Completed Projects
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River Restoration

Project 6.2: Optimising urban stream rehabilitation planning and execution

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Healthy streams are all alike;
every unhealthy stream is unhealthy in its own way
(with apologies to Tolstoy)

Introduction

Urban stream health can be compromised by one or a combination of factors such as:

- Lack of physical habitat
- Modified flow
- Poor water quality
- Lack of riparian vegetation
- Barriers to migration of fish and other biota
- Exotic plants and animals
- Channelisation, erosion and sedimentation.

Stream rehabilitation needs to address some or all of these factors, so it is important to know which interventions will be the most effective and so should received the highest priority.

Research outcomes

The first aspect of our work in this project was an assessment of the effectiveness of improving hydrology by retrofitting a flood retarding basin. Under urban conditions, floods are made more frequent and severe because runoff is increased in both volume and rate, as a result of increased impervious areas. This increase in flood frequency is likely to adversely affect stream biota because of hydraulic forces and increased sediment transport. If the hydrology could be made more natural, i.e. more like it was before urbanisation; perhaps stream health would be improved.

Retarding basins do reduce flood frequency, but are designed to be most effective for large events. Initial work suggested that it was smaller events, around six months to two years average recurrence interval, which were causing the flow stress that influenced biota. Retrofitting a retarding basin might improve the attenuation of these smaller floods and hence improve stream health.

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Although this argument is appealing, once we investigated the specifics of designing the retrofit experiment, we found there were some difficulties. Retrofitting a retarding basin will certainly reduce flow stress but will only improve stream health if flow stress is the critical problem. Following a literature review, discussions with Melbourne Water and ecologists from the Cooperative Research Centre (CRC) for Freshwater Ecology, and field assessments of potential sites, we believe there are four reasons which suggest flow stress is not the ultimate factor limiting stream health in the urban streams we have looked at (mainly in Melbourne's east).

The first piece of evidence is that if flow stress was the only problem, we would expect to see patterns in the occurrence of macroinvertebrates. Taxa that are sensitive to flow should occur in areas of the stream bed that are sheltered from turbulence, high velocities and transported sediment. These regions, known as refugia, have been shown to accumulate sensitive taxa under laboratory experiments. However, in the urban streams we have looked at, and those studied by CRC for Freshwater Ecology, there were no sensitive taxa found in refugia.

The second line of reasoning is related to these findings. In situations of high flow stress (frequent, severe events) two types of taxa would do well: (a) those that can quickly recover from flow stress - their populations may be reduced by an event but they can reproduce rapidly before the next one; and (b) those that can cope with the stress e.g. those that prefer to live in refugia. In fact, the actual urban stream taxa are dominated by type (a) - those that can recover quickly. This suggests there is more than one type of stress - the bugs that can cope with flow stress are wiped out by water quality events (or some other stress). The only macroinvertebrates doing well are those that can recover quickly from disturbance. Reducing one source of disturbance, by retrofitting a retarding basin, would still leave other disturbances (e.g. pollution events) largely untreated.

Results from the CRC for Freshwater Ecology (CRCFE) riffle experiment provide a third reason to suggest that we need to do more than address the flow stress. When high quality refugia are added to a stream (the CRCFE riffle experiment), some sensitive taxa appeared but were subsequently eliminated, probably by some stress other than flow, since they were living in high quality refugia. Similar results were obtained in other projects that emphasised habitat restoration.

The fourth reason to suggest flow stress is not the only critical factor is that urban streams that have high quality refugia have the same taxa as streams with poor or no refugia. If flow stress was the only issue, we might expect to see some sensitive taxa where high quality refugia naturally exist.

These results suggest that urban streams are subject to multiple, frequent, and severe disturbances. This implies that the retrofit experiment could be a high-risk approach to testing factors critical to urban stream rehabilitation, as it would require a lot of resources to improve hydrology with no guarantee of an ecological effect. Instead, the focus for rehabilitation needs to be on catchment scale treatment. Other work by the CRCs for Catchment Hydrology and Freshwater Ecology shows that the emphasis should be on decreasing the area of impervious surfaces that are directly connected to streams.

Application

In urban streams there is a particularly strong link between catchments and waterways because the piped stormwater network is so efficient at delivering water and pollutants. Therefore the effect of urbanisation on streams needs to be addressed at the scale of the impact i.e. the catchment scale. Expecting to be able to mitigate the influence of large scale catchment changes by constructing instream works is probably naïve.

So far, this discussion has been more about what interventions will not work to improve the health of urban streams rather than ways to achieve stream rehabilitation. However, there is a way forward, partly motivated by the results discussed here, but in larger part due to the work of Dr Chris Walsh and others in the CRC for Freshwater Ecology in the project Urbanisation and the Ecological Function of Streams and Dr Tim Fletcher in the Urban Stormwater Quality Program of the CRC for Catchment Hydrology. We have developed a framework for stream restoration based on new approaches to stormwater drainage (Walsh et al., in review).

This work is based on the observation that directly connecting impervious surfaces to waterways (as is caused by catchment urbanisation) results in a large increase in runoff frequency. A few millimetres of rain falling on a car park or road will be sufficient to cause surface runoff that will flow into entry pits and then to streams via the urban drainage network. The same piped network will also efficiently deliver any chemical spills directly to streams.

Our proposal is for a new type of urban drainage system that mimics the natural hydrologic system by intercepting the first 15 mm or so of rainfall without producing runoff. The intercepted water is infiltrated, evaporated, transpired or stored for later household use. Larger events will still cause disturbance to stream biota but at a frequency that is closer to natural conditions.

It is possible to predict the values of a range of ecological indicators based on the proportion of catchment area that is impervious and directly connected to water ways (the effective imperviousness). Therefore, if a particular ecological condition is desired, it is possible to work out the allowable effective imperviousness. For degraded streams we are now investigating the feasibility of approaches that could be used to retrofit an existing suburb to achieve the required reduction in connected impervious area.

Although there is strong evidence that reducing effective imperviousness will show improvements in stream health, it is important to test this hypothesis. We are concentrating our work on Melbourne's suburbs where streams are in moderately degraded ecological condition even though development is concentrated in a small part of their catchments and the proportion of imperviousness is quite low. The first sites for investigation have been in the catchments of Dobsons Creek and Little Stringybark Creek that drain the Dandenong Ranges in Melbourne's east. There are also streams nearby that can be used as experimental controls and before data for both control and treated streams are available. Funding and community support are now being sought to redesign the drainage systems in these two catchments. It is also hoped that this experimental approach will be key activity of the proposed eWater CRC.

Further work

The results of this project and other work by the CRCs for Catchment Hydrology and Freshwater Ecology all support the need for catchment scale approaches to streams impacted by urbanisation. This is being addressed in current CRC projects (2003-2006)

- Urban Stormwater Quality Program http://www.catchment.crc.org.au/urbanstormwater
- Urbanisation and the Ecological Function of Streams http://www.wsc.monash.edu.au/urbanwater/D210/

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