

Waitakere City Biodiversity Monitoring Programme:

- 1. Tui & Kereru**
- 2. Phenology**

August 2004

Bibliographic Reference:

Alexander, J.; Chapman, S. 2004. Waitakere City Biodiversity Monitoring Programme: 1) Tui & Kereru, 2) Phenology. Unpublished report for the Waitakere City Council.

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Date: August 2004

Status: Draft

Executive Summary

1. As part of the Waitakere City Council's commitment to undertake state of the environment monitoring and reporting, they have undertaken a native bird monitoring programme at urban forest remnants since 1997. The aim of the programme is to monitor the condition of urban forest fragments and their associated bird populations.
2. Tui and kereru play an essential role in ecological processes, especially in the pollination and seed dispersal of a wide range of indigenous plant species. Given the ecological importance of tui and kereru, and indications of an ongoing decline in kereru abundance, the Waitakere City Council decided to initiate a thorough monitoring programme capable of detecting population trends more accurately.
3. A major factor that influences the abundance of tui and kereru is the phenology (timing of fruiting and flowering) of plant species that they utilise as food sources. An understanding of plant phenology in relation to tui and kereru feeding provides a key management tool for planning and implementing revegetation projects. Given the potential importance and applicability of a good understanding of plant phenology in its reserve network, the Waitakere City Council decided to initiate the collection of phenology data at 27 bird monitoring sites throughout Waitakere City.
4. The purpose of the research described in this report is: 1) to extend the distance sampling based monitoring programme established in 2003 for tui and kereru to include winter data collection; 2) to extend vegetation data collection to investigate the winter phenology of indigenous vegetation; and 3) to investigate the relationship between tui / kereru population densities and the phenology of indigenous vegetation at the Waitakere City Council bird monitoring sites during winter.
5. Tui and kereru populations were sampled using variable-length slow-walk transects between 100 and 500 metres in length (depending on the area of the site) and 40 metres wide (20 metres either side of the transect line). Additional data (distance and bearing from transect) were collected to allow future analyses using distance sampling – the most accurate monitoring method currently available for tui and kereru.
6. Tuis were present at 24 of the 26 monitoring sites sampled. Population densities were only calculated for 19 sites because while tui were present at other sites, they were further than 20 metres away from the centre line of the transect. Where tuis were present along transects, population densities ranged from 0.3 per hectare (Kay Road Balefill) to 7.5 per hectare (Claude Abel Reserve). Other sites with high tui population densities (> 2 per hectare) were the Manukau Harbour foreshore reserves: Karaka Park, Takaranga Reserve and Warner Park.
7. Kereru were present at six of the 26 monitoring sites sampled. The density of kereru populations ranged from 0.3 per hectare to 1.3 per hectare. In descending order of kereru population density, the sites with kereru were: Claude Abel

Reserve, Te Henga Wetland, Swanson Scenic Reserve, Takaranga Reserve, Henderson Valley Scenic Reserve and Rahui Kahika Reserve.

8. Baseline data on the winter phenology of trees, shrubs and climbers were collected at the reserves where bird monitoring was undertaken. A 100 m transect was walked at each site and the extent and nature of any flowering or fruiting was recorded. The composition and structure of the vegetation along each transect was also recorded.
9. It is recommended that the Waitakere City Council: a) implements pest control at key WCC reserves; b) locates kereru nests at the beginning of each breeding season and protects them from predators; c) implements or continues revegetation with an emphasis on increasing the availability of winter food sources for tui and kereru within the WCC reserve network; and d) plans weed control to avoid removing exotic species that provide winter food for tui and kereru unless native plants are able to provide an alternative winter food source.

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CD-Rom	
• PDF and Microsoft word versions of this report	
• Raw bird monitoring and phenology data	

1. Background

Prior to the arrival of humans to New Zealand, the indigenous terrestrial fauna was free of predatory mammals (Daugherty *et al.* 1993). The wildlife encountered by the first humans to arrive in New Zealand was remarkable in its distinctiveness and diversity. The uniqueness of New Zealand's native birdlife has led to New Zealand being described as a 'land of birds' (e.g., Moon 2001). Tragically, New Zealand's unique biodiversity has endured introductions of alien species and the effects of habitat loss resulting in extinctions, range contractions, and reduced densities – all of which have severely disrupted ecological communities (Wilson 2004). Fifty-one bird species have become extinct in New Zealand. In Waitakere City, twenty-three bird species are classified as rare, threatened or uncommon (Chapman & Alexander 2003) and kereru is the only species remaining that can disperse fruits greater than 12mm in diameter. As such, regeneration of large-fruited trees such as tawa, taraire and kohekohe is limited to areas where kereru persist.

The Waitakere City Council (WCC) adopted the International Convention on Biological Diversity during 1993. In partnership with the community, WCC embarked on a pioneering biodiversity programme thus signalling a commitment to be at the forefront of the management, protection and restoration of biodiversity. WCC's resolve to halt the decline of the City's indigenous biodiversity was strengthened by the release of the National Biodiversity Strategy in 2000, a document that gave biodiversity issues a strong focus at a national level. In partnership with the community the WCC has implemented a range of practical biodiversity protection, monitoring and restoration initiatives.

The WCC initiated a bird monitoring programme in 1997. Concerns about the state of kereru populations in Waitakere City were raised when analyses of five years of bird count data indicated an ongoing decline in kereru *Hemiphaga novaeseelandiae* abundance (Chapman & Alexander 2003). To investigate the density and trends of kereru populations the WCC initiated a monitoring programme based on distance sampling (Barraclough 2000) in 1993 (Alexander & Chapman 2003). Tuis *Prosthemadera novaeseelandiae* were also included in the monitoring programme because, like kereru, they play a major role in ecological process such as pollination and seed dispersal. The factors most likely to influence the abundance and population trends of tui and kereru include food availability, nest site availability, and predation by introduced mammals.

This report presents the results of winter monitoring of the density of tui and kereru populations at 26 of the WCC's network of 27 bird monitoring sites (Figure 1). Also included are the results of winter phenology sampling (timing of flowering and fruiting) of native trees, shrubs and climbers from the same 26 sites. The collection of phenology data during winter is important as it enables the availability of food for tui and kereru to be assessed at a time when food is most limited. Combining information on phenology with tui and kereru monitoring data is potentially an important management tool for use in the planning and implementation of ecological restoration initiatives.

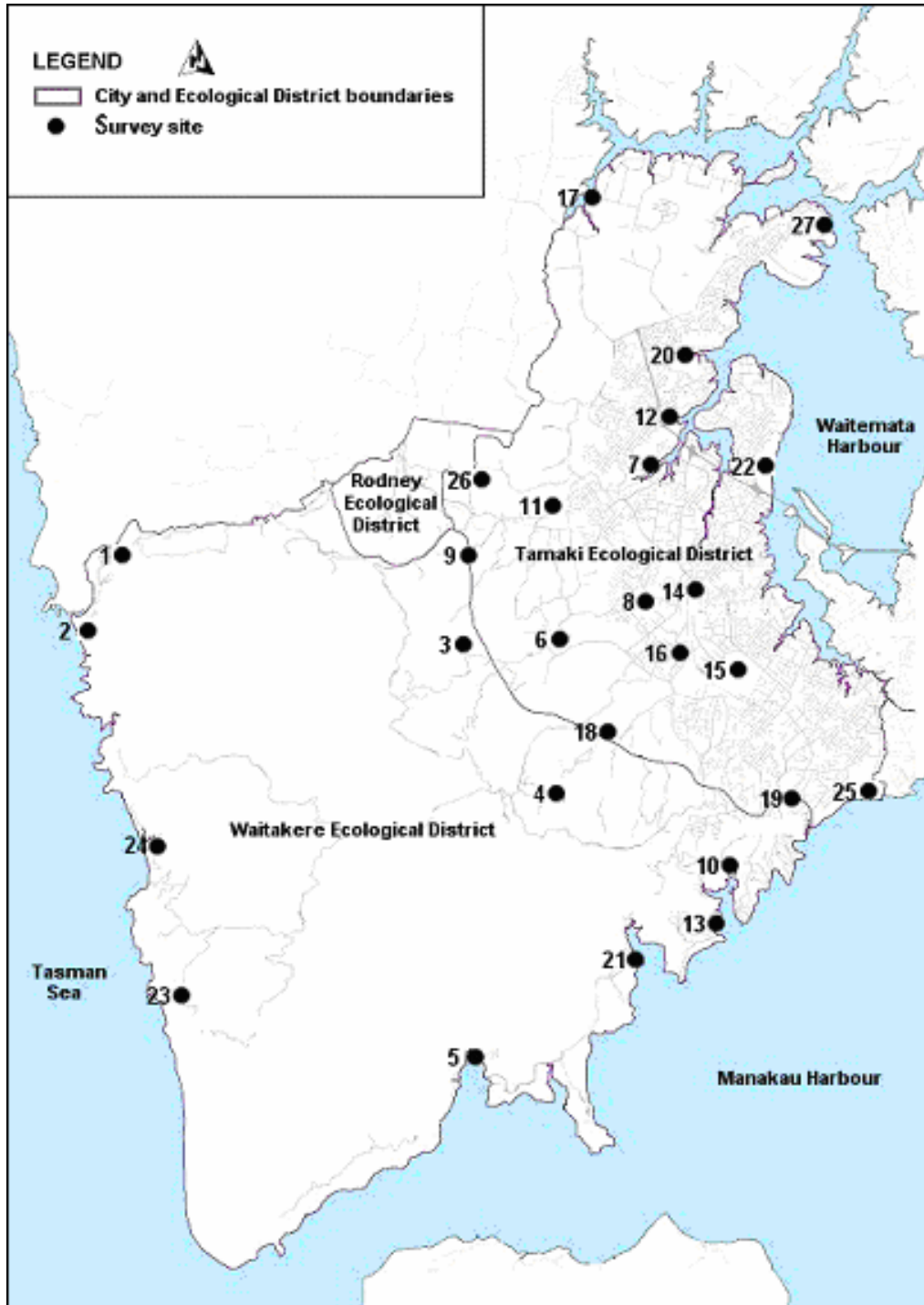


Figure 1. Location of bird and phenology survey sites in Waitakere City (2004; see Table 1 for site names).

Table 1: Bird monitoring site names, habitat, location and recent management actions.

Site no.	Site Name	Habitat	Location	Possum control (2004)	Other management actions
1	Te Henga Wetland	Freshwater wetland, raupo reedland	Bethells Road, Te Henga		Weed control
2	Bethells Beach	Sand dune, dune shrubland	Bethells Road, Te Henga		Revegetation
3	Mountain Road Esplanade	Regenerating kanuka-podocarp-forest	Mountain Road, Henderson Valley		
4	Douglas Scenic Reserve	Mamaku-mixed broadleaf forest	Raroa Terrace, Waiaatarua		
5	Huia Reserve	Grassland, marine tidal flats	Huia Road, Huia		
6	Henderson Valley Scenic Reserve	Secondary podocarp-broadleaf forest	Candia Road, Henderson Valley		
7	Chorley Reserve / Sunline Park	Mamaku-mixed broadleaf forest	Sunline Avenue, Massey West	✓	
8	Shona Esplanade	Mature and regenerating podocarp-hardwood forest	Claret Place, Western Heights	✓	Weed control / revegetation
9	Tram Valley Road	Secondary podocarp-broadleaf forest	Tram Valley Road, Swanson		
10	Gill Esplanade	Marine tidal flats, mangrove shrubland	Landing Road, Laingholm		Revegetation
11	Swanson Scenic Reserve	Secondary kauri-kanuka forest	Swanson Road, Swanson	✓	
12	Lowtherhurst Reserve	Secondary kanuka-broadleaf forest	Lowtherhurst Road, Massey East		
13	Warner Park	Puriri composite-pohutukawa forest	Laingholm Drive, Laingholm	✓	
14	Catherine Esplanade	Exotic-regenerating native mix	Vitasovich Avenue, Henderson	✓	
15	Waikumete Cemetery	Exotic-regenerating kanuka mix	Waitakere View Road, Glen Eden		Weed control / revegetation
16	Oratia Esplanade	Mixed willow-bamboo	Newham Road, McLaren Park	✓	
17	Brigham Creek Reserve	Marine tidal flats, mangrove shrubland	Dale Road, Whenuapai		
18	Kellys Bridge Esplanade	Regenerating kanuka forest	West Coast Road, Oratia		
19	Rahui Kahika Reserve	Secondary podocarp-broadleaf-kauri forest	Pendlebury Street, Green Bay	✓	
20	Moire Park	Regenerating kanuka forest	Granville Drive, Massey East	✓	
21	Takaranga Reserve	Coastal broadleaf forest, marine tidal flats	Armour Road, Parau		
22	Harbourview Park	Marine tidal flats, constructed wetland	Te Atatu Road, Te Atatu Peninsula		Weed control
23	Karekare Beach	Pohutukawa forest	Watchmans Road, Karekare		
24	Claude Abel Reserve	Wetland, pohutukawa forest	Garden Road, Piha		
25	Karaka Park / Green Bay Beach	Original pohutukawa coastal forest, marine tidal flats	Portage Road, Green Bay	✓	Weed control
26	Kay Road Balefill	Regenerating kauri-tanekaha-kanuka-rimu forest	Kay Road, Swanson	✓	Revegetation / rodent control
27	Hobsonville Esplanade	Regenerating kanuka forest, marine tidal flats	Hudson Bay Road, Hobsonville		

2. Tui and Kereru

2.1 Introduction

The Waitakere City Council (WCC) has monitored bird populations in Waitakere City since 1997 (Chapman and Alexander 2003). The results of the bird monitoring programme indicated that some native bird species were declining. Of particular concern was an apparent ongoing decline in the abundance of kereru. Along with tui, kereru is an important pollinator and disperser of many native plant species. Kereru is the only known dispersal agent for native plant species with large fruits (e.g., tawa, taraire, puriri, karaka) (Clout & Hay 1989). Given the ecological importance of tui and kereru, WCC decided to implement more detailed monitoring aimed at investigating population trends and the cause(s) of any trends in tui and kereru populations. To gain a clearer understanding of seasonal variation in tui and kereru populations across their reserve network, WCC commissioned Envirollogic Ltd to undertake distance sampling during winter 2004.

2.2 Methods

Tui and kereru populations were sampled at 26 sites spread throughout Waitakere City during winter 2004. The sites were the WCC reserves where distance sampling was undertaken during the spring of 2003 by Alexander and Chapman (2003). The only exception was Douglas Scenic Reserve which was not sampled as permission could not be obtained to cross private land to access the reserve.

Forest bird variable-length transects (Handford 2002, Alexander & Chapman 2003) were used to estimate the density of tui and kereru populations at the sampling sites. Transects were between 100 m and 500 m in length depending on the size of the reserve. Transects were walked slowly and the following data were recorded for all tui and kereru seen or heard: species, number of tui/kereru, distance along transect, distance from transect, angle/bearing from transect. The length of transects and the distance of tui/kereru sightings along transects was determined using a hand-held GPS unit. Distance away from transect was estimated to the nearest metre and bearings/angles from transects were estimated to the nearest 5°.

Additional data were collected to facilitate future analyses based on distance sampling models. Such analyses were not attempted during this study because baseline datasets do not allow for the valid application of distance sampling analyses. To allow tui and kereru population densities to be calculated in the short term, the number of tui and / or kereru per hectare was calculated by only including sightings of tui or kereru within 20 m from either side of the transect in the analysis. Population densities were calculated by multiplying the length of the transect (variable) by the width of the transect (20 m) in which birds were recorded.

To avoid bird activity peaks at dawn and dusk, transects were walked between 7:30 am and 5:30 pm. One round of surveys was conducted during June and a second round was undertaken during July. Surveys were not conducted during strong winds or rain. If these weather conditions developed partway through a day's counts, then that day's surveying was abandoned to continue on another day.

2.3 Results

During the two seasons of distance sampling, tuis were recorded at all 27 monitoring sites although not all sites had tui in both spring and winter (Table 2). Population densities were only calculated for sites where tuis were present within 20 metres of the centre line of the transect in either season. Where tuis were present along transects, population densities ranged from 0.3 per hectare (Bethells Beach, Henderson Valley Scenic Reserve, Shona Esplanade and Kay Road Balefill) to 7.5 per hectare (Claude Abel Reserve) (Table 3). Other sites with high tui population densities (> 2 per hectare) included Karaka Park, Takaranga Reserve and Warner Park (Table 3).

Kereru were recorded at six of the 26 monitoring sites surveyed during winter 2004 (Table 2). The density of kereru populations ranged from 0.3 per hectare to 1.3 per hectare. In descending order of kereru population density, the sites with kereru were Claude Abel Reserve, Te Henga Wetland, Swanson Scenic Reserve, Takaranga Reserve, Henderson Valley Scenic Reserve and Rahui Kahika Reserve (Table 4).

Table 2: Transect lengths, areas, and the presence / absence of tui and kereru at 27 bird monitoring sites during spring 2003 and winter 2004.

Site name	Site number	Transect length (m)	Transect area (Ha)	Tui recorded by DS during spring 2003	Tui recorded by DS during winter 2004	Kereru recorded by DS during spring 2003	Kereru recorded by DS during winter 2004
Te Henga Wetland	1	300	1.2		✓		✓
Bethells Beach	2	500	2.0		✓		
Mountain Rd Esplanade	3	200	0.8	✓	✓		
Douglas Scenic Reserve	4	100	0.4	✓	NS*	✓	NS*
Huia Reserve	5	100	0.4		✓		
Henderson Valley Reserve	6	500	2.0	✓	✓		✓
Chorley Reserve	7	100	0.4		✓		
Shona Esplanade	8	500	2.0	✓	✓		
Tram Valley Road	9	100	0.4	✓	✓		
Gill Esplanade	10	150	0.6	✓	✓		
Swanson Scenic Reserve	11	200	0.8	✓	✓		✓
Lowtherhurst Reserve	12	300	1.2	✓	✓	✓	
Warner Park	13	150	0.6	✓	✓	✓	
Catherine Esplanade	14	100	0.4	✓			
Waikumete Cemetery	15	100	0.4	✓	✓		
Oratia Esplanade	16	300	1.2	✓	✓		
Brigham Creek Reserve	17	100	0.4	✓	✓		
Kellys Bridge Esplanade	18	100	0.4	✓			
Rahui Kahika Reserve	19	500	2.0	✓	✓	✓	✓
Moire Park	20	500	2.0	✓	✓		
Takaranga Reserve	21	300	1.2	✓	✓		✓
Harbourview Park	22	300	1.2		✓		
Karekare Beach	23	150	0.6	✓	✓		
Claude Abel Reserve	24	100	0.4	✓	✓	✓	✓
Karaka Park	25	100	0.4	✓	✓	✓	
Kay Road Balefill	26	500	2.0	✓	✓	✓	
Hobsonville Esplanade	27	200	0.8		✓		

*Not Surveyed – Douglas Scenic Reserve was not surveyed as permission could not be gained to cross private land to enter the reserve.

Table 3: Tui population densities at sites where tui were present within 20m of the transect line (spring 2003 and winter 2004).

Site name	Site no.	Transect Area (Ha)	Tui/Ha spring 2003	Tui/Ha winter 2004
Te Henga Wetland	1	1.2	0.0	1.7
Bethells Beach	2	2.0	0.0	0.3
Mountain Rd Esplanade	3	0.8	0.0	0.6
Huia Reserve	5	0.4	0.0	1.3
Henderson Valley Scenic Reserve	6	2.0	1.5	0.3
Chorley Reserve	7	0.4	1.3	0.0
Shona Esplanade	8	2.0	1.8	0.3
Gill Esplanade	10	0.6	0.0	0.8
Swanson Scenic Reserve	11	0.8	0.0	1.3
Lowtherhurst Reserve	12	1.2	2.1	0.0
Warner Park	13	0.6	3.3	2.5
Waikumete Cemetery	15	0.4	5.0	1.3
Oratia Esplanade	16	1.2	0.8	0.0
Brigham Creek Reserve	17	0.4	1.3	1.3
Rahui Kahika Reserve	19	2.0	1.0	1.3
Moire Park	20	2.0	0.5	0.5
Takaranga Reserve	21	1.2	1.3	2.5
Karekare Beach	23	0.6	0.8	0.8
Claude Abel Reserve	24	0.4	1.3	7.5
Karaka Park	25	0.4	10.0	2.5
Kay Road Balefill	26	2.0	0.3	0.3
Hobsonville Esplanade	27	0.8	0.0	0.6

Table 4: Kereru population densities at sites where kereru were present within 20m of the transect line (spring 2003 and winter 2004).

Site name	Site no.	Transect Area (Ha)	Kereru/Ha spring 2003	Kereru/Ha winter 2004
Te Henga Wetland	1	1.2	0.0	0.8
Douglas Scenic Reserve	4	0.4	2.5	0.0
Henderson Valley Scenic Reserve	6	2.0	0.0	0.3
Swanson Scenic Reserve	11	0.8	0.0	0.6
Lowtherhurst Reserve	12	1.2	0.2	0.0
Warner Park	13	0.6	0.8	0.0
Rahui Kahika Reserve	19	2.0	0.4	0.3
Takaranga Reserve	21	1.2	0.0	0.4
Claude Abel Reserve	24	0.4	2.5	1.3
Karaka Park	25	0.4	0.3	0.0
Kay Road Balefill	26	2.0	0.5	0.0

3. Phenology

3.1 Introduction

The phenology (timing of flowering and fruiting) of trees, shrubs and climbers are an important factor in the availability of food for tui and kereru. Given the importance of year-round availability of fruits and flowers for the persistence of tui and kereru populations, and the potential to use phenological information in the planning and implementation of ecological restoration initiatives, the WCC implemented a data collection project aimed at determining the phenology of indigenous vegetation in their reserve network. This chapter presents the results of winter sampling of the phenology of trees, shrubs and climbers at 26 of WCC's 27 bird monitoring sites during winter 2004.

3.2 Methods

Rapid assessment vegetation surveys were undertaken during June and July 2004 at 26 WCC reserves. The surveys involved slowly walking a 100 m transect at each site. The phenology (i.e., the occurrence and timing of plant reproductive events) of native plant species was assessed by recording the species that were flowering or fruiting. The following details were recorded for each species that was flowering and / or fruiting:

- Abundance of flowers and / or fruit (1 = few, 2 = common, 3 = abundant)
- Maturity of the flowers and / or fruit (1 = immature, 2 = mature, 3 = shed)
- Proportion of plants with flowers and / or fruit (1 = few, 2 = many, 3 = all)

Phenology data from other times of the year, and for species that were not recorded flowering or fruiting, were obtained from a variety of sources including personal observations, Alexander & Chapman (2003), Handford (2002), and Porteous (1993).

3.3 Results

A wide range of indigenous trees, shrubs and climbers were recorded at the monitoring sites. Few species bear flowers or fruit during the colder months, especially from May to September (Table 5). The number of plant species utilised for food by tui and kereru varied considerably from reserve to reserve with Rahui Kahika Reserve standing out as possessing the widest range of food resources. Conversely, relatively few plant species utilised by tui and kereru were recorded at coastal and wetland sites such as Te Henga Wetland, Bethells Beach, Brigham Creek Reserve and Harbourview Park (Tables 5 & 6). Flowering or fruiting of a plant species at one site did not necessarily mean that it was flowering at any or all of the other sites where it was present (Tables 5 & 6). Hangehange (*Geniostoma rupestre*) and karamu (*Coprosma robusta*) were both present at most sites and were flowering and / or fruiting at most sites where they were recorded (Tables 5 & 6).

Table 5: Phenology of trees, shrubs and climbers recorded across the network of WCC biodiversity monitoring sites.

Species	Common name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<i>Acmena smithii</i>	Monkey apple	Flowering											
<i>Agathis australis</i>	Kauri												
<i>Alseuosmia macrophylla</i>								Flowering					
<i>Alectryon excelsus</i>	Titoki									Flowering and fruiting			
<i>Aristolotelia serrata</i>	Wineberry												
<i>Avicennia marina</i>	Mangrove	Flowering and fruiting	Flowering and fruiting	Flowering and fruiting	Flowering and fruiting								
<i>Beilschmiedia tawa</i>	Tawa												
<i>Brachglottis repanda</i>	Rangiora							Flowering					
<i>Caropdetus serratus</i>	Putaputaweta												
<i>Cassinia leptophylla</i>	Tauhinu												
<i>Coprosma areolata</i>													
<i>Coprosma crassifolia</i>													
<i>Coprosma grandiflora</i>													
<i>Coprosma lucida</i>													
<i>Coprosma macrocarpa</i>													
<i>Coprosma repens</i>													
<i>Coprosma rhamnoides</i>													
<i>Coprosma robusta</i>	Karamu												
<i>Cordyline australis</i>	Cabbage tree												
<i>Cordyline banksii</i>													
<i>Corynocarpus laevigatus</i>	Karaka												
<i>Cotoneaster simonsii</i>	Cotoneaster	Flowering											
<i>Cyathodes juniperina</i>	Mingimingi												
<i>Dacrycarpus dactyloides</i>	Kahikatea												
<i>Dacrydium cupressinum</i>	Rimu												
<i>Dysoxylum spectabile</i>	Kohehohe												
<i>Dodonaea viscosa</i>	Akeake												
<i>Elaeagnus x reflexa</i>	Eleagnus	Flowering											
<i>Elaeocarpus dentatus</i>	Hinau												
<i>Entelea arboreescens</i>	Whau												
<i>Eucalyptus saligna</i>	Eucalyptus												
<i>Fuchsia excorticata</i>													
<i>Geniostoma rupestre</i>	Hangehange												
<i>Griselinia littoralis</i>													
<i>Griselinia lucida</i>	Puka												
<i>Hebe stricta</i>													
<i>Hedycarya arborea</i>	Pigeonwood												
<i>Hedychium gardnerianum</i>	Ginger												
<i>Hoheria populnea</i>	Lacebark												
<i>Jasminum polyanthum</i>	Jasmine	Flowering and fruiting	Flowering and fruiting	Flowering and fruiting	Flowering and fruiting	Flowering and fruiting	Flowering and fruiting	Flowering and fruiting	Flowering and fruiting	Flowering and fruiting	Flowering and fruiting	Flowering and fruiting	Flowering and fruiting
<i>Knightia excelsa</i>	Rewarewa												
<i>Kunzea ericodes</i>	Kanuka												
<i>Laurelia novae-zelandiae</i>	Pukatea												
<i>Leptospermum scoparium</i>	Manuka												

Key: = fruiting
 = flowering
 = flowering and fruiting

Fruiting and flowering times vary from year to year and those given in the table are approximations drawn largely from personal observations and from Handford (2002) and Porteous (1993)

Table 5 (continued): Phenology of trees, shrubs and climbers recorded across the network of WCC biodiversity monitoring sites.

Plant List - Flowering / fruiting	Common name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<i>Leucopogon fasciculatus</i>	Mingimingi												
<i>Lonicera japonica</i>	Honeysuckle												
<i>Ligustrum lucidum</i>	Tree privet												
<i>Ligustrum sinense</i>	Chinese privet												
<i>Melicope ternata</i>	Wharangi												
<i>Melicytus macrophyllus</i>													
<i>Melicytus ramiflorus</i>	Mahoe												
<i>Metrosideros excelsus</i>	Pohutakawa												
<i>Metrosideros lianes</i>													
<i>Meulenbeckia complexa</i>													
<i>Myoporum laetum</i>	Ngaio												
<i>Myrsine australis</i>	Red matipo												
<i>Nestegis lanceolata</i>	White marie												
<i>Nothofagus truncata</i>	Hard beech												
<i>Olearia</i> spp.													
<i>Phormium cookianum</i>	Wharariki												
<i>Phormium tenax</i>	Harakeke												
<i>Phyllocladus trichomanoides</i>	Celery Pine												
<i>Pittosporum crassifolium</i>	Karo												
<i>Pittosporum eugenioides</i>	Tarata												
<i>Pittosporum tenuifolium</i>	Kohuhu												
<i>Plagianthus divaricatus</i>	Ribbonwood												
<i>Podocarpus totara</i>	Totara												
<i>Pomaderris kumeraho</i>													
<i>Prumnopitys ferruginea</i>	Miro												
<i>Prumnopitys taxifolia</i>	Matai												
<i>Pseudopanax arboreus</i>	Five finger												
<i>Pseudopanax crassifolius</i>	Lancewood												
<i>Pseudopanax lessonii</i>													
<i>Rhopalostylus sapida</i>	Nikau												
<i>Ripogonum scandens</i>	Supplejack												
<i>Rubus australis</i>	Bushlawyer												
<i>Rubus fruticosus</i>	Blackberry												
<i>Schefflera digitata</i>	Pate												
<i>Solanum aviculare</i>	Poroporo												
<i>Solanum mauritianum</i>	Wooly nightshade												
<i>Sophora chathamica</i>	Kowhai												
<i>Sophora fulvida</i>	Kowhai												
<i>Sophora microphylla</i>	Kowhai												
<i>Streblus heterophyllus</i>	Turepo												
<i>Toronia toru</i>													
<i>Vitex lucens</i>	Puriri												
<i>Weinmannia silvicola</i>													

Key: = fruiting
 = flowering
 = flowering and fruiting

Fruiting and flowering times vary from year to year and those given in the table are approximations only drawn largely from personal observations and from Handford (2002) and Porteous (1993)

Table 6: The distribution and flowering / fruiting of known plant food sources for tui at 27 Waitakere City bird monitoring during winter 2004 (Source of tui diet data: Handford 2002, Higgins & Davies 1996).

Species	Te Henga Wetland	Bethells Beach	Mountain Rd Esplanade	Douglas Scenic Reserve	Huia Reserve	Henderson Valley	Chorley Reserve	Shona Esplanade	Tram Valley Road	Gill Esplanade	Swanson Scenic	Lowtherhurst Reserve	Warner Park	Catherine Esplanade	Waikumete Cemetery	Oratia Esplanade	Brigham Creek Reserve	Kellys Bridge Esplanade	Rahui Kahika Reserve	Moire Park	Takaranga Reserve	Harbourview Park	Karekare Beach	Claude Abel Reserve	Karaka Park	Kay Road Balefill	Hobsonville Esplanade
Flowers																											
<i>Acacia</i> spp.																											
<i>Alseuosmia</i> spp.																											
<i>Beilschmiedia</i> spp.																											
<i>Cordyline</i> spp.																											
<i>Dysoxylum spectabile</i>																											
<i>Eucalyptus</i> spp.																											
<i>Elaeocarpus dentatus</i>																											
<i>Fuchsia excorticata</i>																											
<i>Geniostoma rupestre</i>																											
<i>Hoheria populnea</i>																											
<i>Knightia excelsa</i>																											
<i>Kunzea ericoides</i>																											
<i>Leptospermum scoparium</i>																											
<i>Metrosideros</i> spp.																											
<i>Myoporum</i> spp.																											
<i>Phormium</i> spp.																											
<i>Pittosporum</i> spp.																											
<i>Pseudopanax</i> spp.																											
<i>Sophora</i> spp.																											
<i>Vitex lucens</i>																											
Fruits																											
<i>Acmena smithii</i>																											
<i>Alectryon excelsus</i>																											
<i>Carpodetus serratus</i>																											
<i>Coprosma grandifolia</i>																											
<i>Coprosma lucida</i>																											
<i>Coprosma robusta</i>																											
<i>Dacrycarpus dacrydioides</i>																											
<i>Hedycarya arborea</i>																											
<i>Ligustrum</i> spp.																											
<i>Macropiper excelsum</i>																											
<i>Meliccytus</i> spp.																											
<i>Muehlenbeckia australis</i>																											
<i>Prumnopitys ferruginea</i>																											
<i>Prumnopitys taxifolia</i>																											
<i>Pseudopanax arboreus</i>																											
<i>Pseudopanax crassifolius</i>																											
<i>Ripogonum scandens</i>																											
<i>Schefflera digitata</i>																											

Key: = flowering / fruiting
 = present but non-reproductive

Table 7: The distribution and flowering / fruiting of known plant food sources for kereru at 27 Waitakere City bird monitoring sites during winter 2004 (Source of kereru diet data: Handford 2002, Higgins and Davies 1996).

Species	Te Henga Wetland	Bethells Beach	Mountain Rd Esplanade	Douglas Scenic Reserve	Huia Reserve	Henderson Valley Reserve	Chorley Reserve	Shona Esplanade	Tram Valley Road	Gill Esplanade	Swanson Scenic Reserve	Lowtherhurst Reserve	Warner Park	Catherine Esplanade	Waikumete Cemetery	Oratia Esplanade	Brigham Creek Reserve	Kellys Bridge Esplanade	Rahui Kahika Reserve	Moire Park	Takaranga Reserve	Harbourview Park	Karekare Beach	Claude Abel Reserve	Karaka Park	Kay Road Balefill	Hobsonville Esplanade
Flowers																											
<i>Aristotelia serrata</i>				■																■							
<i>Fuchsia excorticata</i>																				■							
<i>Salix</i> spp.																■											
<i>Sophora</i> spp.	■			■		■	■	■			■	■	■	■		■		■	■	■	■	■		■	■	■	■
Fruits																											
<i>Acmena smithii</i>															■			■									
<i>Alectryon excelsus</i>						■		■				■			■												
<i>Aristotelia serrata</i>				■																							
<i>Beilschmiedia tarairi</i>																											
<i>Beilschmiedia tawa</i>						■		■			■		■														
<i>Carmichaelia arborea</i>	■		■																	■	■						
<i>Coprosma grandifolia</i>			■					■											■	■		■					
<i>Coprosma lucida</i>	■		■	■		■					■		■					■	■	■	■	■				■	■
<i>Coprosma robusta</i>	■	■	■	■	■	■	■	■		■	■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■
<i>Corynocarpus laevigatus</i>						■		■			■		■							■	■			■	■	■	■
<i>Dacrycarpus dacrydioides</i>						■		■			■		■							■	■				■	■	■
<i>Dacrydium cupressinum</i>			■			■		■			■		■							■	■				■	■	■
<i>Dysoxylum spectabile</i>				■									■														
<i>Fuchsia excorticata</i>																				■							
<i>Geniostoma rupestre</i>	■		■	■		■	■	■			■	■	■	■	■			■	■	■	■	■		■	■	■	■
<i>Griselinia</i> spp.																			■	■							
<i>Hedycarya arborea</i>			■			■		■			■		■						■	■						■	■
<i>Ligustrum</i> spp.											■		■		■		■										
<i>Macropiper excelsum</i>				■		■		■			■		■							■	■			■	■	■	■
<i>Meliccytus</i> spp.	■		■			■		■			■		■							■	■			■	■	■	■
<i>Myrsine australis</i>	■		■			■		■			■	■	■	■	■				■	■	■	■			■	■	■
<i>Prumnopitys ferruginea</i>			■			■																					
<i>Prumnopitys taxifolia</i>			■					■																			
<i>Pseudopanax crassifolius</i>	■					■					■	■								■							
<i>Rhopalostylis sapida</i>	■		■			■		■			■		■							■	■			■	■	■	■
<i>Ripogonum scandens</i>			■			■		■					■												■	■	■
<i>Schefflera digitata</i>							■		■	■										■							
<i>Syzygium maire</i>															■												
<i>Vitex lucens</i>													■							■	■	■		■	■	■	■

Key: ■ = flowering / fruiting
 ■ = present but non-reproductive

4. Discussion and Recommendations

Recommendation 1: Pest control should be implemented at key WCC reserves.

Recommendation 2: Kereru nests should be located at the beginning of each breeding season and protected from predators.

Tuis have been detected at every bird monitoring site. At most sites (18), tuis were recorded during both spring and winter. Tui population densities were highest at reserves with the greatest abundance and diversity of native trees, shrubs and climbers. Kereru were present at few of the reserves sampled. For example, kereru were recorded in both seasons at only two sites, Claude Abel Reserve and Rahui Kahika Reserve. Those two sites, along with the other reserves where kereru have been recorded during recent surveys, should be considered Waitakere City's premier reserves. These sites are: Te Henga Wetland, Douglas Scenic Reserve, Henderson Valley Scenic Reserve, Swanson Scenic Reserve, Lowtherhurst Reserve, Warner Park, Rahui Kahika Reserve, Takaranga Reserve, Claude Abel Reserve, Karaka Park, Kay Road Balefill. These reserves are important strongholds for tui and are among the last refuges for kereru in the Waitakere City lowlands.

It is essential that the premier reserves are targeted for predator control because kereru in particular are at very low density (often only one pair is present at most sites where they persist) and the six years of five minute bird count data (Chapman & Alexander 2004) indicates that kereru populations are not recovering. The Department of Conservation has recently reclassified the threat status of kereru as in 'gradual decline' which is based on the prediction that total kereru population will decline 5-30% in the next ten years due to existing threats, and the decline is expected to continue beyond 10 years (Molloy et al. 2002).

Recent research strongly suggests that kereru nesting attempts are unlikely to be successful in the absence of predator control. A Northland study of kereru nesting found that over a period of two years, only one of seventeen monitored nests produced fledged young and the only successful nest was attributed to predator trapping around the nest tree that was in addition to bait station based pest control (Innes *et al.* 2004). Innes *et al.* (2004) concluded that in order to recover kereru populations, possums and rats need to be reduced to trap-catch rates below 5% for the duration of the breeding season (October to March). Reducing densities of possums and rats will also increase food availability for birds and enhance overall forest health (Nugent *et al.* 2002). Given that most WCC reserves with kereru probably have no more than one breeding pair, an approach based on locating and protecting kereru nests is warranted. Such predator control should be additional to reserve-wide pest control aimed at improving the ecological health of the reserves.

Recommendation 3: Revegetation should be implemented or continued with an emphasis on increasing the availability of winter food sources for tui and kereru within the WCC reserve network.

Tuis primarily feed on nectar but they regularly supplement their diets with fruits, invertebrates and occasionally pollen (Heather & Robertson 2000; Higgins & Davies 1996). Kereru mainly eat fruit but also include flowers, leaves and buds in their diet (Heather & Robertson 2000; Higgins & Davies 1996). Kereru breeding is thought to

be strongly linked with the availability of the fruits of certain native trees during winter (especially taraire; Innes *et al.* 2004). When planting for revegetation, special consideration should be given to planting species that provide fruits and / or nectar during the winter months (e.g., puriri, taraire, lancewood, nikau, tree fuchsia, *Weinmannia silvicola*). Planting species with foliage that kereru can feed on when few other food sources are available (e.g., kowhai, *Coprosma* spp., *Hoheria* spp. & *Plagianthus*) is also recommended.

Recommendation 4: Weed control should be planned to avoid removing exotic species that provide winter food for tui and kereru unless native plants are able to provide an alternative winter food source.

Many of the native plant species that were reproductive during the phenology surveys (e.g., *Coprosma* species, hangehange and red matipo) were usually only present within the lower vegetation tiers and thus not as accessible as those exotic species in the upper tiers. Within WCC's reserve network, exotic plant species are almost certainly an important source of food for tui and kereru. Exotic species utilised by kereru include (fruits unless stated): willow (*Salix*; leaves), elm (*Ulmus*; leaves), privet (*Ligustrum*), monkey apple (*Acmena smithii*), morning glory (*Convolvulus*), loquat (*Eriobotrya japonica*), stone fruits, citrus (leaves), gums (*Eucalyptus* spp.; leaves), elder (*Sambucus nigra*), poplar (*Populus*; leaves) and laburnum (*Laburnum anagyroids*; leaves). Exotic species utilised by tui include: bottlebrush (*Callistemon*), (*Eucalyptus*), privet, proteas (*Banksia*, *Grevillea*), monkey apple (*Acmena smithii*), *Prunus*, *Citrus* (fruit), *Acacia* (pollen), coral tree (*Erythrina*), *Azalea*, *Rhododendron* and *Hibiscus*. In particular, privet appears to provide an abundant and reliable supply of fruit for both tui and kereru.

5. References

- Barraclough, R.K. 2000. Distance sampling: a discussion document produced for the Department of Conservation. *Department of Conservation Science & Research internal report 175*. Department of Conservation, Wellington, N.Z.
- Chapman, S.; Alexander, J. 2003. *Waitakere City Biodiversity Monitoring Programme: birds, lizards and frogs*. Unpublished report for the Waitakere City Council.
- Clout, M.N.; Hay, J.R. 1989. The importance of birds as browsers, pollinators and seed dispersers in New Zealand forests. *NZ Journal of Ecology* 12: 27-32.
- Daugherty, C.H.; Gibbs, G.W.; Hitchmough, R.A. 1993. Mega-island or micro-continent? New Zealand and its fauna. *Trends in Ecology and Evolution* 8: 437-442.
- Handford, P. 2002. *Native forest monitoring: a guide for forest owners and managers*. PA Handford & Associates Ltd. PO Box 52, Paekakariki, N.Z.
- Heather, B.; Robertson, H. 1996. *The field guide to the birds of New Zealand*. Penguin Books. Auckland, New Zealand.
- Higgins, P.J.; Davies, S.J.J.F. (eds.). 1996. *Handbook of Australia, New Zealand and Antarctica birds: snipes to pigeons*. Oxford University Press. Melbourne, Australia.
- Innes, J.; Nugent, G.; Prime, K.; Spurr, E. 2004. Responses of kukupa and other birds to mammalian pest control at Motatau, Northland. *New Zealand Journal of Ecology* 28(1): 73-81.
- Molloy, J.; Bell, B.; Clout, M.; de Lange, P.; Gibbs, G.; Given, D.; Norton, D.; Smith, N.; Stephens, T. 2002. Classifying species according to threat of extinction. *Threatened Species Occasional Publication 22*. Department of Conservation, Wellington, N.Z.
- Moon, G. 2001. *New Zealand: land of birds*. New Holland Publishers, Auckland. 160 p.
- Nugent, G.; Whitford, J.; Innes, J.; Prime, K. 2002. Rapid recovery of kohekohe (*Dysoxylum spectabile*) following possum control. *New Zealand Journal of Ecology* 26: 73-79.
- Porteous, T. 1993. *Native forest restoration: a practical guide for landowners*. Queen Elizabeth the Second National Trust, New Zealand. 184 p.
- Wilson, K-J. 2004. *Flight of the huia*. Canterbury University Press, Canterbury, New Zealand.