The role of plants in environmental solutions

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Abstract

Auckland Botanic Gardens (ABG) aims through all its practices to promote abundant life in our gardens, waterways and soil. We believe environmental health is primarily determined by the quantity, diversity and resilience of the life it sustains.

This paper highlights the role plants play to enhance the ABG environment. Important sustainable horticultural practices undertaken at ABG include:

- Minimisation of pesticides utilised in the care of plant collections,
- Support for environmental weeding programmes
- Stormwater management, using concepts such as such as Low Impact Design (LID) which uses plants for the reduction of environmental harm.

ABG is committed to maximizing the health of its plants and gardens without reliance on pesticides, by using programmes aimed at promoting abundant life in our ecosystems. The success of this programme is largely underpinned by an extensive trial programme that identifies those plants which perform and remain healthy without pesticide intervention.

In 2000 the decision was taken to significantly reduce and intimately eliminate the use of insecticides and fungicides. As a consequence, the content of many gardens and collections has changed somewhat, as unhealthy and under-performing plants have been replaced with subjects that have excelled in the trial programme.

Stormwater management and Low Impact Design

ABG applies a stormwater management progamme based on Low Impact Design (LID) principles to protect and enhance the health of our waterways.

A series of connected stormwater treatment devices (a treatment train) has been deployed to optimize the environmental benefits underpinned by the Low Impact Design philosophy. The accumulated benefit of these connected devices contributes significantly to the health of our waterways.

N.B. LID is being re-termed Water Sensitive Design (WSD) by some New Zealand agencies.

LID contributes to our broader objective of maximising environmental benefits and fostering abundant life throughout ABG's ecosystems. The content and arrangement of plantings in LID systems can produce multiple benefits, including stormwater management, ecological enhancement and landscape benefits.

Background

Recently, consideration of plant content has broadened beyond just the attributes that contribute to waterway protection. Environmental benefits can be achieved through plantings that provide habitat for a broad diversity of wildlife. Well considered plant selection can help ensure year-round food supply to invertebrates, birds, lizards and other organisms.

Community acceptance of LID systems is enhanced when a particular feature is visually appealing. Attractive plants that are used to produce creative combinations of form, texture, tone and colour contribute considerably to the aesthetic appeal of the Garden.

Living roofs, vegetated swales and rain gardens place great demands on the resilience of plants. As well as surviving challenging growing conditions, the plants must also perform the required functions if stormwater is to be effectively treated.

The main focus for ABG is the selection and subsequent evaluation of native plant species for suitability in LID systems in order to confidently recommend them for wider use in stormwater treatment across the region. ABG undertakes plant selection and trial programmes to identify and recommend plants with the required attributes.

Plant selection has largely been based on observation of plants in their wild habitats. These selections are informed by understanding the various characteristics plants must have to be successful in a particular application. In many LID applications species adapted to dry conditions have proved more successful than those naturally found in constantly waterlogged situations. The main exceptions are those at the base of vegetated swales and in stormwater wetlands. Species selection is influenced by factors such as the type of system and the depth and composition of any substrate. ABG is progressively compiling shortlists of 'fit for purpose' species for various LID applications.

ABG currently receives approximately one million visits a year and is therefore an ideal place to create awareness of stormwater issues and increase community awareness of LID. To engage visitors and students ABG showcases a comprehensive range of devices in an integrated manner with interpretation that explains how they work and the resultant environmental benefits. Target audiences are public and private agencies that may utilize such systems as well as the general public and school children. 'Sustainable Water Trail' is a printed guide that has been produced to enable visitors to better understand the function and connectability of the various devices. A primary objective of the education/interpretation programme is to stimulate greater awareness and appreciation of waterways so that the community can take increasing responsibility for their care.

The Treatment Train

Save our Streams is an education programme focusing on the ABG streams and waterways. It is delivered to more than 8,000 school children annually at ABG as part of the curriculum-based Learning Through Experience process.

The objective to engage school children with the importance of healthy waterways was the driver for developing and interpreting a series of integrated stormwater treatment devices inside and immediately adjacent to the Potter Children's Garden. These devices include

- Green roofs
- Vegetated swale
- Stormwater planter boxes
- A stormwater tree pit
- An infiltration trench
- A filter strip
- A stormwater wetland.

These devices are collectively referred to as the 'Treatment Train', and they are interpreted under this heading. All stormwater emanating from the Potter Children's Garden is treated through these systems before it reaches natural waterways. The final stage of the Treatment Train is a stormwater wetland that receives water that has already passed through stormwater planter boxes, an infiltration trench and a filter strip.

Nursery Retention Tank

A retention tank was installed at the lower end of the nursery in 1998 to capture water and enable recycling of all runoff from the 6000 m^2 of the nursery. This nutrient-rich water is then recycled to irrigate the nursery plants. During peak flows, the retention tank overflows into an adjacent vegetated swale. The retention tank (and the connected LID devices) reduce the quantity of nutrient-enriched water that reaches natural waterways. The captured water is recycled over nursery crops.

Vegetated swale

Vegetated swales slow stormwater speed, filter out sediment and enable greater infiltration of stormwater into the ground.

The first vegetated swale installed at ABG was a wetland swale (rather than a dry swale) specifically designed to treat stormwater runoff from the nursery and other catchments before it enters the lakes. This is achieved by stormwater passing through plantings that slow water speed with the prime aim of reducing nutrient loadings.

Plant selection for a swale is focused on species able to cope with periodic flooding as well as occasional drought. Plants that filter water without blocking it, such as the reed-like oioi (*Apodasmia similis),* are most suitable for the swale base. Oioi is a New Zealand native species with a reed-like texture that filters water evenly and has a very high roughness coefficient. The 'roughness coefficient' is a key aspect of any plants effectiveness in a vegetated swale. It refers to the extent to which a particular plant slows the water flow.

Plant content is a significant influence on 'residence time', the period stormwater remains within a swale. The ABG swale was originally designed to have a residence time of around 9 minutes. Residence time is determined by several factors including the design of the swale, its gradient and the plant content. The longer the residence time the greater the impact on hydrology flow (how much moisture loss occurs through evaporation and infiltration between entering and leaving the swale). Slower flows also contribute to greater precipitation of sediments, metals, organics and nutrients.

Sediment forebay

ABG's sediment forebay was constructed and planted in 2010. This sediment forebay receives runoff from the vegetated swale and also from neighbouring residential areas, an adjacent grassed overflow car park, and other surrounding impervious surfaces. It reduces stormwater flows and allows sediment and silt to drop out of suspension prior to it reaching the lakes and other natural waterways. It has been engineered to allow ready access for removal of the sediment that builds up on the base of the forebay. It is anticipated that sediment removal will be needed every 5–10 years.

Rain garden

A rain garden was installed in the main ABG car park in 2012. This rain garden collects stormwater run off from the car park and removes sediment before the water enters the stream in the Native Plant Identification Trail. The ABG car park rain garden achieves 70% removal of Total Suspended Solids (TSS).

The use of a free-draining medium in the rain garden influenced the decision to use native coastal species, as it was considered they would be more likely to flourish than wetland species.

Stormwater planter boxes

ABG has installed two stormwater planter boxes in the Potter Children's Garden. Both are plumbed to receive runoff from the rooftop of the adjacent environmental education centre. One utilizes exotic plants; the other is planted with a combination of oioi (*Apodasmia similis*) and the ground-hugging remu remu (*Selliera radicans*); both native species that have performed well. The planter boxes are also used as an educational resource.

Stormwater wetland

A stormwater wetland was installed at the lower northern end of the Potter Children's Garden, as the final stormwater treatment device for all the storm water emanating from this garden. The purpose of the wetland is to hold and eventually absorb the runoff from the Potter Children's Garden, and to cleanse the water in the manner of natural wetlands. Plants can assist with reduction of nutrients and heavy metals, filtering out of sediment particles, decreasing erosion and increasing the food supply and available habitat for wildlife. Carefully crafted plantings can also be extremely beautiful.

Riparian plantings

Riparian plantings were untaken around the two main lakes to improve water quality, increase habitat and improve amenity. The environmental benefits include reduction of water temperature, improved oxygen levels, which reduces aquatic weeds and algal blooms, and improved habitat diversity near the water's edge for aquatic invertebrates and fish. Riparian plantings also reduce nutrient levels by removing nutrients before they enter the water, and they reduce sedimentation and increase water clarity.

The plantings also provide visitors with model examples of native riparian plantings, and the associated interpretation explains their environmental and ecological benefits.

Green (living) roofs

Green roofs contribute to stormwater management by absorbing up to 70 percent of rainwater. They have effective insulation properties, enhance air quality, and they can also provide wildlife habitat for birds, reptiles and invertebrates. They can also be extremely attractive.

ABG has installed three extensive green roofs that utilize shallow layers of substrate (20mm–150mm). They are generally suitable for smaller low-growing drought-resistant plants.

For plants to succeed on a green roof, they must tolerate prolonged aridity and scorching heat and strong winds. It is important to take into account their particular drought-survival mechanism when selecting potentially suitable subjects. Those with deep root systems are unlikely to thrive in a shallow substrate, whereas species with shallow, dense root systems are more likely to establish. Other indicators of suitability include hairy leaves, thick waxy cuticles, tight divaricating habit, light reflective foliage colours and rolled leaves typical of tussocks that minimise moisture loss through transpiration.

Further reading

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