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Streetscale bioretention basins in Melbourne and their effect on local biodiversity

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ABSTRACT

Development of water sensitive urban design (WSUD) in Australia is rapidly changing urban landscapes by incorporating engineered stormwater management systems such as bioretention basins. Despite these landscape changes, little is known about their effect on urban biodiversity. The biodiversities of six bioretention basins and six corresponding paired greenspaces (divided into two subgroups) in the Melbourne area were compared using ground-dwelling terrestrial invertebrates as biodiversity indicators. Overall, the number of species, species richness and diversity displayed a decreasing trend from bioretention basins to gardenbed and lawn-type greenspaces. This trend may reflect the possible decreasing habitat resources. Species composition was significantly different in these landscape types. The differences in low-stratum vegetation, pH, leaf litter depth and gravel were the main habitat factors influencing the invertebrate communities of these landscapes. The transition from traditional urban greenspaces to bioretention basins potentially promises to enhance urban biodiversity. Landscape planning at the urban-design scale should consider reducing lawn as environmentally unsustainable urban greenspaces. At the streetscape scale, a combination of bioretention basins and gardenbed-type greenspaces may provide ecologically robust and aesthetically pleasant urban streets. This study was conducted in a summer season only and caution should be taken in generalizing the outcomes over an entire year.

1. Introduction

Because of the increase of human activities across the world, the need for conservation of biodiversity increases. Such a requirement is even more profound in urban landscapes where human-caused disturbance is intrinsic (Hobbs, 2005). Developing concepts and methods on ecologically engineered systems is a human response to this requirement (Odum and Odum, 2003).

Several studies have been undertaken on the effect of human practices and management regimes on the biodiversity and ecological integrity of agricultural areas (Pokorny and Hauser, 2002), forests (Paulus et al., 2006), woodlands (Bromham et al., 1999) and rangelands (King and Hutchinson, 1983). Fewer studies have focused on the biodiversity potential of urban landscapes (Emilsson, 2008). The important goal of biodiversity enhancement and conservation in urban areas could be achieved by investigation and research into the impacts of any new planning, design or management strategies to be applied in urban landscapes (Rookwood, 1995).

In Australian urban environments, a relatively new concept for stormwater management, namely water sensitive urban design (WSUD), has been applied which incorporates new stormwater management systems such as bioretention basins. Bioretention basins are relatively small engineered vegetated WSUD systems with the capacity to harvest, filtrate and purify stormwater through filter media and under drains before either storing for reuse or discharging the stormwater into downstream drainage systems or into receiving waters (Beecham, 2003). The plan and cross-section of a typical bioretention basin are illustrated in Fig. 1a and b.

Bioretention basins are often employed as replacements for small-scale traditional urban greenspaces in streets or in car parks or they can be integrated with traffic islands in streetscape designs (Melbourne Water, 2005).

The replacements and changes in appearance of the urban landscapes through bioretention basins will result in future landscapes with additional functionality as stormwater management facilities (Melbourne Water, 2005); however, the effect of these changes on

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biodiversity in these small-scale urban landscapes is still largely unquantified.

There is a significant body of knowledge on environmental, biodiversity and habitat values of natural landscape systems but this is mostly for large spatial scales (Joschko et al., 2006). Such studies either investigate the biodiversity of the systems independently (Sperber et al., 2004; Kappes et al., 2006) or as cross-comparison studies (Ulrich, 2004). While studies on biodiversity levels in different landscape types are significant to determine the factors that influence biodiversity in urban landscapes (Duhme and Pauleit, 1998), the cross-comparison studies may provide better insight into sustainable landscape planning and management (Hobbs, 1997). Such studies can provide a clear understanding of the effect of new developments when comparisons are made between pre- and post-development landscapes. In a macro-scale cross-comparison study, Hobbs (2005) compared the differences and similarities on ecology and wildlife management strategies in southern and northern landscapes in South Australia. This study suggested better options for future development of the northern landscapes based on the lessons learnt from the southern area developments. On a smaller scale comparison study, Tanner and Gange (2005) suggested that the construction of golf courses on former farmland could proceed because there were few negative impacts on biodiversity when changing between these two landscape types (farmland and golf courses). However, there is little doubt that changing from natural to urbanised landscapes has negative effects on biodiversity (Alberti, 2008). In order to measure such effects, biodiversity monitoring programs whether in natural or urbanised environments, as independent or cross-comparison studies, have time and cost limitations (Hermy and Cornelis, 2000).

The use of indicator species or assemblages or target taxa is a time efficient and low cost approach for making urgent decisions to achieve conservation goals (Kremen et al., 1993).

There are strong arguments in defence of invertebrates as more powerful biodiversity indicators than vertebrates and vascular plants (Oliver et al., 1998; Duelli and Obrist, 2003). Andersen et al. (2004) believe that biodiversity monitoring programs that ignore invertebrates may be considered as less credible. The dominant contribution of invertebrates in biodiversity monitoring studies over the use of other taxa as biodiversity indicators might be because of their high abundance and diversity, their sensitivity to perturbation and their significant roles in ecological and ecosys-

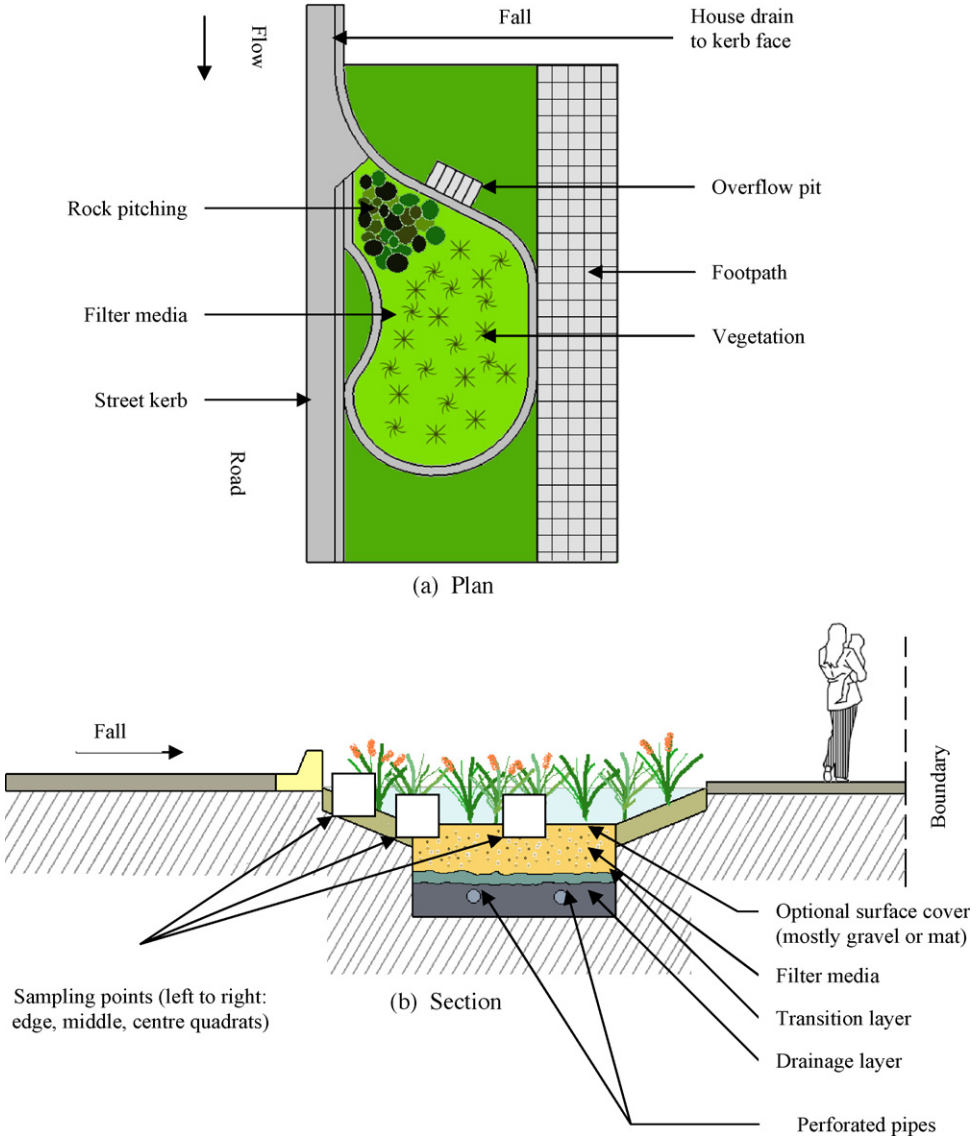

Fig. 1. A bioretention basin (a) plan and (b) section, integrated into a local streetscape (adapted from Melbourne Water, 2005).