Then skeletal channels. Their blue-grey braid is not water
but a hazed meander of trees
marking the shadow-stream, dreaming memory
of river; among singing sands,
the threat and promise of flood.

CHAPTER EIGHTEEN

A giant saved by cancre
sprawls on the riverbank,
propped on an elbow, too twisted to saw,
knotting its timbers, waves the white feather
at decades of axemen,
drops great hollowed branches,
woody caverns for fox and snake.

GRAZING

Grazing by livestock and feral animals, which reached its peak more than a century ago, represents one of the most extensive modern human impacts on river floodplains (Chapter 11). Many developments over the past 100 years have helped ease grazing pressure — for example, the proliferation of watering points and irrigation away from the floodplain; the end of long-distance stock droving; the changeover in many areas from sheep to cattle; the disappearance of palatable native plants; the success of myxomatosis; the development of successful dryland farming and a general move to lower stocking levels. However, despite grazing's reduced impact on floodplains in modern times, livestock and feral animal management remains a major issue.

MANAGING FLOODPLAINS

Any level of grazing is detrimental on floodplains, especially to the native perennial vegetation that keeps these ecosystems functioning. However, it is clearly not practical in most areas of the Murray-Darling Basin to exclude livestock and feral animals. Instead managers should set stocking levels and grazing rotations to maintain and increase a healthy cover of vegetation, and should aim to allow native trees and perennial understorey plants to regenerate. Where grazing control is feasible, the highest priority should be protecting floodplain waterbodies and riverbanks, which are particularly vulnerable to damage by livestock. Watering cattle, for example, trample and graze water plants and bank vegetation, disrupting aquatic ecosystems and opening the way for erosion. They also deposit manure and urine in and near billabongs, upsetting their natural nutrient cycle. Cattle manure contains exotic faecal bacteria, which can spread disease to humans and animals, and which may have significant ecological effects in floodplain waters (Chapter 14).

Rotating livestock, where possible, is very important on floodplains. Reeds and many other native plants can flourish under occasional grazing, so long as they have a chance to recover. Stocking levels should be set to minimise damage to such vegetation, and to promote its regeneration. However, local differences in soils, flooding regimes and vegetation makes any general, Basin-wide advice on stocking rates impossible. Floodplain grazing rotations should take into account the total grazing pressure on a section of floodplain, including grazing by feral and native animals. Again, there is no substitute for local knowledge. Landholders should develop floodplain grazing guidelines within their own communities which are suited to their own conditions.

Wherever possible, stock access to floodplain waters should be limited, and artificial watering points should instead be provided. There is an added advantage to providing such watering points; recent evidence suggests livestock's health and productivity will benefit from access to better quality water. Water piped from a fenced billabong to a nearby trough contains fewer disease-causing microorganisms and less contaminants than water in a billabong to which stock have unimpeded access. The cost of fencing and of providing watering points is often prohibitive for landholders, and this may be an area in which councils, landcare groups and other community organisations can help. A free fact sheet about cheap options for suitable fencing and watering points is now available from the Land and Water Resources Research and Development Corporation. (61) Similarly, a free fact sheet about replanting and managing floodplain reeds is available from the New South Wales Department of Land and Water Conservation. (62)

The future of agriculture in the Murray-Darling Basin will depend on a more careful match of landuse and land capability. This will involve a reassessment of the agricultural potential of our native resources such as saltbush and animal and vegetable 'bush tucker'. New crops and livestock may be introduced which are less damaging to the Australian environment than those originally brought from Europe.
Photo: *David Eastburn, MDBC*

Land use

As a general rule, floodplains should be used only for activities and developments that can cope with frequent inundations, which don't sever flood-prone land from the flooding and drying cycle, and which don't disrupt important ecological processes. The Murray-Darling Basin Commission has issued general guidelines for floodplain developments, and for streamlining the process of applying for the necessary approvals from the many different agencies involved. (63)

In the past most floodplain areas near towns have rightly been seen as unsuitable for dwellings, because of the inevitability of floods. Instead they are typically used to locate sports grounds, golf courses, caravan parks and other recreational and community facilities. Often such developments involve clearing native vegetation and introducing fertiliser, cultivation, irrigation, weed invasion and other damaging practices onto floodplains. Such developments on floodplains should be avoided, and those that already exist should be managed to minimise their impacts — for example by reducing the use and runoff of fertilisers and other chemicals, replanting native vegetation, minimising soil disturbance and maintaining natural flooding regimes. Community-based floodplain monitoring programs, for example looking at the mutation rate of midge larvae mouthparts, may provide more useful guides to river health than similar tests conducted in river channels (Chapter 6).

All floodplain agricultural practices have some negative impacts, but some are less damaging than others. In general, farmers should aim for crops and grazing regimes which are suited to natural flow and flooding cycles, and which do not permanently diminish or exclude the native species on which floodplain and river processes depend. For example, researchers unanimously support the development of river red gum farm forestry on floodplains. Unlike most irrigated crops, river red gum plantations are well-suited to the Murray-Darling Basin's natural flow cycles, and have evolved to survive the high natural variability which characterises the Australian inland environment (Chapter 7). Red gum farm plantations would benefit from more frequent flooding.

Similarly, but with some reservations, scientists support opportunity cropping on intermittent lakebeds, if it is properly managed. Crops of high-value, such as organic wheat, can be grown successfully in the beds of intermittent floodplain lakes as waters recede, with the crops drawing on soil moisture left by the floodwaters. Studies of such opportunistic cropping on lakebeds filled by the Darling River's Great Anabranch have found that it causes minimal ecological damage, so long as no chemicals are used, and so long as some patches of soil are left uncropped as habitat for marsupial carnivores (Chapter 9) and to seed the floodwaters again when the lake next fills. By contrast, the studies show continuous cropping on lakebeds has considerable ecological impacts. Recent moves to expand Australia's 'bush tucker' industry are welcome, as farmed native species usually cause less environmental damage than do exotic species.

Floodplain management has both short-term, tangible effects and longer-term, diffuse effects that are more difficult to quantify. For example, clear guidelines are now available for managing river red gum forests for water bird breeding. (64) The guidelines describe which trees birds prefer for nesting, the flooding regimes required by different tree species and similar management advice. However, much longer-term management problems are equally important, but are often far harder to comprehend. River red gum logs, for example, decompose extraordinarily slowly in water. Individual submerged snags may be hundreds or even thousands of years old. A red gum seedling sprouting on the floodplain today may live for several hundred years, then topple into the river and

To enable fish to migrate during normal flow conditions, fishways are being constructed on weirs. A fishway usually consists of a gently sloping sluiceway containing a series of baffles to reduce the velocity of the water and provide resting compartments for the fish, enabling them to 'climb' over the barrier. This fishway was installed during the refurbishment of Torrumbarry Weir. Photo: *Karen Markwort, CRCFE*

Permanent high watertables near Koondrook in Victoria. While river red gums thrive on regular flooding, the prolonged wetting which is now occuring in some floodplain areas as a result of river regulation will kill these trees. Photo: *David Eastburn, MDBC*

continue to provide habitat for fish and invertebrates for many centuries to come. River desnagging began 140 years ago, but its ecological effects may continue long after the practice has stopped. So too will the long-term effects of removing dead logs from floodplains for firewood, or of stopping river red gum regeneration.

Floodplain structures

As a general guide, floodplain structures, such as levee banks, should only be used to re-establish or maintain natural flooding regimes, not to divert or otherwise alter them. Alienating floodplains from rivers, through either permanent drying or permanent flooding, has many economically and environmentally damaging impacts (Chapter 12). The planning and approval process for floodplain structures needs to take increased account of the costs they impose on the wider community and on the environment. For example, floodplain levees can actually exacerbate the floods they are intended to prevent, by raising flood heights and concentrating the destructive energy of floodwater. Particularly in the northern Basin, such structures are often used to harvest water from catchments and floodplains, removing it from the river system with no accounting. Levees block fish movement, the migration which is very important for their breeding (Chapter 9), and where used to impound water they exacerbate rising watertables.

There are many local variations on the way floodplain structures are used, and have been used in the past. However, one damaging practice has been to use them to 'improve' existing wetlands for grazing, often planting exotic pasture species behind low earthworks. Such ponded pastures not only damage the function of wetlands — with effects felt well beyond any one property's boundary — but they can also introduce new weed species into the river system (Para grass, for example). The practice should be discouraged and regulated.

The ecological functions of floodplains should be taken into account in the construction of all floodplain structures, including roads, culverts, channels and irrigation storages. Wherever possible such constructions should be avoided, or designed to accommodate natural cycles of wetting and drying. Unless they are designed to return alienated floodplains to something closer to the natural regime they will almost always cause damage to floodplain ecosystems and to the rivers they feed and clean.

Existing structures that keep floodplains permanently wet, or permanently dry, should be considered for removal. Obviously this

will not always be possible. Most levees have been built to protect towns or high-value crops from flooding. However, some areas of former floodplain now protected by levees may be being put to only low-value use, or may have gone out of production, and these could be reconnected with their parent river for little or no cost. Disused or under-used levees and other structures could also be brought back into service as regulators, restoring the land they protect to a more natural flooding cycle.

Deliberate draining of floodplain wetlands for pasture or cropping has not been widespread in the Murray-Darling Basin, but it has happened in some areas, notably in northern Victoria and the lower reaches of the River Murray in South Australia. Such drainage works are immensely damaging to floodplains, and should be discontinued and reversed wherever possible. In the past, some farmers have lived to regret draining wet paddocks, discovering too late that they have dried out their only drought-proof pastures.

Sediment and erosion

Rivers and floodplains, almost by definition, are areas in which erosion and sedimentation are part of natural landscape processes. Managing the two issues hinges on an understanding that some level of erosion is natural, and even desirable, and that some level of sediment build-up is necessary to keep the river and floodplain system functioning. Equally important is the understanding that catchment and floodplain processes are inextricably linked, but that remedial actions on floodplains cannot cure sins committed in the catchment, and vice-versa.

The rivers of the Murray-Darling Basin, before European settlement, were mostly small, 'underfit' (Chapter 3) streams travelling in the beds of much larger, older rivers. Compared with modern rates, both erosion and sedimentation happened quite slowly. The sediment carried by rivers came partly from upland catchments and partly from bank erosion — which in turn consisted mostly of sediments laid down by earlier rivers. Catchment and floodplain clearing since the mid-1800s, followed by a series of other activities culminating in river regulation, have enormously sped up both processes (Chapter 11). Most sediment carried by river water now comes from the sub-soil, not the topsoil, which means it originates either from erosion gullies or from river-banks. Increased sediment loads have caused a decline in water quality, and an acceleration of the rate of physical change in the river system.

Erosion needs to be tackled both in the catchment and on floodplains, using well-established techniques to stabilise gullies, especially active ones, and to protect stream banks. Fencing off drainage lines is one of the simplest and most effective ways to minimise damage to sensitive areas. This creates vegetated strips, restoring flow-through wetlands that filter out sediment and nutrients from the catchment.

On floodplains, major soil disturbances such as mining for sand and gravel should be avoided, and every effort should be made to maintain a healthy understorey of perennial, native vegetation. Tillage should be avoided if possible, but always timed to avoid floods. Erosion-prone areas should neither be tilled nor cleared. Dense growths of willows can also cause disturbances, blocking flowing channels and forcing streams to change course. Native reeds, which can protect riverbanks and floodplains from erosion, are preferable.

However, all floodplain planning should include an acceptance that streams can, and do, move. This has important implications for the long-term future of riverfront developments — some of which will inevitably be swallowed up by shifting river channels, while others will lose their river frontage. The complex network of anabranches surrounding many inland rivers means that avulsions happen regularly — rivers can quickly switch course to anabranch channels, cutting off long sections of former river. Trying to prevent such course changes is always expensive, and is usually pointless; the problem simply moves somewhere else and reappears. Studies have found that it is often cheaper to abandon constructions and rebuild elsewhere rather than try to protect riverfront developments with engineering works.

A flood runner distributes water to trees throughout the Barmah forest. River red gums require regular wetting, perhaps two months a year, to maintain vigorous growth. Photo: ***David Eastburn, MDBC***