ECOLOGICAL CORRIDORS

Facilitating the movement of native species throughout the Eastern Bays and beyond

By **Kerry Lukies** on behalf of the Eastern Bays Songbird Project

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Eastern Bays Songbird Project

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New Zealand pigeon / kererū. Photo by Shaun Lee.

Executive summary

The Auckland Council commissioned this research report to identify strategic revegetation sites in the Eastern Bays in order to increase indigenous forest cover, improve the long-term viability of current ecosystems and restore ecological corridors to enable movement of native species throughout the Eastern Bays. While written as an ecological report, it aims to be accessible to a range of readers with little scientific knowledge. The report focussed on private land and transport corridors as both public and Māori land in the Eastern Bays already have comprehensive revegetation strategies in place.

The biodiversity decline driven by habitat loss and introduced mammalian predators results in many native birds, insects and reptiles being confined to pest-free offshore islands, such as those in Auckland's Hauraki Gulf. The pest control efforts by the Eastern Bays Songbird Project suggests that the Eastern Bays can become a safe landing area for native birds returning to mainland Auckland from these pest-free islands. While large areas of green space in the Eastern Bays provide some habitat for native species, ecological corridors between these forested fragments will increase the overall size of available habitat and ensure that birds, along with reptiles and insects, can migrate, disperse and repopulate areas not otherwise used. Reconstructing native habitat through increased planting and establishing connectivity between habitat patches ensures that native species can move freely through modified urban ecosystems such as the Eastern Bays.

Methods used in this report included interviews with members of the local community, consultations with ecologists and desk-based research to determine which native species would be most suitable for the Eastern Bays, how existing forest fragments and corridors could be enhanced, and where new ecological corridors would be most appropriate. Existing forest fragments and corridors, along with proposed corridors for revegetation were outlined on maps of the Eastern Bays Songbird Project zone.

Retaining existing vegetation, removing weeds and competitive exotics and increasing canopy cover on both public and private land were identified as key measures to increase and enhance habitat for native biodiversity in the Eastern Bays. A diverse assemblage of native groundcovers, shrubs and trees were suggested for revegetating backyards and transport corridors in key zones as defined in this report. Enhancing transport corridors and backyards with native vegetation would significantly increase indigenous forest cover, enhance connectivity between forest fragments and help to create a pest-free urban sanctuary where populations of native species can flourish. Revegetation efforts in the Eastern Bays would also be a critical step towards facilitating the movement of biodiversity throughout the area and the wider Auckland region.

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Urban forest fragment (Pamela Place, Kohimarama). Image from Land Information New Zealand.

Introduction

Biodiversity in New Zealand's urban forest fragments

Over time New Zealand's indigenous forested ecosystems have been altered by habitat clearance for agriculture and urban development and browsing by introduced mammals [1]. The combined impacts of habitat loss, fragmentation, and predation by introduced mammalian predators have had negative ramifications for many native species with 90% of New Zealand's birds now considered threatened or at risk [2]. New Zealand's endemic species evolved in the absence of mammals (except bats), and thus many lack strategies to avoid predation. Rats, mustelids, possums, hedgehogs and cats can decimate populations of native species in New Zealand, thus many of our birds, invertebrates and reptiles are confined to pest-free offshore islands and mainland predator-free sanctuaries [3].

Restoring indigenous ecosystems throughout New Zealand is key to halting the decline of biodiversity and a minimum coverage of 10% of native forest is required to provide habitat for species in urban areas [4]. In general, there is higher bird species richness in urban areas with greater vegetation cover [5], but protecting and enhancing existing forest fragments, though crucial, will not be enough to fully restore the biodiversity that has disappeared from these areas. Restoring native fauna in urban areas requires the reconstruction and increase of native ecosystems such as forests. Reconstructing native habitat through increased planting and establishing connectivity between habitat patches ensures that native species can move freely through modified urban ecosystems [2]. Forest fragments in Auckland range from 1 - 17,000 ha (Hunua Ranges) with most forest fragments in urban Auckland <10 ha [6]. In the context of this report, the term 'forest' encompasses both old-growth and regenerating forest.

Ecological corridors to connect forest fragments

Ecological corridors are areas of similar natural habitat that are connected within an inhospitable matrix [7]. Forest fragments may be connected by hedgerow 'corridors' through a matrix of agricultural land, or they may be ponds connected via waterway corridors through a terrestrial matrix. Corridors are often continuous and linear but may be fragmented, like steppingstones. Corridors are often situated alongside existing landscape features such as rivers, streams, field boundaries, roads and railways [8, 9] and can be multipurpose, often incorporating spaces for wildlife, human recreation and environmental processes [10]. Ensuring connectivity between fragmented green spaces in urban areas is not a new concept and has been utilised in European urban planning since the end of the nineteenth century [10].

How do ecological corridors benefit wildlife?

Through human-induced landscape change, wildlife in urban environments have been constricted to small and fragmented habitat patches with limited dispersal which can result in genetic bottlenecks and local extinction [8, 10]. Corridors between large habitat patches can significantly increase the movement of certain species by around 50% [7] enabling migration, dispersal and the repopulation of empty patches by wildlife [11], in addition to increasing the overall size of available habitat [12]. Connectivity promotes gene flow, decreases local extinction rates and increases plant dispersal (Kline & Cahoon, 2010). Ecological corridors not only facilitate the movement of native species but also of pest plants and animals, thus care must be taken to incorporate pest management into corridor design and implementation [8, 11].

Other benefits of ecological corridors

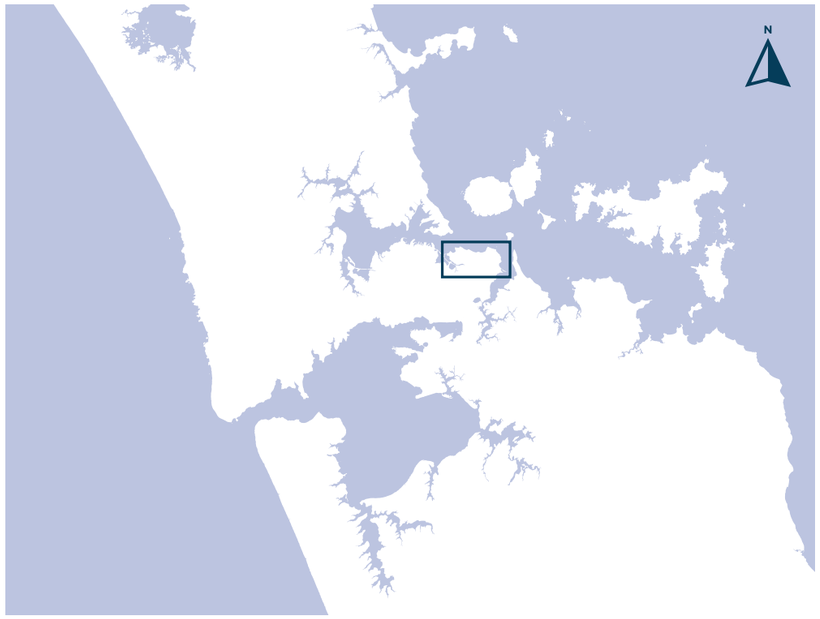
Green spaces such as forest fragments and corridors in urban environments are not only beneficial for ecological reasons but for social and cultural reasons too. Spending time in green space has been shown to improve both mental and physical health [13] and in New Zealand, greener neighbourhoods have been associated with a decreased risk of poor mental health and cardiovascular disease [14]. Vegetation in urban environments also enhances the connection between people and nature [15]. This connection is increasingly important in cities undergoing rapid population growth where green space is limited. Additional benefits of green spaces in urban areas include enhanced scenery, increased property values and the provision of alternative non-consumptive transport routes for walking and cycling [11].

Urban ecological corridors provide numerous environmental benefits. Corridors connect urban, rural and natural landscapes [10], absorb pollution and reduce the urban heat island effect [11]. When located along waterways, riparian corridors prevent flooding, inhibit runoff and erosion, increase nutrient cycling and improve water quality [12]. Thus, ecological corridors in urban areas can have far-reaching positive environmental impacts.

The Eastern Bays Songbird Project

The Eastern Bays Songbird Project (hereafter the Songbird Project) is a community conservation group with a vision of creating an area vibrant with birdlife; where tūī, fantail / pīwakawaka and kererū already present in the Eastern Bays are joined by visiting kākāriki, bellbird / korimako and kākā from the nearby pest-free offshore islands in the Hauraki Gulf. Located 3 km from downtown Auckland, the Songbird Project zone consists primarily of urban housing and in 2018 had a human population of 34,677 [16]. The Songbird Project operates over 1,380 hectares and includes Ōrākei, Mission Bay, Kohimarama, St Heliers and Glendowie. The Songbird Project area is bordered on three sides by water: the Waitematā Harbour to the north, Tāmaki Estuary to the east and Pourewa Creek to the west.

Since the Songbird Project began in 2017, the focus has been on significantly reducing rat and possum numbers in the Eastern Bays, supporting the Pest Free Auckland 2050 and Predator Free NZ 2050 initiatives. By June 2020, pest control efforts by the group had removed a reported 550 possums and 1600 rats



The location of the Eastern Bays Songbird Project zone in Auckland.

from the area. The group aimed to complement the existing ecological restoration activities occurring on public land by engaging the community and encouraging pest removal in residential backyards. The pest control efforts by the Songbird Project community suggests that the Eastern Bays are fast becoming a safe landing area for native birds dispersing to mainland Auckland from pest-free Rangitoto, Motutapu and Motuihe / Te Motu-a-Ihenga, a mere 4-7km offshore.

Another goal of the Songbird Project is to increase and enhance existing habitat to ensure that birds that arrive in the Eastern Bays can move between the forest fragments and use the area as a steppingstone between the Waitematā and Manukau Harbours, the islands of the Hauraki Gulf, and the Hunua Ranges. Many of the parks and reserves in the Eastern Bays have planting and pest control programmes already in place by Auckland Council and volunteer groups. This habitat enhancement will provide foraging and roosting opportunities for native birds, however, a lack of connectivity between these forest fragments has been identified as a barrier to bird dispersal in the area [17]. This can be mitigated through habitat enhancement on both private and public land between forest fragments which will create ecological corridors and facilitate bird dispersal in the Eastern Bays and beyond.

Red-crowned parakeet / kākāriki. Photo by Shaun Lee.

Report Objectives

Several reports have been written and management plans are already in place to enhance green space in the Eastern Bays. The Ōrākei Open Space Network Plan provides a thorough assessment of recommended improvements for parks and reserves in the area [18] and the Ōrākei Visual Framework and Te Pou o Kāhu Pōkere - Iwi Management Plan highlights several ecological enhancements planned for Ngāti Whātua Ōrākei land in Ōrākei [19, 20].

The Songbird Project has already engaged many private landowners in pest control and would like to extend the existing backyard conservation efforts to include habitat creation and enhancement for native species. Therefore, this report aims to build on the existing recommendations by Auckland Council, the Ōrākei Local Board (ŌLB) and Ngāti Whātua Ōrākei by identifying strategic revegetation sites on private land and road corridors in the Eastern Bays. The specific objectives of this report are to provide revegetation suggestions to:

1. **Increase indigenous forest cover** to create habitat for native species including birds, insects and reptiles
2. **Improve the long-term viability of current ecosystems**
3. **Restore ecological corridors to enable movement of native species** throughout the Eastern Bays and the wider Auckland region

Research Methods

This report incorporates knowledge from a range of sources including the place-based knowledge of the local community and mana whenua, primary and grey literature, ecologists and local government.

Place-based knowledge

Interviews were carried out with members of the local community to determine which native species people would like to see return to the Eastern Bays, how existing forest fragments and corridors could be enhanced, and where new ecological corridors would be most appropriate. Included in the interviews were Merania Kerehoma and Jessica Hiscox on behalf of Ngāti Whātua Ōrākei, the mana whenua of the area, members of local conservation groups: John Laurence from the Eastern Bays Songbird Project, John La Roche from Friends of Kepa Bush and the Pourewa Restoration Group, Martin Heffer from Selwyn Bush, Alan Minson and Don Morrison from the Mission Bay Kohimarama Residents Association and Mens Shed Auckland East, Frances Battersby of Kohimarama Valley Forest and Edward Duff of Glendowie and Tahuna Torea.

Desk-based research

Google Scholar was used to search the primary literature on ecological corridors, specifically those in New Zealand's urban areas. Reports from other conservation groups on landscape connectivity were also reviewed including NorthWest Wildlink and Forest Bridge Trust.

Google Earth version 9.3.116.1 [21] satellite imagery was used to identify existing forest fragments and corridors within the Songbird Project zone, and where, on both public and private land, additional vegetation would enhance connectivity between the existing fragments.

Ecological input

Various ecologists were consulted for their input on implementing ecological corridors in urban Auckland, bird movement in urban environments and appropriate plant species. Ecologists included Margaret Stanley (University of Auckland), Bruce Burns (University of Auckland), Robyn Simcock (Landcare Research) and Tim Lovegrove (Auckland Council).

Findings and recommendations

Current status of the Songbird Project zone

The Eastern Bays consists primarily of urban housing with pockets of green space and water on three sides. Significant remnant forest fragments in the area include Kepa Bush and Dingle Dell, and the forest associated with the wetland at Tahuna Torea. Extensive areas of green space are also found in the suburb of Ōrākei at Bastion Point / Whenua Rangatira and at Pourewa, both of which are currently being revegetated by Ngāti Whātua Ōrākei. Additionally, significant landforms of volcanic origin are Glover Park / Whakamuhu and Taylor's Hill / Te Taurere, two reserves managed by Auckland Council at the eastern end of the Songbird Project zone. A vegetated corridor lines the northern, eastern and western borders of the Eastern Bays.

Most canopy cover (vegetation 3m +) in the Eastern Bays are the forest fragments of parks, reserves and Māori land although private backyards also contribute a considerable amount. Several forested gullies in Kohimarama and St Heliers are in private ownership and contribute to the overall canopy cover in the Eastern Bays. Canopy cover across the entire ŌLB zone was 19.7% in a 2013 survey [22]. Local government hope to increase this to 24% [18] through revegetation efforts such as the One Billion Trees programme by the New Zealand Government [12, 18].

Native species and their dispersal requirements

Birds

The vision of the Songbird Project identifies six native bird species that the group would like to see in the Eastern Bays; bellbird / korimako, kākāriki, kākā, tūī, fantail / pīwakawaka and kererū. All of these species have been identified as suitable candidates for reintroduction to urban areas in New Zealand [23], but require intensive pest control and a year-round food supply to flourish [3]. Please note the scientific and Māori names of all species are recorded in the Appendix if not mentioned in-text.

Bellbird, kākāriki and kākā are all rare on the Auckland mainland but are present on many of the pest-free islands in the Hauraki Gulf. Tūī, kererū and fantail are already found in the Eastern Bays in low numbers as are swamp harrier, silvereye, grey warbler, kingfisher, morepork and shining cuckoo, which is a seasonal migrant. The dispersal abilities of whitehead, North Island robin, saddleback and stitchbird were considered insufficient for these species to colonise the Eastern Bays unaided [24-27], and some, such as saddleback and stitchbird are highly vulnerable to introduced predators [28], so these species were not considered.

There are other terrestrial species which may appear in the Eastern Bays as occasional vagrants. These include New Zealand falcon, which occurs more commonly further south although a few exist in the Hunua Ranges, long-tailed cuckoo which passes through on migration but is also common on Little Barrier / Hauturu, and tomtit, which occur in small numbers on nearby Rangitoto and which are also quite common in the Hunua and Waitākere Ranges [28].

Eastern Bays Songbird Project target bird species and their habitat and dispersal requirements

Bellbird / Korimako / Anthornis melanura. Photo by Edin Whitehead.

Bellbird dispersal requirements

Bellbirds are common in urban areas in the South Island but absent from most of the mainland North Island north of the Waikato and Coromandel Peninsula. Bellbirds were observed in St Heliers before the 1970s, presumably visiting from Motuihe Island [29]. In 2005 bellbirds dispersed from Little Barrier and crossed a 23 km sea-gap to recolonise Tāwharanui [30]. Recently bellbirds have been sighted at Devonport having presumably crossed from Rangitoto, where they are now becoming well established following the eradication of mammalian predators [28]. The minimum home range of bellbirds was determined to be at least 3.7 ha [31], and individuals may forage tens of kilometres from breeding sites [32]. Bellbirds forage on flax, kōwhai, rewarewa and pōhutukawa nectar [31, 33] and also consume honeydew, small fruits and invertebrates [28]. Nests are often well-hidden behind the dead fronds of tree ferns / ponga [33] or in dense tangles of vegetation. Bellbirds are vulnerable to predation by rats, especially at night-time in their roosts. They require habitat with low pest densities [30], especially in the northern North Island where ship rat densities can be high [28].

New Zealand pigeon / Kererū / Hemiphaga novaeseelandiae. Photo by Edin Whitehead.

Kererū dispersal requirements

Kererū are present in urban Auckland throughout the year and spend most of their time within a home-range of 326 ha [44]. They are very strong fliers and have been tracked travelling up to 102 km, crossing Foveaux Strait between the South Island and Stewart Island [45], and also observed travelling between Cape Rodney and Little Barrier, a distance of 21.5 km [45]. Kererū are the most important dispersers of large fleshy fruits such as miro, pūriri, taraire and tawa, so they are a keystone species in forest regeneration [28]. They forage on the fruits and foliage of species such as pūriri, cabbage tree, nīkau and kōwhai in urban Auckland, in addition to feeding on the fruits and foliage of many exotic species [28, 44].

Kākā / Nestor meridionalis. Photo by Edin Whitehead.

Kākā dispersal requirements

Kākā are known to travel between Great Barrier / Aotea, Little Barrier and the mainland and have been observed as far away as the Waitākere Ranges (~100 km). They are well established and common in the Hunua Ranges, especially in the areas being managed to conserve kōkako, and recently they have bred successfully on Waiheke [28]. Kākā dispersing from Great and Little Barrier Islands are often seen during winter and spring in urban Auckland, but at present they are not known to breed in the urban environment [28]. In recent years, kākā have become quite common in urban Wellington following dispersal from nearby Zealandia (Karori) Sanctuary where they were re-established following translocation [37]. Their diet consists of invertebrates, seeds, fruit, sap, nectar and pollen from various plant species, with hinau, five-finger and tawa being important food sources [38]. Mammalian pests have varying impacts on kākā. Kākā nest in tree cavities and can coexist with rats, but chicks and nesting females are vulnerable to stoats, while fledged young are very vulnerable to cat predation because they may spend about a week on the ground after they leave the nest [28]. Kākā also compete for food with possums [39].

Tūī / Prosthemadera novaeseelandiae. Photo by Edin Whitehead.

Tūī dispersal requirements

Tūī are very mobile and are commonly seen in forested, rural and urban areas [40, 41]. They have been tracked flying 20 km from urban areas back to native forest in spring to breed [41]. Natal dispersal is usually 1-1.5 km [42] and maximum dispersal is 100 km [43]. In spring, tūī forage on the nectar of a wide range of native plants including kōwhai, rewarewa, pūriri, fuchsia, flax, rātā and pōhutukawa, along with exotics such as brush cherry, various flowering gums and flame trees [28]. Other trees and shrubs, both native and exotic, are important food sources at other times of the year when tūī forage on honeydew, fruits and invertebrates [41-43].

Red-crowned parakeet / Kākāriki / Cyanoramphus novaezelandiae. Photo by Edin Whitehead.

Kākāriki dispersal requirements

Kākāriki nest in cavities, rock crevices, tree trunks and burrows in remnant forest, and replanted forest and grassland on Tiritiri Matangi [34]. They can travel at least 65 km over open water, as observed with one individual travelling from Motuihe Island to Little Barrier [34]. The minimum habitat size required for kākāriki is likely 100 ha of forest and mammalian predators should be absent or near absent [35]. Kākāriki spend much time feeding on the ground where they are extremely vulnerable to cat predation [28]. They roost at night in tree cavities where they are also vulnerable to rats and stoats. They forage on a wide range of species including *Coprosma* spp., rewarewa, pōhutukawa, *Muehlenbeckia*, kānuka and pūriri [36]. Kākāriki nest in natural cavities in large trees such as pōhutukawa and pūriri [34]. Kākāriki are rare vagrants to mainland Auckland, with occasional sightings in bush remnants and urban gardens in Birkenhead, Torbay and Glenfield, between 15-25km from the presumed source population at Tiritiri Matangi [37]. Kākāriki have been reintroduced to several inner Gulf islands and Tāwharanui. There are no recent records from the Hunua or Waitākere Ranges [28].

Fantail / pīwakawaka / Rhipidura fuliginosa. Photo by Edin Whitehead.

Fantail dispersal requirements

Fantails are habitat generalists and one of few native birds found in heavily modified urban environments far from large forest patches [46]. They survive well in forest fragments and plantings in urban parks and large gardens, and they readily disperse across urban landscapes [47] though their maximum dispersal distances are unknown. Fantails are insectivores [46] and well-treed urban environments clearly provide the food resources they need [28]. Fantail nests are vulnerable to predation by ship rats, but fantails produce multiple broods in the one season, so populations can recover quickly following predation [46].

Invertebrates and reptiles

The Songbird Project is primarily focussed on restoring native bird species to the Eastern Bays, thus birds are the primary focus of this report. However, the role of invertebrates and reptiles in ecosystem function is recognised and suggestions are made for habitat enhancement that will likely benefit reptiles and invertebrates in addition to birds.

Due to their often poor dispersal abilities, beetles found in remnant forest fragments in urban areas are likely relicts from earlier times when connectivity was greater [50]. Therefore, remnant forest fragments in urban areas can act as important reservoirs for native invertebrates. In some instances, poor dispersers can gradually colonise restored habitats [48], a migration that can be assisted through ecological corridors. However, some species may be unable to reach restoration sites unaided and translocation may be required [48].

A large crane fly / Tipulidae spp emerging from its larvae case in Selwyn Bush. Photo by Shaun Lee.

Little is known about the habitat requirements and dispersal abilities of most native invertebrates [48]. Some species have specific habitat requirements that are often not fully understood, whereas others are generalists and are found in a variety of locations. For example, some native beetles found in remnant forest fragments were absent from the same plant species in urban gardens 100 m away [49]. Some restoration sites and gardens had similar compositions of native invertebrates but these differed from invertebrates found in remnant forest habitats [48]. These differences may be due to the dispersal abilities of some invertebrates (e.g. flightlessness or the inability to cross

In Pourewa and Kepa Bush in Ōrākei, 346 invertebrate species were discovered during a BioBlitz held in 2015 [51], many of which were native species. Included in these (description and number of species in parentheses) were nematodes (roundworms, 34), spiders, harvestmen and false scorpions (38), mites (9), beetles (39),

katydids, wētā and cockroaches (6), thrips (5), flies and mosquitoes (mainly scuttle flies, 32), bugs (insects with piercing and sucking mouth parts, 35), butterflies and moths (50), ants, wasps and bees (78), amphipods (small crustaceans, 5), isopods (woodlice, slaters and pillbugs, 3) and molluscs (12) [51]. Invertebrates of note were the large forest ghost moth (*Dumbletonius unimaculatus*) and the pūriri moth (*Aenetus virescens*). No reptiles were mentioned in the BioBlitz report.

with ample basking surfaces that are free from predators [53]. The fruit and nectar from at least 23 native plants are consumed by native geckos and skinks, making them short-distance (< 20 m) seed dispersers [54, 55]. Native lizards generally have a small home range and only occasionally have they been observed moving a distance of 60 – 70 m [55 and references therein]. Due to the limited dispersal abilities of many native reptiles and invertebrates, well-connected ecological corridors can help facilitate their movement.

Pacific gecko. Photo by Shaun Lee.

Seven native reptiles are found in the Auckland region: Auckland green gecko (*Naultinus elegans elegans*), forest gecko (*Mokopirirakau granulatus*), Pacific gecko (*Dactylconemis pacificus*), copper skink (*Oligosoma aeneum*), ornate skink (*Oligosoma ornatum*), moko skink (*Oligosoma moco*) and shore skink (*Oligosoma smithi*) in addition to the introduced rainbow, or plague skink (*Lampropholis delicata*) [52]. These reptiles can persist in small patches of suitable habitat

Large forest ghost moth / Dumbletonius unimaculatus. Photo by Shaun Lee.

Retain existing vegetation

Retaining and managing existing forest fragments is key to facilitating the reintroduction of wildlife into urban areas in New Zealand [12, 23] due to the food and habitat they provide for native species, and seed sources for backyards [56]. Mature trees (10+ m) in particular provide ample foraging and nesting opportunities and increased bird diversity is observed in urban areas where remnant old-growth forest is conserved [57]. A large tree may support more than 30 other plant species growing on bark and perching high in the canopy [58]. Forests regenerate slowly and the full range of their diversity (with associated lichens, mosses, mycorrhizae, fungi and insects) is not easily replaced, thus patches of remnant native vegetation in urban areas should be protected regardless of how small or fragmented. Larger forest fragments (2 - 5 ha) provide higher quality breeding habitat for a wider range of bird species than smaller fragments [4], therefore, increasing vegetation in buffer zones around remnant patches will deliver greater ecological benefits than starting afresh [8]. Moreover, retaining vegetation preserves soil and fungal health, which enhances the growing conditions for other plants [8].

Hebe / Pseudoveronica spp. Photo by Kerry Lukies.

Coarse woody debris such as stable dead trees and logs, in addition to leaf litter, provides food and habitat for an abundance of insects and reptiles, which in turn are eaten by birds [50, 52, 53]. One of the most iconic insects of deadwood is the huhu beetle, whose larval development stage requires wood to remain moist for two to three years [58]. Private landowners can be encouraged to keep an 'untidy garden' to enhance habitat for reptiles and insects [58, 59], especially those with poor dispersal abilities [48].

Longhorn beetle / Xylotoles spp feeding on rotting wood. Photo by Shaun Lee.

Most (61%) of Auckland's urban forests are on privately owned land [22], therefore, it is important that the community value and protect native vegetation in their own backyards. Increased protection of backyard vegetation in the Eastern Bays is needed, especially of mature trees, which will help to retain canopy cover and increase native biodiversity.

Protecting vegetation on private property will require communicating the ecological importance of large trees to the local community, for example, taraire, pūriri and nīkau in providing winter fruit for kerurū or trees with cavities providing habitat for kākā and bats [22]. Several forest fragments in the Eastern Bays are partially in private ownership such as Kohimarama Valley Forest (Pamela Place Reserve), Glen Atkinson Reserve and other vegetated gullies of Kohimarama and St Heliers. These properties should be a focus for communication of the importance of retaining vegetation but also protected by Auckland Council rules and regulations.

Many mature pōhutukawa and introduced Norfolk pines line the beaches of the Eastern Bays along Tāmaki Drive. Pōhutukawa are valued for social and cultural reasons in addition to providing food and habitat for native species. Many trees along Tāmaki Drive have been underplanted with rengarenga which increases the resource availability for native species and provides some habitat complexity [60]. Norfolk pines are a common site along Auckland's East Coast beaches and are valued for their cultural heritage. As benign exotics, Norfolk pines should be retained and at the end of their lives replaced with native trees. Any additional vegetation planted along the waterfront should aim to increase the diversity of native plant species present and provide a year-round food supply for native fauna [12, 59]. Native plants should include coprosmas, berry-producing *Muehlenbeckia*, hebes and coastal flaxes [58].

Pohutukawa underplanted with rengarenga on Tāmaki Drive. Photo by Kerry Lukies.

Remove weeds and competitive exotics

Auckland is the weediest city in New Zealand [61]. A multitude of pest tree, vine and groundcovers can be found within the Eastern Bays on public, private and Māori land. Weed removal is a priority in and around significant ecological areas (as per the Regional Pest Management Plan, RPMP), on the coastal fringes to reduce weed dispersal to the pest-free Hauraki Gulf islands [62] and within the ecological corridors suggested in this report. The RPMP focuses on a limited number of plants, therefore the Songbird Project community should aim to:

1. Remove a wider range of exotic plant species to stop weeds replacing weeds.

2. Find and remove uncommon exotic plants to stop them from becoming widespread.

3. Discourage the planting of any weedy species, even if they aren't officially 'banned' from sale under the RPMP. This includes all of the species listed in the RPMP that are known to be weeds but have yet to legally be controlled [58].

Arum lily / Zantedeschia aethiopica. Photo by Kerry Lukies.

Reducing the prevalence of exotic invasive species on private land may require an education process whereby the negative impact of weeds and the benefits of planting native vegetation is explained. Information on the negative impact of weeds should be disseminated throughout the Eastern Bays and weed removal encouraged through a series of events such as 'weed swaps' or school competitions that collect moth plant pods. These tactics have been used elsewhere in Auckland.

Examples of common weed species present in the Eastern Bays are climbing asparagus, moth plant, jasmine, arum lily, ladder fern, woolly nightshade, tradescantia, wild ginger, Chinese privet, tree privet, brush wattle, agapanthus, evergreen buckthorn, Bolivian fuchsia and pampas grass, among others [58, 63-66]. Volunteers operating in parks and reserves continually remove seedlings of exotic species common in backyards from predominately native forest fragments [66]. Nurseries in the area should be encouraged to promote native species over exotics and stop selling weed species, even if they are not yet prohibited from sale [58].

Urban forest fragments are often degraded by weed infestations, spread by the consumption of seeds and vegetation by rats, possums and some birds [12]. While many of the residents surrounding forest fragments in the Eastern Bays are already involved in pest control, further habitat enhancement is needed. In this context 'habitat enhancement' refers to weed control, animal pest control and planting native vegetation.

Community weeding day at Kohimarama Valley Forest Pamela Place Reserve. Photo by Frances Battersby.

Community weeding bees in areas such as Kohimarama Valley Forest are necessary to remove the plethora of weeds present and allow naturally established native ferns, herbs and woody plants to develop unsmothered [58].

A range of palms including Bangalow, Phoenix, king, queen and Chinese windmill palms [67] are common on private properties in the Eastern Bays, many of which outcompete the slower-growing nīkau, New Zealand's only native palm [68]. Several of these exotic palms have sharp spines which can cause injury and are therefore expensive to remove once fully grown. This is the case for phoenix palms, a common species along Tāmaki Drive. Female phoenix palms should be removed and replaced with nīkau palms and males inoculated with pōhutukawa at the intersection of roots and base so the native takes over in time [58]. Landowners should be encouraged to replace exotic palms with the indigenous nīkau or to remove seed heads from all non-native palms to stop them from spreading into other areas [69].

Moreton Bay fig trees are a prominent specimen tree on both public and private land in the Eastern Bays. Some individual trees have historic cultural value, but unfortunately, they are no longer benign due to the introduction of the pollinating fig wasp in the 1990s [70]. Consequently, fig trees are now spreading into places where they are difficult to control, such as the tops of walls and other trees (especially Phoenix palms). Given this, the spaces

Phoenix palms on Tāmaki Drive. Photo by Kerry Lukies.

Increase canopy cover

Reconstructing native habitat and establishing connectivity between habitat patches ensures that birds, reptiles and insects can migrate and disperse through modified urban ecosystems [2, 23]. Many native plants rely on native birds to disperse them (e.g. kereru disperse large fleshy fruits of pūriri and taraire) and generally require active revegetation in the absence of abundant native birdlife [3]. Therefore, active revegetation in the Eastern Bays is key to creating habitat for and facilitating the movement of native species through the area.

Public land

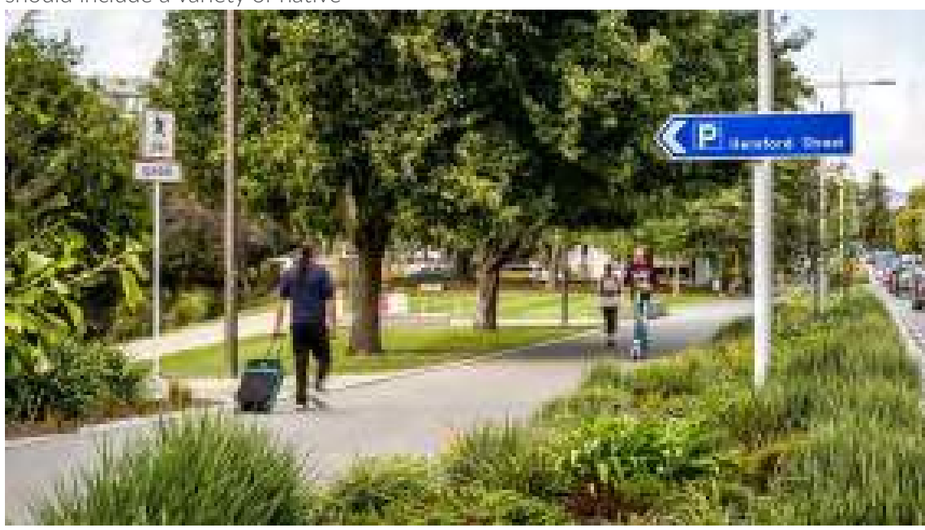
Parks, reserves, transport corridors and public buildings in the Eastern Bays fall under the jurisdiction of Auckland Council. Thirty-nine percent of Auckland's urban forest is in public land; 7% of which are in parks, 9% in road corridors and 23% in other public lands, such as schools [22]. It is the public land covered in exotic grasses, shrubs and trees that could be converted to indigenous species cover. Revegetation of public land should include a variety of native plant species, especially large trees that may be less desirable for planting in private backyards due to space restrictions.

Parks and reserves

Many of the parks and reserves, especially the smaller ones in the Eastern Bays, provide little to no habitat for native bird species as they are dominated by exotic grasses. An opportunity exists to increase the multi-functionality of these spaces to incorporate a range of uses including sports fields, urban forests, playgrounds, walkways, cycleways and other recreational activities. Implementing the habitat enhancement activities outlined for parks and reserves in the Ōrākei Open Space Network Plan [18] will increase canopy cover and improve the diversity of native species present in the Eastern Bays [5].

Transport corridors

Transport corridors provide a unique opportunity to enhance connectivity between forest fragments due to their existing networks and the ability to provide connections where private properties do not [11]. Many road corridors in the Eastern Bays contain



Example of a vegetated road corridor. Photo by NZ Institute of Land Architects, n.d.

exotic grasses and few trees, many of which are exotic species. Competitive exotics and benign exotics at the end of their lives should be replaced with native trees to form corridors.
In the proposed corridors (**Page 29**), revegetating grass berms with native groundcovers, shrubs and trees (where these would not interfere with utility service provisioning) would significantly increase indigenous canopy and enhance connectivity between forest fragments in the Eastern Bays. In addition to planting berms, traffic calming features (e.g. roundabouts, speed bump terminals) can be planted with native grasses and shrubs [8]. When revegetating road corridors, care must be taken to meet safety concerns such as visibility for vehicles and pedestrians [11].

Rail corridors also present opportunities for ecological enhancement. Rail corridors in Auckland are frequently bordered by invasive species such as brush wattle, privet and woolly nightshade, all of which could be replaced with native species to act as ecological corridors. The Eastern Bays Songbird Project should discuss vegetation enhancement along transport corridors with Auckland Council and relevant transport providers.

Traffic calming feature planted in native species. Photo by Kerry Lukies.

Private land

Traditionally, revegetation efforts in urban areas have focussed on parks and reserves, however, this is changing as private land is increasingly recognised for its value in providing habitat and connectivity [71 and references therein]. Private land contributes an enormous amount to urban greenspace and can provide biodiversity benefits through habitat and food provisioning [23]. Backyard vegetation does not have to be entirely indigenous, but incorporating indigenous elements into backyard planting is key to facilitating the movement of native species in urban environments [72].

Statistics New Zealand (2018) reported 13,449 dwellings in the Eastern Bays. This represents a considerable number of backyards that could help to increase canopy cover in the area. Habitat enhancement efforts should focus on properties bordering Significant Ecological Areas (SEA's) and in the ecological corridors suggested from **page 29**. Increasing the amount of native vegetation in backyards and road corridors around existing habitat patches in the Eastern Bays will provide ecological buffer zones and increase overall patch sizes, further benefitting native species [15].

Predator control on private land is widely accepted as a necessary evil to protect native plant and animal species in New Zealand, as shown by the number of community groups engaged in rat, possum and mustelid control [73]. Mustelids are rare in urban areas, thus the primary focus for urban restoration groups are usually rats and possums. Pest control reduces the consumption of seeds, fruit and foliage by rats and possums, thus facilitating the establishment and growth of plants [3 and references therein, 12]. Additionally, removing mammalian predators helps to prevent the depredation of birds, chicks and eggs and creates safer nesting sites [12]. Ongoing pest control is paramount in urban restoration projects such as the Songbird Project, as there is little point in restoring habitat if birds dispersing into the area are depredated by pests on arrival [3] or the habitat is degraded by possum browsing.

A more contentious topic is the prevalence of domestic cats in urban areas, which also kill native birds, insects and reptiles [74]. When rats are removed from an area, but cats remain, cats will readily prey-switch from rodents to native species [75]. In countries where the negative impacts of domestic cats on native wildlife are less acceptable, conservation tools include cat-free suburbs (e.g. the Cats Indoors! campaign by the American Bird Conservancy) or areas where cats must be contained at all times, for example in Canberra, Australia [71, 76, 77]. Reducing the number of free-range cats could be considered in the Eastern Bays to limit the threat to native species.

New developments and sustainable urban design

Existing and new developments can incorporate sustainable design principles to provide habitat for native biodiversity in high-density urban areas. Sustainable design practices such as green roofs, green walls, rain gardens, wetlands, swales and impervious pavements can increase canopy cover and act as ecological corridors in urban areas, facilitating the movement of birds, reptiles and insects [10, 75].

Roof garden in Stonefields. Photo by Kerry Lukies.

Green roofs and walls, in particular, require no additional space [78] and reduce the extent of impervious surfaces that would otherwise lack ecological benefits [75]. Green roof design can be curated to provide excellent habitat for rare insects and reptiles, especially on roofs that are rarely disturbed by humans [79]. In addition to environmental services such as pollution absorption, reduced urban heat island effect, stormwater retention and improved water quality, sustainable urban design can provide educational opportunities and tranquil green space for people to enjoy [75].

New developments are a good opportunity to condition that gardens and road corridors be required and planted with native species to benefit native animals [71 and references therein]. Ensuring berms within new developments are wide enough for trees to be planted or have a planted area in the middle of the road, for example, the design used at Stonefields, can increase canopy cover, create safer streets for pedestrians, be aesthetically pleasing and enhance ecological connectivity [8, 59]. In the context of the Eastern Bays, any new developments planned should aim to incorporate sustainable design which would create new habitat and increase native biodiversity in the area. Ngāti Whātua Ōrākei have proposed sustainable urban designs such as green roofs and rain gardens into new developments in Ōrakei in the Te Pou o Kāhu Pōkere - Iwi Management Plan [20], which will benefit native species.

What to plant? — A diverse assemblage of native species

Planting a variety of species, rather than only a few species, will help provide habitat for a wider range of birds, reptiles and invertebrates [59, 75]. To maximise habitat and value for biodiversity, several individuals of each species and/or clusters of repeated species mixes should be planted to boost flower and fruit volume that helps birds and insects forage efficiently [58]. Larger vegetated areas provide greater habitat than thin strips, and layering groundcover, shrubs, vines and trees can help create greater habitat complexity [58, 75], which has been shown to increase backyard biodiversity [71]. Care should be taken to plant species that provide a year-round food supply for birds [12, 75] otherwise visitation will be seasonal.

Kākā / Nestor meridionalis feeding on seasonal pōhutukawa nectar. Photo by Shaun Lee.

Ecosourcing

Any new vegetation planted within the Eastern Bays should be eco-sourced from local reserves to ensure new plantings are suited to the environmental conditions in the area [12, 60]. The remnant forest at Kepa Bush has been identified as an important seed source for surrounding areas [69]. It is therefore recommended that some of the seed stock for planting in the Eastern Bays should be sourced from there. Raising seeds at the local Ngāti Whātua Ōrākei nursery could facilitate community involvement in revegetation, provide education opportunities and strengthen the relationship between mana whenua and the Eastern Bays Songbird Project.

A diverse assemblage of native species. Photo by Kerry Lukies.

Recommended plant species

A diverse range of native plant species has been suggested for revegetating private backyards, parks, reserves and road corridors in the Eastern Bays. Groundcovers, shrubs and small trees (< 10m) are generally suited to smaller properties whereas large trees (> 20m) could be readily planted in parks, reserves and some road corridors without blocking sunlight or the view of surrounding properties. Planting should be encouraged between May – September to achieve optimal plant survival [75].

Groundcovers, shrubs and small trees (< 10m) suited to the Eastern Bays are outlined below. These smaller species can provide food and habitat for a range of birds, insects and reptiles and several are valued for their use in rongoa (traditional Māori medicine). Note that each plant requires suitable space, light conditions and drainage / moisture.

Recommended groundcovers, shrubs and trees (< 10m) to plant in the Eastern Bays.

List derived from B. Burns, R. Simcock, M. Stanley, pers. comms., 2020; Auckland Council, 2018a.

Common name	Māori name	Scientific name	Recommended for	Max. height
Babies tears	Pānakenake	*Pratia spp.*	• Groundcover	5cm
New Zealand daphne / riceflower	Pinatoro	*Pimelea spp.*	• Groundcover • Green roofs	5-10cm but varies depending on the source
Carex spp. (sedges)		*Carex spp.*	• Amenity planting, swales, floodplains, green roofs, road corridors or path edges to smother weeds	30 to 130 cm
Rengarenga	Rengarenga	*Arthropodium spp.*	• Insects • Green roofs	1m
Cutty grass	Tarangarara	*Gahnia lacera*	• Butterflies • Rain gardens	2m
Muehlenbeckia	Tororaro / Pōhuehue	*Muehlenbeckia complexa*	• Fences and retaining wall cover • Connects ground to the tree canopy • Green roofs • Berries for reptiles	2m
Hebe spp.	-	*Hebe spp.*	• Rongoa (Hebe stricta) • Use small hebes instead of buxus (box) hedging • Green roofs • Nectar for reptiles	30cm to 3m
Flax	Harakeke	• *Phormium tenax* (swamp flax) • *Phormium cookianum* (coastal flax)	• Tūī and bellbird • Insects • Nectar for reptiles • Riparian planting, rain gardens and swales	• Swamp flax 2m; flower spikes 3m • Coastal flax 1m
Gumdiggers soap	Kūmarahou	*Pomaderris kumeraho*	• Backyards	2m to 4m
Karo	Karo	*Pittosporum crassifolium*	• Backyards, hedges • Nectar for reptiles and birds	5m
Coastal daisy	Kotahirau	*Olearia solandri*	• Coastal areas, hedges	5m
Coastal kōwhai	Kōwhai	*Sophora chathamica*	• Backyards • Kererū and tūī • Swales	6m
Pepper tree	Kawakawa	*Piper excelsum*	• Shady sites • Rongoa • Insects • Nectar for reptiles • Kererū	6m
Coprosma spp.	-	*Coprosma spp.*	• Kākāriki • Berries for reptiles • Green roofs	6m
Tree fern	Wheki-ponga	*Dicksonia fibrosa*	• Insects (for bird foraging), damp places incl. stream edges	6m
Five-finger	Whau-whaupaku	*Pseudopanax arboreus*	• Hedges • Very good for birds including kākā • Insects	8m
Puka	Puka	*Meryta sinclairii*	• Birds	8m

Mid-sized tree species (10 - 20m) suited to the Eastern Bays are outlined in below. Both cabbage trees and nīkau palms are tall and thin and therefore will not obscure sunlight and views but will provide food for native birds [59]. This means they are suitable for the many properties in the area with Harbour views.

Recommended mid-size trees (10m - 20m) to plant in the Eastern Bays.

List derived from B. Burns, R. Simcock, M. Stanley, pers. comms., 2020; Auckland Council, 2018a.

Common name	Māori name	Scientific name	Recommended for	Max. height
Whitey wood	Māhoe	*Melicytus ramiflorus*	• Insects • Birds, especially bellbird • Nectar for reptiles	10m
Ngaio	Ngaio	*Myoporum laetum*	• Coastal areas • Bellbird	10m
New Zealand Jasmine	Kaihua	*Parsonsia heterophylla*	• Climbing vine useful to cover walls	10m
Marbleleaf	Putaputawētā	*Carpodetus serratus*	• Insects, including many pollinators • Swales	10m
Silver fern	Ponga	*Cyathea dealbata*	• Shady sites • Insects, especially moths	10m
Karaka	Karaka	*Corynocarpus laevigatus*	• Kererū • Rain gardens	12m
Tree fuchsia	Kōtukutuku	*Fuchsia excorticata*	• Tūī and bellbird • Sensitive to drought and requires organic-rich soils	15m
Nīkau palm	Nīkau	*Rhopalostylis sapida*	• Replacing exotic palms • Tall and skinny — won't block views • Kererū	15m
Tawapou	Tawapou	*Planchonella costata*	• Kererū and kākā	15m
Tea tree	Mānuka	*Leptospermum scoparium*	• Fantail and bellbird • Nectar for reptiles	15m
New Zealand mahogany	Kohekohe	*Dysoxylum spectabile*	• Tūī and bellbird • Specimen tree • Nectar for reptiles	15m
Pigeonwood	Porokaiwhiri	*Hedycarya arborea*	• Kererū	16m
Lacebark / ribbonwood	Houhere	*Hoheria spp.*	• Kererū and insects • Large clusters of white flowers in autumn	17m
New Zealand Oak	Tītoki	*Alectryon excelsus*	• Insects • Birds, especially kererū • Rain gardens	18m
Cabbage tree	Tī kōuka	*Cordyline australis*	• Replacing exotic palms • Tall and skinny — won't block views • Erosion control — roots hold stream banks • Suits poor soil • Birds, especially kererū and bellbird • Rain gardens • Nectar and berries for reptiles	20m
Kānuka	Kānuka	*Kunzea robusta*	• Scale insects • Bellbird • Nectar for reptiles	20m +

Large tree species (20m +) appropriate for the Eastern Bays are outlined below. Many of these species are best-suited to parks, reserves, some road corridors and schools where they can reach full size while also providing shade. Of these, pūriri is a species of particularly high ecological importance as it produces nectar, fruit and seeds for birds throughout the year [62]. However, to reach its potential it needs to be planted into deep, moist, organic-rich, soils, preferably at least $10m^3$ [58]. Rewarewa is another tall, slender tree that is suited to backyards as it does not obscure sunlight and views while producing food for birds [59].

Recommended large trees (> 20m) to plant in the Eastern Bays.

List derived from B. Burns, R. Simcock, M. Stanley, pers. comms., 2020; Auckland Council, 2018a.

Common name	Māori name	Scientific name	Recommended for	Max. height
Pūriri	Pūriri	*Vitex lucens*	• Birds — important year-round food source • Kererū • Nectar for reptiles • Rain gardens	20m +
Taraire	Taraire	*Beilschmiedia tarairi*	• Kererū	22m
Celery pine	Tānekaha	*Phyllocladus trichomanoides*	• Rongoa • Birds	25m
Tōtara	Tōtara	*Podocarpus totara*	• Can be used as hedging • Insects • Birds • Tolerates compacted, low fertility (but well drained) soil	25m
Rewarewa	Rewarewa	*Knightia excelsa*	• Birds, especially bellbird and kākāriki • Tall and skinny — won't block views • Rain gardens	30m
Pukatea	Pukatea	*Laurelia novae-zelandiae*	• Rongoa • Rain gardens	40m
Kahikatea / White pine	Kahikatea	*Dacrycarpus dacrydioides*	• Kererū	55m

Rare species

As pest numbers are reduced in the Eastern Bays, an opportunity exists to reintroduce plant species that are rare on the mainland due to over-browsing by mammals. These rare species are usually confined to pest-free islands and any individuals planted in the Eastern Bays would bolster the overall population and assist in re-establishing these species on the mainland [62]. Examples of rare plant species that could be reintroduced to the Eastern Bays are listed below.

Recommended rare species to plant in the Eastern Bays.

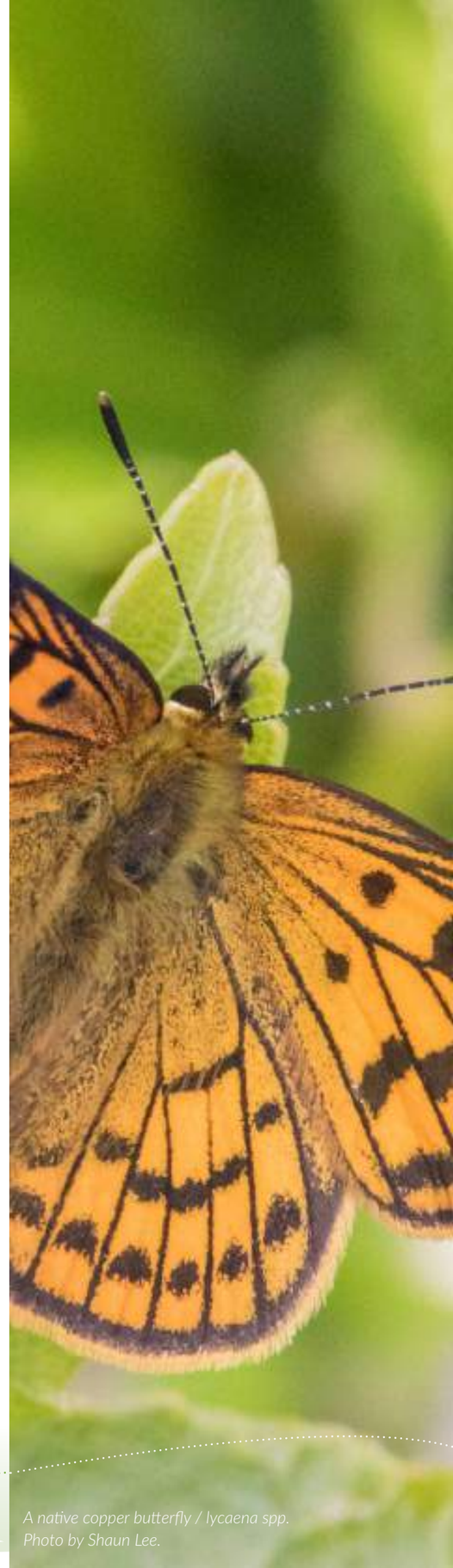
List derived from B. Burns, pers. comm., 2020.

Common name	Māori name	Scientific name
Milk tree	Turepo	*Streblus banksii*
Coastal maire	-	*Nestegis apetala*
Bartlett's rātā	Rātā moehau	*Metrosideros bartlettii*
Fierce lancewood	Horoeka	*Pseudopanax ferox*
King fern	Para	*Ptisana salicina*
Shore spurge	Waiu-tua	*Euphorbia glauca*
Creeping fuchsia	Tōtaea	*Fuchsia procumbens*

Establishment and maintenance of vegetation

Many urban restoration projects in New Zealand have been invaded by weeds following revegetation due to a lack of aftercare [15] thus ongoing management is required to prevent smothering and competition by exotic species [12, 60]. Aggressive, tall weeds should be eliminated before planting to reduce the need for maintenance. These include ginger, bamboo and agapanthus [58]. Additionally, care should be taken to remove weeds that spread from rhizomes or suckers and smother natives such as kikuyu, couch grass, tradescantia, Convolvulus, Japanese honeysuckle, jasmine and madeira vine. Less aggressive, shorter weeds can often be smothered using deep well-wetted mulch. However, this technique is not suited to poorly drained soils as it will exacerbate anaerobic conditions [58].

Weeds and tall grass must be maintained around new plantings; water and fertiliser may also be required. The fertiliser should be placed below 5 -10 cm depth and not on the surface where it will promote weed growth [58, 75]. Maintaining new plants with mulch decreased seedling mortality in an urban Wellington restoration project [80] and should be promoted in the Eastern Bays.



A native copper butterfly / lycaena spp. Photo by Shaun Lee.

A female native red damselfly / Xanthocnemis zealandica on an endemic whau / Entelea arborescens. Photo by Shaun Lee.

Where to plant? — Connecting forest fragments in the Eastern Bays

The remainder of this report identifies forest fragments, existing and proposed corridors, as determined through green space management plans, satellite imagery and interviews with ecologists and local residents. The ŌLB Open Space Network Plan thoroughly details how parks and reserves in the Eastern Bays can be enhanced through weed removal and increased planting of native vegetation. This section focuses primarily on private land and road corridors between forest fragments. The dispersal abilities of the bird species identified from **page 9** are suited to continuous and steppingstone corridors, thus both are incorporated into this section.

The forest fragments, existing corridors and proposed corridors in Ōrākei

a Bastion point
b Pourewa
c Ngapipi Reserve
d Ōrākei border corridor
e Okahu Bay to Kupe St corridor
f Kupe St corridor
g Ngapipi Reserve to Kupe St and Orakei Domain corridor
h Kupe St to Mission Bay corridor
i Kupe St to Patteson Reserve

Native tree planting by Ngāti Whātua Ōrākei at Takaparawhau Bastion Point. Photo by Kerry Lukies.

Ōrākei

Ōrākei is a 280ha suburb at the western edge of the Songbird Project zone. It is bordered by the Waitematā Harbour to the north, Pourewa Creek to the west and south, and the suburb of Mission Bay to the east. Key features of Ōrākei include expansive areas of green space on Ngāti Whātua Ōrākei land at Bastion Point and Pourewa Reserve (ex-St Heliers Bay pony club) and the existing green corridors bordering much of the suburb. The opposing map shows the forest fragments, existing corridors and proposed corridors in Ōrākei.

Parks, reserves and Māori land

Revegetation is already underway at Takaparawhau / Bastion Point and Pourewa Reserve by Ngāti Whātua Ōrākei, and these reserves are considered forest fragments although not fully revegetated yet. When combined with pest control efforts in collaboration with the Songbird Project, these two areas will provide excellent landing sites for native birds recolonising the Eastern Bays from the pest-free Hauraki Gulf Islands. Plans for the Okahu Bay Reserve and Ōrākei Domain include a constructing a wetland and additional native plantings which would benefit many native birds, insects and freshwater fish and improve the water quality in Okahu Bay [19].

Ngapipi Reserve, Wātene Reserve, Paratai South and Paratai North Reserves should be enhanced as per the recommendations in the Ōrākei Open Space Network Plan [18]. Additionally, several of the smaller reserves within Ōrākei currently provide little to no habitat for native species as they are dominated by exotic grasses. These small reserves could act as stepping-stones or form part of linear corridors between forest patches with increased native

plantings if only a single large tree. Examples of these reserves include:

- Fenton Circus could act as a stepping-stone between Paratai South Reserve and Okahu Bay
- Nehu Street Reserve and Reihana Reserve could act as stepping-stones between Pourewa Reserve, the Kupe Street corridor and the Ngapipi Reserve to Kupe Street corridor.

Point and Pourewa Reserve. This road corridor has been identified for enhancement in the Ōrākei Visual Framework [19], Auckland Council's Kepa Bush Reserve Integrated Plan [69] and the Ōrākei Local Paths (Greenways) Programme Plan [81]. At present, street trees are primarily exotic; Eucalyptus with scattered nīkau palms. This corridor should include the Ōrākei Tennis Club, the Ngake walkway, Te Arawa Reserve and private backyards on Kupe Street for additional canopy cover.

Edward (Songbird Project) and Levi (Ngāti Whātua Ōrākei) installing possum traps at Whenua Rangatira.

Backyards and road corridors

Kupe Street corridor – Planting the road corridor of Kupe Street with native groundcover, shrubs and trees would provide a direct connection for bird movement between Bastion Point and Pourewa Reserve. Planting this corridor will require collaboration between Ngāti Whātua Ōrākei, Auckland Council and private landowners.

The Ngapipi Reserve to Kupe Street corridor would facilitate bird movement between the existing Ōrākei border corridor, proposed Kupe Street corridor and vegetation at Bastion Point. This corridor would include backyards and berms on several residential streets and should include additional native plantings at Ōrākei Primary School. The school could adopt the corridor and promote native planting and pest-trapping at households within the corridor to encourage an increase in native biodiversity.

A corridor between Kupe Street and Mission Bay beach and another between Kupe Street and Patteson Reserve would facilitate bird movement between Ōrākei and Mission Bay. These corridors would include backyards and berms on Kurahaupo Street, Aotea Street and Aitkin Avenue and should include Aotea Reserve and Kupe North Reserve and walkway.

New Zealand pigeon / kererū. Photo by Shaun Lee.

The forest fragments, existing corridors and proposed corridors in Mission Bay

a Kepa Bush
b Mission Bay northern border corridor
c Patteson Reserve to Maddills Farm corridor
d Nihill Reserve to Takaparawhau/Bastion Point corridor
e Nihill Reserve to Tamaki Drive corridor

Remnant kohekohe / Dysoxylum spectabile at Kepa Bush. Photo by Shaun Lee.

Mission Bay

Mission Bay is a 108 ha suburb between Ōrākei and Kohimarama with the Waitematā Harbour to the north and Pourewa Creek to the south. Key features of Mission Bay are the remnant forest fragment of Kepa Bush in the south of the suburb and Mission Bay on the northern side with views out to the Hauraki Gulf islands. The opposing map shows the forest fragments, existing corridors and proposed corridors in Mission Bay.

Parks, reserves and Māori land

Kepa Bush is a SEA and is one of the largest tracts (14 ha) of remnant native forest on the Auckland isthmus [69]. Kepa Bush provides quality habitat for native fauna and is an important seed source for the surrounding area [69]. Weed management has been carried out within Kepa Bush since 2001 by Auckland Council and volunteers [69] and is now maintained by Auckland Council and the volunteer group 'Friends of Kepa Bush' [66]. Pest animals have been managed in Kepa Bush by Auckland Council since 2005 [69] and this has been continued by the Friends of Kepa Bush. Continual pest and weed management are required to maintain this reserve.

Patteson Reserve, Mary Atkin Reserve, Atkin Avenue Reserves, Ronaki Reserve, Selwyn Reserve and the two unnamed reserves should be enhanced as per the recommendations in the Ōrākei Open Space Network Plan [18].

Backyards and road corridors

A Patteson Reserve to Maddills Farm corridor would include backyards and berms on Patteson Ave, Dudley Road, Comins Crescent and Codrington Crescent in addition to Patteson Reserve and Nihill Reserve. At present, Patteson Reserve is largely devoid of trees and additional plants around the border of the reserve would enhance its amenity and ecological value [82]. Increasing native vegetation in backyards and berms surrounding both reserves would provide a further ecological buffer zone. This corridor would benefit from additional planting and pest control at Kohimarama School with the help of students and the local community.

A corridor between Nihill Reserve and Bastion Point would include the revegetation of backyards and berms on Codrington Crescent, Atkin Avenue and Nihill Crescent and should include both the Mission Bay Bowling Club and Mission Bay Tennis Club. The Mission Bay Bowling Club is currently unoccupied with an unknown future. This presents an excellent opportunity to build a new community-owned forest fragment in the middle of an urban suburb as has been suggested in the Ōrākei Open Space Network Plan [18].

Bellbird / korimako. Photo by Shaun Lee.

A Nihill Reserve to Tāmaki Drive corridor would involve the revegetation of backyards primarily along Selwyn Avenue and Kohimarama Road and should include additional native plantings and weed removal at Mary Atkin Reserve [82]. This corridor would connect Nihill Reserve with The Mary MacKillop Centre and Tāmaki Drive.

Patteson Reserve showing a lack of vegetation. Photo by Shaun Lee.