help refine the FENZ wetland database.

[21] FENZ data contains the wetland class based on substrate, water regime, nutrients and pH only. It does not assess wetland types based on hydrosystems.
[22] Such as Walls (2005) and Cameron (2008)

For the purpose of this report FENZ data was used as the primary information to characterise wetlands at the regional level. Data collected through the on-going development of the wetland inventory and monitoring of priority wetlands are used to supplement the FENZ data but not discussed in detail in the current report.

4.5.2 Wetland habitat types of Hawke's Bay

FENZ data suggest that most wetlands in the region are swamps, with the remaining wetlands consisting of marsh, fen, seepages and pakihi. Wetland class description is provided in Table I-2, Appendix I.

As part of the wetland inventory development, detailed wetland mapping has been completed for the Tukituki Catchment, identifying wetland types such as ephemeral wetlands and shallow water, as well as those predicted by FENZ (Forbes et al., 2011). According to the same exercise, there are four main hydrosystems represented by remaining wetlands in Tukituki Catchment, with palustrine being the most dominant hydrosystem followed by riverine, lacustrine and estuarine (Table I-1).

4.5.3 Changes in wetland extents

Based on the modelled data from FENZ, both coastal and freshwater wetland extent has been reduced to 2% of the original extent in the region (Figure 4-9 and Figure 4-10). The map includes coastal and freshwater wetlands. Priority wetlands as identified by DoC are shown in red.

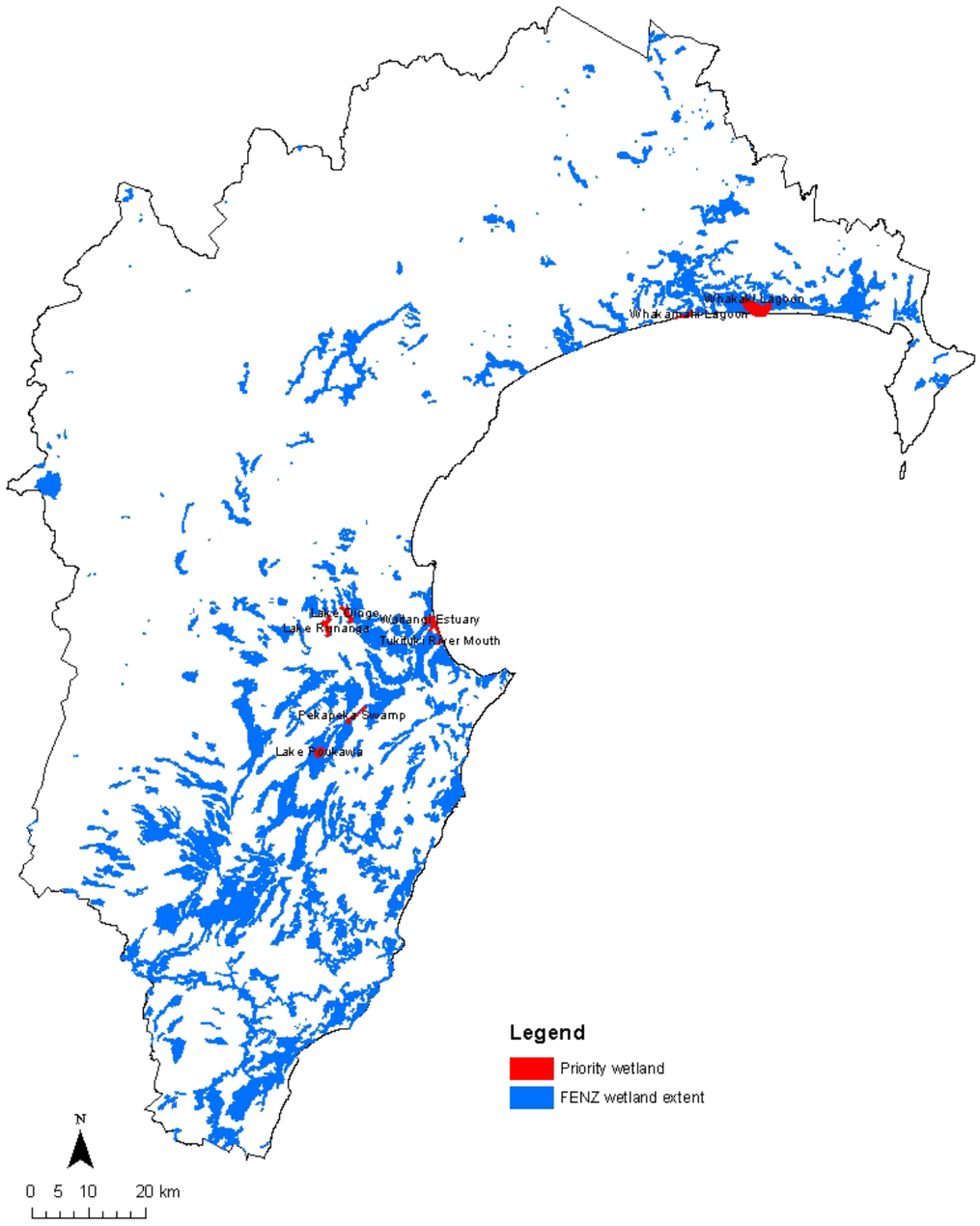

Figure 4-9: The historic extent of wetlands derived from FENZ. The map includes coastal and freshwater wetlands. Priority wetlands as identified by DoC are shown in red.

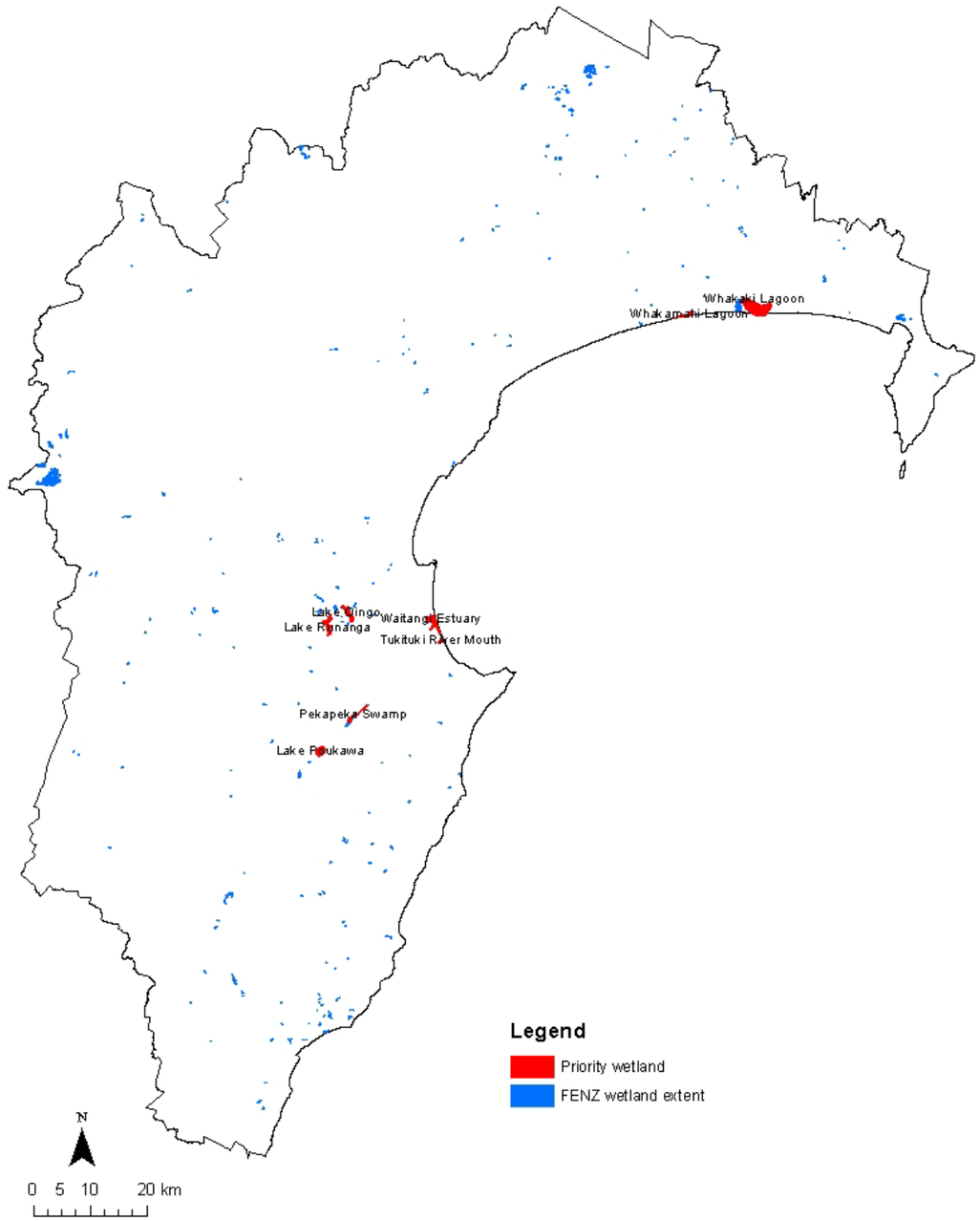

Figure 4-10: The current extent of wetlands derived from FENZ. The current wetland extent is based on the Land Cover Database version 2 (2001). The map includes both coastal and freshwater wetlands. Priority wetlands as identified by DOC are shown in red.

4.5.4 Threats for wetland habitats

Many wetlands have been drained to create land for residential and agricultural uses, and also for flood control and water storage, leaving only 2% remaining. This indicates that wetlands are one of the highly threatened (Acutely Threatened) habitat types in the region.

The remaining wetlands are likely to be modified to varying degrees, and influenced by surrounding landscapes and land activities. Approximately 40% of the remaining wetlands are under formal protection (DoC public conservation and QEII covenants), of which over 60% are located on montane environments. Most wetlands in lowland environments are on private land and afforded little protection.

4.6 Lakes

Understanding of the biodiversity values associated with lakes is generally limited. Some of the region's shallow lakes such as Lake Hatuma have been studied such as Cameron (2007), but there is little information on the biodiversity values of the rest of the lakes in the region. HBRC's lake SoE monitoring programme (currently monitoring nine major lakes in the region) is designed for monitoring the trophic state of the lakes with to understand water quality values rather than understanding biodiversity values.

Lakes are unique aquatic systems with physical, chemical and biological properties contained within water bodies. Lake's open water can act as refuge for native birds including terrestrial birds such as North Island fernbird (see **Table C-1**). However information around the diversity of aquatic invertebrate or plant species that rely on the regions lakes is lacking.

FENZ has lake data layers which enable lake classification and estimation of the effects of human pressures on lakes. This allows lakes to be ranked according to their ability to provide representative protection of a range of lake types. However this analysis is yet to be completed for the region.

4.7 Where to from here - Freshwater

Conclusion and proposed actions as next step are provided for each freshwater habitat type.

4.7.1 Rivers

River systems are inherently dynamic. Adding to the complex nature of the system are engineering modifications such as flood control management and changes in surrounding land use activities. The current knowledge base on biodiversity is not sufficient for establishing reference conditions for river habitats[23] however several tools exist for the evaluation and prioritisation of waterways.

FENZ is a powerful tool, which may be used for prioritisation of sites, be it for water quality management or biodiversity restoration. This is achieved by calculating significance scores based on sites' biodiversity conditions, complementarity, and desirability of maintaining upstream-downstream connectivity (Leathwick, 2010).

A tool called Point-Click-Fish has been developed to predict what fish are likely to occur at any site in any streams (Joy and Death, 2004). The tool, along with FENZ, has been applied to the Hawke's Bay region to predict native fish occurrence in the Tukituki Catchment (Sharp, 2012). While it may require further

[23] Possibility of implementing a methodology to assess temporal changes in the geomorphology of river systems developed by Ian Fuller (Massey University) was mentioned in the memo issued on 25 June 2013, but the decision is yet to be made.

refinement to improve accuracy, the tool could be used for the prioritisation of streams for fish habitat conservation and enhancement, as well as for other purposes such as resource management.

RiVAS (section 4.4.1) has been tested in different regions of New Zealand as well as in Hawke's Bay. RiVAS assessments have been undertaken across Hawke's Bay looking at native fish and birdlife values. It is an easy-to-use tool, and brings about consistency in decision-making process to prioritise rivers for management. Since it employs information obtained from local experts it can be specific to local rivers. The tool can be applied for social and cultural values.

There are some constraints in the use of tools such as the FENZ database. Many of these tools are designed to conduct large-scale analyses, so they may not be readily used in small-scale studies. An understanding of the limitations is necessary for ensuring that results are used appropriately. The accuracy of national databases is only increased through on-going input of actual data collected in the field.

The current HBRC rivers SoE programme is not designed to examine the biodiversity value of freshwater habitats, instead focussing on monitoring changes in water quality. The Macroinvertebrate Community Index (MCI) is measured but this does not measure state and trend at the species level and is not designed to provide a direct assessment of biodiversity value, even though it could be inferred that a high MCI reflects healthy invertebrate community. Monitoring sites are not designed to assess biodiversity state and values but are chosen to represent broad river types for water quality.

DoC has been developing a framework to assess the ecological integrity (EI)[24] of freshwater ecosystems. Proposed indicators to assess the properties of EI include nativeness, pristineness, diversity, and resilience (see Tables 14 & 15 in Schallenberg et al, 2011). The framework adopts a more holistic approach than the existing SoE programme. For example, MCI is measured for structural pristineness, but macroinvertebrate taxonomic richness is also measured to assess diversity, and key indicator species presence is measured for resilience assessment (Schallenberg et al., 2011). This improves the understanding of freshwater biodiversity and fills some of the knowledge gaps associated with freshwater fauna (as is reported in 3.3).

4.7.2 Freshwater wetlands

Coastal and freshwater wetlands boast a high diversity of indigenous flora and fauna, and notably act as significant habitats for 'Threatened' and 'At Risk' bird species (section 3.2.1). Wetlands are one of the most critically threatened habitat types both regionally and nationally because 98% of wetlands have already been lost and the remaining wetlands, particularly in lowland environments, are largely under private ownership. It is critical to improve understanding of these remaining wetlands and to identify wetlands where management approaches can be applied that deliver successful outcomes. The development of a regional wetland inventory is essential to drive this process. The information collected through the regional inventory will be incorporated in and thus improve the FENZ database.

HBRC has been developing a wetland inventory for the Hawke's Bay region. It is critical that this inventory is completed and maintained.

4.7.3 Lakes

There is limited understanding of the biodiversity value of the regions lakes. While historic studies are likely to exist for some of the region's shallow lakes, such as Lakes Poukawa and Hatuma, this information needs to be collated to identify the current state of knowledge.

[24] EI defined by (Schallenberg et al., 2011) is "the degree to which the physical, chemical and biological components of an ecosystem and their relationships are present, functioning and maintained close to a reference condition reflecting negligible of minimal anthropogenic impacts"

Understanding of lake biodiversity can be improved by combining FENZ with DoC's Ecological Integrity framework. This would aid in the selection of lakes most appropriate for biodiversity conservation.

4.8 Recommendations – freshwater

- Establish a framework based on existing tools (e.g. FENZ and RiVAS) for identifying significant freshwater rivers and streams.
- Assess DoC's proposed indicators for measuring the ecological integrity of freshwater ecosystems and establish a programme for monitoring state and trend of freshwater biodiversity.
- Identify biodiversity values in lake habitats by combining FENZ and DoC's EI framework.

Coastal and Marine

This chapter describes the state of knowledge around the biodiversity of the coastal and marine environment of Hawke's Bay. In general coastal and marine areas have high biodiversity values. So far about 8,000 marine species have been identified in New Zealand's marine waters however on average seven new species are identified every fortnight. Marine species make up almost one third of New Zealand's native species (NZ Biodiversity Strategy, 2000).

For the purpose of this document the definition of the coastal and marine environment is as described in the Regional Coastal Environment Plan (HBRC, 2012). The coastal and marine environment includes:

- The coastal marine area (CMA) out to 12 nautical miles as described in Section 2 of the Resource Management Act 1991.
- Any areas identified as being affected by, or potentially affected by, coastal flooding or coastal erosion and
- Any of the following:
  - Tidal waters and the foreshore above mean high water springs (MHWS)
  - Dunes
  - Beaches
  - Areas of coastal vegetation and coastal associated fauna
  - Coastal cliffs
  - Salt marshes
  - Coastal wetlands, including estuaries and
  - Areas where activities occur or may occur which have a direct physical connection with, or impact on, the coast.

The HBRC Regional Coastal Environment Plan (HBRC, 2012) identifies a number of Significant Conservation Areas (Figure 4-11). These include:

- Inter-tidal reefs (Southern Hawke's Bay; Mahia Peninsula)
- Estuaries and lagoons (Porongahau; Tukituki; Waitangi; Ahuriri; Wairoa; Maungawhio).
- Dune systems (OceanBeach; Rangaiika)
- Islands (Bare Island; Portland Island)
- Subtidal reefs (Pania; Mahia Peninsula)
- Subtidal cobble/ pebble habitat (Wairoa Hard; Clive Hard)

Figure 4-11: Significant Conservation Areas in Hawke's Bay as identified by the HBRC Regional Coastal Environment Plan (2012).

4.9 Coastal

The Hawke's Bay coastline stretches 353km from the Mahia Peninsula and Mahanga in the north, to slightly south of Whangaehu. The coastline supports a diverse range of habitats closely related to the geology of the area (Stevens and Robertson, 2005). Coastal cliffs, sandy beaches, extensive dune systems and rock platforms characterise the coastline between Cape Kidnappers and Cape Turnagain. To the north, river mouths, estuaries, gravel beaches and herb fields typify coastal habitats between Tangoio bluff and Te Awanga, with steep cliffs; low-lying dunes, sandy and gravel beaches and rock platforms present north of Tangoio to Mahanga (Stevens and Robertson, 2005).

Alongside the Significant Conservation Areas described above, the Hawke's Bay coastal environment contains a number of terrestrial habitats listed as historically rare (Williams et al., 2007). These are:

- Shingle beaches (Cape Kidnappers to Tangoio Bluff)
- Sand dunes (Ocean Beach, Rangaiika)
- Coastal rock stacks (Cape Kidnappers)
- Coastal cliffs
- Coastal turfs
- Marine mammal haul-outs (Cape Kidnappers)
- Estuaries such as Ahuriri etc.
- Coastal lagoons (Whakaki)

4.9.1 Method

Broad-scale habitat mapping of most of the Hawke's Bay coastline was undertaken in 2005 (Stevens and Robertson, 2005). The technique used for this mapping was based on the National Estuary Monitoring Protocol (Stevens and Robertson, 2005) and used field-verified broad-scale mapping of habitat zones classified by dominant vegetation type and substrate. The broad-scale habitat mapping included all intertidal areas, the coastal terrestrial margin (a 20m habitat margin above MHWS (Mean High Water Spring), and a general characterisation of surrounding land use. This general characterisation has limitations since some coastal habitats such as sand dunes are not comprehensively included by these categories (see Appendix A).

Ecological evaluation of sections of the coastline were undertaken in 2007 (Madarasz-Smith, 2007). A more detailed survey and assessment of the regions coastal sand dunes was carried out in 2002 (Walls, 2002). The report lists 28 identified dune systems, describing their ecological condition, threats and outlining the management actions required to maintain or improve their ecological integrity[25].

4.9.2 Coastal habitat types

According to Stevens and Robertson (2005), the most dominant habitat type in the intertidal area is firm sand (48 %) followed by rock field - reef (35 %). Gravel fields (8 %) dominate the coastline around Napier, but are far less dominant than sand and rock field along the region's coastline. The remainder of the intertidal area is a mixture of boulder field – reef (7 %), cliff (1 %) and cobble field (0.1 %) (Table 4-4).

[25] Sand dune extent reported by Walls (2002) has been under review and re-mapping using Geographic Information Systems by HBRC.

The most common features of the coastal terrestrial margins (20m above MHWS) are cliff (35 %), followed by duneland (22 %), sand (13 %), gravel (10 %), grassland (9 %) and boulder field (8 %). Field observations of the coastal terrestrial margin indicate that most of the land adjacent to the Hawke's Bay coastline has been modified from its native state (Stevens and Robertson, 2005).

Table 4-4: The coastal habitat types in Hawke's Bay based on Stevens and Robertson (2005). The area (Ha.) and percentage of each habitat type along the Hawke's Bay Coastline split into three habitat categories (terrestrial, habitat margin, intertidal).

Habitat type	Terrestrial		Coastal terrestrial margin		Intertidal	
	Ha.	%	Ha.	%	Ha.	%
Native forest	3	0.04				
Exotic forest	637	10.9				
Native scrub/ shrub/ trees	39	0.7	2	0.3		
Exotic scrub/ shrub/ trees	1	0.02				
Tussockland	13	0.2	1	0.1		
Grassland	1,796	30.6	65	9.2		
Duneland	615	10.5	151	21.5		
Rushland	35	0.6				
Herbfield	42	0.7	1	0.1		
Industrial	59	1.0	9	1.3		
Residential	359	6.1				
Cliff	2,137	36.4	247	35.1	36	1.0
Rockfield - reef			1	0.1	1,256	34.9
Boulder field - reef			57	8	248	6.9
Boulder field man-made	0	0.001			9	0.2
Cobble field			1	0.1	2	0.1
Gravel field	51	0.9	73	10.4	290	8.0
Firm sand	77	1.3	93	13.1	1,742	48.4
Water - Estuaries	4	0.1	5	0.7	17	0.5
Total	5,868	100	704	100	3,599	100

4.9.3 Changes in coastal habitats

There are few records of what the coastal habitat once looked like in Hawke's Bay and most coastal ecosystems have been extensively modified from their original form.

Based on the Potential Vegetation of NZ data, indigenous forests extended to the coastline. The optimal forest types in the absence of human disturbance were mainly kahikatea-pukatea-tawa forest, rimu/tawa-kamahi forest, and other podocarp species accompanied by tawa and mahoe. Coastal forest is no longer characteristic of the Hawke's Bay coastal environment. This forest type has been reduced to 0.2% of its original extent (Hashiba, unpublished) and some small remnants exist in Mahia and at Waipatiki beach. Most of the coastal forest was cleared by fire and is now pastoral farmland and scrub.

Sand dunes are another of the coastal habitat types that have been modified and reduced in their extents. Nationally less than 12 % of sand dune habitat is thought to remain. Most of the original dune vegetation cover would have been removed over a relatively short period during early pastoral grazing and droving (G. Jenks, personal communication, 2007). Subsequent stabilisation efforts, continued grazing, residential development and introduced weeds have continued to impact on coastal dune habitat (Henriques, 1990). The regional extent of sand dunes is estimated to be 2,250 ha., including some of the most significant dune systems on the east coast of the North Island such as Ocean beach and Rangaiika (Walls, 2002). Although the original extent of the region's dune systems is unknown, they have undoubtedly been highly modified and reduced, reflecting the national situation around sand dunes. Many features of sand dunes are classified as 'historically rare' ecosystems (see Historically Rare Terrestrial Ecosystems).

The region has five large estuaries (Porongahau, Waitangi, Ahuriri, Wairoa and Maungawhio) and many smaller systems. These habitats have been heavily modified and reduced in size through flood defence works, drainage for development and agriculture, the introduction of exotic species and contamination from storm water inputs. Despite this large-scale modification they remain important feeding and breeding grounds for many rare bird species and are important habitats for many fish species.

Like estuaries, coastal wetlands and lagoons such as the Waitangi Estuary and the Whakaki Lagoon provide habitat for many bird and fish species including anadromous species like eels and catadromous species such as Inanga. The disruption of natural processes for the purposes of flood management regimes and associated land drainage has led to a habitat decline in coastal wetlands including the Whakaki complex (HBRC, 2002)[26]. There can also be a detrimental effect on estuaries from increased levels of sedimentation (Reid et al., 2011).

The intertidal area of the coastline of Hawke's Bay can be split into two areas defined by the dominant habitat type. These are Hawke Bay itself which is dominated by sand and gravel beaches, and the exposed coastlines south of Cape Kidnappers and the Mahia peninsula, where extensive rock and boulder fields are interspersed with sandy beaches. Madarasz-Smith (2007) attributes the highest ecological values to intertidal reef areas, in terms of the diversity of species found in these areas. The reefs of southern Hawke's Bay have large areas of eel grass beds and are reported to be important feeding grounds for a large number of wading birds (Cresswell and Warren, 1990). The reefs around the Mahia Peninsula also have high ecological values (Beaumont et al., 2009) and the peninsula has particularly high values for wading birds. There are SoE monitoring sites on intertidal reefs at Te Mahia, Hardinge Road and Kairakau (Wade, 2011). Sedimentation effects, trampling and seafood harvesting, invasive species and reduced water quality are all potential pressures on intertidal reefs in Hawke's Bay.

[26] At Whakaki, restoration efforts to improve habitat quality have enjoyed relative success and are well supported by the local community. This included reinstating the original outflow in 1997 to restore natural flooding and draining processes.

The largest extent of intertidal coastline habitat is firm sand. The council has SOE monitoring sites of sandy beach fauna at Blackhead, Pourerere, Waimarama, Ocean Beach, Opoutama and Mahanga. Invertebrate communities are believed to be typical of their beach type at this time. Sandy beaches are likely to be important breeding/spatting areas for different species of shellfish. The main threat to sandy beach ecosystems is likely to be vehicle traffic, with many of the region's beaches experiencing large volumes of traffic. This vehicle traffic combined with reduced water quality, shellfish harvesting and modifications of the dune systems are threats to theses ecosystems (Henriques, 1990).

4.10 Marine

The Hawke's Bay coastline stretches for 353 km and the coastal marine area (to 12 miles from shore) covers 701,372 ha. Its deepest point is 1,317 m deep.

4.10.1 Method

Marine habitat types and the animal communities in those habitat types are defined largely by bathymetry (topography of ocean floors) and substrate types. Generalised information on the sediments found in the Hawke's Bay coastal subtidal marine habitat can be found in unpublished maps generated by the Department of Conservation and the Ministry for Primary Industries. By combining sediment and bathymetric information with biological information around marine taxonomic groups it is possible to develop a generalised picture of the Hawke's Bay marine environment. Limited information on the region's marine biological communities exists for some sediment communities (McKnight 1969), subtidal reef communities (Duffy, 1992), marine mammal distributions (Cawthron, 2009), and commercial fish species (MPI).

4.10.2 Marine habitat types

The near-shore marine environment is generally shallow and consists of fine sands and mud. These areas have been reported to contain invertebrate community assemblages found nowhere else in New Zealand (McKnight, 1969) and the region has high biodiversity values in terms of echinoderms (starfish, sea cucumbers etc.) and arthropods (crustaceans) (Beaumont et al., 2009) .

There are comparatively small areas of cobble and pebble habitat at the 'Wairoa Hard' and the 'Clive Hard'. These are highly complex habitats (Thrush et al., 1997), recognised as important nursery areas for many fish, in particular Snapper (Walsh et al., 2012) and Elasmobranchs (rays and sharks).

Areas of shallow subtidal rock reef support diverse algal, invertebrate and fish assemblages at Pania reef and south of Cape Kidnappers (Duffy, 1992). The deeper Lachlan Ridge south of Mahia supports a wide range of fish species that are targeted by recreational and commercial fishermen. The Mahia peninsula itself has a number of subtidal areas of significant ecological value (Hania and MacGibbon, 2004).

4.10.3 Changes in marine habitats

There are few records of changes in the marine habitat of Hawke's Bay. The most informative is a history of the development of the trawling industry in the region (Tai-Perspectives, 1996). This document outlines the depletion of the fish stocks and removal of kelp (*Ecklonia radiata*) forests from the 'Wairoa Hard' by trawlers through the 1960s and 1970s. Fears about the depletion of fish stocks led to the closure of this area to commercial fishing in 1981. The 'Clive Hard' is an area of similar substrate to the 'Wairoa Hard' and is expected to have undergone the same depletion.

Other changes to the regions marine environment are undocumented and unknown. An international collaboration between American and New Zealand scientists has documented unusually large levels of sediment entering the coastal area around the Ruakumara Peninsula to the north of Hawke's Bay (Orpin et al., 2002). The similarity between the geology, land cover, river type and meteorology of this area and Hawke's Bay suggests that Hawke's Bay has similarly heavy sediment inputs. MacDiarmid (2012) ranked sedimentation the third greatest threat to marine habitats and the primary threat from human activities in catchments that discharge into the coastal marine environment. The changes that these sediments may have caused to the marine habitats of Hawke's Bay are currently unknown.

4.11 Where to from here (Coastal and Marine)

Whilst data exist on habitats in the coastal terrestrial margin and intertidal zone, specific species distributions are unknown. Coastal ecosystems are acknowledged to be some of the most diverse ecosystems. However, biological monitoring in these areas is currently restricted to the HBRC SoE monitoring programmes (estuaries, sandy beaches and intertidal reefs) and individual research projects revolving around the Te Angiangi marine reserve. The best available region-wide information is broad-scale habitat mapping conducted by Cawthron (Stevens and Robertson, 2005). However due to its broad-scale nature this misses the nuances of different species compositions forming different habitat types on, and in, different substrates.

Data around the marine environment are currently even more limited. The only broad-scale information available is unpublished sediment maps. Currently there is no framework that enables delineation of particular habitats or distributions of particular animals at a regional scale. For example, the existing 'Marine Environmental Classification' developed by the Ministry for the Environment (2005) classifies the whole of Hawke's Bay marine area as 'Environment 2', which is typified by moderately warm water temperatures and high salinity, where orbital velocities are often high, and chlorophyll-a concentrations are moderate. Tidal currents and sea surface temperature gradients are both moderate.' Such classification is too broad for regional scale marine habitat characterisation.

4.12 Recommendations – coastal and marine

- Map the extent of the subtidal habitats of the Hawke's Bay region.
- Survey the condition of key subtidal habitats.
- Research lifecycles of key indicator species to help inform identification of priority habitats.

Historically Rare Terrestrial Ecosystems

Historically rare terrestrial ecosystems are defined as those being rare before human colonisation of New Zealand, covering less than 0.5% (approximately 134,000 ha) of New Zealand's total area (Williams et al., 2007). There are seventy two such ecosystems classified nationally, occurring from coastal to alpine zones. Sand dunes and wetlands are included as historically rare, but their original rarity is currently uncertain (Williams et al., 2007).

Terrestrial ecosystems that were originally rare often are characterised with endemic and rare species who are adapted to the distinctive environments (Williams et al., 2007). Of the seventy two ecosystems, those that are more threatened than the others are inhabited by a greater number of threatened plant species (Holdaway et al., 2012).

4.13 Method

The original list of Historically Rare Terrestrial Ecosystem (from Williams et al., 2007) was distributed to the relevant experts, who reviewed the list of ecosystems based on published and unpublished information.

4.14 'Historically Rare Terrestrial Ecosystems' found in Hawke's Bay

Twenty of the seventy two Historically Rare Terrestrial Ecosystems identified by Williams et al. (2007) are known to occur in Hawke's Bay (Table 4-5). The level of knowledge about these ecosystems is limited to approximate locations and generalised descriptions (Table H-1, Appendix H).

Due to their restricted distribution and relatively small patch size, these Historically Rare Terrestrial Ecosystems are relatively vulnerable to many threats such as housing development, weed invasions, and agricultural development (Williams et al., 2007).

As part of this report, the extent of sand dunes and frost flats was delineated. The rest of the ecosystems identified do not have comprehensive data around their distribution. DoC has done preliminary mapping for the country, but the data is yet to become generally available (M. Brady, personal communication, 14 May 2014).

4.15 Where to from here – Historically Rare Terrestrial Ecosystems

The Historically Rare Terrestrial Ecosystems are critical for indigenous biodiversity because they are characterised by high species diversity and endemism. These ecosystems frequently occur in lowlands, where most land is not legally protected.

Regional knowledge of Historically Rare Terrestrial Ecosystems is poor. Apart from some of the wetland types and sand dunes, no information exists for the rest of the ecosystems which may occur in the region. Past surveys on chosen wetlands and sand dunes were not designed to collect data necessary to quantify species diversity and endemism of sites. They were also targeted studies, and so do not inform analysis of state and trends in site conditions.

Given the restricted extent, presumably high endemism and high number of threatened species presence, Historically Rare Terrestrial Ecosystems urgently need protection. In order to do so, these sites need identifying and a full inventory taking of their conditions and threats.

4.16 Recommendations - Historically Rare Terrestrial Ecosystems

- Complete the inventory for Historically Rare Terrestrial Ecosystems for Hawke's Bay, identifying other examples not captured in the current inventory.
- Conduct a full ecological survey of known ecosystems.

Table 4-5: Historically Rare Terrestrial Ecosystems known to occur in Hawke's Bay.

Coastal	Active sand dunes
	Shingle beaches
	Coastal rock stacks
	Coastal cliffs and acidic rocks
	Calcareous coastal cliffs
Inland and alpine	Screes and acidic rocks
	Frost flats (old tephra plain > 500 years)
	Frost hollows
	Boulderfields of acidic rocks
	Calcareous cliffs, scarps and tors
	Braided riverbeds
	Cloud forests
Induced by native vertebrates	Seabird burrowed soils
	Marine mammal haulouts
Wetlands	Lake margins
	Cushion bogs
	Ephemeral wetlands
	Tarns
	Estuaries
	Lagoons

5 Conclusion

Where land environments are under threat, so too are aquatic environments. The extent of forest cover in Hawke's Bay has been greatly reduced and fragmented. When associated with the soft geology of Hawke's Bay, this exposes elevated land to high levels of erosion and nutrient loss. This erosion leads to reductions in water quality, and large amounts of sediment entering the regions streams and rivers. The regions estuaries and near shore coastal environment are the receiving environment for this material. In some cases biodiversity change is visible, in other cases they are hidden from view (see section 3.3).

The development of the Biodiversity Inventory is a collective and an on-going exercise. Input of data and expert knowledge will be obtained from key stakeholders to help ensure all the current information around the biodiversity of Hawke's Bay is collated.

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7 Glossary of abbreviations and terms

DoC	Department of Conservation
FENZ	Freshwater Ecosystems of New Zealand
Guilds	Groups of species in a community that exploit the same set of resources in a similar manner, but are not necessarily closely related taxonomically.
HBRC	Hawke's Bay Regional Council
LCDB	Land Cover Database
PNAP	Protected Natural Areas Programme
PVNZ	Potential Vegetation of New Zealand
QEII	QEII National Trust
RAP	Recommended Areas for Protection (identified by DoC under the PNAP)
SoE	State of the Environment (monitoring and reporting led by local authorities)
Strongholds	Habitat sites that hold 2 % or more of the national population
Ungulate	In this report it means large mammals with hooves, typically deer. Farm animals such as cattles and horses are also ungulates.

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Appendix A List of available data

Table A-1: Overview of available data. All information and data are available on request. Open-source information is indicated with asterisks (*) for which sources are listed in Table A-2. Some of the information is sensitive, such as species observation records, and requires permission from relevant authorities for use.

	Name	What it contains	Published Year	Limitation
Threatened Species and Habitats	National Threat Classification System, taxa lists and associated publications*	♠ Classification system (document) is a tool for assigning threat status to native taxa (PDF). ♠ 'Lists' are taxa lists with one of the threat statuses (excel). ♠ 2008-11 taxa lists were checked by Hawke's Bay experts for presence/absence of each taxon as at 2013 (excel).	♠ System (Townsend et al, 2008) ♠ List (2008 – 2011) ♠ HB review (2013)	Not all the lists are reviewed due to lack of expertise in the region.
	Significant habitats for 'Threatened' and 'At Risk' bird species in Hawke's Bay (2013)	Spatial data of habitats for 'Threatened' and 'At Risk' bird taxa (from 2008-2011 taxa list as above) is mapped by regional avian experts in 2013 (spatial, excel).	2013	
	Department of Conservation report on land snails in the East Coast/Hawke's Bay Region*	List of small land snail species that are known to occur in the region (PDF).	2009	No other ecological information (e.g. habitat types, distribution) is found during the process of writing this report
	Department of Conservation report on shallow rocky reef habitats in Hawke's Bay (unpublished report)	Rotenone collections and diver counts from shallow reefs around southern Hawke's Bay	1992	Limited spatial coverage.
	Hawke's Bay Regional Council marine ecology SOE programme	Monitoring data or soft and hard-shore ecology at sites around Hawke's Bay	2014	Limited time series.
	Marine mammal and stranding data	Summarised in Cathwron report number 1698. Marine mammals within Gisborne District Coastal Waters	2010	Focussed on Gisborne District
Terrestrial Habitats	Potential Vegetation of New Zealand (PVNZ)*	♠ Spatial data generated from a predictive model of the extent of forest types that would have existed in a given environments (ArcGIS shapefile). ♠ Subset of data derived from this data include: o Adjusted vegetation type names and description for Hawke's Bay (excel) o Current extent of each forest type in the region (ArcGIS shapefile) o Threat status of each forest type based on % remaining (excel and ArcGIS shapefile)	♠ PVNZ (Leathwick, n.d) ♠ Subset of data (2013)	Resolution is adequate to predict forest types on regional, catchment or site scale. Therefore PVNZ can be used in conjunction with field-base classification such as the one developed by Walls (2013).

	Name	What it contains	Published Year	Limitation
	Regional habitat type classification	Habitat type classification is derived from vegetation types and landforms. It also contains expert opinion on threat status of habitat types (note that the threat status in this classification is different from TENZ)	Walls (2013)	Lacking spatial information for each habitat type. 'Threat Status' is qualitative, and not consistent with nationally-accepted threat classification.
	Threatened Environment of New Zealand (TENZ) classification*	Classification system for land environments based on % of indigenous vegetation remaining (PDF).	Walker et al. (2007)	
	Land Cover Database (LCDB) (version 3.0)*	Digital map of the land surface of NZ.	2012	Land cover classes are broad and do not differentiate vegetation types.
	Public conservation areas (national parks, forest parks, conservation areas, stewardship areas) in Hawke's Bay	Digital map of public conservation administered by DoC, Nga Whenua Rahui, and protected private land under Reserves Act 1977 (ArcGIS shapefile)	Attained 2012	
	Protected Natural Areas Programme (PNAP) reports and data	• Survey reports of ecological districts which overlap with regional boundary (Tiniroto, Waihua, Matawai, Ruahine, Kaimanawa, Maungaharuru, Moawhango, Heretaunga, Eastern Hawke's Bay) (mostly hardcopies) • Digitised Recommended Areas for Protection (ArcGIS shapefile)	1990s to 2000s	
	QEII covenanted areas in Hawke's Bay	Digital map of QEII covenanted area (anonymous).	Retrieved in 2012	
Freshwater Habitats	Freshwater Ecosystems of New Zealand (FENZ) database	Spatial data generated from a predictive model of environmental and biological patterns of freshwater ecosystems (river, lake, wetland) in NZ (ArcGIS shapefile). It also includes a layer for national rankings (based on river conditions, connectivity, complementarity and level of protection) of catchments.	Leathwick et al (2010)	Quality of observational data on which FENZ is built Is not consistent, resulting potentially low accuracy. Resolution is coarse for predicting patterns at regional, catchment, or site scales.
	Point-Click-Fish database for Hawke's Bay	Spatial data generated form a predictive model of the likelihood of a fish species being present in a given freshwater environment. The model is developed by Joy and Death (2005)		Same as the limitation of FENZ database.
	NZ Freshwater Fish Database*	Database for fish presence/absence in New Zealand. Database is administered by National Institute of Water and Atmospheric Research		Quality of data may be inconsistent depending on who collected data.

	Name	What it contains	Published Year	Limitation
	River Value Assessment System (RiVAS and RiVAS+)	• Ranking system for rivers based on natural, recreational, cultural and economic values. • Ranking of Hawke's Bay rivers, implementation of RiVAS and RiVAS+ by local experts (reports).	• Hughey et al. (2011) • Booth (2012); Booth et al. (2012); Booth et al. (2012); Booth et al. (2012); Harris (2012); Hughey et al. (2012); Hughey et al. (2012)	Data only available on major rivers
	Wetland inventory	Wetlands identified and classified (based on hydrosystems, landform) (ArcGIS shapefile, photos). Completed for Tukituki Catchment; Ngaruroro, Tutaekuri and Mohaka catchments in progress.	In progress since 2011	
	Hawke's Bay Regional Council monitoring programme reports and data for top 8 priority wetlands	Ecological information of top 8 wetlands; Pekapeka Wetland, Lake Hatuma, Whakaki Lagoon, Tukituki Estuary, Waitangi Estuary, Lake Runanga, Lake Oingo, Whakamahi/Whakamahia Lagoons (lakes now come under Lake SoE monitoring programme)	Various since 1998	
	Lake State of the Environment monitoring programme reports and data	Ecological information of 9 major lakes in the region, mainly focusing on trophic state of the lakes (i.e. water quality).	Various since 1999 (Lake Hatuma)	Programme is designed to monitor the water quality and not adequately designed for measuring ecological values of lake system.
Costal and Marine Habitats	Significant conservation areas within Hawke's Bay	Regional Council Environment Plan	2008	Limited ecological information
	Habitat mapping of Hawke's Bay coastline	Broad-scale habitat mapping of the Hawke's Bay Coastline	Stevens & Robertson (2005)	Limited resolution and landward extent
Historically Rare Terrestrial Ecosystems	New Zealand's historically rare terrestrial ecosystems*	• Classification method and list of ecosystems (PDF). • Preliminary map at a national scale • Preliminary map of HB sand dunes (ArcGIS shapefile).	• Classification (Williams et al, 2007) • DoC/Landcare ecosystem map (unpulblished) • HB Sand dune map (2013)	

Name	What it contains	Published Year	Limitation
Survey and assessment of Hawke's Bay's coastal sand dunes	Qualitative information of 28 coastal sand dunes, which are ranked based on their ecological, cultural and social values. Management needs specific to each sand dune is also described.	Walls (2002)	Assessment is qualitative based on expert observation, and there is no data that can be re-measured.

Table A-2: List of open-source data. These data are available from sources listed in the table.

Name	Source
National Threat Classification System, taxa lists and associated publications	http://doc.govt.nz/publications/conservation/nz-threat-classification-system/
Department of Conservation report on land snails in the East Coast/Hawke's Bay Region	http://www.doc.govt.nz/publications/conservation/native-animals/invertebrates/land-snail-posters/
Potential Vegetation of New Zealand (PVNZ)	https://lris.scinfo.org.nz/
Threatened Environment of New Zealand (TENZ) classification	http://www.landcareresearch.co.nz/resources/maps-satellites/threatened-environment-classification
Land Cover Database (LCDB)	https://lris.scinfo.org.nz/
NZ Freshwater Fish Database	https://www.niwa.co.nz/freshwater-and-estuaries/nzffd
New Zealand's historically rare terrestrial ecosystems	http://www.landcareresearch.co.nz/science/plants-animals-fungi/ecosystems/rare-ecosystems

Appendix B New Zealand Threat Classification System

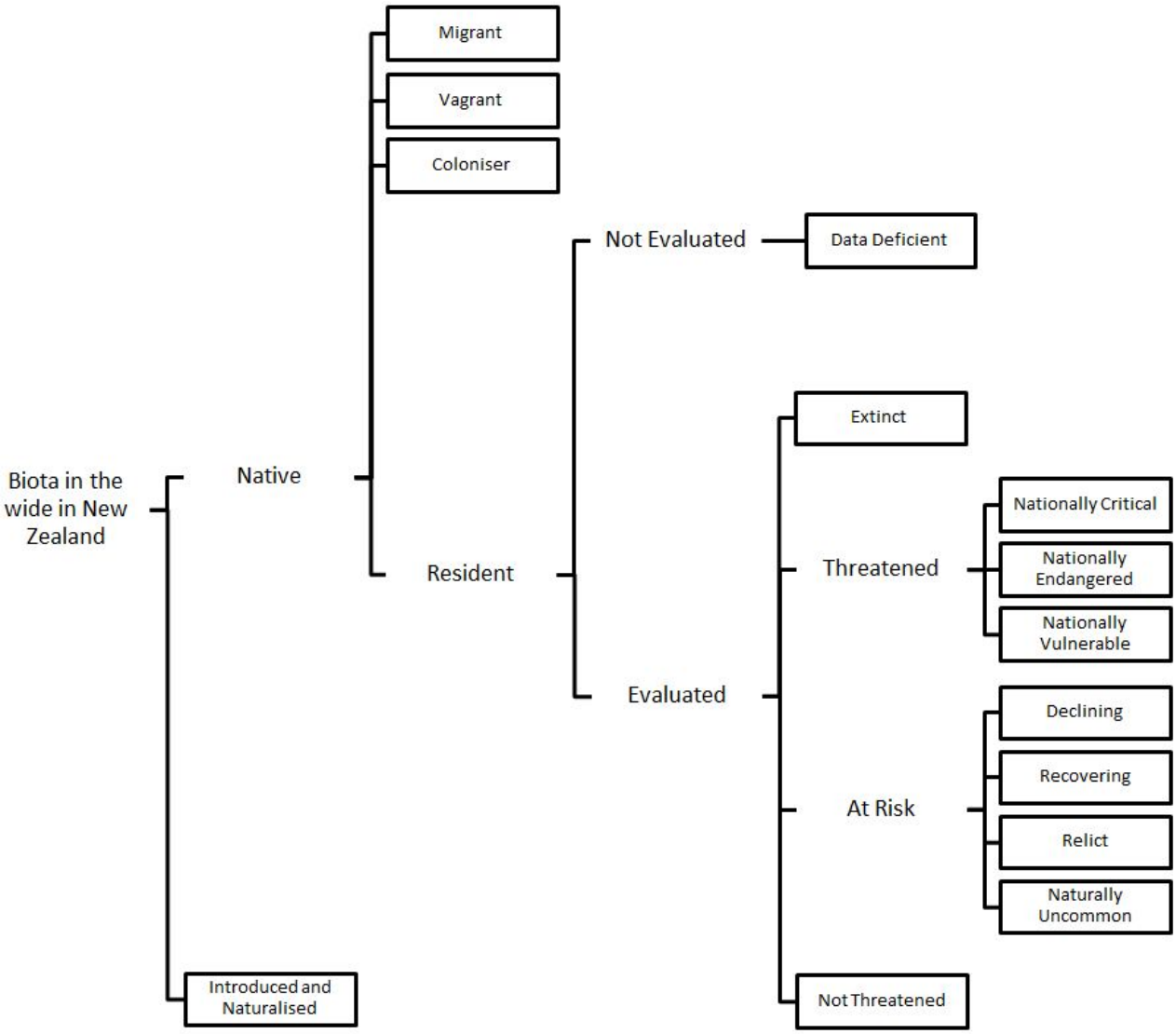


Figure B-1: New Zealand National Threat Classification system (Townsend et al., 2008). Classification is applied to all species that are legitimately named and indigenous to New Zealand. Exotic species are classified as 'Introduced and Naturalised' and excluded from the threat assessment. Main criteria of the threat status are the total population trends calculated over 10 years (or 3 generations), number and size of subpopulations, and area of occupancy (in hectares)

Appendix C Threatened birds and their habitat requirements for Hawke's Bay

Table C-1: Bird species present in Hawke's Bay that are classified as 'Threatened' or At Risk by Department of Conservation (Miskelly et al., 2008) The original list was reviewed by Hawke's Bay avian experts (workshop held on 17 June 2013). Key habitat sites were delineated with some specific information of habitat requirements also being captured during the workshop. Following the workshop, the key habitat sites were digitised using ArcGIS. Further information on population and habitats were added to the table based on published information such as Robertson and Heather (2005) and Stephenson (2011). 'Stronghold' is noted for species if the region holds 2 % or more of the national population. NOTE: This list is **not** a priority species list, i.e. not being in this list does not mean the species are excluded from future prioritisation process.

Common Name	Species Name	Habitats Description	Hawke's Bay Context	National Threat Status		Mapping Check
Grey duck	*Anas superciliosa superciliosa*	Remote wetlands such as forest lakes and rivers	Breeding.	Threatened	Nationally Critical	Not mapped
White heron	*Egretta alba modesta*	Coastal freshwater wetlands and estuaries (No breeding sites in HB)	Rare winter visitor from South Island.	Threatened	Nationally Critical	Not mapped
Black stilt	*Himantopus novaezelandiae*	Coastal wetlands and estuaries. (No breeding sites in HB)	Very occasional visitor from South Island	Threatened	Nationally Critical	Not mapped
Takahe	*Porphyrio hochstetteri*	Tussock grassland and beech forest	Reintroduced to Cape Sanctuary. Formally in the region around Poukawa.	Threatened	Nationally Critical	Forest
New Zealand shore plover	*Thinornis novaeseelandiae*	Coastal rock platforms, estuaries and marsh-turf.	Breeding population and occasional visitor. Sometime in 2012-13, the population of this species has plunged from 80 down to 8 caused by a single rat. DoC is working on restoration of the population (pers. comm. Carlton, D., June 2013)	Threatened	Nationally Critical	Wetland
Bittern	*Botaurus poiciloptilus*	Freshwater wetlands with dense cover of raupo or reeds and lack of disturbance.	Breeding, Strongholds	Threatened	Nationally Endangered	Wetland
Black-fronted tern	*Chlidonias albostriatus*	Coastal estuaries (No breeding sites in HB)	Regular winter visitor from South Island	Threatened	Nationally Endangered	Wetland
Black-billed gull	*Larus bulleri*	Braided riverbeds and river mouths	Breeding. Presumably 3-5 % of the national population (Stephenson, 2011)	Threatened	Nationally Endangered	Wetland
Wrybill	*Anarhynchus frontalis*	Coastal estuaries, rivermouths (No breeding sites in HB)	Rare winter visitor from South Island	Threatened	Nationally Vulnerable	Wetland

Common Name	Species Name	Habitats Description	Hawke's Bay Context	National Threat Status		Mapping Check
North Island brown kiwi (eastern strain)	*Apteryx mantelli*	Their primary habitat is indigenous forest with moderate level of moisture under the canopy. They also thrive in the radiata pine forest with adequate canopy cover, i.e. semi- to mature stand age with adequate moisture under the canopy. Juveniles require predator free environment until they grow big enough to self-defence from predators.	Strongholds. Breeding and reintroduction programme.	Threatened	Nationally Vulnerable	Forest
North Island kokako	*Callaeas wilsoni*	Indigenous forest with lots of fruits, but also eats leaves and new shoots.	Reintroduced to protected area. It was recorded in Kaweka Ranges in 1998 (but presumed extinct?) (pers. comm. Carlton). Present till mid 1970s in Waikaremoana catchment.	Threatened	Nationally Vulnerable	Forest
Banded dotterel	*Charadrius bicinctus bicinctus*	Braided riverbed (breeding), coastal wetlands and estuaries	Major braided riverbeds and coastal areas. Strongholds.	Threatened	Nationally Vulnerable	Wetland
Northern New Zealand dotterel	*Charadrius obscurus aquilonius*	Beaches, rivermouths and estuaries	Strongholds (30-40 birds, c.a. 2000 national population)? Hawke's Bay is the southern end of its distribution[27]. Breeding.	Threatened	Nationally Vulnerable	Wetland
Reef heron	*Egretta sacra sacra*	Rocky shores, wave platforms and intertidal mudflats	Breeding (though limited numbers).	Threatened	Nationally Vulnerable	Wetland
Bush falcon	*Falco novaeseelandiae* "bush"	Forest (both indigenous and plantation), woodland, open tussock lands	Breeding, range mainly in range, but come down lowland over winter. Widespread across the ranges of Ruahine and Kaweka.	Threatened	Nationally Vulnerable	Not mapped - widespread.
Caspian tern	*Hydroprogne caspia*	Coastal sandpits and shellbanks, inshore wetlands and riverbeds.	Breeding (though limited number)	Threatened	Nationally Vulnerable	Wetland
Blue duck, whio	*Hymenolaimus malachorhynchos*	Riverine habitat, moderate to fast flowing, good water quality	Breeding, Strongholds (ca 200 birds),	Threatened	Nationally Vulnerable	Forest
Red-billed gull	*Larus novaehollandiae scopulinus*	Coastal wetlands, estuaries, braided riverbeds (breeding)	Breeding	Threatened	Nationally Vulnerable	Wetland

[27] New Zealand dotterel is now observed in Wellington region (N. McArthur, personal communication, 18 June 2014).

Common Name	Species Name	Habitats Description	Hawke's Bay Context	National Threat Status		Mapping Check
North Island kaka	*Nestor meridionalis septentrionalis*	Indigenous forest, particularly of podocarp or podocarp-beech forests where food (fruits and seeds) are abundant. Best population in HB occurs in Kaweka Ranges (approximately 20 individuals) or Ruahine Ranges. Over winter, it is observed to come down to gardens, feeding on nuts.	Breeding Population in sharp decline in the last 100 years due to predation.	Threatened	Nationally Vulnerable	Forest
Pied shag	*Phalacrocorax varius varius*	Coastal lagoons and lakes	Recorded	Threatened	Nationally Vulnerable	Mapped
New Zealand dabchick	*Poliocephalus rufopectus*	Freshwater wetland, occasionally found on estuarine habitats during winter	Breeding. Strongholds (Approximately 20 % of the national population found in Hawke's Bay)	Threatened	Nationally Vulnerable	Mapped
North Island rifleman	*Acanthisitta chloris granti*	Large, intact indigenous forests	Mostly confined to ranges, very limited in lowlands.	At Risk	Declining	Forest
New Zealand pipit	*Anthus novaeseelandiae novaeseelandiae*	Mainly near coast on braided riverbeds, but also found in more inland riverbeds	Major braided rivers	At Risk	Declining	Not mapped
North Island fernbird	*Bowdleria punctata vealeae*	Shrubland with wet area. Seems to prefer two-tier vegetation (trees and low shrub). They are often observed where vegetation meets open wetlands, but it is presumably due to wetland being refuge from predators. They are also observed using blackberry shrubland.	Breeding, widespread in the region but very sparse	At Risk	Declining	Forest
Northern blue penguin	*Eudyptula minor iredalei*	Rocky coasts and islands	Breeding	At Risk	Declining	Not Mapped
New Zealand pied oystercatcher	*Haematopus finschi*	Braided riverbed (for breeding), coastal estuaries and wetlands.	Breeding	At Risk	Declining	Not mapped
Pied stilt	*Himantopus himantopus leucocephalus*	Braided riverbeds, estuarine	Major braided rivers.	At Risk	Declining	Mapped
Light-mantled sooty albatross	*Phoebetria palpebrata*	Ocean (migratory)		At Risk	Declining	Not Mapped
White-fronted tern	*Sterna striata striata*	Beach, braided riverbed	Breeding.	At Risk	Declining	Mapped

Common Name	Species Name	Habitats Description	Hawke's Bay Context	National Threat Status		Mapping Check
Brown teal	*Anas chlorotis* "North Island"	Optimum habitat type is a wetland (pond or lake) edged with wetland vegetation cover, but as is observed in the Cape Sanctuary, they thrive in a farm pond with a little vegetation such as carex as long as it is a predator-free environment.	Wild population was wiped out by introduced pest species sometime in 1900s. Reintroduced to protected private land.	At Risk	Recovering	Mapped
Variable oystercatcher	*Haematopus unicolor*	Estuarine and brackish area, sandy beaches	Breeding in most of the sandy beaches in HB	At Risk	Recovering	Mapped
North Island saddleback	*Philesturnus rufusater*	Indigenous forest and scrub	Reintroduced to protected private land. They were previously widespread throughout NI.	At Risk	Recovering	Forest
Red-crowned parakeet	*Cyanoramphus novaezelandiae novaezelandiae*	Indigenous forest	Breeding. Reintroduced to protected private land.	At Risk	Relict	Not mapped – sightings need to be confirmed
New Zealand white-faced storm petrel	*Pelagodroma marina maoriana*	Ocean	Breeding	At Risk	Relict	Not mapped
Northern diving petrel	*Pelecanoides urinatrix urinatrix*	Ocean	Reintroduced to protected private land.	At Risk	Relict	Not mapped
Marsh crake	*Porzana pusilla affinis*	Brackish or freshwater wetlands	Breeding	At Risk	Relict	Not mapped
Spotless crake	*Porzana tabuensis plumbea*	Freshwater wetlands	Breeding	At Risk	Relict	Not mapped
Cook's petrel	*Pterodroma cookii*	Coastal forest and scrub for breeding? Ocean for foraging? Migratory?	Reintroduced to protected private land.	At Risk	Relict	Not mapped
Mottled petrel	*Pterodroma inexpectata*	Coastal forest and scrub for breeding? Ocean for foraging? Migratory?	To be reintroduced to protected private lands. Also present in fossil record from Ocean Beach (Worthy, undated).	At Risk	Relict	Not mapped
Long-tailed cuckoo	*Eudynamys taitensis*	Indigenous and exotic forests	Breeding	At Risk	Naturally Uncommon	Forest
Banded rail	*Gallirallus philippensis assimilis*	Saltmarshes, and less often freshwater swamps	Recorded. Proposed for reintroduction to one of the protected private lands.	At Risk	Naturally Uncommon	Forest
Black shag	*Phalacrocorax carbo novaehollandiae*	Rivers, streams, lakes, estuaries	Breeding	At Risk	Naturally Uncommon	Not mapped
Little shag	*Phalacrocorax melanoleucos brevirostris*	Rivers, streams, lakes, estuaries, and also farm ponds	Breeding	At Risk	Naturally Uncommon	Not mapped
Little black shag	*Phalacrocorax sulcirostris*	Lakes, estuaries	Breeding	At Risk	Naturally Uncommon	Not mapped

Common Name	Species Name	Habitats Description	Hawke's Bay Context	National Threat Status		Mapping Check
Royal spoonbill	*Platalea regia*	Freshwater and brackish wetlands, estuaries	Breeding. Stronghold?	At Risk	Naturally Uncommon	Not mapped

Table C-2: Bird species that are extinct from Hawke's Bay ('Locally Extinct') while still present in other parts of New Zealand.

Common Name	Species Name	Records	National Threat Status	
Rowi, Okarito brown kiwi	*Apteryx rowi*	Bones found from Napier South (to be confirmed).	Threatened	Nationally Critical
Orange-fronted parakeet	*Cyanoramphus malherbi*	Recorded throughout NZ	Threatened	Nationally Critical
Kakapo	*Strigops habroptilus*	Formerly widespread	Threatened	Nationally Critical
Stitchbird	*Notiomystis cincta*	Fossil record from Te Waka#1 (Worthy et al., 2002)	Threatened	Nationally Endangered
Fiordland crested penguin	*Eudyptes pachyrhynchus*	Former inhabitant, Good bone deposits from Ocean Beach.	Threatened	Nationally Vulnerable
North Island weka	*Gallirallus australis greyi*	Throughout Wairoa; became extinct in the 1930s - 1940s in the Kawekas, more recent in Wairoa; (strongholds in Motu)	Threatened	Nationally Vulnerable
Little spotted kiwi	*Apteryx owenii*	Subfossil record, 2 specimens from Tarawera.	At Risk	Recovering
Grey-backed storm petrel	*Garrodia nereis*	Fossil record, Te Waka#1 (Worthy et al., 2002)	At Risk	Relict
South Island robin	*Petroica australis australis*	Fossil record from Ocean Beach (Worthy, undated)		Not Threatened

Appendix D Habitat types defined by vegetation types and descriptions for Hawke's Bay

Table D-1: Environmental variables used to build Potential Vegetation of New Zealand (PVNZ). These environmental variables are used to define the Land Environments of New Zealand (Leathwick et al, 2003). Summer day length was added to the model to define the treeline.

	Environmental Variables	Description
Climate	Annual temperature (°C)	Monthly mean daily temperature, averaged across all months
	Winter minimum temperature (°C)	Monthly daily minimum temperature of the coldest month, usually July
	Annual solar radiation (MJ/m²/day)	Monthly mean daily solar radiation, averaged across all months
	Winter solar radiation (MJ/m²/day)	Mean daily solar radiation in June
	Annual water deficit (mm)	Sum of monthly amounts by which evaporation exceeds rainfall
	Monthly water balance (ratio)	Monthly estimates of rainfall/potential evaporation, averaged across all months
	October vapour pressure deficit (kPa)	The capacity of air to take up water vapour in spring, dependent on temperature and humidity
Soils and Landform	Slope (°)	Slope of the land surface, calculated from a digital elevation model or grid of elevations
	Drainage	The rate of water removal from the soil by runoff, percolation and evaporation
	Phosphorus	Analysis of subsoil concentration, using a five-step scale
	Calcium	Analysis of exchangeable calcium, using a four-step scale
	Hardness	Physical resistance of parent material to breakdown, using a five-step scale
	Particle size	Average size of parent material using a five-step scale
	Age	Time elapsed since major reset of soil formation, separating young from old soils using a two-step scale
	Chemical limitation to plant growth	Indicating where chemicals occur at high enough levels to limit plant growth, particularly in saline and ultramafic soils, described in a three-step scale.

Table D-2: Vegetation-based habitat type classification based on Potential Vegetation of New Zealand and Expert knowledge. Original classification in the PVNZ was interpreted based on published information and peer-reviewed by botanical and ecological experts. Given that the PVNZ predicts vegetation types in the absence of large-scale disturbance (natural or anthropogenic), patches of any given habitat type may not exhibit all elements considered characteristic of that habitat type at the present time. Some species listed may not be present, or may be present in different abundances than indicated. Other species not listed can also be present. Sites of the same habitat type can exhibit differences from each other. There may also be differences in predicted composition and actual composition on the ground, particularly as a result of site modification and pest impacts. For example, kamahi used to be widely dominant in the southern Ruahine, Maungaharuru and Heretaunga Ecological Districts, but due to forest clearance and browsing by introduced mammals such as possum, it has been much reduced in extent and abundance.

Code	Vegetation Type Name	Defined As	Predicted Location	% left	Threat Category
1	Podocarp/ broadleaved forest	Tawa forest in association with other common indigenous broadleaved species such as titoki and rewarewa. Rimu, totara, matai, and kahikatea can be emergent above canopy. This forest type can be similar in distribution and composition to Podocarp/tawa-mahoe forest but the former being more restricted to the coastal area.	Remnants of this forest type are predicted to occur on Mahia Peninsula (Mahia Peninsula SR), and very sparsely occur in Heretunga (Cape Kidnappers, RAP 16, 30) and Eastern HB (Silver Range, RAP 1) Ecological districts. PNAP reports of these areas suggest that this forest type is closely related to Podocarp/tawa-mahoe forest (Gridcode 5). QEII 5/05/254 intersects with this forest type.	3%	Acutely Threatened
2	Rimu/tawa-kamahi forest	Tawa and kamahi dominated forest with emergent rimu, miro and totara with less frequent kahikatea and matai. Other broadleaved species such as titoki, mahoe and rewarewa can be more common than kamahi. Black beech can be locally common on dry ridges in hill country. Rimu can be present but often very sparse/rare throughout the region due to selective logging and forest clearance, land use change.	Remnants of this forest type intersect with the following areas: Ruahine FP and Te Heru O Tureia Conservation Area; Tinitoro Ecological District (RAP 118, 136, 137); Maungaharuru Ranges (RAP 17 though no tawa or kamahi); Heretaunga (RAP 17 & 26, though these lack key component spp.); Eastern HB RAP 9 (Maraetotara Plateau) is dominated by this forest type. QEII areas that appear to have this forest type include; 5/04/083, 5/05/032, 5/05/061, and 5/04/101 (the four largest areas).	7%	Acutely Threatened
3	Kahikatea-pukatea-tawa forest	Kahikatea dominated forest on lowland alluvium and floodplains. Commonly associated with swamp species of pukatea and tawa. Other podocarp species such as matai, rimu and totara may be present but restricted to better-drained soils. Titoki can be locally abundant on moist soils. This forest types often falls within landscapes that are heavily modified by production, therefore indicator species may be very low in abundance or not present at all.	Very small remnants scattered along Mangaone River/Mangatarata Stream (near Rissington), Poporangi Stream/Mangatahi Stream, and Waiau/Mangapoike Rivers (near Wairoa/Frasertown). Most of the remnants of this type fall outside of DoC conservation area and RAPs. Following RAP intersect with remnants but contributing only small fractions of each RAP; Heretaunga (RAP 7, 19, 20, 29), Eastern Hawke's Bay (RAP 20, 23, 24), though most of these RAPs don't or only weakly support this forest type. Tinitoro RAP TIN 83 presumably best represents this forest type. QEII areas which appear to have this forest type include; 5/05/079, 5/05/052, 5/05/070, 5/05/104	1%	Acutely Threatened

Code	Vegetation Type Name	Defined As	Predicted Location	% left	Threat Category
4	Podocarp forest	Dominated by podocarp species of matai, kahikatea, totara on flat to rolling terrain in relatively cooler climate. Broadleaved species (e.g. titoki, tawa, maires and fuchsia) are much less abundant than podocarp species. Might be part of frost flats, or highly modified by burning and clearing. Podocarp species can be very sparse.	Remnants are predicted on the south-eastern edge of Kaimanawa FP, north-eastern edge of Kaweka FP, and non-conservation area between Gwavas Conservation Area and Ruahine FP. Small remnant is predicted to be present in the SW edge of Te Matai No 1 & No 2 (Nga Whenua Rahui). Most of these remnants seem to occur in valley floor/riparian zone where it is relatively flat and cool.	2%	Acutely Threatened
5	Podocarp/tawa-mahoe forest	Tawa and mahoe dominated forest with scattered emergent podocarp species of kahikatea, matai, and occasional rimu and totara. This habitat type is found on dry dune land and low hill country.	Mahia Peninsula (Scenic Reserve and RAP 22), Eastern HB (McLeans Bush Reserve) and Heretaunga (Raukawa Range and RAP 30) Ecological districts appear to be strongholds of the remnants of this forest type. QEII - 5/05/002, 5/05/254 are predicted to have this forest type.	2%	Acutely Threatened
6	Podocarp/ broadleaf-fuchsia forest	Podocarp dominated forest over subcanopy of broadleaf (*Griselinia littoralis*) and fuchsia (*Fuchsia excorticata*). Podocarp species of matai, totara, kahikatea or rimu will be present at varying degrees of abundance. This habitat type tends to occur in inland foothills. Fuchsia can be uncommon due to possum browsing, and broadleaf can be uncommon due to deer and goat browsing.	Sparsely & locally occurs in Maungaharuru Ranges and SE edge of Kaweka Forest Park (Birch Range), altitudinal zone of 900 - 1000 m. Maungaharuru RAPs which intersect with this forest type; RAP 14 (broadleaf forest including tree fuchsia), RAP 20 (red beech with kamahi and rimu). RAP 21 (rimu-matai/mahoe-broadleaf forest, tree fuchsia also present in the canopy) may also support this forest type.	12%	Chronically Threatened
7	Hall's totara/broadleaf forest	Canopy is dominated by broadleaf (*Griselinia littoralis*) with common occurence of Hall's totara. This habitat type occurs in montane areas where beech is absent. Kamahi (in wetter climates) and fuchsia might be present among broadleaf. Broadleaf can be very sparse across the region due to deer and goat browsing.	Predicted to be one of the main components in Cashes Bush Conservation Area. Both Boundary Stream SR and Kaweka FP have small portion of this forest type. Small remnants are scattered through Maungaharuru Range and Mohawhango (RAP 1/Nga Whenua Rahui: Aorangi-Awarua), but relevant PNAP records suggest that many of these remnants are not dominated by Hall's totara, but by combination of beech and mountain toatoa accompanied by broadleaf species. Only Maungaharuru RAP 6 (Toronui Bush) has recorded a small patch in which Hall's totara is dominant.	21%	At Risk
8	Hall's totara/silver beech-kamahi forest	Silver beech dominant forest with abundant kamahi, occurring at high elevation (about 1000 m in HB). Hall's totara and other conifers can be emergent at lower elevations where silver beech is less dominant. Northern rata can be present though, like kamahi, it may be rare due to possum browsing. Most of the remaining area is under tussock grassland. Forest might be present prior to European settlement.	Very small remnants are predicted on SW edge of the regional boundary over Ruahine Range at 1000 - 1400 m asl. One of the patches appears to be present in Mohawhango RAP 1 (Aorangi-Awarua), whose record does not clearly support this forest type. NOTE: Other forest types occurring adjacent to this forest type are Hall's totara/BL forest (Gridcode 7), mountain beech forest (17), and mountain beech/red beech forest (18). Most of the silver beech dominant or co-dominant forests (16 and 17) occur in northern HB.	6%	Acutely Threatened

Code	Vegetation Type Name	Defined As	Predicted Location	% left	Threat Category
12	Podocarp/kamahi -beech forest	Podocarp forest dominated by rimu, miro, matai, kahikatea, and totara emerging from the canopy of kamahi and red and/or hard beech. Abundance of kamahi can be very low.	One of the major forest types for both Te Urewera NP and Tarawera Conservation Area. It also occurs on eastern parts of Whirinaki Conservation Park and the eastern rim of Ruahine FP. Though not very well predicted in the Potential Vegetation data, Kaweka Forest Park (Mangatainoka Ecological Zone) has similar forest type according to the record. QEII areas which are predicted to include this forest type are; 5/04/101, 5/07/134, 5/05/141	77%	Less Reduced, Better Protected
13	Podocarp/red-beech-kamahi-tawa forest	Red beech, kamahi and tawa dominated forest. Podocarp species such as miro and rimu may scatter as emergents. Abundance of kamahi can be very low. It is a mid-altitudinal habitat type.	Southern part of the Te Urewera National Park (within HB region) is where this forest type is best represented. Small remaining patches are predicted in Whirinaki Conservation Park, and also in the northern end of Eastern Ruahine Forest Park. The non-conservation area between Te Urewera and Whirinaki may have remnants of this type. Also predicted to have this forest type are Tinitoro RAP 136 (tawa-kamahi dominant in canopy with history of large podocarp being logged) and QEII- 5/04/101.	45%	Less Reduced, Better Protected
14	Podocarp/kamahi forest	Podocarp dominated forest over abundant kamahi. Podocarp species include rimu, miro, kahikatea or matai, totara in varying dominance (dependent on soil drainage and rainfall). Abundance of kamahi can be very low. Tawa, hinau, maires, fuchsia and mahoe can be present. This forest type can be predominant at mid to high altitude.	Small remnants are predicted in the mid-altitudinal zone from Kokomoka Forest (Stewardship Area), through Maungaharuru Range (Cashes Bush Conservation Area, Boundary Stream Scenic Reserve, and Maungaharuru RAPs 16, 20, 21, 22) and Kaweka Ranges (Balls Clearing SR), and to Eastern Ruahine (just above Frying Pan Flat off Gull Flat Rd). However the actual records (PNAP etc.) barely support kamahi-abundant canopy. Some places have red beech in the mix. QEII 5/05/032 is predicted to support this forest type.	19%	Chronically Threatened
15	Podocarp/kamahi forest	(Merged with Podocarp/kamahi forest, above)	[Less than 10 ha. is predicted to be present under optimal conditions, i.e. pre-human, on Kaweka Range]	-	-
16	Silver beech forest	Silver beech dominant forest. Silver beech typically forms pure stands at higher elevation where exposure to high wind, snowfall and prevailing clouds exist. At lower elevation Hall's totara and other conifers may be present in low numbers.	Te Urewera National Park (within the regional boundary, i.e. surrounding Lake Waikaremoana) is predicted to have the single biggest remnant of this habitat type left in the region, and it becomes scarce towards south. Small remnants may exist in Kaimanawa FP, Kaweka FP and adjacent areas of these two forest parks.	97%	Less Reduced, Better Protected
17	Red beech-silver beech forest	Red and silver beech dominated forest are common in mountain regions at mid altitudes. Podocarp species such as miro, rimu and totara can be present in small numbers as emergents. Mountain beech can be present in the canopy in localised sites.	Well represented by DoC's conservation area including Waipunga forest, Whirinaki Conservation Park, Rangitaiki Conservation Area, and northern end of Kaweka Forest Park. However, large remnants also appear to exist outside of conservation area, including adjacent to Kaingaroa plateau (pasture and forestry).	84%	Less Reduced, Better Protected

Code	Vegetation Type Name	Defined As	Predicted Location	% left	Threat Category
18	Mountain beech-red beech forest	Mountain beech and red beech dominated forest (former being more dominant towards the treeline and drier areas and the latter more dominant at lower elevation and in wetter areas). Hall's totara and pahautea (erroneously called kaikawaka) can be present in low numbers. This habitat type is predominant at higher altitudes.	Main forest type for Kaweka and Ruahine Forest Parks (HB part).	85%	Less Reduced, Better Protected
19	Mountain beech forest	Mountain beech dominated forest. The understory is often sparse. It is a common habitat type at higher altitudes where soil is thinner and less fertile, and often exposed to high winds.	Relatively small remnants are predicted within Kaweka Forest Park and larger remnants just outside of this Park, mainly on Owhaoko Block (Maori land). Scattered remnants in southern part of Gwavas Conservation Area. Moawhango RAP 6 record supports this forestry type. Remnants also predicted in QEII 5/07/134.	37%	Less Reduced, Better Protected
20	Podocarp/black/ mountain beech forest	Black beech and mountain beech dominated forest with emergent podocarp species in low numbers, including matai, totara, kahikatea and rimu and miro on wetter sites. This habitat type can be found at mid-altitude zones in dry climates.	A concentration of remnants is predicted in Gwavas Conservation Area, however northern and eastern faces of the range lack Podocarp forest (Ruahine FP Mgt Plan). Kaweka FP (southern part) is also predicted to have concentration of this forest type. The plant list from sentry Box Hut area recorded rimu, kahikatea, matai and black beech but not totara or red beech. QEII (5/07/134) is predicted to have this forest type.	9%	Acutely Threatened
24	Scrub, tussock-grassland and herbfield above treeline	Tussock grasses, large and small herbs and low-stature shrubs dominant, occurring where the environment becomes inhospitable for tree species. 'Treeline' where vegetation changes from forest to non-forest can be abrupt.	Natural distribution of this habitat type is confined to the highest part of ranges such as Kaweka and Ruahine ranges, and very scarce elsewhere. However the current landcover database implies that this habitat type, particularly tussock grasslands, has increased its extent dramatically, which is presumably due to fire and anthropogenic clearance of high-altitudinal forests.	98%	Less Reduced, Better Protected

Table D-3: Alternative classifications of terrestrial habitat types based on current indigenous vegetation for Hawke's Bay (from Walls, 2013). This alternative classification has a different approach to that of the PVNZ-based vegetation type classification. Differences are three-fold. Firstly the classification depicts the current condition of the vegetation. Therefore, it includes many secondary vegetation types as a result of various disturbances such as selective logging, forest clearance and animal browsing. Secondly, it captures the influence of ecological processes which define vegetation types, such as riparian vegetation, which is characterised by species adapted to the distinctive environmental conditions. Thirdly, geographical factors such as altitude and landforms are used for the name of the 'Habitat Category' and 'Vegetation Type Name', instead of species. Also note that the alternative classification integrates wetland and sand dune types driven by different vegetation types. An approximate comparison between the alternative classification and PVNZ-based classification is made, showing relevant PVNZ-based vegetation types (in Grid Codes, Table D 1).

Habitat Category	Vegetation Type Name	Defined As	Geographical Distribution	Threat Status	Justification	PVNZ-based Vege Type (Grid Code)
Coastal dune and beach communities	Coastal dune vegetation with strong indigenous component	A complex mosaic of spinifex, pingao, knobby clubrush, marram grass and various other exotic plants, with areas of jointed rush in wet hollows and bracken on the stable rear dunes. Native vegetation is strongly represented. Spinifex is still dominant in many places. Coastal mat daisy *(Raoulia* aff. *hookeri)* is present in very localised populations. Totara stumps give a clue to the former forest cover on the dunes, which would also have contained matai, titoki, ngaio, mapou, kanuka and akeake.	Best examples are at Ocean Beach and Rangaiika, with good examples at Mahia Peninsula beaches and Waikawa (Portland Island); otherwise small pockets on the coast of Hawke Bay. Coastal mat daisy is only at Whakaki. Sand dunes and exposed beaches of fine gravel.	Acutely Threatened	Includes the best remaining populations of indigenous sand vegetation in the region. However, much modified and there are a number of negative influences causing measurable ecological decline (weeds, browsers - rabbits especially - predators, competitors, stock and vehicles). Only being actively conserved within Cape Sanctuary.	**1,5**
	Coastal dune vegetation with weak indigenous component	Invariably dominated by marram grass, but with some spinifex persisting on the fore-dunes. Totara stumps give a clue to the former forest cover on the dunes, which would also have contained matai, titoki, ngaio, mapou, kanuka and akeake.	Waimarama, Porangahau and various smaller beaches. Sand dunes and exposed beaches of fine gravel.	Moderately Threatened	The indigenous vegetation is in continuing decline. Much restoration potential.	**1,5**
Coastal scarp and Cliff communities	Karaka treeland	Groves and scattered individual trees of karaka, accompanied in places by cabbage trees, ngaio, taupata, titoki, wharangi and/or nikau. Original forest probably dominated by broadleaved species but also containing podocarps (totara, matai and rimu).	Examples occur from Mahia Peninsula to Whangaehu. Coastal scarps.	Acutely Threatened	Very much reduced in extent and condition. Vulnerable to coastal erosion, storm damage and domestic stock. Nowhere formally protected in the region. If protected, could be restored via regeneration and planting to coastal broadleaved forest with or without podocarps.	**1,5**

Habitat Category	Vegetation Type Name	Defined As	Geographical Distribution	Threat Status	Justification	PVNZ-based Vege Type (Grid Code)
	Coastal shrubland	Seral vegetation. Mainly tauhinu (*Ozothamnus leptophyllus*) and coastal shrub daisy (*Olearia solandri*). Manuka present at Earthquake Slip. Matagouri present at Porangahau. Usually still being grazed by domestic stock. Original forest probably dominated by broadleaved species but also containing podocarps (totara, matai and rimu).	Various slopes scattered along the coast.	Moderately Threatened	If grazing was continued or intensified, it would disappear. If left ungrazed it would regenerate into coastal forest, if there were seed sources nearby. Otherwise, planting would be necessary.	**1,5**
Coastal wetlands	Freshwater coastal wetland vegetation	Usually dominated by raupo, but various rushes and sedges present and in places dominant. Prior to human arrival, probably included swamp forest dominated by kahikatea and pukatea, with tawa, nikau, kowhai, cabbage tree, etc.	Biggest and best examples are at Opoutama and Whakaki; small examples elsewhere. Coastal lakes, ponds and swamps.	Moderately Threatened	Some localised protection and ecological restoration, but otherwise vulnerable to domestic stock, weed invasion, drainage and disturbance. Planting is probably necessary if forest is to be restored.	**3**
	Estuarine vegetation	Fringes of sea rush, jointed rush and saltmarsh ribbonwood. Turfs of small low-growing plants such as glasswort, *Samolus repens*, *Selliera radicans* and *Mimulus repens*. Prior to human arrival, probably included fringing swamp forest dominated by kahikatea and pukatea, with tawa, nikau, kowhai, cabbage tree, etc.	Estuaries at Mahanga, Wairoa, Napier, Waitangi, Porangahau.	Moderately Threatened	Some localised protection and ecological restoration, but otherwise vulnerable to domestic stock, weed invasion and disturbance. Planting is necessary to restore forest.	**3**
Lowland wetlands	Inland wetland vegetation	Mostly dominated by exotic willows, but indigenous species present to varying extents, e.g. raupo, harakeke (lowland flax), cabbage tree, kahikatea and various sedges, rushes and aquatic herbs. Originally there would have been extensive swamp forests dominated by kahikatea, with pukatea, tawa, nikau and other broadleaved species.	Pekapeka, Oingo, Runanga, Poukawa, Hatuma and various smaller examples. Freshwater swamps and lakes.	Acutely Threatened	Very much reduced in extent and condition. Vulnerable to weed invasion, domestic stock, drainage and eutrophication. Some ecological restoration underway (e.g. Pekapeka). Planting if required to restore forest.	**3,5**

Habitat Category	Vegetation Type Name	Defined As	Geographical Distribution	Threat Status	Justification	PVNZ-based Vege Type (Grid Code)
	Riparian vegetation	In a few places, indigenous trees form riparian forest; typically totara, matai, lacebark, kowhai, kanuka and cabbage tree. Other sites have small trees and shrubs, including threatened species such as *Pittosporum obcordatum*. In some places, harakeke and toetoe are common. Originally the forest would have included kahikatea, pukatea, tawa, mahoe and other broadleaved species.	Riverbanks and streamsides throughout the region.	Acutely Threatened	Mostly absent because of the history of clearance and farming. Several small sites with rare plants now protected (QEII). Planting is mostly required for restoration.	**3,5**
Lowland alluvial flats forest	Alluvial podocarp forest	Generally isolated, small remnant stands of podocarps (variable amounts of matai, kahikatea, miro, rimu and/or totara), with or without broadleaved tree species or beeches and with understorey vegetation dependent on whether domestic stock are excluded or not. The original forest would have been dominated by giant podocarps, with broadleaved species and/or beech species present in the canopy or subcanopy.	Distributed throughout the lowlands of the region. Valley floors and terraces.	Acutely Threatened	Formerly widespread and abundant, but reduced to a scattering of small remnants. Most of the better remnants have formal protection, but all are vulnerable to weed invasion, mammalian herbivores and predators, drought and storm damage. None are fenced to exclude deer. Planting may be necessary to restore and maintain these remnants, as natural podocarp regeneration is mostly inadequate.	**3,5**
	Alluvial broadleaved forest	Generally isolated, small remnant stands of broadleaved tree species (mainly tawa and titoki but also variable amounts of rewarewa, nikau, kohekohe, pukatea, karaka, mahoe and/or kowhai). Podocarps (matai, kahikatea, miro, rimu and/or totara) may or may not be present and understorey vegetation is dependent on whether domestic stock are excluded or not. The original forests probably cotained or were dominated by giant podocarps: these have mostly been logged, allowing the broadleaved species to dominate.	Mostly in the lowlands of Wairoa District (Waihua, Mahia and Tiniroto Ecological Districts). Valley floors, terraces and gentle slopes.	Acutely Threatened	Formerly widespread and abundant, but reduced to a scattering of small remnants. The better remnants have formal protection, but are vulnerable to weed invasion, mammalian herbivores and predators, drought and storm damage. Planting may be necessary to restore and maintain these remnants, as natural podocarp regeneration is mostly inadequate.	**1,3,5**

Habitat Category	Vegetation Type Name	Defined As	Geographical Distribution	Threat Status	Justification	PVNZ-based Vege Type (Grid Code)
Lowland hill country forest	Black beech forest	Black beech dominant, usually on dry sunny sites such as spurs. Podocarp and broadleaved trees may or may not be present.	Distributed throughout the lowlands of the region. Dry sunny sites, mostly on red metal or argillite, but not on limestone.	Moderately Threatened	Only a scattering of relatively small sites, some of which have formal protection. Vulnerable to deer and goats, drought, storm damage and weed invasion.	**2**
	Podocarp/broadleaved forest	Remnant stands of podocarps (matai, kahikatea, miro, rimu and/or totara) and broadleaved tree species (such as tawa, titoki, rewarewa, nikau, hinau, fuchsia, lacebark, kohekohe, pukatea, karaka, mahoe and/or kowhai). Black beech occasionally present. Mostly the large accessible trees, especially podocarps, have been logged in the past. Therefore the canopy has quite strong secondary elements. The understorey vegetation is dependent on whether domestic stock are excluded or not.	Distributed throughout the lowlands of the region. Hill country, especially in higher-rainfall places such as Wairoa District (Waihua, Mahia and Tiniroto Ecological Districts) and Maraetotara Plateau. Kohekohe, nikau and pukatea absent from most of the area; now mostly in the north-eastern portion.	Moderately Threatened	Many examples formally protected, but vulnerable to weed invasion, mammalian herbivores and predators, drought and storm damage.	**1,2,5**
	Broadleaved forest	Broadleaved tree species dominant (mainly tawa but also variable amounts of titoki, rewarewa, nikau, kohekohe, pukatea, karaka, lacebark, wineberry, cabbage tree, mahoe and/or kowhai). Podocarps (matai, kahikatea, miro, rimu and/or totara) and black beech may or may not be present. Mostly the large accessible trees, especially podocarps, have been logged in the past. Therefore the canopy has quite strong secondary elements. The understorey vegetation is dependent on whether domestic stock are excluded or not.	Distributed throughout the lowlands of the region. Hill country, especially in higher-rainfall places such as Wairoa District (Waihua, Mahia and Tiniroto Ecological Districts) and Maraetotara Plateau. Kohekohe, nikau and pukatea absent from most of the area; now mostly in the north-eastern portion.	Moderately Threatened	Several examples formally protected, but vulnerable to weed invasion, mammalian herbivores and predators, drought and storm damage.	**1,2,5**

Habitat Category	Vegetation Type Name	Defined As	Geographical Distribution	Threat Status	Justification	PVNZ-based Vege Type (Grid Code)
	Kanuka forest	Secondary forest in which kanuka is dominant. Frequently without much other indigenous vegetation due to the presence of domestic stock or feral goats and deer. Where protected from these herbivores, broadleaved trees and shrubs, tree ferns and climbers are able to establish and proliferate. The original forest was mostly combinations of giant podocarps and broadleaved species, with varying amounts of black beech (which was locally dominant).	Distributed throughout the lowlands of the region. Hill country, especially incised valley flanks and abandoned farmland.	Fairly Secure	Increasingly recognised as valuable ecological habitat, for its restoration potential, for erosion control and riparian protection and for honey production. Many examples now fenced from stock and formally protected, though feral deer, goats and possums are problematic in places. Cutting for firewood continues to be a threat. Given the right management and the proximity to seed sources, kanuka forest will naturally develop into mixed broadleaved forest, with or without podocarps and beeches. Otherwise, planting will be necessary.	**1,2,(3),5**
Lowland treelands	Mixed treelands	Clumps or close scatterings of primary or secondary indigenous trees, remnants of former forest or having developed from shrubland or bracken fernland. Typical species are totara, black beech, kowhai, cabbage tree, narrow-leaved lacebark, kanuka, ngaio and karaka. Understorey vegetation is usually absent. The original forest was mostly combinations of giant podocarps and broadleaved species, with varying amounts of black beech (which was locally dominant).	Distributed throughout the lowlands of the region. On valley floors, terraces or hillsides where pastoral farming continues.	Acutely Threatened	Of cultural, aesthetic, shelter and ecological value, but nowhere protected or managed sustainably. Highly vulnerable to storm damage, stock damage and attrition through exposure. Also threatened by farming intensification. Their future is entirely dependent on human input (planting to replace losses).	**1,2,3,5**
Lowland shrublands and bracken fernland	Mixed shrublands	Scrub and less dense shrublands, usually mixtures of manuka and kanuka with varying amounts of tauhinu, bracken, other ferns, small-leaved divaricating shrubs and broadleaved shrubs or saplings. The original forest was mostly combinations of giant podocarps and broadleaved species, with varying amounts of black beech (which was locally dominant).	Distributed throughout the lowlands of the region. On valley floors, terraces or hillsides where pastoral farming is not intensive or has recently ceased.	Moderately Threatened	Not generally regarded as of value, but is frequently the nursery for indigenous forest regeneration and habitat for a distinctive suite of flora and fauna, e.g. fernbird. Given the right management and the proximity to seed sources, such shrublands will naturally develop into mixed broadleaved forests, with or without podocarps and beeches. Otherwise, planting will be necessary.	**1,2,3,5**

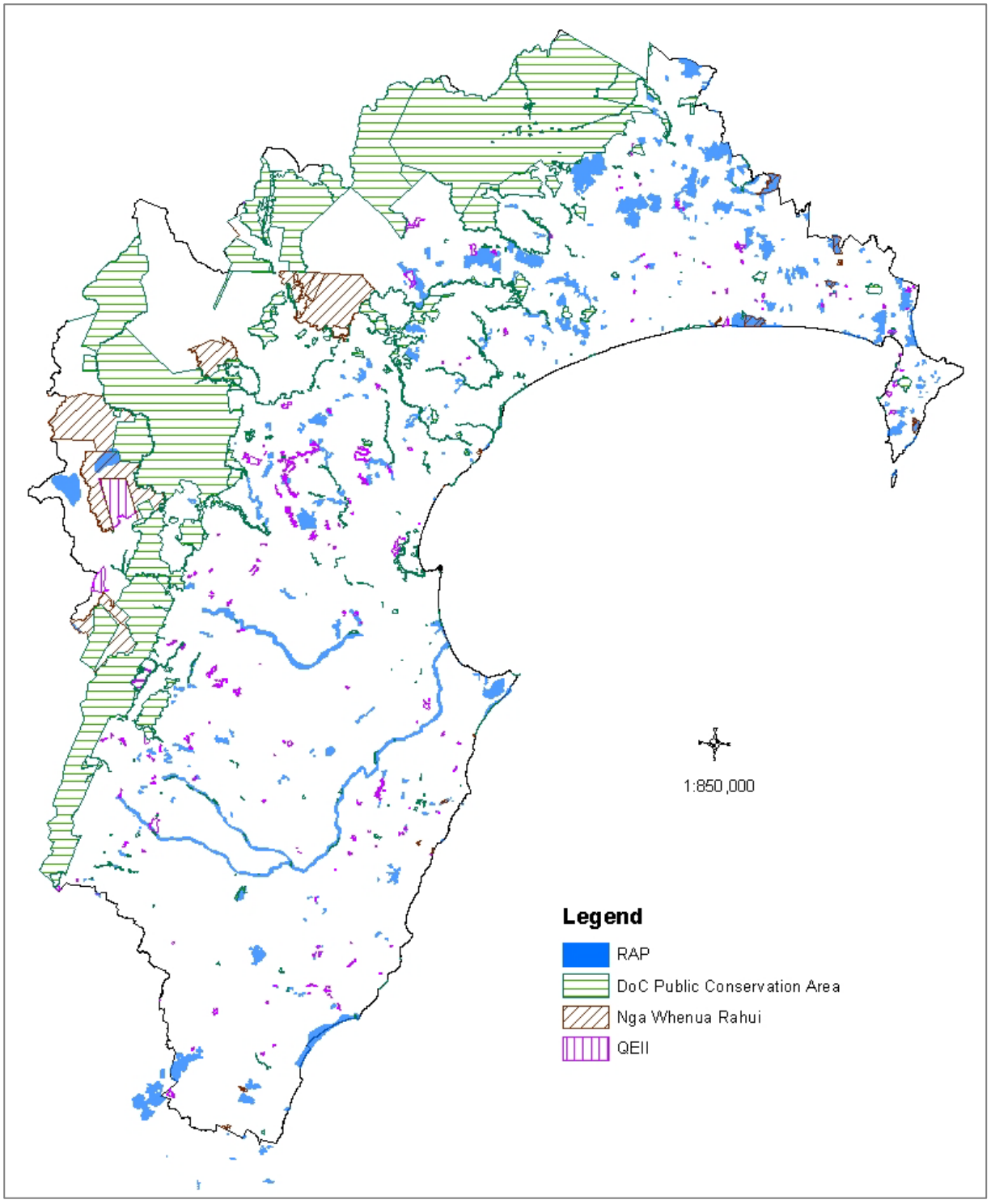
Habitat Category	Vegetation Type Name	Defined As	Geographical Distribution	Threat Status	Justification	PVNZ-based Vege Type (Grid Code)
	Bracken fernlands	Expanses of dense bracken. Often with various shrubs, tree seedlings and saplings and young tree ferns, if not used by domestic stock. In some places over-topped by emergent cabbage trees, karamu, koromiko, etc. The original forest was mostly combinations of giant podocarps and broadleaved species, with varying amounts of black beech (which was locally dominant).	Distributed throughout the lowlands of the region. On valley floors, terraces or hillsides where pastoral farming is not intensive or has recently ceased.	Moderately Threatened	Not generally regarded as of value, but is frequently the nursery for indigenous forest regeneration and habitat for flora and fauna. Given the right management and the proximity to seed sources, bracken fernlands will naturally develop into mixed broadleaved forests, with or without podocarps and beeches. Otherwise, planting will be necessary.	**1,2,3,5**
Montane wetlands	Upland wetland vegetation	Intact lake ecosystems have fringes of tussock sedges, rushes, harakeke, toetoe, kahikatea and cabbage trees, backed by mixed forest of podocarps, beeches, tree ferns and broadleaved trees. Swamps feature sphagnum moss. Modified lake and swamp ecosystems mainly have tussock sedges, rushes, sphagnum moss and manuka.	Lakes Waikaremoana and Waikareiti are among the best (most intact) upland wetlands in New Zealand. Kaweka Forest Park contains some good though much smaller examples. Ngamatea wetland is a large swamp. Otherwise, most examples are small and highly modified.	Moderately Threatened	The best examples are formally protected, but vulnerable to weed invasion, feral animal browsing and predators.	**12,13,16,17, 18,19**
	Riparian vegetation	Variable combinations of trees (kowhai, kanuka, kamahi, cabbage trees, beeches, podocarps, etc.), toetoe, ferns and tough small-leaved shrubs. On flood-prone terraces, mat daisies (*Raoulia* spp.) and other low-growing plants are often common.	Distributed throughout the montane parts of the region. Banks of rivers and streams.	Fairly Secure	Most sites are within formally protected areas (Forest Parks and National Park). However, vulnerable to weed invasion, feral animal browsing and predators.	**12,13,16,17, 18,19**

Habitat Category	Vegetation Type Name	Defined As	Geographical Distribution	Threat Status	Justification	PVNZ-based Vege Type (Grid Code)
Montane forests	Beech forests	Forests dominated by silver beech, red beech or mountain beech, or mixtures of those species. Mountain beech predominates in drier and less fertile conditions. Indigenous conifers (especially Hall's totara and miro, and mountain cedar/pahautea, *Libocedrus bidwillii*) often present. Broadleaved species (especially kamahi and broadleaf) often present also. Understorey vegetation and perched plants such as mistletoes greatly depleted by feral herbivores.	Distributed throughout the mountain lands of the region. Hillslopes and valleys.	Fairly Secure	Most tracts are within formally protected areas (Forest Parks, National Park and Scenic Reserves). However, vulnerable to feral animal browsing and predators. Collapsing in places (e.g. Kaweka Forest Park) due to heavy browsing by sika deer and possums.	**16,17,18**
	Podocarp/broadleaved-beech forests	Large podocarps (rimu, Hall's totara, miro and/or matai) emergent above canopies of broadleaved species (especially kamahi, tawa, broadleaf, rewarewa, hinau and/or maire). Enclaves of beeches (red, silver or mountain, or mixtures of them) in places. Understorey vegetation and perched plants such as mistletoes greatly depleted by feral herbivores.	Distributed throughout the mountain lands of the region. Hillslopes and valleys.	Fairly Secure	Most tracts are within formally protected areas (Forest Parks, National Park and Scenic Reserves). However, vulnerable to feral animal browsing and predators. Wandering stock an issue in places.	**12,13,20, (6,7,8)**
	Low subalpine forests	Low forests near the treeline, of species such as Hall's totara, broadleaf, mountain holly (*Olearia ilicifolia*) and horopito (*Pseudowintera colorata*), with or without stunted silver beech, mountain beech or mountain cedar/pahautea.	Distributed throughout the mountain lands of the region. Localised places near treeline.	Fairly Secure	Most tracts are within formally protected areas (Forest Parks, National Park and Scenic Reserves). However, vulnerable to feral animal browsing and predators.	**6,7,8**
Montane shrublands	Manuka-kanuka scrub	Manuka and/or kanuka dominant. In places, acting as a nursery for the regeneration of beeches, broadleaved species and Hall's totara. The original forest cover would have contained these species.	Distributed throughout the mountain lands of the region. On land that has been cleared of its original forest and repeatedly burnt and/or grazed since.	Fairly Secure	Many tracts are within formally protected areas (Forest Parks, National Park and Scenic Reserves). However, vulnerable to being cleared for forestry (private land), weed invasion (exotic conifers), feral animal browsing and predators. If natural regeneration is able to occur, forests resembling those originally present will develop.	**7,8,12,13,16, 17,18,20**

Habitat Category	Vegetation Type Name	Defined As	Geographical Distribution	Threat Status	Justification	PVNZ-based Vege Type (Grid Code)
	Subalpine scrub and shrublands	Highly variable mixtures of *Dracophyllum* spp., *Hebe* spp., *Coprosma* spp., *Olearia* spp. and other plants such as snow totara (*Podocarpus nivalis*). Often with snow tussocks, mountain flax, speargrasses and/or mountain daisies.	Distributed throughout the mountain lands of the region. Generally above the treeline, but in places at lower altitude (slips, screes, gullies, outcrops and streamsides).	Fairly Secure	Most tracts are within formally protected areas (Forest Parks and National Park). However, vulnerable to feral animal browsing and predators.	**24**
Alpine habitats	Tussock grasslands	Snow tussocks (*Chionochloa* spp.) dominant, but accompanied by alpine daisies, speargrasses, various herbaceous species, cushion plants and other alpine specialists.	Distributed throughout the mountain lands of the region. Generally above the treeline, but in places at lower altitude (slips, screes, gullies, outcrops and streamsides).	Acutely Threatened	Most tracts are within formally protected areas (Forest Parks and National Park). However, they are greatly depleted in ecological condition and highly vulnerable to feral animal browsing, especially by hares and deer. Also vulnerable to invasion by *Hieraceum* spp. and exotic conifers.	**24**
	Herbfields and fellfields	Discontinuous vegetation of alpine daisies, speargrasses, various herbaceous species, cushion plants, mosses, lichens and other alpine specialists. Often with snow tussocks.	Distributed throughout the mountain lands of the region. Above the treeline.	Acutely Threatened	Most tracts are within formally protected areas (Forest Parks and National Park). However, they are greatly depleted in ecological condition and highly vulnerable to feral animal browsing, especially by hares and deer. Also vulnerable to invasion by *Hieracium* spp. and exotic conifers.	**24**

Appendix E Recommended Areas for Protection

Figure E-1: Recommended Areas for Protection (RAP) in Hawke's Bay. The Protected Natural Areas Programme led by DoC in the 1990s and early 2000s was set up to identify examples of indigenous biological and landscape features on private land. The outcome of the programme is a set of Recommended Areas for Protection (RAPs) which represent the best of the range of natural ecological diversity that has survived outside of existing protected natural areas (as shown in line-shaded polygons). Note that the following protected areas are not shown in this map: private land protected under the Reserves Act 1977; parks and reserves owned by local governments.



Appendix F Proposed terrestrial biodiversity indicators and measures

Table F-1: Proposed regional council terrestrial biodiversity monitoring tool (based on(Lee and Allen, 2011)). Indicators and measures are intended to be aligned with DoC's Biodiversity Inventory and Reporting System (Tier 1), and are designed to enable regional councils to assess the ecological integrity (EI) of terrestrial biodiversity. EI is defined as 'the full potential of indigenous biotic and abiotic features and natural processes, functioning in suitable communities, habitats and landscapes (Lee and Allen, 2011). EI has three components: species occupancy (to avoid extinctions); indigenous dominance (to maintain natural ecological processes); and ecosystem representation (to maintain a full range of ecosystems).

	Indicator	Measure	Ecological Integrity Component
State and Condition	Land area under indigenous vegetation	M1: Indigenous land cover, in cover classes, habitat types	Environmental representation
	Biodiversity condition	M2: Vegetation structure and composition	Species occupancy
		M3: Avian representation	Species occupancy
		M5: Vulnerable ecosystems	Environmental representation
Threat and Pressures	Weeds and animal pests	M6: Number of new naturalisations	Indigenous dominance
		M7: Distribution and abundance	Indigenous dominance
	Habitat loss	M8: Change in area under intensive land use	Environmental representation
		M9: Habitat and vegetation loss	Environmental representation
	Climate change	M11: Change in temperature and precipitation	Environmental representation
Effectiveness of Policy and Management	Biodiversity protection	M12: Change in extent and protection of indigenous cover or habitats or naturally rare ecosystems	Environmental representation
		M13: Threatened species habitat	Species occupancy
		M14: Vegetation consents compliance	Environmental representation
	Pest management	M15: Indigenous ecosystems released from pests	Indigenous dominance
		M16: Change in the abundance of indigenous plants and animals susceptible to introduced herbivores and carnivores	Indigenous dominance

	Indicator	Measure	Ecological Integrity Component
	Ecosystem services	M17: Extent of indigenous cover in water catchment	Environmental representation
Community Engagement	Protection and restoration	M18: Area and type of biodiversity protection achieved on private land	N/A
		M19: Contribution of initiatives to (i) species translocations and (ii) habitat restoration	N/A
	Weed and pest control	M20: Community contribution to weed and animal pest control and reductions	N/A

Appendix G River Habitat Types for Hawke's Bay

Table G-1: River predictors used in the predictive models of benthic macroinvertebrate metrics (from Clapcott, et al. 2013). The model identified four predictors as the most important for explaining the deviance in MCI data that defines macroinvertebrate communities. These four predictors are native vegetation (%), heavy pasture (%), flow stability and summer air temperature.

Predictor	Descriptions
NativeVeg	Native vegetation cover in the catchment (%)
PastoralHeavy	Pastoral heavy cover in the catchment (%)
PastoralLight	Pastoral light cover in the catchment (%)
Urban	Impervious cover in the catchment (%)
BareGround	Bare ground in the catchment (%)
Surface Water Allocation	Low flow remaining after the upstream daily surface water allocation is deducted (proportion)
SEGFLOWSTA	Annual low flow/annual mean flow (ratio)
SEGLFLOW4T	Mean annual 7-day low flow (m3/s), fourth-root transformed
SEGJANAIRT	Segment summer air temperature (°C)
SEGMINTNOR	Segment winter air temperature (°C), normalised with respect to SEGJANAIRT
SEGRIPSHAD	Segment riparian shade (proportional)
SEGSLOPESQ	Segment slope (°), square-root transformed
LOCHAB	Weighted average of proportional cover of local habitat using categories of: 1 = still; 2 = backwater; 3 = pool; 4= run; 5 = riffle; 6 = rapid; 7 = cascade
LOCSED	Weighted average of proportional cover of bed sediment using categories of: 1 = mud; 2 = sand; 3 =fine gravel; 4 = coarse gravel; 5 = cobble; 6 = boulder;7 = bedrock
USDAYSRAIN	Days/year with rainfall in the catchment greater than 25 mm
USAVGTNORM	Average air temperature (°C) in the catchment, normalised with respect to SEGJANAIRT
USAVGSLOPE	Average slope in the catchment (°)
USHARDNESS	Average hardness of rocks in the catchment, 1 = very low to 5 = very high
USCALCIUM	Average calcium concentration of rocks in the catchment, 1 = very low to 4 = very high
USPHOSPHOR	Average phosphorus concentration of rocks in the catchment, 1 = very low to 5 = very high
USLAKEPC	Area of lake in upstream catchment (%)
USPEATPC	Area of peat in upstream catchment (%)
USGLACIER	Area of glacier in upstream catchment (%)

Table G-2: River habitat types for Hawke's Bay based on FENZ classification (from Leathwick et al. 2008). Some streams and rivers with a FENZ class may not exhibit all of the characteristics described in this table. (-) means there is no generalised description available from Leathwick, et al (2008).

FENZ LVL 2 Class	Flow pattern	Climate	Gradient	Riparian shading	Substrate	Geographical Location	Example in HB
A1	Unstable	Warm, heavy-rainfall day infrequent	Very gentle	Moderate	Sand	Moderately inland	Small streams in Heretaunga and Ruataniwha Plains, and tributaries in coastal areas from Mahia to Wairoa and Southern Hawke's Bay
A2	Unstable	Warm, maritime, heavy-rainfall day very infrequent	Very gentle	Moderate	Silt		
A3	Very unstable	Warm, maritime, heavy-rainfall day infrequent	Gentle	Moderate	Sand	Coastal	Tributaries flowing into Whakaki Lagoon and other estuaries in Wairoa. Low representation in Southern HB.
A4	Very unstable	Mild, heavy-rainfall day very infrequent	Gentle	Moderate	Sand	Moderately inland, lowland	Small tributaries in middle to lowland hill countries, mainly in central and sourthern HB.
A5	Very unstable	Cool, heavy-rainfall day very infrequent	Gentle to very gentle	Moderate	Gravel, high phosphorus concentration	Moderately inland	Headwaters for Waipunga, Ripia and Taruarau Rivers (high altitude)
B1	Very unstable	Warm, heavy-rainfall day very infrequent	Very gentle	Moderate	Sand with high occurrence of peat soils in catchment	Moderately inland	Small streams around Lake Hatuma, Poukawa and Pukehou area
C1	Unstable	Mild, maritime, heavy-rainfall day infrequent	Very steep	High	Coarse gravels	Coastal	Streams on Mahia and Cape Kidnappers
C2	Unstable	Mild, maritime, heavy-rainfall day moderately frequent	Gentle	Moderate	Coarse gravel with high phosphorus concentration	Moderately coastal	Small headwater tributaries to Ruakituri River, Aniwaniwa range.
C4	Unstable	Warm, maritime, heavy-rainfall day infrequent	Moderate	Moderate	Coarse gravel	Moderately coastal	Lowland to coastal reaches of the main rivers such as Wairoa, Mohaka, Aropaoanui, Esk, Tutaekuri, Ngaruroro, Tukituki, and Maraetotara.
C5	Unstable	Mild, maritime, heavy-rainfall day infrequent	Moderate	High	Coarse gravel	Moderately coastal	Small tributaries in Mahia, Whakaki, Arapaoanui, and southern Hawke's Bay.
C6	Unstable	Warm, heavy-rainfall day infrequent	Gentle	(-)	Coarse gravel	Moderately inland, lowlands	Middle hill country reaches of main rivers (Tukituki and Ngaruroro, Tutaekuri, Esk, Mohaka) and tributaries to these rivers such as Waipawa, Waipunga and Ripia rivers.
C7	Unstable	Mild, heavy-rainfall day infrequent	Steep	High	Coarse gravel	Moderately inland, lowland hills	Montane and foothill streams from Waikaremoana through to Ruahine Ranges
C8	Unstable	Mild, heavy-rainfall day infrequent	Moderate	Moderate	Coarse gravel	Inland, lowland hills	Upper tributaries in southern coastal and Tukituki catchments

FENZ LVL 2 Class	Flow pattern	Climate	Gradient	Riparian shading	Substrate	Geographical Location	Example in HB
C9	Stable	Mild, heavy-rainfall day infrequent	Moderate	Moderate	Gravel	Strongly Inland	Taharua River and its tributaries
C10	Moderately stable	Cool, heavy-rainfall day moderately frequent	Very steep	High	Cobble	Montane	Streams on Ruahine, Kaweka, Te Urewera Ranges
C11		Similar to C10					
C12		Similar to C10					
F1	Unstable	Mild, rainfall day moderately frequent	Very gentle	(-)	Gravel	Moderately inland, plains	Small tributaries to Ngaruroro around Fernhill
F2		Similar to F1					
G1	Unstable	Cool, heavy-rainfall day very infrequent	Moderate	Moderate	Coarse gravel	Montane	Streams on Kaweka and Ruahine Ranges
G2	Stable	Cool, heavy-rainfall day moderately frequent	Moderate	Moderate	Coarse gravel		
G5	Unstable	Cool, heavy-rainfall day very infrequent	Gentle	High	Sand		
G7	Stable	Cool, heavy-rainfall day moderately frequent	Steep	High	Cobble		
G8	Unstable	Cool, heavy-rainfall day very infrequent	Moderate	High	Coarse gravel		
H1	Moderately stable	Cold, heavy-rainfall day infrequent	Steep	Moderate	Cobble		
H3	Moderately stable	Cold, heavy-rainfall day moderately frequent	Very steep	High	Cobble		
H4		Similar to H3					
H5	Stable	Cool, rainfall day moderately frequent	Very gentle	Moderate	Cobble		
H6	Moderately stable	Cool, heavy-rainfall day very infrequent	Steep	High	Coarse gravel		
J1	Stable	Cold, maritime, heavy-rainfall day very frequent	Very steep	High	Cobble		
J6	Stable	Cool, maritime, heavy-rainfall day very frequent	Very steep	High	Cobble		
N2	Moderately stable	Cold, heavy-rainfall day infrequent	Steep	Moderate	Cobble		

FENZ LVL 2 Class	Flow pattern	Climate	Gradient	Riparian shading	Substrate	Geographical Location	Example in HB
N5	Moderately stable	Cold, heavy-rainfall day moderately frequent	Very steep	Moderate	Cobble		

River habitat types (in FENZ classes) represented in Hawke's Bay Regional Council's State of the Environment monitoring programme

Figure G-1: Mangarau Stream at Te Aute Road (FENZ class A1).

Figure G-2: Taurekaitai Stream at Wallingford (FENZ class A4).

Figure G-3: Ngaruroro River at Fernhill (FENZ class C4).

Figure G-4: Mohaka River downstream of Taharua (FENZ class C6).

Figure G-5: Waipunga River at Pohokura road bridge (FENZ class C8).

Figure G-6: Taharua River at Wrights (FENZ class C9).

Appendix H Historically Rare Terrestrial Ecosystems

Table H-1: Historically rare terrestrial ecosystems represented in Hawke's Bay. Williams et al. (2007) have classified seventy two historically rare terrestrial ecosystems. Experts identified the following ecosystems as being present in the region. Expert comments on the level of threats and modification associated with each ecosystem are based on expert knowledge, i.e. not necessarily published elsewhere. This is not an exhaustive list of sites, and there are likely to be more locations that may be classified as one of the Historically Rare Ecosystems. Descriptions of ecosystem types are available at Landcare Research website (http://www.landcareresearch.co.nz/publications/factsheets/rare-ecosystems).

Ecosystem Category	Ecosystem Type	Geographical Distribution, Hawke's Bay Region	Comments
Coastal	Active sand dunes	Beaches from Mahia Peninsula to Whangaehu. Best examples at Ocean Beach, Rangaiika and Mahanga.	Much modified and highly vulnerable.
	Shingle beaches	Most of Hawke Bay shore. Best examples at Whakaki, Bay View and Te Awanga.	Much modified and highly vulnerable, particularly to vehicle damage.
	Coastal rock stacks	Cape Kidnappers, Karamea (Red Island), Hinemahanga Rocks (off Kairakau Beach).	Small, few in number, erosion-prone and vulnerable to weed invasion, predators and disturbance by people.
	Coastal cliffs on acidic rocks	Cape Kidnappers, Earthquake Slip, Mahia Peninsula, other smaller sites.	Erosion-prone and vulnerable to weed invasion, predators and disturbance by people.
	Calcareous coastal cliffs	Napier, Kairakau	Erosion-prone and vulnerable to weed invasion, predators and disturbance by people.
Inland and alpine	Screes of acidic rocks	Mountain lands and steep foothills	Vegetation is heavily modified in farmed sites; otherwise affected by browsing animals.
	Frost flats (Old tephra plain > 500 years old)	Ripia and Waipunga Valleys, second and third biggest frost flats remaining in New Zealand (Smale, unpublished). One of the frost flat remnants is located entirely on private land, and the other's land tenure is a combination of private, Maori and DoC lands. The major threats to this ecosystem are weed invasion, agrichemical drift from the surrounding land use, and off-road vehicle use damaging the ecosystem.	Critically endangered primarily due to weed invasion, topdressing drift and off-road vehicle use.
	Frost hollows	Urewera National Park, Kaweka Forest Park, Ruahine Forest Park; places where cold air ponds nightly.	Distinctive vegetation, largely intact, except for feral animal impact (browsing, pig rooting, trampling).
	Boulderfields of acidic rocks	Mountain lands and steep foothills	Vegetation is heavily modified in farmed sites; otherwise affected by browsing animals.
	Calcareous cliffs, scarps and tors	Te Mata Peak, Maungaharuru Range, Te Waka Range and similar sites.	Sites containing unique plants adapted to limestone and found nowhere else, also endemic land snails. Highly vulnerable to feral animals (pigs, deer, goats, possums, stoats, rats, etc.).

Ecosystem Category	Ecosystem Type	Geographical Distribution, Hawke's Bay Region	Comments
	Braided riverbeds	The lower reaches of the Mohaka, Tutaekuri, Ngaruroro, Tukituki and Waipawa rivers and some of their tributaries.	Highly vulnerable to weed invasion and disturbance by domestic stock, feral animals and people. Key habitat for some threatened species of plants and animals.
	Cloud forests	Uplands of Urewera National Park; southern Ruahine Forest Park.	Affected by feral animals, so less intact and biodiverse than in the past.
Induced by native vertebrates	Seabird burrowed soils	Current: Waikawa (Portland Island) and Motu-o-Kura (Bare Island). Recent past (prior to human arrival and in places as late as the 19th century): Mahia Peninsula; Cape Kidnappers; most coastal dunes, scarps, headlands and knolls; some inland and mountain places such as Titiokura and Wharetiti (Wharite Peak).	The current sites are highly vulnerable to rodents and predators (stoats, ferrets, cats, dogs), also to disturbance by people. Potential sites such as Cape Sanctuary are similarly vulnerable. Past sites are detectable through DNA and mineral traces in soil.
	Marine mammal haulouts	NZ fur seal haulouts are confirmed at Waikawa (Portland Island), Cape Kidnappers, Motu-o-Kura (Bare Island) and Hinemahanga Rocks (off Kairakau Beach). Any of the beaches could have individual fur seals, sea lions, elephant seals or leopard seals hauling out occasionally.	Highly vulnerable to human disturbance.
Wetlands	Lake margins	Lowlands: Lakes Oingo, Runanga, Poukawa and Hatuma are all regionally significant. Uplands: Lakes Waikaremoana and Waikareiti are among the best (most intact) upland lakes in New Zealand; Kaweka Forest Park contains some good though much smaller examples.	The best examples are formally protected, but are all vulnerable to weed invasion, feral animal browsing and predators.
	Cushion bogs	Small examples in the mountain lands of Urewera National Park, Kaweka Forest Park and Ruahine Forest Park; flattish upland places where drainage is impeded and the water supply is permanent. Often on ridge tops.	Distinctive vegetation of wetland cushion plants. Water supply and bog condition somewhat affected by feral deer and hares, due mainly to browse of adjacent vegetation and tracking.
	Ephemeral wetlands	Small examples in the Te Waka and Maungaharuru Ranges; upland places where water ponds in winter but dries up in summer.	Mostly within farmland, so badly affected by cattle. Special plants have been found there in the past.
	Tarns	Small upland tarns occur in the Maungaharuru and Te Waka, either in hanging basins or on high plateaux. In the Ruahine Range many tarns occur on high ridges, mainly in the central and northern portions. Tarns also occur at Kaipo Lagoon, Urewera National Park.	Drainage patterns and vegetation are somewhat modified by feral deer.

Ecosystem Category	Ecosystem Type	Geographical Distribution, Hawke's Bay Region	Comments
	Estuaries	Estuaries of substance occur at Mahia (Maungawhio Lagoon), Wairoa, Napier, Waitangi and Porangahau. Small estuarine systems are at the mouths of most of the smaller rivers and main streams.	Some localised protection and ecological restoration, but otherwise vulnerable to domestic stock, weed invasion, predators and human disturbance.
	Lagoons	Coastal lagoons occur at the mouth of the Wairoa River and in a series on the coastal strip to the east. The largest and most diverse is Whakaki Lagoon.	Some localised protection and ecological restoration, but otherwise vulnerable to artificial drainage, domestic stock, weed invasion, predators and human disturbance.

Appendix I Wetland types

Table I-1: Hydrosystems of wetlands identified in the Tukituki Catchment. Hydrosystem is based on broad hydrological and landform setting, salinity and temperature (Johnson and Gerbeaux, 2004). There are nine hydrosystems recognised by Johnson and Gerbeaux (2004), of which four subsystems are present in Tukituki Catchment (Forbes et al., 2011).

Hydrosystem	Description
Estuarine	Wetlands influenced by salinity, associated with intertidal, and supratidal processes. Types of wetlands in this classification include saltmarshes, intertidal mudflats, and coastal lagoons. Clarkson et al (2003) indicated that salinity values in these wetlands at the inland limit should be at a dilution level of 5‰
Riverine	Wetlands directly associated with rivers. They may be flood associated wetlands of river flood plains or old meanders of the river that have been cut off from the main river channel i.e., ox bow lakes.
Lacustrine	Wetlands associated with the waters, beds and immediate margins of larger standing water bodies. These are large enough to be influenced by the associated processes that drive the characteristic lake features such as wave action and water level fluctuations.
Palustrine	Freshwater wetlands with inputs from groundwater, surface runoff or rain. These are not directly associated with river, coastal or estuarine systems. Examples of palustrine wetlands are seepages, swamps, marshes, fens, shallow water etc. and these make up the majority of wetlands in New Zealand.

Table I-2: Wetland classes (Johnson and Gerbeaux, 2004). Wetland class is defined by substrate factors, water regime and consequent factors of nutrient status and pH.

Wetland Class	Description
Swamp	Wetlands located on peatland or mineral soils that have a moderate flow of surface water and/or groundwater. The drainage of these systems is poor and the water table remains above ground surface in places, usually characterised by open water areas and permanent wetness. Swamps have a moderate to high nutrient status with pH values between 4.8 and 6.3. Vegetation associated with swamps includes rushes, sedges, reeds, tall herbs and scrub types.
Marsh	Wetlands located on mineral soils with a slow to moderate flow of surface water and groundwater. Drainage in these systems is better than in the swamps and the water table is usually just at or below the surface of the ground. Marshes experience high water level fluctuations and experience temporary wetness or drying throughout the year in response to climatic conditions. Nutrient status of these systems is high and the pH ranges are neutral to slightly acidic.
Seepage	Wetlands associated with groundwater inputs with some surface water and have a steady to moderate flow of water. These types of wetlands occur where there is a change of slope or a change in the permeability of the underlying geology which forces the water table to the surface. Vegetation associated with these types of wetlands includes low growing turf species, bryophytes and cushion plant species.
Shallow water	Wetlands associated with standing water bodies with a maximum depth of 2m and a water surface above ground level for all or most of the year. Farm dams were classified under this category as they were most closely related to this wetland class although their maximum depth may be deeper than the limits specified in Johnson and Gerbeaux (2004)

Ephemeral wetland	Ephemeral wetlands receive inputs of groundwater and rain only and have nil to slow water movement through them. They are characterised by marked seasonal drying and wetness and can have water table levels well above or below the ground surface. There is usually a marked zonation of vegetation communities due the fluctuation of water levels. Ephemeral wetlands are important due to the rare or specialist species that may use this system.
Bog	A peatland which receives its water supply only from precipitation, receiving neither groundwater nor any nutrients from adjacent or underlying mineral soils. It is oligotrophic, poorly aerated and usually markedly acid. It occurs on hill crests, basins, and terraces. Vegetation types are wide-ranging, dominants including mosses, lichens, cushion plants, sedges, grasses, ferns, shrubs and trees.
Fen	A wetland with a predominantly peat substrate that receives inputs of groundwater and nutrients from adjacent mineral soils. It is low to moderate acidity and oligotrophic to mesotrophic. It mainly occurs on slight slopes such as fans and toes of hillsides where they may grade downslope to swamp. Vegetation is often composed of sedges, restiads, ferns, tall herbs, tussock grass or scrub.
Pakihi/Gumland	Wetland characterised by ultra-infertile acidic soils with an impervious horizon, prone to temporary drought. It is frequently saturated with water but seasonally dry, occurring on level to rolling or sloping land in districts of high rainfall, the soils are old and severely leached of most nutrients. Vegetation is often dominated by heathland species.
Saltmarsh	A wetland class embracing estuarine habitats of mineral substrate in the intertidal and subtidal zones, but also including those habitats in the spratidal zone. It includes non-vegetated habitats such as mudflats, and where vegetated, it can be herbfield to rushland, scrub and mangrove scrub or low forest.