

Evaluation of the Hamilton City Council Plants for Gullies Programme

2012

ERI report number: T001

Bruce D. Clarkson, Fiona M. Clarkson & Catherine L. Bryan

Environmental Research Institute
Te Pūtahi Rangahau Taiao
THE UNIVERSITY OF WAIKATO

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Evaluation of the Hamilton City Council Plants for Gullies Programme

2012

Table of Contents

Background

The Gully Restoration Programme was established as a partnership between Hamilton City Council (HCC) and the local community. The aim of the programme is to raise public awareness and appreciation of Hamilton's gully systems, and actively promote and enable the physical restoration of this resource. The programme was developed in association with the Environmental Protection Overlay (est. 1987), which applies specific rules to areas of the city with gullies. These rules acknowledge the importance of gullies in the city and provide a baseline to manage the impacts of development. The programme has included a range of initiatives: the development of the Gully Restoration Guide, distribution of newsletters, holding gully workshops, and the Plants for Gullies programme.

The Plants for Gullies programme, the main focus of this report, provides native plants to Hamilton City gully-owners to encourage the enhancement of indigenous biodiversity in the city. Since 2002, 12,000 native plants have been allocated to local residents that are actively restoring the gullies on their properties. The programme is run through annual application rounds that see successful applications receiving eco-sourced plants from local nurseries. The council and nursery staff provide restoration advice at the time of plant transfer and also six to twelve months later in a follow-up visit. Anecdotal information and feedback from some participants indicated that the programme had successfully provided encouragement and best practise guidelines for restoration of participants' gullies. However, these outcomes had not been quantified or thoroughly investigated and thus, the environmental, social and economic influence of the programme was not well understood; this report was commissioned to help fill that knowledge gap.

Report overview

The main purpose of this report is to assess the uptake and outcomes of the Hamilton City Council's Plants for Gullies programme, as part of the Gully Restoration Programme. The evaluation was conducted using two different methods; 1) a comprehensive phone survey of participants, and 2) an ecological survey of participants' gully systems. The phone survey evaluated participant satisfaction with the programme and established the main motivations and barriers to gully restoration. The quantitative vegetation survey was used to evaluate the current state of ecological restoration within these gully systems. Both assessment methods were also used to determine the contribution that the programme has made to private restoration efforts. The following sections outline the evaluation methods, describe key findings and provide recommendations for the future of the Plants for Gullies programme.

Methods

Sixty participants from the Plants for Gullies programme were selected at random from a HCC gully owner database. Participants were sent a project description and consent form, which they signed and returned if they were happy to participate. A total of 40 participants responded and granted permission. Ethics approval to conduct the survey was obtained from

The School of Science and Engineering Human Research Ethics Committee, University of Waikato.

Phone survey

The phone survey questionnaire (Appendix 1) was adapted from Jay & Stolte (2011) and aimed to address the following:

- Participant summary information (Q 1, 2, 3, 4)
- Participants' satisfaction with the programme (Q 9, 9a, 22)
- Survivorship of allocated plants (Q 16, 17)
- Motivation for restoring gully systems (Q 10, 11, 13, 14,)
- Gully restoration priorities (Q 12, 15, 20, 21a)
- Attributes of gullies and benefits of restoration (Q 5, 6, 7)
- Barriers to restoration/challenges faced (Q 19)
- Value of the programme's educational and follow-up material (Q 7,17a, 17b, 18)

The questionnaire was developed in accordance with the University of Waikato ethics regulations and was accepted by the ethics committee. Each participant was asked a total of 27 questions at a time of day that suited them. The questionnaire took an average of 30 minutes to complete and was generally received very well by the participants with many enthusiastic conversations. A total of 38/40 phone interviews were completed; two participants who had given consent were unable to be contacted. Particular questions did not apply to all participants and thus the number of responses varied between questions.

Vegetation survey

The ecological survey and biodiversity assessment (Appendix 2) was designed to determine the following:

- Abundance and diversity of native plant species at restoration and control sites
- Abundance and diversity of invasive plant species at restoration and control sites
- Engagement and application of restoration guidelines
- Benefits of gully restoration (such as native regeneration, fauna food source, biodiversity enhancement)
- Stage of gully restoration and the next step in restoration process

Plant species at each gully property were surveyed in either the whole site or a sub-plot if the site was large. To provide an overview at each restoration site, the surveyors recorded estimates of local native, nonlocal native, and exotic species abundance as a percent cover. This information was also recorded for nearby control sites that had not received any restoration or management and were in the same gully system as the private restorations (3/38 of the private restoration sites did not have suitable control sites nearby). At each restoration site, surveyors made note of the presence of native regeneration, iconic and/or rare flora and fauna species, habitat linkage to other restored gully systems, plant placement (i.e. suitability of plant locations as per gully restoration guidelines). A total of 38 vegetation assessments were completed.

Results: Phone survey

Participant summary (Q 1, 2, 3, 4)

Surveyed participants had been actively restoring their gully systems for an average of 7.9 years (range=1–28 years). An average of 10.3 hours per month was spent on maintaining and enhancing their gully systems. Of the total gully section owned, participants were working on restoring an average of 76.6% of that section. When asked to grade their restoration progress, most considered that they were just over half way (average of 6.2 on a scale of 1–10 with 10 being complete), with four participants rating their restoration as complete (10).

When asked how they found out about the programme the majority of participants had been referred via HCC advertisements (including packages in Land Information Memorandum (LIM) reports, mail outs, and newspaper advertisements) or affiliated staff (including: Tim Newton, Gerard Kelly and Peter Morris). Many had also become aware of the programme through the gully restoration seminar series which was hosted at the University of Waikato and/or via communication with Professor Bruce Clarkson. Participants were also notified via friends and neighbours who were involved in the programme.

Participants' satisfaction with the programme (Q 9, 9a, 22)

Overall, the majority of Plants for Gullies participants were very satisfied with the programme, giving it an average rating of 8.96 out of 10. The lowest score was 5 and over half of the participants (21/38) rated programme satisfaction as 10/10. A number of reasons were given for such high levels of participant satisfaction; these have been summarised in Figure 1 below. The most frequently cited reason for programme satisfaction related to the helpfulness of staff and the useful advice received from nursery owners Peter Morris and Wayne Bennett, and HCC staff Tim Newton and Gerard Kelly. Participants were also happy with the plant quality and that they were eco-sourced. The concept of free plants was also a key reason for participant satisfaction; "it's a great motivation when you get things for free" and others said that the programme provided incentive for their gully restoration. Finally, participant satisfaction was also due to the uptake of the programmes educational aspects, programme follow-up (including gully visits by HCC staff and the distribution of newsletters), and the ease of the programme's application process (Figure 1).

Seven participants expressed criticism of the programme and thus provided lower satisfaction scores (5–7.5), these comments included dissatisfaction with the application process (for which participants needed to provide a detailed plan/report of the section of gully they intended to restore); the amount of plants received; health of the plants received; and the programme's relevance for advanced restoration projects (see Appendix 3). For an example, one participant said that while they were grateful for the plants they received, they called the application process "bureaucratic"; "the reporting becomes meaningless and onerous after a while, it's hard to keep track and I have stopped applying now". Another participant, who had an advanced stage restoration explained that "Initially it was really good …. now we are beyond the early pioneer species and smaller plants they offer as part of the programme". However, all criticisms were balanced by positive comments from the same participants.

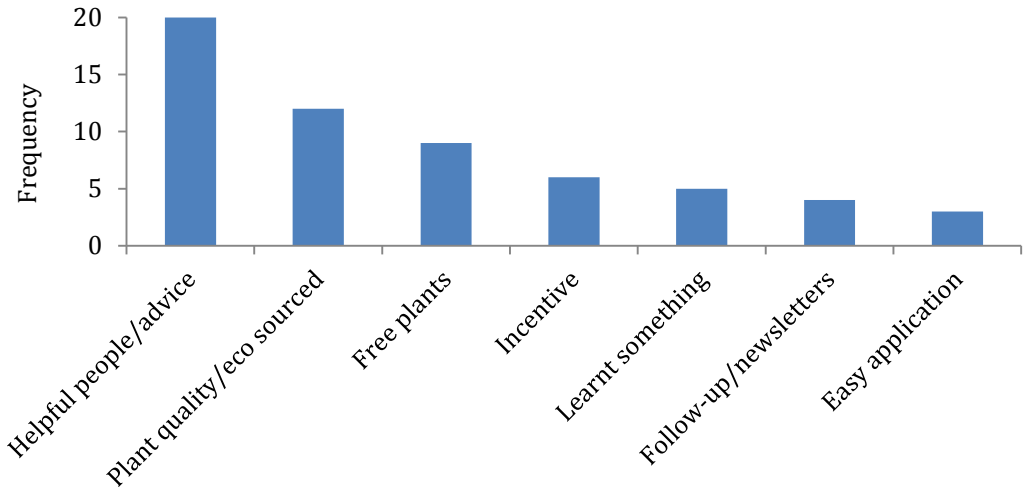

Figure 1 Plants for Gullies Programme: Reasons for participant satisfaction (n=38).

Motivation for restoring gully systems (Q 10, 11, 13, 14)

A wide range of factors were found to be important for motivating participants in restoring their gullies. Participants rated a list of factors which would possibly motivate them to restore their gully systems from 1-5 with 5 being highly motivating. All factors shown below appeared to have high motivational value to participants, with the average rating of each factor ranging from 3.3-4.6 (Figure 2). The factors with the highest motivational value were personal satisfaction and attracting birds.

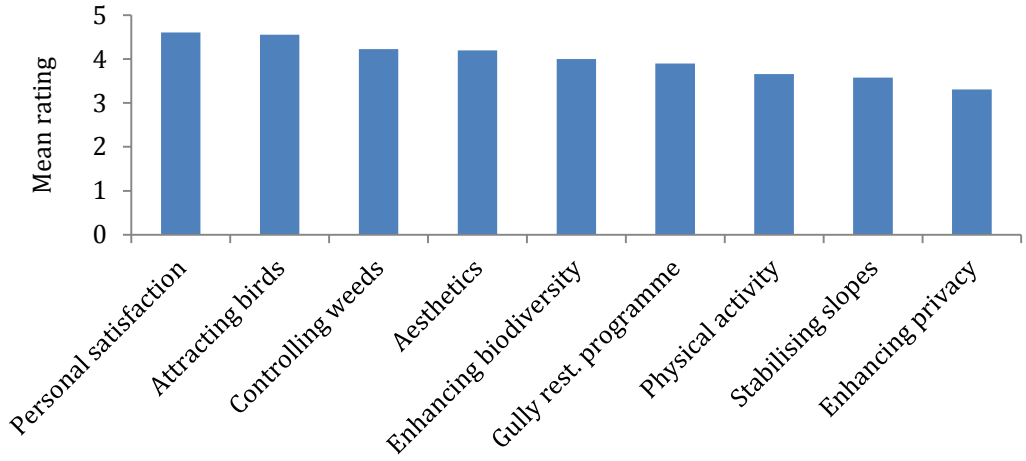

Figure 2 Mean rating (on a scale from 1–5) of potentially motivating factors for private gully restoration (1: not motivating–5: highly motivating).

Other motivating factors not shown in Figure 2 but reported by participants included; "the will to finish what I have started", "it motivates me that I am contributing to expanding the native urban system", "increasing accessibility", "it will be a good playground for the kids when its restored", "quality time with grandson in a restored environment", "neighbours restoration work", "something for kids to enjoy and learn from", "nice place to entertain people", "adding value to the house", and "sharing it with others".

Participants were asked whether their motivation levels had been influenced since receiving the free plants from the programme. They were asked to rate their motivation levels on a scale from 1-10, with 1 being less motivated, 5 being no more or less motivated, and 10 being more motivated. The majority (29/38) felt that receiving the plants had increased their motivation levels for undertaking their gully restorations, with the mean score from all participants being 7.5. A total of 7/38 participants felt their motivation levels had neither increased nor decreased since receiving plants from the programme and one participant felt as though they had become less motivated saying they become "discouraged by the job at hand".

Since receiving plants from the programme, participants were asked how many more plants they had added to their gully restoration. While only 2/37 had not added any additional plants to their gully systems the remaining 35/37 participants had added varying amounts ranging from 1 to over 1000 (Figure 3), with an average of 196 privately sourced plants added per participant. Of these privately sourced plants added to the gully systems on average 94.2% were native.

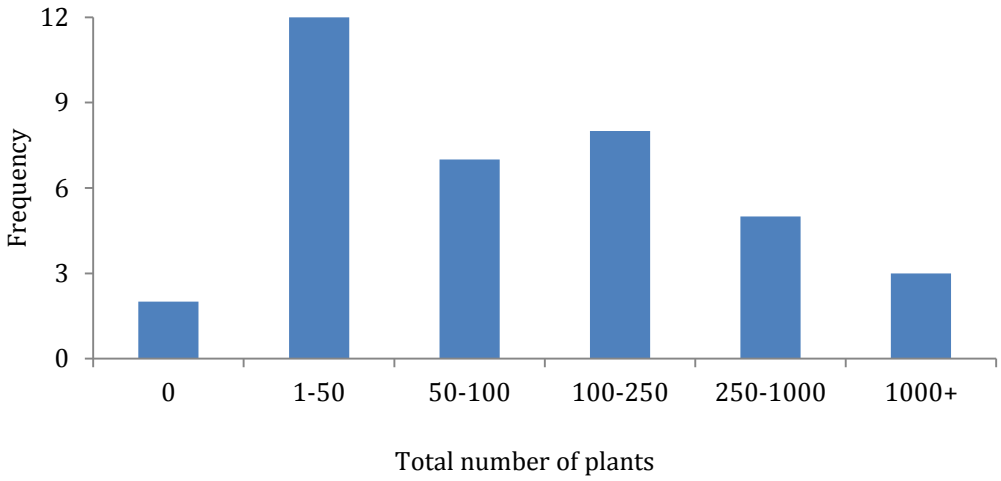

Figure 3 Numbers of privately sourced plants added to private gully restorations since receiving plants from the Plants for Gullies Programme (n=37).

Attributes of gullies and benefits of restoration (Q 5, 6, 7)

One of the most distinct results during this questionnaire was the value the gully owners place on natural attributes ('nature') of their property. Thirty one people said that they valued natural aspects of their gully, such as flora, fauna and wilderness. Also frequently reported was the value of privacy, and the peaceful escape that gullies provide (Figure 4). Attributes that made up the 'other' category included: cultural use, watching the trees grow, utilising the natural environment for environmental education, accessibility, and growing produce to be self-sufficient.

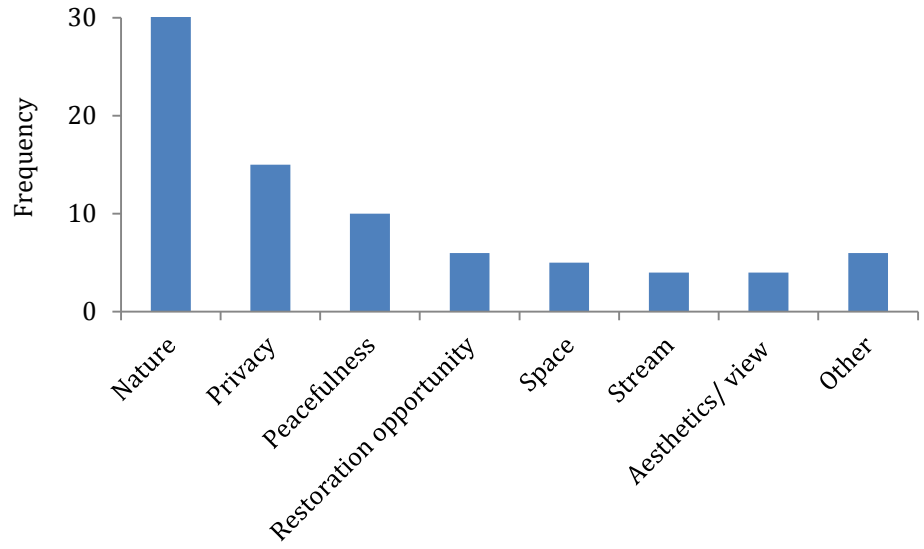

Figure 4 The most valued attributes of privately owned gully systems (n=38)

To identify the benefits of gully restoration, participants were asked about the changes they have noticed since commencing restoration. Twenty-five people reported increased bird visits and nesting, 22 said that they had reduced weed abundance, and 20 said there was increased regeneration of native species.

Gully restoration priorities (Q 12, 15, 20, 21a)

Participants were asked to rate a list of factors which they may or may not consider when purchasing plants for their gully systems. Factors were rated from 1-5 with 5 being an important consideration. Overall, all factors listed were important to participants with the average rating of each factor ranging from 3.3-4.6 (Figure 5). The fact that plants were eco-sourced was the most important consideration overall, followed closely by the aesthetic value of the plant, the ability of the plant species to stabilise a bank, and finally the cost (Figure 5).

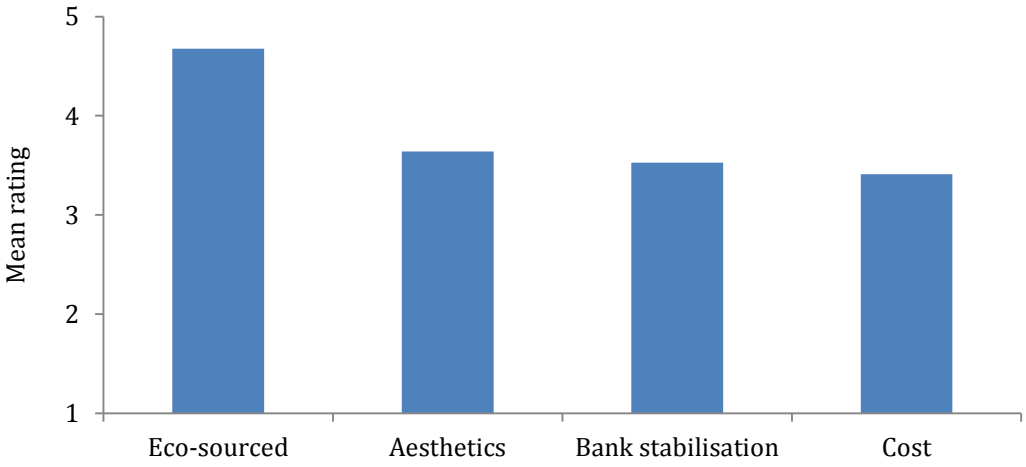

Figure 5 Mean rating (on a scale from 1–5) of factors which participants potentially consider when purchasing plants (1: not considered–5: an important consideration).

Participants were also asked to list any other factors which were important to them when considering purchasing plants for their gully systems. They came up with a range of factors including: plant height at purchase – one metre is appropriate to establish successfully when planted; potential plant height – to ensure it does not block views when fully grown; the potential to grow in wet and/or appropriate habitats; diversity and/or rarity, potential for providing food and habitat for fauna; the potential for self-seeding and/or ease of propagating from seed; and advice from Peter Morris.

Both pest control measures and the importance of biodiversity were also addressed in the participant questionnaire. Participants were asked if they had undertaken any pest control in their gully. Seventeen people reported controlling possums while 14 undertake no control, 11 control rats, and one person has live-trapped feral cats. Finally, when asked to rate the importance of enhancing biodiversity and controlling weeds in their gullies (out of 10), the mean ratings were 8.7 and 8.9, respectively.

Barriers to restoration/challenges faced (19)

A list of the potentially challenging factors of private gully restoration was presented to participants; and they rated these factors from 1–5 (with 5 being extremely challenging). Figure 6 shows the mean rating for each factor. Overall, participants rated pest plants as the greatest challenge they face with many comments such as "Weeds restrict native growth and it is a constant effort to keep on top of them". Other factors that present a large challenge to most of the participants undertaking gully restoration were a lack of time; physical aspects of the gully such as steep slopes, and financial limitations. The least challenging factor overall were safety concerns, however some participants had experienced acts of trespass and/or vandalism (young trees removed).

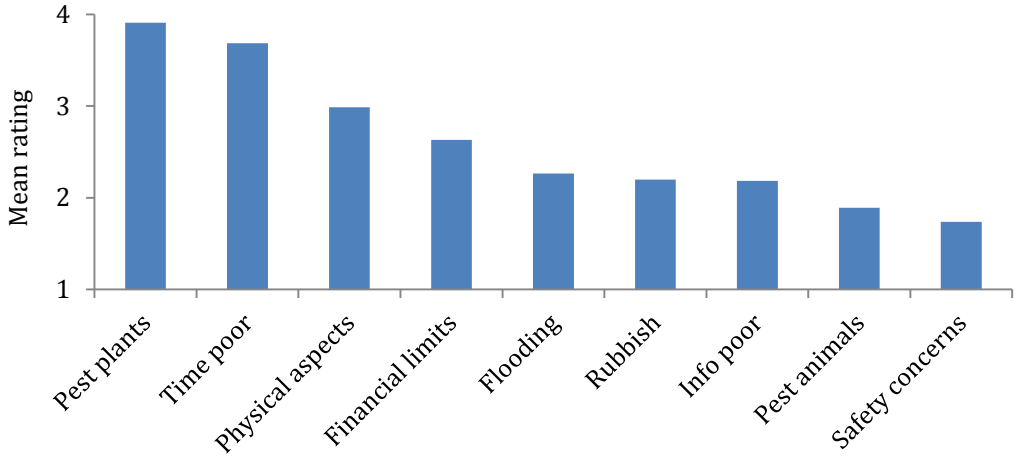

Figure 6 Mean rating (on a scale from 1–5) for potentially challenging factors of gully restoration (1: not challenging–5: extremely challenging).

Survivorship of allocated plants (Q 16, 17)

Gully participants were asked if they had lost any of the plants they received from the Plants for Gullies programme and if so, what percentage. The mean was 8.3 % lost, a number of

reasons were given for this loss, the most frequent being the recent severe drought, flooding, or to planting them in the wrong place in the earlier years of their restoration.

Educational aspects of the programme (Q 7,17a, 17b, 18)

Questionnaire participants frequently explained that they had learnt a lot about habitat suitability of native plants; they often talked about the importance of planting the right plant in the right place for success of their restoration. Weed management and botanical knowledge were also frequently mentioned as areas where they had gained better understanding. Six participants said they had learnt that gully restoration is an on-going and dynamic process which provides many lessons along the way. Other reported factors are presented in Figure 7.

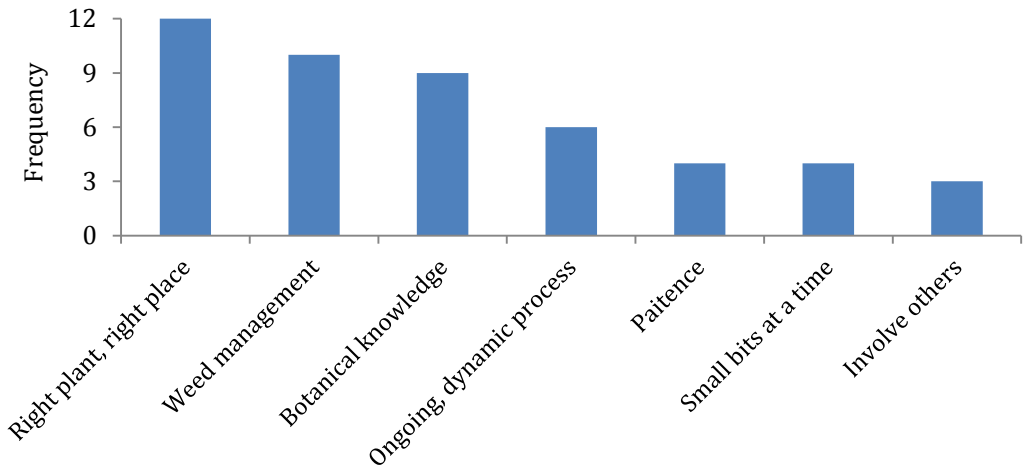

Figure 7 Key learning outcomes of participants of the Plants for Gullies Programme (n=38).

The Plants for Gullies and Gully Restoration programmes offer experiences and resources to gully owners that can enhance their understanding of restoration processes and provide opportunities for further learning. These opportunities include visits to the nursery supplying the plants, visits to restored gullies, educational workshops, and a printed Gully Restoration Guide. The participants were asked to rate the value of these programme features from 1 to 5, with 5 indicating the most value. Figure 8 shows that the visit to the nursery and the Gully Restoration Guide were most valuable, closely followed by the gully visit, workshops and mail out information.

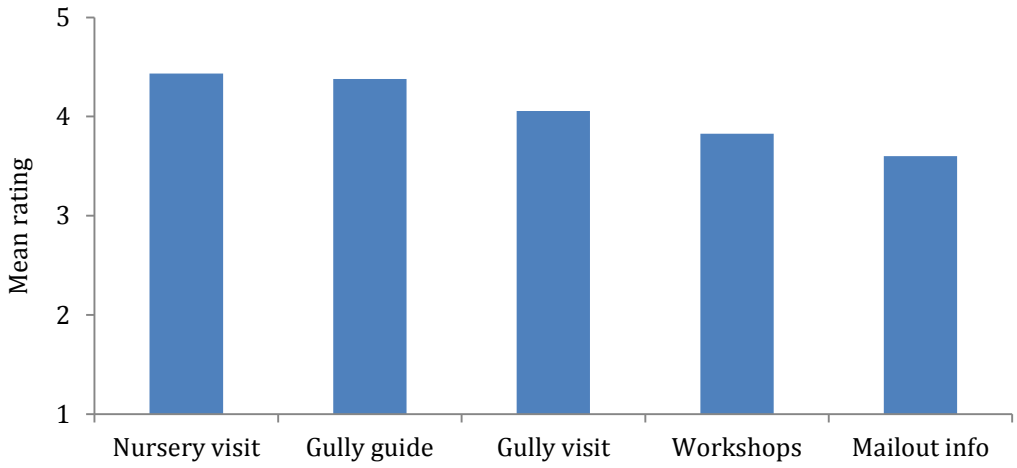

Figure 8 Mean rating (1–5) of educational aspects of the Gully Restoration Programme and the Plants for Gullies Programme (1: not valuable–5: highly valuable).

When asked if they had any suggestions for improvements to the Gully Guide, most participants were pleased with it, however there were four key changes that were requested by different people (Figure 9). Participants suggested the inclusion of more information on weeds, more native plants, bigger and better pictures, and some later stage advice for gullies that are past the early-successional stages.

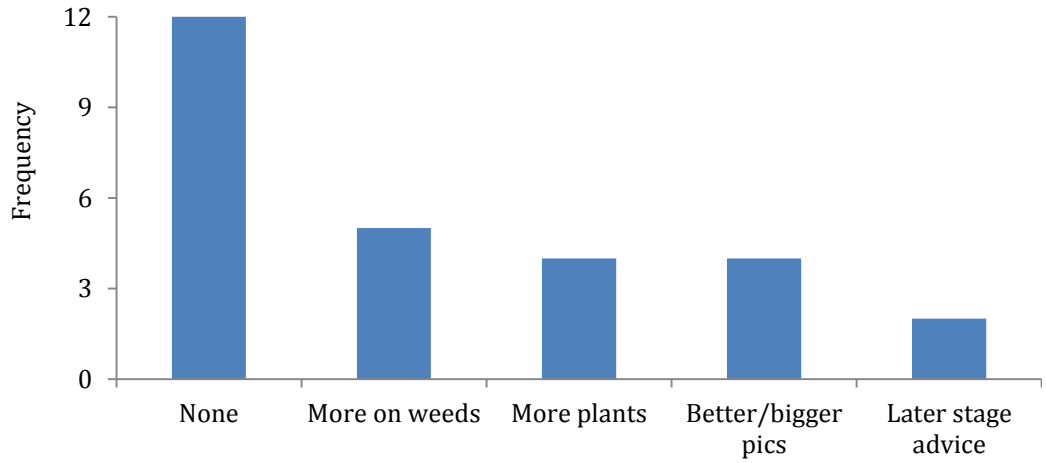

Figure 9 Suggested changes to the Gully Restoration Guide by participants on the Plants for Gullies Programme.

Results: Vegetation survey

Overview of gully vegetation

The surveyed gullies were classified into categories which related to the primary objectives and design of the observed plantings (Figure 10). The majority of gully systems (32/38) were being restored in accordance with a native ecological restoration ("Restoration"). Some gully systems were laid out in a highly landscaped fashion and would be considered more of a conventional garden with a focus on native species ("Garden/landscaping"). Finally, two gully systems were planted with the primary aim of enhancing bird diversity; these were composed of a diverse range of native and exotic species which attracted birds ("Bird biodiversity").

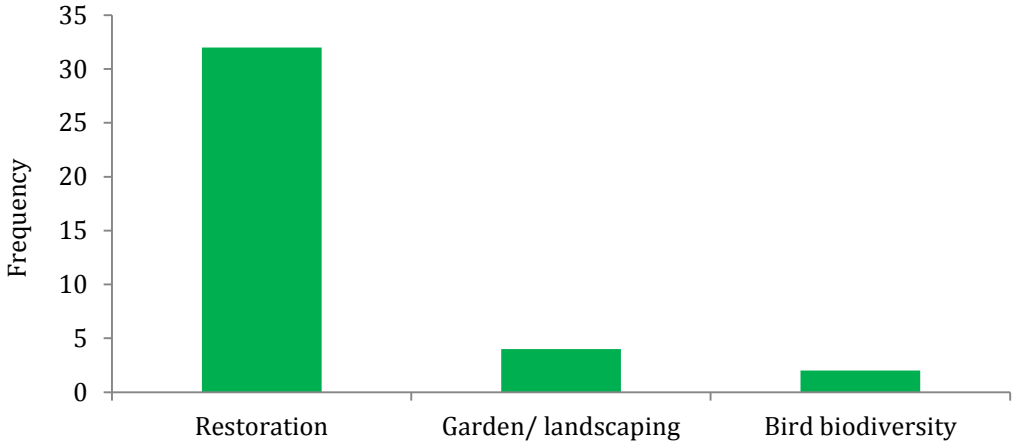

Figure 10 The primary objectives of the surveyed gully plantings.

The surveyed gullies were extremely diverse in terms of native and exotic vegetation diversity and abundance. Comparison restored sites with control sites (Figure 11) clearly show that areas where restoration is being undertaken ("restored") have significantly more native species and significantly fewer exotic species than the "control" sites. This comparison also shows greater abundance of nonlocal natives in restored versus control sites (Figure 11). See Figure 12 for photos of typical control site and restored gully sites.

.

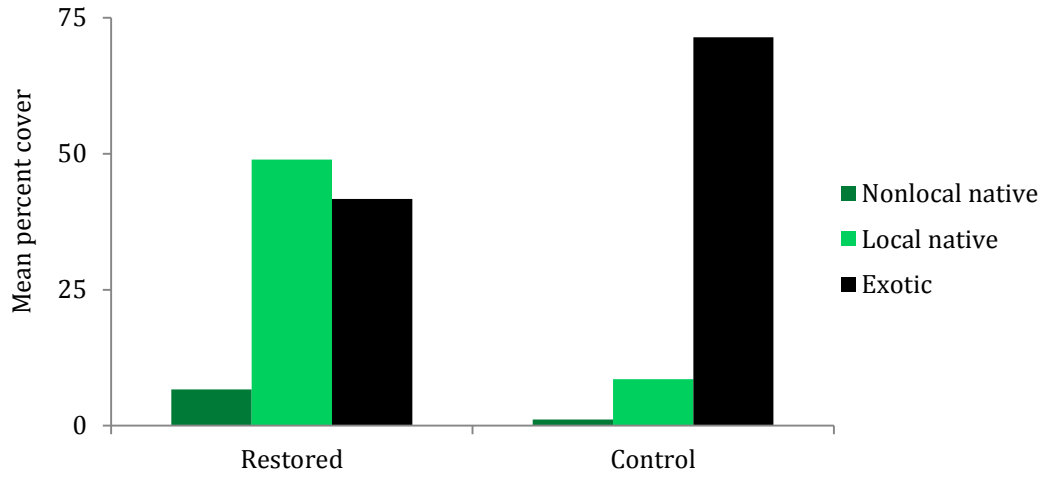

Figure 11 Mean percent cover of non-local native, local native and exotic vegetation at restored (n=38) and control (n=35) sites.

Figure 12 Images of control and restored gully systems in Hamilton city. **A:** Typical control site with prominently exotic vegetation, in this case a canopy of exotic willow (*Salix*), shrub layer including arum lily (*Zantedeschia aethiopica*),and ground cover of exotic grasses. **B:** Typical gully restoration in early successional stage, with young pioneer natives such as kanuka (*Kunzea ericoides*) and cabbage tree (*Cordyline australis*) planted in the shrub layer, and exotic grasses still dominant in the ground cover. **C:** Typical well developed mid successional gully restoration with mature pioneer native species creating canopy closure.

Abundance and diversity of native and exotic plant species

Figure 13 compares the diversity (mean number of species) of native and exotic species in two categories: stems (trees and shrubs), and ground cover. Native species diversity was greater than exotic diversity in restored sites for stems but not for ground cover species. In support of the cover estimates presented above, the native diversity was greater in restored sites than control sites for both stems and ground cover plants (Figure 13).

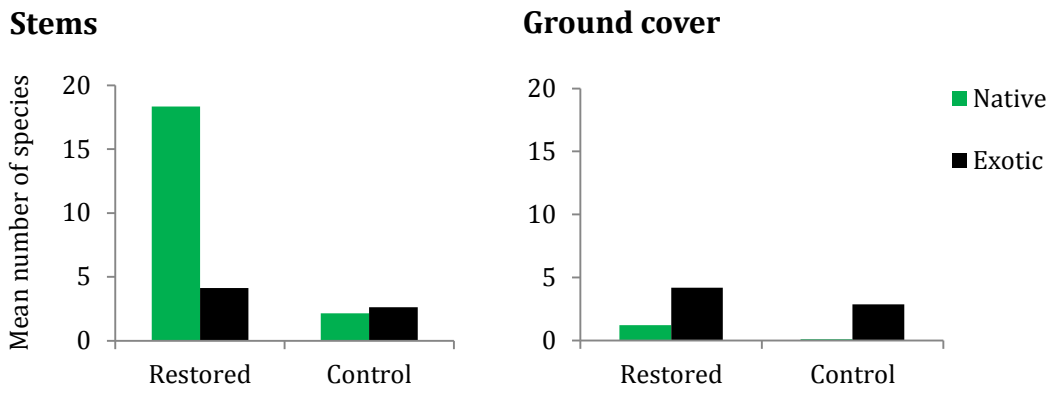

Figure 133 Species diversity of restored and control sites in tree and shrub layers and ground cover layers.

A total of eight restored gully systems had well developed, closed canopies. Figure 14 compares the overall native and exotic species diversity in the stems layer, ground cover layer and combined layers (both stems and ground cover) at restored sites with closed canopies, restored sites with open canopies and control sites (control sites had predominantly open canopies). The results show lower exotic diversity in sites with canopy cover than those with open canopies. This analysis also shows greater native diversity under closed canopies (Figure 14).

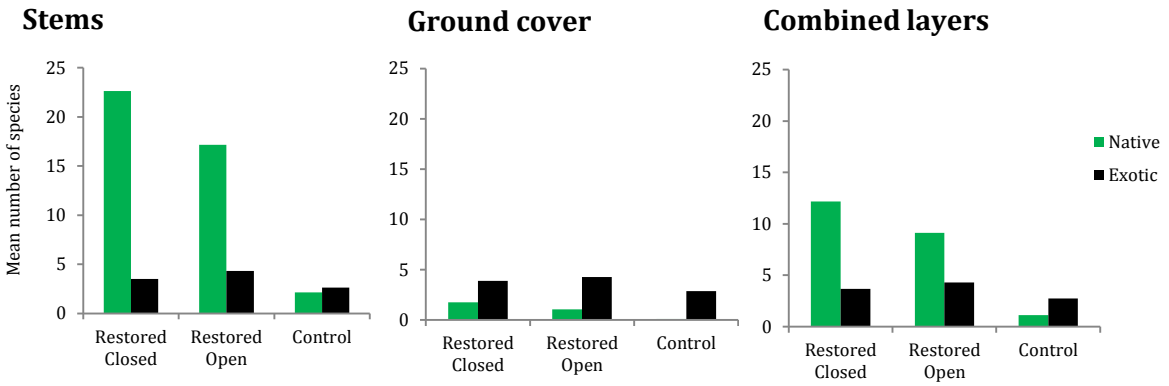

Figure 144 Mean native and exotic species diversity in the stems layer, ground cover layer and combined layers at restored sites with closed canopies (Restored Closed), restored sites with open canopies (Restored Open), and Control sites (Control) showing.

Of the 38 gullies visited, natural regeneration of native species was noted at 20 different sites. The most common species included *Coprosma robusta*, and *Hoheria* species (both local *Hoheria sexstylosa* and northern *Hoheria populnea* are growing throughout the Hamilton gully systems and commonly hybridise, hence seedlings were only identified to genus level) each recorded regenerating at 10 gully sites (Figure 15). Other common species found regenerating in gully systems included: *Cordyline australis*, *Macropiper excelsum*, *Melicytus ramiflorus*, *Pseudopanax* species, *Dacrycarpus dacrydioides*, and members of the tree fern genera; *Cyathea* and *Dicksonia* (Figure 15). Most significant, the locally rare *Syzygium maire* and the locally uncommon *Earina mucronata* and *Metrosideros diffusa* were found to be regenerating in some restored gully systems (Figure 15).

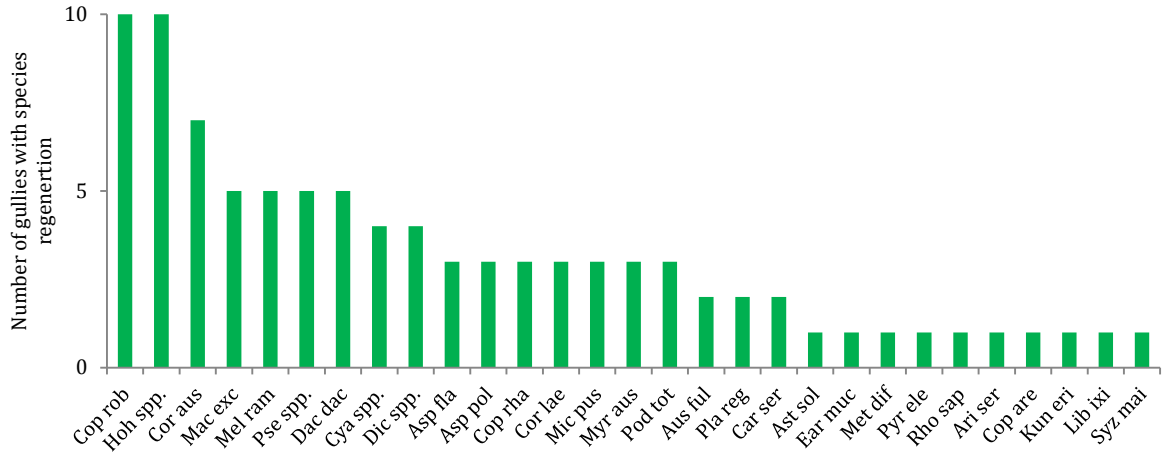

Figure 15 Range of species naturally regenerating in private gully sections. Cop rob: *Coprosma robusta*, Hoh spp.: *Hoheria* species, Cor aus: *Cordyline australis*, Mac exc: *Macropiper excelsum*, Mel ram: *Melicytus ramiflorus*, Pse spp.: *Pseudopanax* species, Dac dac: *Dacrycarpus dacrydioides*, Cya spp.: *Cyathea* species, Dic spp.: *Dicksonia* species, Asp fla: *Asplenium flaccidum*, Asp pol: *Asplenium polyodon*, Cop rha: *Coprosma rhamnoides*, Cor lae: *Corynocarpus laevigatus*, Mic pus: *Microsorum pustulatum*, Myr aus: *Myrsine australis*, Pod tot: *Podocarpus totara*, Aus ful: *Austroderia fulvida*, Pla reg: *Plagianthus regius*, Car ser: *Carpodetus serratus*, Ast sol: *Astelia solandri*, Ear muc: *Earina mucronata*, Met dif: *Metrosideros diffusa*, Pyr ele: *Pyrrosia eleagnifolia*, Rho sap: *Rhopalostylis sapida*, Ari ser: *Aristotelia serrata*, Cop are: *Coprosma areolata*, Kun eri: *Kunzea ericoides*, Lib ixi: *Libertia ixioides*, Syz mai: *Syzygium maire*.

Signs of engagement and application of restoration guidelines

For the most part, applicants of the Plants for Gullies programme have successfully adopted the key restoration guidelines of the programme, specifically the appropriate placement of native species in relation to habitat and successional trajectory. The native species supplied by the programme which were identified during the survey of the gully systems were all planted in suitable places and appeared healthy. Furthermore, a wide range of local and non-local native species that where were not supplied by the programme had also been planted in a number of gully systems and the majority of these were in suitable habitats and appeared healthy. Only a few cases of plants being planted in the unsuitable habitat were identified. This included a number of the locally rare species *Syzygium maire* (which in this particular case were not sourced from the programme) planted in unsuitable exposed/open sites, approximately half of these individuals were dead and the rest were in poor condition.

The level of weed maintenance varied from site to site due to both the stage of the restoration (older restoration projects with established canopy system require less maintenance as weeds were shaded out) and the amount of time the owners were able to dedicate to maintaining weeds. Over all, the majority gully owners were successfully maintaining weeds to the extent that they did not prevent the growth and survival of planted native species in the gully systems. There were only two exceptions where weeds, such as Japanese honeysuckle (*Lonicera japonica*), were essentially smothering and compromising the growth and survival of native species. These were restored gully sites where the owners were either not physically able to continue with gully restoration, or not able to safely access sites where native plants needed weed maintenance.

Stage of restoration

As mentioned earlier, a total of eight gully systems had well developed, closed canopies, out of these, three could be considered late successional – close to completion with mass regeneration and a diverse range of mature native species. Of these three late successional restorations, one was a particularly good example of lowland forest, one had a well-established wetland system and the other had intermittent exotic plantings to enhance bird diversity alongside a rich diversity of mature natives. All other systems ranged from very early stage restoration to having intermittent mature natives forming partial canopy closure.

Discussion: Phone survey

Participant summary

It is clear from the phone survey results that the majority of participants involved in the Plants for Gullies programme dedicate a lot of time and energy into restoring their gully systems. They have been working on these gully systems for an average of 7.9 years and spend an average of 10.3 hours per month maintaining and enhancing them.

It is also apparent that the programme is being successfully advertised to Hamilton city gully owners through a range of mediums including local advertisements, community seminars and lecture series, and LIM reports. Advocates affiliated with the programme are also raising public awareness.

Participants' satisfaction with the programme

Such outstanding participant satisfaction levels (an average score of 8.86 out of 10) were frequently attributed to affiliated staff/advocates of the programme, as well as plant quality and suitability (eco-sourced). This community engagement and quality delivery are two of the programmes key strengths. The few criticisms made about the programme with regard to the application process, the quantity of plants received, and the programme's relevance for advanced restoration projects need to be addressed. While some more experienced restorers may find them redundant, the application processes are useful to ensure the correct restoration methods are being applied and that plants which are best suited to each site are provided. The number of plants provided varies from year to year and is dependant of the total number of applications, the scale of the proposed restoration, and the number of plants made available through the programme, hence some applicants do not get their requested number of plants. Finally, the programme is currently tailored to the initial and intermediate stages of restoration projects. It is clear from the high participant satisfaction levels that both the Plants for Gullies programme and gully restoration programme serve as an excellent introduction to the restoration of degraded gully systems, however as these restoration projects progress to more advanced systems there is demand for later successional resources. It is recommended that educational tools, such as the Gully Restoration Guide, are updated to incorporate more information on these later successional communities (see Gully Restoration Guide improvement suggestions).

Motivation for restoring gully systems

Participants noted a range of key factors which motivated them to undertake gully restoration, overall the most commonly cited factors for motivation were 'personal satisfaction' and 'attracting birds'. It is encouraging to note that overall participant motivation had been enhanced significantly since receiving plants from the programme. It is also encouraging that the majority of participants (35/37) had added personally sourced plants to these systems, of which 94.2% were native species. These results clearly indicate that the Plants for Gullies programme is an effective incentive for private gully restoration.

Attributes, benefits, priorities and barriers to restoration

Overall, the most valued attributes of private gully systems were the natural aspects such as flora, fauna, and wilderness. Importantly, these values took precedence over more conventional gardening values such as aesthetics/view. Similarly, when purchasing plants for their gully systems, participants listed 'eco-sourced plants' as their most important consideration. Eco-sourced (locally sourced) plants are more likely to be adapted to the environmental variability of the area, and thus have higher survivorship (Soule´ 1986; Schaal & Leverich 2005). Eco sourcing maintains natural plant distributions and gene pools, while the introduction of less fit genotypes can reduce the viability of adjacent wild populations (Ellstrand 1992). The importance of eco-sourced material is communicated throughout the programme and the uptake of its importance from participants indicates that they are prioritising the requirements of successful ecological restoration. This awareness is also apparent through the high score participants gave to both the importance of biodiversity and controlling weed species. The high rating (8.9/10) that participants gave to the importance of controlling weeds reflects the significant challenge that weeds present.

The ecological benefits of gully restoration efforts were also widely evident to participants of the programme, with many reporting increased bird visits, reduced weed abundance and increased regeneration of native species. More quantitative benefits are discussed in the vegetation survey section.

Survivorship of allocated plants

While the majority of plants survived, a mean of 8.6% of allocated plants did not. The losses were attributed to a number of reasons, but mainly included drought, flooding and planting in the wrong place. Many people mentioned that in the earlier years of their restoration the loss was attributed to planting in the wrong place and the fact that they could now identify this incorrect placement indicates that they are now confident in identifying correct habitat for specific species. Furthermore, nursery owner Peter Morris, who allocates plants to participants, has developed and fine-tuned a comprehensive system which ensures participants are fully informed and educated about the placement of different species within their gully systems. This system includes an assessment of the gully topography and habitat based on information provided in the application process, a tour of the nursery to discuss which plants would be best suited to the varied environments in one's gully system, and finally the allocation of plants coupled with labels which indicate habitat requirements.

Educational aspects of the programme

The dominant learning outcome of the programme was the concept of 'right plant, right place' (as mentioned above) and the successful uptake of this concept was commonly attributed to the work of Peter Morris and Wayne Bennett through nursery visits, and the help of the Gully Restoration Guide. Practical learning outcomes of the programme also included weed management and botanical knowledge. The uptake of these concepts provides further evidence to show that the programme is an effective means of encouraging and educating people to undertake successful ecological restorations in their private gully systems. To add to this evidence, the value which participants place on the educational aspects of the Gully Restoration programme indicates that these aspects play a key role in effectively communicating the concepts of the programme. Some participants also commented that the events that gather gully owners together are beneficial for sharing ideas and "creating a community of like-minded people".

Gully Restoration Guide improvement suggestions

Participants were happy with the content of the current edition of the Gully Restoration Guide; however we did receive some valuable suggestions for its improvement. As the biggest barrier to restoration was pest plants, the suggestion of adding more information with regard to their identification would be a constructive and essential addition. Revised editions of the guide should also incorporate larger photos which are more tailored to aiding plant identification. Finally, the addition of more plants and more information about later stage/later successional systems would be important to ensure the continuation of viable ecological restorations. Specifically, we would recommend adding a wider diversity of ground cover and epiphytic species to the guide as these plant groups were the most depauperate in the gully systems.

Discussion: Vegetation survey

Overview of gully restoration

It is encouraging to see that the majority of surveyed property owners appear to be committed to actively restoring or recreating native habitat according to ecological principles promoted by the programme. Ecological restoration is the most effective method for returning a degraded ecosystem to a self-maintaining state with abundant native biodiversity and intact ecosystems. Projects that prioritise garden/landscaping or bird biodiversity are also very beneficial as they can also contribute to enhancing native biodiversity through native regeneration and increased habitat for native flora and fauna.

Abundance and diversity of native and exotic plant species

The vegetation survey clearly indicates a significant increase in the total percent cover of native species and a reduction in the percent cover of exotic species in restored sites when compared to control sites. There is also a significant increase in native species diversity of restoration sites compared to control sites. It is clear from the survey that increased native species cover and diversity can be attributed to the restoration efforts of private gully owners alongside the plant contributions and education provided by the Plants for Gullies programme.

Complete canopy cover is often reported to reduce the diversity and abundance of exotic species in gully sites. The comparisons of closed canopy systems with open or partially closed canopies indicates that, as expected, the more advanced restorations with closed canopy systems have higher levels of native plant diversity and lower levels of exotic diversity. Field observations indicated that as canopy systems matured the shade intolerant weed species such as Wandering Jew (*Tradescantia fluminensis*) and Japanese honey suckle become less abundant.

Regeneration of many of the plant species provided by the programme, including locally rare species *Syzygium maire*, is a direct result of private gully restoration. This is due to many of the plants provided by the programme being reproductively mature, and thus being quick to set seed and regenerate in favourable conditions. While the regeneration of species not provided by the programme, including uncommon wind dispersed species such as *Earina mucronata*, *Metrosideros diffusa,* is likely to be an indirect result of the restoration efforts (e.g. an increase in habitat suitability due to increased canopy closure and reductions in edge effects) – essentially the restoration plantings are making the restored system more favourable to germination and survival of more sensitive, later successional native species.

Signs of engagement and application of restoration guidelines

There is further evidence of uptake of the practical and educational aspects of the programme (discussed in survivorship of allocated plants and educational aspects of the programme, above) with results showing all participants to have carried out the appropriate placement of native species in relation to habitat and successional trajectory (with minor exceptions) and are taking adequate action to control weeds. Many of the additional native species not supplied by the programme which participants had planted were also not listed in the Gully Restoration Guide hand out, indicating external research by the gully owner. This suggests that the programme not only promotes uptake of the provided educational aspects but encourages research and interest beyond its provisions.

Synthesis

To summarise, it is clear from the results of this research that the participants undertaking gully restoration, with the help of the Plants for Gullies programme, are successfully assisting the improvement of native biodiversity in Hamilton gully systems. It is also evident that the delivery and uptake of the Plants for Gully programme itself is effective.

Participants within the programme dedicate a lot of time and energy to restoring their gully systems, and through the Plants for Gullies programme they have reported an overall increase in motivation levels to achieve restoration goals. It is therefore imperative that the current level of community outreach is maintained to ensure continued uptake of the programme from both new and existing members.

Not only are current participants successfully reintroducing the supplied native species into their gully systems, they are also adding large quantities of privately sourced native species. These participants were able to draw upon the knowledge they have acquired through participation in programme to add valuable diversity to their gully systems. The uptake of education on native species requirements is made possible through a fine-tuned and

comprehensive process of plant allocation, which ensures participants are fully informed and educated about the placement of different species within their gully systems.

The importance of eco-sourced material is communicated throughout the programme and the uptake of its importance from participants indicates that they are prioritising the requirements of a successful ecological restoration. This uptake is also apparent through the high rating participants gave to both the importance of biodiversity and controlling weed species. The emphasis participants gave to the importance of controlling weeds highlights a well-known issue that was also ranked the as most challenging factor in restoration.

A key recommendation for the programme would be the development of an updated edition of the Gully Restoration Guide, which appears to be highly successful, and the most utilised component of the programme's educational tools. Specifically, requests have been made for additional plant identification tools (both native and exotic), with a wider variety of species, and more information about later stage/later successional systems. Such additions are important to ensure the continuation of diverse and viable ecological restorations.

Finally, the significant increase in native cover and diversity coupled with the reduction in exotic species as restored systems mature should be considered a robust reason to maintain the Plants for Gullies programme and gully restoration programme in Hamilton City. This significant enhancement in the biodiversity of gully systems is undoubtedly a positive contribution to the natural heritage of the city and programme as it stands would be an excellent template to implement in other New Zealand cities with gully systems or similar unrestored habitats.

References

Ellstrand, N. C. 1992. Gene flow by pollen: implication for plant conservation genetics. Oikos 63:77–86.

Schaal, B. A., and W. J. Leverich. 2005. Conservation genetics: theory and practice. Annals of the Missouri Botanical Garden 92:1–11.

Soule´, M. E., editor. 1986. Conservation biology. The science of scarcity and diversity. Sinauer Associates, Sunderland, Massachusetts.

Appendix 1: Questionnaire for Evaluation of Hamilton City Council's Plants for Gullies programme 2011

Adapted from: Jay, M. & Stolte, O. 2011. Human Ecology of Urban Gully Restoration: A New Zealand Example. *Urban Habitats, 6*. http://urbanhabitats.org/v06n01/urbanravine_full.html

Information provided during phone call:

Hi, it's _____ here from the University of Waikato. I'm calling in regard to the Plants for Gullies programme and was wondering if you had 10 – 20 minutes to answer the questionnaire discussed in the letter you received recently?

Yes? Great, I'll quickly read you our disclaimer

No? Can we arrange a time that would suit you better?

If you would prefer not to answer, please feel free to refuse. You have a right not to participate, a right not to answer any particular question and a right to withdraw from the interview at any time. You also have the right to withdraw any information you have provided up to three weeks after your telephone interview. Please also feel free to ask any questions about the survey during the interview or site visit. All information gathered will remain confidential and no link between answers and participants will be able to be made.

So we have 22 questions to ask you, and I'll get started with number 1…

Landowner name:

Landowner address:

No. of plants received:

Years received:

Instructions:

Circle appropriate no.

Tick appropriate box(s)

1. What year did you begin restoring your gully?

Restoration = management steps undertaken to reverse degradation and improve health of a site (e.g. weed control, eco-sourced native planting, pest control, habitat enhancement)

2. On average, how many hours do you spend each month restoring your gully?

1 2 3 4 5 6 7 8 9 10+ hours

3. Approximately what percentage of your gully section are you restoring?

10 20 30 40 50 60 70 80 90 100%

4. Out ten, with ten being complete or almost complete, how much progress have you made in your gully restoration?

1 2 3 4 5 6 7 8 9 10

(i.e: no planting/ little to no weeding) Gully restoration is nearly complete

Notes:

5. What changes have you noticed in your gully since you started restoring it?

- ☐ More birds
- ☐ Native (or desirable) plant reproduction
- ☐ Less weeds
- ☐ Less erosion
- ☐ Other, please explain:

6. What attributes do you value most about your gully?

- ☐ Peacefulness
- ☐ Privacy
- ☐ Flora and fauna, nature, wilderness
- ☐ Opportunity to restore natural environment

- ☐ Space
- ☐ Other, please explain:

7. What are the key things you have learnt through restoring your gully?

8. How did you find out about the Plants for Gullies programme?

9. Out of 10, how satisfied were you with the Plants for Gullies programme, with ten being very satisfied?

1	2	3	4	5	6	7	8	9	10
Not satisfied								Very satisfied	

9a. Would you like to say why you give it this rating?

10. Since receiving plants from the Plants for Gullies programme how many other plants have you planted in total?

0-5	5-25	25-50	50-75	75-100	100+

11. What percentage of these plants were native?

10	20	30	40	50	60	70	80	90	100%

12. What are your main considerations when purchasing plants for your gully? (Score 1 to 5 with 5 very important and 1 not important).

- ☐ Cost
- ☐ Aesthetics
- ☐ Bank stabilisation
- ☐ Native
- ☐ Eco-sourced
- ☐ Other, please explain:

13. Have you been more motivated to undertake gully restoration since receiving plants from the programme?

1 2 3 4 5 6 7 8 9 10

Less motivated much the same more motivated

14. What motivates you to restore your gully? (Score 1 to 5 with 5 highly motivating and 1 not motivating).

- ☐ Stabilising slopes
- ☐ Enhancing biodiversity
- ☐ Attracting birds
- ☐ Controlling weeds
- ☐ Personal satisfaction/enjoyment
- ☐ Physical activity
- ☐ Aesthetics
- ☐ Enhancing privacy
- ☐ Gully Restoration Programme
- ☐ Other, please explain:

15. Have you undertaken any pest control/management in you gully? Please explain:

16. Have you lost any of the Plants you received from the programme? If yes, what percent in total?

10 20 30 40 50 60 70 80 90 100%

17. Why do you think these plants died?

- ☐ Drought
- ☐ Flooding
- ☐ Weed smothering
- ☐ Animal pest
- ☐ Wind
- ☐ Unknown / No obvious reason
- ☐ Other, please explain:

17a. Did you find the following educational aspects of the Gully Restoration Programme of value? (Score 1 to 5 with 5 extremely valuable and 1 not of value)

- ☐ Visit to a nursery supplying plants in Plants for Gullies program

- ☐ Visit to restored gully
- ☐ Educational workshops
- ☐ Gully guide
- ☐ Other, please explain:

17b. if you received the gully guide do you have any suggestions for improvement?

18. Out of ten, with ten being extremely valuable, was the mail out information from the Gully Restoration Programme of value to you?

1	2	3	4	5	6	7	8	9	10
Not at all				Somewhat				Great value	

19. What factors do you find challenging when restoring your gully? (Score 1 to 5 with 5 very challenging and 1 not challenging).

- ☐ Lack of time
- ☐ Lack of information / knowledge
- ☐ Pest plants
- ☐ Pest animals
- ☐ Rubbish
- ☐ Flooding
- ☐ Security / safety concerns
- ☐ Financial limitations
- ☐ Physical aspects (e.g. too wet/steep)
- ☐ Other, please explain:

20. Out of ten, with ten being extremely important, how important is it to you to enhance native biodiversity in your gully?

1	2	3	4	5	6	7	8	9	10
Not important			Somewhat important				Extremely important		

21a. Out of ten, with ten being extremely important, how important is it to you to control weeds in your gully?

1	2	3	4	5	6	7	8	9	10

Not important Somewhat important Extremely important

21b. (If Q. 20 below 5) What are some of the reasons for this?

22. And finally, do you think the Gully Restoration Programme should continue to be funded by the Hamilton City Council?

Yes / No

Suggestions/recommendations?

Questions for Tim?

Appendix 2: Vegetation survey sheet

Site Description						
Landowner:				Date:		
Address:				Site Number:		
				Area (ha):		
Slope (°):				Start time:		
Topo description:				Finish time:		
% Erosion:				Photo ID:		
Hydrology:	Flowing	Wetland	Dry	Non-flowing		
Surr. landuse:	Industrial	Parkland	Farmland	Residential		
Stream name:						

Vegetation of study site						
Tier	Species	Height (m)	Frequency	% Cover	J/M	L/NL/W

Vegetation Quantification:

Percent Local cover:

Percent Nonlocal cover:

Percent Weeds:

Site Notes (Iconic species, Restoration Threats, Habitat Linkage, SNA, seed collection)

Gully Surrounds (Control)						
Tier	Species	Height (m)	Frequency	% Cover	J/M	L/NL/W
Vegetation Quantification: Percent Local cover: Percent Nonlocal cover: Percent Weeds:						
Site Notes (Iconic species, Restoration Threats, Habitat Linkage, SNA, seed collection)						

Appendix 3:

Table 1 Criticism of the Plants for Gullies Programme (in reference to participant satisfaction).

	Criticism
1	The amount of plants they give you is not really worth it.
2	The reporting becomes meaningless and onerous after a while, it's hard to keep track and I have stopped applying now. Bureaucratic process.
3	Unfortunately we missed some of the applications - did not get in on time.
4	Felt overwhelmed by the task at hand and it would be nice if the council was able to help out more or initiate a co-operative working bee.
5	Initially it was really good and the nursery people came for a visit - were very helpful. Now we are beyond the early pioneer species and smaller plants they offer as part of the programme.
6	Appreciative of the plants, but received less than 50 which I wanted.
7	Received lots of kowhai that were floppy and required staking.