Native Biodiversity Information

Issues and Options for the Manawatu District

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June 2002

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Front Cover Photo
A wetland-beech-podocarp forest, framed by key plants
Pohangina valley, Manawatu District
Photo: Helmut Janssen

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EXECUTIVE SUMMARY

The Manawatu-District's native biodiversity is unique both internationally (endemic species) and nationally (kahikatea wetlands, podocarp-tawa lowland and conifer-rata-broadleaf forests). Species inter-relationships and dependence upon one another (their evolved functional links) are more pronounced in this region's native lowland ecosystems than in the beech or kauri forest ecosystems of other parts of New Zealand. The nearest existing equivalents in New Zealand are the lower flanks of Mt. Taranaki and the rata-podocarp-broadleaf forest of the South Island's west coast.

Native biodiversity has been lost in the District and the Manawatu-Wanganui region more recently than in many other parts of New Zealand. Interior habitat of native lowland, wetland, coastal and hill-country ecosystems has been reduced to a point where native ecosystem processes are not sustainable and native biodiversity continue their rapid decline. Many native species have become extinct within the last 160 years (huia, stitchbird, saddleback, kokako, brown teal). Populations of remaining native species (for example of brown kiwi, kaka, parakeets, fernbird) are under immense pressures from habitat loss, spatial segregation, pest predation and competition and the continuing disintegration of evolved functional links.

Threshold

The threshold between gradual and exponential native biodiversity decline is reached where original ecosystems (their interior habitats) are reduced in extent to less than 20 %. Historic native lowland ecosystem loss has thus breached the threshold for native biodiversity and ecosystem sustainability. Under the 20 % threshold every native ecosystem remnant is therefore significant in terms of section 6 (c) of the RMA 1991, based the two criteria, representativeness and ecological context.

Applying additional criteria, such as habitat size, the diversity of native keystone species or the presence of indicator, rare or distinct species, prioritizes significant native sites. Spatial analyses complement such criteria to identify top priority habitat nodes. Habitat nodes have high key species diversity and abundance. Corridors can establish useful emigration links from such nodes to more fragile isolated habitats.

Integrated Response

The goal "halting native biodiversity decline" requires restoring native ecosystem processes. Robust biodiversity information is an essential prerequisite to design an effective response at regional and local scales. Sustainable land management practices that integrate production and protection as well as animal and plant pest control can effectively and efficiently achieve the goal.

Two strategic objectives to achieve the goal over the coming 20 years are to:

1. Reach the 20 % threshold for interior habitat of the District's native ecosystems and
2. Control pests effectively.

A stratified management approach differentiates significant from priority sites to efficiently implement the goal's strategic objectives:

1. Significant natural areas (SNAs):
    - Exclude stock from SNAs
    - Extend basic low cost pest control to all SNAs. Very important since animal pest numbers are presently unchecked in the Manawatu District, due to the absence of Animal Health Board possum control operations.
    - Advocate integrating production and protection objectives on private land.
    - Respond to requests for Environmental / Biodiversity grants (reactive).

2. Prioritised significant native sites:
    - Proactive approach to individuals landowners or landcare groups offering Environmental / Biodiversity grants to integrate production and protection objectives on land around prioritised sites.

Grants should be used to:

- Achieve compact interior habitat shapes by fostering native regeneration where sites are convoluted and within corridors.
- Control plant and animal pests concurrently.
- Convert existing native edge habitat to interior habitat by establishing tree crops (selectively harvestable native or exotic deciduous trees) around native forest edges
- Establish corridors to connect top nodes and priority sites.

CONTENTS

Table of Figures

Table of Tables

1. Introduction

This paper presents the state and pressures on native biodiversity[1] in the Manawatu District and proposes an effective response that could halt the decline of native biodiversity within 20 years.

2. Background to this Report

The Manawatu District Council prepares a state of the environment report for the District. The Regional Council was asked to provide information on the state and pressures on native biodiversity and ecosystem functions in the District. This report provides an analysis of the issues and options for the Manawatu District.

2.1 Biodiversity Vision

New Zealand's biodiversity vision statement aspires to "halt the decline of native biodiversity" within 20 years. Any useful contribution towards such a goal requires recognition of the state and pressures on regional native biodiversity and to devise an effective and efficient strategy that can achieve the vision statement for the District and the Region.

3. Environmental Facts

Native biodiversity has undergone immense changes since human settlement began in the District. The losses of native ecosystems[2] continue to challenge any sustainable future for the District's native biodiversity as isolated native animal and plant populations fade away in degraded habitats.

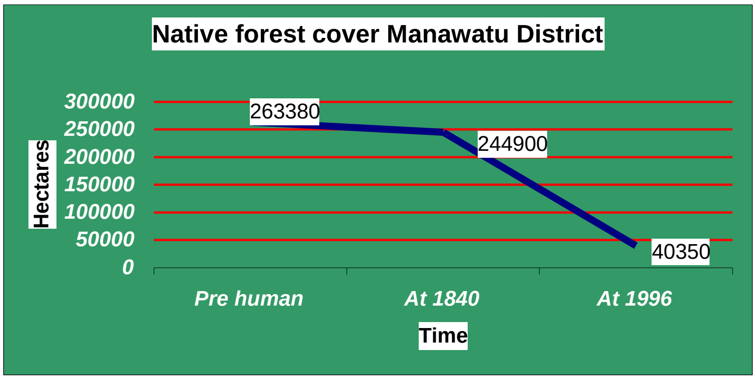

Figure 1: Native forest cover Manawatu District

[1] Biodiversity refers to the diversity of species, between species (site adapted populations of a species) and ecosystems.

[2] Ecosystem is a distinct physical environment with associated plants, associated animals and other organisms that function and interact as a distinct system.

Native ecosystem functions and resilience erode as exotic animal and plant pests compete with and consume native biota.

3.1 Mammalian Invasions

The first wave of human immigrants affected bird life in this region to the same extent as elsewhere in New Zealand. Unlike most other parts of New Zealand, the Region's native ecosystems were little affected by forest clearance until European settlement from the mid- 19th century (Figure 1). Humans soon found their limitations on the "bird islands" in terms of food supply. This was one important incentive to introduce exotic species to New Zealand. Figure 2 shows both native and exotic species numbers for New Zealand's taxa. Note the logarithmic scale on the graph's y-axes. The centre "% endemic" column shows the percentage of all species within a particular taxon that are found nowhere else but in New Zealand.

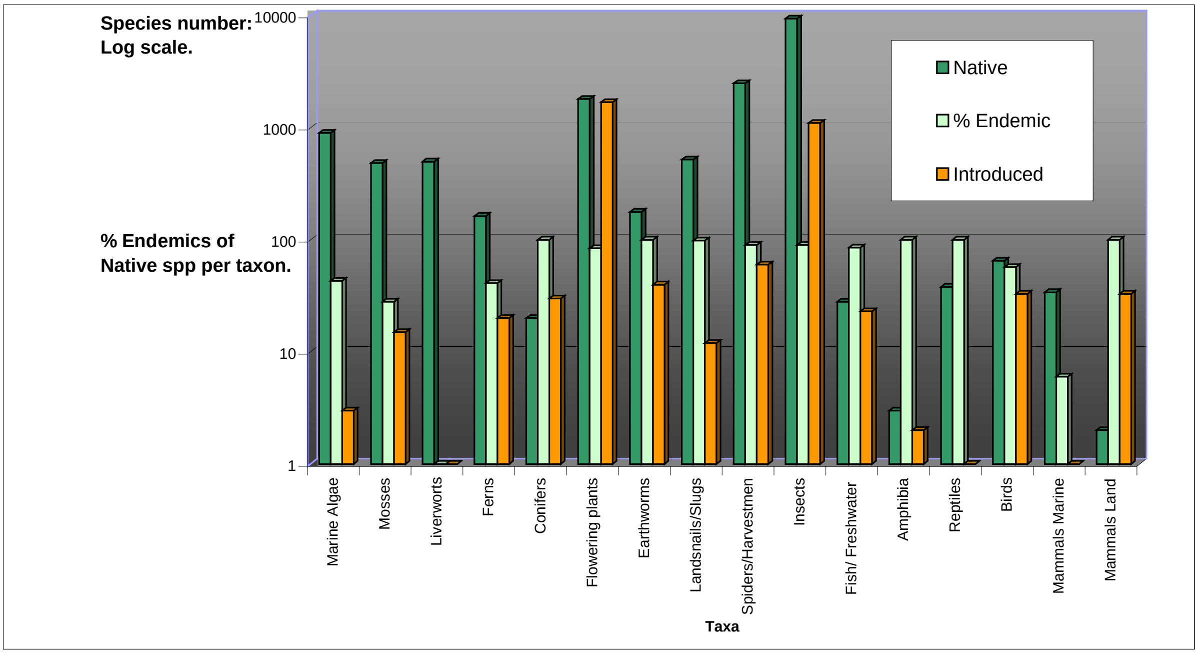

Figure 2: Comparison of NZ Native and Introduced Species Numbers

(Regionally relevant national data. National data collated by Dr Carol West, DoC Southland)

As the process of exotic invasions in New Zealand continues, it confirms scientific evidence that cosmopolitan exotic pest species do replace uniquely adapted native species, thus reducing overall species diversity and ecosystem resilience in the long-term.

3.2 National and International Significance of the Manawatu

Of the region's native plants and animals, 84% occur nowhere else on Earth, more than any other island nation. The Kahikatea swamp forest, once common on the Manawatu plains, is one of the world's oldest surviving forest communities (about 180 million years). The lineage of today's forest communities reaches back 6 million years, the time the lower North Island emerged from the sea (Fleming, 1979).

The Manawatu-District's temperate broad-leaved evergreen forest ecosystems are unique amongst the world's temperate forests. The District hosts many highly diverse ecosystems, including the lowland podocarp-tawa and kahikatea wetland forests, the hill-country conifer-rata-broadleaf forests, the cool-temperate beech and mountain cedar forests, tussock, alpine, coastal, dune and rain fed wetland ecosystems. The District's conifer-rata-broadleaf forest ecosystems top the earth's temperate forests in terms of plant species diversity. The most diverse and functionally linked native communities in New Zealand, the podocarp-tawa and conifer-rata-broadleaf forests covered its lowland and hill-country (Godley, 1984).

The District's distinct podocarp-broadleaf forests uniquely contribute to New Zealand's international recognition as one of 23 global biodiversity hotspots, which are recognized for their globally outstanding biodiversity value.

Figure 3 shows native forest fragment guardianship in the region in relation to our major ecosystem classes. 28% of the District's native forests[3] are privately owned, nearly all of which are remnants of the severely diminished lowland and hill country forest ecosystems.

[3] Graphic representations for forest classes are based on the Land Cover Database (LCDB v. 1, edition 2). The spatial resolution of forest-cover types is 1 ha and accuracy in hill-country is between 90 to 95%. As such, the LCDB is useful for national reporting and to provide an overview at regional and district scale, but is unsuitable as a baseline from which land cover changes can reliably be assessed over time. Such capabilities are presently being developed.

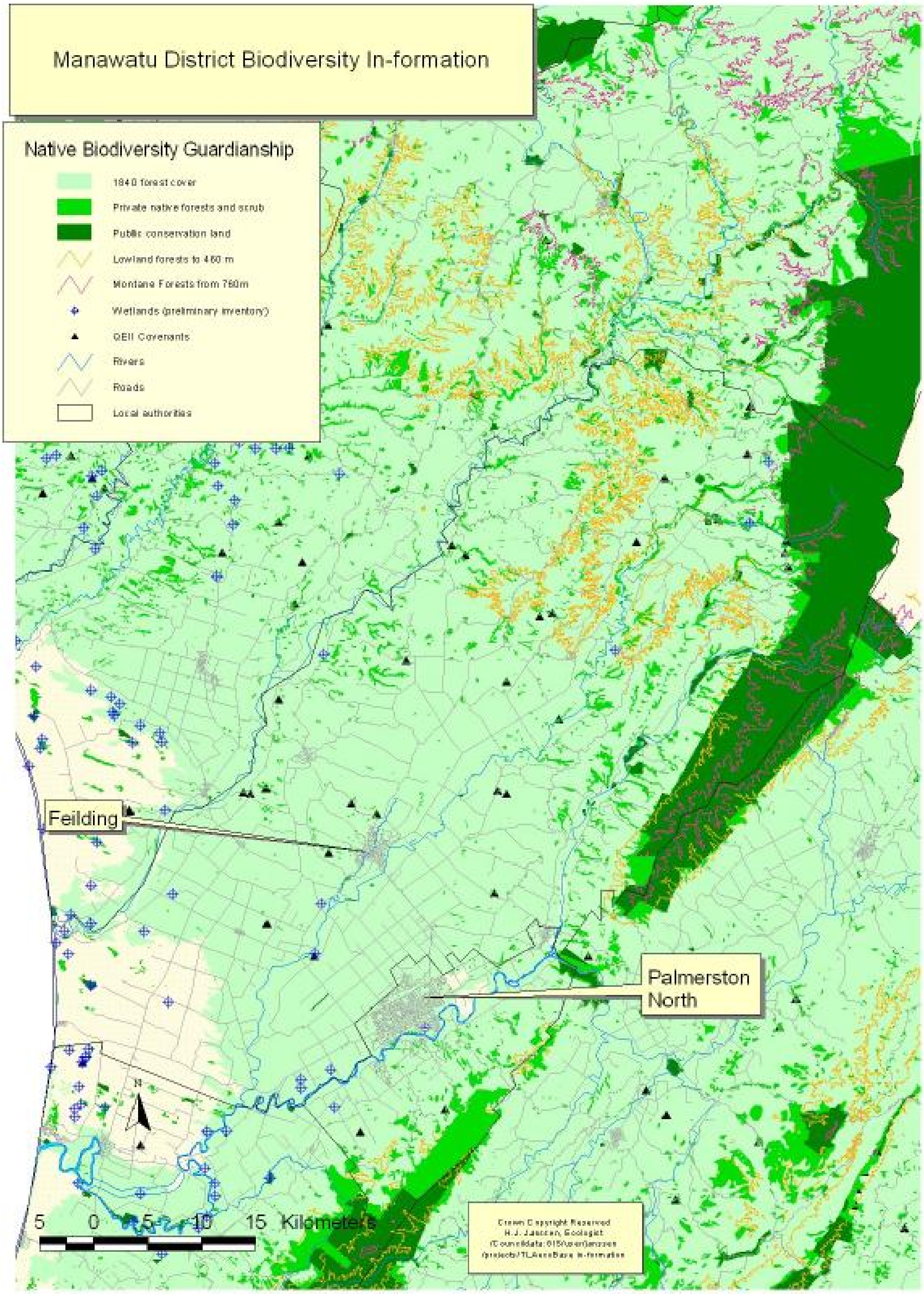

Figure 3: Native biodiversity loss and guardianship

Altitudinal and seasonal climatic gradients determine community composition and ecosystem dynamics such as fruiting and flowering periodicity and bird migration. The orange contour line (460 m) divides the lowland forest ecosystem, characterised by tawa canopies and emergent native conifers, from hill-country forest, characterised by conifer rata broad-leaf associations, without tawa and other associated lowland forest plants. The red contour line (760 m) is the approximate transition from hill-country forests to mountain ecosystems such as beech-hardwood forest, mountain cedar forest, leatherwood shrubs, wetlands, tussock and alpine herb fields. The paucity of functional lowland forest ecosystems affects the viability of plant and animal populations and their decreasing numbers affects hill country and mountain forest ecosystems processes, such as plant propagation.

Note the remarkable placement of both contour lines in terms of delineating boundaries of forest clearance. The 460-m contour line encircles most steep and exposed forests of the southern Ruahine range. The 760-m contour line follows remarkably close the boundary of the northern Ruahine range.

4. Desired Outcome

Halt the decline of native biodiversity in the Manawatu District.

This calls for the restoration of ecosystem functions throughout the District.

5. Ecosystem-Functions

Ecosystem functions refer to evolved functional links[4] and symbioses[5] that are particularly important in this region's ecosystems.

Ecosystem functions are threatened by:

1. The historic and continuing loss of:
    - Distinct native ecosystems
    - Interior habitat
    - Site adapted and remnant plant or animal populations (ecotypes)
    - Symbiotic plant or animal species (keystone species)

2. The fragmentation of forest or wetland habitat

3. Invasive plant or animal pests

[4] Between complex webs of site adapted organisms that **efficiently** cycle and conserve energy and nutrients, which define a native ecosystem and sustain its resilience.

[5] Symbiosis refers to dissimilar organisms mutually benefiting each other (fruiting plants and seed distributing birds; nutrient exchange between plants and fungi; humans and…, etc).

5.1 Native Keystone Species' Role in Sustaining Ecosystem Functions

Conservation efforts have often focused on saving critically endangered species. Scientists have realised that a more proactive ecosystem approach is required to enhance the survival of isolated populations and the resilience of native species (Murphy and Kelly, 2001) and their ecosystems. Ecosystem inventories and monitoring are required for environmental policy development and integrated ecosystem management can achieve native biodiversity outcomes. Ecosystem inventories, monitoring and management usefully focus on assessing and maintaining native ecosystem functions on both private and public land.

Throughout New Zealand's long isolation, birds, lizards and invertebrates have co-evolved with New Zealand's flora, resulting in intricate symbiotic relationships. Species that are pivotal to uphold such symbiotic relationships are referred to as keystone species.

Keystone species have a prominent role in sustaining ecosystem functions such as pollination, regeneration and food supply at times of scarcity. Keystone birds are particularly important for the propagation of a wide range of plant genera. For example, stitchbirds, bellbirds and tuis have a dual symbiotic function as pollinators and seed distributors of native shrubs and trees. Kereru are essential to the propagation of large seeded native trees such as matai, miro, black maire, hinau, karaka, taraire and tawa. Certain native plants (see plants framing the cover photo) are particularly important[6] in that their winter or early spring fruiting or flowering helps sustain native bird populations.

Native conifer-broadleaf plant communities depend on native birds to successfully regenerate. Native birds rely on the continuity and periodicity of fruit production. Forest ecosystem connectivity from mountains to sea provides food-resources over winter for seasonally migrating flocks of birds, which vacate their summer breeding territories in the ranges.

The highly diverse native plant community of previously extensive lowland forests and wetlands provided food-supply continuity, sustaining resilient animal populations. Now, habitat fragmentation and pests threaten a species' long-term survival, as remnant native animal and plant populations continue to perish from sites and shrink in distribution.

Figure 4, illustrates indicators of forest intactness:

1. Presence of species (Kaka, Robin, NZ parakeet, Kiwi) requiring intact habitats (large trees, few mustelids and cats)

[6] Miro (*Prumnopitys ferruginea*); Hinau (*Elaeocarpus hookerianus*), *Astelia spp*; *Pseudopanax spp*; *Fuchsia excorticata;* Kowhai (*Sophora spp*); *Metrosideros fulgens; Ripogonum scandens;* Kohekohe *(Dysoxylum spectabile); Nothofagus spp.* with scale insect and honeydew.

2. Diversity of keystone species (Kereru, Tui, Bellbird, plants that fruit or flower over the winter period) and
3. Native forest shapes (differentiating compact to extremely elongated shapes that correlate with increasing edge influence at native sites).

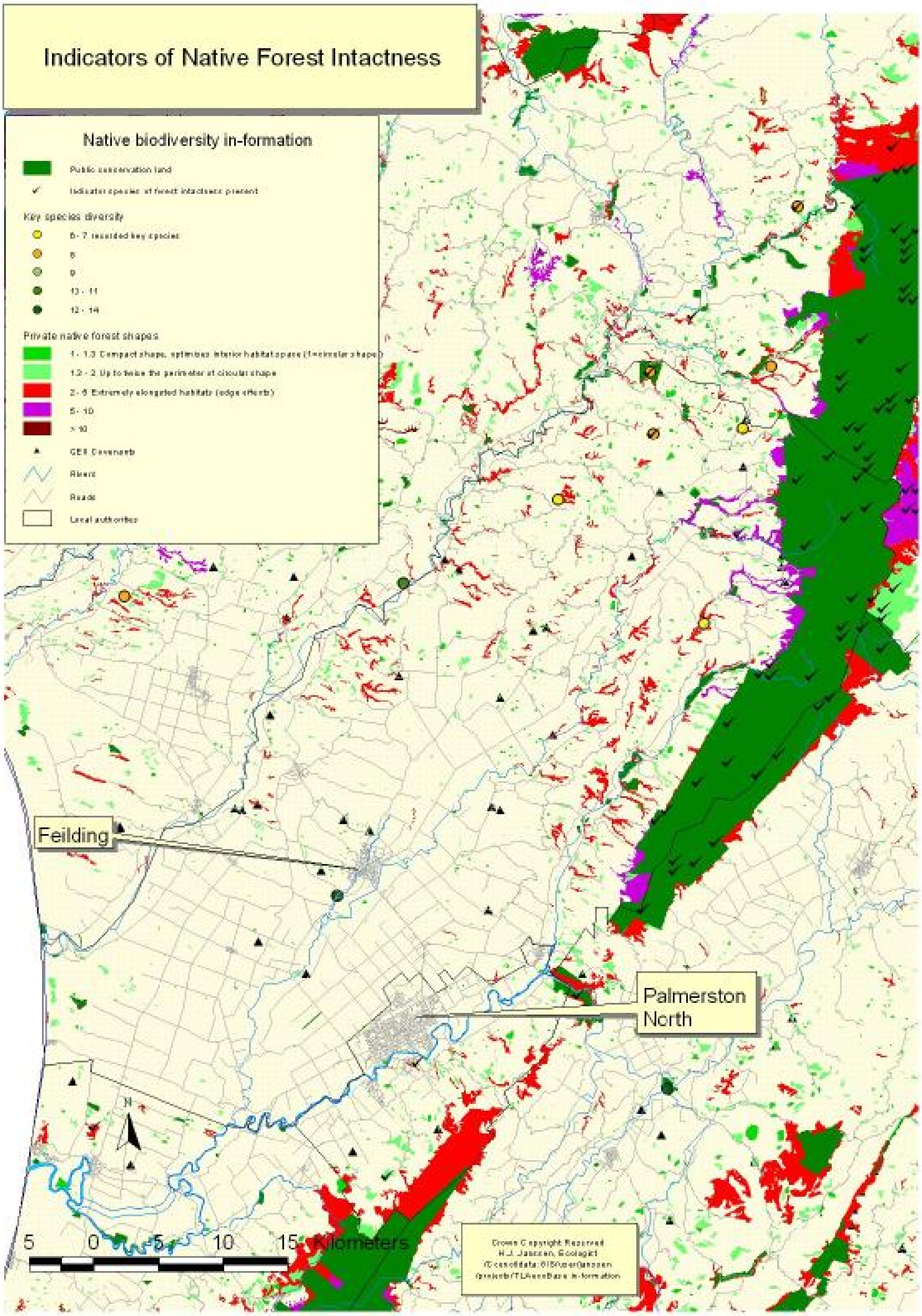

Figure 4: **Indicators of native forest intactness**

5.2 Effects of Habitat Shape

Compact habitat shapes (Shape index: SI < 1.3)[7] of patches that are over 10 hectares tend to have more interior relative to edge habitat and thereby provide a more favorable habitat for native animals and plants. In elongated habitat shapes (> 2. Figure 4, red and purple sites), edges tend to dominate. Edge effects penetrate native forest for 50-100m, depending on aspect, exposure and slope. Many exotic species and pests intensely compete with native animals and plants in edge habitat, which is why, integrated management of edges, conversion to interior habitat and pest control is necessary.

Figure 5 shows that most remnants are compact (SI <1.3) and small. However, due to their small size and despite their compact shape most have little interior habitat.

Conversely, quite a few of the large remnants with a shape-index (SI < 2, Figure 4, large red and purple sites) also have substantial areas of interior habitat, despite the site being dominated by edge effects. Elongated shapes make useful corridors, particularly where they are broad enough to contain interior habitat. It makes both ecological and management sense to plant up convoluted edges, thus creating sufficient interior habitat space for native biota.

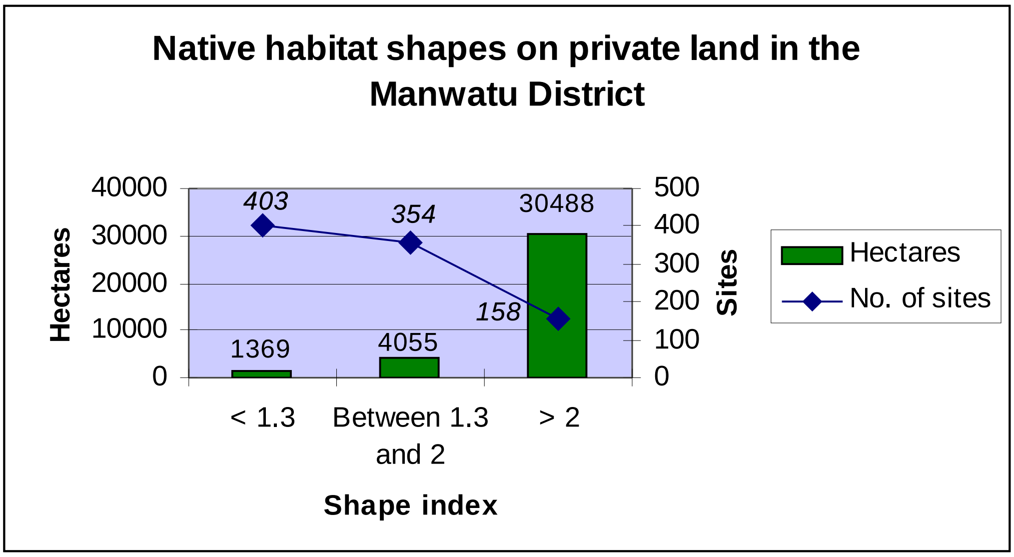

Figure 5: Native habitat shapes

[7] A shape index of 1 is a perfect circle and shape index 2 means that perimeters are more than twice the length the perimeter could be for a fragment of a certain size.

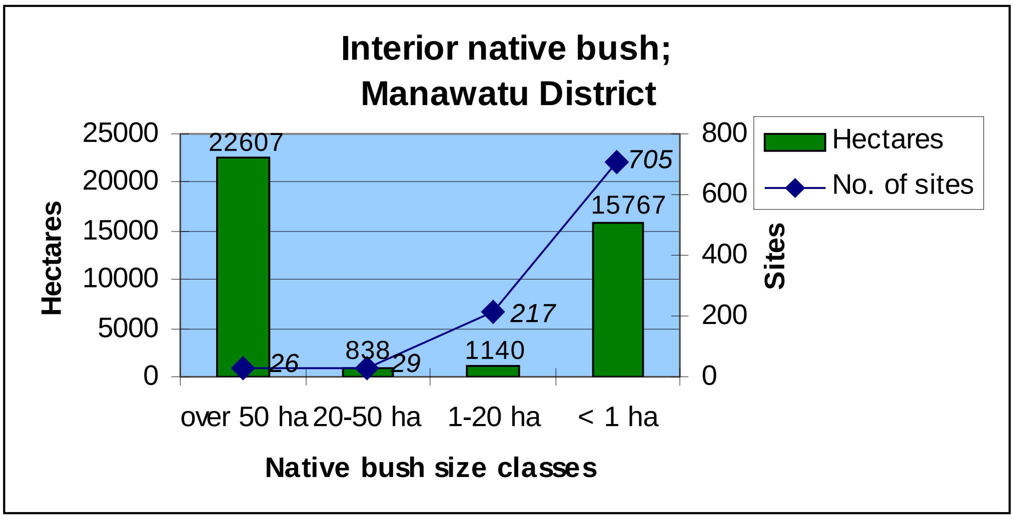

Figure 6: Interior native bush

Figure 6 shows a fragmentation pattern of very few large remnants and the plethora of small to medium sized temporary habitats. Every interior habitat patch is valuable for a native bird on its seasonal migration from the uplands to the lowlands. These small interior habitats are not only important as temporary stopovers for the birds but also in that their visit supports local plant populations via pollination and propagation.

Figure 7 shows that while much public land is predominantly interior habitat, native forests on private land are predominantly edge habitat.

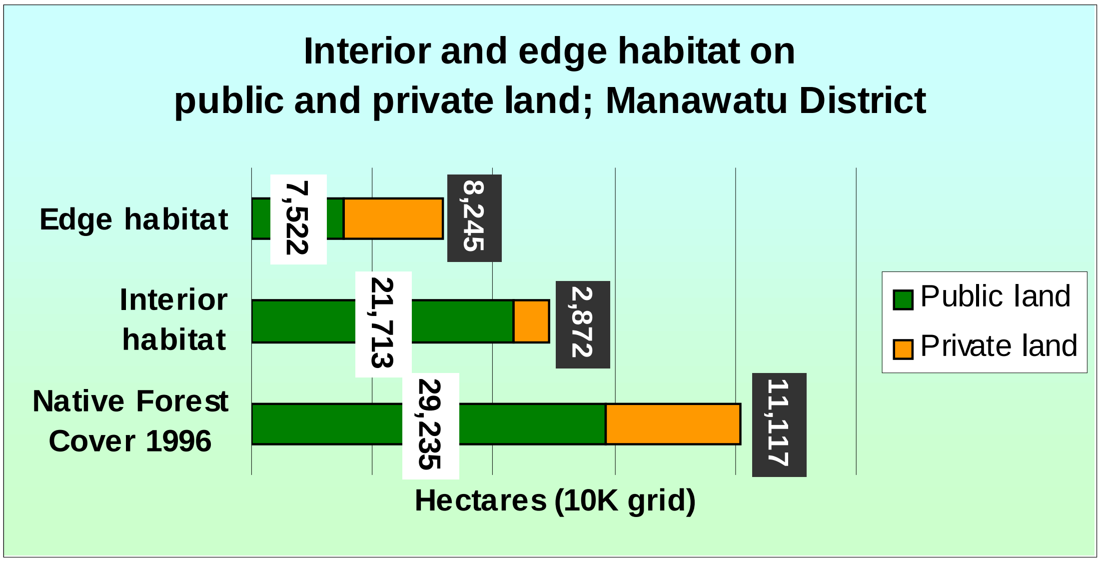

Figure 7: Interior and edge habitat on private and public land

Most native plants and birds have adapted to live in permanent forests and therefore prefer the interior part of a forest remnant, whereas most exotic plant and animal species, including pests prefer habitat edges. Most fragments of lowland native forest ecosystems have little interior habitat left, and are mainly edge habitats. Converting excess edge habitat into interior habitat space can therefore help reduce pest pressure from mustelids, exotic climbers and foster a native succession (Brockie, 1992).

The distribution of native forests and fragments is largely a legacy of past forest clearance. There is much scope for improving native ecological functions by securing and connecting interior habitat patches. Many existing native corridor fragments need to be purposefully connected in order to accomplish the ecological function of a corridor.

5.3 Isolated Native Birds

Figure 8 shows resource issues from a Bellbird's perspective. Since the demise of the Stitchbird (*Notiomystis cincata*) from the District, Bellbirds (*Anthornis melanura*) are now upholding essential ecological functions of pollination and propagation (Murphy and Kelly, 2001; Castro and Robertson, 1997) of many small seeded native plants (O'Donnell and Dilks, 1994; Williams and Karl, 1996).

Several studies (review by Spurr, 2000) confirm that breeding Bellbirds favour interior habitat and require a minimum of 1-hectare of stoat- and cat free native habitat per pair to successfully raise their fledglings (red patches signify temporary stopovers for pairs).

A South Island study (H. North, pers. com.) indicates that female Bellbirds do not venture further than 5 km from their forest home (red buffers around habitats over 20 hectares).

A sustainable bellbird population requires at least 20 to 50 hectare of quality and predator free native habitat (green and ochre patches, which have red 5-km buffer to indicate female bellbird range).

The female range of 5 km affects the potential of bellbirds to reach and re-establish in the more isolated habitats.

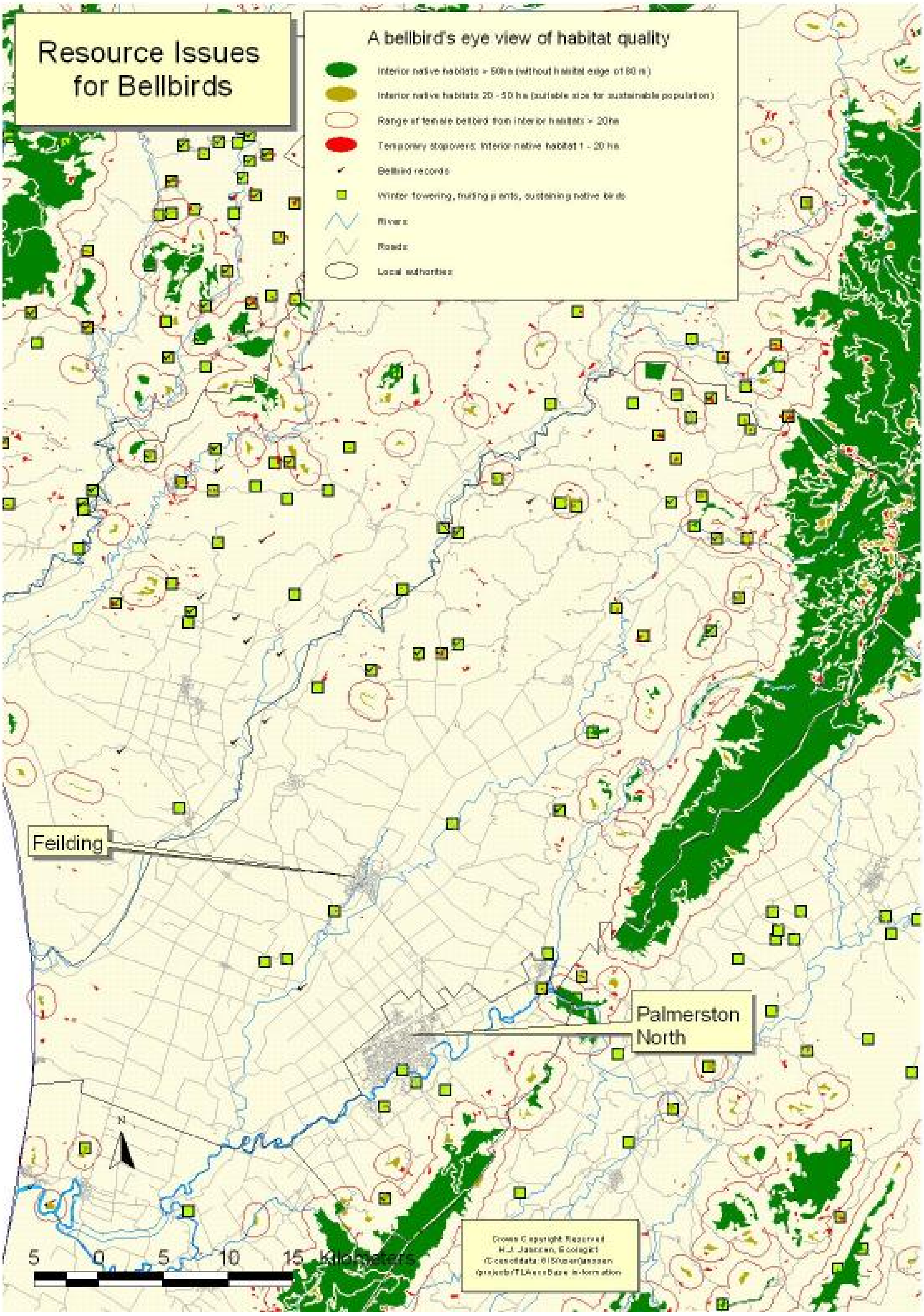

Figure 8: Resource Issues for Bellbirds

5.4 Isolated Native Plants

Habitat size, shape and its isolation are important factors determining the long-term viability of many native populations. Habitat fragments need to be of sufficient size, or at least in close proximity to each other to support not just a few individuals but an entire population in order to ensure its persistence (Hinsley, 2000).

Comparatively many native plant species have separate male and female plants (dioecy), whereas most exotic temperate plants unite both sexes in one plant (Godley, 1985). Most of our highly valued and long-lived native conifers (Figure 9) are dioecious (Van Uden, 1998). Different growth rates between sexes and preferential logging of larger trees may have depleted one sex from a patch, with dire consequences for the long-term survival of the local population in that patch. Thus sufficiently large patch size and habitat connectivity are as important to sustain viable plant populations as they are for native birds.

The small patches less than 20 hectares are shown in red. Isolated small patches are where the lineage of native conifers may be under threat. Extinction of a keystone plant or bird population from a forest fragment can severely compromise the survival of co-evolved plants and animals that rely on their symbiotic relationship for pollination and seed distribution. Most native forest remnants of the lowland and hill country are presently too small and too isolated to sustain a native bird population year round. This also affects the continued survival of important remnant native plant populations.

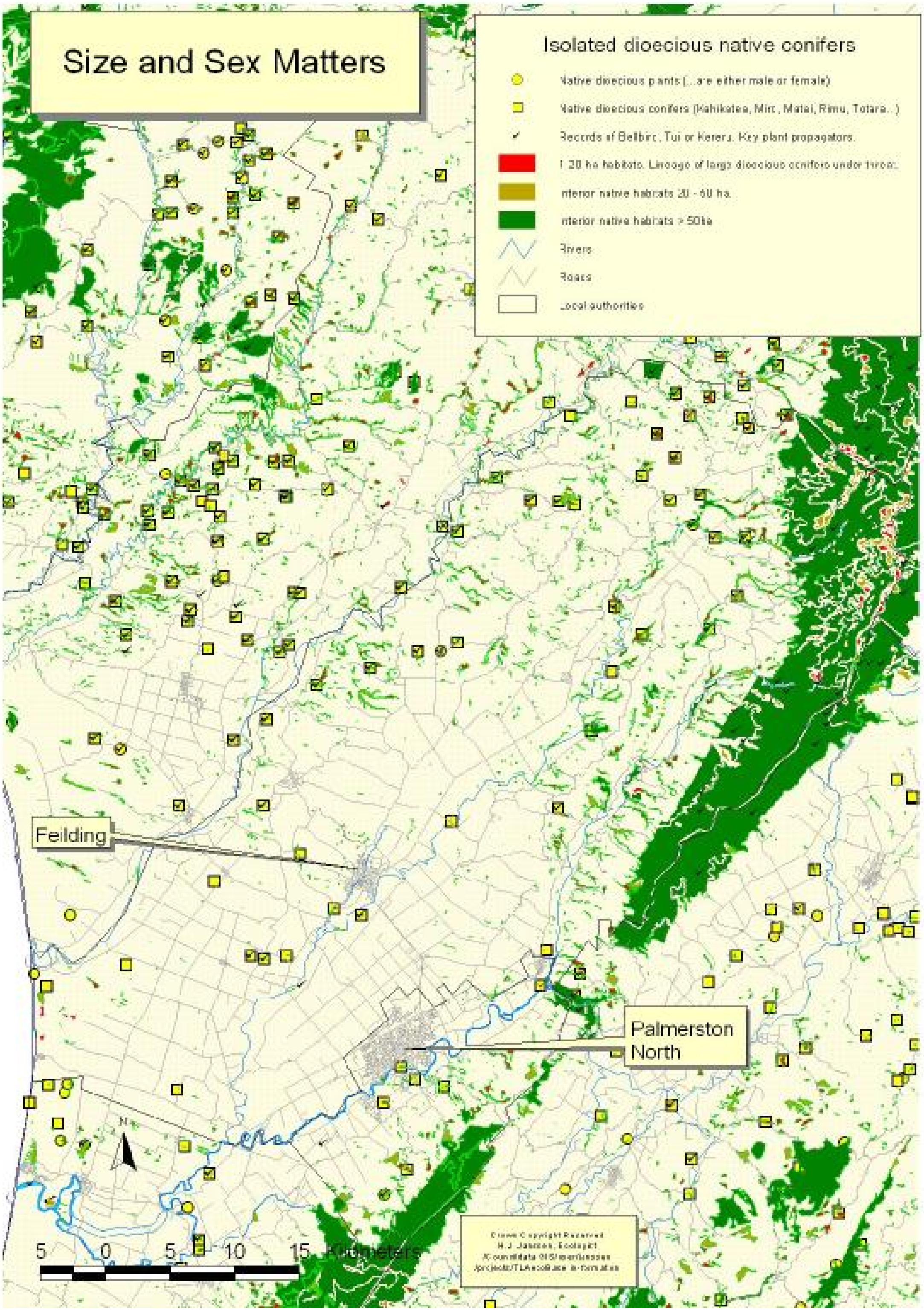

Figure 9: Size and Sex Matters

6. Thresholds

The Manawatu District has lost over 90% of native hill-country forest-ecosystems, over 95% of the District's prolific lowland-, coastal and wetland ecosystems have gone. The only ecosystem classes relatively well represented are the region's mountain ecosystems (mountain cedar, beech-podocarp, leatherwood, tussock, wetlands and alpine) at over 760 m, most of which are on public conservation land. However, severe canopy dieback of once spectacular rata mountain forests bear witness to the tragic effects of possum on native biodiversity.

The combination of habitat loss and effects of introduced pests since 1840 has already led to the rapid demise of ancient native population strongholds, followed by the extinction of the huia, the brown teal, the saddleback, the stitchbird and the kokako from this District. The loss of the oldest and most majestic forest types has been on a similar scale.

The 97% loss of wetland habitat has led to the local extinction of once common brown teal populations from the District's kahikatea swamplands. The Fernbird and mudfish populations have been reduced and fragmented to such an extent that, unless wetland habitats are restored, both species are likely to join the unclosed list of local native extinction.

Where ecosystems have lost over 75% of their original area, ecosystem resilience rapidly erodes as native animal and plant populations die out, severing evolved functional links and increasingly compromising overall ecosystem functions.

The threshold for native ecosystem loss, beyond which the extinction rate of populations tends to grow exponentially and ecosystem functions disintegrate, has been estimated and confirmed to be around 20% of their original extent (Meurck, 1998; Norton and Roper-Lindsay, 1999).

The sheer scale of early clearance has breached this vital threshold which is required to sustain basic functions of native ecosystems in the District.

Table 1: Thresholds for native ecosystem sustainability

Thresholds for native forest ecosystem sustainability in the Manawatu District.	%	Hectares
Total pre human forest cover	100	263,384
1840 cover in % of total (pre human)	93	244,896
1996[8] cover in % of total	15	40,352
1996 cover in % of 1840 cover	16	40,352

8 The land cover data base (LCDB) is derived from Spot satellite images, taken in 1996.

Thresholds for native forest ecosystem sustainability in the Manawatu District.	%	Hectares
Public land as % of 1996 cover	72	29,235
Private forest as % of 1996 cover	28	11,117
Interior habitat as % of 1996 cover	61	21,713
Interior habitat on private land as % of 1996 cover	7	2,872
Interior private forest as % of total	1	2,872

Native ecosystem sustainability threshold as % of total	20	52,676
Interior habitat 1996 as % of total	8	21,713
Interior habitat restoration required over coming 20 years to reach threshold and achieve the national biodiversity strategy goal	250	30,994

The table shows that the District's 1996 native forest cover of 40,352 ha comes to 15 to 16 % of the original cover. 61 % of 1996 native forest cover is interior habitat, the rest native edge forest.

Overall, interior habitat has been reduced to 8 % of the original total. A 2.5 fold general increase of interior habitat (30,994 ha) is needed to reach 52,676 hectares, the 20 % threshold for native ecosystem sustainability in the District.

6.1 Repairing the threshold

Integrating production and protection can re'pair' the decline of native biodiversity in the Manawatu District, as:

1. The impact on a biodiversity outcome is considered in all land use activities.
2. Schedules to restore prioritised sites are implemented.
3. Stock is excluded from remaining native habitats.
4. Animal and plant pests are controlled in an integrated manner.
5. Native habitat fragments' interior space is enhanced and secured
6. Isolated native habitat fragments are connected with tree-lands that enhance sustainable production and native biodiversity protection.

An emphasis needs to be placed on restoring ecosystem functions of coastal and lowland ecosystems. The coastal dune systems and the river margins are obvious corridor sites. The upper lowland and hill-country, (250 - 760 m) features many remnants where biodiversity conscious fencing and some afforestation could greatly increase the interior habitat space and enhance native ecosystem resilience. Planting up tree crops, or selectively harvestable timber trees around native remnants could rapidly generate the interior habitat space required to reach the threshold for native biodiversity.

7. Significance Classified

From the above account it is apparent that each one of the remaining native-, and some exotic habitats significantly sustain native biodiversity. Even scrubby habitats can support native ecological functions by connecting many highly fragmented interior native habitat remnants. The national and regional focus on native biodiversity and sustaining ecosystem functions provides the opportunity to integrate many activities to better effect.

Native lowland, coastal and hill-country ecosystems have been reduced to well below the 20% threshold. In fact only 8% interior habitat remains, which best sustains native ecosystem functions. Therefore all remaining native remnants on private land are significant in terms of section 6 (c) of the RMA 1991 (Norton and Roper-Lindsay, 1999), based on their high representativeness and significance in terms of a site's ecological context. Furthermore many of these native remnants qualify on the grounds that the sites:

1. Contain species or populations that are:
   - Rare
   - Distinct (species at their limit of distribution or isolated populations)

2. Sustain ecosystem functions as witnessed by the presence of:
   - Keystone species (sustain unrelated species and a habitat's ecological functions)
   - Indicators of habitat intactness (relatively predator free sites with all original forest tiers present)

3. Are very large (>20 hectares) and able to sustain viable populations long-term
   - Are large (1-20 ha), sustaining connectivity in terms of bird migration and seed distribution between larger patches
   - Have interior habitat (< 1ha) that is important in terms of sustaining larger sites or adjacent populations (ecological context).

Figure 10 shows prioritised sites, by applying the above categories, which were derived from the complete list of significant native remnants. A schedule of such sites is available.

It is important to keep in mind that the prioritised site list is as complete as data coverage and its quality permits, i.e. preliminary. Many sites have not been assessed yet, some data are old and additional site-data[9] is often required to:

[9] Particularly on the presence and abundance of important native keystone and threatened species and a complete list of pest threats

- Derive a priority rating and
- Design the most effective integrated management options.

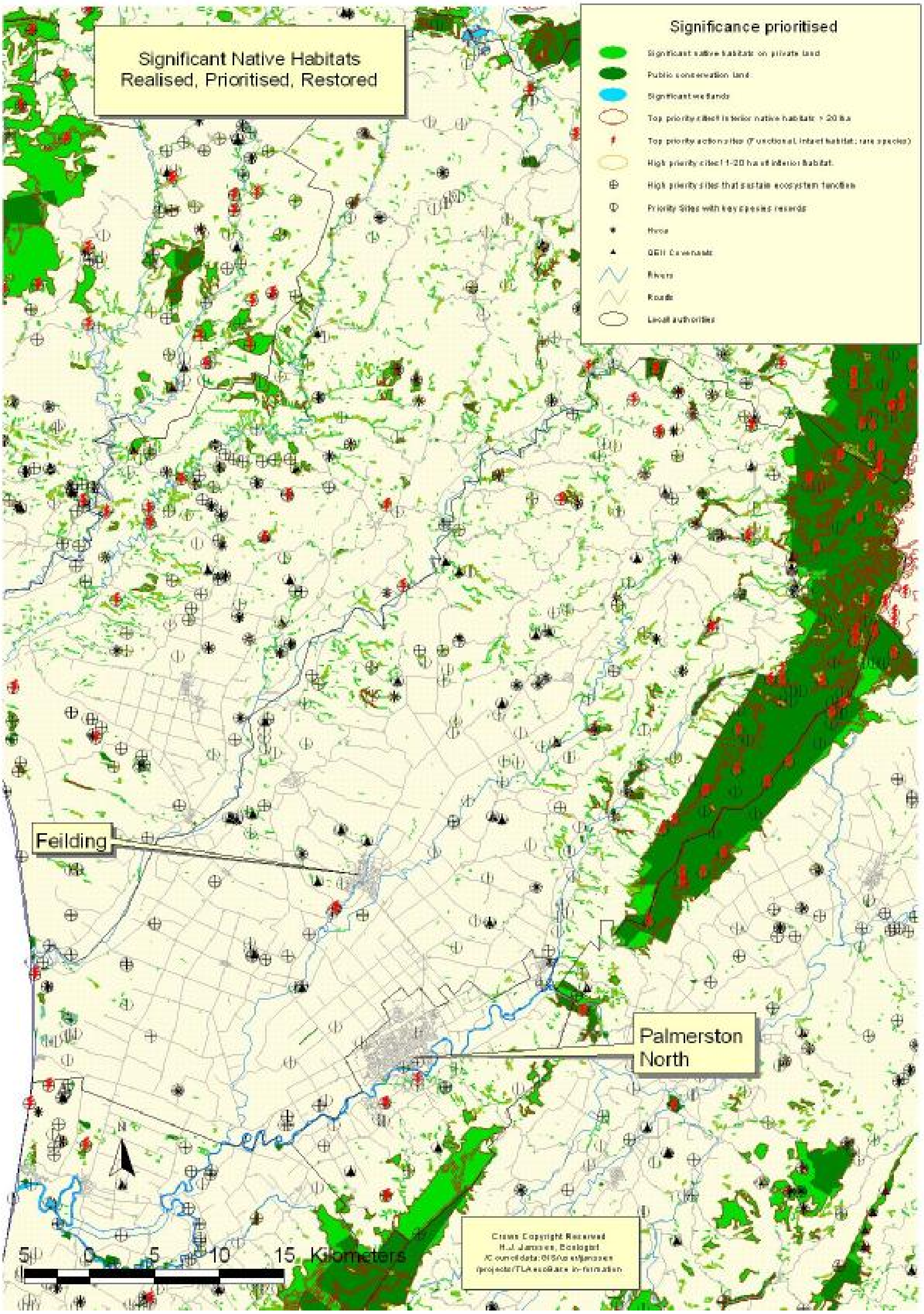

Figure 10: Significant habitats prioritised

Figure 10 also shows QE II Covenant sites and Regional Council's list of "high value conservation areas" (HVCA). This list is linked to the Regional pest strategies.

HVCAs are a list of 'icon' native sites, derived from "protected natural areas surveys"(1987) and the opinion of the regional soil and pest-monitoring scientist. After stock exclusion and with private landowner consent animal pest control is carried out once, with the expectation that landowners continue with follow up pest control operations. The main target species are possum, goats and mustelids. However, HVCAs pest control implementation has been minimal resulting in insufficient and ineffective biosecurity and biodiversity outcomes.

The HVCA list has been useful but is now going to merge into a classification system that incorporates new biodiversity information and analysis techniques that can:

- Identify significant sites and
- Prioritise sites for management at local and regional scales.

Thus the HVCA list is neither a schedule of native biodiversity priority sites, nor a list of significant sites.

8. Proactive and Integrated Response

The Regional Council's ecosystems monitoring and research programme focuses on assessing pressures on-, and state of native biodiversity and ecosystem function and developing and monitoring an effective response. Such information is then applied to prioritise sites within the districts and the region. Natural units such as catchments, ecosystems, environmental domains, regional or territorial local authority boundaries, provide useful units of management and implementation.

Key criteria for prioritization:
Top priority sites are ones that:
- Contain rare species or indicator species of habitat intactness
- Contain high key species diversity
- Are large enough to sustain viable plant and animal populations (> 20 hectares).

High priority sites are ones that:
- Contain key stone species.
- Contain winter food sources for native birds
- Maintain connectivity (stepping stone sites 1-20 hectares or wetland-connecting watercourses)

Priority sites have some key species present.

Such sites need to be included into a revisable schedule in regional and district plans with implementation criteria attached that foster partnership between landowners, TLAs, NGO's and research organisations.

An integrated response:
Establishing sustainable native biodiversity in the District requires integrating existing responses and developing new ones such as:

1. Developing comprehensive biodiversity policy at regional and district level
2. Keeping stock out of native remnants (interior and edge) at all times,
3. Converting native edge to interior habitat by planting tree crops[10] around the forest edge.
4. Integrated control of plant and animal pests.
   - Animal pest control is a priority in the Manawatu District, since most of the District is not covered by AHB possum control operations.
5. Monitoring pressures, state and responses on native biodiversity and ecosystem functions
6. Prioritising new sites and drafting management plans
7. Modifying policy schedules of prioritised, significant native biodiversity sites
8. Generating a culture of public environmental responsibility (via environmental education)
9. Facilitating restoration planting with sustainable harvesting rights
   - Initial public funding via environment trust and grants,
   - Then private responsibility for sustainable land and biodiversity management
10. Restoring lowland, coastal, wetland and hill-country ecosystems up to the 20% threshold over the coming 20 years.

Habitat nodes contain high keystone species diversity and are top priority sites (Figure 10). Establishing linking corridors from such resilient habitat nodes to isolated habitat fragments is a high priority, since emigration from nodes provides more fragile isolated habitats with founding keystone populations. In essence much of the required 31,000 hectares of additional interior habitat would be generated by fencing native remnants in a way that maximizes

[10] A sustainable development fund, set up under the proposed Local Government Act, could establish regionally and environmentally desirable economies of scale that could not grow under free market conditions alone. This is due either to initially small volume of products and associated limiting processing or marketing capacity or the fact that future rather than present generations will benefit most.

The rural community has planted trees for supplementary stock feed or shelter in the past and further interest could be generated with short rotation coppice-able and ground-durable stands for general farm maintenance (fencing) such as Shipmast Robinia or Totara or erosion control plantings of highly valuable Pecan, Hickory, Black Maire, Rewarewa, Chestnut, Hazel or Walnuts and other multiple purpose trees.

interior habitat space, with concurrent control of both animal and plant pests and establishment of tree crops on bare paddocks.

Emphases should be given to establishing corridors between the large forest remnants in the northern part of the District and along the Rangitikei, Oroua and Pahiatua Rivers. The northern corridors could well link up with the many large native remnants in the Rangitikei und Wanganui Districts. Such a corridor would link the southern Ruahine ranges with the lowland native forest ecosystem of the lower Wanganui catchment.

A second corridor axis would follow the Pahiatua, Rangitikei, and Oroua rivers, the latter providing a connection via Kitchener Park with substantial native coastal forests, that are left to regenerate and succeed some pine forests. A succession towards native interior habitat space from bare land usefully begins with exotic trees[11], where native species cannot be sourced locally.

The traditional approach spatially segregates production and protection. There is considerable scope to move beyond this, and to integrate private production and public biodiversity protection aspirations on private land (Parliamentary Commissioner for the Environment, 2001). Many native plants will regenerate and naturally succeed exotic tree lands and forests, due to their greater shade tolerance, as long as exotic shrubs or forests are neither clear-cut nor burnt but selectively harvested. Such selective "shelterwood" harvesting practices (Janssen, 1992) are commonplace in comparable regions and countries, where ecosystem services are valued.

This strategy of securing and expanding existing interior habitat, connecting hill country with lowland and coastal dune forest ecosystems, could over the coming 20 years restore native ecosystem resilience in the District and achieve the national biodiversity goal.

The proposed vision is to create a forested or park-like landscape that achieves both, sustainable production of a wider range of products and native biodiversity protection.

[11] Fire climax trees (*Pinus* and *Eucalyptus* spp.) and very shade tolerant exotic conifers (*Tsuga Pseudotsuga, Abies* and *Thuja* spp.) will displace native ecosystems if not carefully managed (prevented from seeding and burning) and should therefore never be planted anywhere near native remnants.

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