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Urban Rivers and Streams: Important Community Wetlands needing informed Management

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SUMMARY: Most urban rivers and streams have been regarded as little more than useful conduits for stormwater and runoff. However, they have many other important and useful attributes. They can add significantly to the aesthetic appeal of the urban landscape. They can be valuable recreational foci. They offer educational opportunities at a variety of levels. And several scientific questions can be investigated using urban rivers and streams as research sites. Increased recognition is being given to these additional attributes so that urban rivers and streams are increasingly being seen as an important community asset of greater value than was formerly the case. To optimize the values of urban rivers and streams requires informed and effective management. In broad view, this must take the form of prophylaxis, monitoring and remedial actions, but a number of specific issues need to be individually addressed according to location. Some important issues of this sort include the determination of how wide riparian corridors should be, the management of exotic plants, floodplain management, and the management of seasonally temporary rivers and streams. Aquatic ecologists (limnologists) have an important role in the resolution of such issues.

THE MAIN POINTS OF THIS PAPER

- Urban rivers and streams are important community wetlands and assets
- They are valuable not only as hydrological conduits for stormwater and runoff, but also have aesthetic, recreational, educational, ecological and scientific values
- Effective management is needed if values are to be optimized
- Well-planned research and investigations are needed to underpin management
- The role of aquatic ecologists is important given the importance of biological interactions.

1. INTRODUCTION

Most aquatic ecologists (limnologists) have largely confined their interests to waters outside the urban environment. Running waters within urban environments have attracted little attention and the limited number of studies of them that exist are largely monitoring or descriptive exercises. This situation needs correction given the increasing number and volume of urban waters, the need for their effective management, and their importance and value.

The aim of this paper is threefold. First, it aims to draw attention to the many values of urban rivers and streams over and beyond their importance as conduits for stormwater and runoff. Second, it discusses some issues concerning urban rivers and streams of management interest. And third, it indicates some directions for future research and investigation.

Whilst the overall perspective of the paper is general, it has a basis on recent studies in the Adelaide urban environment, in particular studies undertaken to provide advice to engineers and management authorities (Tonkin and Associates, Patawalonga and Torrens Catchment Board) and a number of investigations by post graduates at the University of Adelaide. Of special interest are the theses of Blaylock (1996), Byles (1996) and Outram (1997). Emphasis on local studies has been on the Sturt Creek, Brownhill Creek, and the Field River, all of which lie within suburban or semi-rural areas south of Adelaide, and open drains in Adelaide urban areas.

2. THE IMPORTANCE OF URBAN RIVERS AND STREAMS

Historically, most cities arose near fresh waters, either lakes or rivers. These provided supplies for domestic and other needs and places for the disposal of unwanted wastes. Mismanagement and ignorance soon degraded them so that new non-urban sources of supply had to be found although wastes continued to be discharged. Waste discharge eventually led to the development of unhealthy conditions and when these posed a direct hazard to human health it was recognized that wastes needed to be disposed of elsewhere. Indeed, the recognition that hygenically safe drinking water was important to human health and that urban rivers overloaded with human wastes were medically hazardous was one of the most significant events in human history. The technological response to this recognition, that is, the provision of hygenically safe urban supplies of water and the rapid removal and disposal of wastes from urban areas, has been a major factor enabling the development of extremely large and dense urban populations.

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But development of new sources of supply and the disposal of human wastes elsewhere did not lead to the return of urban rivers and streams to their natural conditions. Once they had been degraded, little if any thought was given to their rehabilitation, and, besides, urbanization itself provided another set of anthropogenic impacts (see, for example, Morison and Williams, 1995). Instead, the main value of almost all was then perceived as being hydrological conduits for stormwater and runoff from the urban area (as well as, sometimes, of use as disposal sites for some waste material). This perception was maintained even in cities where rivers and streams had never served to supply water or been used for the disposal of human wastes.

To increase the efficiency of the use of urban rivers and streams as hydrological conduits, they were frequently canalized, often confined to underground pipes (Figure 1), or, where flooding was a possibility (and because of potential litigation even when this possibility was only faint), placed within concrete channels with broad sides (Figure 2). In short, urban rivers and streams were viewed as no more than useful drainage constructions, albeit of natural location, which also served to improve water quality to a limited extent, and engineers were asked to reconstruct them where necessary and manage them. Engineers, acting within their terms of reference and responsibly, did just that.

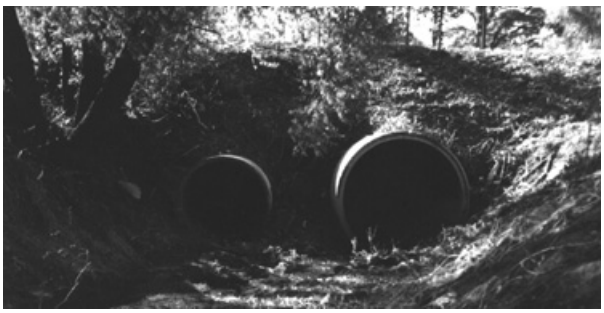

Figure 1: Natural stream in suburban Adelaide, South Australia, before entering underground pipes.

Figure 2: Lower reaches of Sturt Creek, Adelaide. Note large concrete canal and broad lateral area.

However, in at least some early cities, and much later in others, the presence of some urban waters was also regarded as adding to the quality of life. They were seen as significant aesthetic elements of the urban landscape. More recently, the government authorities of many modern and developing cities have come to recognize that water, either in constructed wetlands containing standing water or within pre-existing or restored watercourses, can add to the appeal of cityscapes and provide visual relief within the built environment. There has been the development of what one engineer has termed a 'new drainage ethic' (Nicholas 1994).

Recognition of values over and above aesthetic and practical ones has also occurred in the recent past. Urban rivers and streams are seen as having important recreational and educational values. This view now prevails even where urbanization has been intensive and comprehensive over mnay years, as in many European cities (e.g. Liverpool, U.K.; see Nolan and Guthrie 1998). Contemporary views then are that urban rivers and streams, in addition to removing stormwater, runoff and moderate amounts of non-hazardous waste as well as improving water quality, are valuable community assets because:

1. They can add to urban aesthetic qualities.
2. They can support recreational activities (walking, bird- watching, photography, etc).
3. They can provide habitats of educational use.
4. They represent natural (albeit disturbed) ecosystems of ecological (conservation) value.

Less widely recognized is the fact that they can also serve as sites where several important scientific questions can be investigated. An example is the effect of stress on aquatic communities (e.g. Towns' 1985 study of the effect of desiccation on the fauna of Brownhill Creek, Adelaide). Certainly their biodiversity has been greatly underestimated - as recent studies of Sturt Creek, Adelaide, by Blaylock (1996, 1997) and of at least some streams in Melbourne and suburbs by Sharpe et al. (1997) have shown. Past underestimation of the values of these attributes has meant that a valuable community asset has been greatly abused and misused.

Only strong community pressure can reverse the historical trends to treat urban rivers and streams primarily as hydrological conduits for stormwater and runoff removal. Indeed it is vital that community support is provided to foster local/regional stewardship and management initiatives and activities. Once the wider community value of urban streams and rivers has been recognized, there are usually no major impediments to river and stream reconstruction and rehabilitation other than appropriate levels of community determination, political leadership and funding. Even if these attributes are in relatively short supply, a number of straightforward measures can be put in place which can rapidly increase the wider value of rivers and streams. They include appropriate government regulations, installation of trash racks and simple treatment facilities, and community education.

The results often rapidly justify the measures: unappealing drains serving single end-uses become appealing community resources serving multiple ends (Figure 3). In some cases, community pressure to bring about such changes, and the case for them, are sufficiently strong that expensive engineering constructions (e.g. wide concrete channels) may be replaced by restorations of the natural landscape they displaced. None of these changes, of course, is of lasting value unless accompanied by improvements in stormwater quality and a reduction in the impact of flood flows. A number of government initiatives reflects changed community attitudes to river health (e.g. National River Health Strategy and the National Water Quality Management Strategy [NWQMS]).

Figure 3: Sturt Creek, suburban Adelaide, shortly before entering a broad concrete channel. This stream has retained many of its natural characters at this point, including high biodiversity (Blaylock 1996).

Engineers themselves are far from insensitive to community pressures of this sort as the following statement by Joliffe (1994) indicates:

"Challenges facing the stormwater industry as the result of the environmental awareness are numerous and include: the need to improve stormwater quality in built and developing areas; the need to minimise stream erosion; a desire for the use of natural channels rather than highly engineered floodways in developing areas; the need to control flooding while providing open space corridors which enhance recreational and visual amenity; the need to integrate the stormwater system into an enhanced urban design and the need to minimise erosion during construction activities".

Whilst this statement does not mention the importance of educational and scientific values, it is clearly a progressive response to changed public perceptions. Many other indications of the recently increased sensitivity of Australian urban water managers exist (cf. Katsantoni 1990, Conrick and Ribi 1994, Anderson 1996, Schaffer and Maelzer 1996, Anon. 1998).

3. ISSUES OF MANAGEMENT INTEREST

Prophylactic, monitoring and remedial activities are the key to effective management of urban rivers and streams in a general sense. More specific management issues include determination of the width of the riparian zone, the management of temporary streams, setting limits to the use of the floodplain (e.g. for agistment), and the management of exotic plants and animals. Only these are discussed further but there are many others not discussed. Of particular note in some Australian cities (e.g. Melbourne) is the influence of urban streams on receiving waters. Thus, Harris et al. (1996) concluded that the future health of Port Phillip Bay is dependent on a substantial reduction in the annual nitrogen load from inflowing streams and rivers. Note that discussion centres upon issues within the context of the Adelaide region. Note also that because of many differences between the nature of urban Australian rivers and streams from that of urban rivers and streams on other continents, caution is needed in applying the results of investigations carried out elsewhere.

3.1 The width of the riparian zone

The presence of riparian (or buffer) zones, that is, strips of land on either side of a watercourse, is now regarded worldwide as an effective protective and restorative mechanism in the conservation and management of rivers and streams. These riparian zones are as important - if not more important - in urban situations as in non-urban ones. A considerable literature on this subject now exists but for the most part is largely European or North American in focus (e.g. Pinay et al., 1990; Risser, 1990; Large and Petts, 1996). Literature of more local interest includes reports by Barling and Moore (1992), Bennett (1990), MacNeill (1992), Riding and Carter (1992) and Saunders and Hobbs (1991).

In determining the width of the riparian zone, important factors to be considered are the desired functions of the zone, especially for wildlife and bank protection, recreation, water quality improvement and sediment control. Recommended widths to achieve these functions vary from <5 to >200 m. Also to be considered are particular local requirements such as special landscape features of amenity value and community interest. Thus, careful mapping is a prerequisite in determining riparian zones. Widths may vary according to ecological and environmental requirements at particular sites - although the importance of significant longitudinal continuity is emphasized. Matters of safety, public access, cost and the privacy of adjoining properties also need consideration.

3.2 Management of temporary streams

Because of the strongly seasonal pattern of rainfall in many Australian cities, including Adelaide, many suburban and urban streams are essentially dry during the non-rainy season (summer in the southern half of Australia). If they contain water during the dry season, this is either because urban catchments permit more rapid runoff after unpredictable rainfall events (thunderstorms) or because they receive runoff from the domestic use of water (e.g. in gardens) or other wastewater.

Management of these sorts of stream poses a unique challenge; urban streams in most of Europe and North America exhibit quite different seasonal hydrological patterns. The aim of management in this case should be to optimize year-round values (e.g. recreation) without degrading seasonal ones dependent upon the presence of water. The Field River, south of Adelaide (Figure 4) is a case in point. This river flows only in winter at which time it has a biota typical of temporary streams. Its landscape and recreational values are present all year, however, wet or dry.

Figure 4: Field River, suburban Adelaide, a temporary stream. The photograph was taken shortly before the stream dried at this point.

3.3 Limitations to the use of floodplains

All rivers and streams, urban or otherwise, reflect events taking place on their catchments. Events which take place in those areas immediately contiguous to rivers and streams are the most directly influential. For urban rivers and streams, such areas may roughly be equated to floodplains, i.e. those areas liable to be flooded and on which government regulations (and prudence) disallow urban development. In private ownership, these regions are often used as sportgrounds, for market gardens or to provide pasture for cattle, sheep or horses, either on a permanent basis or temporarily during agistment. All such uses have impacts upon the river or stream within the floodplain, though the extent of the impact varies.

Particularly damaging use occurs when the regions are used for pasturing livestock. Damage results from the destruction of riparian and submerged vegetation, trampling of the bottom sediments, the addition to the watercourse of faeces and urine from the stock, and increases in water turbidity resulting from the trampling and excrement. Robertson (1998) points to the widespread damage to non-urban Australian wetlands caused by livestock with access to them; there is little reason to believe that his results do not apply to the urban environment. The most obvious and sensible management option to this situation involves the removal of livestock from vulnerable areas.

3.4 Management of exotic plants and animals

Many plants and animals not native to Australia have established viable populations in or near Australian inland waters. Urban rivers and streams have not escaped invasion. Indeed, they include many of the sites where initial invasion occurred.

Of plants, the most obvious and perhaps important are those which have colonized the riparian zone (Buckney 1995). These include willows, blackberries, ashes, hawthorns and olive trees. Less obvious but equally intrusive are the many exotic herbaceous species. In some streams, these dominate riparian plant communities. Byles (1996) found that exotic species outnumbered native ones by 2:1 in the riparian zone of the Sturt Creek, for example. The effects of these exotics have not yet been fully determined but seasonal differences in leaf-fall patterns between exotic and Australian species are likely to have some effect.

The most direct approach to the management of exotic plants has been to remove or poison as many as possible. However, removal may lead to additional problems (e.g. bank destabilization, increased turbidity, loss of habitat) so this approach needs to be followed with care. If removal forms part of management, questions needing resolution include: what is the rationale for removal? What effects will removal have? What species should be used to replace them?

Many exotic animals have invaded urban rivers and streams. The most obvious include the carp, *Potamopyrgus antipodarum* (a snail), and mallards. The effects of these are different but are generally regarded overall as deleterious to the natural character of the stream or river that has been invaded. Appropriate management of them is still being developed.

4. DIRECTIONS FOR FUTURE RESEARCH AND INVESTIGATION

Despite the wider recognition of the values of urban rivers and streams, research and investigations of them remain limited. Limnologists continue to focus on natural running waters outside urban areas and most government agencies are preoccupied with rural water resource problems. This is understandable but has constrained the accumulation of knowledge needed to inform and support effective management of urban

rivers and streams, i.e. management to maintain values. Increased recognition of the importance of urban rivers and streams (and increased funding opportunities) will encourage limnological and governmental interest.

The second important step must be the implementation of well-planned programs of research and investigations. Most investigations of urban rivers and streams so far have been essentially of a descriptive nature or have monitored particular criteria considered to be of medical significance (though biological monitoring is of increasing use, cf. Smith et al. (1997). Comprehensive studies of the sort needed to underpin management remain few, and even fewer are studies concerned with the fundamental form and function of urban rivers and streams. Initially, such programs will continue to be descriptive and consider the fundamental questions: what impacts have occurred and continue; what effects have these impacts had and have on community structure and ecosystem form and function; what is the overall status (health, ecological integrity) of the river or stream in question; and exactly what attributes of the river or stream are valuable and to what extent are they optimized?

Programs of research and investigation must become more prescriptive and will need to consider questions which address specific management issues. Such issues include:

1. How best to restore and manage degraded systems.
2. How best to implement stormwater management regulations.
3. Improved measures for stormwater pollution control.
4. Improved techniques for river and stream 'health' assessment in urban situations (what are reasonable measures of 'health' in such situations?).
5. The effect of specific pollutants in urban runoff (such as heavy metals from roads).
6. The biological effects of unnatural hydrological patterns
7. The effects on river and stream values of alienation of 'floodplains'
8. The determination of desirable riparian corridor width.
9. The management of exotic plants and animals and the effects of management strategies.
10. How best to manage temporary urban streams and rivers.
11. How to manage urbanization with minimal impact on streams.

There is obviously no shortage of topics requiring investigation and research before the management of urban rivers and streams can rest on a more informed and less insecure basis than is the case at present. Further topics are listed by ASTEC (1995). In the resolution of many if not all of these issues, limnologists (aquatic ecologists) have an important - indeed critical - role. After all, most of the issues involve biological interactions and are not amenable to resolution by engineers alone. The urban water program of the CRCFE (Lawrence and McMahon 1998) is clear evidence of that.

Whilst the topics requiring investigation and research address management concerns, such research need not be less rigorous, demanding or intellectually interesting than fundamental limnological concerns and ultimately may well inform and enlighten such research. It should be emphasized that ecosystem processes and ecosystem form and function do not cease to exist simply because the ecosystem involved is disturbed.

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