

Ecological Restoration in Hamilton City, North Island, New Zealand

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Abstract

Hamilton City (New Zealand) has less than 20 hectares of high-quality, indigenous species dominated ecosystems, and only 1.6% of the original indigenous vegetation remains within the ecological district. A gradual recognition of the magnitude of landscape transformation has gathered momentum to the stage that there is now a concerted public and private effort to retrofit the City by restoring and reconstructing indigenous ecosystems. The initial focus was on rehabilitating existing key sites, but has shifted to restoring parts of the distinctive gully landform that occupies some 750 ha or 8% of the City. A new initiative at Waiwhakareke (Horseshoe Lake) will involve reconstruction from scratch of a range of ecosystems characteristic of the ecological district over an area of 60 ha. This address will examine a vision for ecological restoration in Hamilton City within the context of policy, education, and community dimensions that have triggered a shift from traditional parks and gardens management to ecosystem management.

Introduction

The Hamilton Ecological District (159,376 ha) in the northern North Island of New Zealand is one of the most modified districts in New Zealand with only 1.6% of the indigenous vegetation remaining (Leathwick et al. 1995). At least 20% of its indigenous flora is threatened or extinct and more than one half of its indigenous bird species have gone. Hamilton City (9427 ha) (Fig. 1), in the centre of this transformed landscape, has only a few tiny remnants of the former indigenous forest cover, perhaps less than 20 hectares in total of high quality indigenous habitat. The largest remnant is Jubilee Park (Claudelands Bush), a 5.2 hectare reserve comprising *Dacrycarpus dacrydioides* (kahikatea) forest (Whaley et al. 1997). Another important remnant is Hammond

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Figure 1. Aerial view of Hamilton City (showing the Waikato River) and its location within the centre of northern New Zealand. (Photo courtesy of Hamilton City Council).

Bush (Fig. 2), floristically the richest of the Hamilton indigenous remnants. Despite its small size (1 hectare), it supports an impressive 145 native plant species (de Lange 1996) and is regularly visited by *Hemiphaga novaeseelandiae novaeseelandiae* (kereru). Recently, native *Chalinolobus tuberculatus* (long-tailed bats) have also been recorded in the area (E. Ganley pers. comm. 2001). However, the widespread native nectar-feeding bird, *Prothemadera novaeseelandiae novaeseelandiae* (tui) (Fig. 3) is only a rare visitor to Hamilton City.



Figure 2. Hammond Bush, Waikato Riverbank, Hamilton. Adjacent is the mouth of a small gully system (part of the Mangaonua system), crossed by a 1.5m wide boardwalk. Indigenous evergreen vegetation (appearing as dark green) is clearly distinguished from the deciduous exotic vegetation (mainly *Salix cinerea*).



Figure 3. The widespread native nectar-feeding bird, *Prosthemadera novaeseelandiae novaeseelandiae* (tui), sitting on *Phormium tenax* (flax). Photo courtesy of Max McRae.

Although the indigenous biodiversity resource is very limited, Hamilton City does possess an extensive network of gullies. These extend from the Waikato River through many suburbs of the City, occupying around 750 hectares or 8% of the City area (Downs et al. 2000) and are considered a unique feature of the Hamilton area (McCraw 2000). Four major gully systems (Kirikiriroa, Mangakotukutuku, Mangaonua and Waitawhiriwhiri) and numerous minor systems exist (Fig. 4). As McCraw (2000) has shown, the gullies are the result of the undermining of a geological formation of sand, silt, peat and gravel known as the Hinuera formation. Around 15,000 years ago, the Waikato River started to cut down through this material creating its present channel and as it deepened, springs were exposed along the riverbanks. As water drained from the surrounding land, these springs undermined the banks, in a process known as spring sapping, causing slips and creating a network of streams draining into the Waikato River. This process was repeated again and again giving rise to erosion and the formation of the steep-sided and intricate network of gullies that adjoin the river today. Despite being poorly treated in the past, the gullies have now been recognised (Clarkson & Downs 2000) as the central focus of a city-wide restoration of indigenous ecosystems because they are the main wildlands in an otherwise entirely built landscape (Fig. 5).

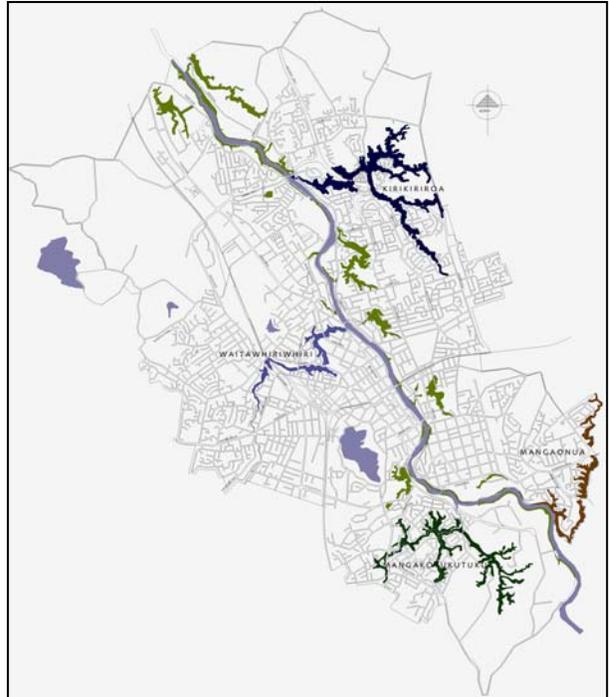


Figure 4. Gully systems of Hamilton City. The four major systems (Kirikiriroa, Mangakotukutuku, Mangaonua and Waitawhiriwhiri) are labeled. Peat Lakes and the Waikato River are also shown in blue. The city area is 9427ha.



Figure 5. Urban development adjacent to the Mangakotukutuku gully system.

Restoration and Policy Background

The significance of the gullies as a potential focus for landscape enhancement was highlighted as early as 1972 (McLeary 1972) but only in recent years has the move to make use of them gathered momentum. A Gully Protection Zone had been in force since 1989 but this related more to building requirements than protection of gullies *per se* and was ineffective at

protecting ecological features or preventing infilling of gullies associated with subdivision development. In recent years, to meet the requirements of the Resource Management Act (1991) and obligations of international agreements such as Agenda 21, the Hamilton City Council has undertaken a substantial information gathering exercise to improve knowledge of natural values within the City. This has included an evaluation of a range of ecological, landscape and hazard areas, and the preparation of a map based on the boundaries of these areas, termed an Environmental Protection Overlay (EPO). This map forms part of the District Plan, which also sets out policies and rules relating to components or layers of the EPO, developed in consultation with the community (Vare 2000). As well, a Gully Management Plan (2001) has been developed providing a comprehensive plan for restoration of the publicly owned gullies but recognising the need to also involve the owners of adjoining privately owned gullies.

Investigation of ecological resources on public and private lands included a comprehensive survey, in order to identify key ecological sites within the City (Downs et al. 2000). Some 67 key sites were identified with a total area of 76 ha and an average area of 1.1 ha. Extant vegetation ranges from *Kunzea ericoides* (kanuka) forest of well-drained river and gully scarps to *Typha orientalis* (raupo) reedlands fringing peat lakes, with many intermediate types. Gully floor vegetation is frequently dominated by the deciduous exotic tree *Salix cinerea* (grey willow), though beneath this is often an understorey dominated by indigenous plants including ferns, *Melicactus ramiflorus* (mahoe) and *Cordyline australis* (cabbage tree). Even where weeds are dominant, gullies still provide some important ecosystem services, such as supporting desirable wildlife. Native birds persist even in these highly modified systems, with seven species, including *Ninox novaeseelandiae novaeseelandiae* (morepork), *Halcyon sancta vagans* (New Zealand kingfisher), *Zosterops lateralis lateralis* (silveryeye), *Rhipidura fuliginosa placabilis* (fantail) and *Gerygone igata* (grey warbler), widespread (Innes 2000).

The original gully vegetation can be deduced from historical records, from the composition of extant remnants and from macrofossil deposits (Clarkson & Clarkson 2000). This information provides a context for developing restoration goals and gives an indication of the diverse range of native plants appropriate for restoration plantings. Publications such as the Gully Restoration Guide (Wall & Clarkson 2001) and Botany of the Waikato (Clarkson et al. 2002) provide information on which plants to use, where to plant them (Fig. 6) and how to look after them.

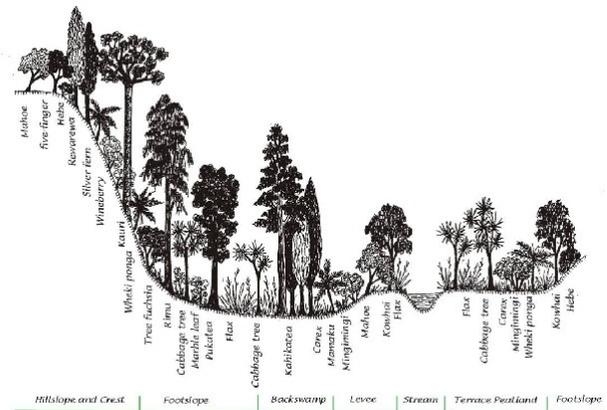


Figure 6. Gully profile with locations of native plant species (from Wall and Clarkson 2001).

The benefits of gully restoration are numerous and wide-ranging. These include improved environmental, aesthetic, scenic and cultural values. Native plants perform important ecosystem functions. The nectar-producing *Sophora microphylla* (kowhai) flowers feed native birds, the fleshy fruits of the native conifers like *Dacrydium cupressinum* (rimu) feed the birds and in turn are spread by them, and *Hoheria sexstylosa* (lacebark) grows into a good-sized nurse tree within five years and flowers profusely every autumn. Reintroducing a range of plant species once found in Hamilton gullies could also address the local shortage of native plant resources for rongoa (traditional Maori medicine) (McGowan 2000). As well as enhancing terrestrial habitats, gully restoration benefits aquatic life in streams. Riparian planting leads to cooler, more shaded streams with stable undercut banks - the preferred habitat of some native fish species including *Galaxias fasciatus* (banded kokopu) and *Gobiomorphus huttoni* (redfin bullies) (Hicks 2000).

From the work of restoration pioneers, we know that it is possible to have a good canopy cover of native trees established in a gully setting within 15-20 years (Fig. 7). But there is still much to accomplish. *Prosthemadera novaeseelandiae novaeseelandiae* (Tui) are an icon for restoration success and a comparison with other North Island cities showed it may be necessary to have almost 100 hectares of quality habitat within Hamilton City, or 1000 hectares within 10 kilometres of the City, to support resident tui. Increasing the current area of habitat towards these threshold figures would at least result in more regular tui visitors than at present.



Figure 7. The successfully restored gully of G. and A. Edgar, Hamilton. Restoration has been ongoing for 25 years and has achieved an excellent canopy cover free of weed species. *Cordyline australis* dominates the centre of the photo and there is a large specimen of *Dacrydium dacrydioides* behind.

Successful Gully Restoration

The key ingredients for successful gully restoration identified by Clarkson & Downs (2000) and Morris (2000) are summarised here. It is sensible to use existing remnants or key sites with a significant indigenous component as nuclei for restoration projects. Buffering issues and the development of corridors and linkages can then be considered. A range of different restoration strategies from complete weed clearance and replanting of the site to canopy manipulation of *Salix cinerea* (willow) and other exotics is available. The strategy adopted will vary depending on the budget available, access to volunteer labour, and the need to protect extant specimens of native plants. The value of ecosourcing rests mainly in the superior performance of locally sourced ecotypes or races, as well as the need to conduct authentic restoration in important reserves such as Hammond Bush. Native species propagated from ecosourced plant material have been used successfully in numerous restoration projects throughout the City.

Matching species preferences to site conditions through careful site selection is rewarded by greater survival and growth of the species planted. There are also considerable benefits obtained by mimicking natural succession processes and it is necessary to consider enrichment planting or spreading of seed of later successional species once a good canopy cover of trees has been established. Regular aftercare and weed and pest control is all-important for the continuing success of a restoration project. Controlling weeds and pests can be expensive but without this management the

investments made in restoration projects can be very quickly compromised.

Increased use of indigenous species in a range of settings, such as hedge plants, specimens in parks, and as integral components of home gardens, will positively influence and buffer the restoration projects being undertaken. For example, a survey of *Cordyline australis* (cabbage trees) growing in gardens and gullies in a suburb of Hamilton City showed that the planted garden trees were the most likely invasion source of the populations which had developed in the adjacent Kirikiriroa Gully (Clarkson 1999). The land-use change from rural (grazed) to City subdivision thus provided the opportunity for some native species to recolonise the gullies. Recent widespread establishment of indigenous plants along road ways and the ever expanding area of restoration plantings is therefore likely to increase the opportunities for indigenous species to reinvade areas, including those areas currently dominated by exotic plants.

Wider Restoration Plans

It is apparent merely by inspecting a map of Hamilton City that the restoration of gullies cannot be conducted in isolation from other restoration projects. Not only do the individual gullies need to be restored but they need to be linked to the Waikato River, the peat lakes and the extant lowland forest remnants. Thinking even more widely, the potential exists to establish further linkages and commence a regional-scale restoration, by the establishment of riparian plantings or corridors along the Waikato River to link with forest in the north and south.

The Gully Restoration Guide (Wall & Clarkson 2001) and the Hamilton City Council Gully Reserves Management Plan (2001) provide the information base on which to commence a city-wide restoration, and there is an ever-increasing number of community group, school and private gully restorations. A recent advent has been the first advertisement for a housing subdivision proclaiming a gully enhancement approach. As at October 2003, some 187 ha of land in Hamilton City is under restoration of some form, including 142 ha on public land and 45 ha on private land. The Hamilton City Council Community Planting Coordinator, has, in 2003, supervised the planting of more than 25,000 indigenous plants by the council and community groups. A gully restoration database holds information on almost 500 gully properties where restoration is underway or the owners have expressed an interest in beginning a restoration project. Gully restoration seminars and practical workshops, native plant giveaways, a gully restoration newsletter and funding for school or community led projects are all incentives which have been used to promote the city-wide

restoration of gullies. To provide the ecological science needed to underpin the restoration efforts, the University of Waikato has initiated several research projects. These include documenting the biodiversity values of key sites, assessing the success of 5-40 year old restoration plantings, and seeking solutions to specific problems, for example pest fish and the weed *Solanum mauritianum* (woolly nightshade).

Because of far-sighted decision making by the Hamilton City Council, there are currently unique opportunities to considerably advance the wider restoration plan. A Natural Heritage Park (Waiwhakareke, Horseshoe Lake) will be developed on some 60 ha of land owned by the Hamilton City Council, with five ecosystems representing a major proportion of the original diversity of the Hamilton Ecological District being reconstructed. The five ecosystems have been delineated (McQueen & Clarkson 2003) on the basis of the varied soils, topography and water table of the area (Fig. 8). Over the next 20 years, this project will significantly increase the area of indigenous vegetation within the City and provide a valuable stepping-stone for native birds in the northwestern quadrant of the City, only 11 km from extensive indigenous forest habitat. Within this same time-span, there is also the possibility of erecting a pest proof fence around some areas, protecting native birdlife and plants from mammalian pests such as *Rattus rattus*, *Rattus norvegicus* (rats), *Mustela ermina* (stoats), *Mustela furo* (ferrets), *Trichosurus vulpecula* (possums), *Erinaceus europaeus occidentalis* (hedgehogs) and *Oryctolagus cuniculus* (rabbits), once these have been eradicated within. We intend to use the opportunities provided by this project to conduct fundamental ecological research on assembly rules for reconstructing ecosystems and to provide practical training for undergraduate restoration ecology students.



Figure 8. The proposed ecosystem reconstruction of Waiwhakareke (60ha within the city).

- Kauri forest (ridge crest)
- Rimu/tawa forest (hillslope)
- Kahikatea-pukatea forest (semi-swamp)
- Harakeke (lake margin)
- Peat Lake/aquatic habitat

Conclusion

By bringing together ecological understanding and the best-practice techniques of pest management, native plant propagation, planting and animal breeding and recovery programmes, successful city-wide restoration is achievable. While it is important to consider the broader long-term restoration task, the higher-level goals are best attained through a series of smaller, manageable stages. Changing ecosystem dominance from exotic deciduous trees to indigenous evergreen trees will assist but not completely solve some of the current weed problems. Shifting the local seed rain balance from exotic to indigenous brings us closer to the threshold where it will be more likely that regeneration and recruitment will be of indigenous species rather than ubiquitous exotics. Consideration of all components of the ecosystem, not just the trees, promotes a fully functioning restored ecosystem. Successful restoration projects will be more likely within the developing city-wide strategy based on community support, empowerment and partnerships. A convergence and stretch of skills and technology is taking the City from a traditional parks, gardens and utilities management approach into the realms of ecosystem management. Restoration or retrofitting within the City will significantly contribute to an ecological transformation of the Waikato Region.

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