How can urban riparian planting chime with residential garden design?
An amenity planting trial for urban streamsides

Leslie Haines and Jacqueline Margetts[1]

Introduction
Current research on riparian planting in urban areas is focussing on indigenous revegetation. The RNZIH conference proceedings Greening the City (Dawson, 2005) provides a broad overview for New Zealand. This emphasis on native plants and their associated ecological values is appropriate for much riparian planting, especially where native biodiversity is to be maximised. Many cities, such as urban Auckland with an extensive range of ridges and gullies, provide a network of streams that run through public and private spaces. In public places, where streams remain above ground, they are increasingly being restored predominantly through community revegetation initiatives using local indigenous plants. This practice fits well with the policies for water quality management, to reduce erosion and pollution, to provide shade for aquatic wildlife, and to fulfil the commitment to indigenous biodiversity. These initiatives, supported and promoted by many local authorities (ARC, 2001; Hamilton City Council, 2002; WCC, 1999; amongst others), have increased the local indigenous species in the environment and fulfil some of the requirements of the New Zealand Biodiversity Strategy.

During an investigation into urban streams it became very apparent that where a stream flows through a residential garden it is seldom incorporated into the design of the garden, and most often the area is screened off or abandoned – a marginalised component of the garden (Fig. 1). Thibault (1997) questions whether a stream is seen as an amenity or a liability and therefore treated 'in a manner not consistent with the rest of the property'. Even in more public places such as the Unitec campus in Mt Albert, Auckland, streams are seen as problematic (Fig. 2). The 'backyard biodiversity' concept (Brakey, 2005; Meurk, 2003) extends indigenous riparian plantings beyond public space to include streams through private property. This strategy may not necessarily be the most desirable approach, however, for streams which flow through private gardens, where cultural expression of a different aesthetic can be important.


Fig. 1 An Auckland urban stream which has been abandoned.


Fig. 2 Unitec campus: Wairaka Stream has little amenity and ecological value.

By their very character gardens are rarely ecologically stable and therefore require continuous maintenance. The current ecological landscape design paradigm looks to integrate the ecological, cultural and aesthetic to address the complexities of urban and rural environments. Makhzoumi and Pungetti (1999) describe ecological design as *'any form of responsible design that minimises environmental destructive impacts by integrating itself with living processes'*. This approach focuses on an awareness of the limitations and potential of the existing landscape and attempts to reduce the ecological instability of gardens, thus reducing the need for intensive maintenance.

The role of plants in the designed garden may be to provide form, structure, beauty, and change (Fig. 3). Mark Johnson (1999) suggests that garden aesthetics emphasises order, continuity, orientation, sensations of beauty and place, a sense of care, and so on.


Fig. 3 A designed garden showing structure, form, aesthetics and potential for change.

He goes on to suggest that '*the urban landscape need not look ecological to communicate ecological values to people'*. Rather than looking, as Nassauer (1997) suggests, *'for the beauty in the indigenous*', this research project concentrates on the parallel approach also proposed by Nassauer, of '*finding the ecology in the exotic'* within the riparian zones of designed gardens. Designers

[1] The School of Architecture and Landscape Architecture, Unitec New Zealand, Private Bag 92025, Auckland; lhaines@unitec.ac.nz; jmargetts@unitec.ac.nz

need to be able to select from a broad range of plants, both native and exotic, and know that their choice is appropriate in terms of ecological functioning and impact, yet still possess the desired aesthetic qualities.

Streams are highly disturbed systems, and urban streams, in particular, are subject to frequent and intense disturbance events by flooding. Plants have a role in stream ecology by interacting with stream biota and the surrounding land. Plants provide shade and shelter which ameliorates the temperature and conditions; shed leaves form a food supply for stream animals and micro-organisms; and plant roots control erosion by binding soil and reducing the direct impact of the force of the flood, thereby reducing downstream sedimentation.

Some of these ecological functions in a managed environment can be performed by exotic species, and in fact, some can play important functional roles (Kendle and Rose, 2000). For example, soil erosion control in rural New Zealand is predominantly managed by planting willow and poplar cultivars selected and propagated specifically for this role. Recent research by Phillips, Marden and Rowan (2005) into the potential for woody natives to predominantly fill this role of erosion control has not conclusively generated viable native replacements so far, especially for large streams. In this case the limiting factor appeared to be the structure and depth of the root systems.

It is recognised that in the utilisation of exotic species there is the risk of garden escapes, especially where the stream flooding causes disturbance to the vegetation and ground, carrying plant propagules downstream. In this context, exotic plants are tied very strongly into the discourse of weeds, especially in the Auckland region of New Zealand where there is extensive and ongoing naturalisation of exotic plants. When the relative merits of native versus exotic species are discussed in the literature the invasive characteristics of exotic species are highlighted, as invasive species are considered detrimental to natural ecosystems. The ever-tightening biosecurity measures in New Zealand and many other countries bear witness to increasing intolerance of introduced invasive species. So when selecting exotic plants for streamside planting from the thousands of species available in New Zealand, we need to ensure the species we are choosing for design have not become invasive. Less than 150 species have been listed as environmentally invasive in Auckland (ARC, 2002), but currently we are vigilant, on the lookout for species that might be moving from naturalised to becoming invasive. So when we choose plants for gardens, especially where these are in disturbed environments such as riparian areas, we need to be alert to the character of the species and its potential for becoming invasive. This isn't always easy as many common garden plants, once thought 'safe' are frequently re-classified as invasive. Current examples of plants in this category include agapanthus, phoenix palm and bangalow palm; all three of which are extensively used in Auckland gardens, and the proposed re-classification of these plants as invasive weeds is causing much debate.

There is a lack of information with respect to the performance of exotic garden plants in riparian areas, especially in relation to key ecological functions, and this research sets out to make a start on addressing this deficit. A plant trial was set up to investigate planting options that will not only provide for the stream ecology, but also meet the criteria of the planting themes and design of the adjacent garden.

Plant trials

Plant selection was intended to meet a number of criteria including the ability to complete the trial within approximately one growing season. Plants for this trial were selected on the following criteria: readily available; are used for planting in designed gardens; tolerate damp conditions for some of the time; are non-invasive; would not be detrimental to the ecology; are herbaceous, non-woody.

The plants selected were: *Acorus gramineus* (Japanese sweet flag, Japanese rush), *Euphorbia amygdaloides* var. *robbiae*, *Hakonechloa macra* (Hakone grass, Japanese forest grass), *Hemerocallis* cv. (a dwarf selection of daylily), and *Zantedeschia* cv. (a dwarf selection of calla lily). For comparison, a native species of sedge commonly used in riparian areas was selected – *Carex secta* (Niggerhead, Pūkio), known to have an extensive root system effective in binding soil. After some discussion with local Auckland practitioners experienced in planting natives in riparian areas, it was decided to include two other *Carex* species – *C. lessoniana* (rautahi) and *C. virgata* (swamp sedge), both naturally more common than *C. secta* in the Auckland area. This gave us five exotic species and three native species.

Our trial planting design was selected to give each species an equal chance of being close to the stream edge, so we used a Latin Square layout – not dissimilar to two adjacent 8×8 SUDOKUs. Plants were evenly placed at 0.5m spacings. Two Auckland sites were chosen to implement the trial. One site was at Unitec, beside the Wairaka Stream in Mt Albert. The other was on private land beside the Waikumete Stream in Glen Eden. Both streams have a history of flooding. The Wairaka on average floods over its banks three times per year and is not atypical of suburban streams in size and disturbance regime (Fig. 4).

Fig. 4 Wairaka Stream in flood the year previous to our trial.

The Waikumete is larger and floods more frequently, with more intense flood events. The Wairaka Stream is in full sun while the Waikumete Stream has trees along the banks providing shady conditions. During the trial, information was collected on the extent of flooding, post-flooding recovery by plants, size of plants, root and above-ground biomass as an indicator of erosion control, and survival rate.

Preliminary results

1. Plant size

Measurements of plant height and width were used as a preliminary indicator of above-ground biomass and of plant cover.

After a period of 14 months the *Zantedeschia* was the tallest exotic species at both sites. *Euphorbia*, *Hemerocallis* and *Zantedeschia* were shorter at the Waikumete site in the shade, while *Acorus* and *Hakonechloa* were taller in the shade. When the size of the exotic species were compared to the native species, all exotic species were shorter (partly related to the potential of the species, e.g., *Acorus*). *Carex secta* was the tallest species at both sites (i.e., sun and shade conditions) compared to all other species. All three native species were shorter at the Waikumete site in the shade, in particular *Carex lessoniana* was more than 50% shorter than at the sunny site (Fig. 5).

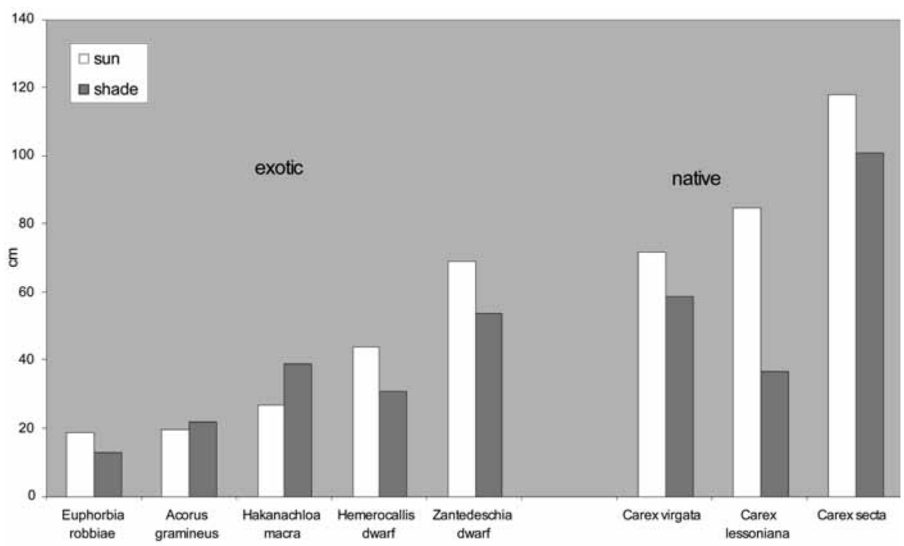

Fig. 5 Height comparisons between sun and shade conditions, and exotic and native species.

The resulting exotic plant widths had less variation compared to plant height for each species. However, *Euphorbia* produced offshoots while the original central plant died back. In the shade, the number of offshoots was limited to 2–3 whereas numerous offshoots were produced in sunny conditions. The plant spread of *Euphorbia* was 90% less in the shade. When we compared exotic and native species, exotic species were narrower than the natives. *Carex lessoniana* had a similar proliferating habit to *Euphorbia* with 80% less spread in the shade (Fig. 6).

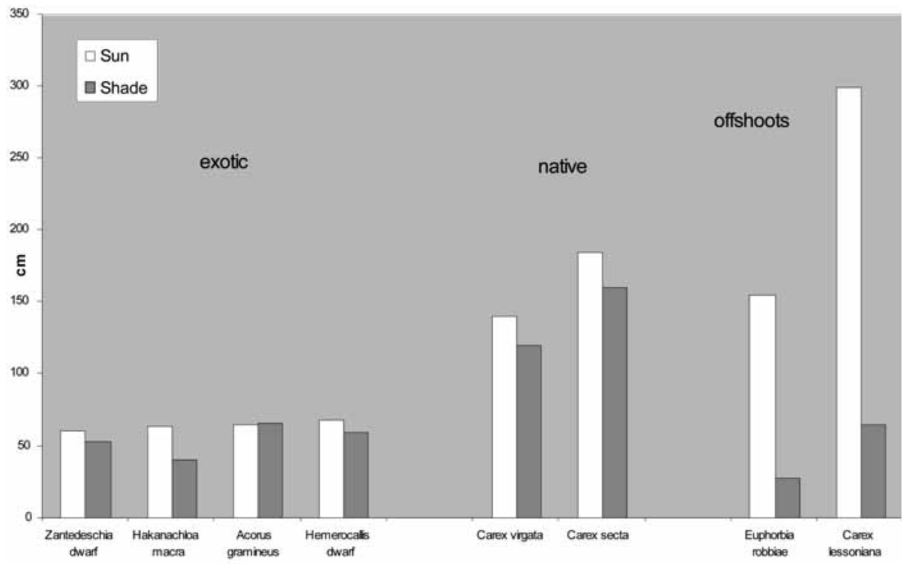

Fig. 6 Width comparisons between sun and shade conditions, exotic and native species, and species producing offshoots.

In general, there was a mixed response to sun and shade conditions. Two species were affected particularly by the shade and seemed to have collapsed. *Carex lessoniana* in the shade was 44% shorter than when planted in the sun and *Hemerocallis* was about 70% shorter. Even at the sunny site the *Hemerocallis* was being affected by competition for light at the planting density of the trial. One species that appeared to perform very similarly at both sites was *Acorus* which appears to tolerate the broadest range of light conditions.

2. Plant response to flooding

There were three coinciding flood events for both sites during the trial period. At the Wairaka Stream, none of these events were intense enough to overtop the bank. Modifications to the stream system occurred upstream during the period of the trial, increasing the holding capacity during flood events resulting in the reduced flood effect – unfortunate timing for the purposes of our trial. At the Waikumete Stream two of the flood events impacted on the trial area, one covering the majority of the plants (Fig. 7).

Fig. 7 Waikumete Stream flooding, immersing some plants and depositing debris.

Here also, modifications upstream to incorporate a settling pond resulted in reduced intensity of flood events over the past two years at this site.

The longest flood event during our trial had a duration of approximately 40 minutes, and was therefore unlikely to have affected plant growth. Usually only species very sensitive to 'wet feet' would be affected by this length of time under water. All plants recovered from the flood effect that laid them flat, and no deaths were recorded after the floods.

However, there was some plant loss but deaths appeared to be in relation to lack of light. At the shady site about 40% of *Euphorbia* plants died, and there was a small loss of *Zantedeschia* and *Carex lessoniana*. At the sunny site competition between plants appeared to have affected *Hemerocallis* particularly with 40% plant death.

Overall *Carex secta* was competitive at both sites but was more robust in sunny conditions: it was 15% shorter and 62% narrower in the shade.

3. Overall plant appearance

The appearance of plants is of course important for designed gardens. In particular the plants need to look healthy, maintain their characteristic form and colour, and produce flowers where desirable.

General visual health of the plants was greatest in the sunny site. Flowering overall was greatest in the sunny conditions with *Zantedeschia* and *Hemerocallis* having the most showy flowering. The grasses, sedges and *Euphorbia* rely on their form and/or foliage colour for aesthetic values. The appearance of *Acorus* is the least affected by harsh conditions except for collecting debris as the flood event receded (Fig. 8). This had visual impact rather than being a detriment to health and the effect was minimal and gradually diminished over time.

Fig. 8 *Acorus gramineus* post-flood with debris deposit.

Conclusion

These results are only preliminary, and when more comprehensive statistical data is available this will provide more confident comparisons between species and their suitability for shady or sunny streamsides. The final stage of the trial is to remove the plants and compare the root structure and biomass as an indicator of erosion control suitability. *Carex secta*, an indigenous riparian species, is known to have a vigorous root system and will be the basis for comparisons for the other species. It will be a combination of the root structure, biomass, plant size and spread that will determine the final results especially for ecological functioning in terms of erosion control and the benefits this has to stream quality and the reduced flow of sediment to estuaries and harbours.

The advantages of offering a wider range of suitable plants for gardens are that designers will be encouraged, not only to consider more carefully the planting of the stream sides, but also be guided to choose those species which are most suitable for the task, which look good, and will also be ecologically beneficial.

References

ARC (Auckland Regional Council) (2001). Riparian Zone Management: strategy, guideline, planting guide. Auckland Regional Council.

ARC (Auckland Regional Council) (2002). Auckland Regional Pest Management Strategy 2002–2007. Auckland Regional Council.

Brakey, G. (2005). Backyard biodiversity. In: Dawson, M.I. (ed.). Greening the City: bringing biodiversity back into the urban environment. Proceedings of a Conference held by the Royal New Zealand Institute of Horticulture in Christchurch, 21–24 October 2003. Royal New Zealand Institute of Horticulture, Christchurch.

Dawson, M.I. (ed.) (2005). Greening the City: bringing biodiversity back into the urban environment. Proceedings of a Conference held by the Royal New Zealand Institute of Horticulture in Christchurch, 21–24 October 2003. Royal New Zealand Institute of Horticulture, Christchurch. 310 p.

Hamilton City Council (2002). Gully Restoration Guide. Hamilton City Council.

Kendle, A.D. and Rose, J.E. (2000). The aliens have landed! What are the justifications for 'native only' policies in landscape plantings? *Landscape and Urban Planning 47:* 19–31.

Meurk, C. (2003). The 2003 Banks Memorial Lecture: Cities are cultural and ecological keys to biodiversity futures. *New Zealand Garden Journal (Journal of the Royal New Zealand Institute of Horticulture) 6(2):* 3–10.

Nassauer, J.I. (1997). Placing Nature: culture and landscape ecology. Island Press, Washington DC.

Phillips, C. (2005). Erosion and sediment control using New Zealand native plants: what do we know? In: Erosion control seminar proceedings: Protecting the environment as an asset, 11–13 September 2005, Palmerston North Palmerston North, New Zealand Institute of Highway Technology and the Turfgrass specialists. Pp. 1-17.

Thibault, P.A. (1997). Ground cover patterns near streams for urban land use categories. *Landscape and Urban Planning 39*: 37–45.

WCC (Waitakere City Council) (1999). Greenprint. Waitakere City Council.

Leslie Haines and Jacqueline Margetts are Lecturers in Landscape Architecture at Unitec in Auckland.