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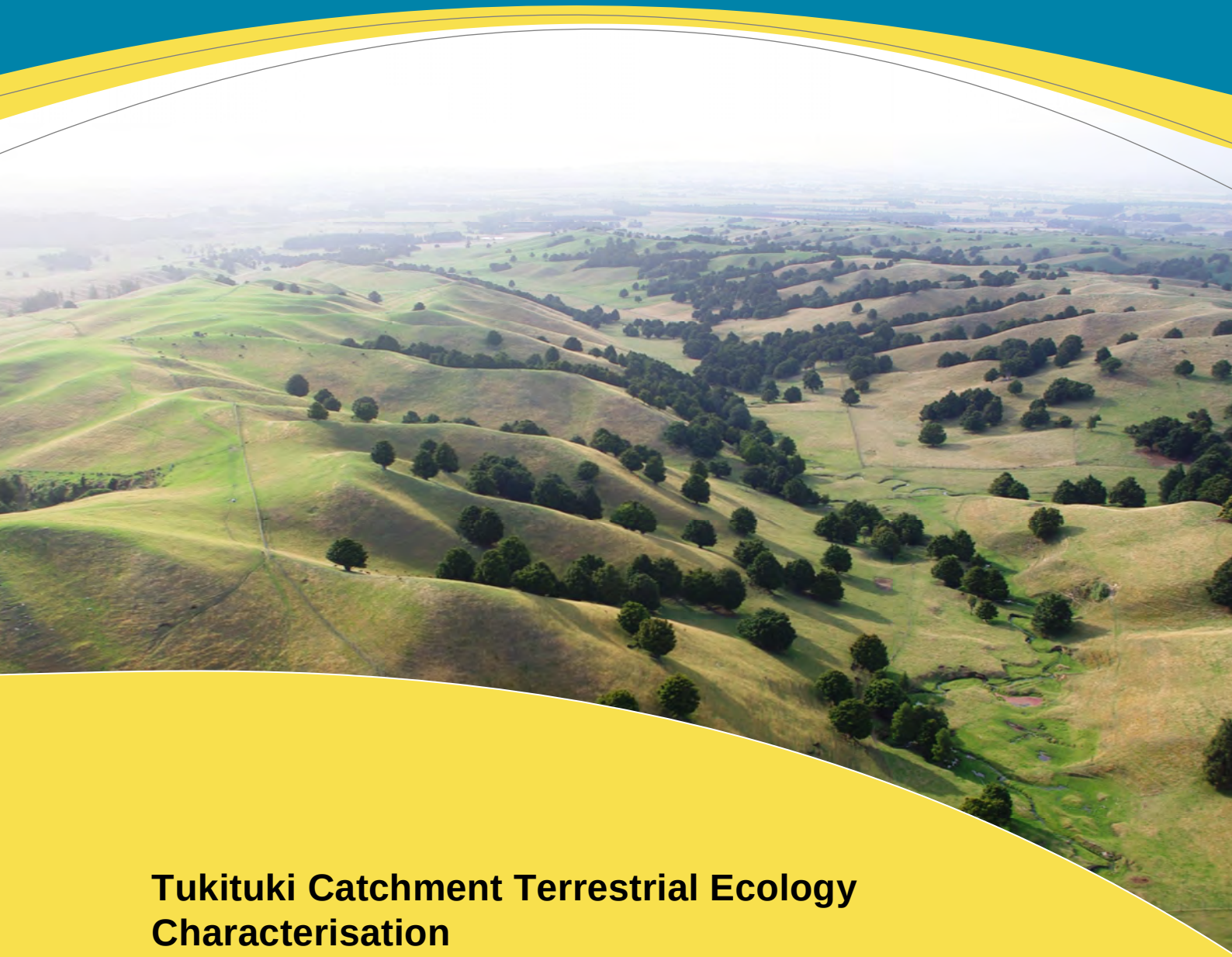

Tukituki Catchment Terrestrial Ecology Characterisation

Prepared for Hawke's Bay Regional Council

December 2011

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HBRC Plan Number 4294

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Tukituki Catchment Terrestrial Ecology Characterisation

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ACKNOWLEDGEMENTS

This project was commissioned by the Resource Management Group of the Hawke's Bay Regional Council. Thanks to Graham Sevicke-Jones who provided client liaison. Several HBRC staff also made valuable contributions to technical elements of the project, namely Fiona Cameron (wetland ecology) and Keiko Hashiba (lizard field survey). Avifauna matters were addressed by Dr. Brent Stephenson (Eco-Vista Photography and Research). Herpetology matters were addressed by Trent Bell and Sarah Herbert (Ecogecko Consultants). Alan Lee made DoC biodiversity records available for this project. Big thanks are also due to all of the landowners who allowed access to their land for the purposes of this project.

Prepared in conjunction with:

1 Introduction

This report presents the findings of an analysis of the character of terrestrial ecology elements of the Tukituki River Catchment. In this context the character description focuses on the qualities and peculiarities of terrestrial ecology values across the Catchment.

The project scope also includes consideration of specific avifauna values associated with the waterways of the Tukituki Catchment and risks to those values associated with future changes in water flow regimes. The Ruataniwha Water Augmentation Scheme is applied as a specific example of effects to avifauna values.

1.1 Objectives

The overall objectives of this project are to:

1. Characterise the terrestrial ecology values of the Tukituki Catchment, and to
2. Assess the potential influence on those values that changes in river flow or channel morphology within the main rivers of the Catchment may have.

1.2 Study area

1.2.1 Location and key features

The Tukituki Catchment is located within the Hawke's Bay Region. In the north it is bounded by the Karamu and Ngaruroro River Catchments. To the west beyond the Ruahine Range crest water flows to the Rangitikei River and flows to the North Islands west coast. To the south is the Manawatu Catchment, and smaller coastal catchments drain away to the east and southeast.

The main urban areas of the Catchment are Waipukarau and Waipawa. Many other small settlements are present also.

The largest waterways of the Catchment are the Makaroro, Waipawa, Tukituki, Makaretu, Tukipo, Mangatewai Rivers and the Mangaonuku and Makara Streams. Although, many other waterways drain the Catchment.

The Tukituki Catchment spans three distinct Ecological Districts[1]. In the western most portions, the Ruahine Ecological District encompasses the area of the catchment approximately west of Moorcock Stream and most of the Wakarara Range. To the east of this is the Heretaunga Ecological District, which covers the majority of the Catchment and extents in an eastern direction. Its eastern most boundary is with the Eastern Hawke's Bay Ecological District. This boundary broadly follows the alignment of the Tukituki River (to the northeast), straying from it in places for distances up to around 5km. To the east of the Heretaunga Ecological District the Eastern Hawke's Bay Ecological District covers the eastern most parts of the catchment and continues in its coverage over the land between the Tukituki Catchment and the Pacific coastline.

As with many areas of eastern New Zealand the Tukituki Catchment is subject to a predominantly south-westerly wind flow. Much of the moisture carried from the Tasman Sea is dropped on the axial ranges and a rain shadow is cast across eastern areas. This rain shadow is apparent within the Tukituki Catchment as average annual rainfall decreases in a eastern direction, from more than 2,400mm at the crest of the Ruahine Range, to as little as 900mm within the Ruataniwha Basin (within less than 40km).

[1] An 'Ecological District' is defined by DoC as: "*a local part of New Zealand where geological, topographical, climatic and biological features and processes, including the broad cultural pattern, interrelate to produce a characteristic landscape and range of biological communities*" (DoC).

Many parts of the Tukituki Catchment are within the 'Southern Hawke's Bay' dryland environment[2]. This dryland zone is *relatively* moist (high rainfall: potential evapotranspiration ratio) environment with infertile soils, often derived from younger sedimentary rocks such as mudstones and siltstones. In those areas of the catchment where it applies, the dryland climate is an important consideration for ecological character assessment and ecological management.

1.2.2 'Catchment Units' for description

The Tukituki Catchment has been divided into six distinctly different 'Units' (termed 'Catchment Units' or 'Unit'). The six units are shown below, along with their unique letter reference. Unit boundaries were derived using Land Environments of New Zealand data (at Level IV). LENZ Level IV Land Environments are mapped as Figure 2-2 on Page 5.

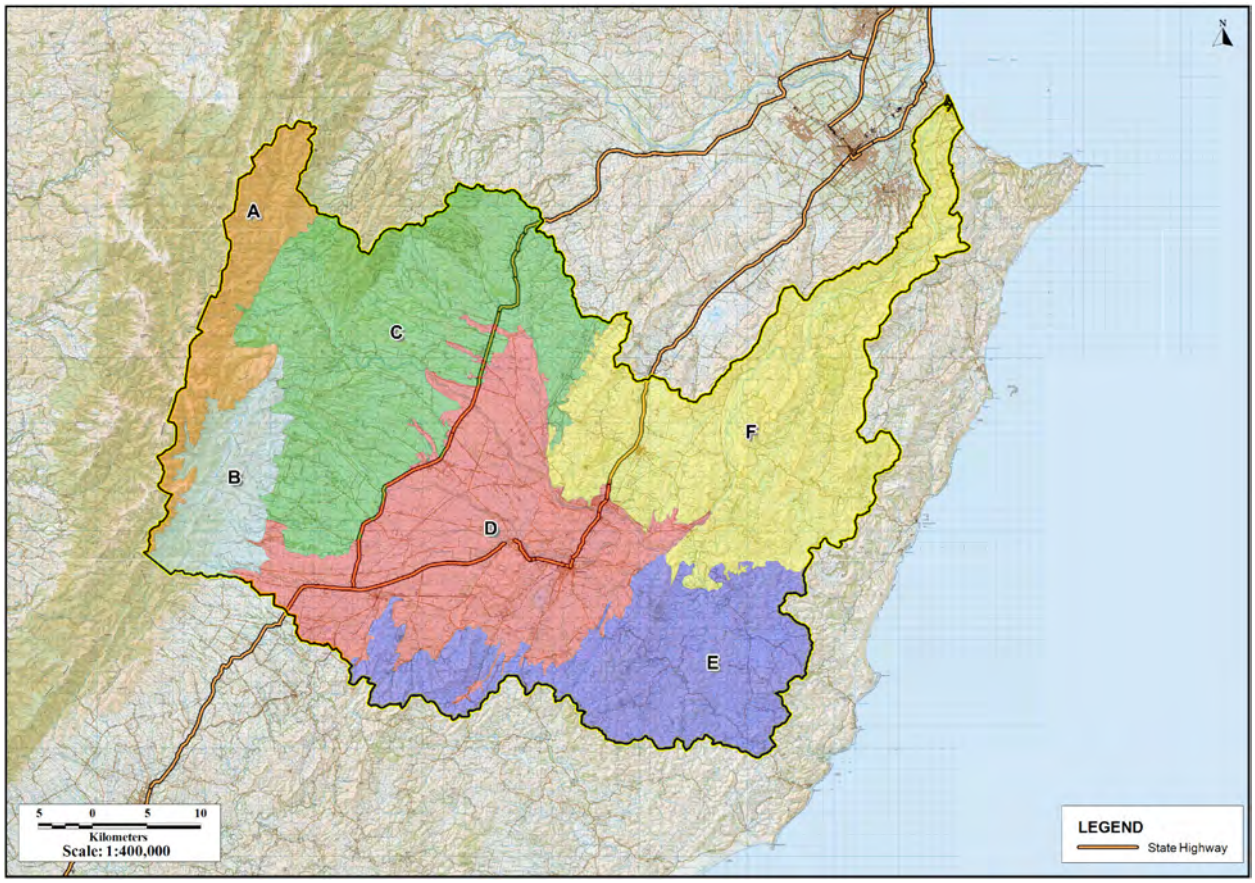


Figure 1-1: Tukituki 'Catchment Units' for description.

[2] The availability of water is one of the key drivers of biological patterns at all scales. Low water availability is a defining feature of 'dryland' environments, which typically support biota with some degree of adaptation to moisture stress. Water availability depends upon the balance between rate of supply (usually rainfall), run-off and demand (evaporation), rather than simply upon the amount of rainfall received. See Rogers *et al*, 2001.

1.3 Report structure

Section 1 sets out the report objectives and provides an overview of the study area and its key features. It also describes the 'Units' derived to help structure the characterisation project.

Section 2 provides background information on current land cover, LENZ classes, wind direction/intensity and DoC Recommended Area for Protection sites within the Catchment (which is supported by Appendix H, which also contains SSWI sites of the Catchment).

Section 3 provides a detailed description of the terrestrial ecology character of the Tukituki Catchment, starting with a catchment scale overview (to minimise repetition of material) and then a unit by unit description.

Section 4 takes a landscape ecology viewpoint on the catchment, with a focus on pattern and process, and the important ecological functions seed dispersal and pollination by kereru, tui and bellbird.

In Section 5 the reports scope narrows to consider risks to river bird populations from changes in flow regime, looking both generically and using the Ruataniwha Water Augmentation Scheme as an example.

Section 6 summarises many of the report's main points on a unit by unit basis.

At the very end of the document (Appendix K), a set of photographs is included to help illustrate descriptions given in the text. Individual photographs are referred to using footnotes throughout the text. In addition a disk is included inside the front cover, which contains almost 4,000 high resolution 'geotagged' photographs taken of the Catchment during 2011.

1.4 Methods

1.4.1 Landform, geology and soil

Landform characteristics were assessed on a 'Unit by Unit' basis, using LENZ descriptions along with topographical maps, slope maps, Google Earth aerial imagery and aerial and ground based field observations. Geology descriptions were largely taken from the LENZ database, but also from other published sources, and backed by field observations. Soil descriptions were taken from LENZ data and also for the area within the Ruataniwha Basin - from Griffiths, 2004.

1.4.2 Climate

Climate descriptions were compiled from LENZ data and from rainfall data sourced from NIWA's Cliflow database. Wind rose data was provided by the HBRC.

1.4.3 Land cover and flora

Land cover was described using LCDB2 data, and from the aerial and ground based field observations. From LCDB2 the distribution of remaining indigenous cover was determined, and mapped. This also provided the basis for mapping of Threatened Environments.

Flora descriptions were made from 'walk through' field surveys at various sites, and backed by compiling published flora descriptions and those descriptions contained within other reports, such as DoCs Protected Natural Area Survey reports. The unpublished MSc thesis[3] which investigated the floral characteristics of indigenous forest remnants in Unit C was drawn from where appropriate. Threatened flora species were searched for during flora surveys, and the actual and potential presence of threatened flora was determined largely from exiting records and knowledge of species specific distributions and habitat requirements.

[3] Forbes, 2010.

1.4.4 Avifauna

As with other parts of the characterization, flights over the Tukituki River catchment on 1 February 2011 gave an introduction to the catchment, its land-use and particular sites of importance. It also helped to envisage which particular areas were worthy of ground-based surveys and where effort should later be committed. Photographs taken on this day also helped with determining sites of interest and habitat types.

During late March 2011 survey records held by Department of Conservation (Napier) were assessed. From these records a database of sites, species of birds noted, and other information of interest was created.

Following this desktop exercise, visits to various sites within the catchment were undertaken over 11 days, during March, April and September 2011. Visits varied from brief visits into areas of interest, with half an hour or so spent detailing species encountered and other likely species being noted, through to an entire day being spent at some sites. Only one site (Lake Hatuma) was visited twice, with single visits to all other sites. A full list of these sites along with waypoints and track logs, and notes taken during those days has been compiled. It should be noted that a large number of other sites were seen from the ground whilst driving through the sub-catchments. From these passing visits, assessments of likely species have also sometimes been made.

Further records of species of interest were also pooled from a number of different sources. Regional Records from the Hawkes Bay Region of the Ornithological Society of New Zealand were analyzed for records of species of particular interest. Regional records were dated between July 1987 to June 2008, and species of interest included both threatened species[4] and other native species that are found within sites of interest or in fragmented habitats away from their 'normal' range. A number of papers and reports have been published on the Ruahine Ranges and the associated foothills following bird surveys over the years[5], and the expected distribution of some species was also checked against the 'Atlas of bird distribution in New Zealand 1999-2004'[6]. Work on specific species, such as blue duck, was also carried out by staff from the Department of Conservation over the past few decades, and information from surveys and reports assessed and used to determine distribution and numbers of some of these species[7]. Other reports detailing river surveys, such as Parrish (1988) were also used during this assessment.

1.4.5 Lizard fauna

We identified the most appropriate survey techniques to use for the probable species within the habitat types identified. Habitat types representative of the catchment, with the potential to hold populations of lizards were selected for field survey. Several sites were also nominated for survey on the basis of pre-existing lizard records on the DOC BioWeb *Herpetofauna* database: Smedley Station/Wakarara Range, Moorcock River terrace and Te Mata Peak.

We identified sites across the Tukituki catchment which supported examples of each of the eight habitat types. Both the habitat type and an assessment of the possible species present were used to nominate the survey techniques at each site. The reverse planning procedure suggested by Sutherland (2006) was used to identify optimal and achievable survey designs. Sites and cover placement were non-randomly selected to maximize detectability of lizards based on our current knowledge of their habitat requirements.

For each lizard captured, we recorded: species, location (cover ID or GPS location if spotlighting), sex (geckos only), life stage (adult, sub adult, juvenile, neonate). For the geckos and skinks at Te Mata Peak, we recorded snout-vent length, tail length (if the tail was complete or broken without regeneration, this was length of either the full tail; or if the tail was regenerated, the length of the vent to the break, and the break to the tail tip), weight, behaviour (e.g. layer of Onduline or what it was doing when seen) and took photographs of the dorsal, lateral and ventral surfaces.

Kanuka/manuka-dominant habitat at Smedley Station was night spotlighted by a team of five people.

[4] as per Miskelly *et al*. 2008.
[5] Challies, 1966; Fromont, 1991.
[6] Robertson *et al* 2007.
[7] Williams unpubl.; Adams and Abbott 2002.

Double-layered Onduline artificial cover objects (ACOs)[8] (400mm x 280mm) were used to survey for skinks and semi-arboreal geckos (common and Pacific geckos). GPS locations of all covers were taken. When checking ACOs we also recorded the following: observer(s), weather data (temperature, relative humidity, heat index, cloud cover (est. %), wind (Beaufort scale)), and the start and finish time.

1.4.6 Bat fauna

Bat fauna descriptions are based on unpublished reports, no additional surveys were undertaken as part of this project.

1.4.7 Terrestrial invertebrate fauna

Ground active terrestrial invertebrates were sampled using replicated pitfall trapping, over a period of 30 days. Moths were sampled by replicated UV light trapping. See Appendix E for a description of analytical methods of terrestrial invertebrate samples.

[8] Lettink and Cree, 2007.

2 Background

2.1 Current land cover and Land Environments

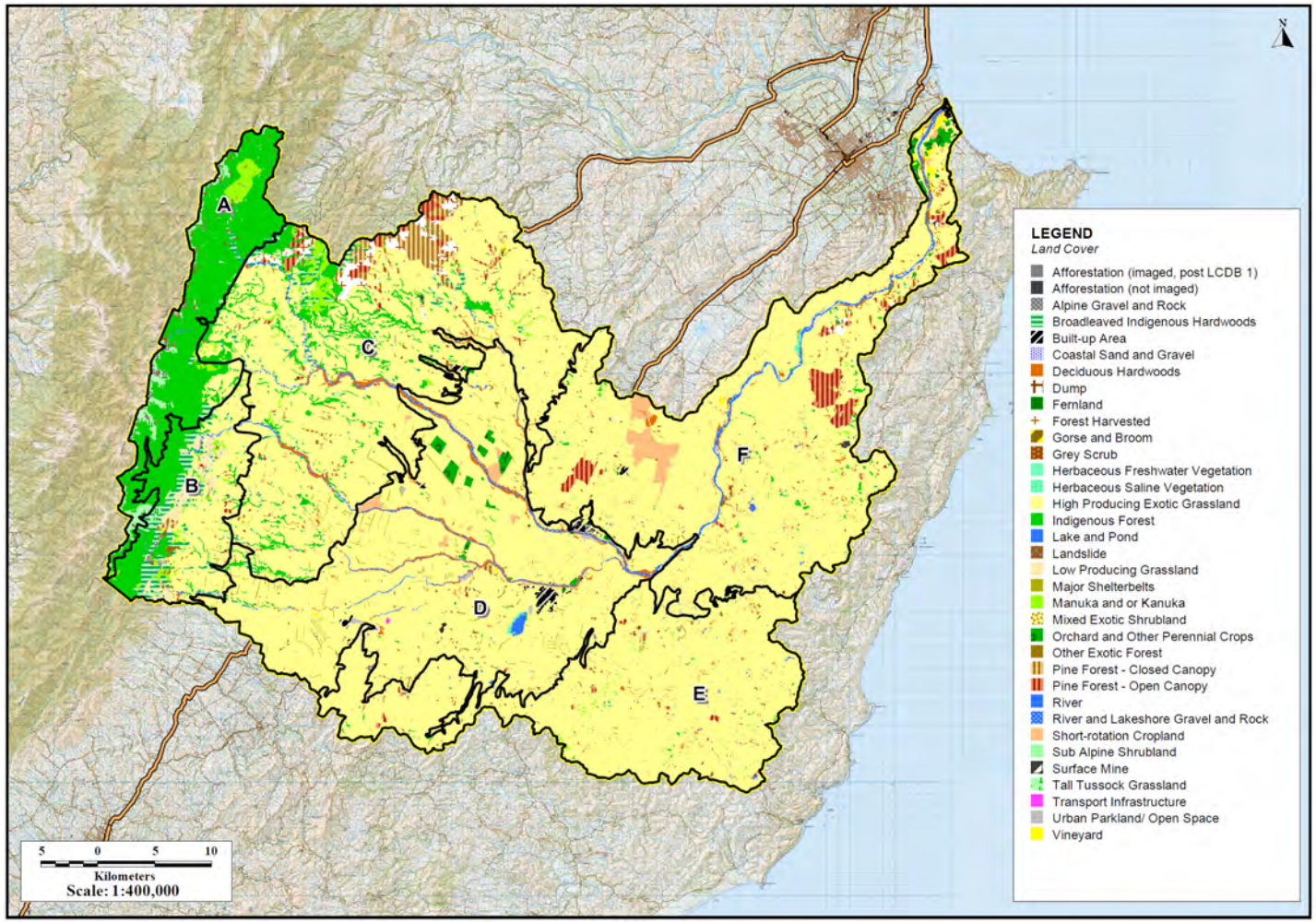


Figure 2-1: Land cover types across the Catchment (LCDB2 data).

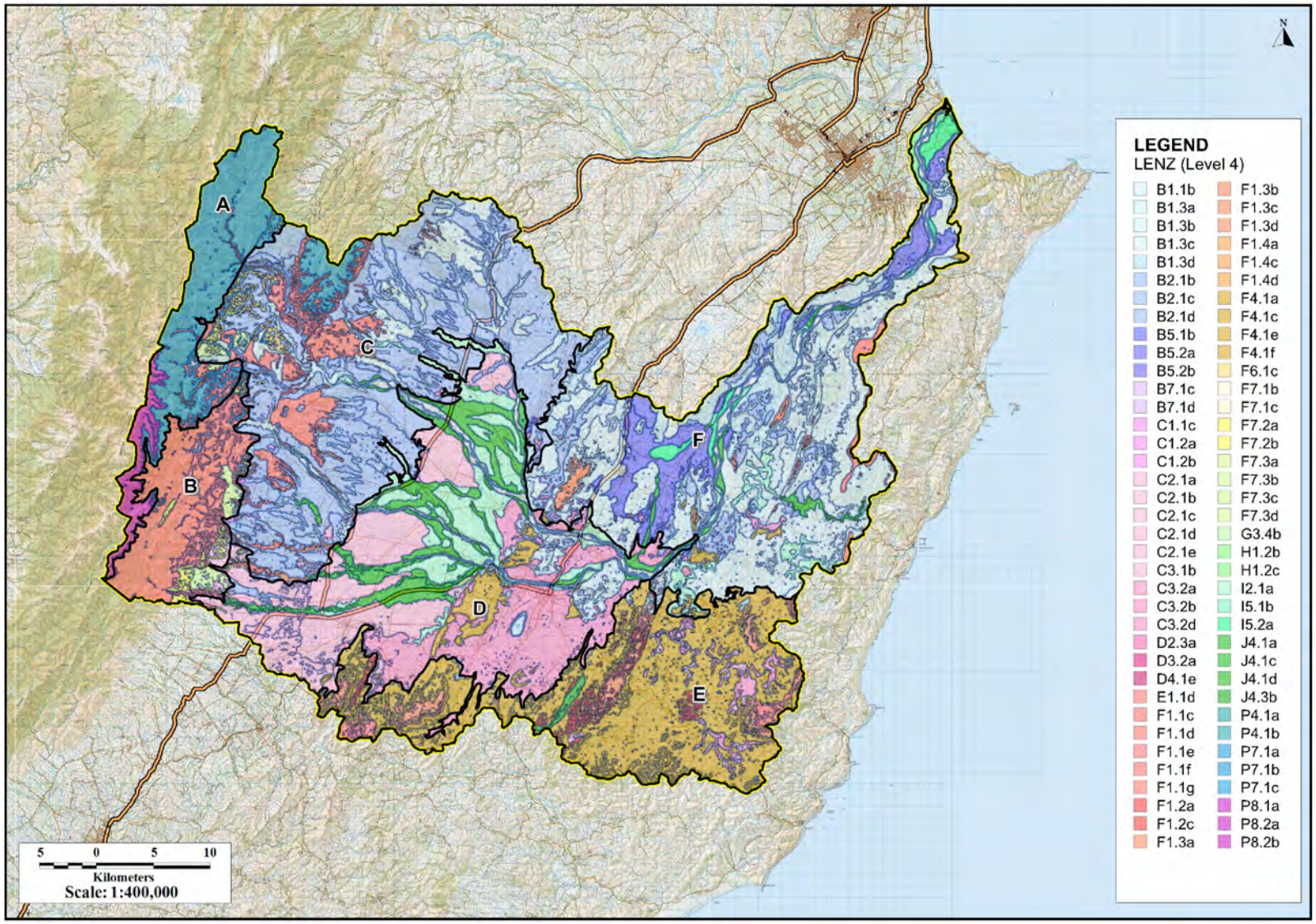
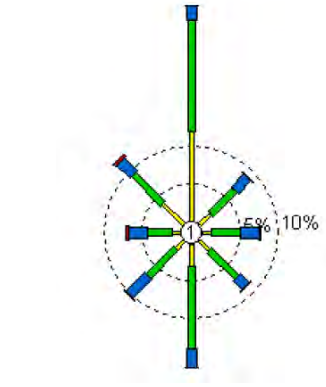
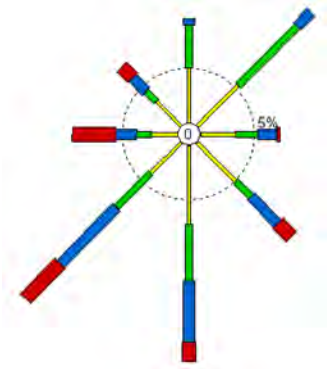


Figure 2-2: LENZ (Level IV) classification of the Catchment (Catchment Units shown).

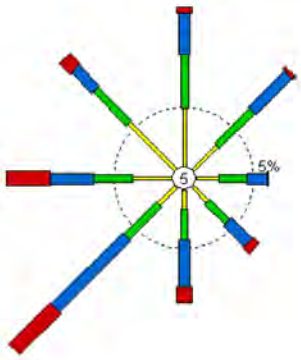
2.2 Windrose data



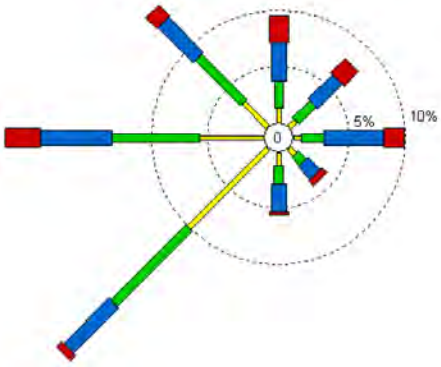
Gwavas Forest Head Quarters



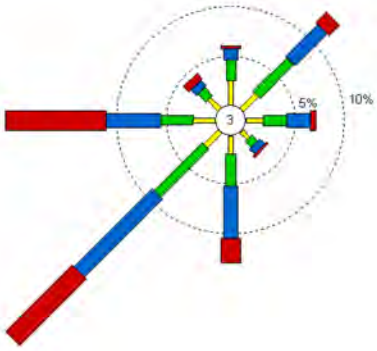
Te Aute



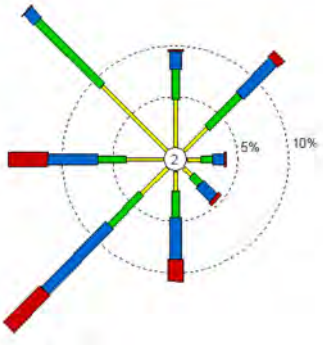
Ongaonga



Omakere



Takapau Plains



Waipukurau

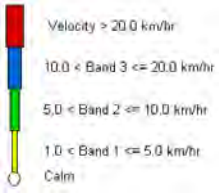


Figure 2-3: Windrose data for specific sites within the Tukituki Catchment.

2.3 Department of Conservation, 'Protected' and 'Recommended Areas for Protection'

The sites below are those classified by the DoC as sites currently protected or recommended for protection (RAP), or listed in the Central Hawke's Bay District Plan as having significant nature conservation value. Many of these sites were visited through the course of this study.

Table 2-1: Protected and sites recommended by DoC for protection (RAPs) within the Tukituki Catchment.

Reference	Ownership	Site name	Site type	Location
Catchment Unit A				
CHBDP 'Site 1'	Crown	Ruahine State Forest Park	Various	Axial ranges
CHBDP: 'Site 8'; RAP42 (H)	Crown	Tukituki riverbed	Shingle riverbed	-
Catchment Unit B				
CHBDP 'Site 1'	Crown	Ruahine State Forest Park	Various	Axial ranges
CHBDP: 'Site 8'; RAP42 (H)	Crown	Tukituki riverbed	Shingle riverbed	-
RAP39 (H)	Private	Makaretu River	Broadleaved forest on alluvial terraces and escarpments	North of Snee Road
Catchment Unit C				
CHBDP: 'Site 2'	Crown	Gwavas Conservation Area	Hill country forest	Wakarara Range
CHBDP: 'Site 8'; RAP42 (H)	Crown	Tukituki riverbed	Shingle riverbed	-
CHBDP 'Site 16'; RAP42 (H)	Crown	Waipawa Riverbed	Shingle riverbed	-
CHBDP: 'Site 18'	Crown	-	Bush margin on Makaroro River	Makaroro River
CHBDP 'Site 20'	Crown	Mangaonuku Stream no.1 Marginal Strip	Riparian strip	Near Butler Road
CHBDP 'Site 29'	Crown	Mangatewai Scenic Reserve	River terraces and hill slopes of the Mangatewai River. Podocarp-broadleaved-black beech forest	South of Ashley Clinton Road
CHBDP 'Site 58'	Crown	Springhill Bush Scenic Reserve	Small stream terraces and gentle hill slopes. Totara dominant podocarp-broadleaved forest	McLeod Road

Reference	Ownership	Site name	Site type	Location
CHBDP 'Site 59'	Crown	Monckton Scenic Reserve	Alluvial terrace and hill slopes. Podocarp-broadleaved forest with occasional black beech	Ashley Clinton Road
CHBDP 'Site 60'	Crown	A'Deanes Bush Scenic Reserve	Alluvial terraces with small, wet hollows. Tall podocarp-broadleaved-black beech forest	Makaretu Road
CHBDP 'Site 61'	Crown	Inglis Bush Scenic Reserve	Tall podocarp forest situated on an alluvial terrace of the Tukituki River	Tukituki Road
RAP20 (H)	Private	Puahanui Bush	Podocarp-broadleaved forest	Gwavas Station
RAP21 (H)	Private	Mangamauku Stream	Indigenous forest (riparian)	Mangamauku Stream
RAP24 (H)	Private	Mangaoho No. 2	Black beech forest in gully	Smedley Station
RAP25 (H)	Private	Smedley Bluffs	Broadleaved-beech forest	Smedley Station
RAP26 (H)	Private	Mangaoho No. 1	Indigenous forest and treeland	South of Smedley Road
RAP27 (H)	Private	Holdens No.2	Totara treeland and forest	Springvale
RAP28 (H)	Private	Holdens Bush	Tall podocarp forest	Springvale
RAP29 (H)	Private	Te Pah	Podocarp-broadleaved forest	Te Pah
RAP31 (H)	Private	Condor	Podocarp-mixed broadleaved forest	Blackburn
RAP32 (H)	Private	Worsnops	Podocarp-broadleaved forest and treeland	Blackburn
RAP34 (H)	Private	Khyber Pass	Totara treeland	Makaretu
RAP35 (H)	Private	Eastern Equities	Kanuka treeland	Tikokino Road
RAP36 (H)	Private	Barnsdale	Totara-kahikatea forest	Near Makaretu
RAP37 (H)	Private	Herricks	Totara and black beech forest	Near Ashley Clinton
RAP38 (H)	Private	Mangatewai River	Beech-broadleaf-podocarp forest on escarpments and river terraces	South of Black Road
Catchment Unit D				
CHBDP 'Site 20'	Crown	Mangaonuku Stream no.1 Marginal Strip	Riparian strip	Near Butler Road
CHBDP 'Site 21'	Crown	Mangaonuku Stream no.1 Marginal Strip	Riparian strip	Near Argyll Road
CHBDP 'Site 30'	Crown	Tukituki River Scenic Reserve	Remnant stand of tall podocarp-broadleaved forest dominated by kahikatea and matai. Located on alluvial terraces of the Tukituki River	Scenic Road

Reference	Ownership	Site name	Site type	Location
CHBDP: 'Site 8'; RAP42 (H)	Crown	Tukituki riverbed	Shingle riverbed	-
CHBDP 'Site 41'	Crown	Hatuma Conservation Area	Willow/raupo swamp along western side of Lake Hatuma	Southwest of Waipukurau
CHBDP 'Site 42'	Crown	Hatuma Domain Recreation Reserve	Recreation reserve	Hatuma
RAP41 (H)	Private	Lake Hatuma	Shallow lake with a variety of marginal vegetation types	Southwest of Waipukurau
Catchment Unit E				
RAP15 (E)	Private	Mangarouhi Stream-Waiwhero Stream	Twelve small forest remnants in stream valleys. Highest known density of the rare shrub/tree *Pittosporum obcordatum* (Threatened, Nationally Vulnerable[9])[10].	Oueroa
RAP18 (E)	Private	Motuotaraia	Kanuka-manuka forest and scrub	Northeast of Wanstead (only northeastern part of site is within Tukituki Catchment)
RAP19 (E)	Private	Bush Trig	Forest remnants on alluvial terraces and hill faces	West of Motere Road
Catchment Unit F				
CHBDP: 'Site 8'; RAP42 (H)	Crown	Tukituki riverbed	Shingle riverbed	-
CHBDP: 'Site 22'	Crown	Otane Wildlife Reserve	Peat wetland	Near Pukehou
CHBDP 'Site 31'	Crown	Tukituki River Marginal Strip	Riparian strip	Opposite River Road
CHBDP: 'Site 32'	Crown	Patangata Conservation Area	Riparian	Elsthorpe Road
CHBDP 'Site 55'	Crown	Elsthorpe Scenic Reserve	Indigenous forest remnant	Elsthorpe
CHBDP 'Site 56'	Crown	Elsthorpe Domain Recreation Reserve	Recreation reserve	Elsthorpe

[9] de Lange *et al*, 2009.
[10] Maxwell *et al*, 1993.

Reference	Ownership	Site name	Site type	Location
CHBDP 'Site 62'	Private	Horseshoe Lake	-	Mangarara Road
RAP4 (E)	Private	Hapua	Indigenous forest and treeland	Hawea Stream
RAP5 (E)	Private	Kahuranaki Road Bush	Indigenous forest	Kahuranaki Road
RAP8 (E)	Private	Silver Range	Sandstone 'hogback' with indigenous shrubland	St Lawrence Road
RAP10 (E)	Private	Paeroa	Tawa-podocarp forest	North of Kokatewai Road
RAP12 (E)	Private	Motonui Wetland	Wetland with indigenous shrubland	Atua Road
RAP14 (H)	Crown	Tukituki Estuary	Estuary	Haumoana
RAP30 (H)	Private	Highfield	Limestone landforms and forest	College Road

3 Terrestrial Ecology Character

3.1 Catchment scale overview

The following sections provide a 'catchment' scale overview of the character of terrestrial ecology elements of the Tukituki River Catchment. This is proceeded in Section 3.2 (onwards) by more detailed descriptions on a 'catchment unit' basis, on specific topics where sufficient information is available.

3.1.1 Vegetation cover and rare/uncommon habitats

3.1.1.1 Vegetation cover

The type and extent of vegetation cover varies considerably across the Tukituki Catchment. Broadly speaking, indigenous vegetation cover is most complete in Catchment Units A and B. Here much of the land is protected for conservation purposes and has steeper topography. This makes vegetation clearance less likely and natural reversion to scrub and forest more likely, compared to flat productive land as illustrated on the land cover type map provided as Figure 2-1.

Catchment Unit C contains an ecologically important zone of remnant indigenous vegetation patches and annual average rainfall is still sufficient to support diverse indigenous forest communities. Indigenous cover within this area is embedded within a matrix of primarily pastoral agricultural land use, and substantial areas of exotic plantation forestry.

Catchment Units C, D, E and F are all dominated by high producing exotic grassland, with varying proportions of horticultural and forestry related production land uses. Indigenous cover in these Units is particularly scarce, heightening even more the ecological importance of any remaining indigenous cover[11].

[11] The ecological theory - the 'species-area relationship' is of particular relevance to biodiversity management in these Units. That theory predicts that as habitat loss advances, each additional increment of habitat loss will remove a larger proportion of the original species that it once supported. This effect can also be compounded by other adverse attributes of remaining indigenous cover such as isolation, edge effects and barriers to the movement of species between favorable habitat patches.

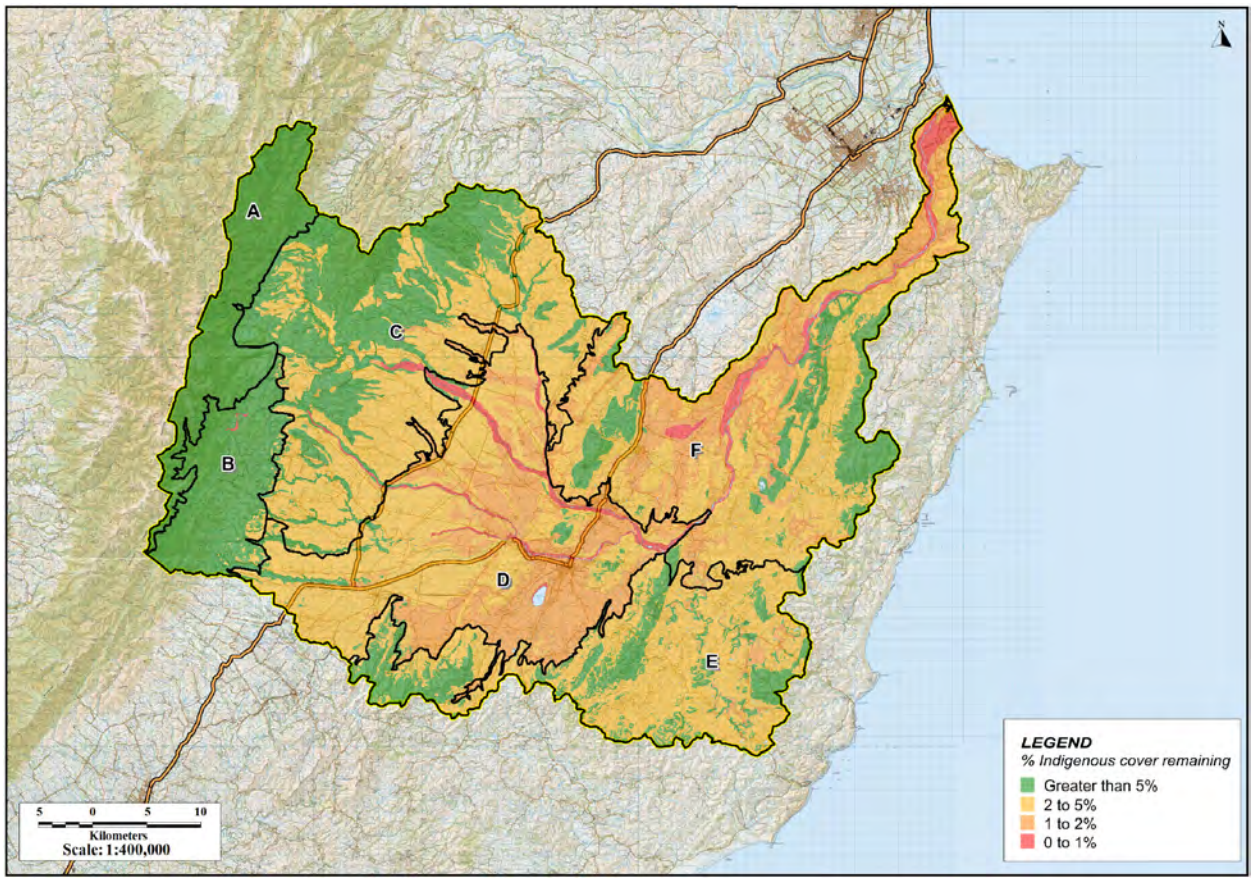


Figure 3-1: The distribution of remaining indigenous cover within the Tukituki Catchment (LENZ data).

Over much of the Catchment, indigenous cover is quite possibly insufficient to maintain or enhance terrestrial biodiversity values. In these areas, consideration of the current and potential role of exotic vegetation (e.g. shelter and amenity plantings) in contributing to the functioning of terrestrial ecology is important for certain ecological functions and species.

The 'Threatened Environments Classification' (TENZ) provides a framework for identifying areas in which much reduced and poorly protected terrestrial indigenous habitats/ecosystems are most likely to occur. Figure 3-2 presents TENZ output data for the Tukituki Catchment (graphs and map). A striking gradient is apparent, from well protected and expansive areas of indigenous cover within Units A and B, to highly denuded and poorly protected areas over much of the remaining Units. The TENZ classification descriptions are provided in Table 3-1 for reference.

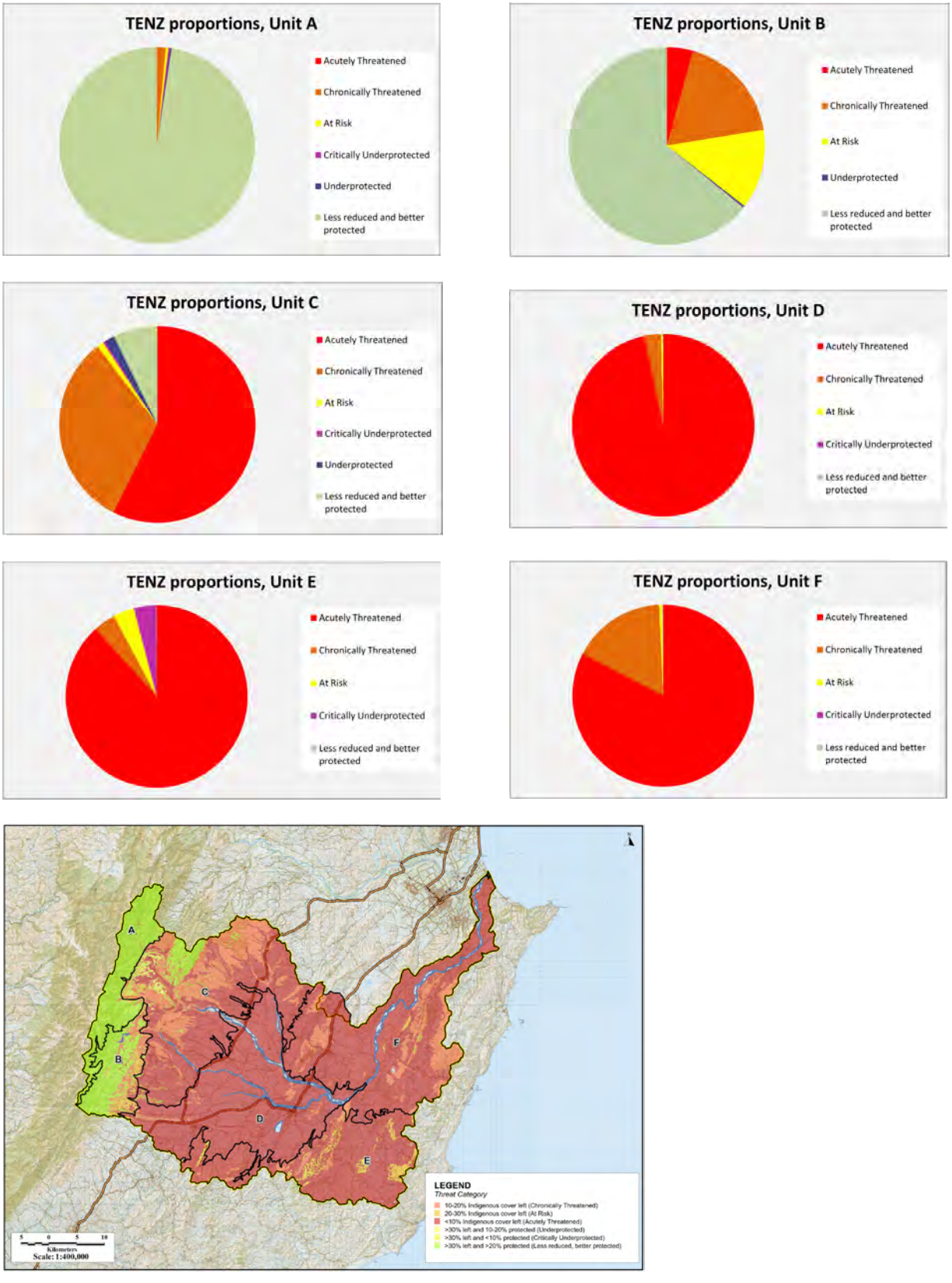


Figure 3-2: 'Threatened Environment' classification proportions and distribution.

Table 3-1: TENZ category descriptions.

Category	Criteria	Name	State of indigenous biodiversity
1	*<10% indigenous vegetation left*	*Acutely Threatened*	*Very little indigenous biodiversity remains in these environments. There are only a few very rare relicts of former indigenous habitats and ecosystems left and what little does remain is typically highly modified, with poor connectivity and degraded ecological linkages. Species threatened by habitat loss are concentrated in these remnants. Further habitat loss may be expected to result in extinction or accelerated decline of remaining indigenous species and ecosystem types, and to severely compromise the viability of other habitat patches remaining nearby in similar environments.*
2	*10-20% indigenous vegetation left*	*Chronically Threatened*	*Indigenous biodiversity in these environments has been severely reduced and remaining habitats are sparsely distributed in the landscape. Risks to biodiversity from fragmentation have become severe, threatening the persistence of many species in these environments. Further habitat loss will disproportionately exacerbate risks to biodiversity.*
3	*20-30% indigenous vegetation left*	*At Risk*	*Indigenous biodiversity in these environments has been much reduced and habitats are seriously fragmented. Therefore, although loss is not as advanced as in Categories 1 and 2, the future persistence of species dependent on habitats in these environments is already compromised. Further habitat loss will exacerbate threats and decrease the security of biodiversity associated with these environments.*
4	*>30% left, <10% protected*	*Critically Underprotected*	*Indigenous habitats in these environments are less reduced and fragmented than in categories 1 to 3, but have very little legal protection and are very rare in private and public conservation areas. This means indigenous habitats are very poorly protected from clearance. Many habitat types (e.g. tussock grasslands and shrublands) are imminently threatened by conversion to more intensive land uses. It is assumed that indigenous biodiversity outside private covenants and public conservation lands receives little conservation management input (e.g. fencing, pest and weed control) and many species may be in decline or at risk of extinction.*
5	*>30% left, 10-20% protected*	*Underprotected*	*As for Category 4 (above), but more indigenous habitat is protected from clearance, and a somewhat higher proportion may receive conservation management inputs.*
6	*>30% left, >20% protected*	*Less Reduced and Better Protected*	*Biodiversity is probably more secure from direct clearance of indigenous vegetation and its consequences than in any other category. However, biodiversity remains vulnerable to other threats such as pests, weeds and extractive land uses. Natural areas here will typically be larger, more intact and better connected, and will often support species, community types and ecotones that now remain only in relatively intact ecosystems. Many threatened species, including most threatened frogs, birds and bats, now survive only here.*

3.1.1.2 'Induced' rare habitats/ecosystems

The following habitat/ecosystem types have become uncommon or rare due to human influences and are important areas for the protection of rare and threatened indigenous biodiversity[12].

Indigenous lowland forest

Lowland forest within the Tukituki Catchment is a critically important habitat type, which has been much reduced in extent over time, and is today largely restricted to discrete areas embedded within a landscape dominated by agricultural land use.

Also of importance as habitat within the Catchment are areas of indigenous cover not yet attaining true 'forest' structure (some sites perhaps never will), such as indigenous treelands, scrub and shrubland communities. The ecological importance of these types of indigenous cover is particularly heightened in areas where indigenous cover is scarce.

Based on LCDB2 data, the Tukituki Catchment contains the following areas of indigenous woody vegetation[13]:

Table 3-2: Area of woody indigenous vegetation cover within Tukituki Catchment.

Woody indigenous vegetation classification	Area of cover (ha)	% of total catchment area
Forest	33,745	9.3
Broadleaved hardwood scrub	4,118	1.1
Manuka/kanuka/grey scrub	3,921	1.1

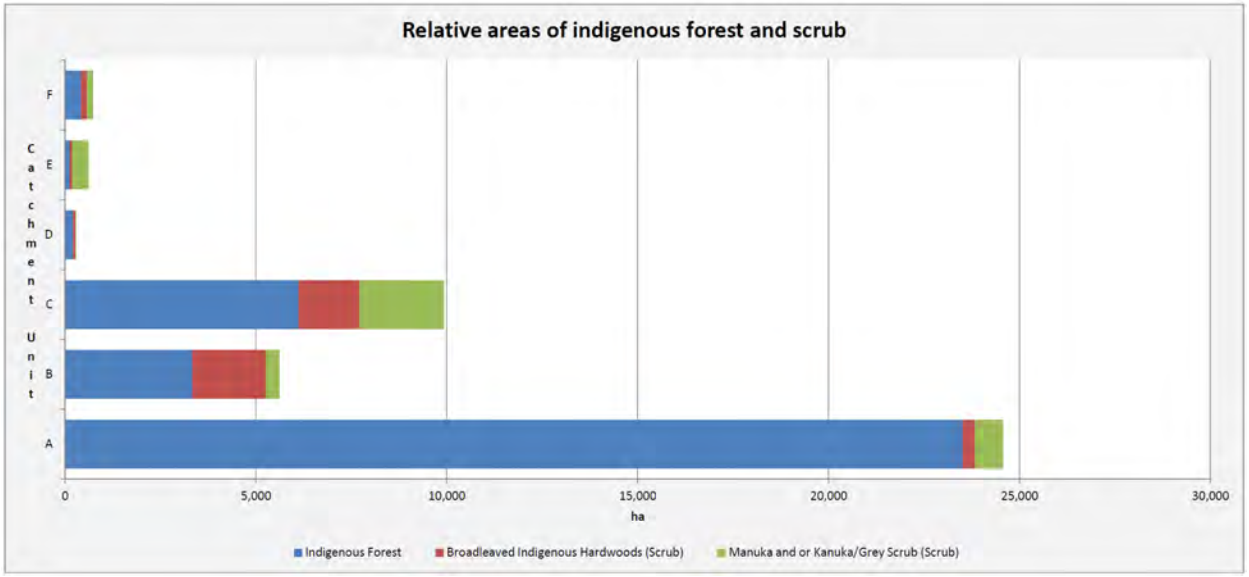


Figure 3-3: Relative area (ha) of indigenous woody vegetation type within Tukituki Catchment Units. Note, a proportion of the indigenous vegetation cover listed for Units A and B is at or above 800m a.s.l

[12] Williams *et al*, 2007.
[13] Note, a proportion of the indigenous vegetation cover listed would at or above 800m a.s.l and would therefore not be classed as 'Lowland' vegetation.

and would therefore not be classed as 'Lowland' vegetation.

The data presented above showing indigenous woody cover as a proportion of the total catchment area, and the breakdown of the area of indigenous cover per catchment unit area clearly demonstrates the scarcity of indigenous woody habitat within the Tukituki Catchment.

Wetlands

From the current study of wetland types and distribution in the Tukituki Catchment there have been 447 wetlands identified (see Table 3-3) covering a land/water area of 578ha (see Table 3-4)[14].

Table 3-3: Number of wetlands, and their type per Catchment Unit.

Hydrosystem	Wetland class	Catchment Unit identifier						Total
		A	B	C	D	E	F	
Estuarine							2	2
Estuarine total number							*1*	*1*
Lacustrine	none assigned				3	1	2	6
	seepage				1			1
	shallow water			1	7	4		12
Lacustrine total number				*1*	*11*	*5*	*2*	*19*
Palustrine	marsh			3	1			4
	seepage	1	5	86	29	38	54	213
	shallow water			53	26	28	15	122
	swamp			10	4	1	6	21
	under construction			1				1
Palustrine total number		*1*	*5*	*153*	*60*	*67*	*75*	*361*
Riverine	ephemeral				3			3
	marsh			12	9		2	23
	shallow water			7	13	3	2	24
	swamp			4	7	2	1	14
Riverine total number				*23*	*32*	*5*	*5*	*64*
Grand Total		**1**	**5**	**177**	**103**	**77**	**83**	**447**
% of all wetlands present		**<1**	**1**	**40**	**23**	**17**	**19**	**100**

[14] An overview of the criteria used for the classification and characterization of wetlands within the Catchment is contained in Appendix A. Maps showing the distribution of wetlands across the Catchment are contained in Appendix B.

Table 3-4: Wetland area (ha), per type for each Catchment Unit.

Hydrosystem	Wetland class	Catchment Unit identifier						Total (ha)
		A	B	C	D	E	F	
Estuarine	saltmarsh						5.14	5.14
	shallow water						1.14	1.14
Estuarine total area							*6.28*	*6.28*
Lacustrine	none assigned				15.00	3.34	42.25	60.67
	seepage				0.69			0.69
	shallow water			1.43	318.93	5.54		325.89
Lacustrine total area				*1.43*	*334.62*	*8.96*	*42.25*	*387.25*
Palustrine	marsh			6.50				6.50
	seepage	0.26	0.65	21.98	10.46	17.61	18.93	69.89
	shallow water			16.26	9.06	14.14	6.62	46.08
	swamp			6.26	1.27	0.20	19.05	26.78
Palustrine total area		*0.26*	*0.65*	*51.00*	*20.79*	*31.95*	*44.60*	*149.25*
Riverine	ephemeral				1.54			1.54
	marsh			2.04	2.43		0.28	4.75
	shallow water			3.01	10.03	3.07	1.77	17.88
	swamp			2.96	5.52	2.26	0.39	11.12
Riverine total area				*8.01*	*19.52*	*5.33*	*2.43*	*35.28*
Grand Total (ha)		**0.26**	**0.65**	**60.43**	**374.93**	**46.24**	**95.56**	**578.06**
% of total wetland area		**<1**	**<1**	**10**	**65**	**8**	**17**	**100**

It is important to note that farm dams were included in this study and make up 176 of all wetlands identified. Although they are artificial in character they do contribute to the overall connectivity for terrestrial species within the landscape and have been included for this purpose. As well as having a value to the connectivity for terrestrial species, they potentially have high primary productivity driving macro-invertebrate communities providing a food source to terrestrial insects with positive effects on higher trophic species and food web dynamics. Recent studies have highlighted the importance of aquatic insect subsidies to riparian predators like arthropods, birds, bats, and herptiles[15].

The farm dams located in the Tukituki Catchment range in size from very small (e.g. 0.02ha) to large (e.g. 3 ha) and have differing levels of riparian cover and associated habitat diversity. Their differing sources of flow will determine the nutrient status of these dams. For example a dam that is capturing a groundwater spring will have improved water quality and potentially lower nutrient inputs of nitrates and phosphates compared to a dam capturing surface flow from a small farm stream. Many of the dams have good riparian cover and macrophyte growth creating a diversity of habitats for primary producers and higher trophic species. There is the potential for the dams with a shallow depth and little macrophyte cover to have high temperature fluctuations during the summer months when temperatures are elevated. These would not be suitable habitat for aquatic organisms to colonise.

[15] Baxter *et al*, 2005.

There are 19 'lakes' identified in the Tukituki Catchment; with varying wildlife and biodiversity values. Lake Hatuma is the most significant within the Heretaunga Ecological District[16] for its high wildlife values. It is a known stronghold for Australasian bittern (*Botaurus australis*), a nationally threatened species[17] with only 750 birds left in New Zealand[18], as well as providing refuge for a number of wading birds (banded and black-fronted dotterel can flock in numbers reaching over 100 birds), waterfowl and fish species.

Horseshoe Lake[19] in the Eastern Hawke's Bay Ecological District[20] is another significant lake for its high wildlife values and has the capacity to support habitat for a number of wetland bird species such as spotless crakes and the Australasian bittern. It is unknown if the site is used for breeding populations of bittern but it is an important feeding site for these and other birds which feed on the eels, frogs and other small fish and zooplankton in the lake.

Palustrine wetlands make up the majority of wetland types in New Zealand[21] and this is reflected regionally. The classes of Palustrine wetlands have been identified and their characteristics are listed in Appendix A. There are 361 palustrine wetlands in the Tukituki Catchment; of these 151 are dams on agricultural land; capturing groundwater seepages, surface run off and headwater springs. The remaining dams have a riverine hydrosystem and are located on stream channels that have been altered to retard the flow of these streams. Many of the seepage wetlands identified in this study are very small and are characterised by turf communities and low growing plant species. The most special is the seepage wetland on Kahuranaki Station which has a mixture of different vegetation types and structures with low growing turf species, carex and native trees evident[22].

Due to poorly drained soils, there are a number of palustrine wetlands along the terraces of the Makaretu, Makaroro and Mangatewhai Rivers. The Makaretu has poorly drained soils on both sides of the river terrace due to impermeable clay deposits at shallow depths[23] and the effects of this clay pan perches the groundwater causing the water table to rise to the surface where these wetlands are located. One of these seepages on the true right bank of the Makaretu demonstrated a wide diversity of wetland plants, small leaved shrubs and trees with distinct connectivity to the forested terraces[24].

3.1.1.3 'Historically' rare habitats/ecosystems

The following habitat/ecosystem types are present within the Tukituki Catchment and are rare, and have been so since before humans arrived in New Zealand. They often are characterised by highly specialised and diverse flora and fauna of endemic and nationally rare status[25].

[16] Lee, 1994.
[17] Nationally Endangered (Miskelly *et al*, 2008).
[18] Pers comm. J.Cheyne, 2011.
[19] See Photograph 1.
[20] Maxwell *et al*, 1993.
[21] Johnson and Gerbeaux, 2004.
[22] See Photograph 2.
[23] Griffiths, 2004.
[24] See Photograph 3.
[25] Williams *et al*, 2007.

Table 3-5: Historically rare habitat/ecosystem types present within the Tukituki Catchment.

Habitat/ecosystem type	Relevant catchment unit(s)
Shingle beach	F
Calcareous cliffs and scarps	D, F
Boulderfields of calcareous rocks	D*, F
Calcareous screes	D*, F
Braided riverbed	A, B, C, D, F
Estuary	F

*Potentially present within this Unit based on the geology type of the Catchment Unit.

3.1.2 Avifauna

The Tukituki River catchment holds a diverse range of bird habitats, from a large sheltered estuary that opens into the sea at Haumoana, to a moderately braided riverbed extending from the sea through to the upper reaches, and then narrower sections of river channel, with clear mountain streams in the Ruahine Ranges.

Away from the riverbed itself significant areas of indigenous forest occur in the headwaters, with the upper reaches outside of the Ruahine Forest Park often having good riparian corridors of remnant indigenous vegetation. Further out from the Range the story changes with considerably less indigenous vegetation remaining in a heavily modified intensively grazed landscape. Some indigenous forest fragments remain, but in the south-eastern Catchment Units these fragments are few and far between.

Freshwater habitats, including lakes, ponds, farm dams, and wetlands are also found within this catchment, although many are man-made, they still provide essential habitat for a range of bird species. The forest and wetland/river habitats are the most important habitats for birds within this river catchment, especially for the endemic and native species. The high producing exotic grasslands that now dominate the landscape offer little to most species of endemic and native birds, especially those classified as threatened[26].

It is rapidly apparent from working within this catchment, that some parts of the catchment are better than others with regards to important bird habitats. Catchment Units A and B are heavily dominated by native vegetation, mainly indigenous forest, and this is home to a wide range of endemic, native and introduced bird species. However, as one moves away from the Ruahine Ranges the Units become more highly modified, and more intensively grazed and afford limited habitat for avifauna. Catchment Unit C still has good indigenous forest and shrubland cover in many places, with some native riparian vegetation in parts. Catchment Unit D has few indigenous forest patches, but does have several important wetland habitats, whilst Catchment Unit E again has very few forest remnants and only a few small wetland sites. Catchment Unit F has a few more remnant forest patches, than the previous two, and a number of good wetland sites, and of course has the very productive estuary as the river enters the sea.

Through this catchment though, is the heart of it all the Tukituki and Waipawa Rivers, that converge roughly midway along its length to become a river of considerable volume and width, with a good

[26] Miskelly *et al,* 2008.

expanse of braided shingle flats that are an important bird habitat in their own regard. Upstream of this confluence, the river supports considerable numbers of riverbed birds.

Of importance for assessing the values of the Tukituki River for riverbed bird species, are the surveys that have been conducted on the main rivers of the Hawke's Bay Region since the 1960s. Surveys were conducted on the Tukituki River in 1967 and 1972 by Ornithological Society of New Zealand (OSNZ) members and in 1984 and 1986 by joint Wildlife Service and OSNZ members[27]. The Ngaruroro and Tutaekuri Rivers were covered during a census in 1962, but it appears the Tukituki River missed out, although the presence of black-fronted dotterel is noted at that time. A joint Forest and Bird, Department of Conservation (DOC), and OSNZ survey was planned for October/November 2009, however weather cancelled this survey and a new survey has not yet been scheduled or carried out. This survey is of great importance in ensuring populations have not declined, and should be carried out as soon as possible before further changes on the river occur.

During the surveys conducted by the Wildlife Service to determine Sites of Special Wildlife Interest (SSWI) in 1983-84, a total of 54 sites were identified within the Tukituki River catchment.

Assessing the relative merits of these sites based on the categories defined within the survey, shows that the majority of the sites were of Moderate (44%) and Potential (39%) value, and that sites of High (7%) and Moderate-High (9%) value were much less common. Of these 54 sites, 22 (41%) were considered to be terrestrial habitats; composed mainly of forest, shrubland, or heathland, whilst 30 (55%) were of a freshwater nature (rivers, lakes, or ponds). Two (4%) sites identified had a combination of both forest and wetland habitats.

Table 3-6: Sites of Special Wildlife Importance (SSWI) identified during the 1983-84 Wildlife Service surveys within the Tukituki River Catchment, and the Catchment Units these occur in.

	SSWI value						
Catchment Unit	High	Moderate -High	Moderate	Potential	Total sites	ha per site	Catchment Unit size (ha)
A	0	0	0	0	0	27,884.6	27,884.6
B	0	0	0	0	0	19,357.2	19,357.2
C	3	1	11	3	18	5,174.1	93,133.2
D	1	0	3	6	10	8,692.0	86,920.1
E	0	0	6	4	10	7,192.3	71,923.2
F	0	4	4	8	16	3,919.8	62,715.9
Total	4	5	24	21	54	6,702.5	361,934.1
% of sites per catchment unit	7%	9%	44%	39%			

Note: A comparison of the number of sites per hectare within each Catchment Unit is included. Also note the size in hectares of each Catchment Unit has been corrected for slope.

Surveys conducted during the period 1992-94 by DOC as part of the Protected Natural Areas Programme (PNAP) identified and surveyed over 100 sites throughout the Tukituki River catchment, with 52 sites being described as Recommended Areas for Protection (RAP) (see Table 2-1 and Table 3-7 and Appendix H). It should be noted that this includes multiple sites at some locations due to forest patches being fragmented, and that if these are excluded and considered as just a single site, this number is greatly reduced to 30 'locations'. In some cases it does make sense to consider each site on its own merits, as sites can sometimes be more than a kilometre apart, and often of differing

[27] summarized in Parrish, 1988.

quality (e.g. some grazed others fenced and stock excluded). It should also be noted that this survey was not entirely independent of the SSWI surveys, and many of the sites determined during that survey, were revisited and included in the PNAP survey. The size (in hectares) shown in Table 3-6 and Table 3-7 also takes into account topography, so is corrected for slope.

Table 3-7: RAPs identified during the surveys conducted by DOC in the period 1992-94 within the Tukituki River catchment (expressed as number of RAPs/ha).

Catchment unit	Individually listed		Sites grouped		Catchment unit size (ha)
	RAP	per ha	RAP	per ha	
A	0	27,884.6	0	-	27,884.6
B	1	19,357.2	1	19,357.2	19,357.2
C	18	5,174.1	17	5,478.4	93,133.2
D	2	43,460.0	2	43,460.0	86,920.1
E	17	4,230.8	2	35,961.6	71,923.2
F	14	4,479.7	8	7,839.5	62,715.9
Total	52	6,960.3	30	12,064.5	361,934.1

From these analyses it is obvious that apart from the Tukituki Riverbed, sites were not designated within Catchment Units A and B largely due to the fact that almost all of Catchment Unit A, and a large proportion of Catchment Unit B, currently lies within the Ruahine Forest Park, an already designated conservation unit. The surveys sought mainly to identify sites outside of currently protected conservation estate, covenanted sites, etc. Therefore, this analysis is not necessarily showing in which catchment units the highest proportion of conservation estate is located, but in which catchment units additional sites considered at the time to be worthy of protection were located[28].

From this, it can be seen that based on catchment unit size (in hectares corrected for topography), Catchment Units F and C had the highest number of sites identified per hectare (both during the SSWI surveys and the PNAP surveys), whilst Catchment Units D and E had the fewest, especially when multiple sites were amalgamated. It should be noted however, that this does not take into account the actual size and specific importance of each site, and should be used only as a guide to indicate a broad pattern. This analysis does however, confirm the impression that one gets when travelling through these catchment units, that is that both Units D and E contain a reduced number of areas of value to birds, and therefore a more highly modified landscape with fewer forest fragments or wetlands. This is also confirmed by the data on land cover within these catchment units (refer Figure 2-1).

With such a large and varied catchment, the bird species present within it are equally diverse, with 102 species being listed in Appendix C. This includes 31 endemic species (30%), 45 native species (44%), and 26 introduced species (26%). More importantly, the list includes 35 species (34%) that currently have some level of threat status, as determined by Miskelly *et al*[29] or a regional threatened status[30] (Table 3-8). The list outlines the catchment units these species are found within, as well as their threat status, and it should be noted that two species (New Zealand pigeon and yellow-crowned

[28] Since the time of those surveys advancements in ecological science has provided a more complete understanding of how fragmented landscapes function. Consequently, within much of the Tukituki Catchment, any remaining indigenous cover is likely to be ecologically important, not just those sites with RAP or SSWI designations. They should be thought of as the 'best' of the remaining sites, rather than the only 'important' sites.
[29] Miskelly *et al,* 2008.
[30] DoC, 1994.

parakeet) do not currently have a National threat status[31] , but are listed due to having a Regional status[32]. The latter does need some revision, with almost two decades having passed since this report was written, and it may be that these two species would be removed from the Regional status listing if this was to happen.

From this list of 35 species, it can be seen that there are a number of species for which sightings within the river catchment are so infrequent as to make any additional management or modification to current practices unnecessary. Great egret (white heron), Eastern reef egret (heron), New Zealand plover (dotterel), shore plover, and wrybill have all been recorded within the catchment at some stage or another. However, specific management of sites for these species is unrealistic due to the scarcity of records. Even if discounted during future management, this management will generally be focused on species for which outcomes would be similar or favorable, and thus these species may benefit nevertheless. Therefore, little mention of these species will be made throughout this report.

Furthermore, although weka were recorded historically at Puahanui Bush (Gwavas Station Wildlife Reserve), perhaps in the 1950s, it seems unlikely that they still exist within the Tukituki River catchment. Historically, the species would have been widespread throughout the Hawke's Bay, including the Tukituki River catchment[33] . There has even been suggestion made that weka were reintroduced to Puahanui at some stage after their disappearance, but this has not been confirmed. Therefore, weka will not be the focus of further discussion.

Pacific black (grey) duck are an interesting case, in that this species is currently headed for extinction within New Zealand, and there is little that can currently be done to avert this. The extremely broad geographical range of the New Zealand subspecies of grey duck has not spared it from competition and genetic introgression from the introduced mallard[34] , and as such it is likely to be extinct on the Mainland within the next few decades. This species is unlikely to be positively (or negatively) affected by management of wetlands within the Tukituki River catchment, or on a National scale. However, that is not to say that wetland restoration and enhancement won't in the short-term at least, positively affect the species on a Regional scale. This species does seem to favour more natural wetlands and riparian margins, and in some areas appears to have increased in numbers following native plantings and restoration of waterways[35] .

[31] Miskelly *et al,* 2008.
[32] DoC, 1994.
[33] Heather and Robertson, 2000
[34] Miskelly *et al,* 2008
[35] E.g. Avon River and other freshwater wetlands in Christchurch, A. Crossland *pers comm.*

Table 3-8: List of bird species found within the Tukituki Catchment, currently considered to have a threat status after Miskelly *et al*[36] or a Regional status[37].

Species	Scientific name	National status	Designation	Regional status	Habitats	Tukituki sub-catchments					
						A	B	C	D	E	F
Northern brown kiwi	*Apteryx mantelli*	Nationally Vulnerable	Endemic	Category B	SS-sc, FT-ex, FT-in	P	U	H	A	A	A
New Zealand grebe (dabchick)	*Poliocephalus rufopectus*	Nationally Vulnerable	Endemic	Category B	WB-iw	A	A	P	P	P	P
Great cormorant (black shag)	*Phalacrocorax carbo*	Naturally Uncommon	Native	-	WB-iw, SW-ow	P	P	P	P	P	P
Little black cormorant	*Phalacrocorax sulcirostris*	Naturally Uncommon	Native	-	WB-iw	A	A	L	P	P	P
Little pied cormorant	*Phalacrocorax melanoleucos*	Naturally Uncommon	Native	-	WB-iw	L	L	P	P	P	P
Great egret (white heron)	*Ardea alba*	Nationally Critical	Native	Category O	WB-iw, SL-cw, SM-cw	A	A	A	P	A	P
Eastern reef egret (heron)	*Egretta sacra*	Nationally Vulnerable	Native	Category O	WB-iw	A	A	A	A	A	U
Australasian bittern	*Botaurus poiciloptilus*	Nationally Endangered	Native	Category O	WB-iw, SL-cw, SM-cw	A	U	U	P	P	P
Royal spoonbill	*Platalea regia*	Naturally Uncommon	Native	Category O	WB-iw	A	A	A	P	U	P
Blue duck	*Hymenolaimus malacorhynchos*	Nationally Vulnerable	Endemic	Category B	WB-iw	P	P	L	A	A	A
Pacific black (grey) duck	*Anas superciliosa*	Nationally Critical	Native	-	WB-iw	U	L	P	P	P	P
New Zealand falcon	*Falco novaeseelandiae*	Nationally Vulnerable	Endemic	Category B	CL-ph, GL-pp, GL-tg, SS-sc, FT-ex, FT-in	P	P	P	L	L	P
Weka	*Gallirallus australis*	Nationally Vulnerable	Endemic	-	FT-in	A	A	H	A	A	A
Baillon's (marsh) crake	*Porzana pusilla*	At Risk, Relict	Native	-	SL-cw, SM-cw	A	A	A	A	A	L
Spotless crake	*Porzana tabuensis*	At Risk, Relict	Native	-	WB-iw, SL-cw, SM-cw	U	L	L	P	P	P
South Island oystercatcher	*Haematopus finschi*	At Risk, Declining	Endemic	-	BS-cs, BS-bg, WB-iw, GL-pp	A	A	A	A	A	P
Variable oystercatcher	*Haematopus unicolor*	At Risk, Recovering	Endemic	Category B	BS-cs, WB-iw	A	A	A	A	A	P
Pied (black-winged) stilt	*Himantopus himantopus*	At Risk, Declining	Native	-	WB-iw, SL-cw, SM-cw	U	L	P	P	P	P
New Zealand plover (dotterel)	*Charadrius obscurus*	Nationally Vulnerable	Endemic	Category B	BS-cs, WB-iw	A	A	A	A	A	U
Banded dotterel (double-banded plover)	*Charadrius bicinctus*	Nationally Vulnerable	Endemic	Category C	BS-cs, BS-bg, WB-iw	U	L	P	P	P	P
Shore plover	*Thinornis novaeseelandiae*	Nationally Critical	Endemic	-	WB-iw	A	A	A	A	A	U
Wrybill	*Anarhynchus frontalis*	Nationally Vulnerable	Endemic	Category B	WB-iw	A	A	A	A	A	P

[36] Miskelly *et al,* 2008.
[37] DoC, 1994.

Species	Scientific name	National status	Designation	Regional status	Habitats	Tukituki sub-catchments					
						A	B	C	D	E	F
Red-billed gull	*Larus scopulinus*	Nationally Vulnerable	Endemic	-	WB-iw, SW-ow	A	A	U	U	L	P
Black-billed gull	*Larus bulleri*	Nationally Endangered	Endemic	-	WB-iw, GL-pp, SW-ow	A	A	U	U	L	P
Caspian tern	*Sterna caspia*	Nationally Vulnerable	Native	Category O	WB-iw	A	A	U	P	A	P
White-fronted tern	*Sterna striata*	At Risk, Declining	Native	-	WB-iw	A	A	A	A	A	P
Black-fronted tern	*Sterna albostriata*	Nationally Endangered	Endemic	Category B	WB-iw	A	A	A	A	A	P
New Zealand pigeon	*Hemiphaga novaeseelandiae*	Not Threatened	Endemic	Category B	SS-sc, FT-ex, WT-wp, FT-in	P	P	P	P	P	P
New Zealand kaka	*Nestor meridionalis*	Nationally Vulnerable	Endemic	Category B	CL-ph, FT-ex, FT-in	P	L	P	P	A	P
Red-crowned parakeet	*Cyanoramphus novaezelandiae*	At Risk, Relict	Native	Category C	FT-in	H	H	H	A	A	A
Yellow-crowned parakeet	*Cyanoramphus auriceps*	Not Threatened	Endemic	Category C	FT-in	P	P	P	A	A	A
Long-tailed cuckoo	*Eudynamys taitensis*	Naturally Uncommon	Native	-	SS-sc, FT-ex, FT-in	P	P	P	A	A	P
Rifleman	*Acanthisitta chloris*	At Risk, Declining	Endemic	-	SS-sc, FT-in	P	P	P	A	A	U
New Zealand pipit	*Anthus novaeseelandiae*	At Risk, Declining	Endemic	-	BS-bg, WB-iw, GL-pp, GL-tg	P	P	P	P	P	P
New Zealand fernbird	*Megalurus punctata*	At Risk, Declining	Endemic	-	SL-cw, SM-cw, SS-sc	L	P	P	A	A	A

Note: National threat status in order of greatest concern to least concern is Nationally Critical, Nationally Endangered, Nationally Vulnerable, At Risk – Declining, At Risk – Recovering, At Risk – Relict, and At Risk – Naturally Uncommon. Regional status follows logically from species in Category A being of highest priority, and species in Category C being of least concern. Category O is for species that are threatened in NZ, but secure in other parts of their range outside of NZ. For the catchment units P = present, A = absent, L = likely, U = unlikely, and H = Historic. Habitat keys are found in Appendix C.

Species considered to be close to local extinction within the Hawke's Bay Region or at the limit of their normal distribution, should be considered priority species within this report and for future survey and management within the catchment. There are several species which qualify, and these are listed below, and potential for management discussed in the appropriate Catchment Unit section:

1. Northern brown kiwi is found in low numbers within the Ruahine Range, with this being the southern limit of their distribution[38]. They do occur in the Kaweka Ranges, but there seems to be very little information about current distribution within this catchment, although sightings have been made in the central Ruahines and around Lake Colenso and the Upper Makaroro in the early 1990s (both sites are in Catchment Unit A) (HB OSNZ records). Further study to determine distribution and population size is warranted.

2. Blue duck are found within this catchment at several locations, with the majority of sightings over the years being within the Makaroro River headwaters[39]. A sighting of adults with ducklings also comes from the Daphne Hut area (headwaters of the Tukituki River) in 1991 (HB OSNZ records), and it is likely that they are widely dispersed, though probably not abundant through other tributaries in the headwaters of this catchment. Although blue duck have supposedly been seen further south around Cattle Creek (in the Ruahine Range), the furthest south they are currently considered to be present is the Oroua catchment on the western side of the range almost directly across from Daphne Hut. So this makes the Tukituki River catchment right on the southern limit of their distribution. No more southerly records were indicated in the Atlas[40], and there is the suggestion that populations in the Tararua Ranges may have died out[41].

3. Red-crowned parakeet are no longer found throughout most of the North Island, with scattered populations seemingly hanging on in isolated patches of indigenous forest[42], including the Ruahine Ranges. Robertson *et al*[43] suggest sightings of this species were made in the grid square that contains both Triplex Creek and Wakarara, and historic records of the species during the 1940-50s were discussed in Challies[44]. It is likely that small numbers still exist and it is worthy of further study, although this may be made slightly more difficult by the fact that yellow-crowned parakeets still occur throughout this area, and observers need to be sure of their identification.

Red-billed gulls are found in relatively low numbers on the Tukituki River, even around the estuary and lower reaches. They are currently listed as Nationally Vulnerable[45], with populations declining markedly in many parts of the country, however, are not discussed further throughout this report. Any management or comments relevant to the more endangered black-billed gull (Nationally Endangered[46]) would also apply to this species.

Other species that currently have a threat status listed in Table 3-8 will be discussed within the relevant sections on the Tukituki catchment units. It is sometimes difficult to determine the relevance of species status with regards to National and Regional population sizes, but in most cases a best guess is given for those species with a listed threat status.

Several species which do not have a listed threat status, and are therefore of less importance with regards to surveys are summarised in the following paragraphs. Those species will not be referred to in the following Catchment Unit sections.

[38] J. McLennan *pers comm.;* DoC, 1992; Heather & Robertson, 2000.
[39] Adams and Abbott, 2002; Williams unpubl.
[40] Robertson *et al,* 2007.
[41] DoC, 1992.
[42] Heather and Robertson, 2000; Robertson *et al,* 2007.
[43] Robertson *et al,* 2007.
[44] Challies, 1966.
[45] Miskelly *et al*, 2008.
[46] Miskelly *et al*, 2008.

White-faced herons are a common species found within a variety of habitats from rivers and lakes, to open grassland where cattle and sheep disturb insect prey. They are listed as widespread and common[47], and so need not be discussed further. Black swan, paradise shelduck, grey teal, and Australasian shoveler are all relatively common waterfowl, with all except the grey teal being game birds which are allowed to be shot to some extent during the duck shooting season. All of these species are currently increasing[48] in spite of this. Black swan are generally confined to the larger lakes and ponds, whilst paradise shelduck are generalists that have adapted well to grazed pastoral land where small farm ponds and dams are available once ducklings have hatched. Grey teal and shoveler are found commonly throughout on farm ponds and dams, wetlands, and even on sections of riverbed. There is little need to discuss these species further.

New Zealand scaup are a little different to the previous waterfowl species in that they are the only true diving duck found in New Zealand, and prefer slightly different habitats to the others. They favour cleaner lakes and ponds, and until recently were only found on one or two larger lakes in Hawke's Bay. However, they were found on several smaller ponds during this survey (including the Rotorunga Lagoons and Long Range Lake) as well as Horseshoe Lake. With a reasonable national population, and relatively small insignificant populations in this river catchment, they are not mentioned further.

Australasian harriers are a very common bird throughout Hawke's Bay, including this river catchment. They occupy most habitats from forest (both indigenous and exotic), shrubland, to grazed pasture, rough pasture, wetlands, lakes and ponds. They have adapted well and benefitted from the highly modified landscape throughout New Zealand, and the introduction of mammalian prey. Although for not quite the same reasons, pukeko also appear to have increased markedly recently, and have adapted very well to live in the modified landscape.

A recent arrival, the masked lapwing (spur-winged plover) has since its arrival in New Zealand in the 1930s[49] expanded to occupy almost every part of New Zealand. They have especially found favour with the modified grassland habitats of Hawke's Bay, and are common throughout these and on the riverbeds and coastal beaches and estuaries. Their arrival in Hawke's Bay in probably the early 1970s was indicated with the first birds being detected on our riverbeds during the 1984 surveys and since then the population has rapidly expanded, although not to the detriment of any other species it would seem. They appear to occupy a niche that was yet to be taken within New Zealand's modified environment.

Morepork are a relatively common species found throughout Hawke's Bay and within the catchment, from the indigenous native forests in the Ruahine Ranges, right through the lowland areas wherever there are small patches of remnant native forest, shelterbelts, exotic forests, and shrubland. Their nocturnal call is a familiar one throughout most parts of rural Hawke's Bay, and really the only places this species is not found is in intensively grazed land with few trees, and the larger urban areas.

The Eastern rosella established itself in the wild in New Zealand in the early 1900s after being kept as cage birds. They have since spread slowly through the North Island, with the first Hawke's Bay records being in the late 1980s. They seem to have had a very restricted range in Hawke's Bay until recently, with expansion towards the coast, having been found near Porangahau in November 2010 (*pers obs*). During the course of this work they were found at a number of sites throughout the catchment, mostly within Catchment Units B and C (e.g. Makaretu River, Mangatewai River area). The spread of this species throughout Hawke's Bay is inevitable, but should be monitored as the species may become a pest in agricultural and orchard areas.

3.1.3 Herpetofauna

The desktop analysis of the lizard species likely to be present or historically present within the Tukituki Catchment may be split into three groups:

[47] Heather and Robertson, 2000.
[48] Heather and Robertson, 2000.
[49] Heather and Robertson, 2000.

- Those that are known to be present from records within the DOC BioWeb *Herpetofauna* database.
- Species known from in or around the Hawke's Bay Region, and likely to be still present within the catchment, or may potentially be present.
- Species recorded in the subfossil records for Hawke's Bay that are likely locally extinct, but in extremely rare situations, may yet still persist.

The DOC BioWeb *Herpetofauna* database was accessed in November 2010 for sightings of lizards within the Tukituki Catchment area. The New Zealand Lizards Database[50] was also accessed in December 2010 to identify lizard species seen in or close to the Hawke's Bay Region. This was done to inform which species are possibly present in the Tukituki Catchment, and to identify areas where they would likely inhabit based on their known habitat requirements.

Recent advances in New Zealand lizard taxonomy have prompted changes in the genus grouping of both geckos[51] and skinks[52]. Therefore, we use the most up-to-date names in this report, but provide the old names in the footnotes for reference. Where a species name does not currently exist, the tag name is given in quotation marks. Threat classifications follow the latest update[53].

Here, we provide basic information on the species potentially present in the Tukituki Catchment, along with conservation risk assessments and positive factors for each of the species. The information for the species descriptions below is provided from Jewell[54] (2008) and the New Zealand Lizards Database[55].

3.1.3.1 Lizard species recorded in the Tukituki Catchment

All of these species have been previously recorded at locations in the Tukituki Catchment. Records are from the DOC BioWeb *Herpetofauna* database[56] or from field observations.

Common skink *O. polychroma*[57]: As the name suggests, this is a very abundant and widespread species in New Zealand, ranging throughout the North Island south of Gisborne and south Taranaki, and all of the South and Stewart Islands. This is a small (SVL 60-79 mm) brown skink, with two morphs existing in the Hawke's Bay area: a lighter brown striped morph with prominent dorsal and lateral stripes and a dark morph with a fainter or no dorsal stripe. Common skinks are terrestrial habitat generalists that inhabit sand dunes, grasslands, herbfields, wetlands, rocky areas, beaches and scrub. They are day-active avid sun baskers. The threat classification for this species is 'Not Threatened'.

Intrinsic Vulnerability
- None.

Risk Factors
- The species is currently undergoing taxonomic revision, which may lead to the recognition of up to five species. The species in the Hawke's Bay area falls under the 'Clade 1' subgroup.

Positive Factors
- Abundant to highly abundant in many parts of New Zealand.
- Large areas of suitable habitat remain, including rank exotic grasslands.
- Not of conservation concern.

[50] http://nzlizards.landcareresearch.co.nz
[51] Nielsen *et al*, 2011.
[52] Chapple *et al,* 2009.
[53] Hitchmough *et al*, 2010.
[54] Jewell, 2008.
[55] Bell, (ed) 2011.
[56] Accessed in November 2010.
[57] Formerly *O. nigriplantare polychroma.*

Wellington green gecko *Naultinus punctatus:* This species has recently been elevated to full species status from *Naultinus elegans punctatus*[58]. It inhabits the lower North Island south of a line spanning from Wanganui to East Cape, and three offshore islands close to Wellington. It is a medium-sized bright green gecko, with a snout-vent length (SVL) of 75-95 mm. An arboreal inhabitant of forest and scrub, including manuka and kanuka shrubland, Wellington green geckos are day-active and can be encountered sun-basking amongst foliage. Populations of this species can be considered regionally significant. The threat classification for this species is 'Declining'.

Intrinsic Vulnerability

- Slow growth, late to maturity (4 years), low annual reproductive output.

Risk Factors

- Locality records are sparse nationwide, especially in the Hawke's Bay Region. Their distribution has become fragmented through loss of lowland forest habitat, and regional populations may be at risk of localized extinction, especially those in the Hawke's Bay Region, because of extensive ecological degradation in the area.
- Assessed as undergoing population decline nationally.

Positive Factors

- Still widely distributed.
- Large areas of habitat remain in the Rimutaka, Tararua and Ruahine Ranges.
- Present at some sites with legal protection, and conservation management, including the ranges listed above.
- Able to occupy seral habitat (regenerating manuka and kanuka shrubland).
- Translocated to Mana and Matiu/Somes Islands in the Wellington region, although the status of these populations remains unknown. A natural population also exists on the mammal-pest free Kapiti Island.

Southern North Island forest gecko *Mokopirirakau* aff. *granulatus* "Southern North Island"[59]: The forest gecko species most likely to be present in the Tukituki Catchment is the southern North Island forest gecko (*M.* "southern North Island"), as this species is present at Boundary Stream Mainland Island, which is about 60 km north-west of Napier[60]. This gecko occurs in the south-eastern area of the North Island to the Manawatu-Wanganui and Hawke's Bay Regions, with the northern limit of its range to be determined. A medium-sized (SVL ~75-85 mm) mottled grey-brown gecko sometimes with yellow patches, it is very similar to the forest gecko *M. granulatus* in appearance and life history. It is an arboreal nocturnal or diurno-nocturnal inhabitant of forest and shrubland which usually occurs on larger branches and trunks of trees, but can be found nearer to the ground in shrubs and ferns, or in creviced clay banks. The threat classification of this species is 'Not Threatened'. Populations of this species can be considered significant for the catchment, and information about its distribution in Hawke's Bay would nationally helpful for determining the northernmost boundary of this species, which is currently unclear.

Intrinsic Vulnerability

- Not known, but likely long life expectancy, slow growth, late to maturity, and low annual reproductive output.

Risk Factors

- Sparse locality records nationwide, and in the Hawke's Bay Region.
- Fragmented range through loss of lowland forest habitats.
- Although it is classified as 'Not Threatened', regional populations may be at risk of localized extinction, especially in the Hawke's Bay Region, because of extensive ecological degradation.

[58] Nielsen *et al*, 2011.
[59] Formerly *Hoplodactylus granulatus* (now forest gecko) or *H*. "Southern North Island" (now southern North Island forest gecko).
[60] Bell and Herbert, 2010.

Positive Factors

- Widely distributed, very large areas of habitat remain.
- Some of this habitat is on protected land, particularly along the Rimutaka, Tararua and Ruahine Ranges.
- Able to occupy seral habitats such as regenerating manuka and kanuka shrubland.
- Present on some predator-free offshore islands (e.g. Maud and Kapiti Islands, and translocated to Matiu/Somes Island) and in some mainland islands (e.g. Boundary Stream Mainland Island and Zealandia / Karori Wildlife Sanctuary).

Common gecko *Woodworthia maculatus*[61]: This species once consisted of several closely related species, and taxonomic resolution is near completion[62]. Currently only North Island common geckos (which occur on the Aupouri Peninsula and south of a line between Whakatane to Wanganui, and offshore islands) and those in the Nelson-Marlborough area are considered to be *W. maculatus.* Common geckos are small (SVL 55-82 mm) to medium-sized brown, grey or olive geckos. Their dorsal patterning is highly variable, with pale transverse bands, blotches, spots or stripes. These animals are generalist in their habitat requirements, being terrestrial and arboreal occupants of forests, scrub, vineland, creviced cliffs, the littoral zones of boulder beaches and vegetated rock tumbles from the coast to ~700m a.s.l. They can also persist in urban areas and production landscapes, providing enough refugia are available (e.g. rocks, logs or vegetation). They are nocturnal, but sometimes sun bask. The threat classification of this species is 'Not Threatened (partial decline)'. Populations of this species can be considered locally significant for the catchment.

Intrinsic Vulnerability

- Not known, but likely long life expectancy, slow growth, late to maturity, and low annual reproductive output.
- Predominantly nocturnal, hence active at similar foraging times as mammalian predators.

Risk Factors

- Many populations are highly localized, and restricted to particular habitat types that offer unusually good protection from introduced mammalian predators, such as scree slopes.
- These populations are usually very isolated from other populations and may be at risk of localized extinction.

Positive Factors

- Still relatively widespread.
- Can be locally abundant in some sites.
- Populations exist in abundance on some mammal predator-free offshore islands (e.g. Mana Island, Stephens Island / Takapourewa). Species present in some mainland islands (e.g. Zealandia, Boundary Stream Mainland Island).

Spotted skink *Oligosoma lineoocellatum*: This species is found in the lower tip of the North Island, islands in the Cook Strait, Nelson and along the east coast of the South Island from Marlborough to Banks Peninsula, however this may represent a species complex. One isolated population has been found near Napier. It is a large (SVL 80-90 mm) dark skink regularly dotted with pale flecks ringed in black. Spotted skinks inhabit coastal to alpine areas including tussockland, rock piles and well-vegetated boulder and cobble beaches. It is a terrestrial and diurnal skink and an avid sun-basker. The threat classification for this species is 'Relict (conservation dependent, partial decline)'. Confirmation of a population in the Tukituki Catchment would be nationally significant. This is because only one population is currently known from Hawke's Bay along the Napier-Haumoana shoreline, but these records date back to 1966-1972, and these populations may now be extinct.

[61] Formerly *Hoplodactylus maculatus*
[62] Nielsen *et al*, 2011.

Intrinsic Vulnerability

- Large body size increases risk of predation[63]. This species also likely exhibits slow growth, late to maturity and long longevity.

Risk Factors

- Populations isolated and localized[64], and at risk of localized extinction.
- Known from only four records along the Napier-Haumoana shoreline (records dated 1966-1972), hence Hawke's Bay populations may now be extinct.
- At risk from shoreline development and habitat degradation in Hawke's Bay, if still present. This includes the loss of driftwood habitats, leading to a reduction in habitat complexity and foraging areas.
- This species may be undergoing taxonomic revision, and may be further split up. The Napier populations appear to be within Clade 1a, which are also represented at Turakirae Head, Baring Head, Matiu/Somes Island and Ward Island in the Greater Wellington Region. However, recent surveys have found these mainland populations have very low abundance.

Positive Factors

- Widespread, occupying a wide range of habitats[65].
- *O. lineocellatum sensu latero* are present on many islands in the Marlborough Sounds[66], and at some sites, densities are very high, e.g. Stephens Island / Takapourewa[67], Upper Buller River[68]. However, this is not necessarily the case for Clade 1a populations, which may be taxonomically significant, and are highly sparse in distribution.
- Boulder bank and scree habitat in some locations where spotted skinks occur offer a degree of protection from introduced predators (likely to be refugial habitat[69]). This habitat may infer that the cobble beaches of the Napier-Haumoana coastline can provide important refugia.

3.1.3.2 Other lizard species likely or potentially occurring in the Tukituki Catchment

Likely species are those species not yet been positively identified as occurring in the Tukituki Catchment, but are known from other localities in the Hawke's Bay Region. Therefore they are considered highly likely to occur within the catchment. Potentially occurring species are those species that are widespread throughout the North Island, but are not well known in the Hawke's Bay Region, or Hawke's Bay represents the edge of their known range. Therefore it is possible, but unlikely, that they could be present within the Tukituki Catchment.

Southern North Island speckled skink *O.* aff*. infrapunctatum* 'Southern North Island' – Likely present: A population of speckled skinks is found at Cape Kidnappers, which is about 10 km south-east-east of the Tukituki River Mouth. Genetic analysis of this population has recently identified it as the southern North Island speckled skink. Apart from the Cape Kidnapers population, several small populations of southern North Island speckled skinks exist around the Wanganui coast, Rangitikei and above Taupo. Wairarapa populations may also be of this species. However, *O. infrapunctatum sensu latero* is widespread, being found throughout the North Island south of Tauranga, on offshore islands in the Cook Strait and the Marlborough, Nelson and Westland areas of the South Island. Speckled skinks are large (SVL: 70-106 mm), mid to dark brown skinks, often with a prominent lighter and darker flecking on the dorsal surface. They typically have a highly notched, broad darker brown stripe running longitudinally down their flanks. They are day-active and avid, but somewhat cryptic sun-baskers. Speckled skinks have been recorded in open forest, shrubland, tussock grassland, rough pasture with debris, rock piles and well-vegetated boulder or cobble beaches, and observations of southern North Island speckled skinks suggests that they use similar habitats. Because this species

[63] Whitaker 1978; Whitaker and Gaze 1999.
[64] Whitaker and Gaze, 1999.
[65] Whitaker and Gaze, 1999.
[66] Whitaker and Gaze 1999
[67] East *et al,* 1995.
[68] Whitaker and Gaze, 1999.
[69] Whitaker and Gaze, 1999.

are not particularly well-known from the Hawke's Bay area except for those at Cape Kidnappers, discovery of a population within the Tukituki would be of national significance.

Intrinsic Vulnerability
- Not known.

Risk Factors
- Extremely localized across the North Island (besides the Cape Kidnappers population, there are three known populations at locations between Patea and Wanganui, and two other locations in inland North Island).
- Little is known about this species, and the conservation status is 'Nationally Vulnerable (data poor, sparse)'.

Positive Factors
- One population in the Hawke's Bay Region is protected via a pest-proof fenced site at Cape Kidnappers. Elsewhere in the North Island, such protection is not available.

Pacific gecko *Dactylocnemus pacificus*[70] - Potentially present, but unlikely: This medium-sized gecko (SVL 70-80mm) is found in the North Island and outlying islands from Whangarei and the Hen and Chickens Islands to the Hutt Valley, but this species is sparsely known between East Cape and Wellington. There is one record of this species in the Hawke's Bay, from Portland Island off Mahia Peninsula seen in 1984[71]. Easily confused with the *Woodworthia* geckos, it is brown, grey or olive with paler bands, blotches, chevrons or stripes that may be drab or bright. It is a nocturnal, semi-arboreal gecko that inhabits forest, scrub, shrubland, flax, and creviced clay banks, rock outcrops and bluffs. It can also be found along coastlines among driftwood, rocks and scrub. The threat classification for this species is 'Relict (conservation dependent, partial decline)', but likely to be undergoing severe decline on the mainland. Not yet recorded in Tukituki Catchment, but single record from Portland Island off Mahia Peninsula (in 1984) suggests this species may be in the Hawke's Bay Region. A population within the Tukituki Catchment would be nationally significant, owing to the poorly known distribution through the central and southern North Island.

Intrinsic Vulnerability:
- Strictly nocturnal, hence active at similar foraging times as mammalian predators.
- Slow growth, late to maturity, and low annual reproductive output (>2 young/female/year).

Risk Factors:
- Highly fragmented mainland distribution[72] . Nielsen[73] noted that has a bizarre disjunct geographical range, with populations in the upper eastern North Island area, but with other populations in southern, and western North Island.
- This species appear to be undergoing severe decline on the mainland, and is vulnerable to continued attrition via local extinctions[74].

Positive Factors
- Widespread (although highly patchy) distribution across the New Zealand mainland[75].
- Highly abundant on offshore islands free of introduced mammalian predator species[76].

Small-scaled skink *O. microlepis* – Potentially present: This species is confined to the central North Island, with most populations occurring around the Kaimanawa Ranges, Kaweka Ranges and Waiouru areas. Scattered populations also occur from the southern Te Urewera district to the northern Ruahine Range. It is a small (SVL up to 67mm) grey to grey-brown skink with a complete or broken

[70] Formerly *H. pacificus.*
[71] Martin, 2010.
[72] Hitchmough, 1997.
[73] Nielsen, 2008.
[74] Hitchmough, 1997.
[75] Hitchmough, 1997.
[76] Hitchmough, 1997.

dark brown dorsal stripe and regular grey patches, giving it a blotchy appearance. This skink is diurnal, and an avid sun-basker. It is a terrestrial inhabitant of boulder river beds, rock piles and grassy areas with loose rocks for cover. The threat classification for this species is 'Declining (sparse)'. Given the restricted range of this species and its sparse distribution in Hawke's Bay, finding a population in the Tukituki Catchment would be of national significance.

Intrinsic Vulnerability

- Not known.

Risk Factors

- Population fragmentation, habitat modification and mammalian predation[77]. All known populations of small-scaled skinks are small and isolated, and the habitats used are patchily distributed. The widespread modification of the upper Rangitikei River Catchment and the Rangitaiki Plains through agricultural development probably increases the risk to populations in those regions. Populations in the Kaimanawa Range are at less risk of habitat modification but are still exposed to introduced predators.

Positive Factors

- The current status of the small-scaled skink population on Motutaiko Island is unknown because of difficulties over access to the island but the skinks there are presumably benefiting from the absence of introduced predators[78].

Ornate skink *O. ornatum* – Potentially present, but unlikely: This large skink (SVL 65-83mm) is widespread, but has a fragmented distribution, throughout the North Island and on many outlying islands. It is not known from Hawke's Bay. It is a brown or grey-brown skink, often with numerous small paler blotches that are commonly edged with black. The sides are grey-brown, brown or reddish brown with darker or lighter flecking or marbling. There is a distinctive black-edged pale teardrop marking beneath the eye. This species is a terrestrial skink that inhabits damper areas (under leaf litter, rocks or logs, or in dense vegetation) in forest, scrub or heavily vegetated coastlines. It is active at any time but is mostly crepuscular (dawn and dusk-active). The threat classification for this species is 'Declining (conservation dependent, partial decline)'. Given that this species is not known from Hawke's Bay, a population in the Tukituki Catchment would be nationally significant.

Intrinsic Vulnerability

- Large body size increases vulnerability to predation.
- This species also likely exhibits slow growth, late to maturity and long longevity.

Risk Factors

- Rare in sites not managed for mammalian pests. Lizard monitoring in biodiversity sanctuaries to date have indicated that this species is only detectable within managed areas, and not in reference areas, suggesting extremely low abundance in unmanaged areas[79].
- This species may be undergoing taxonomic revision in the near future, which may lead to recognition of at least three new species within this complex.

Positive Factors

- Widespread across the North Island.

Copper skink *O. aeneum* – Potentially present, but unlikely: Copper skinks are a common and widespread species in the North Island and outlying islands, but its distribution is somewhat fragmented, and there are few reports from the central and eastern North Island between Lake Taupo and Wairarapa. It is not currently known from Hawke's Bay. It is New Zealand's smallest native skink (SVL 55-67 mm), and is copper to brown in colour, sometimes with darker or lighter flecks. There are distinct denticulate (tooth-like) alternate black and pale markings around the mouth. They are

[77] Hitchmough, 2002.
[78] Hitchmough, 2002.
[79] Bell and Herbert, unpub. Data.

crepuscular, and are cryptic and seldom come out into the open. Copper skinks live in forest, shrubland, coastlines and rough grassland with adequate groundcover such as logs, rocks, leaf litter or long grasses or dense herbage. Can also live in built-up areas in compost heaps, gardens etc. The threat classification of this species is 'Not Threatened (partial decline)'. Given that this species is not known from Hawke's Bay, a population in the Tukituki Catchment would be locally significant.

Intrinsic Vulnerability
- Not known.

Risk Factors
- Not known.

Positive Factors
- Local abundance and widespread distribution indicates that *O. aeneum* are not under threat.

Rainbow skink [introduced] *Lampropholis delicata* – Potentially present, but unlikely: This species is an exotic skink introduced from eastern Australia. While it has not yet established in Hawke's Bay, it inhabits the North Island northwards from Waikato, Bay of Plenty and the Coromandel Peninsula[80] and has been spreading rapidly in the North Island, it is possible that this species has reached Hawke's Bay. This is a tiny skink, with a SVL of 40-55 mm. It is brown to grey-brown sometimes with faint darker speckling or a dorsal stripe, and wide darker brown stripes down the flanks. It lays eggs which are 8-10mm long, white and leathery. This skink tends to prefer open areas such as rough grasslands gardens and wastelands, usually associated with human development. It is often found among leaf litter and low dense vegetation, often in high abundances. Its threat classification is 'Introduced and Naturalised (secure overseas)'.

3.1.3.3 Subfossil lizard records from Hawke's Bay

The following five species (except for Whitaker's skink) have been found in the subfossil record within the Hawke's Bay area[81], and are now presumed locally extinct. However it is always an unlikely possibility that populations may still exist, especially if they have been virtually undetectable at very low densities thus far. Discovery of any of these species in Hawke's Bay would be of national significance.

Duvaucel's gecko *H. duvaucelii:* This species is known mostly from offshore islands in the Cook Strait, and off the north-eastern coast of the North Island. However, a single specimen has recently been discovered at Maungatautari Ecological Island in Waikato, although its origins remain unclear. This is New Zealand's largest living gecko, with an SVL of 100-161 mm (Northern form) or 95-120 mm (Southern form). It is robust-bodied and grey, olive-grey or dark brown with bands, rows of blotches or sometimes even rough-edged stripes. The Northern form typically has drab markings, whereas the Southern form has bolder markings, with a thick white band across the nape of the neck. This gecko is a nocturnal habitat generalist, using both arboreal and terrestrial habitats. They take refuge in hollows and crevices under stones or in bluffs or rock outcrops, under driftwood, sometimes empty petrel burrows in forest, scrub, coastal vegetation (flax or reeds) and cliffs. The threat classification for this species is 'Relict (conservation dependent)'.

Marbled skink *O. oliveri*[82]*:* It is uncertain whether the subfossil specimens found in Hawke's Bay are from *O. oliveri* or *O. townsi*[83]*.* This species may consist of two species, tagged by Jewell[84] as the marbled skink *O. pachysomaticum*, which is restricted to the Poor Knights Islands, and Oliver's skink *O. oliveri*, which is found on the Aldermen and Mercury Islands. This is a medium to large and robust skink species (84 mm SVL in the Mercury and Aldermen Islands, and 114 mm SVL in the Poor

[80] Gill and Whitaker, 1996.
[81] Worthy, 1987.
[82] Formerly *Cyclodina oliveri.*
[83] Towns, 1999.
[84] Jewell, 2008.

Knights). It is brown or olive-brown, usually with light or dark flecks, but sometimes uniform in colouration. A teardrop marking is present beneath the eye, sometimes as part of denticulate markings along the lips. It is a terrestrial and nocturnal inhabitant of forest and scrub. Both the Poor Knights and Alderman and Mercury Islands populations are considered to be *O. oliveri* by Hitchmough *et al*.[85], who consider the conservation status of this species to be **'**Relict (conservation dependent, range restricted)'.

Towns skink *O. townsi*: It is uncertain whether the subfossil specimens found in Hawke's Bay are from *O. oliveri* or *O. townsi*[86]. Town's skinks are restricted to the Mokohinau Islands, Hen and Chickens group, Little Barrier and Great Barrier Islands. Translocations have been undertaken to three additional islands. It is a medium-sized (SVL 87-95 mm) skink, which is light brown, tan or dark brown with irregular flecks. There is a white, black edged tear-drop marking under each eye. They are nocturnal and terrestrial inhabitants of forest and scrub. The threat classification for this species is 'Recovering (conservation dependent, range restricted)'.

Robust skink *O. alani*[87]: This species is currently restricted to islands off the coast between Bay of Plenty and the Aupouri Peninsula, but subfossil records suggest it once occurred throughout the North Island[88]. Unlikely to be confused with any other species, robust skinks are very large (SVL up to 142 mm) and thick-set skinks. They are predominantly mid to dark brown or pinkish-brown with large indistinct pale cream to yellow-brown blotches. The sides are a light grey to grey-brown also with blotches. Usually has a pale yellow, black edged tear-drop marking below each eye. They are nocturnal, terrestrial inhabitants of low coastal forest to scrub, although forest is suspected to be the optimal habitat prior to range restriction. The threat classification for this species is 'Recovering (conservation dependent, range restricted)'.

Whitaker's skink *O. whitakeri*[89]: This species is currently restricted to the Mercury Islands and Pukerua Bay, north of Wellington. Subfossils have been found in Northland and Waitomo and it is likely that this species was once found throughout the North Island. This is a medium-sized skink with an SVL of 80-101 mm. The back is yellow-brown to dark brown with indistinct to prominent darker and lighter flecks. The sides are yellow, cream or brown, often heavily mottled with black (particularly around the neck and shoulders) through to black with lighter spots. It inhabits leaf litter on the forest floor and crevices between rocks underneath coastal scrub. Whitaker's skinks are most active for a few hours after dusk, but can be active during other periods in the night and day. The threat classification for this species is 'Nationally Endangered (conservation dependent, range restricted)'.

3.1.3.4 Analysis of available lizard habitat

In order to assess the quality of each catchment unit for each lizard species known to be present, likely present, or potentially present in the Tukituki Catchment, we quantified the amount of habitat (in hectares) in each Catchment Unit that is potentially suitable. To achieve this, we carried out a further analysis of the LCDB2 land cover classifications identified in each catchment unit. Each classification was ranked as 'optimal', 'marginal', 'poor' and 'unsuitable' for potential occupancy by each of the lizard species, in accordance with assessment of the information available on habitat requirements of each species.

- *Optimal* was defined as suitable unmodified habitat with species presence expected;
- *Marginal* as suitable modified habitat with species presence expected;
- *Poor* as modified and low-quality habitat with species absence expected, and;
- *Unsuitable* as those habitats clearly uninhabitable (such as rivers and ponds, or alpine or subalpine areas for lowland species) where the species is expected to be absent.

[85] Hitchmough *et al*. 2010.
[86] Towns, 1999.
[87] Formerly *C. alani*
[88] Worthy, 1987.
[89] Formerly *C. whitakeri*

The classifications for each species are presented in Appendix D. The area inhabitable by each species was considered to be the sum of the optimal and marginal habitats available (Table 1-2), given that poor-quality habitats were considered unlikely to support a species in any great abundance.

Analysis predictions. Species able to persist in modified open habitats, that is common geckos and common, copper, small-scaled, speckled, and spotted skinks, could be widespread throughout the Tukituki Catchment if suitable microhabitats are available (such as protective ground cover, rock piles and rock faces), given that large areas of total habitat are available across all catchment units (Table 3-10). However, for these species, Units A-C provide the largest areas of optimal habitat (2,635 to 24,912 ha in Units A-C versus 299 to 887 ha in Units D-F, Table 3-10). Species requiring forested or scrub habitats (green, forest, and Pacific geckos and ornate skinks) are likely to be more restricted to catchment Units A, B and C, owing to the drastic reduction in optimal scrub or forested habitats in the more developed catchment Units (5,621 to 24,912 ha in Units A-C versus 299 to 736 ha in Units D-F, Table 3-10).

The distribution of species that can live in both closed and open-canopy habitats, common geckos and copper skinks, is likely to be decoupled from forested habitats. It is expected that all native lizard species are the most widespread and abundant in Catchment Units A, B and C, given the large areas of optimal habitat. In contrast in Catchment Units D, E and F, it is expected that lizard, particularly forest or scrub-dwelling lizards, will have more fragmented distributions and/or tend to occupy marginal habitat patches, or small fragments of optimal habitat.

Catchment Units C, D, E and F have the most available habitat for colonization by rainbow skinks as these all support large areas of modified open habitat types that are preferable for their establishment. However Unit D, followed by F and C are probably the those most at risk of rainbow skink establishment, given rainbow skinks tend to be moved about by people, and these catchment units are the most densely settled.

From a biodiversity point of view, Catchment Unit C is likely to host the most lizard diversity owing to the mix of forested and open habitats, providing consistently large amounts of total available habitat for all native species (10,674 to 86,163 ha). Catchment Unit F also provides habitat to all native species, in smaller areas, but with a fairly consistent area in total available habitat across all native species (Table 3-10). Catchment Units A and B appear to be more biased towards occupancy of forest-dwelling lizards, and Units D and E more biased towards open-habitat lizards.

Issues with habitat-only analysis. It must be noted that the land cover classes are broad-scale and do not account for smaller-scale or non-habitat determinants of lizard habitat suitability, such as refugia created by smaller creviced rock outcrops, rock faces or boulder fields, or predator, parasite and prey densities, therefore they can only be taken as an indication of the area available for potential inhabitation by a species.

Small-scaled skinks. Although small-scaled skinks are not currently known within the Tukituki Catchment, we included this species in the analyses because they have been detected in catchments to the west and north of the Tukituki, particularly the Ngaruroro. The possible distribution of small-scaled skinks within the Tukituki Catchment is further limited by its dependence on areas of bare rock (rock piles, cliffs or outcrops), therefore this species is very unlikely to be present. The amount of non-coastal bare rock available is likely to be a better predictor of their potential range. Catchment Units A (575 ha), C (433 ha), D (697 ha) and F (573 ha) have the largest areas of bare rock (versus 197 ha in Unit B and 21 ha in Unit E), with the most rock in Units C, D, and F being river and lakeshore gravel. Therefore, we consider small-scaled skinks to have the highest chance of occurring in Catchment Units A and western parts of C.

Speckled, ornate and spotted skinks. The larger-bodied speckled, spotted and ornate skinks are likely to have their ranges restricted in the total areas of available habitat due to their increased susceptibility to predation. Therefore, we would expect them to be more likely to be found in areas with good refugia from predators available, such as rock crevices, dense ground-covering vegetation or cobble beaches.

Table 3-9: Eight broad habitat types in the Tukituki Catchment capable of supporting native lizard species.

Habitat stratification*	Catchment units (%cover)	Lizards possibly present**										Sites nominated	Survey***
		Np	Wm	Mfg	Dp	Op	Ol	Oss	Om*	Oo	Oa		
(G) non-riparian gravel and rock	**A (3.17%), B (0.70%), C (0.03%), E (0.01%)**											Ruahine Forest Park, Kashmir Road access	See T
(B) coastal gravel beach	**F (0.02%)**						x					Haumoana / East Clive Beach	90 O
(P) production landscapes	**A (4.24%), B (56.24%), C (77.26%), D (91.24%), E (95.22%), F (86.09%)**											**Te Mata Peak (rock outcrops in grazed pasture)** **Smedley station (also K & F)** **Farmland, Silver Range (also K)**	**30 O** **See K** 40 F & 40 O
(R) willow riparian zone protection planting / riverbank	**A (0.24%), B (0.72%), C (1.48%), D (3.74%), E (0.83%), F (2.47%)**											Several sites along the river corridor	None
(T) montane tall tussock grassland.	**A (6.35%), B (1.01%), C (0.07%)**											Ruahine Forest Park, Kashmir Road access	30 O
(S) native shrubland	**A (1.89%), B (12.32%)[#], C (2.02%), D (0.11%), E (0.19%), F (0.28%)**											**Silver Range (RAP 8 Eastern ED)** **Moorcock river terrace (also F)**	**30 O** **None**
(K) kanuka/manuka scrub/forest	**A (4.63%), B (2.52%), C (1.94%), D (0.03%), E (0.52%), F (0.22%)**	x	x									Eastern edge Motuotaraia (RAP 18 Eastern ED) Kahuranaki Road Bush (RAP 5 Eastern ED) Smedley station (also P & F) Farmland, Silver Range (also P)	None None 90 O, 6.25ph Sp See P
(F) lowland podocarp-broadleaf forest	**A (75.80%), B (23.43%), C (7.66%), D (0.37%), E (0.32%), F (0.67%)**		x	?	?							Inglis Bush SR Moorcock river terrace (also S) Smedley station (also P & F)	40 F None None

*S = Includes broadleaved indigenous hardwoods, subalpine shrubland and grey scrub, P = Low producing grassland, high producing exotic grassland, shelterbelts, orchards and perennial crops and vineyards, R = Willows and poplars, river and lake shore gravel and rock, G = alpine gravel and rock, and landslide. **Lizard species abbreviations: *Naultinus punctatus* – Np; *Woodworthia maculatus* – Wm; *Mokopirirakau* "Southern North Island forest gecko" – Mfg; *Dactylocnemis pacificus* – Dp; *Oligosoma polychroma* – Op; *O. lineoocellatum* – Ol; *O.* "Southern North Island speckled skink" – Oss; *O. microlepis* – Om*; ornate skink *O. ornata* – Oo; copper skink *O. aeneum* – Oa. x indicates species recorded previously (DOC BioWeb *Herpetofauna* database), a ? indicates unknown gecko sp. detected. **Oligosoma microlepis* is not known within the Tukituki Catchment but occurs in the Ngaruroro Catchment. ***Survey methods: O = Onduline ACOs, F = closed cell foam covers, Sp = spotlight search, ph = person hours.** Dark grey shading indicates optimal habitat, light grey shading indicates marginal habitat.

Table 3-10: Land use cover in hectares in each unit of the Tukituki Catchment suitable for the possible lizard species present.

Catchment unit	Np	Wm	Mfg	Dp	Op	Ol	Oss	Om	Oo	Oa	Ld
Optimal habitat											
A	24,573	24,912	24,573	24,573	3,680	3,680	2,855	3,680	24,573	24,573	2,482
B	5,621	5,632	5,621	5,621	2,635	2,635	2,535	2,635	5,621	5,621	13,162
C	9,931	9,931	9,931	9,931	4,350	4,350	4,329	4,350	9,931	9,931	75,303
D*	299	299	299	299	845	845	845	845	299	299	82,451
E*	612	615	617	612	505	505	505	505	612	617	69,861
F*	720	736	720	736	887	887	887	872	720	736	54,676
Total available habitat											
A	24,573	27,057	24,913	24,575	4,361	4,361	3,536	4,361	24,575	25,631	3,536
B	5,936	19,057	5,906	5,895	15,744	15,744	15,645	15,733	5,884	18,914	15,645
C	16,190	86,163	10,859	10,884	80,060	80,060	80,038	79,850	10,674	86,053	80,038
D*	3,041	85,063	2,823	3,583	84,748	84,748	84,748	83,477	2,339	85,001	84,748
E*	1,892	71,090	1,231	1,229	70,962	70,962	70,962	70,701	968	71,090	70,962
F*	5,394	59,306	4,637	5,183	56,570	56,570	56,570	55,312	4,264	59,306	56,570

Lizard species abbreviations: Wellington green geckos *N. punctatus* – Np; common gecko *W. maculatus* – Wm; Pacific gecko *D. pacificus* – Hp; forest gecko *M.* "Southern North Island forest gecko" – Mfg; common skink *O. polychroma* – Op; small-scaled skink *O. microlepis* – Om; speckled skink *O.* 'Southern North Island speckled skink' – Oss; spotted skink *O. lineoocellatum* – Ol; ornate skink *O. ornata* – Oo; copper skink *O. aeneum* – Oa; rainbow skink *L. delicata* – Ld.

* *O. microlepis* is unlikely to inhabit these catchment units due to its more northern and western distribution, e.g. the Ngaruroro Catchment.

Note: Table shading indicates habitat suitability, with darkest shading being most optimal grading to lighter shading indicating less optimal.

3.1.4 Bat fauna

Surveys carried out by the Ongaonga field centre of the Department of Conservation between 1999 and 2003 detected bats at varying abundances at indigenous forest sites within Catchment Units C, D and F. While species data is not available from these surveys, if known distributions are relied upon, bats detected in those areas would be Long-tailed bat 'North Island' (*Chalinolobus tuberculatus*). This species has been recorded widely throughout the North Island. The species is considered to be 'Nationally Vulnerable' as, while large, the population has a high ongoing or predicted decline[90].

The data below illustrates the ability of this species to persist in highly modified landscapes, an example being Catchment Unit F. This agrees with observations of long-tailed bat presence in other regions, where they have been reported from a range of modified habitats such as exotic pine forest, farm shelterbelts, farm buildings and even the outskirts of some cities[91].

Bat survey data collected from indigenous forest remnants within the Tukituki Catchment is presented below.

Table 3-11: Results of DoC walking transect bat surveys carried out using a Bat Box III bat detector.

Surveys conducted between 1999 and 2003.

Reserve / Area	Catchment Unit	No. transects	% transects encounter bats	Total time (minutes)	Total bat passes	Total bats seen	Max. bats seen at once
Inglis Bush	C	9	66	190	47	15	3
A'Deanes Bush	C	7	57	137	17	3	2
Puahanui Bush	C	8	62.5	156	10	3	2
Springhill S.R	C	4	0	65	0	0	0
Lyndsay Bush	D	8	75	173	43	5	3
Pattersons Bush	C	6	0	103	0	0	0
Moncktons Bush	C	6	100	120	70+	23	7
Elsthorpe S.R	F	6	17	129	3	1	1
Mangatewai S.R	C	6	66	145	15	5	1

3.1.5 Terrestrial invertebrate fauna

Terrestrial invertebrate communities were sampled using ground pitfall traps and UV light trapping, to target ground active invertebrates and moths, respectively.

Habitat types sampled were *Pinus radiata* plantation forest, podocarp-broadleaved forest and indigenous tall tussock grassland. Exotic pasture grassland and riparian indigenous restoration planting sites were sampled simultaneously, using the same methods, only in the adjacent Karamu Catchment.

In general, invertebrates could be used to distinguish the different types of habitats. In the combined analysis, three major habitats groupings were evident. First, tussock is clearly separated from other habitats. Pasture and riparian habitats (both at Karamu) are grouped together, and these are separated from the third group of "forest sites". In the forest grouping, Tukituki forest ('Inglis Bush') and pine is more similar to each other than forest at Karamu ('Mahana').

[90] O'Donnell *et al*, 2009.
[91] Daniel and Williams, 1984.

Light trapping of Lepidoptera revealed tussock sites had very high diversity and richness, several significant moth species (uncommon endemics) were found[92].

There was a detectable difference in community structure between the native riparian enhancement planting and pasture. However, riparian sites had not progressed to the stage of being comparable to forest habitats. This was best demonstrated when the two studies were combined and a larger number of samples examined. Pasture and riparian sites were still grouped together, indicating they were most similar.

The forested sites at Karamu (Mahana) and Tukituki (Inglis Bush) were different. Differences in the invertebrate fauna point to Tukituki having a greater leaf litter component as millipedes and *Saphobius* are decomposers and very common in leaf litter. This fits with the fact that 'Mahana' is still recovering from grazing, and would have less leaf litter and woody debris covering the forest floor.

These results confirm that areas of indigenous cover within the Tukituki Catchment provide critical habitat for a diversity of indigenous invertebrate fauna, including uncommon, rare and endemic species.

A full description and interpretation of the terrestrial invertebrate results is provided in Appendix E.

3.1.6 Introduced mammals

3.1.6.1 Humans

People have had, and continue to have, a remarkable influence on the character of the terrestrial ecology values of the Tukituki Catchment. They are also a critical component of future management of terrestrial ecology values, especially where values on privately owned land are concerned.

3.1.6.2 Domestic animals

Sheep, cattle and deer appear to be the most common domestic animals present within the Catchment. The most topical implication of their presence is the impact those browsing/grazing animals have on regeneration of indigenous vegetation. Permanent exclusion of these animals from areas of indigenous cover is a high ongoing management priority for the catchment.

3.1.6.3 Other introduced mammals

A number of introduced mammals are present within the Catchment, which fulfil both browse/graze and predatory roles. Browses/grazers include rabbits, hares, deer, pigs, Australian brush tailed possum and goats. Introduced mammalian predators include members of the rodent and mustelid families, along with cats. Several browsing mammals can also be classed as predators.

3.2 Catchment Unit A

3.2.1 Overview of landform, geology and soil

3.2.1.1 Landform

The landform of Catchment Unit A is dominated by the northern and central Ruahine Range. The terrain in this area of the axial range is steep and mountainous[93]. The Catchment Unit is drained by a large number of waterways, the most substantial being the Makaroro, Waipawa and Tukituki Rivers.

Hill slopes within the Catchment Unit are consistently between 30° to 40°. The highest points within the Catchment Unit are at the head of the Waipawa River, being 'Trig 14041' (1,715m a.s.l) and the neighbouring peak 'Rangioteatua' (1,704m a.s.l). Peaks and ridgelines above 1,300m a.s.l are common.

[92] Notable species include: ***Tmetolophota hartii***. Previously known from very few specimens, but 35 were caught in this study. Usually flying late February to March. Life history unknown. Endemic; ***Aletia longstaffi***. Very localized species, probably associated with fine-leaved *Dracophyllum* in open habitats; ***Graphania olivea***. Rare species, restricted to central/southern North Island; ***Proteuxoa sanguinipuncta***. Australian species, established in North Island since 2007, and especially known from Hawke's Bay. Larva on grasses.

[93] See Photograph 4 for an example of this topography.

3.2.1.2 Geology and soils

Geologically the current Ruahine Range formation is very young, and it is being uplifted rapidly (approximately 4mm per year)[94]. The steepness of the valleys and dissection of the ranges indicates a youthful, unstable landform[95]. It is considered to be 1 to 2 million years old[96]. The geology of the Catchment Unit is predominantly greywacke.

Around 74% of the Catchment Unit features well-drained soils of very low fertility formed from rhyolitic and andesitic tephra with some greywacke, argillite and sandstone. Those soils are strongly undurated and coarse-textured.

A separate Land Environment to the south of the Catchment Unit features imperfectly drained soils of very low natural fertility from greywacke with some argillite. Those soils make up around 15% of the Catchment Unit.

Around 5% of the Catchment Unit features well drained, low fertility soils from mudstone and sandstone. Other soils present in relatively minor proportions include those from LENZ Environments 'E', 'B' and 'D'.

3.2.2 Climate

According to Newsome's[97] New Zealand plot of altitudinal zones[98], the Catchment Unit features 'Lowland', 'Montane', 'Sub-Alpine', 'Low Alpine' and 'High Alpine' zones. Consequently climatic conditions vary greatly with altitude and exposure.

The climate is characteristically cool and cloudy with high annual rainfall and very heavy rain at times. Average annual rainfall on the crest of the Ruahine Range typically ranges from 2,400mm to 3,200mm. Daily rainfalls of up to 150mm can occur at any time of year. Most rainfall comes from the westerly quarter, contributing to a significant 'rain shadow' effect extending from the Catchment Unit across the upper and central Tukituki Catchment. That rain shadow effect clearly influences the composition and character of indigenous forest communities within that area[99].

Snow may occur within the Catchment Unit at any time of year and frequently lies above 1,400m from May until October[100].

Solar radiation is moderate, vapour pressure deficits and water balance ratios are low. Annual water deficits do not occur.

3.2.3 Land cover and flora

3.2.3.1 Land cover

Indigenous vegetation covers around 95% of the Catchment Unit. Only a small proportion of vegetation cover is exotic, and that is largely high producing exotic grassland. Open ground makes up a little over 2% of the Catchment Unit. This is a land cover type predominantly associated with landslides[101], and lesser proportions of alpine gravel/rock and low order gravel river bed[102].

[94] Fromont and Walls, 1991; DoC 1992.
[95] Fromont and Walls, 1991.
[96] Fromont and Walls, 1991.
[97] Newsome, 1987.
[98] At 40°S 'Altitudinal Zones' are Lowland: <800m a.s.l; Montane: 800m a.s.l to 1,100m a.s.l; Sub-Alpine: 1,100m a.s.l to 1,400m a.s.l; Low Alpine: 1,400m a.s.l to 1,650m a.s.l; High Alpine:1,650m a.s.l to 2,100m a.s.l
[99] Forbes, 2010.
[100] DoC,1992.
[101] See Photograph 5.
[102] See Photographs 6 and 7.

Table 3-12: Catchment Unit A land cover type, area and percentage of Unit's cover.

LCDB2 'Name'	LCDB2 '1st Order Class'	Area (ha)	% of Unit
Indigenous vegetation			
Indigenous Forest	Indigenous Forest	23,521.31	84.4
Tall Tussock Grassland	Tussock Grassland	1,425.83	5.1
Manuka and/or kanuka	Scrub	743.35	2.7
Sub-Alpine Shrubland	Scrub	627.54	2.3
Broadleaved Indigenous Hardwoods	Scrub	308.59	1.1
Exotic grassland and scrub			
High Producing Exotic Grassland	Primarily Pastoral	676.42	2.4
Low Producing Grassland	Primarily Pastoral	3.3	0.01
Gorse and Broom	Scrub	1.4	0.01
Open ground			
Landslide	Bare Ground	338.38	1.2
Alpine Gravel and Rock	Bare Ground	198.06	0.71
River and Lakeshore Gravel and Rock	Bare Ground	38.50	0.14
River			
River	Inland Water	1.9	0.01

3.2.3.2 Flora

Given the relief of the Catchment Unit vegetation types are naturally stratified into altitudinal bands, which are described in the very simplified approximation in Table 3-13 below. At lower altitudes human disturbance has been more common and natural patterns have in places been altered. An example of this is within the Forest Park at Kashmir Road end, where a burn in 1946[103] has induced a tussock grassland community, which shows patchy reversion to scrub[104].

[103] Fromont and Walls,1991.
[104] See Photograph 8.

Table 3-13 : Approximation of altitudinal range, zone and characteristic canopy species of Catchment Unit A.

Altitudinal range (m.a.s.l)	Corresponding altitudinal zone[105]	Characteristic canopy species (sub-dominants in brackets)[106]
1,650 to 2,100	High Alpine	tussock
1,600	Low Alpine	
1,500		
1,400		scrub (tussock)
1,300	Sub-Alpine	mountain beech
1,200		mountain beech (yellow pine)
1,100		red beech (halls totara)
1,000	Montane	
800		
700	Lowland	
600		
<600		rimu, matai, kahikatea, totara (broadleaved trees, black beech)

Specific data on rare plant occurrences within Catchment Unit A are unavailable, however a number of nationally and locally important flora are listed by DoC[107] as occurring within the Ruahine Forest Park.

[105] Follows Newsome, 1987; for 40°S.
[106] Taken from Elder, 1965.
[107] See Fromont and Walls, 1991; DoC, 1992.

3.2.4 Terrestrial fauna

3.2.4.1 Avifauna

Due to the relatively large proportion of indigenous forest in this catchment unit, this unit has rather high values with regards to bird species. Within the considerable forested areas in the catchment unit are relatively small numbers of Northern brown kiwi, and as previously noted this area is on the southern limit of this species distribution. The species probably favours indigenous forest within this area, perhaps extending into tussockland and scrub, so there is considerable habitat available to the species.

The area is also important for blue duck, and again as previously noted is likely to be the southern limit for this species in the North Island also. Although the main stay of the blue duck population in the Ruahines is slightly further north (Apias/Ikawetea catchments)[108] which are outside of this rivers catchment, the Makaroro catchment also had a breeding population during surveys in the 1990s[109] and the sightings further south in the Tukituki River headwaters[110] suggest that other rivers and streams may hold breeding pairs of this species.

Current population estimates and distribution are lacking for this species, and are in need of further surveys. This species favours river sections that have high water quality, stable banks and low transport of sediments, riparian native vegetation, and an abundance of aquatic invertebrates[111], and there are many streams and rivers within this catchment unit that on the face of it should qualify. However, predation by introduced mammals and competition for food with trout have likely impacted on the distribution and population size of this species.

The catchment unit is also a stronghold for other threatened species listed in Table 3-8 including New Zealand falcon, New Zealand pigeon, yellow-crowned parakeet, long-tailed cuckoo, rifleman, and still holds small populations of kaka and possibly red-crowned parakeet (as previously discussed).

Falcon occupy both the primary forested areas, as well as the more open shrubland and tussock habitats found in this unit, and are probably widespread throughout. They have previously been recorded at the Upper Makaroro River area, and the Sunrise Hut area[112], the Armstrong Saddle and throughout the Range[113], and Lake Colenso area[114].

New Zealand pigeon, yellow-crowned parakeet, long-tailed cuckoo, and rifleman would mainly utilize the primary and secondary forest throughout this catchment unit, giving extensive habitat for them to range throughout.

Kaka, and if still present, the red-crowned parakeet would use similar habitats, with the former being recorded around Armstrong Saddle Hut[115] and Lake Colenso[116]. The New Zealand pipit is probably also fairly common in the more open areas, especially at higher altitude, on slip-faces, and in more open grassland and sub-alpine areas, as well as along tracks and roads within this area.

Interestingly, but not unexpectedly, fernbird seem to have gone under the radar for this Catchment Unit, with no reference to them by Challies (1966), Fromont (1991) or Robertson *et al* (2007). However, it is unlikely that this species does not exist in this area, being found during this survey in Catchment Unit B, and having a known distribution further north in the Kaweka Ranges at similar altitudes. There is reference to them being in Ruahine Forest Park in Dec 2000[117], but this may well be within Catchment Unit B. This rather cryptic species is almost certainly under-represented in many surveys and studies throughout the country (*pers obs*). If they do indeed exist within this Unit, they would favour secondary growth and shrubland/fernland habitats associated with stream gullies and wetland areas.

The indigenous forests and shrubland associated with this area are also home to the more common endemic and native forest species such as morepork, shining-bronze cuckoo, whitehead, grey fantail,

[108] DoC, 1992; Adams and Abbott, 2002; Williams unpubl.
[109] Williams unpubl.
[110] HB OSNZ records.
[111] O'Donnell, 2004.
[112] HB OSNZ records.
[113] Challies, 1966.
[114] Fromont, 1991.
[115] HB OSNZ records.
[116] Challies, 1966.
[117] HB OSNZ records.

North Island robin, North Island tomtit, grey warbler, silvereye, bellbird, and tui. Of note however, is the fact that robin appear to have never been very common in this area[118]. For many of these common forest species, this Catchment Unit is likely to be a source population for surrounding areas, both within and outside of the Tukituki River Catchment. Some of the species occupying these higher altitude zones may also disperse and migrate out of this Catchment Unit during winter, and this warrants further study. Kaka seen in other Catchment Units during winter (i.e. C and D) almost certainly come from this area.

The largely indigenous vegetation of this Catchment Unit also provides a home for many introduced bird species, most of which do not compete in any way with the endemic or native species. Species such as blackbird, song thrush, dunnock, and chaffinch are all found in good numbers within the taller forest, whilst greenfinch, goldfinch, redpoll and yellowhammer are found throughout the edge habitat, and more open areas.

The area is in great need for new surveys, with no surveys (other than Atlas) having been conducted in the last two decades.

3.2.4.2 Herpetofauna

Species present or likely to be present

Common skinks, common geckos, southern North Island forest geckos, Wellington green geckos. Possibly also spotted and southern North Island speckled skinks. Potential for sparse occurrence of small-scaled skinks.

Herpetofauna database records

No records exist for this Catchment Unit in the Herpetofauna database.

Survey results

No sites in this Catchment Unit were surveyed.

Other records

While not in the Tukituki Catchment, a green gecko sighting[119] in the Kaweka Ranges Forest Park in April 2011 may be indicative of the lizard fauna in Catchment Unit A, as the Kawekas are immediately North of Unit A, and are connected by a near continuous belt of indigenous forest. A “bright green slender” lizard was seen in the northern side of Te Puia Lodge. The lizard “rushed out of the bush, running across the track and disappeared into manuka/kanuka bush”. This lizard is most likely Wellington Green gecko (*N. punctatus*).

3.3 Catchment Unit B

3.3.1 Overview of landform, geology and soil

3.3.1.1 Landform

The majority (c. 60%) of the Catchment Unit features strongly rolling hills, with slopes ranging between 15° and 20°. The hill landforms become less severe towards the east of the Catchment Unit (rolling hills) and phase into undulating plains around the Unit’s eastern boundary with Catchment Unit C.

The band of strongly rolling hills towards the west of the Catchment Unit features peaks and ridgelines commonly between 730m.a.s.l and 925m.a.s.l[120]. Ridges, faces and gullies in the northwestern area of the Catchment Unit below Daphne Ridge and Pohangina Saddle reach altitudes of around 1,000m.a.s.l.

In eastern areas of the Catchment Unit where hill landforms grade towards the remnant high plains, altitudes of around 450m.a.s.l are common, and slopes <15°, and more commonly <10° predominate.

[118] Challies,1966; Fromont and Walls,1991.
[119] Observation by Sandy Haidekker (HBRC).
[120] See Photograph 9 for an example of the strongly rolling hills in this Unit.

The two most substantial waterways draining the Catchment Unit are the Tukituki and Makaretu Rivers[121]. They include reaches of both mountain and shingle phases[122]. Other shingle phase medium order waterways draining the hill county of the Catchment Unit are (from north to south) the Moorcock Stream, Tukipo River, Tangarewai Stream, Mangatewai River and the Makaretu River. A number of low order waterways drain the Catchment Unit to feed these more substantial waterways.

3.3.1.2 Geology and soils

The geology of the Catchment Unit is predominantly greywacke.

Soils over much of the strongly rolling hills are well-drained, of very low fertility formed from mudstone and sandstone. Particularly to the east of the Catchment Unit, soils of similar broad characteristics only formed from greywacke and argillite are locally present. A relatively small area of gently undulating plains in the south east of the Unit features imperfectly drained soils of low fertility formed from loess and some fine alluvium.

3.3.2 Climate

The Catchment Unit features mild temperatures, high solar radiation, moderate vapour pressure deficits and slight annual water deficits. Warmer temperatures and low annual water deficits are characteristic of the eastern lower lying areas of the Catchment Unit.

The most elevated areas of the Unit are within the Montane altitudinal zone[123], and those areas below 800m a.s.l fall within the Lowland altitudinal zone.

3.3.3 Land cover and flora

3.3.3.1 Land cover

Broadly speaking, indigenous land cover within the Catchment Unit reduces from almost complete cover in western areas, to a landscape dominated by exotic pastoral grassland communities in the east.

Areas of the axial range feature forest of beech, beech/podocarp-broadleaf and broadleaf. A fire in 1946 around the upper Moorcock Stream/Moorcock Saddle has induced a vegetation cover of indigenous broadleaved shrubs and tall tussock grassland[124]. The strongly rolling hills to the east of Makaretu North Branch and Moorcock Stream feature substantial areas of indigenous scrub[125].

Around 67% of the Catchment Unit comprises either high or low producing pastoral grasslands. This land cover dominates the less severe topography of eastern parts of the Unit. A number of waterways flow across this area in a west to east direction. Indigenous cover in this area of the Unit is limited to the riparian margins of waterways[126] and scattered treelands amongst exotic pasture grassland.

On the undulating plain landforms to the south east of the Unit the exotic pastoral grassland is punctuated by shelterbelts.

Pine plantations, typically of up to 20ha in area, are scattered across the pastoral portion of the Unit. The largest plantation forest (c.100ha) within the Catchment Unit is located adjacent to Kashmir Road, on strongly rolling hills and extending onto the Moorcock Stream valley floor.

[121] See Photographs 10, 11, 12 and 13 for examples of the character of these two rivers within the Catchment Unit.
[122] Classification follows Mosley and Schumm, 2001.
[123] See Table 3-13 for approximation of altitudinal range, corresponding altitudinal zone and characteristic canopy species for this latitude.
[124] See Photograph 14.
[125] See Photographs 15 and 16.
[126] See Photographs 17, 18 and 19.

Table 3-14: Catchment Unit B land cover type, area and percentage of Unit's cover.

LCDB2 'Name'	LCDB2 '1st Order Class'	Area (ha)	% of Unit
Exotic grassland and scrub			
High Producing Exotic Grassland	Primarily Pastoral	11,581.79	59.8
Low Producing Grassland	Primarily Pastoral	1,315.23	6.79
Gorse and Broom	Scrub	158.17	0.82
Indigenous vegetation			
Indigenous Forest	Indigenous Forest	3,336.34	17.2
Broadleaved Indigenous Hardwoods	Scrub	1,927.20	9.96
Manuka and or Kanuka	Scrub	357.03	1.84
Tall Tussock Grassland	Tussock Grassland	142.68	0.74
Sub Alpine Shrubland	Scrub	11.15	0.06
Grey Scrub	Scrub	2.15	0.01
Exotic forest			
Pine Forest - Closed Canopy	Planted Forest	197.23	1.02
Pine Forest - Open Canopy	Planted Forest	75.79	0.39
Major Shelterbelts	Shelterbelts	21.24	0.11
Other Exotic Forest	Planted Forest	11.34	0.06
Afforestation (imaged, post LCDB 1)	Planted Forest	10.69	0.06
Deciduous Hardwoods	Willows and Poplars	5.63	0.03
Afforestation (not imaged)	Planted Forest	3.31	0.02
Forest Harvested	Planted Forest	1.89	0.01
Bare ground			
River and Lakeshore Gravel and Rock	Bare Ground	97.07	0.50
Alpine Gravel and Rock	Bare Ground	88.47	0.46
Landslide	Bare Ground	11.18	0.06
Inland water			
Lake and Pond[†]	Inland Water	1.58	0.01

[†] Also refer Table 3-4 for total wetland area per Catchment Unit.

3.3.3.2 Flora

In the western portion of the Unit montane vegetation communities are present. These include forests and variations of forest comprising beech, podocarp and broadleaved species. According to the vegetation map drawn by Elder[127] the forest communities on the Ruahine Range within Catchment Unit B are characteristed by the following dominant species.

The fire induced community on the Range in the vicinity of Moorcock Road features snowgrass (*Chionochloa pallens*).

[127] Elder, 1965.

The Range to the south of Moorcock Stream is dominated by kamahi with areas of mountain beech and in places mixed with red beech. North of the Moorcock Stream the vegetation of the Range is mapped as red beech at lower altitudes grading into mountain beech. A substantial area of the red beech forest to the west of the Moorcock Stream is mapped as mixed podocarp-red beech forest. The composition of these forests has been described and mapped by Elder[128] and later by Nicholls.

Riparian corridors within the eastern area of the Unit comprise lowland forests of manuka, kanuka, broadleaf, podocarp and black beech, with various compositions of those types occurring. Several examples of lowland forest composition were described by DoC[129] in 1994:

RAP 39: Makaretu River

> On a gently rounded knoll dropping abruptly into the Makaretu River is[130]: *Podocarp-broadleaved forest. Rewarewa is the dominant tree and comprises ~70% of the canopy, with kahikatea, rimu, matai and kamahi common. Kowhai, maire and kaikomako are scattered thinly throughout. A 30m wide band of black beech skirts the north and west sides of this area. Under the rewarewa canopy the understorey is sparse, mostly regenerating rewarewa, supplejack and ferns, while the black beech has a moderate understorey of mingimingi, Helichrysum lanceolatum and small leaved Coprosma spp.*
>
> On a low alluvial terrace backed by a 30m high escarpment[131]: *mixed podocarp-broadleaved forest covers the terrace with rewarewa again the dominant tree on drier sites. Kahikatea is common in wetter areas and a mix of other tree species including matai, cabbage tree, totara, mahoe and titoki form a closed canopy. On the escarpment a cover of mixed broadleaved species occurs, of this mahoe, kowhai, titoki and marble leaf are common. Small pockets of black beech occur on the drier sites. The predominant vegetation of the wetland area is Carex secta and raupo, though a few small kahikatea and cabbage trees are present.*

3.3.4 Terrestrial fauna

3.3.4.1 Avifauna

With over a third of this Catchment Unit having an indigenous vegetation cover, this is also a significant habitat for both threatened and common endemic and native bird species. The indigenous vegetation is present within both Lowland and Montane climatic zones. Again the species found within this area consist mainly of endemic and native species, and although kiwi is probably not found in this area, this cannot be ruled out. Blue duck have been seen to breed in the Tukituki headwaters near Daphne Hut, and their continued presence should be determined through surveys of the headwaters. Even if blue duck do not still breed here, juvenile birds are almost certainly dispersing into this area, as these birds range over quite large distances, as shown in studies of the birds in the Ikawetea/Apias and Makaroro Rivers[132].

New Zealand falcon are certainly found within this Catchment Unit, with a bird being seen along Kashmir Road during surveys, and several past records from the Triplex Creek area (HB OSNZ records). This area is prime habitat with a mixture of shrubland, beech forest, and open grassy areas, providing plenty of diversity of habitat and forest edges for a wide range of avian prey[133]. Falcon would also range over rough pasture and farmland to the east of the range, and may even breed in areas of rough pasture that have forest remnants and shrubland associated. Younger pine plantations may be of use for this species when breeding, as the species has been shown in recent years to breed quite successfully in exotic pine plantations[134]. However, this habitat is actually quite limited in this Catchment Unit at this time.

Although rivers within this Catchment Unit are still relatively small and do not have extensive areas of shingle, both banded and black-fronted dotterel may be found in small numbers in this area, especially

[128] Elder, 1965.
[129] Lee, 1994.
[130] See Photograph 20 for a view of this forest area.
[131] See Photograph 21 for a view of this forest area.
[132] Adams and Abbott 2002, Williams unpubl.
[133] Heather and Robertson, 2000.
[134] Seaton *et al*, 2009.

the latter, which is often quite at home on smaller narrower stretches of river. The upper reaches of the Tukituki River appear to show some expanses of shingle, and are almost certainly good habitat as long as weed encroachment has not been too great.

The intact continuous indigenous forests in the western part of this Unit are almost certainly home to good populations of other forest birds, and may still have small numbers of kaka and almost certainly yellow-crowned parakeet. Pigeon, long-tailed cuckoo, rifleman as well as common species such as whitehead, tomtit, grey warbler, tui and bellbird would be in good numbers throughout the forested parts of the Unit, and probably throughout the more vegetated tributaries as they head east from the range. Even areas of broadleaved indigenous hardwoods, manuka/kanuka shrubland, and some more established exotic forests with good native understorey would be inhabited by these species.

Fernbird were also found along Kashmir Road during surveys as part of this work, being found along the Moorcock Stream within manuka shrubland in the wetter areas bordering the stream. It is unknown how large the population of this species is within this site, but the type of habitat the birds were found in is rather extensive within this Catchment Unit, and so populations of the species are likely to be fairly healthy. Again due to the species often being difficult to detect, or merely overlooked, there are no previous records of the species for this area either.

Pipit were also found along the roadside of Kashmir Road during this work, and are also likely to be represented by a healthy population within this Catchment Unit in more open grassland and sub-alpine areas within the Ruahine Forest Park, as well as the extensive areas of rough exotic pasture to the east (something like <55% of the total land area of the Catchment Unit).

3.3.4.2 Herpetofauna

Species present or likely to be present

Common skinks, common geckos, southern North Island forest geckos, Wellington green geckos. Possibly also spotted and southern North Island speckled skinks. Low potential for sparse occurrence of small-scaled skinks.

Herpetofauna database records:

A common gecko was recorded at Mill Road, Ashley Clinton[135].

Survey results

Tall tussock grassland, Ruahine FP Kashmir Rd access: No lizards were found under the 29 Onduline covers checked on the 24th of March 2011.

3.4 Catchment Unit C

3.4.1 Overview of landform, geology and soil

3.4.1.1 Landform

Catchment Unit C features three flights of terrace landforms. They are known as the “Remnant High Terraces”, “Intermediate Terraces” and the “Low Terraces”. The High Terrace landform is the most common within this Unit and is represented on the landscape as gently undulating and strongly undulating plains and hills. The Intermediate Terraces are remnants of the Okakea fans, which have been terraced by rivers. Low terraces are more recent, having been deposited after the Taupo eruption.

Around 55% of Catchment Unit C features gently undulating plains and the remainder being strongly undulating plains and hills, strongly rolling hills, strongly rolling foothills and a small proportion of mountainous terrain on the Wakarara Range.

High points of up to 1,000m a.s.l occur on the Wakarara Range. Around Makaroro River and east of the Wakarara Range elevations of between 450m a.s.l and 600m a.s.l are common. Elevations reduce

[135] It actually says Mill Rd, NW Waipawa in the Bioweb Herpetofauna database, but no Mill Road exists in Waipawa and the GPS point corroborates with Mill Rd in Ashley Clinton.

quite rapidly in an eastern direction down to between 200m a.s.l to 260m a.s.l at the Units eastern boundary around State Highway 50.

A number of waterways of varying order drain the Catchment Unit. The main shingle rivers of the Unit are the Mangaonuku and Mangamate Streams, the Waipawa River, Makaroro River, Tukituki River, Tukipo River and Mangatewai River[136].

3.4.1.2 Geology and soils

The Wakarara Range is composed of alternating argillites and sandstones[137]. A greywacke basement probably underlies most of the Catchment Unit.

The soils of the Ruataniwha Plains are described in detail by Griffiths[138], and a description of soils for that area is not repeated here.

The Wakarara Range features well-drained soils of low natural fertility from rhyolitic and andesitic tephra with some greywacke, argillite and sandstone. Soils are characteristically of very low fertility, strongly indurated and coarsely textured.

3.4.2 Climate

Much of the Catchment Unit features mild temperatures, moderate to high solar radiation, low annual water deficits and low or very low monthly water balance ratios. This varies on the Wakarara Range, which experiences only slight annual water deficits.

The Catchment Unit experiences strong rain shadow effects due to its location relative to the Ruahine Range, and the prevailing wind which is from southwestern quarters. For example, average annual rainfall at Makaretu and Ashley Clinton is 1,349mm and 1,360mm respectively, and further to the northeast average annual rainfall at Gwavas and Ongaonga is 1,009mm and 922mm respectively[139].

3.4.3 Land cover and flora

3.4.3.1 Land cover

Although land cover is predominantly high producing exotic grassland, indigenous cover makes up a notable proportion (and ecologically important component) of the Unit. Given the productive nature of much of the Unit, indigenous cover is typically located in less intensively developed areas, such as sites with sloping ground and/or within waterway corridors.

The plain landforms located southeast (eastern end of Ashley Clinton, Makaretu and Tukituki Roads) of the Tukituki River are an agricultural patchwork and indigenous cover in this area is largely restricted to pockets associated with waterway channels[140].

Much of the Unit west of State Highway 50 contains a mosaic of indigenous vegetation sites, of varying types, densities and degrees of isolation[141]. Indigenous cover occurs over a wide variety of landforms.

The northwestern corner of the Unit contains an area of the Ruahine Forest Park, a substantial area of exotic plantation forestry and expansive areas of regenerating indigenous forests and remnant pockets on the Wakarara Range[142]. To the eastern flanks of the Wakarara Range is an area of exotic plantation forestry, bounded by indigenous forests to the west and largely pastoral land cover to the east.

To the east of State Highway 50, an arm of the Catchment Unit extends to the southeast. Exotic grassland dominates this area, indigenous cover is very scarce[143]. Several waterways which drain the

[136] See Photographs 22 to 26 for characteristic views of the river reaches within this Unit.
[137] Grant, 1996.
[138] Griffiths, 2004.
[139] Rainfall data sourced from NIWA's 'Cliflo' database.
[140] See Photograph 27 for an example.
[141] See Photographs 28, 29, 30 of different indigenous vegetation cover types.
[142] See Photographs 31, 32 and 33.
[143] See Photograph 34.

northern portion of this area have been planted with pines, within which indigenous forest is regenerating.

Table 3-15: Catchment Unit C land cover type, area and percentage of Unit's cover.

LCDB2 'Name'	LCDB2 '1st Order Class'	Area (ha)	% of Unit
Exotic grassland and scrub			
High Producing Exotic Grassland	Primarily Pastoral	74,540.53	80.04
Low Producing Grassland	Primarily Pastoral	106.65	0.11
Gorse and Broom	Scrub	54.78	0.06
Mixed Exotic Shrubland	Scrub	2.81	<0.01
Agriculture			
Orchard and Other Perennial Crops	Primarily Horticulture	24.44	0.03
Short-rotation Cropland	Primarily Horticulture	22.43	0.02
Indigenous vegetation			
Indigenous Forest	Indigenous Forest	6,124.38	6.58
Broadleaved Indigenous Hardwoods	Scrub	1,596.35	1.71
Manuka and or Kanuka	Scrub	2,210.25	2.37
Tall Tussock Grassland	Tussock Grassland	110.06	0.12
Herbaceous Freshwater Vegetation†	Inland Wetland	5.85	0.01
Exotic forest			
Pine Forest - Closed Canopy	Planted Forest	3,082.97	3.31
Forest Harvested	Planted Forest	2,302.62	2.47
Pine Forest - Open Canopy	Planted Forest	1,418.31	1.52
Deciduous Hardwoods	Willows and Poplars	488.31	0.52
Major Shelterbelts	Shelterbelts	196.98	0.21
Other Exotic Forest	Planted Forest	185.58	0.20
Afforestation (imaged, post LCDB 1)	Planted Forest	92.98	0.10
Afforestation (not imaged)	Planted Forest	16.55	0.02
Bare ground			
River and Lakeshore Gravel and Rock	Bare Ground	412.19	0.44
Alpine Gravel and Rock	Bare Ground	21.16	0.02
Urban			
Built-up Area	Urban Area	48.00	0.05

LCDB2 'Name'	LCDB2 '1st Order Class'	Area (ha)	% of Unit
Inland water			
River	Inland Water	47.50	0.05
Lake and Pond†	Inland Water	20.13	0.02
Extractive and filling land uses			
Transport Infrastructure	Mines and Dumps	1.39	<0.01

† Also refer Table 3-4 for total wetland area per Catchment Unit.

3.4.3.2 Flora

Indigenous forest communities are a distinctive feature of the Catchment Unit. Broadly, podocarp and broadleaved species are present throughout the forests of the Unit. A component of beech is present in today's indigenous forests, in a general north south banded pattern. At higher altitudes within the western portion of the Unit, towards the Ruahine Range, red beech is present in forests. At lower altitudes, further to the east a component of black beech occurs.

The forest remnants of the Catchment Unit have typically been disturbed to varying degrees by both natural and anthropogenic agents[144].

Observations of some of the main indigenous forest types within the Unit are described in some detail by way of example below:

Podocarp/black beech-broadleaf forest

Located near the Dutch Creek and Makaroro River confluence[145]. Viewed from the air and walked through on one occasion. This area is described as follows:

> The forest has been logged in the past with the loggers targeting rimu as confirmed by a local farmer during the site visit. Rimu stumps were observed on the lower slopes.
>
> Black beech is prominent within the forest canopy particularly on the higher slopes and crests. Matai and kahikatea trees are emergent above the beech/broadleaf canopy throughout. Matai, kahikatea and rimu seedlings and poles are present in varying numbers.
>
> Broadleaved species tend to predominate closer to the river's edge and adjacent river terraces. The species composition is similar to that encountered in the terrace forests further downstream with kowhai, lancewood, kohuhu, lemonwood and mapau the dominant canopy species. Common understorey vegetation includes rangiora, kanono, *Pseudopanax anomalus* and native myrtle.
>
> The distinctiveness of the forest edge at this location is heightened by the flora colonising the sedimentary scarp faces which includes the drooping foliage of the native sweet broom (*Carmichaelia odorata*), tree tutu and the large fern kiokio and diminutive herbaceous plants such as the attractive flowering *Pratia angulata* and spider orchids (*Corybas* spp.).
>
> Forest floor plants typically encountered within this forest type are creek fern, crown fern; hounds tongue fern, hen and chickens fern along with young tree ferns (*Cyathea smithii*), bush flax (*Astelia fragrans*) and bush rice grass.
>
> Notable flora observed within the forest interior included specimens of young tawa and young maire on the river terraces, the endemic orchid *Pterostylis banksii* seen growing on a shady part of the forest floor with healthy leaf litter coverage while on the drier crests below the beech canopy and soft mingimingi understory, scattered tussocks of *Gahnia xanthocarpa* were observed (at upper end of its altitudinal range).

[144] Refer to Forbes (2010) for a description of historical forest disturbance agents for areas within the Catchment Unit.
[145] See Photograph 35 for a view of this forest type.

At mid-height on the hill slope is a matai with a dbh of 93cm, suggesting an approximate tree age of 450 years. On a flat terrace at the toe of this hill slope a matai with a dbh of 88cm and a kahikatea of 118cm dbh are present, suggesting approximate tree ages of 420 years and 460 years respectively.

Despite the influence of historical forest harvesting, the age estimates of these remaining podocarps provide evidence of the 'old age' of this forest unit and the likely high relict conservation values it supports.

Podocarp-broadleaved forests

A podocarp-broadleaf forest on river terrace landform of the Makaretu River, in southeastern Unit C was visited, and the canopy was viewed from an adjacent point on the Takapau Plains proper. This area is described as follows:

The forest canopy comprises a mix of podocarp and broadleaf species. Podocarps include kahikatea, totara and apparently less frequently matai. The conical form of kahikatea crowns emerge above the forest canopy to heights of approximately 20m to 25m. One kahikatea located near the toe of the terrace riser has a dbh of 39.2cm; another has a dbh of 57.5cm indicating a tree age of around 110 years. A third kahikatea in the central area of this forest has a dbh of 71cm, indicating a tree age of approximately 200 years.

As well as podocarps, the canopy composition comprises long-leaved lacebark, kohuhu, mapau, North Island kowhai, mahoe, cabbage tree and lancewood.

The forest understorey appears to have been impacted by stock, and is relatively bare in places. In other areas a dense shrub tier of mahoe, pigeonwood (*Hedycarya arborea*) and mapau is present. The small leaved shrubs *Coprosma crassifolia* and *C. rotunifolia* were noted. A variety of ground ferns were noted also.

Another area of podocarp-broadleaf forest on terrace landform was visited briefly. That area has a forest canopy comprising kahikatea, totara and matai, with mahoe, titoki (*Alectryon excelsus*), lancewood and kohuhu. One matai has a dbh of 55cm, indicating a tree age of around 200 years. A kahikatea in this area has a dbh of 64.5cm, indicating a tree age of around 160 years. Stock have damaged forest structure in parts, and in other areas of this forest fragment regeneration is good, where a shrub tier topping out at around 2m high is present, consisting of mahoe, pigeonwood, mapau, and several species of small leaved shrubs.

Totara treelands

Totara treeland is a characteristic land cover feature within parts of Catchment Unit C[146]. According to Grant[147] totara on the southern Takapau Plain, north of Tikokino and boarding many patches of forest regenerated amongst scrub about the time of early European settlement. That cohort is characteristically 80cm dbh with a bole of 1-2m and are 14m high. They have a dense rounded head.

Totara trees here are hosts to the mistletoe *Ileostylus micranthus*, now rare in Hawke's Bay[148].

Regenerating forests of the Wakarara Range

An account[149] from 1959 describes the character of vegetation cover of the Wakarara Range. Erosion was severe and active, particularly on western slopes. In the area visited mid and lower valley slopes were dominated by manuka, mingimingi and cabbage tree, with pockets of houhere and broadleaf on eastern slopes, and with bracken fern at lower levels.

[146] See Photographs 29 and 36 for examples of totara dominated treelands.
[147] Grant, 1996.
[148] Lee, 1994.
[149] Account by Ashley Cunningham and Published by Grant in 1996. This account is of a traverse of the Wakarara Range, strictly in the adjacent Ngaruroro Catchment, but relevant to the vegetation cover of the Wakarara Range within Unit C.

It was found that there were patches of red and mountain beech, but the area carried a cover of stunted manuka, mingimingi, snowberry, bracken and rushes. A gully south of Poutaki Hut, which drained into the Makaroro River contained red beech of mixed age classes. The forest interior was rather bare, but well developed red beech regeneration occurred in pools of light and at the forest fringe. West of Sugar Loaf (960m.a.s.l) the forest contained mountain beech and scattered red beech, but the understorey was bare apart from scattered mingimingi and putaputaweta. Mountain beech seedlings were rare, but red beech seedlings were common amongst the manuka at the edge of the forest. This stand of forest spanned the altitudes from 580m.a.s.l to 970m.a.s.l.

General and specific location descriptions of forest canopy composition within selected sites of Unit C

Published descriptions of forest canopy composition for general areas and specific locations within Catchment Unit C are presented below. General and specific areas are letter-number referenced in Table 3-16 and Figure 3-4 below.

Whakarara Station[150]

Grant[151] states that the large flat area surrounding the station buildings of Whakarara Station ("*Duff's Flat*") (see Area A1) was covered with a dense stand of about 40ha of podocarps, and species were present in the following descending order of frequency: totara, matai, rimu, miro and kahikatea. Further, Grant states that some totara had diameters of 180cm and boles of 24m, while matai were generally less than 100cm diameter. This area of forest on Duff's Flat was cleared by burning for the establishment of pasture during the mid-1960s[152]. Grant also commented that nikau palm were said to be present (now absent), and tawa were absent.

At the western end of Duff's Flat, on the face rising to approximately 560m (see Area A2) is a pole stand of totara, matai, rimu and kahikatea. Grant observed that "*faulty large totara and matai, with much dead foliage*", are present. This area has not been modified by logging.

Gwavas Forest

According to Grant, Gwavas Forest (see Area B) contains some rimu, matai and kahikatea older than 550 to 600 years.

Gwavas Bush

Gwavas Bush (see Area C) has been settled since 1857 and since then quantities of matai, totara and maire have been felled[153]. According to Grant, Gwavas Bush comprises totara, matai, kahikatea and few rimu, with most podocarps being 350-450 years old or less. He comments that tawa, kotukutuku, black beech and puka are uncommon, and hinau, maire and supplejack are frequent.

Wakarara

Grant states that before milling commenced the land around and south of Wakarara (see Area D) was covered in a mixture of forest types, which log or stump dimensions indicate established around 350 to 450 years ago. In one area dominant species were matai, rimu and miro; in another red beech, matai, rimu and kahikatea; and elsewhere matai and totara were the main species.

Evertree Bush

According to Grant Evertree Bush (see Area E) located c.9km west of Tikokino, is dominated by totara with rimu, and matai next in sequence, occasional miro and a small area of black beech. Grant comments that some matai and totara have been milled. Based on diameter measurements, Grant estimated three totara specimens to be 200, 310 and 320 years old. A matai was estimated to be 280 years old in 1860s[154]. According to Grant associated species included small kahikatea, rewarewa, mahoe, kaikomako, marie, titoki, putaputaweta, rangiora, pigeonwood, mapou, lancewood and supplejack.

[150] Note that this area is actually in the adjacent Ngaruroro Catchment, however the information is considered relevant to forest conditions close by in Catchment Unit C, and are therefore included.
[151] Grant, 1996.
[152] pers. comm. D. Sherning; D. Ward, 2009.
[153] pers. comm. Carola Hudson 2009; Grant, 1996.
[154] These age estimates by Grant (1996) for totara and matai have been corrected to the 1860s by the Author.

Holden's Bush

Approximately 4.5km west of Tikokino is Holden's Bush (see Area F), a remnant stand comprising a canopy of tall kahikatea, matai and totara. According to Grant, tawa is abundant and mapou, rewarewa and supplejack are widespread. The current landowner and descendent of the pioneer run-holder considers that Holden's Bush was only ever "*lightly logged*"[155]. Large diameter stumps, presumably of matai or totara, are occasionally present within the bush.

Hampden Bush

The area of former native forest named Hampden Bush (see Area G) comprised an extensive stand of totara, matai, kahikatea and rimu. Hampden Bush was felled after the 1860s, with only small pockets of forest being retained. Two kilometres northwest of Tikokino, on the rolling country owned by O. Butler, are a dense array of totara and matai stumps, which in the 1860s were 220 to 330 years old.

On the floodplain of the nearby Mangaoho Stream, c.4km west of Tikokino a remnant stand of kahikatea persists.

Peak Station

The main area of native forest on Peak Station (see Area H), located c.3km southwest of Tikokino, was logged in 1855. The main species were kahikatea, matai and totara; however these were accompanied by hinau, kotukutuku, maire, tawa, supplejack, and rimu. Increment core ring counts indicate that at 1855 the forest would have been 350 to 450 years old.

Springhill settlement

Condor

The original owners of this property, the Bibby family, reserved a large area of forest (see Area I) which is now dominated by matai, totara, kahikatea and rimu.

Glen Appin

The forest in this area (see Area J) was felled about 1880. On the ridges totara was dominant, while in gully bottoms matai and kahikatea dominated. Maire was very common, rimu was scattered and miro was rare.

A'Deanes Bush Scenic Reserve

This reserve (see Area K) features widespread rimu, and many are dead or dying[156]. The reserve is well known for a large totara (295cm d.b.h) which may have established 450 years or more ago. Tawa is common[157].

Inglis Bush Scenic Reserve

This forest remnant (see Area L) is established on Matawhero alluvium, deposited by the Tukituki River[158]. The forest is predominantly comprised of kahikatea. Matai is scattered and totara is occasional. Grant recorded two matai aged 380 and 430 years old respectively, and two kahikatea aged 340 and 350 years old.

Mahoe, and titoki are widespread and kawakawa, hinau, tawa and supplejack are scattered.

Ashley Clinton

According to J.W.Watkins, landowner at Ashley Clinton (see Area M), the vegetation of the area during early European settlement, around 1869, was comprised of tall forest patches with matai dominant (to 150cm dia.), rimu (to 150cm dia.), and kahikatea (to 180cm) in wet places. Locally there were clumps of large totara to 150cm dia. On his property there was a dead, hollow totara with a diameter of 275 to 305cm dia.. Miro to 90cm dia. were scattered. Hinau (to 90cm dia.) was common, maire (to 90cm dia.) and rewarewa (to 75cm dia.) were scattered, tawa occurred locally (to 60cm) and supplejack was widespread. Tree rata to 180cm and titoki, five finger, kamahi and beech were scattered.

[155] pers. comm. D. Holden, 2009.
[156] There is strong evidence to support the concept that drought effects are the cause of these tree mortalities (see Grant, 1996; Forbes, 2010).
[157] See Photograph 37.
[158] See Photograph 38.

There was a narrow fringe of vegetation extending east-north-east for 4km which consisted of rewarewa, putaputaweta, houhere, wineberry, lemonwood, kohuhu and manuka; this opened into bracken fern and manuka with totara regeneration. Flax and tutu were common in the scrub areas, and stumps and logs were evident in the fringe zone.

Monckton Scenic Reserve

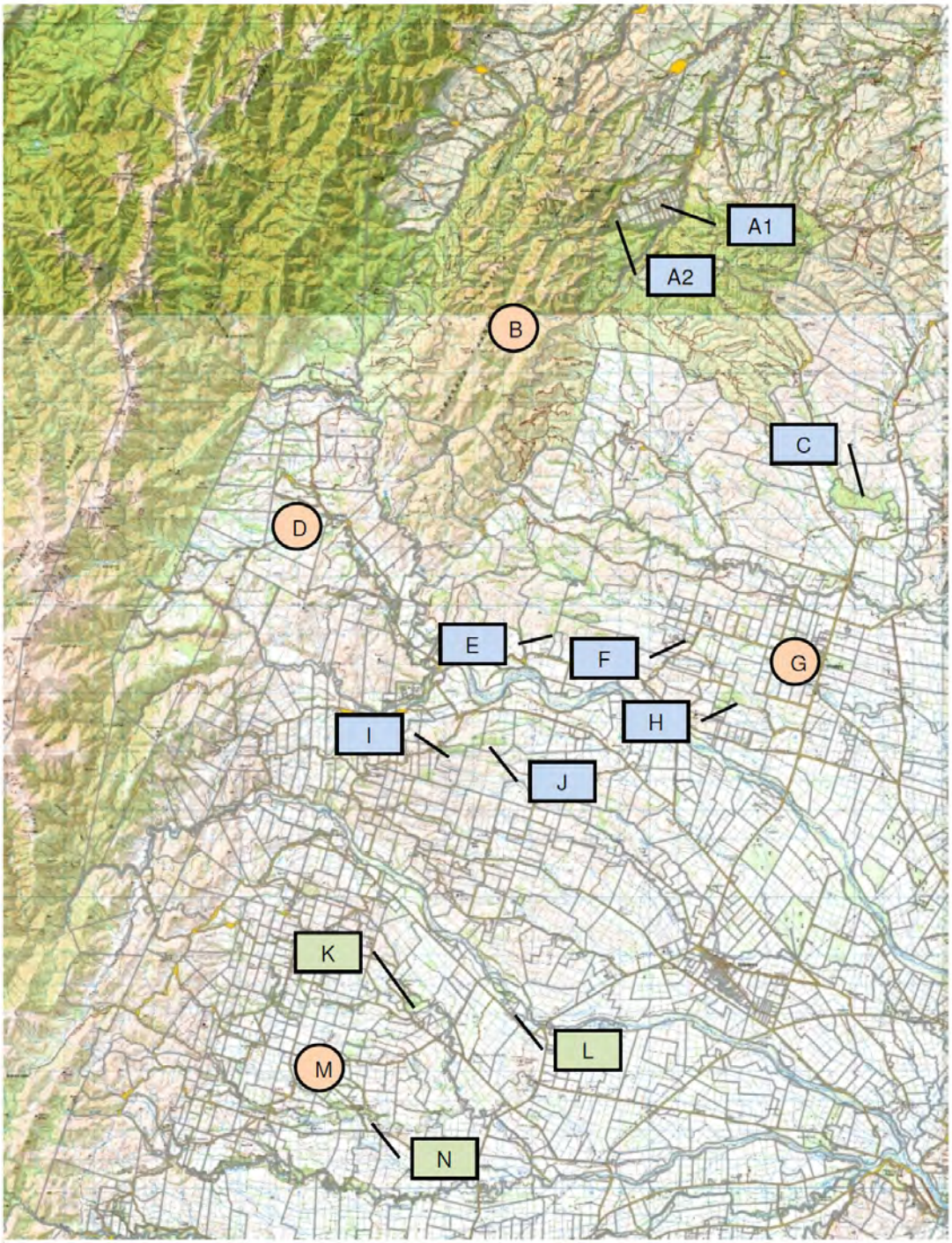
The majority of the reserve (see Area N) contains relatively young vegetation, including black beech, matai, totara, kahikatea, rimu, kotukutuku, titoki, maire, pokaka, rangiora, hangehange, and mahoe.

Many trees within this forest remnant fall within the 260 to 450 age range.

Table 3-16: Qualitative summary of canopy tree composition records.

Reference.	Location.	Canopy tree composition.	Era.*	Pre-logging.	Source.
A1.	Whakarara Stn.	*totara, matai, rimu, miro, kahikatea.***	1930s.	Yes.	(Grant, 1996).
A2.	Whakarara Stn.	*totara, matai, rimu, kahikatea.*	1930s.	Yes.	(Grant, 1996).
B.	Gwavas Forest.	rimu, matai, kahikatea.	1990s(?)	Unknown	(Grant, 1996).
C.	Gwavas Bush.	*totara, kahikatea*, *matai*, rimu, hinau, maire, supplejack.	1970s; 1990s.	No.	(Grant, 1996); (Lee 1994).
D.	Wakarara.	*matai, rimu, miro.*	Unknown	Yes.	(Grant, 1996).
	Wakarara.	*red beech, matai, rimu, kahikatea.*	Unknown	Yes.	(Grant, 1996).
	Wakarara.	*matai, totara.*	Unknown	Yes.	(Grant, 1996).
E.	Evertree Bush.	*totara,* rimu, matai***, miro, black beech.	1990s.	No.	(Grant, 1996).
F.	Holden's Bush.	*kahikatea, matai, totara*, tawa, mapou, rewarewa, supplejack.	1990s.	No.	(Grant, 1996).
G.	Hampden Bush.	*totara, matai, kahikatea, rimu.*	c.1860s.	Yes.	(Grant, 1996).
H.	Peak Station.	*totara, kahikatea, matai,* hinau, kotukutuku, maire, tawa, supplejack, rimu.	1850s.	Yes.	(Grant, 1996); (Lee 1994).
I.	Condor.	*totara,* matai, kahikatea, rimu.	1990s.	No.	(Grant 1996).
J.	Glen Appin.	*totara* (ridges); *matai, kahikatea* (gully bottoms).	1880s.	Yes.	(Grant 1996).
K.	A'Deanes Bush Scenic Reserve.	widespread rimu, tawa common, totara.	1990.	No.	(Grant, 1996).
L.	Inglis Bush Scenic Reserve.	predominantly kahikatea, matai scattered and totara occasional.	1990.	No.	(Grant, 1996).
M.	Ashley Clinton.	*matai****, rimu, kahikatea, totara, miro, hinau, maire, rewarewa, tawa, supplejack, tree rata, titoki, five finger, kamahi, beech.	c.1869.	Yes.	(Grant, 1996).
N.	Monckton Scenic Reserve.	black beech, matai, totara, kahikatea, rimu, kotukutuku, titoki, maire, pokaka, rangiora, hangehange, and mahoe.	1990.	No.	(Grant, 1996).

*Notes: ***** Refers to the era which the canopy tree composition description relates. ****** Refers to whether canopy tree composition description was made before logging. ******* Species to the left of this symbol are listed in order of frequency, as stated by the source. Species in italics are 'dominant' species, where dominance is stated by the source.*



A1	Whakarara Stn (flats)	G	Hampden Bush
A2	Whakarara Stn. (Hillslope)	H	Peak Stn.
B	Gwavas Forest	I	Condor
C	Gwavas Bush	J	Glen Appin
D	Whakarara (general)	K	A'Deanes Bush Scenic Reserve
E	Evertree Bush	L	Inglis Bush Scenic Reserve
F	Holden's Bush	M	Ashley Clinton
		N	Monckton Scenic Reserve

Notes: Circular shaped reference indicates general location of description.
Square shaped reference indicates specific location of description.

Figure 3-4: Layout of general and specific location descriptions of forest canopy composition with Unit C.

A compilation of known rare/endangered or geographically significant plants from the Hawke's Bay lowlands are presented in Appendix F.

3.4.4 Terrestrial fauna

3.4.4.1 Avifauna

This Catchment Unit has a very diverse habitat composition, with the majority of it being made up of exotic grassland, but in many areas this is interspersed with quite significant areas of indigenous forest. This is reflected in the fact that this Catchment Unit had quite a large number of SSWI and PNAP sites designated within it, holding the highest number of Recommended Areas for Protection (RAP) compared to any other Catchment Unit by far (Table 3-7).

The remaining forested patches and regenerating shrubland areas are very important within this mosaic-like landscape. They provide corridors for many of the endemic and native species to move through, and due to altitudinal variation probably provide food sources at slightly different times of the year, allowing more mobile species to move around the catchment unit to where food is currently on offer. This is certainly the case for species like pigeon, tui and bellbird, but may also be important for kaka. Some of the regenerating habitats on farms like Smedley Station are quite massive, and provide significant areas of land for these more common species. For species like whitehead and tomtit these sites are the only places outside of the main forested Ruahine Range where they exist within this catchment.

Although small the Makaroro oxbow[159] and the Makaroro Heath[160] are very rare habitat types, that are clearly favoured and utilized by fernbird.

The importance of exotic forest should also be recognized. Robin, tomtit, whitehead, and even fernbird utilize these areas, or micro-habitats within these forests, and they are likely to hold considerable populations of these birds in some places.

The riverbed habitats within this catchment unit are also home to considerable numbers of birds. Although numbers of riverbed nesting species such as pied stilt, banded dotterel, and black-fronted dotterel are probably relatively low, they should still be considered with regards to management of these areas, and opportunities to control invasive weeds (which will of course have downstream effects) and predators should not be ignored.

The historic records of Northern brown kiwi reported for this Catchment Unit refer to releases of kiwi taken from Northland and released at Puahanui (Gwavas Station Wildlife Reserve) during the early 1980s, with the suggestion that 16 were released up until 1984. This was done in a very adhoc manner by locals and was not sufficiently monitored to understand what happened to these birds post release. However, it is suggested that reports of kiwi around the district have happened on an infrequent basis, and are likely to be these birds. Presence of weka is mentioned in some local literature, but it is likely that these reports are actually of historic records of birds in the area during the 1930-40s. As the distribution of this species shrunk within the North Island, and they became extinct in the region. Neither Northern brown kiwi or weka is now suggested to be within this Catchment Unit.

New Zealand grebe (dabchick) is known from at least one site within this catchment unit (Te Heka Pond), although this unit appears not to be a stronghold for them (see Appendix G). This may be due to the fact that there are perhaps less farm ponds that provide cover for this species to breed on, or could actually be due to the fact that the 1992 dabchick survey was conducted during mid-April when birds have potentially left breeding sites and have dispersed to lower altitudes and large ponds for the winter. It would be worth conducting a full survey of the regions ponds and lakes at the time of breeding to determine where the key sites are for this species during the breeding season.

Australasian bittern have not been recorded within this catchment unit, although habitat for this species is limited, they may occur sporadically. There are certainly no known breeding sites for this species within this catchment unit at this stage.

Blue duck almost certainly occur infrequently in this catchment unit, within the upper sections of the Makaroro River in particular. Juveniles are known to disperse widely[161], and anecdotal reports suggest they may have been seen around the Makaroro/Dutch Creek confluence in the past.

New Zealand falcon is common throughout this area, with a number of records of birds throughout the Wakarara Range, Triplex Creek, and Gwavas Forest (HB OSNZ records). During this work I also saw a

[159] See Photograph 39.
[160] See Photograph 40.
[161] Adams and Abbott, 1992.

falcon at the Makaroro/Dutch Creek confluence, a bird at the Trig on Smedley Station (also seen independently by Adam Forbes), and heard a different bird on the northern edge of Smedley Station and the southern Wakararas. Again this edge habitat, with a good diversity of habitats, is prime falcon country and there are probably a lot of breeding pairs throughout the western and northern sections of this catchment unit. The pine forest within Gwavas Forest is also very good habitat for them, and probably has a relatively high density of falcon pairs in younger stands of forest.

Spotless crakes have not been recorded in this Catchment Unit, but are likely to exist in the right habitat. The old river oxbow on the true right of the Makaroro River just off Wakarara Road (herein called the Makaroro oxbow) is the sort of habitat they might exist, and other patches of wetland habitat should be checked for them.

The rivers within this Catchment Unit hold both banded and black-fronted dotterel, and farm ponds with large muddy margins and wet-boggy fields are also likely to hold black-fronted dotterel. Likewise the stretches of riverbed and associated wet fields, farm ponds (etc) are likely to be good habitat for pied stilt.

New Zealand pigeon are common throughout the Catchment Unit, being recorded in many of the forest patches during SSWI and PNAP surveys, and at most of the forest patches visited during this survey (e.g. Smedley Station, Mangatewai River RAP, Makaroro River/Dutch Creek confluence, A'Deane's Bush, and the Barnsdale RAPs). Being such large mobile birds they are well distributed through the Catchment Unit, and are important seed-dispersers. Likewise, tui and bellbird are widespread through this Catchment Unit, again with good numbers of these two important species in all of the forest patches investigated for this project, and many of those surveyed during the SSWI and PNAP surveys.

Kaka were reported from the Barnsdale RAPs by the owners, who said that a 'pair' of birds had visited during the late winter/spring of 2010, and other reports of birds from the Wakarara Ranges (HB OSNZ records) and A'Deane's Bush exist. These are likely birds that have moved out of the Ruahine Ranges during the winter, when food may be limited or weather becomes a factor, and therefore lower altitude forest patches that hold good food resources could well be important for this species.

Parakeets, almost certainly yellow-crowned rather than red-crowned, are reported from the Triplex Creek area (HB OSNZ records), but have not been reported away from the main range. It is unlikely that they stray too far from this continuous forest, and are unlikely to survive well in isolated forest patches. Long-tailed cuckoo on the other hand may well be found in the forested areas around the Wakararas and Smedley Station area where whitehead (their main host species) are known to exist, and shining cuckoo are likewise probably even more widespread, being found where grey warbler (their most common host species) are found. Shining cuckoo were heard at several locations on Smedley Station, but other forest patches were visited whilst shining cuckoo were not present (being a migrant that is only usually present in New Zealand from September to March). Rifleman were not detected in any of the forest patches away from the range (A'Deane's Bush, Mangatewai River RAP, Barnsdale RAPs, Smedley Station, Makaroro/Dutch Creek confluence) and apparently are not present in Puahanui (Gwavas Station Wildlife Reserve), although they are common around the Triplex Hut area (HB OSNZ records). However, tomtit were found to be very common on the bush and scrub fragments on Smedley Station, and have been reported previously from Gwavas Forest (HB OSNZ records) and one or two records come from Puahanui (Gwavas Station Wildlife Reserve). Recent records of robin also come from Gwavas Forest also (HB OSNZ records), but from not other forest patches within the Catchment Unit.

Pipit are known to occur in the Gwavas Forest area also (HB OSNZ records), and are also very likely to be found in the rough pasture areas within this Catchment Unit, and were recorded on the Tukituki and Waipawa Riverbeds during the surveys there in the 1980-90s.

Fernbird are unlikely to be found throughout most of the Catchment Unit, as the right habitat for this species does not exist in most places. However, they are known also from Gwavas Forest (HB OSNZ records), probably from wetter areas where sedges/raupo wetland or manuka shrubland still exists, often in combination with blackberry thickets or other weedy areas. Fernbird appear to be quite good dispersers, and as long as shrubland or forested corridor areas exist, they seem to be able to find their way into the right sort of habitat where they can survive and breed. Slightly different is the Makaroro oxbow swamp, just under a kilometre upstream from the Makaroro Road bridge. This small and rather insignificant looking swamp (which can be seen from Wakarara Road) had at least 3-4 birds calling within it when checked during this survey. There is almost certainly a relatively stable population of birds within this site, which lies approximately 7km from the base of the Ruahine Range. It is also possible that spotless crake occur at this site. A further report of fernbird comes from just upstream of

the Makaroro River Dutch Creek confluence on Dutch Creek, where an area of shrubland, called the Makaroro Heath exists. During the SSWI surveys fernbird were noted for this site.

The more common forest birds, such as fantail, grey warbler, silvereye, were seen at most of the sites visited during this survey, and recorded at many of the other sites during the SSWI and PNAP surveys. They are likely to be found through a range of habitats including the indigenous forested areas, shrubland, exotic forests, and throughout riparian vegetation.

3.4.4.2 Herpetofauna

Species present or likely to be present

Common skinks, common geckos, southern North Island forest geckos, Wellington green geckos. Possibly also spotted and southern North Island speckled skinks. Potential for sparse occurrence of small-scaled skinks.

Herpetofauna database records

Wellington green gecko, Eastern Ruahine State Forest; Common gecko, Tributary of Makaroro River, Wakarara Range; Forest gecko and unidentified skink, Gwavas Conservation Area, Wakarara Range; Unidentified gecko sp., Inglis Bush Scenic Reserve and White Pine Station.

Survey results

Kanuka and native broadleaf forest bordering pasture, Smedley Station / Wakarara Range:

No lizards were found during a spotlight survey performed at the forest-pasture edge close to Onduline transect A between 11:27pm and 12:45am (6.25 person hours), despite optimal weather conditions (temperature: 13.7-19.8°C, relative humidity: 69.9-90%, cloud cover 0-2/8, wind 0-1 Beaufort Scale, barometric pressure 925.4 hPa, new moon).

However, 5 common geckos and 11 common skinks were found under Onduline ACOs. All lizards were found in transects B and C, none were found in transect A. Transects B and C bordered on older broadleaf forest and surrounded small rock outcrops (<2m high) and boulders in the grass (~ 200 mm across). The grass is grazed but tended to be longer around the rocks, potentially explaining the higher abundance of skinks. Of the common geckos found, two were juveniles, two were adults (1 male, 1 unknown sex) and one was of unknown life stage (escaped). Of the skinks, there was: one neonate, two sub-adults, six adults and two small skinks of unknown life stage (probably neonates or juveniles). Most lizards were the sole occupant of a cover, apart from two common geckos that were found under the same cover.

Inglis Bush

No lizards were recorded during the check on 7 September 2011. A low diversity of invertebrates was noted under the covers, with the predominant taxa being sheetweb spiders (*Cambridgea* spp.). A repeat visit will be undertaken during November during warmer weather conditions.

3.4.4.3 Other records

An unidentified lizard was seen on the pasture edge of A'Deanes Bush Scenic Reserve by Kay Griffiths in 2011.

3.5 Catchment Unit D

3.5.1 Overview of landform, geology and soil

3.5.1.1 Landform

Catchment Unit D is characterized by flat plains, flood plains and gently undulating plains of the Ruataniwha Plains, the Hatuma Basin and the flat land to the north east of Waipukarau, around the confluence of the Waipawa and Tukituki Rivers. These landforms have alluvial origins. Intermediate terraces of around 10,000 years old make up the majority of the Ruataniwhai Plains, along with a lesser proportion of Low Terraces, which generally follow the course of existing water courses.

Slopes on plain landforms are <5°. Altitudes vary across the Unit from around 400m a.s.l in the extreme southwest, reducing in an eastern direction across the plains to 240m a.s.l at Takapau, 200m a.s.l at Ongaonga, 140m a.s.l at Waipukurau and 100m a.s.l at the eastern extent of the Catchment Unit, on the Tukituki River around River Road.

In smaller proportions, yet also prominent on the landscape is the easy rolling and undulating hill landforms which collectively make up around 10% of the catchment unit area. Highest points on hill landforms within the Catchment Unit are Wairakai (310m a.s.l) and Mount Vernon (309m a.s.l). Slopes on those hill landforms are generally 5° to 10°. A band of Remnant High Terraces run along the hills to the northwest of Hatuma settlement.

The main shingle waterways flowing through the Catchment Unit are the Mangaonuku Stream, Waipawa River, Tukituki River, Tukipo River, Mangatewai River and Makaretu River[162].

3.5.1.2 Geology and soils

Geology within the catchment unit is greywacke basement and localised areas of limestone around the unit's eastern hills.

The soils of the Ruataniwha Plains are described in detail by Griffiths[163], and a description of soils for that area is not repeated here.

Soils of the easy rolling hills around Hatuma and to the North of the Tukituki River are imperfectly drained of moderate fertility formed from mudstone (and calcareous mudstone), sandstone and argillite.

Soils in and around the Hatuma Basin are characteristically imperfectly drained with low fertility formed from loess with some dune sand and tephra.

3.5.2 Climate

The climate of the Catchment Unit typically features warm temperature, high solar radiation, and moderate to low annual water deficits. Areas of easy rolling hills near Hatuma feature mild temperatures, moderate vapour pressure deficits and low annual water deficits.

3.5.3 Land cover and flora

3.5.3.1 Land cover

Over 90% of the Catchment Unit is occupied by high producing exotic grassland[164]. Riparian edge protection plantings and riparian forests associated with the main waterways and Lake Hatuma contribute a notable proportion of exotic forest[165]. Orchards and other perennial crops cover a little over 1% of the Catchment Unit[166]. Gravels associated with riverbeds, and small areas of exotic plantation

[162] See Photographs 41 to 48.
[163] Griffiths, 2004.
[164] See Photographs 49, 50 and 51.
[165] See Photographs 52 and 53 (respectively).
[166] See Photograph 54.

forest are two land cover types which each occupy a little less than 1% of the Catchment Unit area. Short-rotation cropland covers less than 1% of the Catchment Unit[167].

Indigenous vegetation cover is very scarce, covering only around 355ha, or 0.41% of the Catchment Unit. It is represented by small isolated podocarp-broadleaved forests and treeland and kanuka forest and treeland characteristically located on alluvial landforms.

Table 3-17: Catchment Unit D land cover type, area and percentage of Unit's cover.

LCDB2 'Name'	LCDB2 '1st Order Class'	Area (ha)	% of Unit
Exotic grassland and scrub			
High Producing Exotic Grassland	Primarily Pastoral	80,631.22	92.76
Low Producing Grassland	Primarily Pastoral	54.43	0.06
Gorse and Broom	Scrub	41.50	0.05
Mixed Exotic Shrubland	Scrub	9.33	0.01
Horticultural crops			
Orchard and Other Perennial Crops	Primarily Horticulture	760.69	0.88
Short-rotation Cropland	Primarily Horticulture	497.53	0.57
Vineyard	Primarily Horticulture	27.09	0.03
Indigenous vegetation			
Indigenous Forest	Indigenous Forest	214.03	0.25
Herbaceous Freshwater Vegetation†	Inland Wetland	62.89	0.07
Broadleaved Indigenous Hardwoods	Scrub	61.99	0.07
Manuka and or Kanuka	Scrub	16.36	0.02
Exotic forest			
Deciduous Hardwoods	Willows and Poplars	1,436.85	1.65
Major Shelterbelts	Shelterbelts	451.57	0.52
Other Exotic Forest	Planted Forest	273.12	0.31
Pine Forest - Closed Canopy	Planted Forest	258.84	0.30
Pine Forest - Open Canopy	Planted Forest	101.19	0.12
Afforestation (not imaged)	Planted Forest	7.52	0.01
Afforestation (imaged, post LCDB 1)	Planted Forest	6.61	0.01
Forest Harvested	Planted Forest	0.77	<0.01
Bare ground			
River and Lakeshore Gravel and Rock	Bare Ground	696.88	0.80
Urban			
Built-up Area	Urban Area	483.43	0.56
Urban Parkland/ Open Space	Urban Open Space	210.15	0.24
Inland water			

[167] See Photographs 55 and 56 for an example of this land cover type.

LCDB2 'Name'	LCDB2 '1st Order Class'	Area (ha)	% of Unit
River	Inland Water	365.72	0.42
Lake and Pond†	Inland Water	210.80	0.24
Extractive and filling land uses			
Surface Mine	Mines and Dumps	23.87	0.03
Transport Infrastructure	Mines and Dumps	15.71	0.02

† Also refer Table 3-4 for total wetland area per Catchment Unit.

3.5.3.2 Flora

Terrestrial indigenous flora within the Unit include treelands of pure kanuka[168] on alluvial plains[169]. Treeland also comprising kowhai (*Sophora tetraptera*) and occasional broadleaved and podocarp species is also present.

Tukituki Scenic Reserve is representative of podocarp-broadleaved forest within Catchment Unit D[170]. Titoki and mahoe are the main species. Kahikatea and matai are dominant podocarps, often emergent above the broadleaved canopy. Specimens of those podocarp species up to around 380 years old are present[171]. While this forest remnant has a well developed structure, little information is available on the flora values it supports.

Indigenous cover is also represented in freshwater herbaceous vegetation associated with wetlands.

Given the scarcity of indigenous cover within the Catchment Unit, any remaining indigenous specimens are ecologically important.

3.5.4 Terrestrial fauna

3.5.4.1 Avifauna

This catchment unit has a much altered landscape, with relatively few patches of indigenous forest or shrubland, and even relatively small amounts of exotic forest. The catchment unit is largely composed of high producing exotic grassland, which may provide habitat for common open country species such as spur-winged plover, paradise duck, and magpie, and the various introduced finches, but provide little attraction for most of the species listed as threatened in Table 3-8.

However, the riverbed within this catchment unit provides a massive amount of breeding and feeding habitat for some key species, including pied stilt, banded dotterel, and New Zealand pipit. These species favour open riverbed with low density of invasive weeds (which provide cover for introduced predators), and this habitat needs to be managed appropriately for these values. This river is significant from both the amount of available habitat and the numbers of riverbed birds that have been reported from it in the past. This will be discussed fully in Section 5.1.1 below.

Only two indigenous forest patches exist in this catchment unit, as noted by the SSWI and PNAP surveys (Eastern Equities, Tukituki Scenic Reserve) (Appendix H), but these are very degraded and need considerable work to manage them. The fact that there is so little surviving makes these two sites of greater importance.

Perhaps the site of greatest importance in the catchment unit is Lake Hatuma, which provides a large area of undisturbed habitat for the Nationally Endangered bittern, as well as significant areas of habitat for other waterfowl, including probably a third of the Hawke's Bay population of dabchick. Other species such as Royal spoonbill, grey duck, spotless crake, pied stilt, Caspian tern and more common forest species also use this very important site.

[168] RAP35 (H).
[169] See Photograph 57.
[170] See Photograph 58.
[171] Grant, 1996.

Dabchick are found throughout this catchment unit, with probably the most notable habitat for this species being Lake Hatuma. This site contains probably at least a third of the Hawke's Bay dabchick population during the autumn/winter months, with around 55 in June 1990 (HB OSNZ records) and during the dabchick survey in 1992 finding 121 birds (36% of the Hawke's Bay population) here (Appendix G, HB OSNZ records). It has been suggested that up to 300 birds have been recorded at this site during winter[172], questioning the results of the 1992 survey which found a total of 335 for Hawke's Bay. This may be related to timing of the counts, or could reflect a substantial increase in numbers between the two counts. Whichever, this site is still of major significance for this species, and the catchment unit as a whole is of importance. During the 1992 survey two other sites had a total of 9 dabchick, with the Tralee Pond (7) and the Argyll Pond (2) both containing birds. During the SSWI and PNAP surveys these two sites, plus the Arlington Road Pond, Hononga Dam, and the Mangaterata Dams were identified as having dabchick. During this work I encountered birds on Lake Hatuma and the Rotorunga Lakes, but did not investigate any of the other sites mentioned. Generally the sites that dabchick are found at have some vegetation on at least part of the shoreline to enable breeding, and they usually prefer quieter sites, although size of the water body varies greatly from the roughly 150 ha Lake Hatuma to the 1.3 ha Hononga Dam.

All three cormorant species are found within this catchment unit, both on the rivers and on many of the ponds and lakes. They breed in low numbers at several sites within this unit.

Great egret (white heron) has occurred irregularly at Lake Hatuma, and perhaps have appeared at other water bodies around the catchment unit infrequently. This is generally during the winter months when birds have migrated northwards from their only current breeding site in New Zealand at Okarito[173]. Royal spoonbill, doing similar migrations from their breeding sites in the South Island, were recorded at Lake Hatuma during this work, with 8 birds seen in September 2011. Although not of regional or National significance, management at this site should take into account the importance of it for long-legged wading birds.

Within this Catchment Unit Australasian bittern have been recorded at a number of wetland sites, but of most importance is the population at Lake Hatuma. This site currently appears to hold at least eight booming males (males make a loud deep 'booming' call to attract mates during the breeding season) around the fringes of the lake (J. Cheyne *pers comm*., *pers obs*), representing the largest booming male population of this species in Hawke's Bay, and possibly up to 40% of the regions booming males. It may also represent close to 5% of the National population if current estimates of around 500-700 birds[174] is accurate. This species is very cryptic and it is difficult to determine accurate numbers, but the National population is likely to be within this estimate, confirming the species threat status. During this work I was able to spend time at the site listening to these birds booming in an attempt to determine numbers of booming males, and was also able to kayak around parts of the lake. It is likely that numbers of females exceed the number of booming males of this polygynous species at this and other sites. There is much yet to learn about this difficult to study species, and a key step in managing this species is protecting habitat and learning more about their breeding ecology. Bittern have also been recorded at a number of other sites in the Unit, with individuals seen within the last few years at the Rotorunga Dams, Wilson Wetland, and end of Linburn Road, Tikokino. These sightings probably represent birds that have been pushed out of favoured breeding habitat due to dry summer conditions, as none are at recognized booming sites nor have enough thick wetland vegetation required for birds to breed in. Maintaining additional sites where birds can move to should their preferred sites become too dry is key to maintaining their population size, as is enhancing and protecting key sites such as Lake Hatuma.

New Zealand falcon, although probably not common throughout most of the Unit, are almost certainly found infrequently throughout the area. It is unlikely that the species breeds in any numbers in the Unit, but individuals, especially juveniles probably range throughout the Unit, especially during autumn and winter. They would range throughout rough pasture areas, and would probably especially associate with areas of shrubland or forest.

Spotless and Baillon's (marsh) crakes were included in a species list for Lake Hatuma[175], and it is known that spotless crake are still present at this site (J. Cheyne *pers comm*.). However, it is thought that

[172] Adams and Smith, 1998.
[173] Heather and Robertson, 2000.
[174] Heather and Robertson, 2000.
[175] Hobson, 2000.

marsh crake are probably not present at this site, nor at any other wetlands within this Unit. Enhancement of sites for bittern are likely to also favour crakes.

Pied stilt are likely to be quite common through this Unit. With the greater amount of braided river habitat within this catchment unit, this provides plenty of area for them to breed, and wetlands and ponds such as Lake Hatuma would all have the right sort of wading habitat for these birds. The Tukituki River visited at the Tamamu Bridge had pied stilt present, and this sort of habitat is representative of the river sections downstream of the SH50 road, on both the Tukituki and Waipawa Rivers. Areas of wet fields are also prime breeding sites for this species, and although not within this catchment, a site near Wanstead had 20+ pairs of pied stilts nesting in a flooded area. Places like the Wilson wetland where wetlands have been recreated would provide breeding and feeding habitat for good numbers of pairs.

Likewise, the increase in available riverbed habitat means that the number of banded and black-fronted dotterels greatly increases within this Unit. Black-fronted dotterel favour similar habitats to pied stilt, and so ponds and lakes with muddy margins are useful for them, as well as the shingle riverbeds. Especially during the autumn and winter when flocking these can be key sites, with Lake Hatuma being a well known site for them, as well as the oxidation ponds at Waipawa and Waipukurau. Banded dotterel throughout this Unit are mainly found on the shingle riverbed habitat, but with considerable available habitat this Unit is a key location for them. Open braided sections are favoured by this latter species.

Caspian terns are regularly seen from the SH2 road bridge crossing the Waipawa River at Waipawa (up to 5 seen at once during this work) (HB OSNZ records, *pers obs*), and I also saw a bird roosting on the riverbed at Tamamu on the Tukituki River during this work. It is unknown whether birds actually breed on the riverbed, or whether they are just feeding over the river, and this warrants further investigation. River surveys at the right time of year are key to determining this. Caspian terns are also seen at Lake Hatuma, and may be the same birds that are seen using the rivers, as this site is located a very short distance (about 3km) from the Tukituki River.

New Zealand pigeon and the other mobile forest species such as tui and bellbird are found throughout this Unit in good numbers. They favour the native forested areas, and were seen at the Makeretu River proposed water storage site in good numbers. They would also use much of the riparian strip along the river corridor, especially in the early spring when the willows and other palatable plant species are starting to come into leaf. Tui and bellbird would similarly use riparian strips, forest fragments, and even urban gardens in Waipawa and Waipukurau when food sources are available, and birds were seen at Lake Hatuma, the Makeretu River proposed water storage site, and the Tamamu bridge area.

Kaka have been reported using the Waipawa township in the past (for almost two months during winter 1998) (HB OSNZ records), and as with sightings within Unit C, these are likely to be birds that have moved out from the Ruahine Ranges during winter to find food sources at lower altitude. Although numbers involved in these movements are not large, it is likely that numbers in the Ruahines are actually not large, so these birds and their movements should still be considered important.

Long-tailed cuckoo probably occasionally occur within this Unit, but with no whitehead for them to use as nest hosts, they are not likely to spend a lot of time in this Unit. The other common forest birds such as grey warbler, fantail and silvereye, are found throughout the Unit within small native forest fragments, exotic forest patches, and riparian vegetation, as well as urban gardens and shelterbelts.

New Zealand pipit are probably relatively common on riverbeds and rougher pasture within this Unit, with birds being found on the river at the Tamamu bridge, and almost certainly at other sites like the Makeretu River proposed water storage site. Fernbird however are probably not found within this Unit, nor are tomtit or rifleman.

3.5.4.2 Herpetofauna

Species present or likely to be present

Common skink, common gecko, Wellington green geckos, possibly southern North Island speckled and spotted skinks along the cobbled riparian margins.

Herpetofauna database records

Wellington green gecko - Waipawa, Southern Hawke's Bay.

Survey results

No surveys were conducted in this catchment unit.

Other records

No public records of lizards were obtained for this area.

3.6 Catchment Unit E

3.6.1 Overview of landform, geology and soil

3.6.1.1 Landform

Catchment Unit E contains the area of hill country at the southern extent of the Tukituki Catchment. It extends from near Takapau in the west to within 5km of the Pacific Ocean at its most eastern part.

Landforms are predominantly easy rolling and rolling hills. A small proportion of the Unit contains strongly rolling or steep hills. Relatively small areas of gently undulating and flat plains occur in some valley floors. Slopes within the Unit are typically 5° to 10°. The valley around Omakere and the Mangamahaki Stream valley contain plains of 0° to 5°. Steeper slopes are associated with (from west to east) Rangitoto (604m a.s.l) and surrounding hills, Turiri Range (The Peak 484m a.s.l), the sequence of high points Ben Lomond (320m a.s.l), Mt Carlyon (394m a.s.l), Two Peaks (358m a.s.l), and at the eastern boundary of the Unit, Omakere (500m a.s.l). These areas feature slopes between 10° to 15°, and occasionally between 15° and 20°.

Altitudes range from around 120m a.s.l in northern areas of the Unit to the elevations listed above, the highest peak being Rangitoto, at 604m a.s.l. Much of the rolling hill country of the Unit lies at between 140m a.s.l and 300m a.s.l.

The most prominent waterways draining the Unit are (from west to east) the Maharakeke Stream, Tangatupura Stream, Mangarouhi Stream, Omakere Stream and Mangamahaki Stream.

3.6.1.2 Geology and soils

The Geology of the Catchment Unit is characterized by mudstones, sandstones and argillite. The moderately hard, light grey upper Cretaceous 'Whangai' argillite occurs within the Unit. Being harder than the surrounding mudstone it forms more elevated steeper country.

Soils are predominately imperfectly drained of moderate fertility from mudstone, sandstone and argillite. Variants of this are well drained soils of low fertility on strongly rolling hills, and well drained soils of low fertility from greywacke and argillite. Soils with origins from alluvial processes are associated with the landforms of various waterway valleys.

3.6.2 Climate

Climate features characteristically mild temperatures, high solar radiation, moderate vapour pressure deficits, low annual water deficits, dry foehn northwest winds, and average annual rainfall of 1,000 to 1,500mm with maximum rainfall occurring in winter.

3.6.3 Land cover and flora

3.6.3.1 Land cover

Almost 97% of the Unit's land cover is pastoral high producing exotic grassland. Around 1.3% of the Unit's area contains plantation forests. Plantation forests are typically *Pinus radiata* of <60ha in area, and set within a pastoral matrix.

Indigenous cover makes up less than 1% (630ha) of the Unit's area. Indigenous cover can be broken down as manuka/kanuka (0.58%; 419ha), indigenous forest (0.18%; 128ha), broadleaved indigenous hardwood (0.09; 64ha), grey scrub (0.02%; 11.10ha), fernland (0.01%; 4.75ha) and herbaceous

freshwater vegetation (<0.01%; 2.44ha). Terrestrial indigenous cover is associated with both hill and alluvial landforms[176].

Table 3-18: Catchment Unit E land cover type, area and percentage of Unit's cover.

LCDB2 'Name'	LCDB2 '1st Order Class'	Area (ha)	% of Unit
Exotic grassland and scrub			
High Producing Exotic Grassland	Primarily Pastoral	69,612.28	96.79
Low Producing Grassland	Primarily Pastoral	186.37	0.26
Gorse and Broom	Scrub	4.10	0.01
Exotic forest			
Pine Forest - Open Canopy	Planted Forest	350.47	0.49
Deciduous Hardwoods	Willows and Poplars	299.92	0.42
Pine Forest - Closed Canopy	Planted Forest	292.80	0.41
Other Exotic Forest	Planted Forest	261.12	0.36
Afforestation (imaged, post LCDB 1)	Planted Forest	39.65	0.06
Major Shelterbelts	Shelterbelts	35.82	0.05
Forest Harvested	Planted Forest	28.47	0.04
Afforestation (not imaged)	Planted Forest	1.86	<0.01
Indigenous vegetation			
Manuka and or Kanuka	Scrub	419.49	0.58
Indigenous Forest	Indigenous Forest	128.23	0.18
Broadleaved Indigenous Hardwoods	Scrub	64.18	0.09
Grey Scrub	Scrub	11.10	0.02
Fernland	Scrub	4.75	0.01
Herbaceous Freshwater Vegetation†	Inland Wetland	2.44	<0.01
Bare ground			
River and Lakeshore Gravel and Rock	Bare Ground	18.66	0.03
Landslide	Bare Ground	2.66	0.00
Inland water			
Lake and Pond†	Inland Water	155.05	0.22
Extractive and filling land uses			
Dump	Mines and Dumps	3.73	0.01

† Also refer Table 3-4 for total wetland area per Catchment Unit.

[176] See Photograph 59 for indigenous forest associated with hill slopes, and 60 for forest associated with alluvial landforms.

3.6.3.2 Flora

Species composition and forest structure varies considerably depending on landform and geological influences.

According to Maxwell *et al*[177]:

General podocarp-broadleaved forest composition, characteristic of mudstone

> *Faces and gullies of mudstone support very mixed forest which commonly include tawa, titoki, rewarewa, lacebark, cabbage tree, kanuka, kaikomako, pigeonwood, hinau, mahoe, lancewood, lemonwood, kahikatea and totara.*

General podocarp-broadleaved forest composition, characteristic of alluvial terraces

> *Alluvial terraces extending across intervening valleys support forests dominated by the podocarps kahikatea, totara and matai, with scattered broadleaved trees such as titoki, black maire, white maire, narrow-leaved maire, cabbage tree, lacebark, narrow-leaved lacebark, ribbonwood, kowhai and many small leaved understorey trees and shrubs including the vulnerable Pittosporum obcordatum.*

General indigenous forest composition, characteristic of steep Whangai argillite

> *On steeper hill country of Whangai argillite tawa-dominated forest with rimu, matai, miro, kahikatea and totara, is present.*[178]
>
> *Some large areas of manuka and/or kanuka forest and scrub also cover Whangai argillite hill country. Smaller areas occur on less steep mudstone hill country. In some places the forest and scrub contains a considerable range of broadleaved and podocarp species, and is at an advanced stage of regeneration to taller mixed forest.*

Cabbage tree treeland, characteristic of former forested sites

> *A distinctive feature of contemporary Eastern Hawke's Bay is the abundance of cabbage tree, scattered throughout very modified landscapes. They are living reminders of departed forests, but few are as yet protected.*

Specific site descriptions

Mangarouhi Stream-Waiwhero Stream (RAP15 (E))

> *Twelve small forest remnants in the Mangarouhi and Waiwhero valleys constitute this RAP*[179]*. Mangarouhi and Waihero Streams meander through very subdued, lower-mid Miocene mudstone hill country. Their valleys are wide and alluvial terraces extensive. Forest remnants are on terraces, terrace risers and faces. Five sites are continuous over more than one terrace.*
>
> *Kahikatea-totara-matai-mixed broadleaved forest (75%):*
>
> *Occurs on terraces and gently sloping terrace risers. Dominated by kahikatea, totara and matai, with some broadleaved trees including lacebark, narrow-leaved lacebark, cabbage trees, black maire, white maire, narrow-leaved maire, ribbonwood and kowhai (Sophora tetraptera). At areas 1 and 2 this forest type is primary: podocarps with diameters of 1-2m are common forming a canopy up to 25m high, and broadleaved trees are scattered beneath. All large podocarps have been logged from other remnants of this forest type.*
>
> *At areas 4-8 secondary podocarps 10-15m high form a canopy with the broadleaved trees. At area 11 podocarps 2-14m high, with average diameter of ~30cm, form the canopy, beneath which the broadleaved trees form a very discontinuous subcanopy.*
>
> *A lower forest tier is composed of small leaved tree species. This tier, generally over 2-3m high includes Melicope simplex, Melicytus micranthus, Coprosma virescens, C. rigida, C. propinqua, C. propinqua x robusta, C. crassiflora, Corokia cotoneaster, Lophomyrtus obcordata, Myrsine divaricata, Streblus heterophyllus, Pseudapanax anomalus and Elaeocarpus hookerianus.*

[177] Maxwell *et al*, 1993.
[178] It is unclear how relevant this forest type is to Catchment Unit E.
[179] See Photograph 60 (also).

Of great significance is the presence also of heart-leaved kohuhu (Pittosporum obcordatum), which is classified as Vulnerable. Over 200 individuals have been counted at this RAP, including the largest individual of the species on record (~9m high, and with a diameter of ~30cm).

Other regionally rare plants in this RAP are Coprosma violacea, Fuchisa percandens and the mistletoe Korthalsella lindsayi.

Totara forest (20%):

Totara forest occurs on faces and terrace risers. Totara, 8-10m high, generally forms 90% of the canopy. Other species scattered in the canopy are cabbage trees, lacebark, kowhai and black maire. Kahikatea and matai are rare. The understorey is very open, with a few trees and shrubs including kohuhu, Melicope simplex and Myrsine divaricata.

Titoki forest (5%):

Titoki forest dominates area 7, and there is a small amount of this forest type on the highest terrace at area 4. As well as titoki, other trees present include cabbage trees, kowhai and lacebark. The understorey is open, with a few small leaved trees and shrubs.

Motuataraia (RAP18 (E))

Hill country of upper Cretaceous Whangai argillite, that is dissected by deeply entrenched streams. Most native vegetation is in or adjacent to gullies[180]*.*

Kanuka-manuka forest and scrub:

Kanuka and manuka 1-10m high form the canopy. As well as being of variable height the canopy also varies in proportions of these two species; in some areas tall kanuka forest is present, with especially large kanuka at the bottoms of some gullies.

In other areas the canopy is a mosaic with both species common and scattered kanuka emergent. In still other areas manuka is the dominant species. Other broadleaved species in or emerging from the canopy are rewarewa and cabbage tree, but these are restricted in number. The understorey is mostly moderately dense, but is very dense in some parts and quite open in others. It is dominated by the shrubs Coprosma rhamnoides, Helichrysum lanceolatum and Leucopogon fasciculatus, but also contains kanuka and manuka. At the bottoms of gullies, mamaku, ponga, mahoe, Coprosma robusta and rangiora are also commonly included in the understorey. The ground cover consists mainly of pasture grass and herbs, moss, leaf litter and scattered ferns.

Note that only the parts of the northern area of Motuataraia are within the Tukituki Catchment. Widespread spray damage to the forest canopy of this RAP was observed during the February 2011 aerial survey.

Bush Trig (RAP19 (E))

Hill country of lower Miocene mudstone.

Tawa-titoki-kahikatea-totara forest:

Five of the largest remnants of this forest type surrounding Bush Trig constitute this RAP. At each area there are a few emergent totara and/or kahikatea, which are over 20m tall and have a diameter of up to ~2m, and at area 1 there is also a large rimu. The canopy is mostly tawa, titoki and secondary kahikatea and totara ~12m tall. The proportions of these species vary between areas.

Other more common canopy or subcanopy trees are mahoe, lacebark, lancewood and rewarewa. At area 4 there is much ngaio and kaikomako also.

Area 1 has been fenced for 2-3 years. The understorey is moderately dense there and is dominated by supplejack, Coprosma areolata, ground ferns, kawakawa (no higher than about 1 metre) and seedlings and saplings of canopy trees (also no higher than ~1m).

[180] See Photographs 61 and 62.

In other areas the same species dominate the understorey but it is much more open, and the ground is very trampled by stock, with cover being restricted to leaf litter and a few scattered ferns.

3.6.4 Terrestrial fauna

3.6.4.1 Avifauna

The few forest fragments that do currently still exist within this hugely modified landscape are of critical importance for bird values within this catchment unit. They provide at least small pockets of habitat for the more common forest species.

Likewise, and probably more importantly, the wetland areas that provide habitat for waterfowl including dabchick, and spotless crake, are of great importance and should be protected adequately to ensure their survival.

Dabchick are present on small farm ponds and lakes throughout this Catchment Unit, with previous records during the dabchick survey in 1992 coming from the Clareinch Road Lake (10), Long Range Lake (9), and Lake Papatika (3) (HB OSNZ records). Previously during the SSWI and PNAP surveys they were additionally reported from Oteka Lake, Te Parae Pond, Tehiwi Pond, and 40 acre Swamp. During this work I visited Long Range Lake and saw one bird, and also found two pairs of dabchick on Nicholls Road Pond 1. It is likely that they are fairly widespread still through this Catchment Unit.

The three species of shags were also seen at a wide range of sites through this Catchment Unit, and as with other areas would utilize the rivers, farm ponds, and lakes within this Unit.

Australasian bittern have only been recorded at one site in this Catchment Unit recently, on a farm pond near Mount Spencer on Farm Road, east of Waipukurau (near the Central Hawke's Bay Landfill site) (J. Cheyne pers comm). This is likely to be a bird looking for feeding habitat due to its favoured site being dry, or a young bird that is dispersing from its natal territory. Lake Oteka also had bittern reported when the SSWI surveys were being conducted, as did the Nicholls Road Ponds. However, there are currently very few sites of note in this catchment unit that would be capable of supporting booming males. Long Range Lake is perhaps the exception, although at this stage it is far too open with grazed edges and not enough dense raupo for birds to hide in.

Spotless crake have also been reported from Lake Oteka and Te Parae Pond, and are probably still present as long as raupo cover is still present. They demand much smaller areas of raupo and dense cover than bittern do.

Pied stilt, and banded and black-fronted dotterel again may be found along the sections of riverbed within this catchment unit, although there is actually very little of this habitat within this Unit. Pied stilt and black-fronted dotterel would be found in wetter pasture areas and along the muddy margins of farm ponds and lakes.

Caspian terns and are unlikely in this catchment unit.

Only a handful of sites, along two main stream valleys, the Mangarouhi and Waiwhero Stream and the Bushy Range on Farm Extension Road, hold any notable indigenous forest. Some sparse kanuka shrubland also exists, but is very limited. Even exotic forests are rare within the Unit. Thus, New Zealand pigeon and the other mobile forest species such as tui and bellbird are found throughout this Unit, but probably have small population sizes, and certainly very little habitat to utilize. Likewise, other smaller forest bird species probably cling to these forested sites, and other small stream valleys and farm ponds which may have scant riparian vegetation.

Neither rifleman, tomtit or fernbird are present in this catchment unit. New Zealand pipit is present, having been seen on rough pasture near some of the bush sites on Farm Extension Road.

Again the high producing exotic pasture would hold common open country species such as spur-winged plover, paradise duck, magpie, and the various introduced finches.

3.6.4.2 Herpetofauna

Species present or likely to be present

Common skink. Possibly common and Wellington green geckos.

Herpetofauna database records

No records exist for this catchment unit in the Herpetofauna database.

Survey results

No surveys carried out in this catchment unit.

Other records

No public records of lizards were obtained for this area.

3.7 Catchment Unit F

3.7.1 Overview of landform, geology and soil

3.7.1.1 Landform

A little over half of the catchment unit features undulating hills, and around 3% features easy rolling hills. Gently undulating and undulating plains occupy around 27% of the Unit, and flat plains and flat flood plains within valley floors occupy around 7% of the unit's area. Around 8% of the unit is occupied with strongly undulating plains and hills.

Plain landforms associated with valley floors are inherently low gradient (<5°), and slope angles of the majority of hill landforms range from 5° to 10°. Hills in the west of the unit, around the Argyle, Waipawa Hill and the Raukawa Range feature slopes between 10° and 15°. The eastern slopes of Kaokaoroa Range, the unnamed hill east of St Lawrence Road, eastern slopes of the Kohinurakau Range and hills flanking the western edge of the Maraetotara Plateau also feature slopes between 10° and 15°. Small areas of very steep ground (15° to 20°) occur around the ridgelines of the unnamed hill east of St Lawrence Road and on Silver Range[181].

Altitudes within the unit range from the highest point – Mt Kahuranaki 645m a.s.l – to sea level at the Tuituki River mouth. Highpoints and ridges of 300m a.s.l to 400m a.s.l are common.

A large number of waterways drain the Catchment Unit. Some of the more prominent are the Old Bed of the Waipawa River/Papanu Stream, Tukituki River main stem, Mangarara Stream, Makara Stream, Waipapa Stream and the Hawea Stream[182].

Talus[183] and boulderfields[184] are present where geology and slope permit.

3.7.1.2 Geology and soils

The geology of the catchment unit is characterized by mudstones, sandstone, argillite and limestone.

The majority of undulating hills of the unit features soils of imperfect drainage and moderate fertility formed from calcareous mudstone. Also a significant proportion of the units undulating hills feature soils derived from southern Hawke's Bay limestone and are of very high fertility. A little less than 10% of the unit features strongly undulating plains and hills of well drained soils formed from sandstone, limestone and greywacke, of very low fertility.

Floodplain landforms typically feature recent soils formed from alluvium and loess.

3.7.2 Climate

The climate of the unit features characteristically mild temperatures, moderate solar radiation, low annual water deficits and low monthly water balance ratios.

[181] See Photograph 63.
[182] See Photographs 64 to 70.
[183] See Photograph 71.
[184] See Photograph 72.

Average annual rainfall for Elsthorpe is 1,200mm. A steep gradient of increasing rainfall depth occurs from Elsthorpe to the higher ground in the east. Within a distance of 6 to 7km rainfall at the head of the Makara Stream exceeds 1,800mm and may exceed 2,000mm annually.

3.7.3 Land cover and flora

3.7.3.1 Land cover

Around 85% of the unit is occupied with exotic pasture grassland. A little over 5% of the Unit is occupied by pine plantations. Many of the plantations are small. Four relatively large pine plantations are present, the largest being c.770ha in area. This unit has the second highest area of plantation forest within the Tukituki Catchment, after Unit C[185].

A concentration of short rotation cropping land is present northeast of Otane, around Drumpeel Road. Orchards and other perennial crops are concentrated towards the coast, to the east of Havelock North and in the vicinity of Haumoana.

Indigenous cover only occupies around 1.3% of the Catchment Unit (830.4ha). Indigenous cover can be broken down as indigenous forest (0.67%; 421.12ha), broadleaved indigenous hardwoods (0.25%; 159.24ha), manuka/kanuka (0.22%; 140.04), herbaceous freshwater vegetation (0.13%; 79.85), grey scrub (0.03%; 21.57ha) and herbaceous saline vegetation (0.01%; 8.54ha).

Gravel associated with riverbeds, principally the Tukituki main stem occupies around 573ha (or 0.91% of the catchment unit).

Table 3-19: Catchment Unit F land cover type, area and percentage of Unit's cover.

LCDB2 'Name'	LCDB2 '1st Order Class'	Area (ha)	% of Unit
Exotic grassland and scrub			
High Producing Exotic Grassland	Primarily Pastoral	52,806.85	84.20
Low Producing Grassland	Primarily Pastoral	244.69	0.39
Gorse and Broom	Scrub	83.73	0.13
Mixed Exotic Shrubland	Scrub	80.38	0.13
Exotic forest			
Pine Forest – Open Canopy	Planted Forest	2,315.63	3.69
Deciduous Hardwoods	Willows and Poplars	975.73	1.56
Pine Forest – Closed Canopy	Planted Forest	627.41	1.00
Other Exotic Forest	Planted Forest	365.48	0.58
Forest Harvested	Planted Forest	213.28	0.34
Afforestation (imaged, post LCDB 1)	Planted Forest	98.45	0.16
Major Shelterbelts	Shelterbelts	66.98	0.11
Afforestation (not imaged)	Planted Forest	61.72	0.10
Horticulture			
Short-rotation Cropland	Primarily Horticulture	1,754.54	2.80
Orchard and Other Perennial Crops	Primarily Horticulture	530.67	0.85
Vineyard	Primarily Horticulture	338.60	0.54
Indigenous vegetation			

[185] See Photograph 73 for an example of exotic forest cover.

LCDB2 'Name'	LCDB2 '1st Order Class'	Area (ha)	% of Unit
Indigenous Forest	Indigenous Forest	421.12	0.67
Broadleaved Indigenous Hardwoods	Scrub	159.24	0.25
Manuka and or Kanuka	Scrub	140.04	0.22
Herbaceous Freshwater Vegetation†	Inland Wetland	79.85	0.13
Grey Scrub	Scrub	21.57	0.03
Herbaceous Saline Vegetation†	Coastal Wetland	8.54	0.01
Bare ground			
River and Lakeshore Gravel and Rock	Bare Ground	572.59	0.91
Coastal Sand and Gravel	Coastal Sand	15.61	0.02
Inland water			
River	Inland Water	534.35	0.85
Lake and Pond†	Lake and Pond	87.38	0.14
Urban			
Built-up Area	Urban Area	97.37	0.16
Urban Parkland/ Open Space	Urban Open Space	7.27	0.01
Extractive and filling land uses			
Surface Mine	Mines and Dumps	5.84	0.01
Transport Infrastructure	Mines and Dumps	1.01	<0.01

† Also refer Table 3-4 for total wetland area per Catchment Unit.

3.7.3.2 Flora

As with Catchment Unit E, floral species composition and vegetation structure varies considerably depending on landform and geological influences.

According to Maxwell *et al*[186]:

General podocarp-broadleaved forest composition, characteristic of mudstone

> *Faces and gullies of mudstone support very mixed forest which commonly include tawa, titoki, rewarewa, lacebark, cabbage tree, kanuka, kaikomako, pigeonwood, hinau, mahoe, lancewood, lemonwood, kahikatea and totara.*

General podocarp-broadleaved forest composition, characteristic of alluvial terraces

> *Alluvial terraces extending across intervening valleys support forests dominated by the podocarps kahikatea, totara and matai, with scattered broadleaved trees such as titoki, black maire, white maire, narrow-leaved maire, cabbage tree, lacebark, narrow-leaved lacebark, ribbonwood, kowhai and many small leaved understorey trees and shrubs.*

Cabbage tree treeland, characteristic of former forested sites

> *A distinctive feature of contemporary Eastern Hawke's Bay is the abundance of cabbage tree, scattered throughout very modified landscapes. They are living reminders of departed forests, but few are as yet protected.*

[186] Maxwell *et al*, 1993.

Sites with limestone characteristics often support distinctive floral assemblages. Limestone sites can support a disproportionally high number of regionally and nationally rare species, and species or forms which are locally endemic.

Specific site descriptions

Mount Erin

Immediately south of Mt Erin, at altitudes up to about 360m a.s.l, and sheltered from the west by the Kohinurakau Range are patches of podocarp-broadleaved forest[187].

According to Grant[188]:

> *The site was inspected in 1954. It consisted of matai to 95cm diameter and up to 24m tall, and kahikatea to 120cm and short; this was ring-counted to about 380 years. One totara about 125cm had been felled. Titoki and ongaonga were the main species, and rewarewa, ngaio, lemonwood and mapou were common. The site was seen in 1991, and as a forest its structure had been totally destroyed and stock were grazing throughout.*

Grazing of this area continues, however despite its degraded state, sites like this still hold great ecological value for their genetic resource, their representative value, and their role in provision of ecological functions (albeit impaired). Sustainable management of such sites is of upmost importance.

Rowes Bush

Nine kilometres south-west of Mount Erin lies Rowes Bush[189].

According to Grant[190]:

> *The forest was predominantly matai with scattered totara and kahikatea. It was noticeable in 1955 that matai on the ridge and to the south of it had very broken, half dead, windswept heads but trees below the ridge to the north were much healthier and taller, and had cleaner boles.*
>
> *There were some almost dead matai of 125cm, 6m bole and no higher than 23m. Several well-decayed matai stumps, 130cm or so, were scattered throughout the bush; very little remained of the logs. Matai diameters ranged from 25cm to 125cm; those with diameters of 45cm were most common and were 200-220 years old.*
>
> *Clearly the smaller-diameter matai are more frequently on sites adjoining the forest fringes, while in the middle of the area the trees are mainly 75-100cm, dating about 300-400 years. Totara had short boles, diameters to 140cm, and were 22m tall. Numerous short boled, heavy-canopied totara have regenerated about 150 to 250 years ago. Kahikatea, 60cm diameter and 26m high, had an approximate age of 280 years. Titoki is abundant and tawa is widespread in the vicinity of the older trees where it is usually to 35cm diameter and 150 years old. Supplejack is scattered in depressions under titoki, tawa and mahoe where large matai grow nearby.*

Elsthorpe Scenic Reserve

In the vicinity of Elsthorpe settlement, lays Elsthorpe Scenic Reserve.

According to Grant[191]:

> *Kahikatea is the dominant species, after which comes matai. The Kahikatea measured are between 75 and 150cm in diameter, 12 to 21m of bole and are 35m tall. Their ages range from 350 to 440 years. However it seems that in some areas both matai and totara have been logged and their place has been taken by tawa and titoki barely 100 years old. Rimu and miro are uncommon, except that a rimu observed was about 350 years old. There are numerous matai*

[187] See Photographs 74 and 75.
[188] Grant, 1996.
[189] See Photograph 76.
[190] Grant, 1996.
[191] Excerpt taken from Grant, 1991.

and totara which have regenerated during the last 200 to 300 years. This pattern indicates that after the close of the Matawhero Period there was wide spread burning. The clearing about the centre of Oero Bush was probably formed in the same way – by burning.

A plant species list for Elsthorpe Scenic Reserve contains five podocarps, 42 angiosperms and 22 species of fern.[192]

Silver Range (RAP8 (E))

The Silver Range is a north-northeast trending range formed of hard, upper Miocene sandstone and dips steeply to the north northwest. The landform is what is referred to as a "hogback"[193].

Olearia furfuracea-whaririki-manuka scrub:

Open shrubland of Oleria furfuracea, whaririki, manuka (~1m high) and some gorse, with scattered cabbage trees, kowhai (Sophora tetraptera) and mahoe. Areas of shrubland are separated by open pasture and dense patches of gorse. The shrubland is most open on the east side of the range where it extends for about 10m below the range crest. Holes in the rock face on the west side of the range support whaririki and gorse as well as Hebe stricta, Coprosma robusta and cabbage trees.

At the time of the DoC survey of this area, it was commented that other portions of the Silver Range were not examined at that time and that further investigations may reveal valuable additions to the RAP area.

Paeroa (RAP10 (E))

Hill country of upper Miocene mudstone, low on the southern flanks of the Maraetotara Plateau.

Tawa-podocarp forest:

The RAP consists of two areas of forest at either end of a ~12ha block of already reserved tawa-podocarp forest. Scattered rewarewa emerge from a tawa dominated canopy. Other trees in the canopy or subcanopy include titoki, mahoe, kahikatea and totara. At area 2 nikau is common also.

The central forest area has been fenced, and stock excluded for ~10 years. It has an understorey that includes much kawakawa as well as nikau, and many ferns and seedlings of, for example, karaka, titoki, pigeonwood and kahikatea. The areas either side have limited understorey vegetation.

At area 1 supplejack, kawakawa and juvenile kaikomako are dominant, with a few ferns and seedlings of canopy and understorey species on the ground. There is less understorey at area 2, being mostly supplejack and ground ferns.

Rata vines are, however, abundant at this RAP, and of special note is the presence of the scrambling climber kiekie which is not common in the northern part of the Eastern Hawke's Bay Ecological District.

Motonui Wetland (RAP12 (E))

A subdued topography of low, rounded hills of upper Miocene mudstone, with wetland covering the valley floors over much of the RAP.

Oleria solandri scrub (40%):

This scrub occurs on the driest part of the valley floor. It is very open, and consists of Loeria solandri, a rush (possibly Juncus gregiflorus) and tall pasture grass. There are two cabbage trees present, only one of which is alive.

[192] Grant, 1991.
[193] See Photographs 77, 78 and 79.

Wetland (40%):

The wetland includes the rushes Juncus articulates and Juncus gregiflorus, and long pasture grass. Azolla sp., chickweed, Polygonum persicaria, and Polygonum salicifolium, are on the surface of the water.

Pastureland (20%).

Highfield (RAP 30 (H))

This RAP is located on the eastern side of the Raukawa Range and comprises two areas of gullies and spurs high on the range, a steep sided gully, and an area of easier slopes. Limestone bluffs and outcrops are a prominent feature of the higher parts of the range.

Area A: Predominantly titoki forest and treeland with a few totara, tawa, matai, mahoe and ngaio scattered throughout. This area has a canopy height of 15-20m and an understorey of dense thickets of tree nettle and low ferns.

Areas B and C: Mainly second growth trees such as mahoe, pate, mapou and lacebark with a canopy height of 10-15m, broken by a few small grassy clearings. There are a few emergent totara and matai and two small stands of almost pure totara are located on ridges [in the] *northern section of this area. On top of the range is a flat area of titoki-totara-matai forest. The understorey of Areas B and C is moderate and is dominated by kawakawa, supplejack, tree nettle and ferns.*

Area D: A stand of open titoki, kahikatea, totara and matai which is grazed and has no understorey. A pocket of regenerating kahikatea is found on a small wet area within this treeland.

Te Mata Peak

Important concentrations of naturally occurring indigenous vegetation cover[194] are present within Te Mata Peak Park. This is represented by shrubland and low forest on limestone cliffs and three significant regenerating or secondary forest patches in valley and face situations.

Limestone cliff communities were described by Elder[195] as:

Phormium colensoi is dominant…kowhai, akepiro (Olearia furfuracea), Pittosporum ralphii, tutu and karamu are abundant wherever they can find a foothold, and may form almost a light forest in suitable localities. In the long grass on the slopes below cliffs that have been fenced off young kowhai are abundant.

Druce[196] points out that dominance of limestone cliffs by *Phormium colensoi* principally applies to those located north of the summit, and those facing north elsewhere. He goes on to state:

South and west of the summit on nearly all south-facing cliffs the large tussock grass, Chionochloa flavicans, shares dominance with flax. It decreases in importance with increasing exposure to direct sunlight. Mixed with the tussocks of flax and grass are shrubs and small trees, the principal species being akepiro, karamu, kowhai and Pittosporum ralphii. Between the large plants and scattered in crevices over the more open parts of the cliffs, are some 35 species of herbaceous plants, among them Senecio colensoi var. colensoi, Gingidium rosaefolium, Celmisia gracilenta, Linum monogynum, Epilobium nummularifolium, Poa anceps var. anceps, Agropyron kirkii, Notodanthonia buchananii, Trisetum sp., Asplenium anomodum,

[194] The majority of which are protected in perpetuity for conservation purposes under Queen Elizabeth II (QEII) Covenant. This legal protection adds to the ecological value of the area.
[195] Elder, 1953.
[196] Druce, 1967.

Craspedia viscosa, Schizeilema trifoliolatum, Geranium microphyllum and G. solanderi var. solanderi. The last four of these are not common.

The more recently prepared ecological management plan for the Park[197] reports the presence of *Pimelea* aff.*aridula* 'Te Mata Peak', a highly threatened[198] daphne endemic to Te Mata Peak and associated with its limestone cliffs.

Walls[199] listed other notable flora associated with Te Mata Peak Park's limestone cliffs as:

Asplenium lyallii	limestone spleenwort	Uncommon in Ecological District.
Celmisia gracilenta var.	narrow-leaved daisy	*At Risk - Naturally Uncommon*[200] (a distinctive form endemic to Te Mata Peak).
Cheilanthes sieberi	hot rock fern	Uncommon in Ecological District.
Chionochloa flavicans f. *temata*	cliff tussock	*At Risk - Naturally Uncommon*[201] (a distinctive form endemic to Te Mata Peak).
Senecio banksii	East Coast groundsel	Regional Endemic.
Vittadinia australis[202]	white fuzzweed	-

3.7.4 Terrestrial fauna

3.7.4.1 Avifauna

Despite the fact that a relatively small percentage of the Catchment Unit is actually covered with indigenous vegetation, it feels a lot more natural than both Units D and E. Forest patches such as those around Elsthorpe and Kahuranaki Road provide some excellent habitat for forest dwelling species, and on the whole populations of pigeon, bellbird, tui, and grey warbler etc are probably fairly high. However, many of these fragments are currently not under formal protection, and so it would be good to see more sites considered for legal and physical protection for conservation purposes.

The riverbed within this Catchment Unit has significant bird values, and this and the estuary are perhaps the greatest bird habitats of the Catchment Unit. The Tukituki Estuary was given a Moderate-High status during the SSWI surveys (Parrish 1988), and this has certainly not diminished. In fact due to bittern being present, and probably breeding in the past this site should be considered as a high priority for protection and restoration.

Several large lakes and wetland areas also exist and although some are protected, others have been opened up to more disturbance through the introduction of the public walkway which runs along the Hawke's Bay foreshore.

Small amounts of exotic forest also exist in this Catchment Unit, and the extent of native understory dictates how valuable these are to birds.

Dabchick have been recorded at a number of sites within this Catchment Unit in the past. During the 1992 dabchick surveys, 22 were found on Lake Roto-o-kiwa, representing nearly 7% of the Region's dabchick population. This lake is clearly therefore of significance of this species, and other reports suggest that 10-30 are often reported from this site (H. Rook pers comm., HB OSNZ records).

[197] Walls, 2006.
[198] "Nationally Critical" (de Lange *et al*, 2009); total population of less than 100 plants.
[199] Walls, 2006.
[200] de Lange *et al*, 2009.
[201] de Lange *et al*, 2009.
[202] Formally listed as threatened, however ecology and distribution now better understood, more abundant than previously thought.

Horseshoe Lake may also be another important site for this species, with only four recorded in August 1988, but around 20 seen in April 1997 (HB OSNZ records). Other sites mentioned during the SSWI surveys are Deep Water Ponds and Longacre Lake, the latter of which was suggested to hold up to 10 birds in summer. East Clive to the north of the Tukituki Estuary often holds at least 2-6 and sometimes 7 birds (HB OSNZ records), and therefore this collection of sites actually represents a significant proportion of the Hawke's Bay population with perhaps around 20-25% of the Hawke's Bay population within this Catchment Unit.

Again this unit is an important one for the three species of shags, with several colonies possibly held along the Tukituki River between the Estuary and the Patangata Bridge, and the Estuary area is noted as being important for these species in the SSWI designation for this site[203]. The estuary seems especially important for little black shag, which has been recorded in numbers up to 150 at this site (HB OSNZ records). They are likely to also occur on many of the freshwater ponds and lakes within this Catchment Unit.

The estuary area is also an important site for over-wintering white heron, and for the long-staying little egret that has been recorded in the Haumoana/Muddy Creek/Waitangi area off and on during the 1970s, but was not seen after 1982. However, probably a different bird has been present almost continuously from May/June 1989 to the present day. Little egrets are again a scarce vagrant from Australia, but this individual seems to have found this area to its liking, and recently in September 2011 a second bird has been seen nearby also. Royal spoonbills also use the estuary frequently during the winter, and during this work two birds were seen at the Haumoana Lagoons. Reef heron would have in the past utilized the rivermouth and estuary, but due to disturbance have not been recorded in the area for many years.

Bittern have been seen around the Tukituki Estuary and associated wetlands on many occasions (HB OSNZ records, J. Cheyne pers comm.), with up to three birds having been seen in this area. Until approximately three years ago it is probable that birds actually bred in this location. But since the construction of the walkway alongside Muddy Creek and past the raupo-beds that this species depends upon, birds have not been heard booming. This is almost certainly not a coincidence, with the walkway encouraging increased public use of the area, with birds being especially prone to disturbance during the spring months when booming. Increased use of the area by dogs is also probably to blame.

Spotless crake are present in the wetlands around the estuary as well, although recent surveys to determine numbers have not been carried out. Marsh crake may also be present at this site, but as yet their presence has not been confirmed.

South Island oystercatcher utilize the estuary in small numbers during high tide, feeding on the mudflats, as do variable oystercatchers, the latter of which may also sometimes breed on the beaches above the high tide mark. However, disturbance by people, vehicles and dogs at the rivermouth is intense, and this species is unlikely to successfully raise chicks at this site. South Island oystercatchers have been seen up the Tukituki River near Rochfort Road (Dec 1998, pers obs), and it is possible that the species is also breeding in low numbers on this river. During surveys on the Ngaruroro River and Tutaekuri River in recent years 2-3 pairs have been observed breeding on each[204] and their presence on the Tukituki River is worthy of further surveys.

Pied stilt, and banded and black-fronted dotterel are found in good numbers on the riverbed sections within this Unit, and within the estuary itself. Banded dotterels and pied stilts also breed along the top of the beach above the high tide zone, and around the East Clive wetland areas. As with the variable oystercatcher and bittern comments above, these are now high use public areas as well.

Shore plover and wrybill have been reported at nearby wetlands and around the rivermouth area, although visits are so infrequent as to be of little importance. They were however mentioned for completeness.

The lower sections of the river and the beach around the rivermouth are however, important sites within Hawke's Bay for nesting black-billed gulls and white-fronted terns (see Table 3-20).

More recently, the birds seem not to nest within this area, or if they attempt to they are disturbed by the almost constant vehicle traffic around the rivermouth and give up or move to other sites. Recently, this has been within the Port of Napier, with black-billed gulls and white-fronted terns being observed nesting there during late 2010 (pers obs). Protection at these sites is key to these species continuing success in

[203] Parrish, 1988.
[204] Stephenson 2010; Stephenson 2011.

Hawke's Bay, and with black-billed gull listed as a 'Nationally Endangered' species this should be considered a priority.

Table 3-20: Important nesting sites within the Tukituki Catchment for black-billed gull and white-fronted tern.

Species	Date	No. of birds (pairs)	Location	Success/Fail
Black-billed gull				
	16/12/82	500	East Clive	?
	23/10/83	c.300	East Clive	?
	29/11/84	(200)	East Clive	Success
	02/01/87	(30)	East Clive	Success
	01/10/88	100+	Tukituki Estuary	Failed
	06/11/88	(200)	Tukituki River	Success
	25/11/89	300	Tukituki River	Failed
	04/11/90	(200)	Tukituki Estuary/River	Failed
	18/11/92	(150)	Tukituki River	Failed
	14/11/98	(350)	East Clive	?
White-fronted tern				
	22/09/83	(500)	East Clive	Fail
	18/10/84	(600)	East Clive	Success
	30/09/85	(30)	East Clive	Fail
	01/11/86	(200)	Tukituki Estuary	Success
	01/10/88	(40)	Tukituki Estuary	Success
	04/11/90	(150)	Tukituki River	Fail
	05/11/94	(600)	Tukituki Estuary	?
	14/11/98	(700)	East Clive	?

It is possible that black-billed gulls have also taken to nesting further up the river, away from such intense human disturbance, as they do on the Ngaruroro River at Mangatahi. It would be worth investigating this, and at the same time investigating whether Caspian terns are also breeding somewhere along the stretch of riverbed within this Catchment Unit. Caspian terns do utilize the estuary and rivermouth for feeding and roosting, and this area is often stated as being one of the largest roosting sites for this species. During the winter months it is also often used by roosting black-fronted tern, with up to 26 birds having been recorded on the estuary or at the rivermouth (HB OSNZ records and published as CSN within Notornis). Being one of two main sites within Hawke's Bay where this species roosts during the winter months, this site is clearly of importance to this Nationally Endangered species.

New Zealand pigeon are relatively common throughout the forested areas of this Catchment Unit, being found at several of the sites visited during this work, such as the Silver Range, Kahuranaki Road Bush 1, Elsthorpe Scenic Reserve and Paeroa 1 and 2. They are frequently seen in the river valley, and are seen within the urban area of Haumoana, as well as having been recorded at many of the forest sites surveyed during the SSWI surveys. Likewise tui and bellbird were found in good numbers within the forest fragments surveyed during this work and previous surveys. Grey warbler, fantail, and silvereye were likewise found throughout most places, and shining cuckoo would be expected to have a similar

distribution. Kaka occasionally make it as far as Haumoana and Te Awanga (HB OSNZ records), as do New Zealand falcon. However, both of these species are unlikely to spend much time within this Unit.

In particular the forest patches visited during this survey were checked for the presence of rifleman. This species still exists in forest fragments on the Maraetotara Plateau, some of which are within 3 km of some of these fragments visited (i.e. Paeroa 1 is approximately 3km from the Maraetotara Scenic Reserve that has a healthy population of this species). This population on the Maraetotara Plateau represents the most isolated population of this species in Hawke's Bay, making it of significance. It is entirely possible that the species does exist in one or two of the forest fragments, and further searches would be worthwhile, particularly focusing on the Kahuranaki Road Bush fragments and the Paeroa fragments.

New Zealand pipit is common throughout the riverbed sections within this Catchment Unit, being observed at several sites during this work (Tamamu Bridge, Patangata Bridge, and Small's). They are also common throughout the rough pasture which is extensive in this area.

Fernbird are almost certainly absent from this Catchment Unit.

3.7.4.2 Herpetofauna

Species present or likely to be present

Common, spotted and speckled skinks. Common and Wellington green geckos.

Herpetofauna database records

Spotted skink, Haumoana, 8 km north-east of Hastings. The GPS location for this sighting sits within a vineyard as at 2011. It is unclear if the GPS co-ordinate is accurate, since we would have thought Haumoana Beach to be a more likely site. We are unsure if this site has always been a vineyard.

Survey results

Te Mata Peak: On the 20th of April 2011, 20 common geckos (6 neonates, 2 juveniles, 5 sub-adults, 3 adults, 4 unknown age) and three common skinks (1 neonate, 1 juvenile, 1 adult) were observed under the 30 ACOs. Of the common geckos whose age was identified, most (81%) were immature. Of the captured geckos, incidence of regenerated (19%) or broken tails (0%) was low, suggesting that predation on this population is probably low, notwithstanding undetected mortalities. Of the skinks, only the adult had a regenerated tail. During the second check on the 30th of May 2011, we observed 31 common geckos (18 neonates, 4 juveniles, 5 sub-adults, 4 adults) and three common skinks (2 juveniles and 1 adult) under 28 of the covers. Again, most (87%) of the geckos found were immature. During the third check on the 7th of September, we found 8 common geckos and no common skinks.

Haumoana/East Clive Beach: All covers were checked on the 20th of April 2011. During this check, two skinks were briefly observed either under or running out of the Onduline covers C6 and C12 in transect C, which starts about 500m south of the Tukituki river mouth. The skinks were both dark in colour and had an estimated total length of 11.5 cm and 13 cm. The skink that was observed briefly running out of the cover had the appearance of a spotted skink, but confirmation is required. The temperature at the time of checking transect C (22.7°C at 11am) made capture and identification of skinks very difficult, thus transect C was resampled during cooler temperatures (16ºC) on the 11th of May 2011. During this check one dark-coloured common skink was observed on ACO12, thus the dark-coloured skinks seen previously are likely to be common skinks. A further check of sixteen of the covers in transect C on the 31st of May 2011 revealed no skinks.

Silver Range: No lizards were recorded during a check of both closed-cell foam covers and Onduline covers in the river corridor or on the Ranges on the 8th of September 2011. A repeat visit will be undertaken during November during warmer weather conditions.

Other records

A common gecko was found on Te Mata Peak by Heli Polonen in 2010. A photograph was provided with this feedback, thus allowing positive identification of this gecko. An unidentified gecko was also seen by Daniel Winchester from DOC in Elsthorpe Reserve in the summer of 2010/2011. A "green lizard" (presumably a green gecko) was reported on a lifestyle block at the north-eastern base of Te Mata Peak Road by Mike Lusk, who was informed by the landowner, Dave Barnard. Common skinks (dark morph) have been observed by Margot McPhail in her residential garden fronting onto Haumona Beach (at the

far end of transect C), an observation which was positively identified by a photograph she provided. Margot has witnessed skink predation by pet cats and a decline in skink numbers since her moving onto the property in the 1980's. She has not seen any spotted skinks.

4 Landscape Ecology Synthesis

Ecological science recognises that in order to meet international goals for the persistence of indigenous biodiversity, it is necessary to protect both biodiversity *pattern* (the full diversity of genes, species, communities, habitats and ecosystems, and landscapes) and the ecological and evolutionary *processes* that sustain this pattern[205].

Landscape ecology is the study of 'how landscape structure affects the processes that determine the abundance and distribution of organisms'. More simply, it is the study of 'how *pattern* influences *process'*.

For reference, key landscape ecology concepts relevant to the terrestrial ecology values of the Tukituki Catchment are outlined below[206]:

Table 4-1: Key landscape ecology principles relevant to the Tukituki Catchment.

Landscape:	An interacting mosaic of elements (e.g. ecosystems) relevant to some phenomenon under consideration, at any scale.
Patch:	The elements that make up a landscape.
Pattern:	The spatial arrangement and composition of the patches that compose a landscape.
Process/function:	Ecological processes/functions operating within the landscape.
Habitat isolation:	The isolation of habitat areas for a given species- a species specific entity.
Matrix:	The dominant and most extensive (and often most modified) patch type in a landscape. It is characterised by extensive cover and a major control over dynamics.
Landscape heterogeneity:	A landscape with many different patterns and structures.
Species-area relationship:	The strong positive relationship between the size of an area and species richness. Operates at many spatial scales.
The role of humans:	Recognising the influence humans have in the change of ecology values and managing the landscape to achieve human objectives.

4.1 Local application

Land use history and climate are key determinants of the variation in today's landscape composition and pattern within much of the Tukituki Catchment. For many terrestrial plants and animals, habitat pattern in the upper catchment (Units A and B) provides good, relatively natural arrangement and composition.

Catchment Unit C is an interesting area, with climate, topography and habitat retention providing the setting for an ecologically important pattern between the more intact upper catchment and highly modified middle and lower catchment.

Further to the east, in areas of more agriculturally productive land (and in many areas - dryer local climates) landscape pattern breaks down. In many areas this change in pattern has been severe and is effectively irreversible, as current and future land use will maintain and perhaps further erode the current pattern.

[205] Walker *et al*, 2006; Margules and Pressey, 2000.
[206] Many of the definitions are taken from Lindenmayer and Fisher, 2006.

The effect of increased landscape homogeneity, reduced habitat size and quality, and increased isolation varies according to the species under consideration, and how they 'experience' that degraded pattern.

Effects can be most severe on plants and animals which have only a poor ability to move between and recolonise areas of favourable habitat, and those which are vulnerable to reduced habitat quality and/or quantity. Examples include many indigenous terrestrial invertebrates, lizards, some birds and certain plant species.

However, all is not lost. With careful planning and action those precious habitat patches, which do remain, present a foundation and potential on which to build. Features such as road alignments, waterway corridors, shelterbelts, less productive areas and exotic habitats can all contribute to a framework of improved ecological management, particularly when designed and managed at the landscape scale.

The following diagram is based on indigenous cover types contained within the LCDB2 database, for the Tukituki Catchment and surrounding areas. The diagram is based on the research by Meurk and Hall (2006). It provides an indication of how well seed dispersal and pollination is likely to be functioning. It is therefore an indicator relevant to maintenance of floristic diversity in forests, which has flow-on effects through these ecosystems at multiple scales. However this approach doesn't take into account the contribution exotic land cover types make to supporting pollination and seed dispersal functions. This is a limitation, and makes the result somewhat conservative (i.e. it assumes non-indigenous land cover types contribute nothing to these functions, which is unlikely to be the case).

However the diagram shows that seed dispersal and pollination functions are likely to be performing well over much of Catchment Units A, B and C. In Catchment Unit D, given the scarcity of forest habitats, this indicator of ecosystem function shows a dramatic decline. Likewise, only some areas of Units E and F have retained sufficient indigenous cover to suggest these important functions continue to operate effectively.

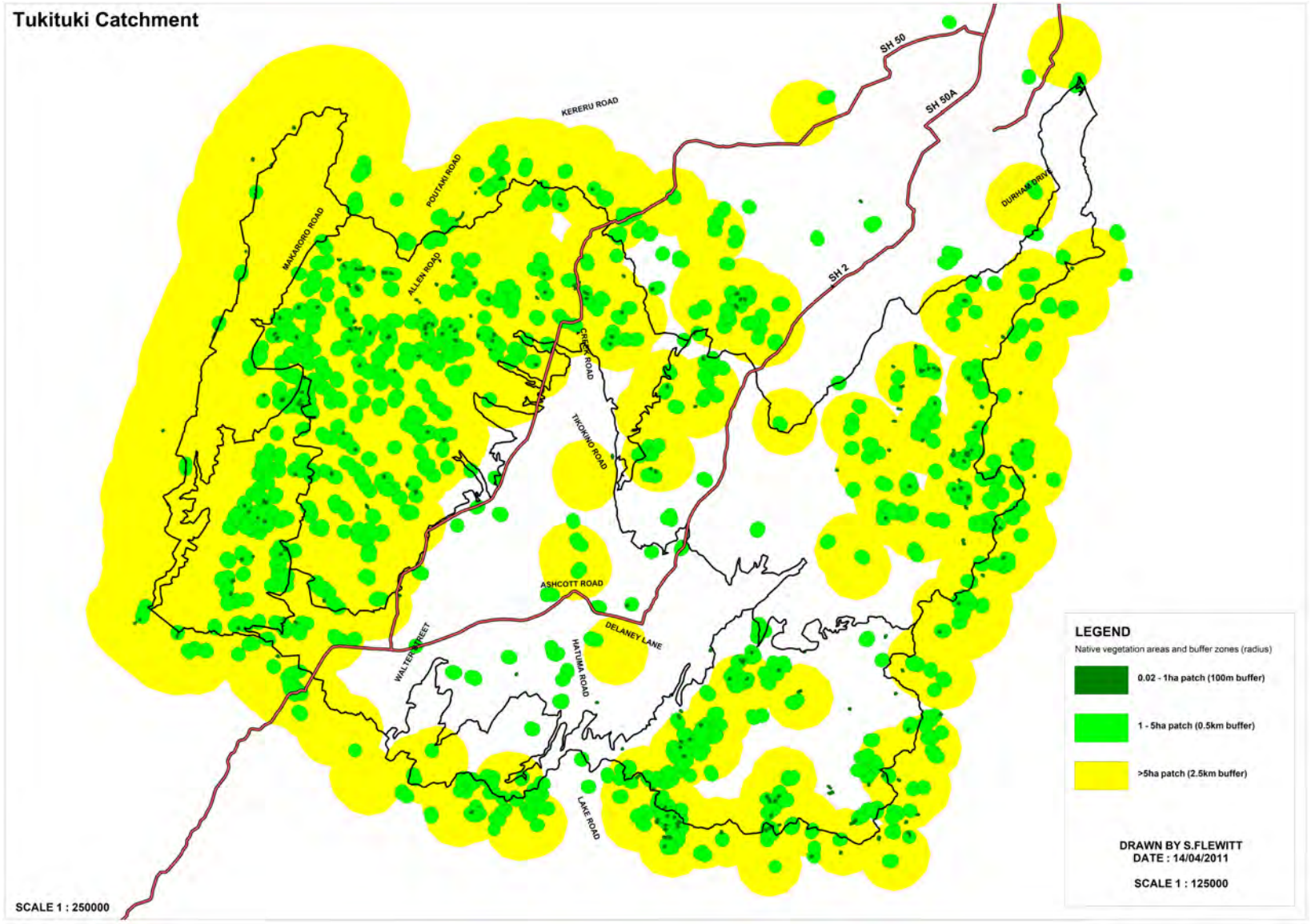


Figure 4-1: Diagram showing predicted coverage of pollination and seed dispersal functions across the Tukituki Catchment (Catchment Units shown).

5 Risks to River Bird Populations from Changes in Flow Regime

5.1 Riverbed bird numbers and previous surveys

5.1.1 Bird species, numbers and regional/national significance of the riverbed for birds

Braided riverbeds are a rare habitat type internationally[207], and although a number exist in the South Island, they are not common in the North Island. The riverbed of the Tukituki River is renowned for its wildlife values, having been listed as 'high' during the SSWI surveys[208]. Reasons for listing the riverbed as a SSWI were stated to be due to it having "the highest number of waders" compared to the other Hawke's Bay rivers, and also because "*black-billed gulls were more common on this river than elsewhere, and three nesting sites were seen. Black-backed gulls were fewer and the colonies were smaller than on the Ngaruroro River. Waterfowl were more common than on the other rivers, particularly on the lower half of the river.*"[209].

Subsequently, most of the Tukituki and Waipawa riverbed were designated RAPs during the PNAP surveys[210]. The RAP extends from the confluence of the Makaroro and Waipawa Rivers, and the Tukituki River from near the top of Tukituki Road, right the way down to the rivermouth. This is a very sizeable and significant area, and is listed due to "*its valuable riverbed habitat supporting high numbers of waders and wetland birds*"[211].

To add to the river's significance is the fact that it holds species from all eight of the water bird guilds[212]. Although recent surveys of the riverbed have not been conducted, the numbers of riverbed birds are likely to be similar to those recorded in past surveys (Table 5-1). Table 5-2 lists numbers of these birds with comparisons of the other Hawke's Bay rivers during the 1984-85 and 1986 surveys.

The number of banded dotterel on this stretch of river make this the largest population of this Nationally Vulnerable species compared with any other Hawke's Bay river. The population recorded during the 1986 survey, based on current population estimates of possibly as few as 25,000 birds[213], would suggest this river may hold almost 5% of the national population (and probably around 55% of the regional river based population).

Add to this the population of pied stilt which might be around 3-4% of the national population (based on c.30,000 birds from Heather & Robertson (2000) (and probably around 50% of the regional river based population), and the occurrence of other threatened species such as white heron, royal spoonbill, grey duck, South Island oystercatcher, black-billed gull, Caspian tern, white-fronted tern, and New Zealand pipit the significance of this riverbed (above the estuary) is clearly apparent. Any changes to flow regime and river management therefore need to be carefully scrutinized before being allowed.

[207] O'Donnell, 2004.
[208] Parrish, 1988.
[209] Parrish, 1988.
[210] Lee, 1994.
[211] Lee, 1994.
[212] As outlined in O'Donnell, 2004.
[213] Southey, 2009.

Table 5-1: Survey results from four riverbed bird surveys on the Tukituki River.

Species	1967	1972	1984	1986
Black shag	46	10	25	36
Little black shag	46	0	0	0
Little pied shag	60	0	15	9
White-faced heron	39	17	61	33
Paradise duck	35	31	390	431
Mallard	255	139 + 59 ducklings	175	273
Grey duck	23	0	0	2
Grey teal	0	0	4	17
Shoveler	0	0	7	15
Spur-winged plover	0	0	85	183
Banded dotterel	500	310 + 12 chicks	963	1149
Black-fronted dotterel	122	95	368	341
Pied stilt	464	323+	1106	482
Black-backed gull	518	136+	704	1202
Red-billed gull	1	0	0	0
Black-billed gull	252	28	107	174
White-fronted tern	0	0	3	0

Note: Surveys during 1967-1984 were joint efforts between OSNZ and Wildlife Service, whilst the survey conducted in 1986 was an OSNZ survey.

Table 5-2: Comparison of counts of riverbed birds between the Tukituki/Waipawa, Tutaekuri, and Mohaka and Ngaruroro Rivers during the 1984-1985 and 1986 Wildlife Service and OSNZ counts.

Species	Tukituki/Waipawa				Tutaekuri		Mohaka		Ngaruroro		TOTAL	
	1984-85		1986		1984-85	1986	1984-85	1986	1984-85	1986	1984-85	1986*
Black shag	25	32%	36	40%	23	49	28	-	3	5	***79***	***90***
Little pied shag	15	23%	9	32%	8	7	41	-	present	12	***64***	***28***
White-faced heron	61	71%	33	59%	4	13	19	-	2	10	***86***	***56***
Paradise duck	390	61%	431	69%	59	47	8	-	183	150	***640***	***628***
Mallard	175	59%	273	75%	35	59	73	-	14	31	***297***	***363***
Grey duck	0	0%	2	100%	1	0	5	-	0	0	***6***	***2***
Grey teal	4	80%	17	65%	1	5	0	-	0	4	***5***	***26***
Shoveler	7	70%	15	100%	3	0	0	-	0	0	***10***	***15***
South Island oystercatcher	0	0%	0	0%	0	0	0	-	10	8	***10***	***8***
Spur-winged plover	85	47%	183	66%	11	38	34	-	52	56	***182***	***277***
Banded dotterel	963	58%	1149	54%	237	509	32	-	438	480	***1670***	***2138***
Black-fronted dotterel	368	57%	341	50%	134	200	13	-	127	145	***642***	***686***
Pied stilt	1106	61%	482	48%	239	310	14	-	461	220	***1820***	***1012***
Black-backed gull	704	20%	1202	32%	600	465	191	-	2056	2134	***3551***	***3801***
Black-billed gull	107	80%	174	71%	1	62	0	-	25	8	***133***	***244***

*note this does not include totals for the Mohaka River which was not surveyed in 1986. Percentages in the Tukituki columns are of the total counts for all four rivers during that year's survey.

5.2 Generic assessment of effects from changes in river flows and/or river morphology to river and terrestrial bird values

Maintenance of flow regimes on rivers is essential for maintaining accessible food supplies, and the feeding and nesting habitat of river birds dependent on freshwater. This is particularly so for threatened species[214]. In particular, maintenance of flows as close as possible to natural regimes during the critical breeding months (August to January) will ensure that the full range of channel types required for birds are present[215].

Disruption of flow regimes is however, unlikely to have completely predictable effects, with complex relationships between flow regimes and other variables such as geomorphology, weeds, and sediment load/type. Braided river bird communities in particular are highly attuned to the natural flow regimes and instability of rivers[216], and are sensitive to the effects of changes in flow regime. Large water projects have caused dramatic changes to the flow regimes of many New Zealand rivers[217].

Outlined below are the main effects that could adversely impact riverbed birds due to changes in river flow regimes.

[214] Hughey, 1985, 1997, 1998; Hughey *et al,* 1989; O'Donnell, 2004.
[215] O'Donnell, 2004.
[216] O'Donnell and Moore 1983; Robertson *et al* 1983.
[217] Young *et al,* 2004.

5.2.1 Changes in physical and chemical characteristics, and water temperature

Storage of water in reservoirs often results in changes to the physical and chemical characteristics (dissolved oxygen, organic matter content, sediment load and temperature) of the water released downstream[218]. Therefore, it is not just reductions in flow regime that have effects on ecological values, but also the 'quality' of the water that remains downstream of any abstraction or water storage facility. If water is to be stored within the current riverbed, rather than pure abstraction and storage off river, then there will likely be far greater changes in physical and chemical characteristics and temperature of water downstream, which are likely to have greater impacts on river ecology and riverbed birds.

Generally the longer the residence time of water within a storage area before release downstream, the greater the potential effects of the water storage, which can have marked affects on the ecology of river systems downstream[219]. Any changes to invertebrate communities are likely to have significant impacts on riverbed birds which feed on these invertebrates, or for which these species are part of a food web. Such impacts on river ecology are also dependent on where the storage facility or abstraction takes place, whether this is closer to the headwaters, or further down the river channel[220].

Furthermore, if flow rates are decreased, whilst intensification of agricultural practices occurs downstream, there is a risk that the effects of nutrients from riparian runoff will be exacerbated. Stream quality has a potentially major impact on the invertebrate community found within it[221], which in turn affects the food availability for riverbed birds. Impacts of any of these changes on riverbed birds are unlikely to be predictable, and may themselves be part of complex interactions between species.

5.2.2 Direct changes in physical structure of rivers

Dams directly threaten riverbed birds by flooding significant nesting and feeding habitats[222]. Untimely discharges from dams upstream can flood nesting sites of birds, and reductions in freshes and floods can lead to channel stabilization, reduction in food availability and increased encroachment of weeds[223]. If flows are reduced so much that channels dry up, there will be an almost complete loss of aquatic birds[224].

Sediment trapping, reduced sediment loads and reduction in bed loads are all likely to impact a rivers physical structure. If too much water is taken, the flows downstream of an intake may not be sufficient to move incoming sediment and sediment deposition will occur[225], thus changing the character of the water and thus food availability for birds[226]. Invertebrate communities are sensitive to changes in substrate type, and if abundance of preferred prey of wading riverbed birds changes, this may impact population numbers or breeding success.

Islands within river systems are particularly susceptible to changes associated with flow regulation[227]. For example, changes in sediment dynamics may cause island growth, migration or erosion[228]. If flows and depths are reduced, previously inaccessible islands may be easily accessed by the public and by introduced predators[229]. Islands may currently be safe nesting sites for riverbed birds, but if distribution and numbers of these islands changes, this may impact available safe nesting habitat. On the lower Rakaia River, 95% of wrybill nests and 90% of banded dotterel nests were on islands separated from the riverbanks by flowing channels[230]. In this study flooding caused most of the breeding failures, with only 10% of wrybill and 12% of dotterel nests being lost to predators. On the smaller Ashley River, where nests were on banks or islands separated by smaller channels, predation was more likely to

[218] Young *et al,* 2004.
[219] Young *et al,* 2004.
[220] Young *et al,* 2004.
[221] Boothroyd and Stark, 2000.
[222] O'Donnell, 2004.
[223] O'Donnell, 2004.
[224] Maloney, 1999.
[225] Young *et al,* 2004.
[226] O'Donnell, 2004.
[227] Young *et al*, 2004.
[228] Young *et al*, 2004.
[229] Young *et al*, 2004.
[230] Hughey, 1985.

affect breeding success. This confirms the importance of braided riverbeds, with channelling and islands, for these riverbed birds.

5.2.3 Indirect changes in physical structure of rivers

As mentioned above, the lowering of flow rates may also cause aggradation of riverbeds between the floodbanks[231], which in turn would require more flood protection works by way of intervention. Beach raking and gravel extraction both cause disturbance and impact on breeding riverbed birds if conducted during the breeding season, and generally cannot be easily carried out during peak flow times of the year. Therefore, the window for any such work would be relatively narrow.

Reduction in flow rates could also reduce weed removal during peak flows. Natural patterns of floods and freshes are the main way that weeds are removed from riverbeds, although not all vegetation is ever cleared this way[232]. Introduced weeds, particularly broom, lupins, and gorse, are particularly invasive and are a serious threat to habitats of braided river birds[233]. Apart from direct impacts (physically decreasing available habitat), exotic weeds are thought to stabilize shingle islands, increase deep channelization of the riverbed, decrease the availability of shallow water foraging areas, and increase risk of predation[234]. Furthermore, when birds are forced to nest closer to the river channels because higher terraces are covered in vegetation, they are subject to an increased frequency of flooding from freshes and floods[235]. This therefore impacts on breeding success with loss of nests, eggs, and chicks at these times.

5.3 The proposed Ruataniwha Augmentation Scheme as an example of potential effects to river bird communities by altered river flows from water abstraction

There are two periods during which impacts from the proposed Ruataniwha Augmentation Scheme could affect the riverbed and its birds. These can be separated into the construction phase, from the start of construction through to the dam first filling, and then the post-construction phase, once the dam has been completed and filled into the future. Both of these phases will have slightly different impacts on the flow regime and water quality, and therefore potential effects are outlined separately.

These comments are based on the 'Ruataniwha Plains Water Storage Project, Hydrology and Water Quality Summary, Working Draft 25th October 2011'[236]. As this is a working document, impacts and effects may change as the configuration of the Augmentation Scheme changes, so points made below may not be entirely transferrable, but are likely to at least indicate the potential for impacts.

Any potential impacts on the river are likely to be greatest in the section of river that will eventually form the Dam and Reservoir (Reach 1). However, also likely to be heavily impacted are Reaches 2 and 3, between the proposed dam toe and the Waipawa River confluence, a section of approximately 12.3 kms. Impacts are likely to be lessened by dilution downstream of the Makaroro and Waipawa confluence, but not necessarily negated.

5.3.1 Construction phase

The construction phase is likely to cause the most physical disturbance of birds (both riverbed and terrestrial) through habitat loss, machinery noise, machinery activity, and alteration to flow regimes. If this construction phase is prolonged it is likely to be carried out during the breeding season for most birds, and will obviously impact directly on species nesting and feeding within the construction footprint.

[231] Young *et al,* 2004.
[232] O'Donnell, 2004.
[233] O'Donnell and Moore, 1983; O'Donnell, 1992; Maloney, 1993; Brown, 1999a, 1999b; Maloney *et al,* 1999.
[234] O'Donnell and Moore 1983; Robertson *et al,* 1983; Balneaves and Hughey, 1990; O'Donnell, 1992; Pascoe, 1995; Hughey and Warren, 1997; Rebergen *et al,* 1998.
[235] O'Donnell, 2004.
[236] HBRC, 2011.

Species of most concern here would be New Zealand falcon, spotless crake, pied stilt, banded dotterel, New Zealand pigeon, rifleman, New Zealand pipit and New Zealand fernbird.

New Zealand falcon (Nationally Vulnerable) is certainly present in the area, having been seen during this study (see sections above), and are particularly vulnerable to human disturbance during the breeding season. The area should be carefully studied to determine the number of pairs occupying the footprint of the dam and reservoir, and their usual nest sites located to determine whether they will be impacted.

Spotless crake (At Risk, Relict) may or may not be found within the area, and surveys for their presence should be conducted. Pied stilt (At Risk, Declining), banded dotterel (Nationally Vulnerable), and New Zealand pipit (At Risk, declining) are almost certainly found within the riverbed sections of this part of the river, and direct disturbance of nesting and feeding areas could have impacts. As construction of the dam wall is carried out, and flooding of the area within the reservoir footprint occurs, species such as New Zealand pigeon (Not Threatened, Category B Regionally), rifleman (At Risk, Declining), and New Zealand fernbird (At Risk, Declining) are likely to be impacted.

In particular fernbird were noted as present within the Makaroro Heath area upstream of the Makaroro River and Dutch Creek confluence during the early SSWI surveys. Surveys to determine their presence and population size should be conducted as soon as possible. Blue duck (Nationally Vulnerable), although probably not nesting or feeding regularly within this area should be considered for potential impacts.

Flooding of considerable areas of native forest will occur when the dam is completed, and this is all on a river which has significant native riparian vegetation. This vegetation forms a corridor for the movements and dispersal of native birds, as well as providing important nesting and feeding habitats. The loss of this forest will need to be mitigated for through plantings and other methods deemed relevant to the area. However, no matter how much area is planted, this will take many years before it is able to support the same numbers of birds, and the impact of the loss of old native trees is difficult to determine reliably.

During construction of the dam there are likely to be impacts downstream through increased sediment load within the remaining flow. This may have immediate impacts on downstream ecology, at least within Reaches 2 & 3, and likely impacts further downstream even with dilution, depending on the degree of sedimentation, and the current flow regime of the river. Impacts in mid-summer, when flow-rates are likely to be lower, are likely to be greater. Exact impacts are difficult to predict, but if sedimentation causes changes to invertebrate species and abundance then this is likely to directly affect riverbed birds through changes in diet.

Changes in flow rates during this time are also likely to affect riverbed birds through reduction in river flows, and those impacts suggested in the previous section. These could include such things as decreased flow rates affecting water temperature and water quality, decreased dilution of nutrient laden runoff, and changes in frequency and volume of freshes and floods. This in turn could change invertebrate communities within the river, affecting the diet of riverbed birds. Moreover, changes in flow regimes are likely to have impacts on sedimentation and aggradation rates, channelling of the river, and weed growth and removal. Indirect effects on riverbed bird predation rates are likely due to these changes, as indicated in the section above.

5.3.2 Post-construction phase

Following the construction of the dam and completion of filling the reservoir, the downstream impacts are likely to be similar to those above. However, in addition the water released could be significantly different in chemical characteristics (dissolved oxygen, organic matter content, sediment load) and temperature of the water being released downstream, and this is likely to impact on invertebrate communities and diet of riverbed birds. With such close proximity to the headwaters, changes in water quality are potentially greater, and thus the impacts on riverbed birds greater.

Fluctuations in lake levels within the reservoir could have considerable impact on birds utilizing the reservoir and surrounding areas[237]. If at all possible fluctuations in reservoir levels should be minimized to reduce these impacts.

[237] Young *et al*, 2004.

Additionally the construction of a hydro-power race which will reduce flow rates within Reach 2 will have much greater impacts within this river section. The impacts of reduced flows have been discussed elsewhere, but are likely to have a considerable effect on riverbed birds within this river section.

6 Summary

6.1 Terrestrial ecology character of the Tukituki Catchment

6.1.1 Catchment Unit A

- This Unit is the most ecologically intact area of the Tukituki Catchment, with large continuous areas of indigenous cover on largely mountainous terrain. Biodiversity in this Unit is largely secured by physical and legal protection administered by the DoC, however predation and browse/grazing pressure are historical and pose ongoing threats to the maintenance of biodiversity.
- Of note the Unit contains areas of rare/uncommon habitats, namely braided riverbed and at relatively lower altitudes, indigenous lowland forest and a small number of wetlands.
- A number of nationally and locally important flora are known to occur within the Ruahine Forest Park and many of those species could be represented within this Catchment Unit.
- The Unit contains populations of a number of threatened, uncommon, endemic and native bird species, most principally Northern brown kiwi, blue duck, New Zealand falcon, New Zealand pigeon, yellow-crowned parakeet, long-tailed cuckoo, rifleman, and kaka. Fernbird hasn't been recorded, but is likely to be present.
- The following lizard species are considered to be present, or are likely to be present within the Unit: common skink, common gecko, southern North Island Forest Gecko, Wellington green gecko. It is possible that spotted and southern North Island speckled skinks are present, and there is potential for sparse occurrence of small-scaled skinks.
- Long-tailed bat (North Island) would undoubtedly be present within the Unit.
- Terrestrial invertebrate values are rich, which is a reflection of habitat integrity and diversity. The potential for the presence of nationally and locally important species is high, as is the potential for the presence of 'new' species.

6.1.2 Catchment Unit B

- This Unit contains expansive areas of indigenous cover (around 30% of Unit), a lot of which falls within the Ruahine Forest Park, and those areas are therefore legally and physically protected. Indigenous forest, and also broadleaved indigenous scrub are prominent components of the Units indigenous cover.
- Indigenous cover is most devoid on the land around the Unit's eastern margins, where land environments with threat classifications of 'Acutely', 'Chronically' and 'At Risk' are prominent. Within the pastoral area of the Unit, indigenous cover is often concentrated within riparian corridors.
- Rare/uncommon habitats present include braided riverbed, lowland indigenous forest and a small number of wetlands.
- A range of indigenous vegetation types are present, varying depending on location and disturbance history. These include forests of beech, podocarp and broadleaved composition. A historical burn has induced a tussock grassland community within Lowland and Montane altitudinal zones, a vegetation community which would normally be present in the Low Alpine altitudinal zone.
- The Unit provides significant habitat for both threatened and common endemic native bird species. The presence of Northern brown kiwi within suitable habitats should not be ruled out. Areas of continuous forest in the western portion of the Unit support good forest bird populations, and may have small numbers of kaka and yellow-crowned parakeet. Blue duck are known from the Tukituki headwaters, near Daphne Hut. New Zealand falcon is present, with an area of prime falcon habitat being the mosaic of indigenous shrubland, forest and open pasture around the Kashmir Road area. Fernbird were also present within this habitat type. Even

though of a relatively small scale, on the shingle riverbeds of the Unit banded and black-fronted dotterel are likely to be present.

- Common gecko has been detected near Ashley Clinton. Common skink, southern North Island forest geckos and Wellington green gecko are likely to be present. There is a possibility that spotted and southern North Island speckled skinks are present; and there is low potential for sparse occurrence of small-scaled skinks.
- There are no bat records available for the Catchment Unit. However, given the habitat types and location on the landscape of the Unit, the presence of long-tailed bat ('North Island') is very likely.
- Of particular note within the Catchment Unit is the presence of notable moth species within the tall tussock grassland. In more pastoral areas, patches of indigenous cover provide important habitat refuge for terrestrial invertebrates.

6.1.3 Catchment Unit C

- An ecologically important component of the Unit's land cover is the remnant indigenous forest and other indigenous scrub and tall tussock grassland, which collectively occupies around 11% of the Unit. Exotic grassland dominates, occupying over 80% of the Unit's area.
- With the dominance by exotic pasture grassland comes dominance of Land Environments of 'Acutely' and 'Chronically' Threatened status. Areas of land on the Wakarara Range represent the 'Less Reduced and Better Protected' category.
- In terms of rare/uncommon habitats, this Unit contains around 40% of all the Catchments wetlands (and 10% of the Catchments wetland area), around 10,000ha of woody indigenous vegetation (a large proportion of this being lowland forest) and more than 400ha of gravel riverbed habitat. The Unit contains the highest number of sites recommended by the DoC as RAP[238] or SSWI[239].
- Indigenous forests on higher ground towards the ranges in the western area contain red beech, then as one moves to the east the red beech component phases into black beech. Podocarp and broadleaved species are present in the forest composition throughout. Totara treelands are known to host the rare orchid *Ileostylus micranthus.*
- Blue duck almost certainly occur infrequently within the upper sections of the Makaroro River, anecdotal reports suggest they may have been seen around the Makaroro/Dutch Creek confluence in the past. New Zealand falcon is common with a number of records throughout the Wakarara Range, Triplex Creek and Gwavas Forest. New Zealand pigeon, tui and bellbird are represented by good sized populations throughout the Unit. Other common forest birds are widely distributed throughout a range of habitats. Kaka are occasional visitors to the Unit, seeking out food or finding refuge from unfavourable weather conditions in the more common mountain habitats. Long-tailed and shining cuckoo are present, as are their nest hosts whitehead and grey warbler (respectively). Tomtit can be locally common and were noted as being so on Smedley Station. North Island robin are recorded from Gwavas Forest, but not in other forest patches of the Unit. Pipit occur in the Gwavas Forest area and are likely present in rough pasture and gravel riverbeds. Riverbeds hold both banded and black-fronted dotterel and farm ponds with large muddy margins and wet-boggy fields are also likely hold black-fronted dotterel. Pied stilt would use these habitats as well. Fernbird distribution is likely very limited, with records and sightings relating to Gwavas Forest, Makaroro Heath and Makaroro Oxbow Swamp.
- Common skink and common gecko were detected from surveys on Smedley Station. Other anecdotal and formal records suggest that the Unit holds populations of southern North Island forest gecko and Wellington green gecko. It is also possible that spotted and southern North Island speckled skink is present, and there is potential for sparse occurrence of small-scaled skink.

[238] Recommended Area for Protection.
[239] Sites of Special Wildlife Interest.

- Bats (presumably Long-tailed bat ('North Island')) have been recorded by DoC from seven different indigenous forest patches within this Unit. Of those sites where bats were detected in the Unit, bats were encountered in at least 57% and up to 100% of survey transects.

6.1.4 Catchment Unit D

- Catchment Unit D's land cover is almost entirely exotic in character. Indigenous cover makes up only around 0.41% (355ha) of the Units area.
- Consequently, the Unit is almost entirely classified as an Acutely Threatened Environment. Any remaining indigenous cover within this Unit is of utmost ecological importance. Also importantly, exotic land cover types within the Unit can provide important 'surrogate' habitat. In terms of biodiversity management careful thought is required as to how this production landscape can be optimised to maintain (and enhance) biodiversity values. Planning at the 'Landscape' scale would be important to allow consideration of the wider landscape pattern and process.
- In terms of rare/uncommon habitats, collectively Unit D contains a large area of gravel riverbed (c.697ha), which is spatially distributed over a relatively wide area adding to its value as a habitat network. The Unit also contains around 23% of all wetlands within the catchment, with a collective total of around 375ha of wetland area (65% of the whole catchments wetland area). The presence of limestone geology results in the occurrence of calcareous cliffs and the potential for localised calcareous screes and perhaps even calcareous boulderfields. Indigenous lowland forest is extremely rare.
- Indigenous flora is primarily represented in indigenous treelands and forests, and also by freshwater herbaceous vegetation associated with wetlands. Tukituki Scenic Reserve is the best example of podocarp-broadleaved forest and contains kahikatea and matai of up to around 380 years old. The 'At Risk' swamp nettle is known from the western shore of Lake Hatuma. With limestone substrates comes the heighted potential for the presence of rare or unusual flora.
- Dabchick is widespread, and Lake Hatuma probably hosts at least a third of the Hawke's Bay dabchick population during autumn/winter months. Three cormorant species are present. The long legged wading birds great egret and Royal spoonbill visit wetland habitats within the Unit. Australasian bittern have been recorded at a number of wetland sites but of most importance is Lake Hatuma, which based on current population estimates hold approximately 40% of the regional and 5% of the national population of this threatened bird species. Spotless crake is known to be present at Lake Hatuma. Pipit can be found on riverbeds and rough pasture. New Zealand falcon would be found infrequently throughout the Unit, especially around areas of rough pasture, scrub and forest. Pied stilt and black-fronted and banded dotterel are present on riverbeds and areas of wet swampy ground. New Zealand pigeon, tui and bellbird are found throughout the Unit, especially in and around areas of indigenous forest and areas of exotic cover particularly those that provide seasonal food sources. At times kaka has been noted within the Unit, having roamed from their more common mountain habitat.
- Lizard species likely to be present are common skink, common gecko, Wellington green gecko and possibly southern North Island speckled and spotted skinks along cobbled riparian margins.
- Bats (presumably Long-tailed bat ('North Island')) were detected at Lindsay Bush, with 75% of survey transects encountering bats. At that site forty three bat passes were encountered and 5 bats were seen.

6.1.5 Catchment Unit E

- Unit E is dominated by pastoral land cover (almost 97%); indigenous cover is sparsely distributed and occupies a small yet important proportion of the Unit (<1%; 630ha).
- Consequently the Unit has very high proportions of Acutely and Chronically Threatened Environments, and those areas which do contain indigenous cover, if not meeting those threat categories, are At Risk or Critically Underprotected.

- Lowland forest is present in very isolated remnants. Many of these areas hold unusually high habitat values for the presence of rare flora and have uncommon indigenous forest-landform (alluvial floodplain) associations. This unit contains around 17% of all of the Catchment's wetlands, and 8% of the total wetland area within the Catchment.
- Of the indigenous land cover compositions, manuka and kanuka scrub is the most extensive, in particular with some large areas covering Whangai argillite hill country. Other forests of broadleaved and podocarp composition exist. Rare plants present within mature indigenous forests include heart-leaved kohuhu (*Pittosporum obcordatum*), *Coprosma violacea*, *Fuchisa percandens* and the mistletoe *Korthalsella lindsayi.*
- Dabchick is present in the small farm ponds and lakes throughout this Unit. The three shag species are widespread within the Unit. Australasian bittern have been recorded within the Unit, although few areas of suitable habitat are currently available. Spotless crake are present, but would be confined to areas of suitable habitat. Pied stilt and banded and black-fronted dotterel may be found on riverbed habitats, although suitable habitats are relatively uncommon within the Unit. Pied stilt and black-fronted dotterel would also use wetter pasture and muddy margins of farm ponds and dams. New Zealand pipit is present, and can be relatively abundant in areas of suitable habitat such as rough pasture.
- Common skink would be present. Also possibly present are common and Wellington green geckos.
- No bat records are available for the Unit. Given the presence of long tailed bats in other areas of the North Island, including amongst production landscapes and isolated forest remnants, their presence in this Unit should not be ruled out.

6.1.6 Catchment Unit F

- Land cover is dominated by exotic grassland (85%) and exotic plantation forests (5%). Indigenous cover is very sparse, covering around 1.3% of the Unit (c.830ha).
- As with Units D and E, the highly modified state of land cover within Unit F means those areas of indigenous cover which do remain are of particular importance. The land within the Unit is almost entirely classified as either Acutely or Chronically Threatened Environments.
- Rare/uncommon habitats present include c.573ha of gravel riverbed, 830ha of indigenous cover, 421ha of which is lowland forest. Wetlands are quite abundant, in particular palustrine seeps and shallow water wetlands. This unit contains 19% of the Catchments wetlands, and 17% of the Catchment's wetland area. Due to the limestone geology of the Unit, calcareous cliffs, screes and boulderfields are present. The value of calcareous bouldfields as common gecko habitat in a highly modified agricultural setting was demonstrated by field survey results as part of this project. Where the main river meets the sea, the Tukituki estuary is formed. Estuaries are rare (historically rare) in some regions, and the Tukituki estuary has high habitat and wildlife values. The coastline at Haumoana is a 'shingle' type, and meets the criteria of 'historically' rare ecosystem.
- Notable flora of the Unit is the presence of *Olearia furfuracea* (uncommon in Eastern ED), the scrambling climber kiekie (uncommon in northern part of Eastern ED), nikau (locally common but of a discontinuous distribution in the Hawke's Bay Lowlands (Adam Forbes pers. obs). Also perhaps of relevance to rare and uncommon flora of Unit F are those species known to be associated with limestone and known to be present on Te Mata Peak's limestone cliffs, many of which drain to the Tukituki Catchment, including *Asplenium lyallii, Celmisia gracilenta* var*., Cheilanthes sieberi, Chionochloa flavicans* f. *temata, Senecio banksii and Vittadinia australis.*
- Dabchick is known from a number of sites in the Unit, and in 1992 Lake Roto-o-kiwa was estimated to hold nearly 7% of the region's population. The three species of shag are present. New Zealand pigeon, tui and bellbird are present within the Unit, especially in forested areas, as are grey warbler, fantail, silvereye and shining cuckoo. Kaka has been recorded visiting Haumoana and Te Awanga. Riflemen were searched for but not found. Given their presence on the near-by Maraetotara Plateau, it is possible they are present in indigenous forest remnants. New Zealand pipit is common throughout riverbed sections and in areas of rough pasture. The Estuary and associated shingle beach are particularly important avifauna sites,

with white heron, little egret and Royal spoonbills using the estuary from time to time. Australasian bittern are known from the estuary, although there are grounds for concern that the recently constructed walkway may hamper future breeding of this threatened bird at the estuary. Spotless crake is present at the estuary. South Island oystercatcher utilise the estuary in small numbers. Pied stilt, banded and black-fronted dotterel are found in significant numbers on riverbeds and within the estuary itself. Shore plover and wrybill are very infrequent visitors to the estuary. Black-billed gull and white-fronted tern nest (or have recently nested) on the lower Tukituki River and coastal shingle beach.

- Common gecko and common skink were both identified during field studies as part of this work (Te Mata Peak). Common skink were found on the shingle beach near Haumoana. There is a record for spotted skink at Haumoana, albeit somewhat dated. Speckled skink and Wellington green gecko are potentially present in favourable habitats.
- Bats (presumably Long-tailed bat ('North Island')) were detected by DoC at the indigenous forest remnant Elsthorpe Scenic Reserve. However, as earlier stated, given the presence of long tailed bats in other areas of the North Island, including amongst production landscapes and isolated forest remnants, their presence beyond Elsthorpe Scenic Reserve in this Unit is quite possible.

6.1.7 Landscape ecology

- Within much of the Catchment land use history and climate are key determinants of the variation in today's landscape composition and pattern. Indigenous vegetation cover is skewed with larger more continuous areas of indigenous cover being present in the western hill country on more elevated sites.
- Between the western hills and State Highway 50 (Unit C) is an ecologically important band of remnant indigenous forest habitats, which form a quite unique habitat network able to support a number of common and rare/endangered species.
- Units D, E and F are comparatively denuded of indigenous cover, and ecological pattern and process is impaired. Due to scarcity factors, the ecological importance of those remnants that do remain is particularly heightened in Units C, D, E, and F. This is reflected in the overwhelming dominance in those Units of Acutely and Chronically Threatened Environments.
- A number of rare/uncommon habitat types are present within the Catchment. These include habitats that have become rare from human related actions (induced) such as indigenous lowland forest and wetlands and those which were rare/uncommon at the time of human arrival (historically rare), such as shingle beach, braided riverbed, estuary, calcareous cliffs, screes and boulderfields.
- Plotting of predicted seed dispersal and pollination functions for the Catchment suggests these critical ecological functions are operating well in Units A, B and C, but breakdown over much of the remaining Units.
- Generally, protection of existing habitats and habitat networks is a key to maintaining biodiversity values within the Catchment. Restoration and expansion of existing habitats, along with use of landscape features such as road alignments, waterway corridors, shelterbelts and less productive areas and other exotic habitats can all contribute to a framework of improved ecological management, particularly when designed and managed at the landscape scale. Plant and animal pests are another critically important factor for terrestrial biodiversity management.
- Specific biodiversity management priorities and approaches should be prepared on a Catchment Unit basis, and integrated using a landscape scale framework.

6.2 Risks to river birds from changes in flow regime

- Braided riverbeds are rare and significant habitats. Most of the Tukituki and Waipawa riverbed were designated RAPs during the PNAP surveys. To add to the river's significance is the fact that it holds species from all eight of the water bird guilds.

- The number of banded dotterel on this stretch of river make this the largest population of this Nationally Vulnerable species compared with any other Hawke's Bay river; and this river may hold almost 5% of the national population. Add to this the population of pied stilt which might be around 3-4% of the national population and probably around 50% of the regional river based population, and the occurrence of other threatened species such as white heron, Royal spoonbill, grey duck, South Island oystercatcher, black-billed gull, Caspian tern, white-fronted tern, and New Zealand pipit, and the significance of this riverbed (above the estuary) is clearly apparent.

- Maintenance of flow regimes on rivers is essential for maintaining accessible food supplies, and the feeding and nesting habitat of river birds dependent on freshwater, particularly threatened species. In particular, maintenance of flows as close as possible to natural regimes during the critical breeding months (August to January) will help to ensure that the full range of channel types required for birds are present. However the effect of disruption of flow regimes is unlikely to be completely predictable.

- Likely effects to avifauna are outlined below:

  Generic (non-project specific) effects:

  - Food web effects from water quality and flow related influences on invertebrate communities.
  - Direct loss of bird habitat due to inundation at reservoir sites.
  - Flooding of nesting sites from untimely water releases.
  - Changes in flood frequency causing any of the following: channel stabilization, reduction in food availability, weed encroachment and loss of wetted area.
  - Sediment trapping, reduced sediment loads and effects to river morphology and linked effects to bird habitat and invertebrate communities (food availability).
  - Changes in the availability, security and character of 'island' habitats.
  - Changes in river morphology demanding the need for additional flood control activities.
  - Changes to bird nesting location, birds forced to nest on lower level sites more consequently vulnerable to flooding (caused by a range of factors linked to river flows).

  An example of potential effects from Ruataniwha Augmentation Scheme:

  <u>Construction phase:</u>

  - Physical disturbance to birds within and close to the development area through machinery noise, activity and alteration of flow regimes. Effects potentially pronounced during bird breeding seasons.
  - Loss of habitat from inundation. Includes riverbeds and riparian habitats.
  - Impact to landscape pattern and process from habitat loss. Changes to the available habitat for mobile species potentially reducing their viability and restricting related ecological functions.
  - Effects to river birds from reduced downstream water quality (e.g. from sediment discharges to the rivers water column) and consequential changes in food availability. These effects perhaps more pronounced during river 'low flow' periods.
  - Changes in river flow quantity during reservoir filling and consequential effects to river birds from factors such as water quality, flood/fresh frequency and the influence of these factors on river bird habitat and food availability.

  <u>Post construction phase:</u>

  - Effects potentially similar to those outlined for the construction phase, only in addition:
    - Effects of reservoir water quality on invertebrate communities and potential influence on river bird food availability.
    - Reservoir water level fluctuations and impacts on birds using the reservoir and surrounding areas.
    - Reduced flows from the additional construction of a hydro-power race.

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Appendix A Wetland classification and character

Wetlands vary in type and structure according to topographical, climatic, biological as well as hydrological processes, such as water table fluctuations, vegetative structure, source of flow and nutrient status as well as other factors[1].

Hydrosystem Classification

There are 4 main classifications of wetlands in the Tukituki River Catchment as described by Johnson and Gerbeaux (2004). A list of these wetland types is listed below with a description of their main features of classification. The first level of classification (Level I) is by Hydrosystem level and is based on the broad hydrological and landform setting, salinity and extremes of temperature. The four main classifications are for wetlands associated with land (palustrine), rivers (riverine), lakes (lacustrine) and coasts (estuarine)

Palustrine – Palustrine wetlands are 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.

Riverine – Riverine wetlands are 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 – Lacustrine wetlands are the 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.

Estuarine - Estuarine wetlands are influenced by salinity and are associated with intertidal, and supratidal processes. Types of wetlands in this classification include saltmarshes, intertidal mudflats, 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‰.

Subsystem classification

Subsystem classification is the second and less formal classification of hydrosystem types and categorises wetlands on their hydrological functions including periodicity of inundation, water source, water regime and fluctuation. This classification level was not carried out for the wetlands in this study due to the scope of the project but this information would need to be included in individual wetland assessments carried out on site where these characteristics are more apparent.

Wetland class

There are nine wetland classes recognised in Johnson and Gerbeaux (2004) and these have been used to classify the wetlands identified in this study. Descriptions of each of the wetland classes identified in this study and examples of each of the wetland types are explained below. Wetland classes are governed by substrate factors, water regime and the consequent factors of nutrient status and pH (sic.) Table A1 summarises the main characteristics of each wetland class found within the Tukituki catchment during this study. Wetlands are dynamic and may fall into more than one wetland class causing problems when trying to categorise them. For example an ox bow lake on a river floodplain, that is not directly associated with surface inundation from the riverine system will be characterised as a palustrine hydrosystem. The wetland class could be either shallow water due to the maximum depth of the standing water body falling below the 2m limit or seepage due to the primary inputs of groundwater causing the raising of the water table above the surface. Due to the scope and survey methods of the study wetland classes have been

[1] Ward & Lambie, 1999.

assigned using expert opinion and ground truthing is recommended to ensure that appropriate wetland classes are assigned using the classification keys developed by Johnson and Gerbeaux (2004) relating to nutrient levels, pH and water regime.

Seepage

Seepage wetlands are 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 classified under this category are 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).

Swamp

Swamps are 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

Marshes are 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.

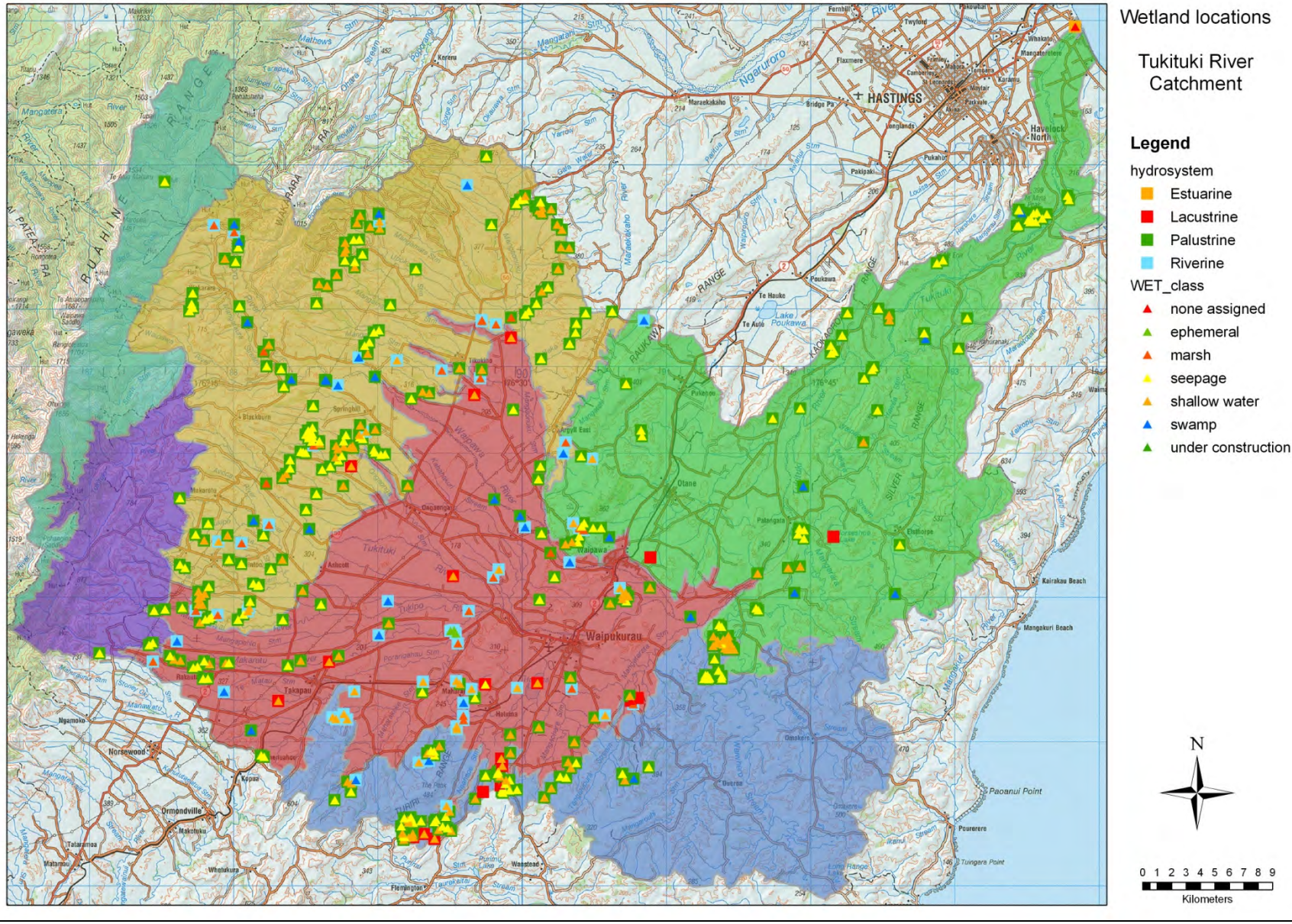
Ephemeral

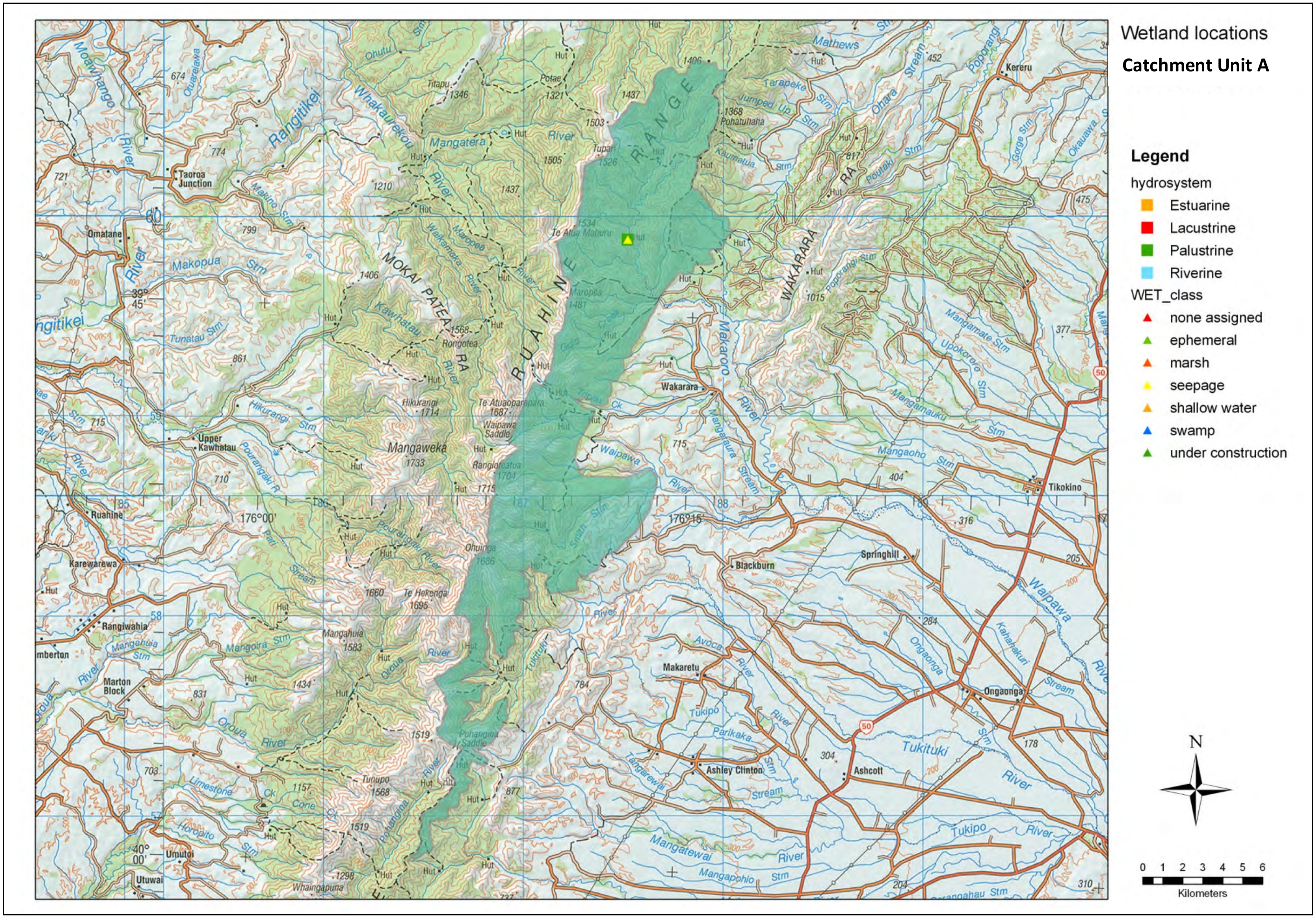
Ephemeral wetlands receive inputs of groundwater and rain only and have nil to slow water movement through them. They are characterised by marked seasonal drying and wetness and can have water table levels well above or below the ground surface. There is usually a marked zonation of vegetation communities due the fluctuation of water levels. Ephemeral wetlands are important due to the rare or specialist species that may use this system.

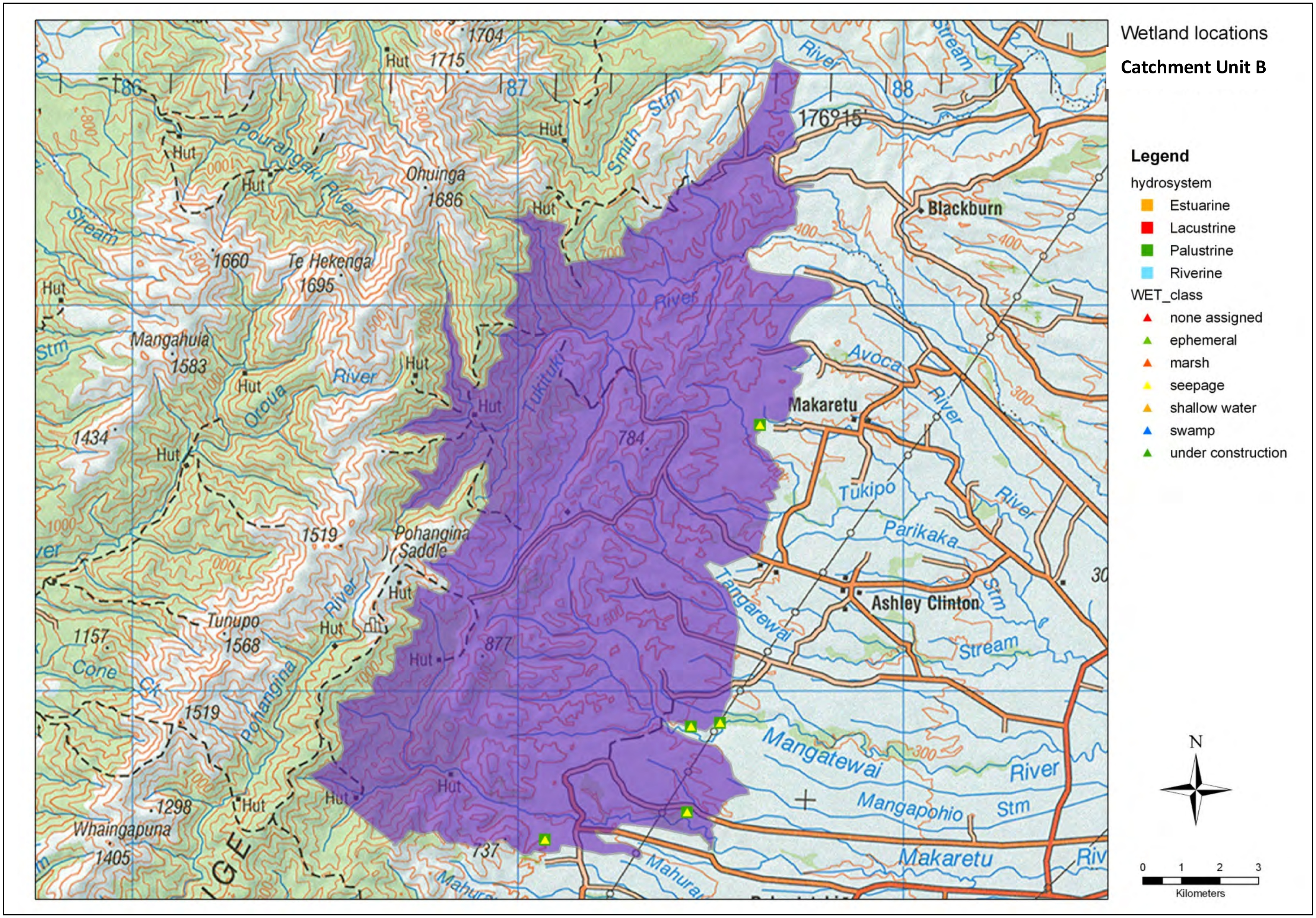
Table A1

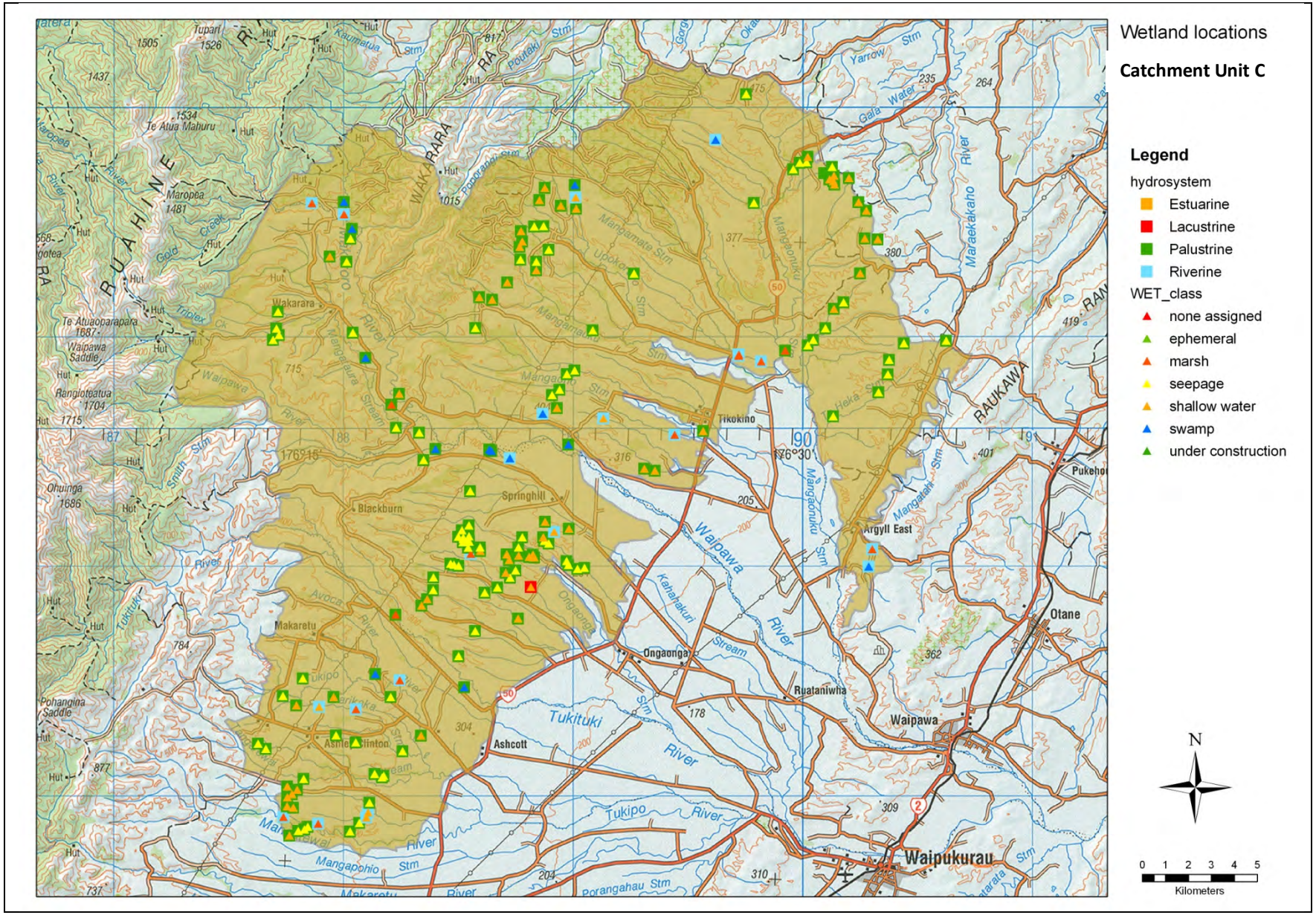
Wetland Class	Substrate	Water source	Drainage	Water table position	Nutrient status	Characteristic vegetation
Seepage	Peat, mineral or rock	Groundwater and/or surface water	Moderate to fast	Slightly above or below the surface	Low to high	Turf plants, cushion plant and bryophytes
Shallow water	Usually mineral	Lake, river or adjacent groundwater	Nil to good	Permanently above the ground surface	Low to high	Macrophytes, periphytic algae,
Swamp	Peat or mineral	Mainly surface water + groundwater	poor	Usually above surface in places	Moderate to high	Usually rushes, reeds, tall herbs, scrubby vegetation but can also be associated with forest
Marsh	Usually mineral	groundwater + surface water	Moderate to good	Usually below ground surface	Moderate to high	Rush. Grass, sedge or scrub types
Ephemeral	mineral	Groundwater + rain	poor	well above to well below ground surface	moderate	Marginal zones of turf and sedge sward

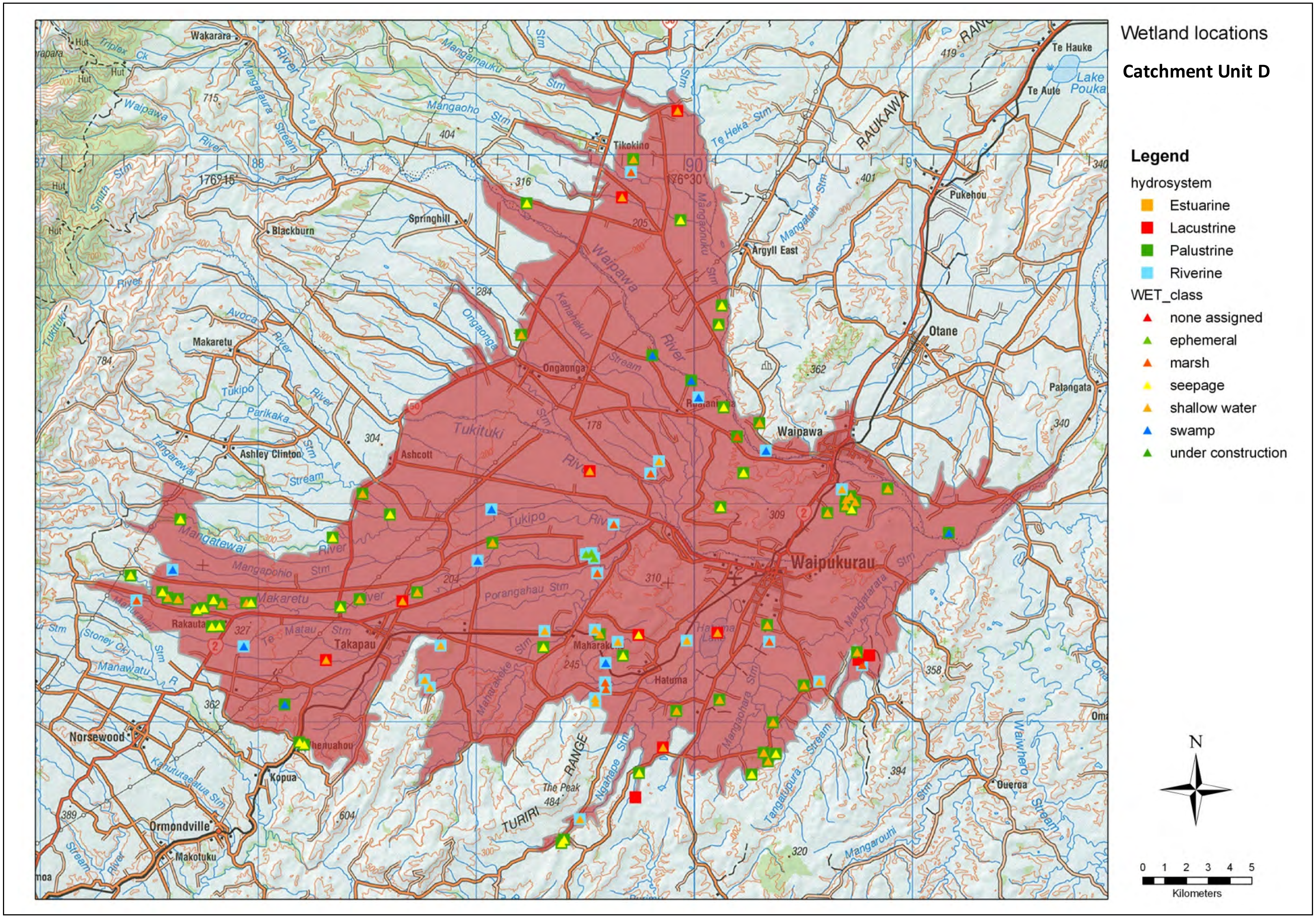
Appendix B: Wetland location/type maps

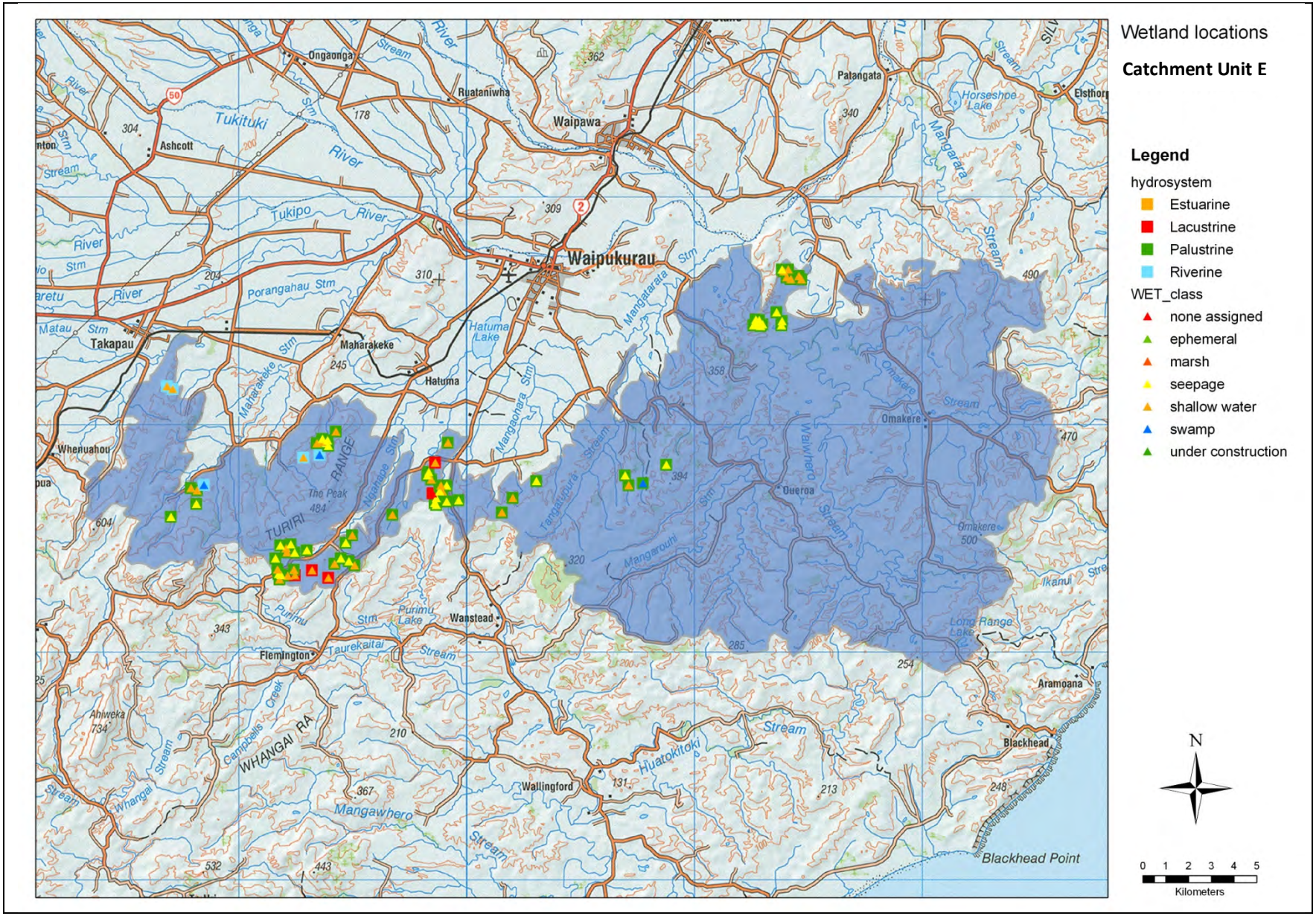

Wetland locations
Tukituki River Catchment
Legend
hydrosystem
Estuarine
Lacustrine
Palustrine
Riverine
WET_class
none assigned
ephemeral
marsh
seepage
shallow water
swamp
under construction
HASTINGS
Waipukurau
Ormondville
Norsewood
Takapau
Waipawa
Otane
Paoanui Point
N
0 1 2 3 4 5 6 7 8 9
Kilometers

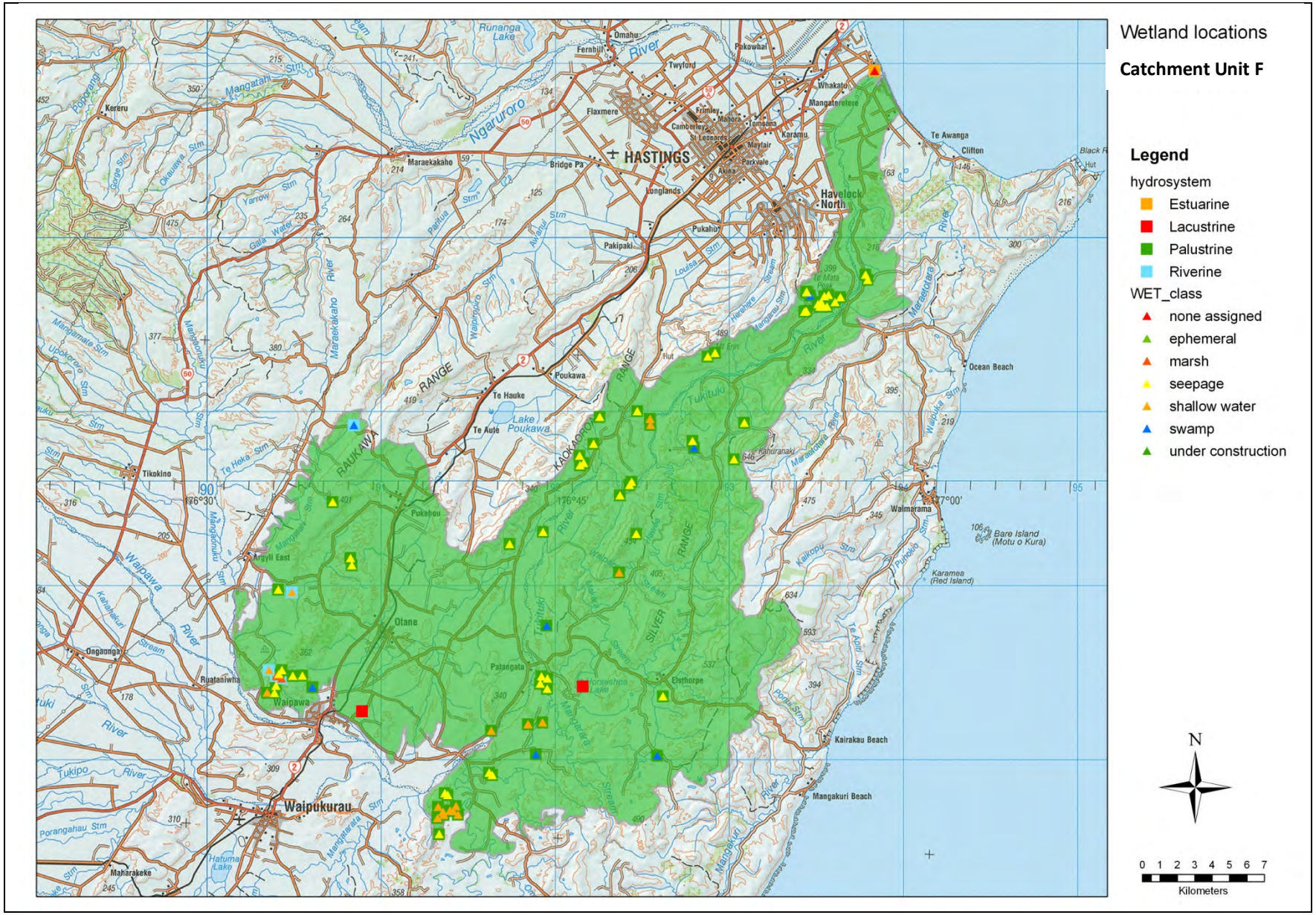

Wetland locations
Catchment Unit A
Legend
hydrosystem
Estuarine
Lacustrine
Palustrine
Riverine
WET_class
none assigned
ephemeral
marsh
seepage
shallow water
swamp
under construction
N
0 1 2 3 4 5 6
Kilometers
RUAHINE RANGE
MOKAI PATEA RA
WAKARARA RA


Wetland locations
Catchment Unit B
Legend
hydrosystem
Estuarine
Lacustrine
Palustrine
Riverine
WET_class
none assigned
ephemeral
marsh
seepage
shallow water
swamp
under construction
N
0 1 2 3
Kilometers
Blackburn
Makaretu
Ashley Clinton
Tukituki River
Avoca River
Tukipo River
Parikaka Stm
Tangarewai Stream
Mangatewai River
Mangapohio Stm
Makaretu River
Pohangina River
Pohangina Saddle
Oroua River
Pourangaki River
Smith Stm
Ohuinga 1686
Te Hekenga 1695
Mangahuia 1583
Tunupo 1568
Whaingapuna 1405
Cone Ck
Hut
1704
1715
1660
1434
1519
1157
1298
784
877
737


Wetland locations
Catchment Unit C
Legend
hydrosystem
Estuarine
Lacustrine
Palustrine
Riverine
WET_class
none assigned
ephemeral
marsh
seepage
shallow water
swamp
under construction
Tikokino
Springhill
Blackburn
Makaretu
Ashcott
Ongaonga
Ruataniwha
Argyll East
Otane
Waipawa
Waipukurau
Wakarara
Ruahine
Raukawa
Waipawa River
Tukituki River
Tukipo River
Mangaonuku Stm
Kahahakuri Stream
Mangamate Stm
Mangamaire Stm
Mangapohio Stm
Porangahau Stm
Maraekakaho River
Yarrow Stm
Gala Water
Poutaki Stm
Kaumatua Stm
Triplex Ck
Gole Creek
Maropea River
Waipawa Saddle
Pohangina Saddle
Rangiotoatua
Te Atuaoparapara
Te Atua Mahuru
Maropea
Ohuinga
Tupari
N
0 1 2 3 4 5
Kilometers


Wetland locations
Catchment Unit D
Legend
hydrosystem
Estuarine
Lacustrine
Palustrine
Riverine
WET_class
none assigned
ephemeral
marsh
seepage
shallow water
swamp
under construction
N
0 1 2 3 4 5
Kilometers
Wakarara
Tikokino
Springhill
Blackburn
Argyll East
Pukehou
Te Hauke
Te Aute
Lake Pouka
RAUKAWA
Otane
Patangata
Makaretu
Ongaonga
Ashcott
Ashley Clinton
Waipawa
Waipukurau
Takapau
Rakauta
Maharakeke
Hatuma
Norsewood
Kopua
Ormondville
Makotuku
Ouerua
TURIRI RANGE
The Peak
Tukituki River
Waipawa River
Tukipo River
Makaretu River
Mangatewai River
Porangahau Stm
Mangarouhi
176°15'
176°30'


Wetland locations
Catchment Unit E
Legend
hydrosystem
Estuarine
Lacustrine
Palustrine
Riverine
WET_class
none assigned
ephemeral
marsh
seepage
shallow water
swamp
under construction
Waipukurau
Waipawa
Ongaonga
Ruataniwha
Ashcott
Takapau
Maharakeke
Hatuma
Hatuma Lake
Porangahau Stm
Tukituki River
Tukipo River
Whenuahou
Omakere
Oueroa
Wanstead
Flemington
Wallingford
Aramoana
Blackhead
Blackhead Point
Long Range Lake
Horseshoe Lake
Purimu Lake
WHANGAI RA
TURIRI RANGE
The Peak
Mangawhero
Huatokitoki
N
0 1 2 3 4 5
Kilometers


Wetland locations
Catchment Unit F
Legend
hydrosystem
Estuarine
Lacustrine
Palustrine
Riverine
WET_class
none assigned
ephemeral
marsh
seepage
shallow water
swamp
under construction
HASTINGS
Havelock North
Waipukurau
Waipawa
Otane
Waipawa River
Tukituki River
Ngaruroro River
Lake Poukawa
Lake Hatuma
Ocean Beach
Kairakau Beach
Mangakuri Beach
Bare Island (Motu o Kura)
Karamea (Red Island)
N
0 1 2 3 4 5 6 7
Kilometers

Appendix C Tukituki Catchment bird species list

						Tukituki Catchment Unit					
Species	**Scientific name**	**Nat. status**	**Desig.**	**Reg status**	**Habitats**	**A**	**B**	**C**	**D**	**E**	**F**
Northern brown kiwi	***Apteryx mantelli***	NV	En	Cat B	SS-sc, FT-ex, FT-in	P	U	H	A	A	A
New Zealand grebe (dabchick)	***Poliocephalus rufopectus***	NV	En	Cat B	WB-iw	A	A	P	P	P	P
Australasian gannet	***Morus serrator***	NT	Na	-	WB-iw, SW-ow	A	A	A	A	A	P
Great cormorant (black shag)	***Phalacrocorax carbo***	NUn	Na	-	WB-iw, SW-ow	P	P	P	P	P	P
Little black cormorant	***Phalacrocorax sulcirostris***	NUn	Na	-	WB-iw	A	A	L	P	P	P
Little pied cormorant	***Phalacrocorax melanoleucos***	NUn	Na	-	WB-iw	L	L	P	P	P	P
Spotted shag	***Stictocarbo punctatus***	NT	En	-	SW-ow	A	A	A	A	A	P
White-faced heron	***Egretta novaehollandiae***	NT	Na	-	WB-iw, GL-pp, SL-cw, SM-cw	L	L	P	P	P	P
Great egret (white heron)	***Ardea alba***	NC	Na	Cat O	WB-iw, SL-cw, SM-cw	A	A	A	P	A	P
Little egret	***Egretta garzetta***	Vag	Na	-	WB-iw, SL-cw, SM-cw	A	A	A	A	A	P
Eastern reef egret (heron)	***Egretta sacra***	NV	Na	Cat O	WB-iw	A	A	A	A	A	U
Intermediate egret	***Ardea intermedia***	Vag	Na	-	WB-iw, SL-cw, SM-cw	A	A	A	A	A	P
Cattle egret	***Ardea ibis***	Mig	Na	-	WB-iw, GL-pp, SL-cw, SM-cw	A	A	A	P	U	P
Australasian bittern	***Botaurus poiciloptilus***	NE	Na	Cat O	WB-iw, SL-cw, SM-cw	A	U	U	P	P	P
Royal spoonbill	***Platalea regia***	NUn	Na	Cat O	WB-iw	A	A	A	P	U	P
Mute swan	***Cygnus olor***	I&N	Int	-	WB-iw	A	A	A	P	L	P
Black swan	***Cygnus atratus***	NT	Na	-	WB-iw	A	U	U	P	P	P
Feral (greylag) goose	***Anser anser***	I&N	Int	-	WB-iw, GL-pp	A	L	P	P	P	P
Canada goose	***Branta canadensis***	I&N	Int	-	WB-iw, CL-ph, GL-pp	A	U	A	L	P	P
Paradise shelduck	***Tadorna variegata***	NT	En	-	AS-us, WB-iw, CL-ph, GL-pp	P	P	P	P	P	P
Blue duck	***Hymenolaimus malacorhynchos***	NV	En	Cat B	WB-iw	P	P	L	A	A	A
Mallard	***Anas platyrhynchos***	I&N	Int	-	AS-us, WB-iw, CL-ph, GL-pp	P	L	P	P	P	P
Pacific black (grey) duck	***Anas superciliosa***	NC	Na	-	WB-iw	U	L	P	P	P	P
Grey teal	***Anas gracilis***	NT	Na	-	WB-iw	U	L	P	P	P	P
Australasian shoveler	***Anas rhynchotis***	NT	Na	-	WB-iw	U	L	P	P	P	P
New Zealand scaup	***Aythya novaeseelandiae***	NT	En	-	WB-iw	A	A	A	P	P	P

						Tukituki Catchment Unit					
Species	**Scientific name**	**Nat. status**	**Desig.**	**Reg status**	**Habitats**	**A**	**B**	**C**	**D**	**E**	**F**
Swamp (Australasian) harrier	***Circus approximans***	NT	Na	-	WB-iw, CL-ph, GL-pp, GL-tg, SL-cw, SM-cw, SS-sc, FT-ex, FT-wp, FT-in	P	L	P	P	P	P
New Zealand falcon	***Falco novaeseelandiae***	NV	En	Cat B	CL-ph, GL-pp, GL-tg, SS-sc, FT-ex, FT-in	P	P	P	L	L	P
Brown quail	***Coturnix ypsilophora***	I&N	Int	-	GL-pp, SS-sc	A	U	P	U	U	U
Common (ring-necked) pheasant	***Phasianus colchicus***	I&N	Int	-	GL-pp, SS-sc, FT-ms, FT-ex	P	L	P	P	P	P
Wild turkey	***Meleagris gallopavo***	I&N	Int	-	GL-pp, SS-sc, FT-ms, FT-ex	A	L	P	P	P	P
California quail	***Callipepla californica***	I&N	Int	-	GL-pp, SS-sc, FT-ms, FT-ex	P	L	P	P	P	P
Weka	***Gallirallus australis***	NV	En	-	FT-in	A	A	H	A	A	A
Baillon's (marsh) crake	***Porzana pusilla***	AR-rt	Na	-	SL-cw, SM-cw	A	A	A	A	A	L
Spotless crake	***Porzana tabuensis***	AR-rt	Na	-	WB-iw, SL-cw, SM-cw	U	L	L	P	P	P
Pukeko (purple swamphen)	***Porphyrio melanotus***	NT	Na	-	AS-us, WB-iw, CL-ph, GL-pp, SL-cw, SM-cw	P	L	P	P	P	P
Common coot	***Fulica atra***	Col	Na	-	WB-iw	A	A	A	A	P	P
South Island oystercatcher	***Haematopus finschi***	AR-dc	En	-	BS-cs, BS-bg, WB-iw, GL-pp	A	A	A	A	A	P
Variable oystercatcher	***Haematopus unicolor***	AR-rv	En	Cat B	BS-cs, WB-iw	A	A	A	A	A	P
Pied (black-winged) stilt	***Himantopus himantopus***	AR-dc	Na	-	WB-iw, SL-cw, SM-cw	U	L	P	P	P	P
Pacific golden plover	***Pluvialis fulva***	Mig	Na	-	WB-iw	A	A	A	A	A	U
New Zealand plover (dotterel)	***Charadrius obscurus***	NV	En	Cat B	BS-cs, WB-iw	A	A	A	A	A	U
Banded dotterel (double-banded plover)	***Charadrius bicinctus***	NV	En	Cat C	BS-cs, BS-bg, WB-iw	U	L	P	P	P	P
Black-fronted dotterel	***Charadrius melanops***	Col	Na	-	BS-cs, BS-bg, WB-iw	A	L	P	P	P	P
Shore plover	***Thinornis novaeseelandiae***	NC	En	-	WB-iw	A	A	A	A	A	U
Wrybill	***Anarhynchus frontalis***	NV	En	Cat B	WB-iw	A	A	A	A	A	P
Masked lapwing (spur-winged plover)	***Vanellus miles***	NT	Na	-	BS-cs, BS-bg, WB-iw, GL-pp	L	P	P	P	P	P
Bar-tailed godwit	***Limosa lapponica***	Mig	Na	-	WB-iw	A	A	A	A	A	P
Ruddy turnstone	***Arenaria interpres***	Mig	Na	-	WB-iw	A	A	A	A	A	P
Red (lesser) knot	***Calidris canutus***	Mig	Na	-	WB-iw	A	A	A	A	A	P
Red-necked stint	***Calidris ruficollis***	Mig	Na	-	WB-iw	A	A	A	A	A	P
Pectoral sandpiper	***Calidris melanotos***	Vag	Na	-	WB-iw	A	A	A	A	A	P

						Tukituki Catchment Unit					
Species	**Scientific name**	**Nat. status**	**Desig.**	**Reg status**	**Habitats**	**A**	**B**	**C**	**D**	**E**	**F**
Sharp-tailed sandpiper	***Calidris acuminata***	Mig	Na	-	WB-iw	A	A	A	A	A	P
Curlew sandpiper	***Calidris ferruginea***	Mig	Na	-	WB-iw	A	A	A	A	A	P
Parasitic jaeger (Arctic skua)	***Stercorarius parasiticus***	Mig	Na	-	SW-ow	A	A	A	A	A	P
Black-backed (kelp) gull	***Larus dominicanus***	NT	Na	-	AS-ua, AS-us, AS-md, BS-cs, WB-iw, GL-pp, SL-cw, SM-cw, SW-ow	P	P	P	P	P	P
Red-billed gull	***Larus scopulinus***	NV	En	-	WB-iw, SW-ow	A	A	U	U	L	P
Black-billed gull	***Larus bulleri***	NE	En	-	WB-iw, GL-pp, SW-ow	A	A	U	U	L	P
Gull-billed tern	***Sterna nilotica***	Vag	Na	-	WB-iw	A	A	A	A	A	U
Caspian tern	***Sterna caspia***	NV	Na	Cat O	WB-iw	A	A	U	P	A	P
White-fronted tern	***Sterna striata***	AR-dc	Na	-	WB-iw	A	A	A	A	A	P
Little tern	***Sterna albifrons***	Mig	Na	-	WB-iw	A	A	A	A	A	P
Black-fronted tern	***Sterna albostriata***	NE	En	Cat B	WB-iw	A	A	A	A	A	P
White-winged black tern	***Chlidonias leucopterus***	Mig	Na	-	WB-iw	A	A	A	A	A	U
New Zealand pigeon	***Hemiphaga novaeseelandiae***	NT	En	Cat B	SS-sc, FT-ex, WT-wp, FT-in	P	P	P	P	P	P
Rock (feral) pigeon	***Columba livia***	I&N	Int	-	AS-ua, AS-us, CL-ph, GL-pp, FT-ms	U	L	P	P	P	P
African (Barbary) collared-dove	***Streptopelia roseogrisea***	I&N	Int	-	AS-ua, AS-us	A	A	A	A	A	P
Sulphur-crested cockatoo	***Cacatua galerita***	I&N	Int	-	FT-ms, FT-wp, FT-in	U	A	A	A	A	P
New Zealand kaka	***Nestor meridionalis***	NV	En	Cat B	CL-ph, FT-ex, FT-in	P	L	P	P	A	P
Eastern rosella	***Platycercus eximius***	I&N	Int	-	CL-ph, GL-pp, FT-ms, FT-ex, FT-in	P	P	P	P	L	A
Red-crowned parakeet	***Cyanoramphus novaezelandiae***	AR-rt	Na	Cat C	FT-in	H	H	H	A	A	A
Yellow-crowned parakeet	***Cyanoramphus auriceps***	NT	En	Cat C	FT-in	P	P	P	A	A	A
Shining bronze-cuckoo	***Chrysococcyx lucidus***	NT	Na	-	SS-sc, FT-ms, FT-ex, FT-wp, FT-in	P	P	P	P	P	P
Long-tailed cuckoo	***Eudynamys taitensis***	NUn	Na	-	SS-sc, FT-ex, FT-in	P	P	P	A	A	P
Morepork	***Ninox novaeseelandiae***	NT	En	-	CL-ph, SS-sc, FT-ms, FT-ex, FT-wp, FT-in	P	P	P	P	P	P
Sacred kingfisher	***Todiramphus sanctus***	NT	Na	-	WB-iw, CL-ph, GL-pp, SL-cw, SM-cw, SS-sc, FT-ms, FT-ex, FT-wp, FT-in	P	P	P	P	P	P
Rifleman	***Acanthisitta chloris***	AR-dc	En	-	SS-sc, FT-in	P	P	P	A	A	U
Sky lark	***Alauda arvensis***	I&N	Int	-	BS-bg, WB-iw, CL-ph, GL-pp, GL-tg	P	P	P	P	P	P

						Tukituki Catchment Unit					
Species	**Scientific name**	**Nat. status**	**Desig.**	**Reg status**	**Habitats**	**A**	**B**	**C**	**D**	**E**	**F**
Welcome swallow	***Hirundo neoxena***	NT	Na	-	AS-us, WB-w, CL-ph, GL-pp, GL-tg, SL-cw, SM-cw	P	P	P	P	P	P
New Zealand pipit	***Anthus novaeseelandiae***	AR-dc	En	-	BS-bg, WB-iw, GL-pp, GL-tg	P	P	P	P	P	P
Dunnock	***Prunella modularis***	I&N	Int	-	AS-ua, AS-us, CL-ph, GL-pp, SS-sc, FT-ms, FT-ex, FT-wp, FT-in	P	P	P	P	P	P
Common blackbird	***Turdus merula***	I&N	Int	-	AS-ua, AS-us, CL-ph, GL-pp, SS-sc, FT-ms, FT-ex, FT-wp, FT-in	P	P	P	P	P	P
Song thrush	***Turdus philomelos***	I&N	Int	-	AS-ua, AS-us, CL-ph, GL-pp, SS-sc, FT-ms, FT-ex, FT-wp, FT-in	P	P	P	P	P	P
New Zealand fernbird	***Megalurus punctata***	AR-dc	En	-	SL-cw, SM-cw, SS-sc	L	P	P	A	A	A
Whitehead	***Mohoua albicilla***	NT	En	-	SS-sc, FT-ex, FT-in	P	P	P	A	A	A
Grey fantail	***Rhipidura fuliginosa***	NT	En	-	AS-ua, AS-us, SS-sc, FT-ms, FT-ex, FT-wp, FT-in	P	P	P	P	P	P
North Island robin	***Petroica longipes***	NT	En	-	FT-ex, FT-in	P	L	P	A	A	A
North Island tomtit	***Petroica toitoi***	NT	En	-	FT-ex, FT-in	P	P	P	A	A	A
Grey gerygone (warbler)	***Gerygone igata***	NT	En	-	AS-ua, AS-us, SS-sc, FT-ms, FT-ex, FT-wp, FT-in	P	P	P	P	P	P
Silvereye (waxeye)	***Zosterops lateralis***	NT	Na	-	AS-ua, AS-us, SS-sc, FT-ms, FT-ex, FT-wp, FT-in	P	P	P	P	P	P
New Zealand bellbird	***Anthornis melanura***	NT	En	-	AS-ua, AS-us, SS-sc, FT-ms, FT-ex, FT-wp, FT-in	P	P	P	P	P	P
Tui	***Prosthemadera novaeseelandiae***	NT	En	-	AS-ua, AS-us, SS-sc, FT-ms, FT-ex, FT-wp, FT-in	P	P	P	P	P	P
Australian magpie	***Gymnorhina tibicen***	I&N	Int	-	AS-us, CL-ph, GL-pp, SS-sc, FT-ms, FT-ex, FT-wp, FT-in	P	P	P	P	P	P
Rook	***Corvus frugilegus***	I&N	Int	-	CL-ph, GL-pp	L	L	P	P	P	P
Common starling	***Sturnus vulgaris***	I&N	Int	-	AS-ua, AS-us, CL-ph, GL-pp, SS-sc, FT-ms, FT-ex, FT-wp, FT-in	P	P	P	P	P	P
Common myna	***Acridotheres tristis***	I&N	Int	-	AS-ua, AS-us, CL-ph, GL-pp, FT-ms	A	A	L	P	P	P
House sparrow	***Passer domesticus***	I&N	Int	-	AS-ua, AS-us, CL-ph, GL-pp, SS-sc, FT-ms, FT-ex, FT-wp, FT-in	P	P	P	P	P	P
Chaffinch	***Fringilla coelebs***	I&N	Int	-	AS-ua, AS-us, CL-ph, GL-pp, SS-sc, FT-ms, FT-ex, FT-wp, FT-in	P	P	P	P	P	P
European greenfinch	***Carduelis chloris***	I&N	Int	-	AS-ua, AS-us, CL-ph, GL-pp, SS-sc, FT-ms, FT-ex, FT-wp, FT-in	P	P	P	P	P	P
European goldfinch	***Carduelis carduelis***	I&N	Int	-	AS-ua, AS-us, CL-ph, GL-pp, SS-sc, FT-ms, FT-ex, FT-wp, FT-in	P	P	P	P	P	P
Common redpoll	***Carduelis flammea***	I&N	Int	-	AS-ua, AS-us, CL-ph, GL-pp, SS-sc, FT-ms, FT-ex, FT-wp, FT-in	P	P	P	P	P	P
Yellowhammer	***Emberiza citrinella***	I&N	Int	-	AS-ua, AS-us, CL-ph, GL-pp, SS-sc, FT-ms, FT-ex, FT-wp, FT-in	P	P	P	P	P	P

Habitat key		
AS-ua	Artificial surfaces	Urban area
AS-us	Artificial surfaces	Urban open space
AS-md	Artificial surfaces	Mines and dumps
BS-cs	Bare or lightly vegetated surfaces	Coastal sand
BS-bg	Bare or lightly vegetated surfaces	Bare ground
WB-iw	Water bodies	Inland water
CL-ph	Cropland	Primarily horticultural
GL-pp	Grassland	Primarily pastoral
GL-tg	Grassland	Tussock grassland
SL-cw	Sedgeland	Coastal wetland
SM-cw	Saltmarsh	Coastal wetland
SS-sc	Scrub and shrubland	Scrub
FT-ms	Forest	Major shelterbelts
FT-ex	Forest	Planted forest
FT-wp	Forest	Willows and poplars
FT-in	Forest	Indigenous forest
SW-ow	Saltwater	Open water

Appendix D Suitability of LCDB2 cover classes for specific lizard species

LCDB2 land cover classes present in the Tukituki Catchment, and the degree of suitability for each of the lizard species potentially present. Habitat suitability classifications: o = optimal, m = marginal, p = poor, u = unsuitable.

LCDB2CLASS	LCDB2NAME	Np	Wm	Mfg	Dp	Op	Ol	Oss	Om	Ld	Oo	Oa
1	Built-up Area	u	u	u	u	u	u	u	u	u	u	u
2	Urban Parkland/ Open Space	m	m	m	m	m	m	m	p	o	u	m
3	Surface Mine	u	u	u	u	u	u	u	u	u	u	u
4	Dump	u	u	u	u	u	u	u	u	u	u	u
5	Transport Infrastructure	u	u	u	u	u	u	u	u	u	u	u
10	Coastal Sand and Gravel	p	o	p	o	o	o	o	u	o	p	o
11	River and Lakeshore Gravel and Rock	p	m	p	p	o	o	o	o	o	p	m
12	Landslide	p	o	m	p	o	o	o	o	o	p	m
13	Alpine Gravel and Rock	u	u	u	u	o	o	u	o	u	u	u
20	Lake and Pond	u	u	u	u	u	u	u	u	u	u	u
21	River	u	u	u	u	u	u	u	u	u	u	u
30	Short-rotation Cropland	u	u	u	u	u	u	u	u	u	u	u
31	Vineyard	p	m	p	p	m	m	m	p	o	p	m
32	Orchard and Other Perennial Crops	p	m	p	m	m	m	m	p	o	p	m
40	High Producing Exotic Grassland	p	m	p	p	m	m	m	m	o	p	m
41	Low Producing Grassland	p	m	p	p	m	m	m	m	o	p	m
43	Tall Tussock Grassland	p	m	p	p	o	o	o	o	o	p	p
45	Herbaceous Freshwater Vegetation	p	p	p	p	p	p	p	p	p	p	p
46	Herbaceous Saline Vegetation	p	p	p	p	p	p	p	p	p	p	p
50	Fernland	p	m	o	m	m	m	m	m	m	m	o
51	Gorse and Broom	p	m	m	m	m	m	m	m	m	m	m
52	Manuka and or Kanuka	o	o	o	o	o	o	o	o	m	o	o

LCDB2CLASS	LCDB2NAME	Np	Wm	Mfg	Dp	Op	Ol	Oss	Om	Ld	Oo	Oa
54	Broadleaved Indigenous Hardwoods	o	o	o	o	o	o	o	o	m	o	o
55	Sub Alpine Shrubland	u	u	u	u	o	o	u	o	u	u	u
56	Mixed Exotic Shrubland	m	m	m	m	m	m	m	m	m	m	m
57	Grey Scrub	m	m	m	m	m	m	m	m	m	m	m
61	Major Shelterbelts	m	m	m	m	m	m	m	m	m	m	m
63	Afforestation (imaged, post LCDB 1)	m	m	m	m	p	p	p	p	p	m	m
64	Forest Harvested	p	p	p	p	p	p	p	p	p	p	p
65	Pine Forest - Open Canopy	m	p	p	p	p	p	p	p	p	p	p
66	Pine Forest - Closed Canopy	m	p	p	p	p	p	p	p	p	p	p
67	Other Exotic Forest	m	m	m	m	m	m	m	p	m	p	m
68	Deciduous Hardwoods	m	m	m	m	m	m	m	m	m	m	m
69	Indigenous Forest	o	o	o	o	p	p	p	p	p	o	o

Naultinus punctatus **– Np;** ***Woodworthia maculatus*** **– Wm;** ***Dactylocnemis pacificus*** **– Dp;** ***Mokopirirakau*** **"Southern North Island forest gecko" – Mfg;** ***Oligosoma polychroma*** **– Op;** ***O. microlepis*** **– Om*;** ***O. "*****Southern North Island speckled skink" – Oss;** ***O. Lineoocellatum*** **– Ol; rainbow skink** ***L. delicata*** **– Ld; ornate skink** ***O. ornata*** **– Oo; copper skink** ***O. aenea*** **– Oa.**

Appendix E Terrestrial invertebrate analyses

Terrestrial Invertebrate Identification and Interpretation from Karamu and Tukituki River Habitats

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DATE: April 2011

Contents

Summary

Project and Client
MWH approached Landcare Research Ltd in November 2010 to process terrestrial invertebrate samples from Karamu and Tukituki River Habitats, identify taxa and interpret the data under a bioindicator framework as part of an assessment of the health of terrestrial vegetation systems.

Methods
MWH supplied pitfall trap samples. Invertebrates from these samples were identified to order, and for Coleoptera (beetles) and Hymenoptera (wasps/bees/ants), lower level identification was provided were feasible. MWH also supplied light trap samples at Tukituki, where Lepidoptera were identified to the lowest possible level.

At Karamu, sites were grouped *a priori* into three habitats for interpretation: native riparian enhancement planting, mown riparian exotic grassland (called pasture in this report), native forest retired from stock grazing c.9 years ago. There were four replicates of each habitat, sampled using 6 pitfall traps for one month.

At Tukituki, sites were grouped *a priori* into three broad habitat categories for interpretation: tall tussock grassland; lowland Broadleaved indigenous forest (forest remnant); *Pinus radiata* forest. There were four replicates of each habitat, sampled using 6 pitfall traps for one month. Light traps samples were also provided for two pasture sites.

Both studies were also combined to compare differences and similarities in the habitats.

Statistical analyses of the data included: i) assessments of richness and diversity to compare habitats, and ii) multivariate ordination to show the similarity of sites and habitats. Terrestrial invertebrate data was interpreted under a bioindicator framework. That is, use of i) sub-sampling, ii) higher taxonomic levels, iii) the use of RTUs (recognisable taxonomic units) and their subsequent identification, and iv) the use of focal groups (e.g. Coleoptera, Hymenoptera, Lepidoptera).

Results
In general, invertebrates could be used to distinguish the different types of habitats. In the combined analysis, three major habitats groupings were evident. First, tussock is clearly separated from other habitats. Pasture and riparian habitats (both at Karamu) are grouped together, and these are separated from the third group of "forest sites". In the forest grouping, Tukituki forest and pine are more similar to each other than forest at Karamu.

Light trapping of Lepidoptera revealed tussock sites had very high diversity and richness, several significant moth species (uncommon endemics) were found.

There was a detectable difference in community structure between the native riparian enhancement planting and pasture. However, Riparian sites had not progressed to the stage of

being comparable to forest habitats. This was best demonstrated when the two studies were combined and a larger number of samples examined. Pasture and riparian sites were still grouped together, indicating they were most similar.

The forested sites at Karamu („Mahana") and Tukituki (Inglis Bush) were different (Figure 4). Differences in the invertebrate fauna point to Tukituki having a greater leaf litter component as millipedes and *Saphobius* are decomposers and very common in leaf litter. This fits with the fact that „Mahana" is still recovering from grazing, and would presumably have less leaf litter and woody debris covering the forest floor.

Conclusions

This study showed that even using a relatively simple protocol, invertebrates could easily be used to distinguish the differences of habitats. The results could be used to form a very basic baseline for what is expected in other sites of similar habitats. Furthermore, the results could be used to monitor disturbance/changes in such habitats over time.

Guidelines for interpreting terrestrial invertebrate data are basically non-existent in New Zealand. Unfortunately, there is no comparable "MC Index" used for freshwater habitats. Such a system for terrestrial environments is urgently needed in New Zealand to assist many agencies with interpreting invertebrate data associated with landuse change, restoration, land management etc.

1. Introduction

Invertebrates are now recognised as important components of biodiversity (Yen and Butcher, 1997, Ward 2004, Ward & Lariviere 2004). They are important in all ecosystems in terms of species numbers and biomass, and play vital roles in processes such as pollination, soil formation and fertility, plant productivity, organic decomposition, and the regulation of populations of other organisms through predation and parasitism (Yen and Butcher, 1997, Ward 2004, Ward & Lariviere 2004).

Furthermore, invertebrates are increasingly being recognised as important indicators of environmental changes. Kremen *et al*. (1993) suggested that terrestrial arthropods could be used for virtually any monitoring challenge. Conservation and biodiversity assessments that use invertebrates allow patterns of diversity and environmental quality to be measured at scales that are often more meaningful than those measured using plants and vertebrates (Yen and Butcher, 1997). The majority of invertebrates are also more sensitive to environmental perturbations than plants and vertebrates due to their rapid breeding rates and relatively short generation times (Kremen *et al*., 1993). In addition, invertebrates exhibit a wide range of body sizes, growth rates, life history strategies and ecological preferences, which can be linked with specific variables to provide a greater understanding of invertebrate responses to environmental conditions and to generate predictive models for ecosystem biodiversity (Yen and Butcher, 1997).

The wider acceptance of invertebrates as indispensable components of biodiversity has led to a rapid increase in broad-based surveys (i.e. a survey incorporating a wide range of invertebrate taxa) and greater pressure to provide information and guidelines for invertebrate conservation and monitoring.

A number of rapid biodiversity assessment (RBA) approaches have been suggested to overcome these problems. RBA approaches generally fall into four categories: (1) restricted sampling in place of intensive sampling (sampling surrogacy); (2) the use of higher taxonomic levels than species (species surrogacy); (3) the use of recognisable taxonomic units (RTUs) identified by non-specialists (taxonomic surrogacy); and (4) the use of surrogate taxa in place of all taxa (taxon-focusing).

Rapid Biodiversity Assessment (RBA) approaches have arisen mainly to help overcome many of the difficulties associated with large-scale invertebrate surveys. The two main objectives of RBA are to reduce the effort and cost of sampling, and to summarise complex ecological details so they can be understood by non-specialists (Yen and Butcher, 1997).

This report interprets terrestrial invertebrate data from a series of Karamu and Tukituki River habitats under the context of using invertebrates as bioindicators of different habitats, and habitat condition.

2. Objectives

The objective of this project is to assess and interpret terrestrial invertebrate data from a series of Karamu and Tukituki River habitats and determine if invertebrates can act as bioindicators of different habitats, and habitat condition.

3. Methods

Invertebrate sampling and analysis

MWH supplied pitfall trap samples. Invertebrates from these samples were identified to order, and for Coleoptera (beetles) and Hymenoptera (wasps/bees/ants), lower level identification was provided were feasible. MWH also supplied light trap samples at Tukituki, where Lepidoptera were identified to the lowest possible level.

At Karamu, sites were grouped *a priori* into three habitats for interpretation: native riparian enhancement planting, mown riparian exotic grassland, native forest retired from stock grazing c.9 years ago. There were four replicates of each habitat, sampled using 6 pitfall traps for one month.

At Tukituki, sites were grouped *a priori* into three broad habitat categories for interpretation: tall tussock grassland; lowland Broadleaved indigenous forest (forest remnant); *Pinus radiata* forest. There were four replicates of each habitat, sampled using 6 pitfall traps for one month. Light traps samples were also provided for two pasture sites.

Invertebrate samples were processed by straining the sample through a series of sieves to remove debris (wood, leaves, dirt). The sample was then poured onto a 35 x 45 cm tray and invertebrates were examined using a swing-arm microscope with magnification of 100x. The first 100 invertebrates seen in the sample were identified to order and counted for analysis. If occurring within the „first 100", any beetles (Coleoptera) and wasps/ants (Hymenoptera) were removed from the sample for lower level identification – these acted as bioindicators. Lepidoptera, from light trap samples, were identified to the lowest possible level. Identification was carried out using keys and comparing specimens in the New Zealand Arthropod Collection.

For statistical analyses, species richness, abundance and diversity (Shannon"s H`) were calculated in PRIMER"s DIVERSE module. The composition of invertebrates was compared across sites using an nMDS ordination in PRIMER v5.0 software, using a Bray-Curtis similarity matrix (4^{th} root transformation) from 10 restarts. This analysis was carried out for all invertebrate together, except light trap samples which were analysed separately. Species which contributed the most to differences between habitats were examined using a SIMPER analysis in PRIMER.

4. Results

The composition of invertebrate communities is influenced by many environmental factors, but key habitat variables include: vegetation type, history of disturbance, stock grazing, size of the site, and isolation of the site (Didham et al 2009).

Karamu

There was a very strong difference between each type of habitat at Karamu. Table 1 shows that richness and diversity were significantly different, with Forest having higher number of species (i.e. richness) and diversity. Figure 1 shows no overlap in the three habitats in terms of invertebrate composition, meaning that there were very strong differences between the habitats. Species which contributed the most to these differences are listed in Table 2.

Overall, there was still some similarity between pasture and riparian habitats, in that i) richness and diversity were lower than forest, and ii) there was more of a "generalist fauna" compared to forest. However, the native riparian enhancement planting was also clearly intermediate between pasture and forest. Yet riparian had not progressed to the stage of being comparable to forest habitats. The nature of these differences are given in Table 6.

Table 1. Patterns of terrestrial invertebrates for habitats at Karamu (*significant results in bold). Averages based on using sites as replicates.

	Riparian	**Pasture**	**Forest**	**P value**
Richness (S)	10.5	11.7	20.5	**0.003***
Abundance (N)	113	119	134	0.44
Diversity (H`)	1.4	1.8	2.2	**0.02***

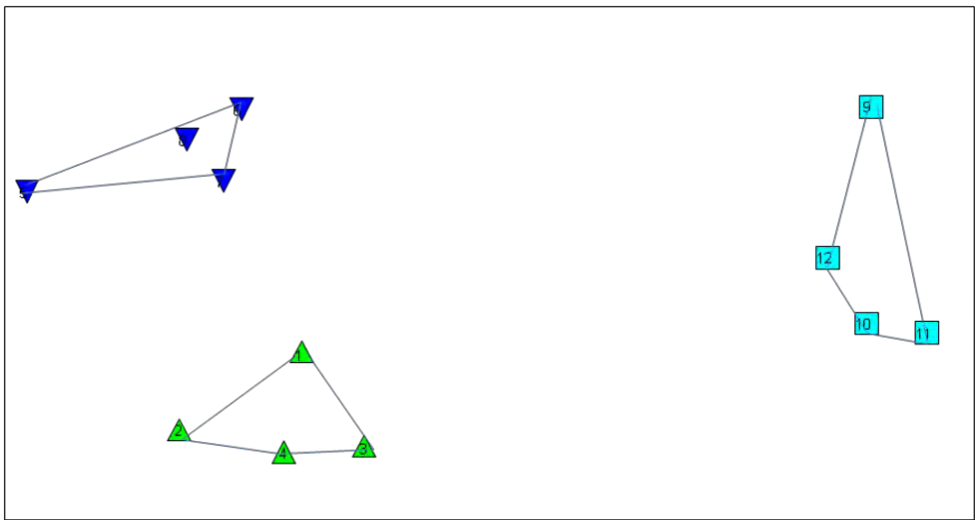

Figure 1. Composition of terrestrial invertebrates analyses for Karamu habitats: riparian (green triangle), pasture (dark blue inverted triangle), forest (light blue square).

Table 2. Showing which taxa contribute the most to differences between habitats (i.e. bioindicators) at Karamu.% contribution accumulates. Table splits into three subsections.

Riparian v Pasture	**Taxa**	**Riparian**	**Pasture**		**%Contribution**
Crickets/grasshoppers	Orthoptera		xxx		13
Parasitoid wasps	Diapriidae	xxx			22
Landhoppers	Amphipoda	xxx			28
Spider hunter wasp	*Priocnemis* Sp1		xxx		34
Ground beetle	*Rhytisternus miser*	xxx			39
Ant	*Nylanderia* sp		xxx		44
Rove beetle	Staphylinidae 1	xxx			48
Riparian v Forest	**Taxa**	**Riparian**		**Forest**	**Cum. %Contribution**
Slaters	Isopoda	xxx			9
Ant	*Prolasius advenus*			xxx	15
Ant	*Pacycondyla*			xxx	20
Landhoppers	Amphipoda	xxx			25
Beetle	*Hypodacnella*			xxx	29
Spider hunter wasp	*Sphictostethus*			xxx	33
Larvae	Larvae			xxx	37
Moths	Lepidoptera			xxx	41
Parasitoid wasps	Hymenoptera			xxx	45
Ground beetle	*Rhytisternus miser*	xxx			48
Pasture v Forest	**Taxa**		**Pasture**	**Forest**	**Cum. %Contribution**
Slaters	Isopoda		xxx		7
Crickets/grasshoppers	Orthoptera		xxx		14
Ant	*Prolasius advenus*			xxx	19
Ant	*Pacycondyla*			xxx	23
Landhoppers	Amphipoda			xxx	28
Parasitoid wasps	Diapriidae			xxx	32
Beetle	*Hypodacnella*			xxx	35
Spider hunter wasp	*Sphictostethus*			xxx	39
Larvae	Larvae			xxx	42
Spider hunter wasp	*Priocnemis* Sp1		xxx		45
Ground beetle	*Megadromus*			xxx	48

Tukituki

There was a very strong difference between each type of habitat at Tukituki. Table 3 shows that richness and diversity were significantly different, with Forest having higher number of species (i.e. richness) and diversity. Figure 2 shows no overlap in the three habitats in terms of invertebrate composition, meaning that there were very strong differences between the habitats. Species which contributed the most to these differences are listed in Table 4. The nature of these differences are given in Table 6.

Table 3. Patterns of terrestrial invertebrates for habitats at Tukituki (*significant results in bold). Averages based on using sites as replicates.

	Riparian	**Pine**	**Forest**	**P value**
Richness (S)	10	10	14.5	**0.03***
Abundance (N)	121	106	117	0.44
Diversity (H`)	1.40	1.43	1.86	**0.03***

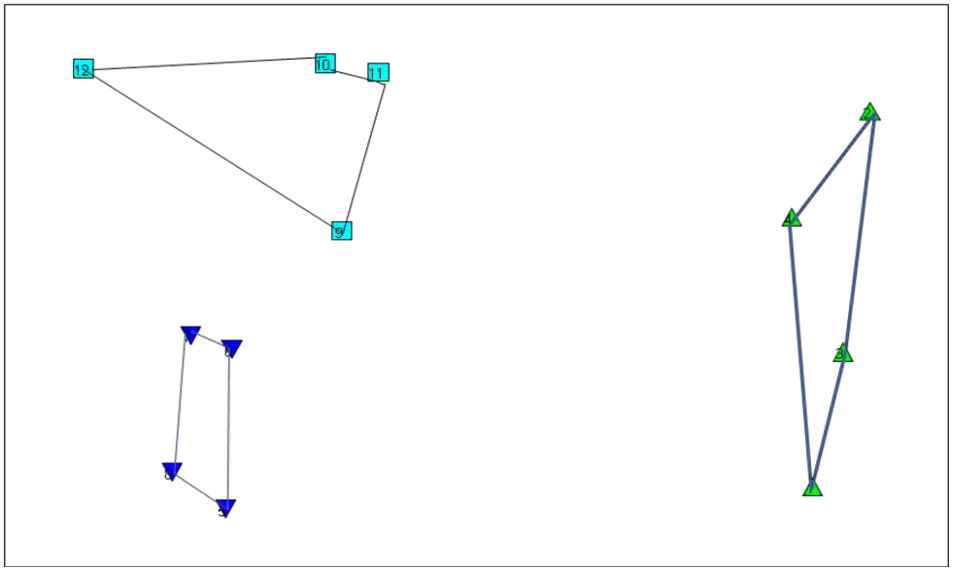

Figure 2. Composition of terrestrial invertebrates analyses for Tukituki habitats: tussock (green triangle), pine (dark blue inverted triangle), forest (light blue square).

In general;

- Tussock samples were characterised by high numbers of mites, a native ant - Monomorium antarcticum, and tiger beetle *Cicindela tuberculata* (tiger beetle)
- Pine samples were characterised by high numbers of harvestmen, darkling beetles, and wasps (*Aucklandella*, *Sphictostethus*)
- Forest samples were characterised by landhoppers, the native ant *Pachycondyla*, millipedes, *Saphobius inflatipes*. These insects are heavily involved with decomposition, and indicate significant leaf litter and woody debris.

Table 4. Showing which taxa contribute the most to differences between habitats (i.e. bioindicators) at Tukituki.% contribution accumulates. Table splits into three subsections.

Tussock v Pine	**Taxa**	**Tussock**	**Pine**		**%Contribution**
Landhoppers	Amphipoda		xxx		15
Mites	Acarina	xxx			29
Harvestmen	Harvestmen		xxx		38
Ant	*Monomorium antarcticum*	xxx			45
Parasitoid wasp	*Aucklandella*		xxx		50
Tussock v Forest	**Taxa**	**Tussock**		**Forest**	**%Contribution**
Mites	Acarina	xxx			13
Landhoppers	Amphipoda			xxx	23
Ant	*Pachycondyla*			xxx	30
Ant	*Monomorium antarcticum*	xxx			37
Millipedes	Diplopoda			xxx	42
Spiders	Araneida			xxx	48
Scarab beetle	*Saphobius inflatipes*			xxx	52
Pine v Forest	**Taxa**		**Pine**	**Forest**	**%Contribution**
Harvestmen	Harvestmen		xxx		10
Millipedes	Diplopoda			xxx	17
Scarab beetle	*Saphobius inflatipes*			xxx	24
Ant	*Pachycondyla*			xxx	30
Darkling beetle	*Kaszabedelium aucklandicum*		xxx		35
Ground beetle	*Holcaspis*			xxx	40
Parasitoid wasp	*Aucklandella*		xxx		45
Spider Hunter wasp	*Sphictostethus*		xxx		50

For light trapping, tussock sites had much higher species richness and abundance of Lepidoptera than other habitats (Table 5). Forest sites were most like tussock sites but had only 20% similarity (Figure 3). Pine and pasture sites had very few moths caught (Table 5).

Notable species include (all from tussock sites, all in the family Noctuidae):

- *Tmetolophota hartii*. Previously known from very few specimens, but 35 were caught in this study. Usually flying late Feb to March. Life history is unknown. Endemic
- *'Aletia' longstaffi*. Very localised species, probably associated with fine-leaved *Dracophyllum* in open habitats.
- *Graphania olivea*. Rare species, restricted to central/southern North Island.
- *Proteuxoa sanguinipuncta*. Australian species, established in North Island since 2007, and especially known from Hawkes Bay. Larva on grasses.

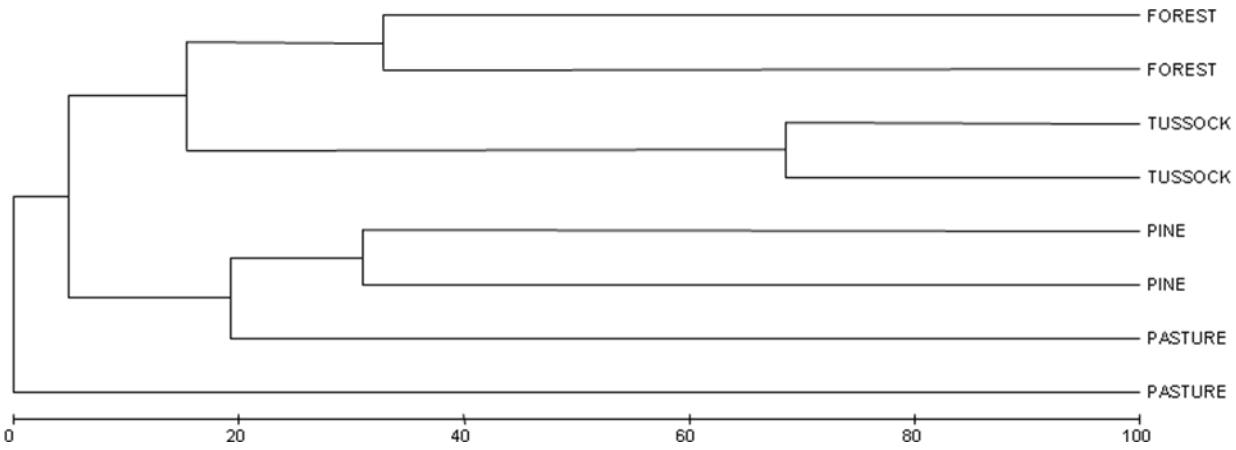

Figure 3. CLUSTER diagram for light trap results for Lepidoptera at Tukituki. Similar samples are grouped more closely together.

Table 5. Light trap results for Lepidoptera at Tukituki.

	Site	**Richness (S)**	**Abundance (N)**	**Diversity (H`)**
Tussock	**1**	26	137	2.6
Tussock	**2**	29	194	2.6
Forest	**1**	10	23	1.7
Forest	**2**	9	13	2.0
Pine	**1**	5	10	1.4
Pine	**2**	7	8	1.9
Pasture	**1**	4	4	1.3
Pasture	**2**	1	1	na

Combining the Karamu and Tukituki data

Because these two studies were carried out with the same sampling and sample processing the data from them can be combined to compare further differences and similarities between habitat types.

Figure 4 shows three major habitats groupings. First, tussock is clearly separated from other habitats. Pasture and riparian habitats (both at Karamu) are grouped together, and these are separated from the third group of "forest sites".

In the forest grouping, Tukituki forest and pine are more similar to each other than forest at Karamu. Although one replicate of Tukituki forest was found in the Karamu forest grouping.

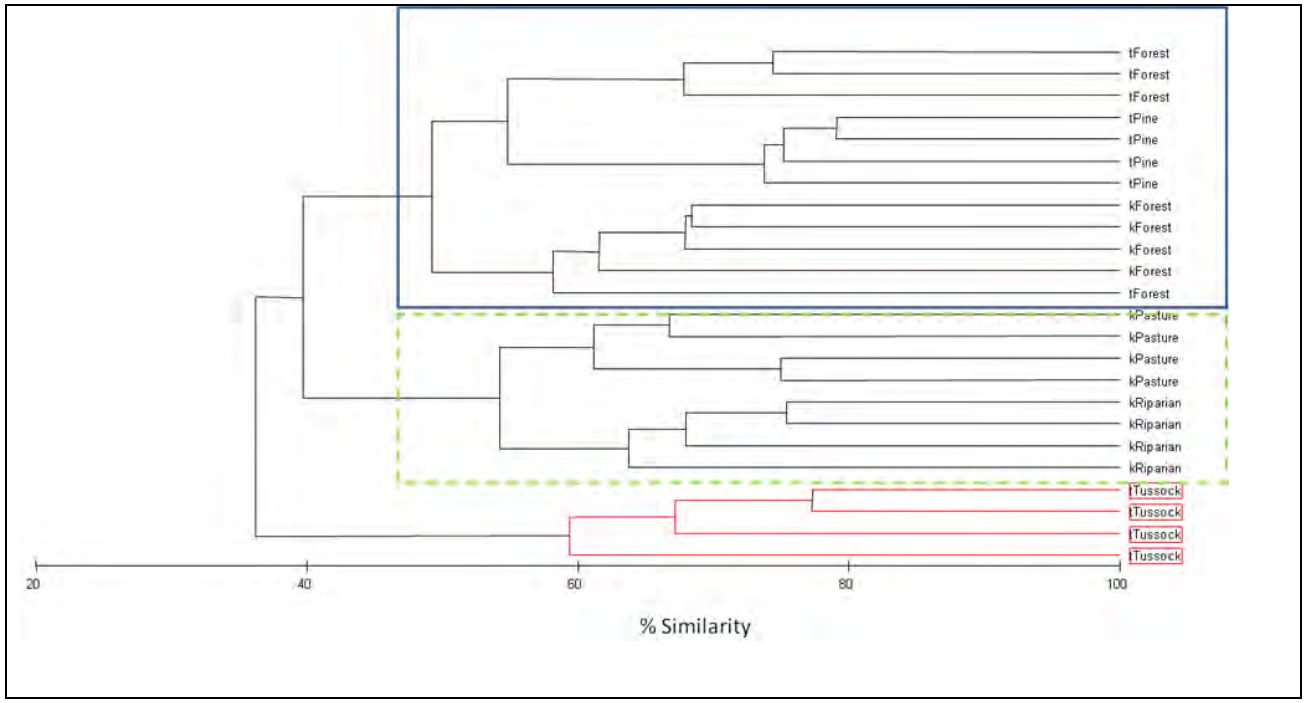

Figure 4. CLUSTER diagram for invertebrate data for both Karamu (k) and Tukituki (t) habitats. Similar samples are grouped more closely together.

Summary of habitat signs from the biota

A summary of the terrestrial invertebrate characteristics of the habitats of the Karamu and Tukituki River study area.

Table 6. Habitat quality signs provided by terrestrial invertebrates

Invertebrates Characteristic	What the feature indicates
Forest (Tukituki)	
Landhoppers, *Pachycondyla* (Ant), Millipedes, *Saphobius inflatipes* (Scarab beetle)	heavily involved with decomposition, and indicate significant leaf litter and woody debris
Pine Forest (Tukituki)	
Harvestmen, darkling beetles, parasitoid wasps (*Aucklandella*, *Sphictostethus*)	General diversity but not overly specialised
Forest (Karamu)	
Prolasius advenus (ant), Diapriidae (parasitoid wasps)	Common taxa in forests which have some type of disturbance
Riparian (Karamu)	
Slaters and Landhoppers	General decomposition in disturbed areas
Rove beetles	Generalists, scavengers
Relatively low numbers of beetles and wasps	Lower general diversity
Pasture (Karamu)	
Crickets	Common in grass habitats
Nylanderia sp (ant)	Introduced ant, common in disturbed areas
Relatively low numbers of beetles and wasps	Lower general diversity
Tussock (Tukituki)	
Mites	Associated with grasses?
Monomorium antarcticum (ant)	Common in tussock/bare ground
Cicindela tuberculata (tiger beetle)	Usually found in open bare ground

5. Conclusions

Not surprisingly, habitat factors strongly influenced the terrestrial invertebrate samples. In general there were very strong differences between each of the habitats.

Pasture and Riparian

There was a detectable difference in community structure between the native riparian enhancement planting and pasture. However, there was still some strong similarity between these two habitats, in that i) richness and diversity were lower than forest, and ii) there was more of a "generalist fauna" compared to forest.

Riparian had not progressed to the stage of being comparable to forest habitats. This was best demonstrated when the two studies were combined and a larger number of samples examined. Pasture and riparian sites were still grouped together, indicating they were most similar. If riparian plantings were further progressed we would have seen them grouped with „forest sites".

Comparison of Forests

The forested sites at Karamu („Mahana") and Tukituki (Inglis Bush) were different (Figure 4). If they had been very similar they would have been mixed together in the Cluster figure. Karamu forest had (relatively) more *Prolasius advenus* (ant) and Diapriidae (parasitoid wasp), but less millipedes, *Saphobius inflatipes* and *Holcaspis* (SIMPER analysis).

It is difficult to say why these two forest had a different invertebrate composition without knowing more about any differences in ground cover, substrate, type measurements. However, the above differences point to Tukituki having a greater leaf litter component as millipedes and *Saphobius* are decomposers and very common in leaf litter. This fits with the fact that „Mahana" is still recovering from grazing, and would presumably have less leaf litter and woody debris covering the forest floor.

In this study, invertebrates could be used to distinguish the different types of habitats, at either Karamu or Tukituki. The results could be used to also form a very basic baseline for what is expected in other sites of similar habitats to what was sampled here. Furthermore, the results could be used to monitor disturbance/changes in such habitats over time.

Guidelines for interpreting terrestrial invertebrate data are basically non-existent in New Zealand. Unfortunately, there is no comparable "MC Index" used for freshwater habitats. Such a system for terrestrial environments is urgently needed in New Zealand to assist many agencies with interpreting invertebrate data associated with landuse change, restoration, land management etc.

6. Acknowledgements

Chris Winks for identification of Beetles, and Robert Hoare for identification of Lepidoptera.

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Appendix F Rare/endangered or biogeographically significant plants of the Hawke's Bay lowlands

Species	Description	Known location(s) (if any)
Coprosma aff. *Parviflora.*	A small erect tree up to 6 m tall, with small rounded pale leaves and violet fruit. Very difficult to distinguish from the suite of accompanying lookalikes. Distinguished from other *coprosmas* by deep orange inner bark.	*New Zealand*: Eastern North Island (Gisborne, Hawke's Bay, Wairarapa); Canterbury. *Hawke's Bay*: The historic Oringi Clearing (location mapped in Grant 1996), near Dannevirke (Tony Druce record, not recently reconfirmed). At least two sites near Tikokino: Mangaonuku Stream near Gwavas, c.NZMS 260 U22/092542; north bank of Waipawa River, c.U22/987479 (Tony Druce records via Peter de Lange, not recently confirmed). The only confirmed current site is on Ken Baldwin's land, Mangarouhi Stream, SE of Waipukurau - five known trees in two forest remnants identified as recommended areas for protection (RAP 15, Areas 4&6) in the Eastern Hawke's Bay PNAP Survey (Maxwell et al 1993): V23/ 245248 (two trees), V23/244244 (three trees).
Heart-leaved kohuhu (*Pittosporum obcordatum*). Threat status: Threatened - Nationally Vulnerable.		*New Zealand:* A scattering of alluvial sites from Northland to Southland. *Hawke's Bay:* Recorded from three separate localities in Eastern Hawke's Bay: 1. Phillips' Bush in a bend of the Tukituki River (NZMS 260 V22/336477), one 7m tall tree, protected with a tiny fence, on an alluvial terrace. 2. In five sites in the Mangarouhi-Waiwhero stream system SE of Waipukurau, all identified as RAPS in the Eastern Hawke's Bay PNAP Survey (Maxwell et al. 1993): • Area 2, V23/233250, 30 plants; • Area 4, V23/244248, 51 plants; • Area 5, V23/245246, 45 plants; • Area 6, V23/244244, 98 plants plus seedlings; • Area 11, V23/263226, 21+ plants, plus seedlings.
Swamp nettle (*Urtica linearifolia*). Threat status: At Risk – Declining.	A semi-woody herbaceous nettle with a weak climbing ability and narrow leaves with stinging hairs.	*New Zealand:* Scattered lowland swamp sites from Bay of Plenty to Otago. *Hawke's Bay:* Four recorded sites: 1. Eastern shore of Oingo Lake, SW of Napier (NZMS 260 V21/325756). 2. Willow Swamp (Otane Government Purpose Reserve), N of Otane (V22/222434). 3. Western shore of Hatuma Lake, Waipukurau (V23/103256). 4. Awahiwi, E of Dannevirke (V23/216073).
Small native daphnes (*Pimelea aridula*	Small low-growing shrubs with grey-green leaves covered in silvery hairs and pinkish-cream	*New Zealand:* North and South Islands from Maungaharuru Range south. *Pimelea aridula* s.s. is confined to Central Otago.

Species	Description	Known location(s) (if any)
agg.) (two entities). Threat status: Threatened – Nationally Critical.	flowers.	*Hawke's Bay:* There are two geographically and genetically distinct entities that are confined to Hawke's Bay: 1. A small population known only from Te Mata Peak (NZMS 260 V22/449597). First described by Elder (1953); collected by Druce (1967). By 1997 has become very rare on site (Geoff Walls found only 5 plants). 2. A much stronger population on the crests of the Maungaharuru and Te Waka Ranges, northern Hawke's Bay. This entity is distinctly hairier than the Te Mata Peak one.
Pterostylis aff. *Graminea.* Threat status: At Risk – Naturally Uncommon.	A slender green hood with a pinkish tint.	*New Zealand:* Hawke's Bay and Nelson-Marlborough. *Hawke's Bay:* Reputed to have been found in Elsthorpe Scenic Reserve, but the exact locality isn't clear.
Bulbophyllum tuberculatum.	Small rare epiphytic orchid	Known from the Hawke's Bay lowlands.
Pleurosorus rutifolius. Threat status: At Risk – Naturally Uncommon.	A small fern.	Limestone outcrops (rare), known from the Hawke's Bay lowlands.
Teucridium parvifolium.	Closely branched small leaved shrub.	Known from only a few sites. Grows on margins of open conifer forest, in tall scrub and on rock outcrops.
Mistletoes (*Tupeia Antarctica (At Risk – Declining); Ileostylus micranthus; korthalsella lindsayi*).	Small cryptic parasitic plants becoming nationally rare.	Known from only a few sites in the Hawke's Bay lowlands.
Myriophyllum robustum. Threat status: At Risk – Declining.	A water plant.	Formerly collected from horseshoe lake (in 1961) but probably now extinct there.

Appendix G Hawke’s Bay dabchick survey results

Location	Catchment Unit	Number seen	% HB	%Tukituki	%National
Te Heka Pond	C	7	2.1%	3.8%	0.4%
Argyll Pond	D	2	0.6%	1.1%	0.1%
Lake Hatuma	D	121	36.1%	66.1%	6.1%
Rotorunga Lagoons	D	0	0.0%	0.0%	0.0%
Te Tui Dam	D	0	0.0%	0.0%	0.0%
Tralee Pond	D	7	2.1%	3.8%	0.4%
Waipawa oxidisation	D	0	0.0%	0.0%	0.0%
Waipukurau Oxidisation ponds	D	0	0.0%	0.0%	0.0%
Clareinch Rd Lake - Rangitapu?	E	10	3.0%	5.5%	0.5%
Long Range Lake	E	9	2.7%	4.9%	0.5%
Nicholls Road Ponds 1	E	0	0.0%	0.0%	0.0%
Nicholls Road Ponds 2	E	0	0.0%	0.0%	0.0%
Papatika Lake	E	3	0.9%	1.6%	0.2%
Craggy Range Pond	F	0	0.0%	0.0%	0.0%
Horseshoe Lake	F	2	0.6%	1.1%	0.1%
Lake Te Roto O Kiwa	F	22	6.6%	12.0%	1.1%
Longacre Lake	F	0	0.0%	0.0%	0.0%
Total		**183**	**54.6%**	**100.0%**	**9.2%**

The figures shown above are taken from the 17-19 April 1992 Hawke's Bay dabchick survey conducted by the Ornithological Society of New Zealand. The total Hawke's Bay population recorded during that survey was 335 birds, with 183 of them being found within the Tukituki River Catchment. The total national population is estimated to be around 2,000 birds (Heather & Robertson 2000).

Appendix H DoC ‘Recommended Areas for Protection’ and ‘Sites of Special Wildlife Interest’ of the Tukituki Catchment

Catchment Unit	Site	Name	Habitat type	Value	NZTM Easting, Northing
Recommended Areas for Protection (DoC)					
B	RAP-HTG39	Makeretu River	Forest	RAP	1872403.960, 5566518.100
C	RAP-HTG19	Glentui	Wetland/Forest	RAP	1899115.210, 5593341.840
C	RAP-HTG20	Puahanui Bush	Forest	RAP	1897514.440, 5591840.290
C	RAP-HTG21	Mangamauku Stream	Forest	RAP	1890009.450, 5590637.380
C	RAP-HTG24	Mangaoho No. 2	Forest	RAP	1884505.960, 5589835.290
C	RAP-HTG25	Smedley Bluffs	Forest	RAP	1882504.820, 5589234.330
C	RAP-HTG26	Mangaoho No. 1	Forest	RAP	1887107.580, 5590236.290
C	RAP-HTG27	Holdens No. 2	Forest	RAP	1887508.500, 5587834.770
C	RAP-HTG28	Holdens Bush	Forest	RAP	1891511.410, 5587135.340
C	RAP-HTG29	Te Pah	Forest	RAP	1892512.640, 5584934.060
C	RAP-HTG31	Condor	Forest	RAP	1883206.790, 5583430.730
C	RAP-HTG32	Worsnops	Forest	RAP	1882406.480, 5582630.020
C	RAP-HTG33	Gunsons	Forest	RAP	1888510.850, 5580930.360
C	RAP-HTG34	Kyber Pass	Forest	RAP	1881406.880, 5578226.970
C	RAP-HTG36	Barnsdale	Forest	RAP	1882208.010, 5575325.320
C	RAP-HTG37	Herricks	Forest	RAP	1879307.070, 5571222.190
C	RAP-HTG38	Mangatewai River	Forest	RAP	1878306.930, 5568820.550
D	RAP-HTG35	Eastern Equities	Forest	RAP	1899118.690, 5578430.910
D	RAP-HTG41	Lake Hatuma	Wetland	RAP	1901022.330, 5563820.800
E	RAP-EHB15a	Mangarouhi Stream - Waiwhero Stream 1	Forest	RAP	1912531.121, 5559218.537
E	RAP-EHB15b	Mangarouhi Stream - Waiwhero Stream 2	Forest	RAP	1913231.329, 5563221.644
E	RAP-EHB15c	Mangarouhi Stream - Waiwhero Stream 3	Forest	RAP	1913831.780, 5563321.776
E	RAP-EHB15d	Mangarouhi Stream - Waiwhero Stream 4	Forest	RAP	1914532.337, 5563121.684
E	RAP-EHB15e	Mangarouhi Stream - Waiwhero Stream 5	Forest	RAP	1914532.346, 5563021.606
E	RAP-EHB15f	Mangarouhi Stream - Waiwhero Stream 6	Forest	RAP	1914432.294, 5562721.365
E	RAP-EHB15g	Mangarouhi Stream - Waiwhero Stream 7	Forest	RAP	1914632.490, 5562220.996
E	RAP-EHB15h	Mangarouhi Stream - Waiwhero Stream 8	Forest	RAP	1914932.620, 5563421.952
E	RAP-EHB15i	Mangarouhi Stream - Waiwhero Stream 9	Forest	RAP	1915733.477, 5560419.686
E	RAP-EHB15j	Mangarouhi Stream - Waiwhero Stream 10	Forest	RAP	1916033.696, 5560619.864
E	RAP-EHB15k	Mangarouhi Stream - Waiwhero Stream 11	Forest	RAP	1916233.830, 5560920.112
E	RAP-EHB15l	Mangarouhi Stream - Waiwhero Stream 12	Forest	RAP	1916133.730, 5561220.338
E	RAP-EHB19a	Bush Trig 1	Forest	RAP	1915333.547, 5553214.148
E	RAP-EHB19b	Bush Trig 2	Forest	RAP	1914332.823, 5552313.437
E	RAP-EHB19c	Bush Trig 3	Forest	RAP	1914232.733, 5552813.808
E	RAP-EHB19d	Bush Trig 4	Forest	RAP	1914532.944, 5553214.119
E	RAP-EHB19e	Bush Trig 5	Forest	RAP	1914933.205, 5554314.964

Catchment Unit	Site	Name	Habitat type	Value	NZTM Easting, Northing
F	RAP-HTG30	Highfield	Forest	RAP	1909525.140, 5585038.050
F	RAP-EHB4a	Hapua 1	Forest	RAP	1926939.638, 5585141.654
F	RAP-EHB4b	Hapua 2	Forest	RAP	1926839.456, 5585642.077
F	RAP-EHB4c	Hapua 3	Forest	RAP	1926739.273, 5586142.500
F	RAP-EHB5a	Kahuranaki Road Bush 1	Forest	RAP	1930843.230, 5584541.821
F	RAP-EHB5b	Kahuranaki Road Bush 2	Forest	RAP	1930443.257, 5582239.679
F	RAP-EHB5c	Kahuranaki Road Bush 3	Forest	RAP	1930443.322, 5581839.320
F	RAP-EHB5d	Kahuranaki Road Bush 4	Forest	RAP	1930343.296, 5581438.946
F	RAP-EHB8	Silver Range	Forest	RAP	1926239.851, 5580337.321
F	RAP-EHB10a	Paeroa 1	Forest	RAP	1930844.484, 5576234.378
F	RAP-EHB10b	Paeroa 2	Forest	RAP	1930844.571, 5575533.753
F	RAP-EHB12	Motonui Wetland	Wetland	RAP	1928343.095, 5568827.598
F	RAP-HTG14	Tukituki Estuary	Estuary	RAP	1938544.690, 5609567.400
-	RAPHTG42	Tukituki/Waipawa Riverbed	River	RAP	-
Sites of Special Wildlife Interest					
C	SSWI3	Middle Stream Bush	Forest	M	1874706.922, 5587785.882
C	SSWI4	Cullens Swamp	Wetland/Forest	M	1874382.059, 5589259.267
C	SSWI8	Barnsdale Kahikatea	Forest	M	1882523.146, 5576035.402
C	SSWI9	Barnsdale Dam	Wetland	P	1881405.237, 5575334.563
C	SSWI10	Mill Road Bush	Forest	P	1879692.474, 5573003.029
C	SSWI11	A'Deane's Bush SR	Forest	H	1882212.899, 5574762.785
C	SSWI12	Hardy Road Bush	Forest	M	1884013.549, 5583498.539
C	SSWI13	Haswell Bush	Forest	H	1885699.119, 5578325.997
C	SSWI14	Makarora Heath	Forest	M-H	1880058.075, 5595873.128
C	SSWI15	Mangataura Bush	Forest	M	1879891.951, 5589928.888
C	SSWI16	Mangaoho Bush	Forest	M	1886301.181, 5590024.262
C	SSWI17	Smedley Scrub	Forest	M	1883677.772, 5594399.193
C	SSWI18	Makarora Pond	Wetland	M	1882474.935, 5587385.561
C	SSWI22	Ngaruru Bush	Forest	M	1888336.658, 5580997.858
C	SSWI23	Oldfield Bush	Forest	P	1892567.334, 5584998.108
C	SSWI24	Mangamauka Bush	Forest	M	1890878.970, 5590079.324
C	SSWI42	Te Heka Pond	Wetland	M	1901304.401, 5586492.685
C	SSWI45	Puahanui Bush	Forest	H	1897334.583, 5591820.939
D	SSWI21	Foley's Dams	Wetland	P	1890353.312, 5561537.803
D	SSWI34	Rotorunga Lagoons	Wetland	P	1898690.094, 5558557.528
D	SSWI39	Tukituki River Scenic Reserve	Forest	P	1900237.805, 5568033.248
D	SSWI40	Lake Hatuma	Wetland	H	1900950.475, 5564077.380
D	SSWI41	Arlington Road Pond	Wetland	P	1899010.765, 5560196.061
D	SSWI43	Tralee Pond	Wetland	M	1900678.847, 5583764.253
D	SSWI44	Argyll Pond	Wetland	M	1901531.971, 5581543.615

Catchment Unit	Site	Name	Habitat type	Value	NZTM Easting, Northing
D	SSWI71	Hononga Dam	Wetland	M	1908196.429, 5564606.067
D	SSWI73	Mangaterata Dams	Wetland	P	1911027.676, 5567638.772
D	SSWI74	Te Tui Dam	Wetland	P	1907507.360, 5562886.262
E	SSWI35	Nicholls Road Ponds 1	Wetland	P	1897345.366, 5556307.104
E	SSWI36	Nicholls Road Ponds 2	Wetland	P	1896888.081, 5556319.972
E	SSWI72	Peacocks Bush	Forest	P	1913190.967, 5563184.222
E	SSWI117	Long Range Lake	Wetland	M	1921624.395, 5550589.099
E	SSWI118	Oteka Lake	Wetland	M	1921793.146, 5553330.593
E	SSWI119	Te Parae Pond	Wetland	M	1920528.031, 5553915.455
E	SSWI120	Papatika Lake	Wetland	M	1918252.820, 5557641.107
E	SSWI121	Tehiwi Pond	Wetland	M	1919002.199, 5564760.185
E	SSWI122	Whenuahou	Wetland	P	1922621.312, 5559989.859
E	SSWI123	40 acre swamp	Wetland	M	1920867.960, 5559489.911
E	SSWI165	Clareinch Road Lake	Wetland	P	1924661.949, 5560939.456
E	SSWI166	Clareinch Road Dam	Wetland	P	1924166.017, 5559580.252
F	SSWI76	Lake Te Roto O Kiwa	Wetland	M-H	1913275.726, 5585791.596
F	SSWI77	College Road Bush	Forest	P	1908493.989, 5585010.039
F	SSWI78	Moturoa Willow Swamp	Wetland/Forest	M	1912520.241, 5581693.584
F	SSWI124	Horseshoe Lake	Wetland	M-H	1921647.401, 5574206.229
F	SSWI125	Elsthorpe Road Bush	Forest	P	1923083.566, 5576454.519
F	SSWI126	Deep water ponds	Wetland	M	1918973.364, 5570253.429
F	SSWI167	Elsthorpe Scenic Reserve	Forest	M	1925504.552, 5574647.327
F	SSWI168	Paeroa Bush 1	Forest	M	1931039.075, 5576139.977
F	SSWI170	Paeroa Bush 2	Forest	P	1930459.457, 5575057.671
F	SSWI171	Rowe Road Bush	Forest	P	1924081.748, 5585946.950
F	SSWI194	Craggy Range Pond	Wetland	P	1939149.149, 5597701.447
F	SSWI195	Longacre Lake	Wetland	M-H	1937954.827, 5597551.692
F	SSWI198	Tukituki Rivermouth	Estuary	M-H	1938566.127, 5609619.070
F	SSWI200	Haumoana Lagoons	Wetland	P	1939173.330, 5608412.020
Other sites mentioned					
C	-	Makaroro oxbow	Wetland	-	1881951.000, 5587040.500
D	-	Wilson wetland	Wetland	-	1895991.800, 5571411.700
D	-	Tamamu bridge	River	-	1914725.000, 5570154.100
F	-	Small's	River	-	1937350.500, 5597709.500

Abbreviations: Recommended Area for Protection (RAP); SSWI wildlife value criteria abbreviations are: O, Outstanding; H, High; M-H, Moderate-High; M, Moderate; P, Potential.

Appendix I Native plants to consider for lizard habitat restoration

While all plants potentially provide habitat for lizards, the following have specific functions for lizards. Most plant information is sourced from Eagle (2006 a, b). Species in bold font are very hardy pioneer plant species suitable for starting a planting project.

Common name	Latin name	Expected benefit	Habitat
Monocots			
Whaririki, mountain flax, coastal flax.	***Phormium cookanium.***	Refuge and nectar for geckos.	Coastal to subalpine cliffs, tussockland and scrub.
Harakeke, New Zealand flax.	***Phormium tenax.***	Refuge and nectar for geckos.	Mainly in damp places.
Cabbage tree, ti kouka, ti.	***Cordyline australis.***	Refuge for geckos under the skirt of dead leaves forming around the trunk, possible nectar source for geckos.	Lowland and lower montane forest. Shrubland, grassland and swamp margins.
Narrow-leaved snow tussock.	***Chinochloa pallens.***	Skink habitat and refugia.	
Red tussock.	***Chinochloa rubra.***	Skink habitat and refugia.	Sea level to alpine grasslands to 1,900m.
Herbaceous plants			
Common speargrass.	***Aciphylla squarrosa.***	Skink refuge and habitat, protection from predators.	Subalpine grasslands.
Wild spaniard.	***Aciphylla colensoi.***	Skink refuge and habitat, protection from predators.	Alpine and subalpine grasslands and herbfields.
Wire rush, lesser wire rush.	***Empodisma minus.***	Skink refuge and habitat.	
Trees and shrubs			
Rimu.	***Dacrydium cupressinum.***	Habitat complexity, protection.	Lowland forest.
Totara.	***Podocarpus totara*** var. ***totara.***	Habitat complexity, protection.	Lowland forest.
Mountain totara, thin-barked totara, Hall's totara.	***Podocarpus hallii.***	Habitat complexity, protection.	Montane and subalpine forest (common), lowland forest (less common).
Snow totara.	***Podocarpus nivalis.***	Habitat complexity, protection.	Upper forest margins, alpine and subalpine scrub.
Tawa.	***Beilschmiedia tawa.***	Skinks.	Sea level to c. 1000m asl, forest.
Matagouri, tumatakuru.	***Discaria toumatou.***	Habitat for geckos and skinks, protection from predators.	Coastal to montane scrub.
Kamahi.	***Weinmannia racemosa.***	Flowers, loose bark / holes, invertebrates.	Lowland to montane forest.
Weeping matipo.	***Melicytus divaricata.***	Berries a possible food source.	Lowland to subalpine forest and scrub.
	Pentachondra pumila.	Berries a possible food source.	Subalpine and alpine grassland, rocky places and boggy ground.
	Androstoma empetrifolia.	Berries a possible food source.	
Miro.	***Prumnopitys ferruginea.***	Knotholes in wood refugia for geckos.	Lowland and montane forest.

Common name	Latin name	Expected benefit	Habitat
Matai, black pine.	***Prumnopitys taxifolia.***	Knotholes in wood refugia for geckos.	Lowland forest.
Mahoe, whitey-wood.	***Melicytus ramiflorus.***	Fruits, complexity.	Lowland and montane light forest and margins throughout.
Mahoe wao, narrow-leaved mahoe.	***Melicytus lanceolatus.***	Fruits, complexity.	Montane forest and margins.
Manakura, small-leaved mahoe.	***Melicytus micranthus.***	Fruits, complexity.	Lowland forest especially on lowland alluvial flats.
	Cyathodes pumila.	Fruit possible food source for common skink.	Boggy ground in mountain areas.
Prickly mingimingi.	***Leptecophylla juniperina*** (eastern form).	Berries a possible food source.	Usually montane.
Kahikatea, white pine.	***Dacrycarpus dacrydioides.***	Forest and pacific geckos (habitat).	Lowland forest, often dominant in swamp forest.
Silver beech.	***Nothofagus menziesii.***	Forest geckos (habitat?).	Lowland and subalpine forest. Absent from the Ruahine Ranges, but possibly suitable for lowland restoration.
Northern rata.	***Meterosideros robusta.***	Forest gecko seen consuming nectar from possibly southern rata ***M. umbellata*** (species uncertain, Whitaker 1987), therefore this species may also provide nectar for forest geckos. Also provides habitat complexity.	
Ngaio.	***Myoporum laetum.***	Nectar source, honeydew host.	
Kawakawa, pepper tree.	***Macropiper excelsum ssp. Excelsum.***	Berries.	Mainly coastal, lowland.
Hangehange.	***Geniostoma ruprestre.***	Undertstorey habitat complexity, used by forest geckos.	
Manuka.	***Leptospermum scoparium.***	Habitat for geckos, cover for skinks and nectar.	
Kanuka.	***Kunzea ericoides.***	Gecko habitat.	
Snowberry, takapo, taupuku.	***Gaultheria antipoda.***	Habitat for geckos, fruit possible food source.	Lowland to montane shrubland.
Mountain snowberry.	***G. depressa*** var. ***novae-zelandiae.***	Fruits possible food source for common, spotted and small-scaled skinks.	Montane and subalpine grassland, herbfield and open scrub.
	Gaultheria nubicola.	Fruits possible food source for common, spotted and small-scaled skinks.	Ruahine range only
	Gaultheria. macrostigma.	Possible food source for common, spotted and small-scaled skinks.	Montane to lower. subalpine open scrub, grassland and rocky places.
Patotara.	***Leucopogon fraseri.***	Fruit consumed by common skinks, spotted skinks and common	Coastal dunes and lowland to subalpine

Common name	Latin name	Expected benefit	Habitat
		geckos (Lawrence 1997, Spencer ***et al***. 1998).	shrubland, grassland and rocky places.
	Acrothamnus (prev. Leucopogon) colensoi.	Fruit of consumed by common skinks and common geckos (Lawrence 1997, Spencer et al. 1998).	Mountainous species.
Mingimingi.	***Leucopogon fasciculatus*** (southern form).	Berries a possible food source (Spencer et al. 1998).	Coast to lower montane.
	Coprosma petriei?	Fruit consumed by common skinks and common geckos (Lawrence, 1997).	NI central mountains, tussock grassland and dry river beds up to 1200 m a.s.l.
Taupata.	***Coprosma repens.***	Shore skinks (***O. smithi***) observed eating fruit (Whitaker 1987), thus a likely fruit source for coastal lizards. Common geckos use as habitat.	Coastal.
Karamu.	***Coprosma robusta.***	Habitat for common geckos and possibly other geckos, possible fruit source for geckos.	
Twiggywood.	***Raukaua anomalus.***	Divaricate. Good refuge and habitat for geckos, particularly green geckos. Fruit a possible food source.	
Poataniwha.	***Melicope simplex.***	Divaricate. Good refuge and habitat for geckos, particularly green geckos.	
Korokio.	***Corokia cotoneaster*** (form I, Eagle 2006a).	Divaricate. Good refuge and habitat for geckos, particularly green geckos (Knox, 2010).	
Twiggy coprosma.	***Coprosma rhamniodes.***	Divaricate. Good refuge and habitat for geckos, particularly green geckos. Possible fruit source.	
Mingimingi.	***Coprosma propinqua* var. *propinqua.***	Divaricate small-leaved shrub that provides refuge and fruit for common gecko (Wotton, 2002) and common skink (Freeman, 1997). Good habitat for green geckos.	Lowland?
Vines and climbing plants			
Black vine, puka.	***Muehlenbeckia australis.***	Valuable habitat and refuge for skinks and geckos. Also refuge for invertebrate prey.	
Pohuehue, wire plant.	***Muehlenbeckia complexa.***	Valuable habitat and refuge for skinks and geckos. Refuge for invertebrate prey.	
Pohuehue, creeping muehlenbeckia.	***Muehlenbeckia axillaris.***	Fruit consumed by common geckos (Wotton 2000). Refuge for invertebrate prey.	Montane and subalpine river beds, gravelly and rocky places.
Ferns			
Tree fern species.		Habitat and low-height refuge (under dead fern fronds) for forest geckos, probably other gecko species.	
Tanglefern.	***Gleinecha dicarpa.***	Refuge for skinks.	

Common name	Latin name	Expected benefit	Habitat
Epiphytes			
Kowharawhara, tree bush lily.	***Astelia solandri.***	Forest geckos, habitat and refuge.	Lowland forests.
Kahakaha, tank lily.	***Collospermum hastatum.***	Forest geckos, habitat and refuge.	Lowland forests.
Kiekie.	***Freycinetia banksii.***		
Non-vegetative habitat supplements			
Dead wood.		Refuge and basking surface for skink and gecko species.	
Rock piles, cobbles.		Refuge and basking surface for skink and gecko species. Particularly important for small-scaled skink and other semi-saxicolous species such as spotted and speckled skinks.	

Appendix J Important points for the future Tukituki EMEP project

Points for future preparation of Tukituki EMEP

Points for further specific study

- *River bird values.* Reach scale assessment of the presence and distribution of specialist river bird populations, particularly nesting colonies of at risk and threatened species.

- *River reach prioritisation*. Evaluation of the relative importance of river reaches as habitat for river birds. The evaluation should attempt to rank river reaches of the Tukituki Catchment with reaches of those other significant braided rivers, namely the Ngaruroro and Tutaekuri Rivers. The objective of this exercise is to help to identify and prioritise river reaches for management actions such as beach raking and protection from potentially impacting flood protection activities. This is especially important when resources are too limited to perform all of the work which would ideally be required to be completed during an optimal seasonal 'window'.

- *Indigenous vegetation protection.* The current project identified a large amount of indigenous cover within and adjacent to the various waterway corridors. The scale of the current project is 'catchment wide' and reach specific inventory or classification of indigenous cover was not appropriate. However many of the river corridors were flown, and a large number of 'geotagged' photos are available for the EMEP project. This indigenous cover is important for the maintenance of biodiversity, and the ecological importance is heightened even further in areas classed as Acutely and Chronically threatened environments.

- *Landscape ecology opportunities*. The Tukituki River and all its tributaries cross a diverse range of environments and cover a vast land area. Opportunities are presented for landscape scale planning for the waterway network, to optimize its performance for habitat provision and the contribution it makes to maintenance of biodiversity values at the landscape level. One approach would be to develop a set of criteria to evaluate indigenous habitats against, in the context of elements such as viability, habitat provision, ecological function, rarity, opportunities for public involvement and consistency with landscape ecology principles.

Appendix K Photographs

Photograph 1: View of Horseshoe Lake towards the south. Catchment Unit F.

Photograph 2: Part of seep wetland on the southwestern flank of Mt Kahuranaki. Note presence of woody indigenous vegetation. Catchment Unit F.

Photograph 3: Seep wetland on the True Left side of the Makaretu River. An unusually high floral diversity and association with indigenous podocorp-broadleaved forest adds to the distinctiveness of this wetland. Catchment Unit C.

Photograph 4: Typical topography of Catchment Unit A, upper Smith Stream Valley. High point on skyline at left of view is 'Paemutu' (1,682m a.s.l).

Photograph 5: Example within the Makaroro River Valley of a large landslide within Catchment Unit A.

Photograph 6: Low order (torrent phase) tributary of Makaroro River (c. 1,000m .a.s.l) (Unit A).

Photograph 7: Shingle bed at confluence of Gold Creek and Makaroro River (Unit A).

Photograph 8: View south from Moorcock Saddle of area of fire induced tussock grassland in foreground. Makaretu River North Branch in middle distance (Unit B).

Photograph 9: Example of strongly rolling hill landforms. View from Moorcock Ridge down the Moorcock Stream Valley, Kashmir Road visible sideling face. Catchment Unit B.

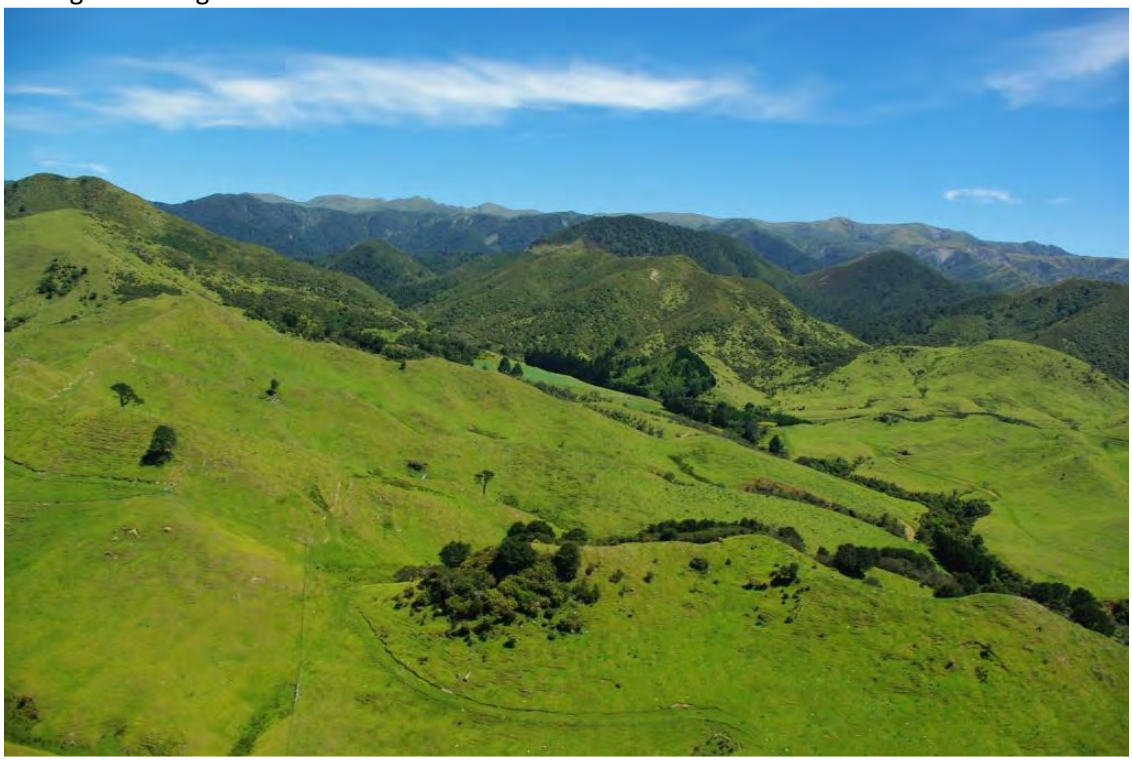
Photograph 10: Character of the upper Tukituki River (approximately 1.5km downstream of Daphne Hut) within the Ruahine Forest Park. Catchment Unit B.

Photograph 11: Character of the upper Tukituki River in its semi-pastoral setting, entrenched within escarpments. Catchment Unit B.

Photograph 12: Makaretu River North Branch. Catchment Unit B.

Photograph 13: Character of the Makaretu River between Snee and Paget Road. Catchment Unit B.

Photograph 14: View of area partially burned in 1946, note fire induced shrubland and tussock grassland and pockets of forest. Rocky Knob (1,226m a.s.l) on skyline at left of photo, Moorcock Saddle on ridgeline at right. Catchment Units A and B.



Photograph 15: Example of indigenous regenerating scrub on hill country. View northwest from around 'Fernlea'. Unnamed tributary of the Mangatewai River runs through centre of view. Catchment Unit B.

Photograph 16: Example of indigenous regenerating scrub on hill country. View west up Mangatewai Stream South Branch. Catchment Unit B.

Photograph 17: Example of well vegetated riparian margins of the Mangatawai Stream North Branch. Catchment Unit B.

Photograph 18: Example of well vegetated riparian margins of the upper Tukipo River. Catchment Unit B.

Photograph 19: Example of well vegetated riparian margins of the upper Tukipo River. Catchment Unit B.

Photograph 20: Aerial view of the podocarp broadleaved forest of RAP 39 ("Area 1"). Catchment Unit B.

Photograph 21: Aerial view of the podocarp broadleaved forest (in alluvial situation) of RAP 39 ("Area 2"). Catchment Unit B.

Photograph 22: View of the Mangaonuku Stream (upstream), the reach below State Highway 50 crossing. Unit C.

Photograph 23: View of the Waipawa River (upstream), adjacent to Makaroro Road and Evertree. Note heavily vegetated riverbed. Unit C.

Photograph 24: View of the Makaroro River (downstream), near Dutch Creek convergence. Note relatively open gravel substrates. Unit C.

Photograph 25: View of the Tukituki River (upstream), reach between Tukituki Makaretu and Eastwood Road. Unit C.

Photograph 26: View of the Mangatewai River (downstream), south of Ashley Clinton/Black Road intersection. Excellent indigenous forest cover, a characteristic attribute of this river corridor. Unit C.

Photograph 27: View of the agricultural character of the southeastern area of Catchment Unit C. Note indigenous cover largely confined to waterway alignments.

Photograph 28: Example of indigenous forest within a matrix of agricultural land use. Bush fragment in centre of frame is c.250m north of A'Deanes Bush. Catchment Unit C.

Photograph 29: View toward the west, approximately parallel with Smedley Road, of totara treeland over exotic pasture grassland. Wakarara and Ruahine Ranges are on the skyline. Catchment Unit C.

Photograph 30: View northwest towards the Ruahine Range (Unit A) and the Makaroro River. Mosaic of indigenous shrubland, treeland and forest amongst pastoral land use. Catchment Unit C.

Photograph 31: View east into Dutch Creek valley from above the Wakarara Range. Mosaic of plantation and indigenous forests. Ruahine Range on skyline, Makaroro River visible at left. Unit C.

Photograph 32: View to the east from above the Wakarara Range, across 'Shunt Road'. Characteristic mixed age plantation stands extend into the distance, where pasture is just visible. Unit C.

Photograph 33: View across the Wakarara Range. Characteristic mosaic of pasture, beech, manuka and regenerating broadleaved species. Unit C.

Photograph 34: Typical view of the character of the arm of the area to the east of State Highway 50. Catchment Unit C.

Photograph 35: Example of podocarp/black beech–broadleaved forest on hill landforms at left of view. View directed down the Makaroro River, very near the Dutch Creek confluence. Catchment Unit C.

Photograph 36: Sequence of grazed indigenous treelands on river terraces. Kanuka and kowhai on low terrace (Unit C), totara dominates on higher terraces (Unit D). Wakarara Range visible in the distance.

Photograph 37: A'Deanes Bush Scenic Reserve, viewed towards the west. Unit C.

Photograph 38: View towards the west, up the Tukituki River of Inglis Bush Scenic Reserve. Unit C.

Photograph 39: Makaroro Oxbow. Unit C.

Photograph 40: Makaroro Heath. Dutch Creek flows from right to left in incised gully near top of photo. Unit C.

Photograph 41: View of Mangaonuku Stream prior to its convergence with the Waipawa River. At the boundary of Catchment Units D and F, within Unit D.

Photograph 42: View of Waipawa River near upstream extent of Unit D, upstream of State Highway 50. Note, gravel extraction underway within river channel, and indigenous treeland on distant terrace right.

Photograph 43: View of Tukituki River (upstream) at Ongaonga Waipukurau Road Crossing. Note open gravel substrate and dense willow edge protection plantings. Unit D.

Photograph 44: View of point of confluence between Tukituki (left) and Waipawa (right) Rivers. Unit D.

Photograph 45: View of Tukipo River, between State Highway 50 and Mangatewai River confluence. Unit D.

Photograph 46: View of Mangatewai River within Catchment Unit D. Around the boundary between Catchment Units C and D. Terrestrial ecology values associated with the Mangatewai River undergo dramatic change.

Photograph 47: View (upstream) of the Makaretu River, upstream of State Highway 2-Snee Road intersection. Note hoary willow cover on low terrace, plantation forests and indigenous cover. Unit D.

Photograph 48: View (upstream) of the Makaretu River near the State Highway 2-Frazer Road intersection. Exotic edge protection plantings dominate riparian zone, open gravel substrates. Unit D.

Photograph 49: View of exotic pasture grassland, which is the most dominant land cover type within Catchment Unit D. View north along Tukituki Road. Unit D.

Photograph 50: View of exotic pasture grassland, currently managed for dairy production. View south, photograph taken near Ashcott-Burnside Roads intersection. Unit D.

Photograph 51: View of exotic pasture grassland, currently managed for dairy production. Note radial irrigator. Unit D.

Photograph 52: View of exotic edge protection plantings. View upstream, Waipawa River near Ongaonga Waipukarau Road. Unit D.

Photograph 53: View across Lake Hatuma towards the south. Note expansive area of exotic forest around western (right) lake margin. Unit D.

Photograph 54: View across orchards within the Ruataniwha Plains. Location south of the Waipawa River adjacent to State Highway 50. Unit D.

Photograph 55: View of short rotation cropland. Note radial irrigators. East of Butler-Tikokino-Makaroro Roads intersection. Unit D.

Photograph 56: View of short rotation cropland and pasture. Location south of Ashcott Road, near State Highway 50 intersection. Unit D.

Photograph 57: Remnant kanuka forest and treeland on alluvial plain landform (RAP35 (H)). Located amongst production land cover types west of Argyll East-Tikokino Road intersection. Unit D.

Photograph 58: View toward the west of Tukituki Scenic Reserve, a remnant podocarp-broadleaved forest on alluvial landform. Unit D.

Photograph 59: View towards the north of areas of regenerating indigenous forest on hill slopes with southern aspects. Mt Carlyon (394m) out of frame to the right. Unit E.

Photograph 60: View northwest of (distant) remnant alluvial podocarp-broadleaved forests (RAP15 (E)). This is a rare vegetation landform association within the Ecological District. Contains *Pittosporum obcordatum* and three other regionally rare plant species. Unit E.

Photograph 61: View toward the south of kanuka-manuka forest and scrub (Motuotaraia (RAP18(E)) on Cretaceous Whangai argillite. Unit E.

Photograph 62: Another view, only to the northeast of the kanuka-manuka forest and scrub (Motuotaraia (RAP18(E)). Unit E.

Photograph 63: Steeply sloping ground of Silver Range 'hogback' landform. Note indigenous cover present. Unit F.

Photograph 64: An area of exposed gravels reveals the alignment of the former bed of the Waipawa River, viewed toward the north. Location north of Homewood Road. Unit F.

Photograph 65: Typical character of Tukituki main stem in the vicinity of the Makara confluence. Unit F.

Photograph 66: Typical character of Tukituki main stem in the vicinity of Moore Road. Unit F.

Photograph 67: Typical character of Tukituki River at its point of convergence with the Pacific Ocean. Unit F.

Photograph 68: Typical character of Tukituki River at its point of convergence with the Pacific Ocean. Note shingle beach. Unit F.

Photograph 69: Typical character of Tukituki River at its point of convergence with the Pacific Ocean. Note shingle beach. Unit F.

Photograph 70: View of the Hawea Stream near Silver Range. Note indigenous cover within entrenched stream channel. Unit F.

Photograph 71: Steeply sloping ground on eastern face of prominent unnamed hill (454m a.s.l), located west of St Lawrence Road. Note localized talus and scattered indigenous cover. Cabbage tree treeland indicator of former forest cover. Unit F.

Photograph 72: Limestone boulderfield on eastern slopes of Te Mata Peak. Unit F.

Photograph 73: View of the largest continuous pine plantation within the Catchment Unit, located on the northern end of the Silver Range landform. Hawea Stream valley visible in valley floor. Unit F.

Photograph 74: Grazed indigenous forest remnant on the eastern face of Mount Erin. Unit F.

Photograph 75: View of a second area of grazed indigenous forest on the eastern face of Mount Erin. Unit F.

Photograph 76: View of Rowes Bush, a valuable remnant of the catchment's lowland forest cover. Unit F.

Photograph 77: Wide view of the Silver Range 'hogback' landform. Supports areas of indigenous shrubland. Unit F.

Photograph 78: View to the north along the ridgeline of Silver Range.

Photograph 79: Closer view of indigenous cover on hogback landform.