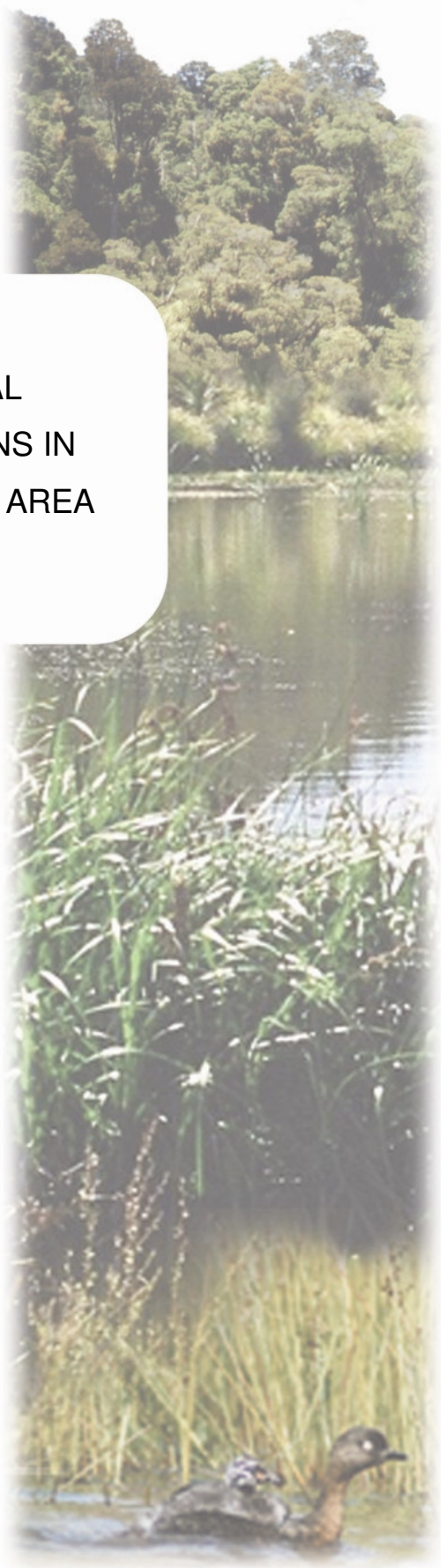
OVERVIEW OF ECOLOGICAL NETWORKS AND CONNECTIONS IN THE SMARTGROWTH PROJECT AREA



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1. INTRODUCTION

In 2006, Environment Bay of Plenty undertook a study to identify ecological corridors within the catchment of Tauranga Harbour (Environment Bay of Plenty 2006). Wildland Consultants was commissioned by Environment Bay of Plenty to identify corridors in that part of the SmartGrowth area not within the catchment of Tauranga Harbour, including the open coastline extending north adjacent to Tauranga Harbour (Wildland Consultants 2007). The identification of ecological corridors is a key component of the SmartGrowth strategy for the western Bay of Plenty. This report provides an overview of the two studies, draws them together, and provides rankings of all the corridors across the SmartGrowth area. The three reports should be read together. Refer to the other reports for background information and descriptions and maps for each of the corridors.

2. PROJECT SCOPE AND DEFINITIONS

The project brief was "to identify, map, and prioritise all existing ecological corridors and potential ecological corridors within the SmartGrowth area". Corridors can be thought of as narrow, linear landscape elements that connect two or more patches of distant habitat (c.f. Soule and Gilpin 1991), although for this study a "corridor" was not required to be linear or continuous, and the term has been used to refer to actual and potential ecological linkages and connections between areas of indigenous vegetation and habitat, including:

- discrete areas of indigenous vegetation or habitat linked by a natural feature such as a waterway;

- a discontinuous band or strip of indigenous vegetation area which extends across one or more bioclimatic zones and encompasses remnants of indigenous vegetation separated from each other by relatively narrow patches of exotic vegetation (e.g. agricultural and/or horticultural land uses). These corridors typically extend from the coast inland to the Papamoa Hills or the Kaimai Range;

- continuous (or nearly continuous) bands of indigenous vegetation that extend across large parts of the study area. Some of these linkages extend outside of the study area (e.g. to the south);

The underpinning concept is connectivity or potential connectivity. The connections may not be linear and need not be continuous – the key is the functional connection between remnants. The classic linear corridor and ecological networks are potential means for achieving that connectivity (Hilty *et al*. 2006). A corridor may simply mean habitats that are sufficiently close to each other (i.e. functionally linked) to enable dispersal between them. The project used networks of natural areas to identify potential corridors, looking at proximity of remnants and the possible connections between them, including representation of sections of ranges to sea. This approach addresses the need for biodiversity to be assessed and managed at a landscape scale where remnants are all that remain. Opportunities for ecological corridors outside of the catchment of Tauranga Harbour are mainly linear strips along water bodies,

whereas Environment Bay of Plenty (2006) focussed more on opportunities related to remnants of existing indigenous forest and potential links to the harbour margin.

3. METHODS

Tauranga Harbour Catchment

Corridors within the catchment of Tauranga Harbour were identified and prioritised by Environment Bay of Plenty (2006) using in-house Geoview spatial layers showing significant natural areas. Corridors and potential corridors were identified as networks of significant natural areas that were adjacent, linked, or nearby. Each corridor was evaluated using nine criteria: size and shape, representativeness, natural diversity, rarity, naturalness, long term viability, buffering and surrounding landscape, fragility and threat, and community support. The corridors were then ranked (i.e. relative priorities were assigned), based on the representation of "viable examples of all species and ecosystems in a given area".

Remainder of Study Area

Corridors beyond the catchment of Tauranga harbour were identified and prioritised by Wildland Consultants (2007), using the following methods:

- Existing information about natural areas was collated and evaluated (refer to the reference list presented with the report).
- Relevant digital data was compiled and evaluated, particularly data layers previously prepared for the evaluation of ecological constraints in the Smart Growth area by Wildland Consultants in 2003, and significant natural areas identified in the Western Bay of Plenty District plan (2002).
- Recent aerial photographs of the study area were examined.
- Ecological features were mapped, including waterways, recommended areas for protection (as per Beadel 2006), sites identified in council plans (e.g. Western Bay of Plenty District Plan 2002, Regional Coastal Environment Plan 2003), protected natural areas (covenants and land administered by Department of Conservation), and other examples of indigenous vegetation.
- Actual and potential ecological corridors and linkages were identified using the above information.
- Vegetation, flora, and fauna in each corridor were described, based mainly on existing information.
- Some sites were checked in the field, particularly those for which there was a lack of existing information.

- The ecological values represented in each corridor were then assessed against a suite of criteria (representativeness, diversity and pattern, shape, ecological viability and sustainability, naturalness, rarity and special features, and fragility and threat), and relevant spatial attributes were measured.

- The ecological evaluations and spatial data were used as a basis to assign relative ecological priorities. High priority corridors were selected to "include the best examples of representative ecological units" and "include as wide a range of representative ecological units in a single large area as possible" (Environment Bay of Plenty 2006).

- Management options and priorities were also developed, based on ecological information and GIS data.

Overview

This report summarises the two reports described above, and evaluates all of the corridors within the SmartGrowth study area to produce a comprehensive prioritisation of all corridors identified in the study area.

4. CORRIDORS IN THE CATCHMENT OF TAURANGA HARBOUR

Environment Bay of Plenty (2006) identified six corridors in the catchment of the Tauranga Harbour (refer to Figure 1):

- Tuapiro;
- Work Road;
- Te Puna;
- Hidden Gorge;
- Otawa;
- Aongatete-Waipapa.

Four of the corridors (Tuapiro, Work Road, Te Puna, and Hidden Gorge) extend inland from the harbour to the base of the Kaimai Range, one extends from the harbour inland to the Papamoa Hills (Otawa corridor), and one is on the margin of the Tauranga Harbour between Aongatete and Waipapa. Brief descriptions of each corridor are provided below. Refer to Environment Bay of Plenty (2006) for more detail.

Tuapiro Corridor

The Tuapiro Corridor extends from the Tuapiro Estuary, which is located towards the northern end of Tauranga Harbour, inland to the Kaimai Range. It spans the coastal, semi-coastal, and lowland bioclimatic zones, in the Tauranga and Te Aroha Ecological Districts. The corridor encompasses approximately 1,317 ha, including 29 ha which has been identified as a 'significant ecological site' in the Western Bay of Plenty District Plan (2002), including 460 ha of indigenous vegetation and 15 km of rivers and streams.

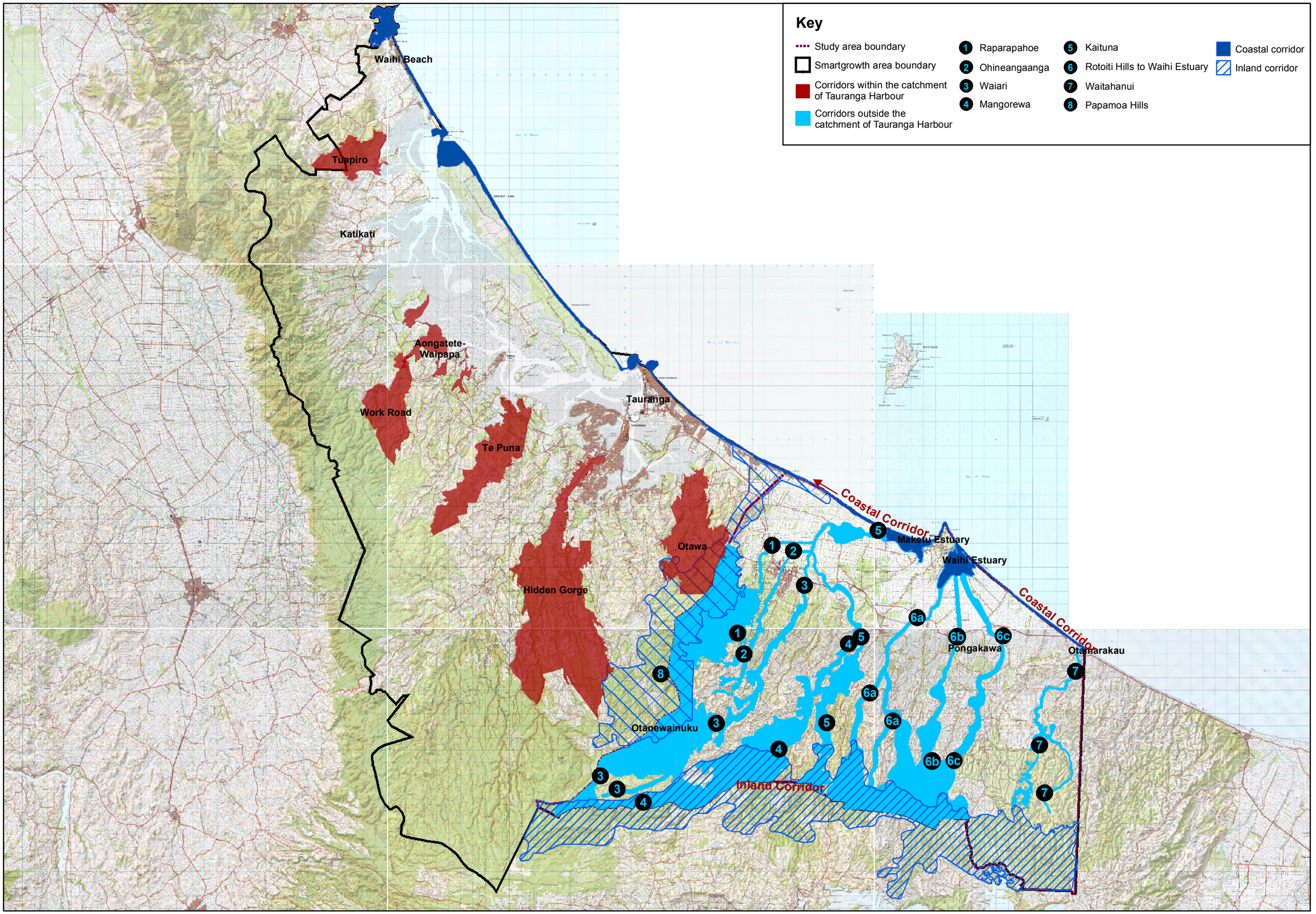

Figure 1: Actual and potential ecological corridors and linkages in the SmartGrowth study area

N

0 10 20 km

Wildlands

Scale: 1:285,000
Date: 05/06/07
Cartographer: LKM

Work Road Corridor

The Work Road corridor encompasses *c.*1,933 ha between the Wainui Estuary and the Kaimai Range. It includes forested gullies, particularly adjacent to the Wainui and Whatakao Rivers and their tributaries, and coastal and estuarine wetlands. The Wainui Scenic Reserve is a distinctive feature of the corridor because it is one of the few remaining examples of terrestrial indigenous vegetation in the Tauranga Ecological District. This corridor includes 743 ha of indigenous forest, 42 km of rivers and streams, and 2.4 ha of wetland. A key value is the connection between the Wainui Estuary and the Kaimai Range. About half of the corridor is recognised as significant ecological sites in the Western Bay of Plenty District Plan.

Te Puna Corridor

The Te Puna corridor extends from the Te Puna and Waikaraka estuaries to the base of the Kaimai Range, encompassing approximately 2,912 ha. It spans the coastal and semi-coastal bioclimatic zones and includes good quality estuarine vegetation types, which also provide habitat for threatened indigenous bird species (e.g. fernbird and banded rail), and the Te Puna Quarry Park. It includes 705 ha of indigenous forest, 56 km of rivers and streams, and 5.3 ha of wetlands, some of which is protected in Environmental Programmes, under covenants, and in reserves.

Hidden Gorge Corridor

The Hidden Gorge corridor encompasses *c.*7,498 ha between the Waikareao Estuary (in Tauranga City) and indigenous vegetation on the Papamoa Hills and Kaimai Range. It extends along the Kopurererua Stream and part of the Omanawa River. Protected natural areas within the corridor include the Tautau Scenic Reserve and the Hidden Gorge Scenic Reserve. This is a relatively large corridor that includes 2,512 ha of indigenous forest, 265 km of rivers and streams, and 62 ha of wetlands. The lower reaches are subject to intensive land subdivision for residential and industrial uses. A key value is the linkage between the Waipapa Estuary and the Kaimai Range.

Otawa Corridor

The Otawa Corridor extends across three bioclimatic zones (coastal, semi-coastal, lowland) from the Rangataua Estuary to the Papamoa Hills, encompassing approximately 3,248 ha. Indigenous vegetation and habitats within the corridor are confined to estuarine saltmarsh and shrubland on the margins of the estuary, at the northern end of the corridor, and indigenous forest at the southern end of the corridor. The latter includes 782 ha of significant ecological sites recognised in the Western Bay of Plenty District Plan, with a total of 1,214 ha of indigenous vegetation, 67 km of rivers and streams, and 4.3 ha of wetlands.

Aongatete-Waipapa Corridor

The Aongatete-Waipapa Corridor encompasses the margin of Tauranga Harbour between Aongatete and the Omokoroa Golf Course. It is mainly estuarine wetlands and intertidal flats, and includes habitat for marsh birds. Vegetation types within this

corridor includes mangrove scrub and shrubland, searush and oioi sedgelands, and marsh ribbonwood scrub. This corridor includes the Aongatete, Wainui, Apata, and Waipapa estuaries and Te Hopai Island, all of which are recognised as Category 1 natural areas. The key value of this corridor is to protect estuarine indigenous vegetation and marshbird habitats.

5. CORRIDORS IN THE REMAINDER OF THE SMARTGROWTH AREA

Wildland Consultants (2007) identified ten actual or potential ecological corridors within that part of the SmartGrowth project area outside of the catchment of Tauranga Harbour (refer to Figure 1):

- Raparapahoe;
- Ohineangaanga;
- Waiari;
- Mangorewa;
- Kaituna ;
- Waihi Estuary to Rotoiti Hills;
- Waitahanui;
- Papamoa Hills;
- The Coastal Strip;
- Inland corridor.

Eight of these corridors are oriented roughly north-south and extend from the coast inland to the Papamoa Hills and the Mamaku Plateau: Raparapahoe, Ohineangaanga, Waiari, Mangorewa, Kaituna, Waihi Estuary to Rotoiti Hills, Waitahanui, and Papamoa Hills. Two west-east corridors were also identified: the Coastal Strip which extends along the open coast, and an inland corridor which extends along the inland boundary of the study area. The Raparapahoe, Ohineangaanga, and Waiari corridors are all in the lower Kaituna catchment, and link with the Papamoa Hills corridor. The Mangorewa is also in the Kaituna catchment, but is situated further upstream. Brief descriptions of each corridor are provided below. Refer to Wildland Consultants (2007) for more detail.

Raparapahoe Corridor

The Raparapahoe corridor encompasses *c.*3,713 ha and links the Papamoa Hills (including Otawa Scenic Reserve) to the Kaituna River. It encompasses the Raparapahoe Stream and its tributaries. It also includes most of Otawa Scenic Reserve, where the dominant canopy species are tawa, kohekohe, and kamahi. The middle and lower reaches of the corridor are dominated by exotic vegetation; predominantly agricultural and horticultural land.

Ohineangaanga Corridor

The Ohineangaanga corridor encompasses *c.*430 ha of the catchment of the Ohineangaanga Stream and has potential to be linked to the Raparapahoe corridor.

The upper section of the stream is confined to a gorge and steep-sided gullies dominated by indigenous vegetation. The lower reaches of the corridor are dominated by exotic vegetation where the stream passes through Te Puke and agricultural land between Te Puke and the Kaituna River.

Waiari Corridor

The Waiari corridor is centred on indigenous vegetation along the Waiari Stream and its headwater tributaries. It encompasses *c.*4,934 ha and extends from the eastern side of the Mamaku Plateau and the southern flanks of Otanewainuku to the Kaituna River. Indigenous vegetation in the upper reaches of the corridor is characterised by tawa-dominant forest. The northern *c.*6 km of the corridor is agricultural and horticultural land.

Mangorewa Corridor

The Mangorewa corridor encompasses *c.*4,397 ha and extends along the Mangorewa River from its headwaters on the Mamaku Plateau (northwest of Rotorua) to the point where it flows into the Kaituna River. It includes tributaries of the upper Mangorewa River. For most of its length, the river is confined to a deeply-incised gorge contiguous with adjacent indigenous forest, emerging from the gorge two kilometres or so before it joins the Kaituna River.

Kaituna Corridor

The Kaituna corridor encompasses *c.*2,557 ha of the lower catchment of the Kaituna River, and includes the Maketu Estuary. The upper part of the corridor is characterised by a deeply-incised gorge which is a ribbon of predominantly indigenous vegetation adjoining extensive areas of pine plantation. The river emerges from the gorge south of Paengaroa, and the vegetation and habitats within this part of the corridor are predominantly agricultural and horticultural in character. Closer to the sea there is a large remnant wetland, the Kaituna Wildlife Management Reserve, and within *c.*1 km of the sea part of the river flows into the Maketu Estuary while the remainder flows directly to the coast at Te Tumu (the "Kaituna Cut"). The lower reaches of the Raparapahoe, Ohineangaanga, Waiari, and Mangorewa corridors are contiguous with the Kaituna corridor.

Rotoiti Hills to Waihi Estuary Corridor

Waihi Estuary is located on the eastern side of the Okurei headland (Town Point). Four canals and a network of smaller drains flow into the Waihi Estuary. Three potential sub-corridors, encompassing a total of *c.*7,460 ha, can be recognised in this catchment, based on the canals that they discharge into: Pokopoko, Wharere, and Pongakawa, which are all highly modified. The estuary and its margins include examples of estuarine and coastal wetlands, but the wider catchment is highly modified. The plains north of SH2 are predominantly dairy farms, while the hills south of the highway are a mixture of pastoral land and exotic plantation forest with only narrow strips of indigenous vegetation along waterways. The closest sizeable areas of indigenous vegetation inland of the estuary are more than fifteen kilometres distant (e.g. Roydon Downs Scenic Reserve).

Waitahanui Corridor

The Waitahanui corridor (*c.*599 ha) provides an ecological link between Rotoehu Forest and the coast at Otamarakau, with the Waitahanui Stream being the basis of the corridor. The headwaters of the stream arise in the extensive area of exotic forest towards the southwest boundary of the study area, including some as far inland as Rotoehu Forest. The margins of the Waitahanui Stream and its tributaries include small areas of indigenous forest and grey willow wetland, some of which are within land administered by the Department of Conservation or are protected by covenants. It is noteworthy that of all the corridors considered in the Wildland Consultants (2007) report, the Waitahanui Stream is the only waterway which has a relatively 'natural' stream channel in its lower reaches and a relatively natural connection to the coast.

The Coastal Strip Corridor

A coastal corridor extends along the coast from Waihi Beach, in the northwest of the study area, to Otamarakau Beach in the east. In the east it includes Bowentown Heads and Matakana Island. It also encompasses Mauao and the coastal dunes between Mauao and the Kaituna River, the Maketu Spit, and Maketu Estuary. Continuing east, it includes the coastal cliffs around the Okurei headland (which separates Maketu Estuary from Waihi Estuary), Waihi Estuary and Pukehina spit, and the stretch of open coast between Pukehina and Otamarakau. It includes both high quality and heavily modified examples of dune vegetation and coastal and estuarine wetlands.

Inland Corridor

A potential inland corridor extends along the southern boundary of the SmartGrowth study area between the Mamaku Plateau in the west and the Rotoiti Hills in the east. It includes the upper catchments of the Waiari, Mangorewa, Kaituna, Rotoiti Hills to Waihi Estuary, and Waitahanui Corridors, and is linked to the Raparapahoe and Ohineangaanga Corridors through indigenous vegetation to the east of the study area. The Inland Corridor also extends across the southern boundary of the study area, to the shores of Lakes Rotoiti and Rotoehu. It is characterised by areas of indigenous vegetation which are separated by agricultural land and exotic forest.

Papamoa Hills Corridor

The Papamoa Hills corridor extends along the Papamoa Hills from Otanewainuku to the coast at Papamoa Beach. It encompasses more than 11,000 ha, of which 7,600 ha (69%) is indigenous vegetation. It includes relatively large areas administered by the Department of Conservation and also the Papamoa Hills Regional Park. There is considerable potential for intensive pest management in indigenous forest and also revegetation of gully systems to the north.

6. RELATIVE PRIORITIES IN TAURANGA HARBOUR CATCHMENT

Part of the brief for this project was to assign relative ecological priorities for each of the corridors. As outlined in Section 4 of this report, Environment Bay of Plenty (2006) identified and prioritised corridors within the catchment of Tauranga Harbour and selected high priority corridors to "include the best examples of representative ecological units" and to "include as wide a range of representative ecological units in a single large area as possible". On this basis, Environment Bay of Plenty (2006) prioritised the corridors in the catchment of Tauranga Harbour as set out below. These corridors are not listed in order of relative priority. Further investigation is to be undertaken, by Environment Bay of Plenty, of opportunities for active management within selected corridors.

High Priority Corridors

- Margins of Tauranga Harbour (Aongatete-Waipapa)
- Hidden Gorge
- Work Road

Second Priority Corridors

- Otawa
- Te Puna
- Tuapiro

7. RELATIVE PRIORITIES IN REMAINDER OF STUDY AREA

Wildland Consultants (2007) prioritised the ten corridors identified within the remainder of the SmartGrowth project area as set out below (in rough order of priority):

Highest Priority Corridors

- The Coastal Strip
- Kaituna

Second-Priority Corridors

- Mangorewa
- Waitahanui
- Papamoa Hills
- Raparapahoe
- Ohineangaanga
- Waiari

Longer-Term Priorities

- Inland corridor
- Rotoiti Hills to Waihi Estuary

8. OVERALL PRIORITIES

The full suite of 16 corridors identified within the SmartGrowth study area by Environment Bay of Plenty (2006) and Wildland Consultants (2007) has been prioritised, based on relative ecological values, as set out below. The three categories of relative priorities contain corridors of a similar level of relative priority. It is not feasible to place all corridors in an ordered list of relative priorities. Discussion of relative priorities is provided in the next section, under the same sub-headings.

Highest Priority Corridors Overall

- The Coastal Strip (including Matakana Island)
- Margins of Tauranga Harbour (Aongatete-Waipapa)

Second-Priority Corridors Overall

Level 1

- Kaituna (including Maketu Estuary)
- Mangorewa
- Papamoa Hills
- Hidden Gorge

Level 2

- Work Road
- Te Puna
- Tuapiro
- Otawa

Level 3

- Waitahanui
- Raparapahoe
- Ohineangaanga
- Waiari

Longer-Term Priority Corridors

- Inland Corridor
- Rotoiti Hills to Waihi Estuary

While only a limited number of corridors have been identified as being of "highest priority", all of the corridors identified in this report provide opportunities for ecological restoration and enhancement.

9. DISCUSSION OF RELATIVE PRIORITIES

9.1 Highest priority corridors

The two corridors in this category have a similar level of relative priority as they both contain good quality and threatened vegetation and habitat types. The margins of Tauranga Harbour are a high priority because they include a diverse range of estuarine and freshwater wetlands, which are habitat for a variety of indigenous species of marine and freshwater fishes avifauna, and flora, some of which are threatened or uncommon. The Tauranga Harbour has been recognised as a wetland of international significance (Cromarty and Scott 1996).

The coastal strip corridor is also a high priority because it includes examples of habitat types which are nationally uncommon (i.e. coastal dunes and coastal wetlands). It includes both high quality and more modified examples of these habitat types. High quality sites within the coastal corridor include wetlands on Matakana Island, in Maketu Estuary and in Waihi Estuary, and dunes on Matakana Island (which are particularly significant) on the Maketu Spit and between the Kaituna River and Papamoa. Other priority sites are dunes which are currently of good quality but which will become degraded if existing weed infestations are not controlled and/or if steps are not taken to prevent vehicle damage, e.g. Otamarakau, and some of the dunes at Papamoa, Mount Maunganui, and between Bowentown and Waihi Beach.

9.2 Second priority corridors

This category has been divided into three groups, Levels 1, 2, and 3, with a similar approximate level of relative priority. The first includes the Kaituna, Papamoa Hills, Mangorewa, and Hidden Gorge corridors. The second level includes four corridors that all link with Tauranga Harbour: Work Road, Te Puna, Tuapiro, and Otawa. The third level is four modified catchments in the western part of the study area: Waitahanui, Raparapahoe, Ohineangaanga, and Waiari. These latter corridors will require more effort and resources to achieve ecological restoration, as compared to those in the higher categories.

Level 1

The Kaituna corridor is a high priority because it includes large areas of indigenous forest in the inland part of the corridor and freshwater and estuarine wetlands in its lower reaches (e.g. Maketu Estuary, Kaituna River wetlands). Wetlands have been greatly reduced in extent in the Western Bay of Plenty, and some of the best remaining examples are within the lower reaches of the Kaituna corridor. If the Kaituna corridor is protected and restored, it would create an ecological link between the coast and the lower ends of the Raparapahoe, Ohineangaanga, Waiari, and Mangorewa corridors.

The Papamoa Hills Corridor includes a regionally significant and relatively large tract of indigenous vegetation on the Papamoa Hills. Revegetation of parts of the Papamoa Hills Regional Park, and enhancement of waterway reserves and urban areas of Papamoa has the potential to restore elements of a functional ecological corridor between the coast and the summit of Otanewainuku, with a good diversity of ecological units and habitat types. This corridor is contiguous with the Otawa and Hidden Gorge corridors identified by Environment Bay of Plenty (2006) and the Raparapahoe and Waiari corridors identified by Wildland Consultants (2007). The link with the Hidden Gorge and Otawa corridors provides an actual and potential ecological link between the Papamoa Hills and Tauranga Harbour. The Hidden Gorge corridor is also a high priority, particularly if it is managed as part of a plan to restore/manage the Papamoa Hills corridor, with which it is contiguous.

The Mangorewa catchment has extensive areas of good quality indigenous vegetation and riverine/stream habitats, with relatively little effort required to restore linkages in the lower catchment (where it is connected to the Kaituna corridor). Intensive pest control is already underway to protect threatened species such as kokako.

The Hidden Gorge corridor encompasses a large proportion of the headwaters of the Kopureurerua Stream, including stream margins and wetlands that are already subject to an ecological restoration initiative. It also links with the Papamoa Hills corridor.

Level 2

This second sub-grouping includes the Otawa, Work Road, Te Puna, and Tuapiro corridors, which connect with the margins of Tauranga Harbour. The Otawa corridor also connects the Papamoa Hills to Tauranga Harbour (Rangataua Estuary). The Otawa, Work Road, Te Puna, and Tuapiro corridors have, at a general level, similar ecological values, with high values in the parts of Tauranga Harbour that they connect to.

Level 3

The Waitahanui corridor is an interesting case in that it is an entire catchment, with a good quality waterway connecting forested headwaters to the coast at Otamarakau.

The Raparapahoe, Ohineangaanga, and Waiari corridors all have similar values, but connect with the Kaituna corridor rather than with the high-value Tauranga Harbour.

9.3 Longer term priorities

These are corridors with large proportions that are highly modified and will require significant investment to restore functional corridors. For these reasons, and because there are much higher priorities elsewhere in the SmartGrowth project area, it is best to regard these corridors as being much longer-term issues, to be addressed when opportunities and resources allow.

9.4 Further evaluation

Ultimately, prioritisation of corridors or sites within particular corridors will be subject to factors other than ecological values alone. An inter-agency project team will consider a number of other factors before setting final priorities for corridors. Community, landowner, practical, political, and social considerations will influence the ultimate priority setting process. These will include factors such as the number of landowners, their level of support, the length of corridor which is already protected, the extent of works already undertaken by Environment Bay of Plenty in environmental programmes; the intensity and types of adjacent land use, and the amount of land management effort and resourcing required to address issues.

10. MANAGEMENT TO PROTECT AND ENHANCE CORRIDORS

The corridors which have been identified represent actual and potential ecological linkages, and all would benefit from enhancement and/or restoration. Key management requirements include:

- fencing to exclude domestic stock from areas of indigenous vegetation and from waterways;
- planting to restore indigenous vegetation cover;
- the control of introduced pests (both plants and animals) in natural areas;
- the restoration of hydrological regimes that have been altered by, e.g. draining of wetlands and/or channelisation of streams and rivers;
- legal protection of natural areas.

Management to protect and enhance ecological corridors inevitably triggers the need, on a case-by-case basis, to consider the need to address the full suite of issues associated with ecological protection and enhancement. An overview of these issues is set out below.

10.1 Grazing

Exclusion of domestic stock is generally one of the most basic requirements to protect or restore natural areas. Most of the natural areas along the corridors identified in this project are bounded by land which is managed intensively for economic return. Adjacent land uses can affect ecological corridors in a number of ways, but perhaps the most obvious negative impacts are those of domestic stock, particularly cattle, which have major effects on vegetation as well as direct and indirect effects on water quality and instream habitat values. They deposit excrement into waterways, either directly or through runoff, cause physical damage to the banks and beds of waterways through trampling, and browse or trample (and destroy) understorey and streamside vegetation. An effective way of preventing some of these impacts is to ensure that all waterways are fenced to exclude stock.

10.2 Water quality and nutrients

Land management practices, such as the use of fertilisers, also affects instream habitat values. This can be moderated by establishing fenced riparian buffers, and by

restoring indigenous riparian vegetation and wetlands. Six of the corridors follow waterways between coastal and inland sites. It could be anticipated that improved management of these corridors will result in improved water quality in the lower reaches of the corridors and in the receiving waters (e.g. Maketu and Waihi Estuaries). However, this would be unlikely to eventuate without management of the many small waterways which flow into the lower reaches of each corridor, in addition to the larger waterways which comprise a corridor, and this can only be achieved in the medium to long term. It must also be remembered that the lower reaches of some of the larger waterways flowing into the estuaries are subject to significant nutrient inputs, from farmland, and this will not be mitigated by riparian protection or planting.

10.3 Land subdivision

Land subdivision can place increased pressure on natural areas, particularly relating to intensification of land use, pest plants (particularly 'escapes' from domestic gardens and horticultural operations), and domestic pets. Land use controls in District Plans need to address these issues so that actual and potential corridors and linkages are not compromised.

10.4 Plantation forest management

Where indigenous riparian vegetation comprises a narrow ribbon within an exotic plantation forest, there is a risk that the indigenous vegetation will be damaged when trees are harvested. This can be minimised if the logging operations avoid felling trees into riparian margins, and do not push debris into riparian zones.

10.5 Pest plants

Pest plants are present within or on the margins of most natural areas within the study area. Pampas is present on the coastal dunes, and is widespread on the margins of estuaries, on patches of higher ground within saline wetlands, and on higher ground throughout freshwater wetlands such as the Kaituna wetland, as well as being present on forest margins, disturbed sites, and steep faces. Wild pines are also present across a range of landforms and habitat types. Other key invasive species present in the study area include Japanese honeysuckle, brush wattle (*Paraserianthes lophantha*), boxthorn (*Lycium ferossimum*) on coastal dunes, willows (*Salix* spp.) in wetlands, wild kiwifruit (*Actinidia chinensis*), and privet species (*Ligustrum* spp.). Weed control will be an ongoing component of ecological management undertaken in the corridors.

10.6 Pest animals

Introduced mammals browse on indigenous vegetation and prey on indigenous birds, reptiles, and invertebrates. Natural areas generally within the corridors would benefit from the control of possums, rats, mustelids, and feral cats. Rabbits should be controlled on sand dunes and at planting sites. Intensive pest control is being undertaken on dunes and beaches, for protection of New Zealand dotterel on Matakana Island and at Maketu and there is potential for expansion of this work. Intensive pest management is also underway at inland sites such as Otanewainuku and Aongatete Forest.

10.7 Indigenous revegetation

Seven of the corridors originate inland and extend to the coast, being orientated broadly south-north. The most intact areas of indigenous vegetation are located in the upper (i.e. inland) reaches of each corridor, whilst the lower reaches closer to the coast are highly modified. In these lower reaches, the corridors represent potential ecological linkages which have the potential to be restored. The approximate length of each coastal-inland corridor which requires revegetation is presented under the heading "Spatial Characteristics" in each of the corridor descriptions. There are also "gaps" between areas of indigenous vegetation in the inland corridor which have the potential to be connected by natural regeneration or revegetation plantings, or a combination of these two approaches. Revegetation can be undertaken to restore a continuous corridor of indigenous vegetation or to create "islands" of indigenous vegetation which can then be used as "stepping stones" by mobile species.

Careful species selection will ensure the ecological 'integrity' of any planting-based revegetation/restoration projects undertaken within the corridors. Only locally-sourced ("eco-sourced") indigenous species should be used in plantings, with planting suites matched to the habitats present. 'Appropriate' species are those which occur naturally in similar habitats within the relevant ecological district. 'Inappropriate' indigenous species in ecological restoration plantings includes the use of a species (such as kauri) beyond its geographical range or outside of the bioclimatic zone in which it naturally occurs (e.g. planting a coastal species such as taupata too far inland), and planting species in a habitat where they would not naturally occur, e.g. planting whaririki (mountain flax; *Phormium cookianum*) in a wetland habitat which would be more suitable for harakeke (flax; *Phormium tenax*). The CoastCare programme follows these principles, with species matched to relevant parts of the dune ecosystem. If plants are "eco-sourced" (i.e. grown from seeds or propagules collected from plants occurring naturally in an area) they will be representative of the genetic diversity of the ecological district and/or the local area, and are also more likely to grow vigorously in that area than plants sourced from other parts of New Zealand. Cultivars of indigenous species (e.g. variegated flax, red akeake, variegated pittosporums) should not be used for ecologically-based restoration plantings.

Restoration plantings are likely to be dominated by a relatively limited number of fast-growing shrubs or small trees (e.g. manuka, kanuka, karamu, harakeke, koromiko, ti kouka) that will rapidly create a closed canopy and exclude weeds. However, it is important that a monoculture or near-monoculture is not created, particularly at sites where there are no nearby seed sources to naturally increase the diversity of the planting site over time. In addition to the fast-growing species, slower-growing tree species can be planted to provide food and/or habitat for indigenous birds. Suitable species include puriri, pigeonwood, fuchsia (*Fuchsia excorticata*), titoki, kanono, kohekohe, totara, miro, rewarewa, makomako, and tawa, although some of these are slow-growing and require shelter, and should only be planted after initial cover has been established. In wetlands, on appropriate sites, species diversity can be enhanced by planting trees such as kahikatea, ti kouka, and swamp maire (*Syzygium maire*), and by planting a buffer of terrestrial vegetation on wetland margins.

In addition to species selection, site selection and site size are important considerations when planning any revegetation/restoration project. Ideally, indigenous riparian margin vegetation should be a minimum of twenty metres wide on larger waterways but can be narrower on small tributaries. If sites are being planted to link areas of indigenous vegetation (for example, to link forested areas along the 'inland corridor') consideration will need to be given to the size of the areas to be planted and their shape in relation to 'edge effects' and the habitat requirements of indigenous fauna (e.g. suitable food species, territory sizes).

10.8 Habitat enhancement for fauna

Avifauna

Most corridors originate inland, in the lowland bioclimatic zone and follow rivers and streams to the coast. Typically, the southern parts of these corridors include indigenous forest located in gorges and on hill country, the middle reaches are highly modified and dominated by agricultural land, and the northern limits include small and/or modified coastal wetlands and sand dunes. The southern parts of the corridors are habitats for forest fauna (e.g. tui, kereru, bats) but there is only very limited or no habitat for these species in the lower parts of the corridors. Similarly, wading birds which utilise habitats along the coastal margins of the study area generally do not use habitats available further inland. Predator control to protect waders is already underway at Maketu and on Matakana, and there is potential to extend these initiatives.

Threatened bird species recorded in southern parts of the corridors (e.g. kiwi, kokako) are most likely to be able to be successfully managed/re-introduced in the larger forest tracts contiguous with the upper parts of some of the corridors or to benefit from the restoration of the 'inland corridor' (refer to Section 15). However, all of the corridors have the potential to act as refuges or provide seasonal habitats for these species.

Indigenous Fish

The mobile species which are most likely to benefit from corridors between coastal and inland sites in the short- to medium-term are those that rely upon instream habitats, particularly fish. For this reason, management of the corridors should include measures aimed to protect/enhance habitats for fish. Such measures should include improvement/protection of water quality, reducing nutrient and sediment runoff, excluding domestic stock from waterways and their margins, protection or restoration of indigenous vegetation along riparian margins, restoring/creating wetlands adjacent to the waterways, creating more 'natural' flow channels (e.g. by removing stopbanks and infilling drains), management of minimum flows, and removal of barriers to fish passage.

Invertebrates and Herpetofauna

Invertebrates are a key component of indigenous ecosystems but are often overlooked in ecological restoration projects. Management to protect and enhance invertebrate populations often involves measures such as exclusion of domestic stock but can also include much more intensive management to control predators such as cats, mustelids,

and rodents. The same types of management are required for the protection and enhancement of lizard populations.

Habitat Diversity

An important consideration in habitat enhancement is to restore a diverse range of habitat types. This helps to optimise the diversity of fauna and ensure that there is habitat for each fauna species throughout its life cycle and between seasons. For example, different plants produce flowers and fruits at different times of the year, so a diversity of plant species is required to ensure a constant food source for nectivorous and frugivorous birds - a near monoculture of a limited number of plant species cannot provide this. The habitat requirements of fish vary throughout their life cycles as they migrate between saline and freshwaters, and utilise spawning sites. For these reasons, habitat enhancement for fauna should aim to protect, enhance, and restore a diversity of inter- linked habitat types (e.g. estuarine wetlands, freshwater wetlands, and terrestrial habitats) and to ensure that each of the habitats includes a diverse range of the indigenous plant species and vegetation types which naturally characterise the habitat types present.

10.9 Monitoring

Monitoring is important, to evaluate whether management goals have been met. Monitoring involves recording data using repeatable and objective methods, so that the data can be used to detect levels and patterns of change. Monitoring is therefore useful for measuring the effectiveness of methods and for detecting the outcomes of various management actions. Outcomes include such things as changes in the assemblage of species at a site, the abundance of a single species, or water quality in a waterway. A monitoring system can rely on quantitative measurements (e.g. species numbers and/or sizes within a defined area), semi-quantitative methods (e.g. estimates of canopy cover, taped bird calls to elicit responses, listening surveys for birds at fixed stations), or more qualitative methods such as photopoints to monitor vegetation structure and composition.

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REFERENCES

Beadel S.M. In press 1994: Otanewainuku Ecological District Survey Report for the Protected Natural Areas Programme. Unpublished report, Department of Conservation, Rotorua.

Cromarty P., Scott D.A. (Eds) 1996: *A directory of wetlands in New Zealand*. Department of Conservation, Wellington, New Zealand. 395 pp.

de Lange P.J.; Norton D.A.; Heenan P.B.; Courtney S.P.; Molloy B.P.J.; Ogle C.C.; Rance B.D.; Johnson P.N.; Hitchmough R. 2004: Threatened and uncommon plants of New Zealand. *New Zealand Journal of Botany 42*: 45-76.

Environment Bay of Plenty 2006: Ecological networks and connections in the Tauranga catchment. *Environment Bay of Plenty Internal Report 2006/03*.

Hilty J.A., Lidicker W.Z. Jr, Merenlender A.M. eds. 2006: Corridor ecology: The science and practice of linking landscapes for biodiversity conservation. Washington DC: Island Press. 323 pp.

Hitchmough R., Bull L., and Cromarty P. (comp.) 2007: New Zealand Threat Classification System lists - 2005. *Science and Technical Publishing*. Department of Conservation, Wellington. 194 pp.

Pierce R.J.; Shaw W.B. 2003: A review of opportunities and priorities for kiwi management in the Bay of Plenty region. *Wildland Consultants Ltd Contract Report No. 619.* Prepared for Environment Bay of Plenty, Whakatane.

Soule M.E.; Gilpin 1991: The theory of wildlife corridor capability In *Nature Conservation 2: the role of corridors* (Eds. Saunders D.A., Hobbs R.J.). Surry Beatty and Sons, Chipping Norton.

Western Bay of Plenty District Council 2002: *Western Bay of Plenty District Plan*. Western Bay of Plenty District Council, Tauranga.

Wildland Consultants 2003: Ecological constraints to development in the Western Bay of Plenty. *Wildland Consultants Ltd Contract Report No. 555.* Prepared for Smart Growth Project. 19 pp.

Wildland Consultants 2007: Ecological networks and connections in the SmartGowth project area outside of the catchment of Tauranga Harbour. *Wildland Consultants Contract Report No. 1404.* Prepared for Environment Bay of Plenty.