Waitakere City Biodiversity Monitoring Programme:

1. Tui & kereru
2. Phenology

December 2003

Environmental and Resource Consultants

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Executive Summary

1. The Waitakere City Council has a commitment to undertake state of the environment monitoring and reporting. Since 1998 the Waitakere City Council has undertaken a native bird monitoring programme at urban forest remnants. 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 the 27 bird monitoring sites throughout Waitakere City.

4. The purposes of the research described in this report are: 1) to initiate a monitoring programme for tui and kereru capable of determining population densities and, in the longer-term, accurate population trends; 2) to initiate data collection to allow the monitoring of the 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.

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). Additional data (distance and bearing from transect) were collected to allow future analysis using distance sampling – the most accurate monitoring method currently available for tui and kereru.

6. Tui were present at 21 of the 27 monitoring sites. Population densities were only calculated for 16 sites because while tui were present at 5 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 10 per hectare (Karaka Park). Other sites with high tui population densities included Shona Esplanade, Lowtherhurst Reserve, Warner Park, Douglas Scenic Reserve and Waikumete Cemetery.

7. Kereru were present at only seven of the 27 monitoring sites. The density of kereru populations ranged from 0.2 per hectare to 2.5 per hectare. In descending order of kereru population density, the sites with kereru were Douglas Scenic Reserve, Lowtherhurst Reserve, Warner Park, Rahui Kahika Reserve, Claude Abel Reserve, Karaka Park and Kay Road Balefill.

8. Baseline data on the phenology of indigenous trees, shrubs and lianes were collected at the 27 bird monitoring sites. 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. The data presented in this report should be used in the planning of revegetation projects. In particular, plantings should be designed to provide kereru with food resources throughout the year.

10. It is recommended that the Waitakere City Council: a) continues the tui/kereru monitoring programme described in this report on an annual basis; b) extends the phenology research to obtain local data for all months of the year; c) initiates predator control programmes at sites where kereru are present; and d) designs revegetation plantings aimed at providing year-round food for kereru.

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1. Background

Pre-human ecological processes in New Zealand occurred in isolation from other landmasses and in the absence of non-volant terrestrial mammals (Daugherty *et al*. 1993). The resulting biota was remarkable in its taxonomic and ecological distinctiveness and diversity. New Zealand's unique avifauna 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 1997). For example, 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.

In response to increasing concerns regarding the state of the City's biodiversity, WCC voluntarily 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, whereby biodiversity issues were given a high 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 1998. 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 abundance (Chapman and Alexander 2003). The monitoring was unable to accurately determine the extent or cause of kereru decline because the method used (five-minute bird counts) was only capable of indicating possible trends in the conspicuousness of birds. To investigate the density and trends of kereru populations the WCC has initiated a more thorough monitoring programme. Tuis were also included in the monitoring programme because, like kereru, they play a major role in ecological process such as pollination and seed dispersal. Furthermore, the tui is one of the only indigenous bird species the general public are likely to encounter. 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 baseline data on the density of tui and kereru populations at the WCC's network of 27 bird monitoring sites (Figure 1). Also included are the results of preliminary research on the phenology (timing of flowering and fruiting) of native trees, shrubs and lianes at the 27 monitoring sites. The collection of phenology data is important because the information indicates the availability of food for tui and kereru. Furthermore, information on phenology is an important management tool for the planning and implementation of ecological restoration initiatives.

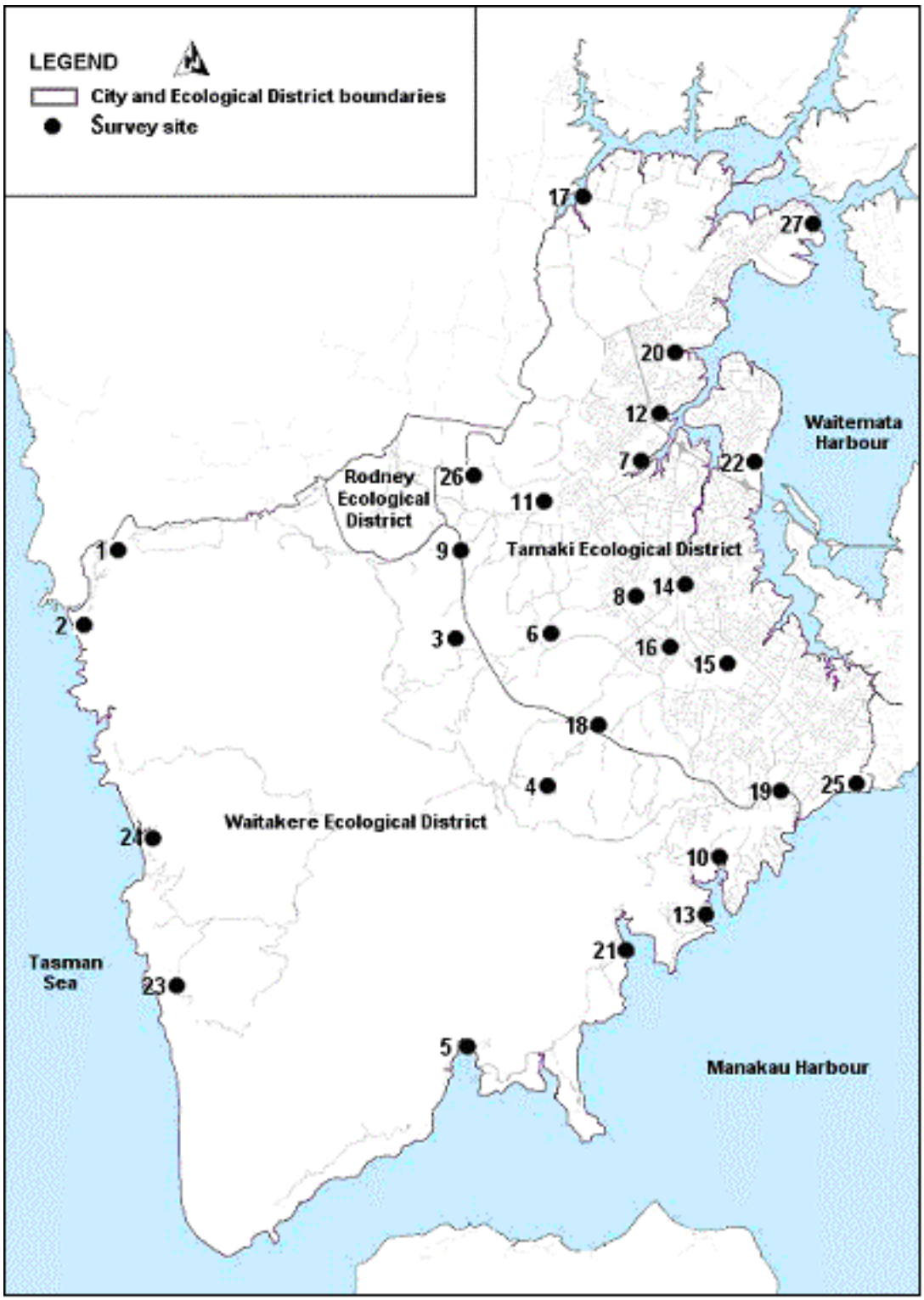

Figure 1. Location of bird and phenology survey sites in Waitakere City (2003). (See Table 1 for site names)

2. Tui and Kereru

2.1 Introduction

The Waitakere City Council (WCC) has monitored bird populations in Waitakere City since 1998 (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 (*Hemiphaga novaeseelandiae*; NZ pigeon). Along with tui (*Prosthemandera novaeseelandiae*), 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 and 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.

2.2 Methods

Tui and kereru populations were surveyed at 27 sites spread throughout Waitakere City during spring 2003. The sites were those where 5-minute bird counts were undertaken during the summer of 2002/3 by Chapman and Alexander (2003). All of the sites were WCC reserves except for the Auckland University owned site at Tram Valley Road, Swanson.

Forest bird variable-length transects (Handford 2002) were used to estimate the density of tui and kereru populations at the survey sites. Transects were between 100 m and 500 m in length depending on the area of the survey site. 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. A hand-held GPS unit was used to measure the length of transects and to determine the distance of tui/kereru sightings along transects. 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.

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 September and a second round was undertaken during October. Surveys were not be made 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

Tuis were present at 21 of the 27 monitoring sites (Table 1). Population densities were only calculated for 16 sites because while tui were present at 5 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 10 per hectare (Karaka Park) (Table 2). Other sites with high tui population densities included Shona Esplanade, Lowtherhurst Reserve, Warner Park, Douglas Scenic Reserve and Waikumete Cemetery (Table 2).

Kereru were present at only seven of the 27 monitoring sites (Table 1). The density of kereru populations ranged from 0.2 per hectare to 2.5 per hectare. In descending order of kereru population density, the sites with kereru were Douglas Scenic Reserve, Lowtherhurst Reserve, Warner Park, Rahui Kahika Reserve, Claude Abel Reserve, Karaka Park and Kay Road Balefill (Table 2).

Table 1. Transect lengths, areas, and the presence / absence of tui and kereru at 27 bird monitoring sites during 2003.

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

*Indicates sites where tui and kereru were recorded during the 5-minute bird count conducted during summer 02/03 (Chapman and Alexander 2003)

Table 2: Tui and kereru population densities at sites where tui and / or kereru were present (September-October 2003).

Site name	Site no.	Area (Ha)	Tui/Ha	Kereru/Ha
Douglas Scenic Reserve	4	0.4	5.0	2.5
Henderson Valley Scenic Reserve	6	2.0	1.5	0.0
Chorley Reserve	7	0.4	1.3	0.0
Shona Esplanade	8	2.0	1.8	0.0
Lowtherhurst Reserve	12	1.2	2.1	0.2
Warner Park	13	0.6	3.3	0.8
Waikumete Cemetery	15	0.4	5.0	0.0
Oratia Esplanade	16	1.2	0.8	0.0
Brigham Creek Reserve	17	0.4	1.3	0.0
Rahui Kahika Reserve	19	2.0	1.0	0.4
Moire Park	20	2.0	0.5	0.0
Takaranga Reserve	21	1.2	1.3	0.0
Karekare Beach	23	0.6	0.8	0.0
Claude Abel Reserve	24	0.4	1.3	2.5
Karaka Park	25	0.4	10.0	0.3
Kay Road Balefill	26	2.0	0.3	0.5

3. Phenology

3.1 Introduction

The phenology (timing of flowering and fruiting) of native trees, shrubs and lianes is an important factor in the availability of food for tui and kereru. Concern over possible declines in kereru abundance in Waitakere City prompted the WCC to initiate research into tui and kereru population densities. Given the importance of year-round availability of fruits and flowers for the persistence of kereru populations, and the potential to use phenological information in the planning and implementation of ecological restoration initiatives, the WCC also implemented a data collection project aimed at determining the phenology of indigenous vegetation in their reserve network. This chapter presents baseline phenological data collected at the WCC's 27 bird monitoring sites during September and October 2003.

3.2 Methods

Rapid assessment vegetation surveys were undertaken during September and October 2003 at 27 sites throughout Waitakere City. 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, Handford (2002), and Porteous (1993).

The structure and composition of the vegetation was described by estimating the relative abundance of each species present in each tier of the vegetation (seedling/groundcover, sapling, shrub, subcanopy, canopy and emergent) using the following scale: 1 = rare, 2 = occasional, 3 = common, 4 = very common and 5 = dominant.

3.3 Results

A wide range of indigenous trees, shrubs and lianes were recorded at the 27 monitoring sites. Few species bear flowers or fruit during the colder months, especially from May to September (Table 3). 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 4 & 5). 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 4 & 5). The only exception to this was kowhai (*Sophora* spp.), which was flowering at every site it was recorded (Tables 4 & 5). 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 4 & 5).

Table 3: Phenology of indigenous trees, shrubs and lianes recorded across the network of monitoring sites

Plant List - Flowering / fruiting	Common name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Agathis australis	Kauri												
Alectryon excelsus	Titoki												
Alseuosmia macrophylla													
Avicennia marina	Mangrove												
Beilschmiedia tawa	Tawa												
Brachyglottis repanda	Rangiora												
Caropdetus serratus	Putaputaweta												
Cassinia leptophylla	Tauhinu												
Coprosma areolata													
Coprosma crassifolia													
Coprosma grandiflora													
Coprosma lucida													
Coprosma macrocarpa													
Coprosma repens													
Coprosma rhamnoides													
Coprosma robusta													
Cordyline australis	Cabbage tree												
Cordyline banksii													
Coriaria arborea	Tutu												
Corynocarpus laevigatus	Karaka												
Cortaderia spp.	Toetoe												
Cyathodes juniperina	Mingimingi												
Dacrycarpus dacrydioides	Kahikatea												
Dacrydium cupressinum	Rimu												
Dysoxylum spectabile	Kohekohe												
Elaeocarpus dentatus	Hinau												
Entelea arborescens	Whau												
Freycinetia baueriana	Kiekie												
Fuchsia excorticata	Fuchsia												
Geniostorna rupestre	Hangehange												
Griselinia littoralis													
Griselinia lucida	Puka												
Hebe spp.													
Hedycarya arborea	Pigeonwood												
Hoheria populnea	Lacebark												

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 3 (continued): Phenology of indigenous trees, shrubs and lianes recorded across the network of monitoring sites.

Plant List - Flowering / fruiting	Common name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Knightia excelsa	Rewarewa			F	F	F	F			L	L	L	L
Kunzea ericodes	Kanuka	L	L	F	F	F							
Leptospernum scoparium	Manuka			F	F	F				L	L	L	L
Leucopogon fasciculatus	Mingimingi									L	L	F	F
Macropiper excelsum	Kawakawa	F	F							L	L	L	F
Melicope ternata	Wharangi	F	F	F						L	L	L	L
Melicytus ramiflorus	Mahoe	F	F	F						L	L	L	L
Metrosideros excelsus	Pohutakawa	L	L	F	F	F							L
Metrosideros lianes		L	L	L	F	F							L
Meulenbeckia complexa		F	F	F									L
Myoporum laetum	Ngaio	L	F	F	F							L	L
Myrsine australis	Red matipo	F	F	F	F							L	L
Nestegis lanceolata	White marie	F	F	F							L	L	F
Nothofagus truncata	Hard Beech	F									L	L	L
Olearia spp.		F	F							L	L	L	F
Phormium tenax	Harakeke	L	F	F	F							L	L
Phormium cookianum	Whararikí	L	F	F	F							L	L
Phyllocladus trichomanoides	Celery Pine			F	F						L	L	
Pittosporum crassifolium	Karo		F	F	F					L	L	L	L
Pittosporum eugenioides	Tarata			F	F	F					L	L	L
Pittosporum tenuifolium	Kohuhu	L	F	F	F	F					L	L	L
Plagianthus divaricatus	Ribbonwood	F	F	F	F							L	L
Pomaderris kumeraho		F								L	L	L	F
Podocarpus totara	Totara			F	F						L	L	
Prumnopitys ferruginea	Miro			F	F	F	F					L	
Prumnopitys taxifolia	Matai		F	F	F	F					L		
Pseudopanax arboreus	Five finger	F	F	F				L	L	L	F	F	F
Pseudopanax crassifolius	Lancewood		L	L			F	F	F				
Pseudopanax lessonii	Houpara	L	L						F	F	F		
Ripogonum scandens	Supplejack					F	F	F					
Rhopalostylus sapida	Nikau	FL	FL	FL	FL	FL	FL	FL	FL	FL	FL	FL	FL
Schefflera digitata	Pate		L	L		F	F	F					
Sophora chathmanica	Kowhai	F	F	F	F					L	L	L	F
Sophora microphylla	Kowhai	F	F	F	F					L	L	L	F
Sophora fulvida	Kowhai	F	F	F	F					L	L	L	F
Spinifex sericeus		F											
Streblus heterophyllus	Turepo	F	F									L	L
Toronia toru					F	F					L	L	
Vitex lucens	Puriri	FL	FL	FL	FL	FL	FL	FL	FL	FL	FL	FL	FL
Weinmannia silvicola						F	F	F	F	F			

Key: F = fruiting; L = flowering; FL = 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 4: The distribution and flowering / fruiting of known plant food sources for tui at 27 Waitakere City bird monitoring sites during September and October 2003 (Source of tui diet data: Handford 2002).

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																											
Alseuosmia spp.																											
Beilschmiedia spp.																											
Cordyline spp.																											
Dysoxylum spectabile																											
Elaeocarpus dentatus																											
Fuchsia excorticata																											
Geniostoma rupestre																											
Knightia excelsa																											
Metrosideros spp.																											
Myoporum spp.																											
Phormium spp.																											
Pittosporum spp.																											
Pseudopanax spp.																											
Sophora spp.																											
Vitex lucens																											
Fruits																											
Alectryon excelsus																											
Carpodetus serratus																											
Coprosma grandifolia																											
Coprosma lucida																											
Coprosma robusta																											
Dacrycarpus dacrydioides																											
Hedycarya arborea																											
Macropiper excelsum																											
Melicytus spp.																											
Muehlenbeckia australis																											
Prumnopitys ferruginea																											
Prumnopitys taxifolia																											
Pseudopanax arboreus																											
Pseudopanax crassifolius																											
Ripogonum scandens																											
Schefflera digitata																											

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

Table 5: The distribution and flowering / fruiting of known plant food sources for kereru at 27 Waitakere City bird monitoring sites during September and October 2003 (Source of kereru diet data: Handford 2002).

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																											
Aristotelia serrata																											
Fuchsia excorticata																											
Sophora spp.																											
Fruits																											
Alectryon excelsus																											
Aristotellia serrata																											
Beilschmiedia tarairi																											
Beilschmiedia tawa																											
Coprosma grandifolia																											
Coprosma lucida																											
Coprosma robusta																											
Corynocarpus laevigatus																											
Dacrycarpus dacrydioides																											
Dacrydium cupressinum																											
Dysoxylum spectabile																											
Fuchsia excorticata																											
Geniostoma rupestre																											
Griselinia spp.																											
Hedycarya arborea																											
Macropiper excelsum																											
Melicytus spp.																											
Myrsine australis																											
Prumnopitys ferruginea																											
Prumnopitys taxifolia																											
Pseudopanax crassifolius																											
Rhopalostylis sapida																											
Ripogonum scandens																											
Schefflera digitata																											
Syzygium maire																											
Vitex lucens																											

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

4. Discussion and Recommendations

4.1 Summary and Relevance of Findings

4.1.1 Tui and Kereru

Since 1998 the WCC has conducted annual monitoring of bird populations in Waitakere City using five-minute bird counts (Chapman & Alexander 2003). Five-minute counts are used extensively throughout New Zealand and are a useful bird monitoring technique because they measure an index of overall abundance (Dawson & Bull 1975). Annual five-minute counts in Waitakere City indicated that tui and kereru conspicuousness had decreased at all monitoring sites (Chapman & Alexander 2003). Given the ecological importance of tui and kereru in Waitakere City, it was necessary to obtain accurate information about their population densities and trends. The distance sampling method was employed in this study because it allows estimation and monitoring of absolute population densities (Barraclough 2000). Other agencies (e.g., ARC, DOC) also utilise distance sampling to monitor bird populations (T. Lovegrove, ARC, pers. comm.). Powlesland *et al.* (2003) recommended that distance sampling should be used to monitor kereru populations to ensure numbers do not decline to such a critically low level that local extinction is inevitable.

The primary outcome of this study is a baseline dataset of tui and kereru population densities at 27 sites throughout Waitakere City. Valid distance sampling analyses of the data will not be possible until further surveys have been conducted. However, preliminary population densities were estimated by only including sightings within 20 metres of transects and calculating the number of tui and kereru per hectare surveyed. While only preliminary results, the densities presented in this report do provide an indication of tui and kereru population densities at the time of sampling. Compared with kereru, tuis are more widespread and abundant therefore the main focus of the remainder of this discussion is on kereru.

4.1.2 Phenology

The results of the phenology survey provide a solid baseline upon which subsequent surveys can advance. Apart from the September and October observations, the phenology dataset was almost entirely obtained from unpublished personal observations and observations published in the literature. Few published phenology observations relate specifically to Waitakere City, or even the Auckland Region.

Certain native plant species are erratic in their flowering and fruiting patterns (Simpson 1992). For example, rimu and beech species produce viable seed infrequently (once every 5 to 16 years). Some species produce few seeds one year and a heavy crop the next (e.g., pigeonwood) whereas other species produce large volumes of seed every year (e.g., *Coprosma robusta*). The time of year in which native plants produce seed varies geographically for some species (e.g., tawa, taraire and karaka) but not for others (e.g., kohekohe and kahikatea). The reasons for these variations are not well understood in most cases (Simpson 1992). Despite the complex variations, an understanding of native plant phenology is essential when attempting to provide year-round food resources for native birds. As there is considerable variation in plant phenology it is necessary to extend the phenology surveys to obtain local phenology data for all months of the year.

4.2 Kereru Ecology and Management

Kereru are absolutely critical to sustaining the ecological health of Waitakere City's mixed podocarp-broadleaf forests. Kereru disperse over 70 plant species and are the only remaining species capable of dispersing fruits greater than 12mm in diameter. As such, the dispersal of karaka, tawa, taraire and puriri is totally dependent on the presence of kereru (Mander *et al.* 1998). Kereru were present at only seven of the 27 monitoring sites and their presence indicates that the seven sites are probably also important habitats for other forest-dwelling bird species (e.g., fantail & grey warbler). The absence or low population density of tui and / or kereru does not necessarily indicate poor habitat quality. For example, coastal and wetland sites may provide significant habitat for other indigenous bird species. The research described in this report has established a baseline upon which future monitoring can build. Questions about trends in tui / kereru population densities and the role of plant phenology in population trends can only be answered when the results of future monitoring are compared with the results of the present study.

While kereru can survive for several months on a diet of leaves and buds, they usually only breed when ample fruit is available. Limited fruit availability results in little breeding and a shortened breeding season (Mander *et al.* 1998). In fact, studies undertaken in the Whirinaki, Central North Island, Nelson and Hawkes Bay have shown that Kereru nesting strongly coincides with mast fruiting of podocarps (e.g., Powlesland *et al.* 2003; Clout *et al.* 1995). Exotic plant species are likely to be an important component of kereru diet, especially in urban areas. Research on urban kereru on Auckland's North Shore found that exotic plant species such as privet, morning glory, and monkey apple comprised 40-60% of kereru diet (May 2000). As these species fruit during winter, they may provide urban kereru populations with year round food.

In Waitakere City, tui, and to a lesser extent kereru, utilise food resources in urban and semi-urban areas (Clout & Craig 1995). Such resources are probably very important at times when high-energy foods are rare or unavailable in native forest. However, individuals in urban areas probably face an increased risk of window strike, vehicle collision and predation (Mander *et al.* 1998). This strengthens the argument for providing a year-round food supply in forest fragments thereby reducing the need for kereru to seek food resources elsewhere.

Kereru have a low reproductive rate (one egg per clutch and not breeding yearly) and a potential lifespan of 20-30 years. However, without predator control few nesting attempts are likely to be successful. Studies at five mainland sites suggested that nesting success varied from 0 to 22% (Powlesland *et al.* 2003). At mainland sites the mean life expectancy of Kereru ranges from 1.2 years (Whangarei, Northland) to 5.5 years (Wenderholm, North Auckland) (Clout *et al.* 1995; Pierce & Graham 1995). However, reducing possum and rat populations to low densities can dramatically enhance Kereru nesting success. For example, pest control increased kereru nesting success from 0 to 100% at Motatau (Innes *et al.* 2003) and from 0 to 45% at Wenderholm (Clout *et al.* 1995). Carefully planned and implemented pest control measures can deliver similar results in Waitakere City.

4.3 Management Options

There are four categories of management options available to WCC to halt and reverse the decline of kereru and tui populations:

1. Predator control to enhance survival and breeding success

A combination of predator management and revegetation using known kereru food plant species may be required before kereru populations are able to flourish. Without a predator management programme, predation may continue to limit kereru (and other indigenous birds) population densities below the limits governed by food and nest site availability. Similarly, as kereru breeding success is highly correlated to food availability, predator management alone may not lead to the recovery of kereru populations.

To increase the productivity of kereru and tui, we strongly recommend that the WCC, in partnership with local communities, undertake pest control of mammalian predators during the birds entire breeding season (November-March), at the following sites:

- Manukau Harbour foreshore reserves (especially Karaka and Warner Park)
- Rahui Kahika Reserve
- Lowtherhurst Reserve
- Kay Road Balefill
- Opanuku and Oratia Stream corridors (especially Shona Esplanade)

2. Revegetation and habitat protection to provide food and nest sites

Revegetation planting aimed at providing food and nest sites for kereru and tui should consist largely of the following:

- Fast growing trees to provide nesting sites in the medium term (e.g., kanuka)
- Species that provide nectar and / or fleshy fruits at important times of the year (e.g., kowhai and pigeonwood usually produce many flowers and fruits respectively at the start of the breeding season)
- Species that flower and / or fruit throughout the year (e.g., puriri and nikau)
- Species with foliage that kereru can feed on when few other food sources are available (e.g., lacebark).
- Species (e.g., puriri) that provide both nest sites and a year-round high-quality food source should feature strongly in revegetation projects.

3. Education and advocacy to reduce indigenous bird mortality resulting from window strike, vehicle collisions, and predation by domestic pets

4. Continue and extend the biodiversity monitoring programme and the phenology monitoring

To date, the WCC bird-monitoring programme has enabled an assessment of the population trends of relatively common species (Chapman and Alexander

2003). However, as the research has indicated that declines in tui and kereru populations are ongoing, the situation for uncommon, coastal or wetland species is uncertain and may be perilous. Thus it is absolutely critical that the WCC invites and facilitates the involvement of the Auckland Regional Council and the Department of Conservation in the Waitakere City Biodiversity Monitoring Programme. This is necessary to address the gaps in the information on the state of the City's biodiversity. For example, the conservation status of bird species present in the Waitakere Ranges is largely inferred from fieldwork undertaken for the Waitakere Ranges Protected Natural Areas Programme prior to 1989. In addition, the fieldwork undertaken for the northwestern portion of Tamaki Ecological District Protected Natural Areas Programme only involved limited presence/absence rapid assessment surveys rather than the monitoring required to assess population trends of threatened species (Denyer *et al*. 1993; Julian *et al*. 1998; Table 6).

Table 6. Threatened birds of Waitakere City.

Common name	Scientific name	Status*	Source
Australasian bittern	*Botaurus poiciloptilus*	V	Denyer *et al*. (1993)
Banded dotterel	*Charadrius bicinctus bicinctus*	V	Slaven (1989)
Banded rail	*Rallus philippensis assimilis*	V	Denyer *et al*. (1993)
Blue penguin	*Eudyptula minor*	UW	Denyer *et al*. (1993)
Caspian tern	*Sterna caspia*	V	Slaven (1989)
Grey duck	*Anas superciliosa superciliosa*	UW	WCC (2001)
Grey faced petrel	*Pterodroma macroptera gouldi*	UW	Denyer *et al*. (1993)
Marsh crake	*Porzana pusilla affinis*	V	Denyer *et al*. (1993)
N.Z. dotterel	*Charadrius obscurus*	V	Slaven (1989)
N.Z. falcon	*Falco novaeseelandiae*	V	Slaven (1989)
N.Z. pigeon	*Hemiphaga novaeseelandiae novaeseelandiae*	V	Julian *et al*. (1998)
N.Z. pipit	*Anthus novaeseelandiae novaeseelandiae*	UW	Denyer *et al*. (1993)
North Island fernbird	*Bowdleria punctata vealeae*	V	Denyer *et al*. (1993)
North Island kaka	*Nestor meridionalis septentrionalis*	V	Denyer *et al*. (1993)
Reef heron	*Egretta scara sacra*	V	Slaven (1989)
Shinning cuckoo	*Chrysococcyx lucidus lucidus*	UW	Denyer *et al*. (1993)
Sooty shearwater	*Puffinus griseus*	UW	Denyer *et al*. (1993)
Spotless crake	*Porzana tabuensis*	V	Denyer *et al*. (1993)
Spotted shag	*Stictocarbo punctatus punctatus*	UW	WRPS (1978)
Tomtit	*Petroica macrocephala toitoi*	UW	Denyer *et al*. (1993)
Variable oystercatcher	*Haematopus unicolour*	R	Slaven (1989)
White faced heron	*Ardea novaehollandiae novaehollandiae*	UW	Denyer *et al*. (1993)
White heron	*Egretta alba modesta*	E	Slaven (1989)

*Key: V = vulnerable; UW = uncommon in Waitakere City; R = rare; E = endangered

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.

Chapman, S.; Alexander, J. 2003. Waitakere City Biodiversity Monitoring Programme: birds, lizards and frogs. Unpublished report for the Waitakere City Council.

Clout, M.; Craig, J. 1998. Restoration for vertebrates. Restoring the health & wealth of ecosystems: A Conference on Ecological Restoration in New Zealand. Unpublished proceedings of conference held at Christchurch, New Zealand, 28-30 September 1998.

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.

Clout, M.N.; Karl, B.J.; Pierce, R.J.; Robertson, H.A. 1995. Breeding and survival of New Zealand pigeons *Hemiphaga novaeseelandiae. Ibis 137*: 264-271.

Dawson, D.G.; Bull, P.C. 1975. Counting birds in New Zealand forests. *Notornis 22*: 101–109.

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.

Denyer, K.; Cutting, M.; Campbell, G.; Green, C.; Hilton, M. 1993. *Waitakere ecological district: survey report for the protected natural areas programme*. Auckland Regional Council, Auckland.

Handford, P. 2002. *Native forest monitoring: a guide for forest owners and managers*. PA Handford & Associates Ltd. PO Box 52, Paekakariki, N.Z.

Innes, J.; Nugent, G.; Prime, K.; Spurr, E. 2003. Responses of kukupa and other birds to mammalian pest control at Motatau, Northland. *New Zealand Journal of Ecology* (in press).

Julian, A.; Davis, A.; Tyrrell, M. 1998. Draft report: ecological survey of Waitakere City lowlands: northwestern portion of Tamaki Ecological District. Unpublished Waitakere City Council report.

Mander, C. J.; Hay. R.; Powlesland, R. 1998. Monitoring and management of kereru (*Hemiphaga novaeseelandiae*). Department of Conservation technical series no. 15.

May, S. 2000. Findings from the urban kereru project, North Shore, Auckland. Unpublished report, School of Environmental and Marine Science, University of Auckland.

Moon, G. 2001. *New Zealand: land of birds*. New Holland Publishers, Auckland. 160 p.

Pierce, R.J.; Graham, P.J. 1995. *Ecology and breeding biology of kukupa (*Hemiphaga novaeseelandiae*) in Northland*. Science & Research Series No. 91. Department of Conservation, Wellington, N.Z.

Porteous, T. 1993. *Native forest restoration: a practical guide for landowners*. Queen Elizabeth the Second National Trust, New Zealand. 184 p.

Powlesland, R.G.; Wills, D.E.; August, A.C.L.; August, C.K. 2003. Effects of a 1080 operation on kaka and kereru survival and nesting success, Whirinaki Forest Park. *New Zealand Journal of Ecology 27(2)*: 125- 137.

Simpson, P. 1992. Sustaining genetic integrity through restoration using local plant provenances. Pages 336-346 in Proceedings of the International Conference on Sustainable Land Management. Hawkes Bay Regional Council, Napier

Slaven, O.C. 1989. Wildlife report for the Protected Natural Areas programme. Unpublished Auckland Regional Council report.

Waitakere City Council. 2001. *State of the city report*. Waitakere City Council. Waitakere City, New Zealand.

Waitakere Ranges Protection Society. 1978. Wainamu-Te Henga: a study. Unpublished report. Waitakere Ranges Protection Society.

Wilson, K-J. 1997. Extinct and introduced invertebrate species in New Zealand: a loss of biodistinctiveness and gain in biodiversity. *Pacific Conservation Biology 3*: 301-305.

6. Appendices

Appendix. Bird monitoring datasheet

Site name: _____ Grid reference: _____ GPS location: _____

Date: _____ Start Time: _____ Observers: _____ Day (circle): 1 2 3 4 5

Conditions:

Temperature (C): _____ Wind (0-6): _____ Precipitation (0-5): _____ Clouds (0-100%): _____ Noise (0-3): _____

Habitat description:

Station	Species	No.	DT	Sex	Age	Flock Size	Prev. Count	# Fly Over	Comments

Bird counts: Categories, Definitions and Descriptions

Sex: Record the sex (Male, Female, or Unknown) of the bird wherever possible.
Age: Record the age category (Adult, Juvenile, or Unknown) of the bird wherever possible.

Flock Size: For most species, each individual bird will be treated independently as a separate observation, but for species that usually occur in clusters or flocks, the appropriate unit is the cluster or flock, and not the individual bird.

Flyover: The number of birds of a particular species that fly above the top of the vegetation canopy, and do not appear to be foraging, displaying, or behaving in any other way that might suggest a link to the habitat below them.

Prev. Plot: (Previous Plot?) Place an X in this column if it is thought that the bird was already detected during a previous count during the same sampling period.

Clouds (0-100): Record percent cloud cover, rounded off to the nearest 10 percent. This should be a number between 0 (no clouds) and 100 (complete overcast).

Temp (°C)	Explanation
1	0-5, cold
2	5-11, cool
3	11-16, mild
4	16-22, warm
5	>22, hot

Wind Code	Explanation
0	calm (< 2 km/h)
1	smoke drifts (2-5 km/h)
2	light breeze felt on face, leaves rustle (6-12 km/h)

3	leaves and twigs in constant motion (13-19 km/h)
4	small branches move, raises loose paper, dust rises (20-29 km/h)
5	fresh breeze, small trees sway (30-39 km/h)
6	strong breeze, large branches moving, wind whistling (40-50 km/h)

Precip. Code	**Explanation**
0	no rain
1	mist or fog, dripping foliage
2	light drizzle
3	light rain
4	heavy rain; difficult to hear birds

Noise Code	**Explanation**
0	quiet; normal background noises; no interference
1	low noise; might be missing some high-pitched songs/calls of distant birds
2	medium noise; detection radius is probably substantially reduced
3	high noise; probably detecting only the loudest/closest birds

DT Code	**Explanation**
1	heard first, but not seen (i.e., detected initially by sound) during the 5-min count
2	seen first (regardless of whether it was later heard or not) during the 5-min count
3	heard first, but then seen (a DT of 1 can be changed to a 4) during the 5-min count
4	heard, but not during the 5-minute sampling period
5	seen, but not during the 5-minute sampling period

Appendix. Phenology data form

Waitakere City vegetation phenology data form

Site name: _____

Site number: _____ **Date:** _____

Codes

Frequency (Freq.)	0=none	1=few	2=some	3=many
Flowers/fruits age (Age)		1=immature	2=mature	3=shed
Proportion (Prop.)	0=none	1=some	2=most	3=all

Species	Flower Buds			Flowers			Fruits		
	Freq.	Age	Prop.	Freq.	Age	Prop.	Freq.	Age	Prop.

Notes:

Frequency (Freq.) is an estimate of the relative abundance of each reproductive stage
Age is the estimated age of the reproductive stages
Proportion (Prop.) is the estimated proportion of individuals of the species flowering and / or fruiting
***All estimates are averaged for the transect**

Appendix. Glossary

Biodiversity	The variability among living organisms and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.
Community	All the groups of organisms living together in the same area, usually interacting or depending on each other for existence.
Ecological restoration	The active intervention and management of degraded biotic communities, landforms and landscapes in order to restore biological character, ecological and physical processes and their cultural and visual qualities.
Ecological services	Activities of a species that benefit other species or the biological community as a whole.
Ecology	The study of organisms in relation to one another and their surroundings.
Ecosystem	An interacting system of living and non-living parts such as sunlight, air, water, minerals and nutrients. Ecosystems can be small and short-lived, for example, water-filled tree holes or rotting logs on a forest floor, or large and long-lived such as forests or lakes.
Ecosystem resilience	The ability of an ecosystem to respond and adapt to external environmental stresses.
Endangered species	Any species that is in danger of extinction throughout all or a significant portion of its range.
Endemic species	An indigenous species which breeds only within a specified region or locality and is unique to that area.
Habitat	The place where an organism naturally occurs.
Healthy ecosystem	An ecosystem that is stable and sustainable, maintaining its organisation and autonomy over time and its resilience to stress.
Indigenous species (or native)	A plant or animal species which occurs naturally in New Zealand.
Megafauna	Large or relatively large animals with charisma.
Monitoring	To systematically and repeatedly measure conditions in order to track changes.
Rare species	Species with small world populations that are not at present endangered or vulnerable but are at risk.

Specialist species	A species that can survive only under a very narrow range of environmental conditions or habitats
Species	A population of individuals that are more or less alike, and that are able to breed and produce fertile offspring under natural conditions.
Survey	Systematically observing, counting or measuring characteristics at a defined location over a defined period of time.
Sustainable Management	Managing the use, development, and protection of natural and physical resources in a way or at a rate which enables people and communities to provide for their social, economic and cultural well-being and for their health and safety while (a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations, (b) safe-guarding the life-supporting capacity of air, water, soil, and ecosystems, and (c) avoiding, remedying, or mitigating any adverse effects of activities on the environment. *Resource Management Act 1991*
Threatened species	A term used to include rare, vulnerable, endangered and species of unknown conservation status.
Vulnerable species	A species that is likely to become endangered unless the circumstances and factors threatening its abundance, survival or evolution cease.

Note: Most of these definitions are adapted from the New Zealand Biodiversity Strategy

Appendix.

CD-Rom containing the following:

- Alexander, J.; Chapman, S. 2003. Waitakere City Biodiversity Monitoring Programme: 1) Tui & Kereru, 2) Phenology. Unpublished report for the Waitakere City Council. (PDF and Microsoft Word formats)

- Tui and kereru transect raw data (2003) (Microsoft Excel format)

- Phenology transect raw data (2003) (Microsoft Excel format)