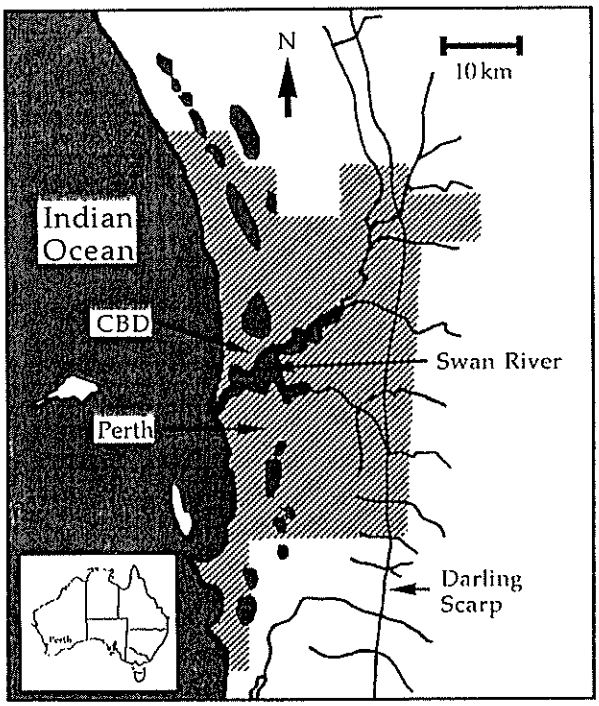
Urban lakes of Perth (western Australia)

A history of degradation and loss

Mark A. Lund

At home [the U.K. presumably], a lake is known only as a sheet of water which seldom or never dried up, and it is naturally associated in one's mind with pleasant and picturesque scenery, but here it is quite different... there is an air of desolation about these lakes which strikes the spectator at once ... It is complete still life without one point of interest in it, as far as striking scenery goes, and totally different from anything I ever saw outside Australia.

These sentiments were expressed in an 1847 Perth newspaper. Similar attitudes have largely been responsible for the loss and degradation of the urban wetlands of Perth from its foundation until recently.



Map showing the current extent of wetlands in the Perth metropolitan area.

Traditional and European Wetland Managers

Aborigines have occupied the region around Perth for about 38,000 years. They made extensive use of the wetlands as sources of water and food (fish, waterfowl, turtles, frogs and edible aquatic plants). Aboriginal people are believed to have managed and possibly modified the wetlands by selective burning of fringing vegetation to increase productivity.

The British founded the Swan River Colony (later to be renamed Perth) in 1829 on a site surrounded by wetlands, adjacent to the Swan River. As Perth expanded, wetlands were drained for housing and market gardens, as it was quickly realized that the lakes were too shallow to provide useful sources of drinking water. Therefore, some were subdivided into lots, some were drained for market gardens, some used for recreation, and others used for road reserve. Interestingly, on many occasions settlers misjudged their ability to drain the wetlands and initially flooding was a serious problem. Within 16 years of settlement, six wetlands, representing approximately 50-70 ha of open water, were drained and built over. The low perceived value of wetlands has meant that reclamation of wetlands for urban development continues to the present day.

Perth is the capital city of the State of Western Australia and currently boasts a population of over one million. Perth has a 'Mediterranean' climate with hot, dry summers and cool, wet winters. The city lies on the Swan Coastal Plain (SCP), a series of parallel sand dunes which are bordered by the Indian Ocean to the west, the Darling Scarp to the east and extend approximately 100 km north and south of Perth. In the depressions between the dunes, the water table becomes exposed, forming chains of wetlands. As the wetlands are largely surface expressions of the groundwater, they generally have no surface inflows or outflows, although, in extremely wet years, there is evidence to suggest that groups of wetlands became linked. The seasonal changes that are experienced within the major groundwater aquifers have an important influence on the water levels of many of the wetlands.

This article will restrict itself to the Perth metropolitan area and the following types of wetland: lakes (permanent water), swamps (seasonal lakes, dry in summer) and flood plains (areas of flat land, seasonally inundated).

In few Australian cities has the 'Australian Dream' of a house on a quarter-acre block been so achievable as in Perth. Hence, the rate of urban expansion has been considerable with the city now covering around 2030 km^2. Estimates of the area of wetlands lost from the SCP range from 60 to 80 percent. Unfortunately, the loss of wetlands per se represents only a portion of the problem, the other is the degradation of the remaining wetlands.

Wetland Uses

Health risks associated with high fecal coliforms and attempts to reduce disturbance to water birds have stopped active recreation on the wetlands. Prior to this they had been used for swimming, boating, water skiing, diving, fishing and catching edible crayfish. Current use is restricted to passive recreation, BBQ's, walking, bird watching, picnicking, bird feeding and so on. Lake Monger, a popular lake close to central Perth, was estimated to receive over 12,000 visitors per week.

Causes of the degradation

The sentiments expressed at the start of this article are prevalent even today. There is a strong perception that our natural wetlands are not as attractive as Northern Hemisphere lakes. This has fostered a mentality that the wetlands should be altered to 'improve' their appearance. These improvements include lawns to the

lake edge, infilling of swampy areas, dredging (to increase depth) and removal of fringing vegetation. This is particularly so in newly developing suburbs, which are frequently populated by immigrants from the Northern Hemisphere who are often uncomfortable with the uniqueness of the Australian bush. Aside from 'improvements,' the wetlands are also seen as convenient receiving environments for pollutant discharge, including storm water.

Artificial maintenance of water level

The majority of wetlands are shallow (1 - 4 m deep) and seasonal. As dry wetlands are deemed unattractive, many now have water levels artificially controlled (with outlets to control winter flooding and the addition of well water in summer). One of the arguments for this practice, other than pure aesthetics, is that it provides a permanent water source for fauna. Countering this argument are that permanent flooding can lead to the death of fringing vegetation (in particular *Melaleuca* trees) and the majority of fauna has evolved to cope with seasonal drying.

Nutrient enrichment

Many of the wetlands are used for water compensation (directing storm water drains into the wetland). Surface runoff on Perth's sandy soils is normally very low, but the increase in hard surfaces (roads, roofs, etc.) through urbanization increases runoff significantly. Many wetlands are now experiencing unusually high water levels, as a result of urbanization of their catchment. The storm water that enters the lakes carries nutrients (from lawns and gardens) and pollutants (oil, pesticides, etc.) from the surrounding urban area. The groundwater also carries fertilizers from surrounding lawns into the lake. This input can be quite significant. When the lawns around Lake Monger ceased to be fertilized, the levels of total P dropped from around 800 $\mu g\ l^{-1}$ to 150-250 $\mu g\ l^{-1}$. High nutrient loads and high summer temperatures (air temperatures vary between 30 and over 40° C) can result in blue-green algal blooms (up to 700 $\mu g\ l^{-1}$ of chlorophyll *a*) of *Anabaena* and *Microcystis*. Associated with algal blooms are localized problems of avian botulism, fish kills, noxious smells, and nuisance levels of non-biting midges (Chironomidae). The latter has resulted in the regular spraying of some wetlands for the past 27 years with Temephos (Abate®). Copper sulphate has been used occasionally to control algal blooms, with varying success.

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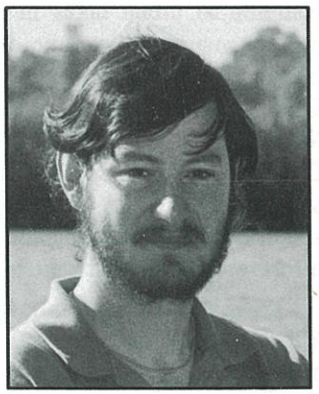

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Physical modifications

Physical modifications to the wetlands include some that are probably beneficial for urban lakes, such as the construction of islands (for waterbird habitat safe from predation by cats, rats and dogs), and the construction of walkways to provide access for bird watching and educational purposes. Other modifications are more detrimental and include the use of walls to replace the shoreline, dredging, mining (sand, peat or diatomaceous earth), use as a sanitary landfill, and infilling. Walls which form the shore of the lake result in a loss of habitat, especially for invertebrates, and are rarely necessary for other than aesthetic purposes. Mining can have three major influences; 1) the physical disruption to habitat, 2) reduction in pH through oxidation of iron sulphides, and 3) deepening of the lake, which can result in long periods where the lake is thermally stratified (the wetlands are normally too shallow for this). The use of wetlands as sanitary landfill sites was an occasional practice in the 1950-60s, and was usually described as a lake beautification project. Although the areas of the wetland which had been used for landfill were eventually capped with a layer of clay, they continue to be a source of nutrients and other pollutants to the remaining area of water.

Replacement of native plants with exotics

Other modifications that are also usually the result of 'beautification' schemes are the removal of fringing vegetation to provide householders with an uninterrupted vista of open water. Characteristically the fringing vegetation of the wetlands on the SCP was dominated by Paperbarks trees (*Melaleuca* sp), with occasionally bands of reeds (*Typha*, *Schoenoplectus* and *Baumea*). These plants are also believed to be at least partially responsible for highly colored (brown color or gilvin) waters in many wetlands. The color has been shown to limit algal growth, even at high nutrient levels, by either limiting light penetration or through binding micronutrients. In many areas, the native vegetation has been removed and replaced with lawns. The poor nutrient status and water holding capacity of the sandy soils means the lawns require high quantities of fertilizer and watering. Along with exotic grasses, many other plants have been introduced, including water hyacinth (*Eichhornia crassipes*), Salvinia (*Salvinia molesta*), several species of *Cyperus* (e.g. Papyrus), Willows and Para grass (*Urochloa mutica*). Both Salvinia and water hyacinth are controlled, as they have been declared noxious weeds. In the 1950s, water hyacinth covered Lake Monger and was eradicated with Hormex®. In some lakes submerged macrophytes are considered a problem where they break the surface and thus are considered unsightly.

Water birds

The feeding of water birds is a popular local tradition, in fact many people believe that the birds require this supplementary feeding for survival. It is extremely unlikely that this is, in fact, the case, and addition

of large quantities of bread probably increases the risk of avian botulism. Council rangers tell stories of small truck loads of stale bread being dumped into wetlands, sometimes without the plastic wrap being removed. Some Councils are now trying to discourage feeding with varied success. Councils have generally placed signs saying 'Please do not feed the birds' without providing any form of explanation as to why not, which I believe contributes to people ignoring the signs. Many degraded wetlands support large numbers of water birds; this doesn't reflect the health of the wetland, but rather the fact that large numbers of birds commute from healthier lakes nearby to feed. The loss of wetland area is also likely to have concentrated birds in those which remain.

Exotic water birds have been introduced to many wetlands, including domestic geese, muscovy and mallard ducks. Mallards, in particular, pose a major threat as they are capable of interbreeding with native ducks, producing fertile offspring.

Fish

The seasonal nature of the majority of wetlands has resulted in a very limited native fish fauna (only seven species). A variety of fish have been introduced into the wetlands for aesthetics (goldfish), fishing (prior to the 1980s) and mosquito control. Fish introduced for angling include common carp, redfin (English) perch, bream (probably Silver Perch; now extinct) and tench (now extinct). In 1934, the mosquitofish (*Gambusia holbrooki*) was introduced into Western Australia by an amateur fish breeder; they were later spread by Heath Authorities to control mosquitos. There is little evidence to suggest that mosquitoes were ever a serious problem prior to the introduction. Regardless of whether they control mosquitos (many researchers consider them relatively ineffective) or not, the fish prove a problem by consuming a wide range of invertebrate taxa. It has also been suggested that their aggressive behavior may lead to the driving out of native species. At present, comparatively little is known about the effects of these introductions on wetland ecosystems. The introduction of these fish raises questions as to whether biomanipulation may be a useful restoration technique; in the studies I have undertaken this appears not to be the case.

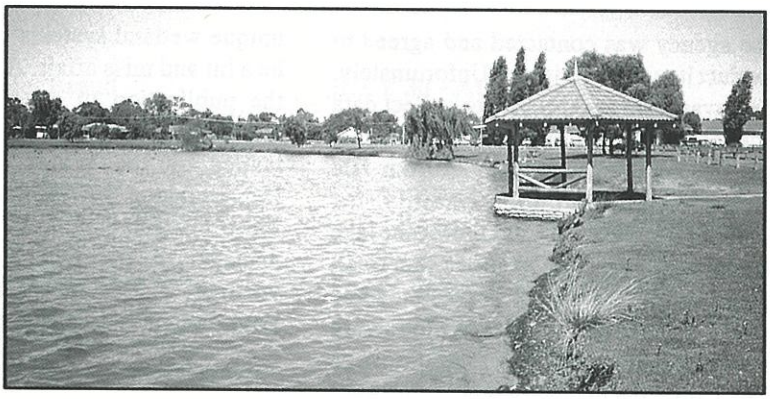
Legislative Protection of Wetlands

Wetlands are either owned freehold by private landowners, local councils and government departments, or are on Crown Land which is often vested in a Government Department (e.g. Department of Conservation and Land Management). Legislative protection works through the three tiers of government (Commonwealth, State and Local) using a variety of Acts. The two most important are Ramsar wetlands (International treaty for the protection of migratory birds) and a State Environmental Protection Policy (EPP) (1992) which prohibits unauthorized filling, mining, drainage into or out of, and effluent discharge into lakes on the SCP that contained over 1000 m^2 of water on 1st of December 1988. This date marks the start of Summer when normally wetland levels would be at their highest. However, 1988 had a dry winter, and as a result of this and the fact that many wetlands fall under the minimum size, only 5.3 percent of the total wetland (using a very broad definition of wetland) area of the entire SCP was protected. The EPP was particularly important, as for the first time it allowed Government to regulate wetland damage on freehold land. Although many wetlands were overlooked, these policies are reviewed periodically and this problem may be addressed in the future.

Management and Restoration

Aside from legislation, management of the wetlands is usually left to the agency responsible for the wetland. Management Plans have been written for many of the wetlands; however, few have really been acted on. Management as a whole, certainly

at the local government level, is largely reactive. As a result there have been few attempts at lake restoration. The approaches that have been tried are dosing with aluminum sulphate, dredging, and nutrient diversion. In only one case was a coordinated approach used to tackle the problem. This involved a study of North Lake, where a nutrient and water budget identified two drains as the main sources of nutrients. The most polluting drain was redirected, and the other drain was passed though an artificial wetland to reduce nutrient loads. After a shaky start, a monitoring program was established to determine the effectiveness of the restoration. Unfortunately, this type of restoration involving a detailed evaluation of the problem, followed by treatment and then monitoring to measure success is atypical. The scenario normally followed is one where the local residents complain, the agency responds by deciding to clean up the wetland, the agency determines the best method (how is often a mystery), and then it is implemented. If there are no further complaints it is deemed a success. Perhaps this is a cynical view of the process but, certainly from my perspective, this approach leads to a treatment of symptoms, not cause, wasted money (e.g. dredging where no attempt is made to control



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Jackadder Lake, a typical degraded wetland in an urban area.

nutrient rich surface inflows), and a failure to build up detailed knowledge on restoration processes (i.e. everyone's working in the dark).

An example of this is a study I was involved in at Jackadder Lake. This small lake was eutrophic, and had problems with algal blooms and nuisance midges during summer. In response to public concern, the agency responsible decided, rather than spraying the lake again, to try and fix the problem. Addition of aluminum sulphate was the chosen option. I became involved when I learned through the grapevine what was planned.

The agency was contacted and agreed to conduct it as an experiment. Unfortunately, there was little opportunity to collect data from before the treatment, despite the fact that the addition was delayed from late spring to mid-summer (mainly for bureaucratic reasons). I monitored the lake for the next year. The exercise was to all intents and purposes a failure (despite some overly optimistic reports which were produced at the time). This I ascribe to one main cause, the major sources of nutrients were not determined prior to the addition. As a result it is doubtful whether the addition of aluminum sulphate was the best strategy.

Another example involves water withdrawal, Perth on an annual basis obtains approximately 30 percent of its drinking water from groundwater. The groundwater comes from two aquifers located on either side of the Swan River. To protect these aquifers, overlying development has been minimized. As wetlands are reflections of the groundwater, any lowering of the groundwater will potentially impact wetlands. The Water Authority has developed complex models of groundwater movement to use as a basis for planning the best sites for withdrawal. Despite this, or because of it, a series of wells were placed near a chain of valuable wetlands to abstract about four million cubic meters per year (a very small amount). The models were used to plan where the wells could be sunk so as to minimize potential environmental impact. Yet it is obvious that for such a low yield of water, the potential environmental harm was not justifiable and the wells should have been relocated in a less sensitive area. Unconnected with this was a government decision to place a housing estate on the same aquifer (Jandakot Mound). To ensure the site would not flood, the water table was lowered through a system of drains. The drains linked into a chain of wetlands. This has led to excessive water levels in many of these wetlands.

Until such time as a structured approach to wetland restoration and management is taken by agencies, protection of Perth's unique wetland systems will continue to be a hit and miss affair. A positive note is the publication of a series of detailed scientific reports on a variety of wetland issues by the Water Authority and Department of Environmental Protection. The first volume of the series is written for managers. At the media launch of the first volume, the State Minister for the Environment stated that the degradation of Perth's wetlands was the result of ignorance, and that the publishing of the series should rectify that problem. Let's hope he was right.