Human use of the south-west river systems

- Early human use
- Modern river water use
- Drainage
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- Recreation and sport
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6.1 Early human use

Humans probably began to use rivers not long after the first few persons stepped upon the continent, at least 40,000 years ago (Shaw 1984). One of the earliest known sites of Aboriginal occupation in the south-west is along the upper Swan River and dates back 38,000 years (O’Connor et al. 1989). Just what use these first Australians made of rivers has been pieced together from various sources, including archaeological evidence, the observations of later day Aboriginal culture by the early European settlers and the memories of Aboriginal descendants.

In the south-west during summer, Noongar people would congregate around the lake systems, many of which were and still are connected to river systems, to take advantage of large concentrations of animals, especially waterfowl, taking refuge from drought. In winter these wetland areas would become relatively unpleasant and Aboriginal people would disperse to drier areas along with their game. The lower estuarine reaches of streams such as the Serpentine River and Bennett Brook on
the Swan River were popular ‘supermarkets’ where frogs, birds, turtles and fish could be caught and root stocks harvested (Hallam 1975; Hallam 1987; O’Connor et al. 1989). On both these streams, weir-like fish traps were constructed of brush. Fish would be driven towards a trap where they could easily be speared as they swam over the weir crest and along a raised chute (O’Connor et al. 1989). It is thought that similar fish traps were used near Albany (O’Connor et al. 1995). Fish were also caught in pools by sweeping them towards the shore using brush as a simple form of net (Armstrong 1836).

In addition to offering food, river systems were also the major pathways for Noongar people travelling through the region and especially across the Darling Range. Not only did the rivers form permanent routes between major feeding areas, such as lake systems and the estuaries, they provided pleasant camping sites on the river pools and supplies of fresh water from the many springs that are found along the flanks of the rivers (O’Connor et al. 1995; Horwitz and Wardell-Johnson 1996). Even the naturally saline rivers, such as the Pallinup, had freshwater springs along them. A freshwater pool near the junction of the Pallinup River and Warperup Creek was a regular camping spot (O’Connor et al. 1995).

For the Noongar peoples, rivers were literally rivers of life, and it is not surprising that they did and still do figure greatly in their mythology and spiritual life. Of special significance is their dreaming ancestor, the serpentine Waugal. The Waugal belief relates to a profound respect for water in a dry land which, given the spiritual dimension in human life, has become expressed as a creative force, deity or spirit in animalised form (O’Connor et al. 1989), perhaps because the river meanders and pools and riffles evoke the form and movement of a snake-like creature.

Just over two hundred years ago the long custodianship of the Australian continent by the Aboriginal peoples was interrupted. In the south-west, this began with the arrival of Europeans by boat about 170 years ago, first at Albany and then on the Swan River estuary. Not surprisingly, both sites were selected because of the availability of nearby fresh water. For the Europeans to expand their colony and begin farming, they also had to find inland sources of fresh water. Perhaps because of their curiosity and a natural propensity to share, and because the Europeans appeared to offer some advantages, some local Aborigines cooperated with the settlers and led them inland along their well worn river routes, pointing out sources of fresh water (O’Connor et al. 1995). Some even shepherded flocks of sheep along traditional pathways. Inevitably, however, cultural differences, particularly an unwillingness to share on the part of most Europeans and the displacement of Aboriginal communities by the growing settlements, led to conflict which took a heavy toll of Aboriginal people. But disease took a heavier one. After tens of thousands of years of isolation from the continent of Asia, Aboriginal people had a low natural immunity to the diseases that the settlers brought with them and they died in large numbers (O’Connor et al. 1995). On the Beaufort River there is an important Aboriginal site known as ‘Measles Bridge’, where measles first broke out amongst Aboriginal people living on that river (O’Connor et al. 1995).
6.2 MODERN RIVER WATER USE

6.2.1 Early settlement

The early European settlers moved out of the centres of Albany and Perth to impose on Australia an agrarian way of life developed around the Mediterranean over thousands of years. The tools of the trade were horses, cattle, sheep, goats and pigs, cereal crops, fruit trees and a wide variety of vegetables, all exotic and all to be grown in neatly arranged paddocks. This intense use of the land required clearing of the native vegetation and large quantities of fresh water: for livestock watering, sheep washing (to clean the wool prior to shearing) and dipping (for disease control), household uses and irrigation; and later, reticulation of market gardens, orchards and pastures. All this was at a density of human occupation far in excess of that of the Aboriginal peoples. Furthermore, stock routes with reliable watering points were needed to shepherd sheep and take them to market.

With the development of rail transport after 1880, fresh water was required to provision the steam engines (Horwitz and Wardell-Johnson 1996). Flour mills and timber mills, some constructed as early as the 1850s (Lund and Martin 1996; Horwitz and Wardell-Johnson 1996), also needed water for their steam engines. So settlers searched for water along the old Aboriginal pathways, the rivers, and often established settlements along them (Horwitz and Wardell-Johnson 1996). For example, Toodyay, Northam, York and Beverley are located on the Avon, and Augusta, Nannup, Bridgetown and Boyup Brook on the Blackwood. Most of these towns were major steam rail transport centres and/or mill towns in their day. The flour mill at York still stands as does the flax mill at Boyup Brook, built during the Second World War and now a tourist and conference centre on the banks of the Blackwood (Horwitz and Wardell-Johnson 1996).

To show how rivers played a role in establishing settlement, it is worth mentioning one very ordinary example. In 1858, George Stedman Watts and his two sons were camping in the Darling Range south-east of Perth when their horses strayed into the bush. Whilst the party tracked them along the later named Bannister and Wandering Brooks for about 30 km, they came upon a freshwater spring on the banks of the Wandering Brook, about 8 km upstream of the Hotham River. Encouraged by the quality of the country Stedman Watts sought and was given freehold title to the land in 1861. He coined the name ‘Wandering’ which was later given to the town of the same name (Schorer 1974). Incidentally, the town of Pingelly derives its name from an Aboriginal word meaning ‘small gully of water’, and the town of Boyup Brook from an Aboriginal name for a local pool, ‘Boyup’ (Horwitz and Wardell-Johnson 1996; Lund and Martin 1996).

Fresh water was not the only resource that rivers provided. In the very early days of the Swan settlement, it was the relatively rich red alluvial soils of the Swan and Canning river floodplains that were found to be the most useful for agriculture (Seddon 1972; Jarvis 1979; Appleyard and Manford 1979). The Canning River was also an important transport route, particularly for timber which was loaded at Mason’s Landing at
Cannington for transport down to Fremantle (Carden 1968). In the days of the horse and buggy the local river pools were important recreational and social amenities. For example, Burlong Pool on the Avon River was a popular picnic site for local farming families during the early part of the 20th century, as was Perry’s Pool on the Hotham, (WAWRC 1992a; Lund and Martin 1996). Gibbs Pool on the Harvey River was a popular ‘swimming hole’ at about the same time. The early introduction of the redfin perch, a fine table fish, along with the existing native freshwater cobbler and marron and the many waterfowl that took refuge from drought on the river pools, enabled fishing and duck shooting, and provided an important source of food for settlers in the early days before their farms could supply all their needs.

But life is full of irony, and so it was for the settlers and their descendants. It was not long after the establishment of towns and farm houses on the major rivers, that frequent flooding called into question the wisdom of their locations. For example, the Swan-Avon system flooded twenty-seven times between 1830 and 1955, the last one having such serious consequences on human settlements that it led to a major river training program (Harris 1996). The town of Williams was moved to a better location soon after flooding in 1905 and many other towns in the south-west have been affected by flooding over the years, leading to a range of flood protection works (Lund and Martin 1996). If not for the decline in rainfall since the 1960s flooding would be a continuing problem, made worse in some areas no doubt by widespread clearing which increases flood intensity.

Furthermore, with the changing surface and groundwater hydrology of the south-west, brought about by widespread clearing, salinisation became a problem and many settlers or their children soon found their once fresh rivers turning salty. Also, increasing soil erosion and the use of fertilisers led to sedimentation and nutrient pollution. In time many rivers, especially in inland areas, became less useful for watering and less attractive for recreation. Marron, perch and cobbler began to disappear by the 1960s (Horwitz and Wardell-Johnson 1996; Lund and Martin 1996). Today many river pools in farming areas are foul and saline in summer when they are most needed, and often shrouded in dead trees. Fortunately, the success and experience of south-west farmers gave them sufficient wealth to take advantage of new technologies and develop innovations to collect water from elsewhere, and also to afford vehicles fuelled by fossil energy to move further afield in search of recreational opportunities. For most rivers the only use remaining was the basic one of drainage, and even this has become compromised in recent years by erosion and sedimentation.

But today’s rural people have not turned their back on the rivers. Years of living in a dry land have developed a yearning for the things of life that spring from water and have kindled a growing movement of farmers and rural townspeople to manage rivers and bring back some if not most of the values that were so cherished by the country’s first human inhabitants.
6.2.2 Scheme water supply: the dams and weirs

The long hot dry summers of the south-west necessitate the storage of water in order to maintain a year round supply. Some coastal areas have ready made storages of water, in the form of groundwater or more specifically, extensive shallow freshwater aquifers. Today much of Perth and the towns of Bunbury, Albany and Esperance get their water from coastal aquifers. Large dams also provide a form of water storage, but these can only be built where the shape of the land is suitable.

With Perth's rapidly growing population of the late 1800s and the need for irrigation on the coastal plain, it was only a matter of time before water supply engineers looked constructively at the fresh rivers of the Darling Range with their deep valleys. The first dam, the Victoria, was completed in 1891 and was constructed on Munday Brook, a tributary of the Canning River (Le Page 1986). It was a comparatively small structure by today's standards with a 15 m high wall, capable of impounding only 0.9 million cubic metres (MCM) and capturing about 86% of the stream's average flow (PWDWA 1985).

Water was also needed for the goldfields region and the growing number of wheatbelt towns. However, the relatively flat and ancient wheatbelt and goldfields areas have neither freshwater rivers or fresh groundwater, nor the hilly terrain needed to build large dams. The solution was a major country water supply scheme designed by C.Y. O'Connor and completed in 1902 (Le Page 1986). For this scheme the large Mundaring Weir was built on the Helena River, a tributary of the Swan. It had a 30 m high wall, impounded 21 MCM of water and was capable of capturing 50% of the average stream flow (PWDWA 1985).

Since those early pioneering years, twenty-three dams have been built on the hills' rivers, with reservoirs ranging in size from 0.3 MCM to over 200 MCM, and capturing a full 32% of the total freshwater flow from the scarp between Perth and Bunbury (Williams pers. comm.). Only the large brackish or saline rivers, the Avon and the Murray, have not been dammed. About twenty scarp streams also flow freely to the Swan Coastal Plain or into the Murray.

South of Bunbury, there are few public water supply dams and all are small (under 0.8 MCM), mostly on the tributaries of the major rivers (PWDWA 1985). For example, a small dam was built on the Lefroy Brook early in the century to supply the town of Pemberton and its trout hatchery, and later in 1985 a larger dam was built upstream on Big Brook to supplement this supply. The larger of the lower south-west dams are located near Nannup, Manjimup and Denmark. Only the last is located on the main channel of a river, the Denmark. One of the smallest dams lies on the upper Gardner River near Northcliffe, a fine example of a small attractive and relative unobtrusive facility which blends in with the scenic beauty of the surrounding forest.

Not all dams in the south-west have the same function. Storage dams store water, capturing a proportion, if not most, of the water that flows into them. Pipehead dams do not store water, but hold a portion of the 'run of the river' flow for immediate transfer by pipeline to a large storage dam, upstream on the same river system or in an
adjacent catchment. The South Dandalup Dam is a large storage dam which can hold far more water than its small catchment can produce in all but the wettest years. It was constructed to store water from adjacent streams and from dams that are known to overflow regularly and thus lose water. Unfortunately, because of the run of recent relatively dry years the South Dandalup has mostly been empty since it was completed in 1974 (PWDWA 1985).

Two dams in the south-west, the Wellington and Denmark, on the Collie and Denmark Rivers, have had to be taken off town water supply owing to increasing water salinity caused by salinisation in their partially cleared catchments (WAWA 1989). Both catchments are being rehabilitated and have strict controls on clearing to prevent further increases in salinity. Similar controls have been placed on the Warren and Kent catchments which are earmarked for future water supply and the Helena catchment which provides water to the Mundaring Dam (WAWA 1989).

6.2.3 Country town and farm water supply

Country people collect and store water in various ways, often without depending on river systems. For domestic use, water collected on roof tops is stored in tanks. Stock are often watered from excavated soaks or from dams placed below springs and seepage areas. Earth dams are placed on a slope or in a depression with or without a contour bank or drain to intercept rainfall runoff and bring water to the dam. For many wheatbelt country towns, which are not connected to water supply schemes supplied by the large Mundaring and Harris River Dams, small dams placed at the base of small bushland, rock or bitumised catchments, with very high runoff rates, are the main means of water collection and storage.

Farm water supplies that make direct use of river systems are to be found closer to the coast where the more dissected terrain enables the construction of gully dams and the underlying clayey soils reduce percolation of water into the ground. These dams are usually small, inundating only a few hectares of land at most, and have walls constructed of earth. Their small size and the high runoff rates of their mostly pastured catchments mean that most of them can only collect a few per cent of the average annual streamflow. For this reason it is not unusual to see a series of dams along a watercourse, forming a step-like pattern down a valley. Gully dams are most common in the middle Blackwood, Donnelly and Warren catchments where they are essential to the growing horticultural industry.

Gully dams made of earth are not much different in function from the large concrete and stone public dams; both serve to capture and store a portion of the water leaving the catchment. But whereas a great deal of research and planning goes into the construction of public dams to ensure their safety in times of flood when large flows overtop the dam, the same cannot be said for many private gully dams. Yet their construction from earth and their location in high rainfall and largely cleared areas renders them far more prone to collapse during flash floods. Although these dams may comply with sound engineering principles, their construction was not based
on the rigorous investigations into catchment discharge required for public supply dams, and thus their stability during high rainfall events is not assured. Indeed, public dams are required to meet ever more stringent international safety standards and old dams occasionally have to be upgraded.

6.2.4 Irrigation

Irrigated agriculture from surface water resources is a major land use on the southern Swan Coastal Plain, covering about 12,000 ha and consuming about 200 MCM of Darling Range water annually (Stone pers comm.; WAWA 1990). This water is supplied by seven dams with reservoirs ranging in size from 9 to 185 MCM (WRC data). The dams and most of the channel systems which bring water to the farms were built between the 1910s and 1970s (WRC data). Nearly all of the irrigated land in the Waroona, Harvey and Wellington Irrigation Districts is simple pasture, mainly supporting cattle.

In the late 1980s about 60% of the irrigated area and 65% of the water was used by about 170 dairy farms to produce nearly half of the State’s supply of milk (WAWA 1990). The rest of the land and water was mainly used for beef production, but a small proportion was used for horticulture. Today, viticulture and other forms of horticulture are becoming more important, mainly replacing beef production. A trend towards higher value products is expected to continue as land users are required to meet the real costs of irrigation in the near future (WRC 1998).

While irrigation enables high agricultural production to continue over the long dry summer, it is not without its environmental problems. About 33% of the irrigated land is suffering depressed yields caused by salinisation and waterlogging (WAWA 1990). The problem is caused by rising groundwater, due to leakage from the channel system and over-watering, and the build-up of salt through evapotranspiration in poorly drained areas. It is made worse in some areas by the high salt content of the water from the Wellington Dam, which in some years reaches 1000 mg/L, too high for long-term sustainable agriculture in the absence of good drainage which permits the efficient through-flow of salts (WAWA 1990). Studies done in the Dardanup area have shown that about three times as much salt is applied to the land in the irrigated water as runs off in drains, leaving large amounts of salt to pass into groundwater (WAWA 1990). In many areas, brackish groundwater underlies farmland, often rising to the surface and affecting crops in winter.

The solution to this problem is lower water use and better drainage, but drainage also has impacts. Irrigated farmland is fertilised, and water passing from the land to the drains carries nutrients that pollute downstream waterways. About 58% of the irrigated area of the coastal plain drains to the Leschenault Inlet and 34% to the Peel-Harvey Estuary (WAWA 1990).
6.3 DRAINAGE

The most basic use which humans derive from river systems is drainage. This section deals with drainage not only in relation to natural streams but also to modified ones and entirely artificial waterways.

Drainage whether natural or otherwise is needed for two basic reasons, to remove large amounts of water deposited in storms (stormwater) and to lower the watertable to enable some form of land use. In the southern suburbs of Perth, large seasonally swampy areas have had to be drained to permit residential development, and with the spread of hard rooftops and roads, drains were needed again to remove stormwater. There is an irony here, in that most swampy areas are low lying and flat and do not allow rapid stormwater drainage once urban development is established. Such areas are prone to flooding during heavy rainfall.

In other low-lying areas of the Swan Coastal Plain and along the south coast to Albany, land has had to be drained to permit agriculture. In the early days, the new settlers did not have the resources and expertise to carry out the broad scale drainage that was needed. So in 1894 requests were made to government for drainage improvements. With the passing of the first Drainage Act in 1900, extensive drainage works were initiated over the following 30 years, involving the modification of existing natural streams (mostly the removal of woody debris or channel enlargement) and construction of new drains (AWRWC 1992b). In the irrigation districts, drainage was also needed to carry irrigation water away, to prevent waterlogging and to allow an efficient throughput of water to prevent the build-up of salts.

All of this work took place on the southern Swan Coastal Plain and along the coast between Denmark and Albany, and today there are six drainage districts: Mundijong, Waroona, Harvey, Roelands, Busselton and Albany, which together drain about 320,000 ha of land (AWRWC 1992b). There are also large areas of private drainage on the Scott Coastal Plain, about Walpole-Nornalup and east of Albany. Also, in the wheatbelt, where widespread clearing has led to groundwater rise and salinisation, drainage is increasingly considered necessary to prevent waterlogging by intercepting and carrying away salty groundwater before it rises to the land surface.

Artificial drains are usually trapezoidal in cross section, being wider at the top than the bottom, with steep sloping sides. The drain is designed to carry a larger than typical flood when bankfull and to minimise upstream flooding, typically to no more than three days in rural areas (AWRWC 1992b; Jim Davies et al. 1994). Most drains are straight and have a slope sufficient to generate a flow of no more than 1 m per second, which is not too energetic to cause erosion. Drains of this design have a number of advantages: they require the excavation of a minimum amount of earth, minimise bed area and thus drag and require smaller bridges and culverts to span them (AWRWC 1992b). Many landowners prefer wider drains because of the perception that they can carry more water. But actually, while wide drains hold more water, actual conveyance may be reduced by increasing drag caused by the greater area of contact between the water and the bed.
While drains open up areas to development and may increase economic income, they are not without their problems. Their steep sides are prone to collapse and damage by livestock, which is worsened in times of flood, resulting in serious erosion and sedimentation. If drains are not grazed by livestock, they quickly become infested with weeds and may need to be periodically cleaned out. This is usually done by spraying and where necessary a back-hoe is used to dig out accumulations of sediment and plant material and to scrape bare the sides of the drains (Jim Davies et al. 1994). Spoil is usually dumped beside the drain, creating levee banks. In this way drains increase in width and depth over the years (Jim Davies et al. 1994). Some old suburban drains have already reached backyard fences.

Drains are expensive to build and maintain. The operating cost of the drainage districts was estimated at over $2.5 million in 1992-93 (English 1994). More striking is the replacement cost for the 2510 km of drains in the six drainage districts, which was estimated at $93.7 million for the same period (English 1994). This figure allows us to estimate drainage value of river systems. For example, the Kalgan River system has been estimated as having about 4000 km of streamline (Weaver et al. 1994), giving it a notional asset value of $150 million. And the Kalgan, being a river ecosystem albeit moderately degraded, is far more than a mere drain.

### 6.4 Flood Protection

Drainage systems, natural or otherwise, by their very nature reduce flooding but they can also cause it by transferring large quantities of water downstream to low-lying areas and by allowing water upstream from the ocean during storm surges. The Geographe Bay catchment about the town of Busselton, has both problems. For these and other reasons, the Buayanup, Vasse and Capel Rivers were diverted from their estuaries to discharge directly to the sea, and floodgates were placed at the mouths of the Vasse and Wonnerup Estuaries (Olsen and Skitmore 1991). The nearby Five Mile Brook was similarly diverted to protect Bunbury. Further to the north, the Harvey River was diverted for 21 km to discharge to the sea rather than occasionally flood a large low-lying area of land between the town of Harvey and the Harvey Estuary (Olsen and Skitmore 1991). This large community employment project was carried out by 2500 men using shovels and wheel barrows during the great depression of the 1930s (Le Page 1986).

As was discussed in Chapter 2, serious flooding can also occur when floodwaters burst river banks and inundate extensive floodplains, on which may be valuable farming land or settlements. In this case the obvious course of action has always been to increase the conveyance capacity of the river. This can be done in two ways. The first is called ’river training’ which involves channel straightening and the removal of vegetation and debris to reduce drag and thus increase the flow velocity. A secondary effect is incision which increases channel
depth and in turn further increases velocity (as stated in Section 2.2.4, velocity is mainly a function of depth). Thus the river not only flows faster, it can also hold more water, which in itself is a form of flood mitigation. In the south-west, 187 km of the Avon River between Toodyay and Brookton was 'trained' (though not straightened) between 1958 and 1970 (Harris 1996). This action is perceived to have had a major deleterious impact on the river, largely involving the mobilisation and transportation of huge quantities of sediment and the subsequent sedimentation of river pools. While the flood mitigation function of the trained Avon River is considered to be limited (Binnie and Partners 1985), similar but smaller scale works carried out in the 1960s along 13 km of the Collie River, near Collie, have been successful in preventing flooding of the town of Collie, and with no serious sedimentation problems (Olsen and Skitmore 1991).

An alternative approach to flood mitigation is to raise the river with levee banks. Such works have been carried out on the Greenough River, south of Geraldton, on the Avon River at Northam, and on the Preston River at Bunbury (WAWA 1994). Levee banks are also located on 3 km of the Harvey River diversion. Landowners with substantial pasture land on the floodplain of the lower Moore River have also erected levees to reduce flooding. Although levees are effective means of containing floodwaters, they do so at the price of increasing effective channel depth and thus stream power. Leveed rivers are powerful rivers and should the levees ever break the extra power is available to do much damage. Furthermore, if the levee is only located on one side of the river, the raised water level may erode the upper level of the opposing high natural bank, a situation which appears to exist on parts of the west bank of the lower Moore River as it flows along the eastern edge of a high sand dune.

As an extreme example of flood protection, consider the lower Preston River. It has been straightened, streamlined, widened and constrained within levees 4.4 km long, in a series of works carried out between the 1950s and 1980s (Olsen and Skitmore 1991). The levees were raised and strengthened following floods in 1964. In addition the river has been relocated to make way for harbour developments, and will be moved again as the harbour grows.

A curious fact about flood protection works is that they are generally only supported by the local communities whilst past floods are still fresh in their memories. As time goes by, and the recollections of past floods slowly dim, the cost burden of maintaining drains, training schemes and levee banks becomes intolerable; landowners refuse to pay drainage rates, local governments drop channel maintenance programs and no one, as it turns out, appears to have responsibility for particular levee banks (Olsen and Skitmore 1991; Jim Davies et al. 1994; WAWA 1994). That is, until the next big flood.

Lastly, the large water supply dams are also a form of flood protection. The inhabitants of the lower Collie may one day be thankful for the presence of two large dams, the Wellington and the Harris, on the Collie system.
6.5 RECREATION AND SPORT

Rivers of the south-west provide a wide range of recreational opportunities, including swimming, boating, fishing and shore based activities, such as walking, picnicking and camping (Feilman 1987; Madden 1995). In the early days of European settlement, people from the Perth urban areas would take rail and later bus excursions to John Forrest National Park (Jane Brook), Mundaring Weir, Lake Leschenaultia (on Cookes Brook), Araluen (Stinton Creek) and Serpentine Falls (Olsen and Skitmore 1991). Today, these sites are still important to the Perth community.

With growing affluence, increasing leisure time and the advent of the motor car, people now have access to recreational sites on rivers from Geraldton to Albany, and there is a wide range to choose from. Along the Darling Scarp the irrigation dams, which do not have to provide drinking quality water, are available for recreation, as is the small Big Brook Dam nestled amongst regenerating karri forest near Pemberton. Because the dams close to Perth are not available for recreation in order to protect water quality, recreational facilities are provided at the base of the dam walls, sometimes around a natural river pool or a previously existing small dam. Some famous old swimming sites like Lake Leschenaultia and Fonty’s Pool near Manjimup are actually old disused gully dams.

A number of rivers in the south-west still provide recreational opportunities amongst natural surroundings or the aspect of a free flowing wild river. One of the best examples is the Murray River where it flows through the dense jarrah-marri forest of the Darling Range. Now part of the Lane-Poole National Park, it provides a major recreational area for thousands of people, especially over the long weekends of the early part of the year when the weather is usually fine. The Warren River National Park provides similar opportunities, but with the added feature of overhanging tall karri forest.

The larger powerful rivers are popular for boating. Some, like the Donnelly, Warren and Frankland, are probably canoed more for their scenic values than for the ‘wild’ river experience, but rivers like the Murray and the Deep provide both wild, turbulent waters and scenic qualities. The Avon and Blackwood, although highly altered along much of their canoeable lengths, provide the longest continuously canoeable sections. For this reason, these rivers can support major sporting events, involving both powered and unpowered boats, like the Avon Descent from Northam to Perth which takes place in August, and the Blackwood Classic from Bridgetown to Augusta on the Queen’s Birthday holiday weekend. The canoeing and swimming legs of the Blackwood Marathon take place between the Winnijup and Jayes Bridges on the Blackwood River between Boyup Brook and Bridgetown.

A more subdued experience is provided by lonely river pools. Some of these, like the Ellendale Pool on Greenough River near Geraldton, are amongst farmland, while others are deep within forest, such as the Barrabup Pool on the St Johns Brook near Nannup. In fact there are hundreds of river pools throughout the south-west that would do for an afternoon’s swim, family
The Wellington Dam on the Collie River. It was completed in 1933 and twice raised, in 1944 and 1960. It can store 170 million cubic metres of water. Photo: D. Moss

Flood control levees on the trained lower Preston River. The levees are to protect the City of Bunbury from flooding. Photo: J. Garbutt
Trout fishing on the Lefroy Brook near Pemberton.  Photo: S. Neville - Ecotones

Canoeing on the Avon River.  Photo: Unknown
picnic or a lonely night’s camp, under black, leafy and starry skies.

Scenic drives are also available along some rivers. One of the best is the drive from Balingup to Nannup that winds its way along the deep Blackwood valley. The best time is morning in late winter, when the hillsides of deep green paddocks, pines, jarrah and marri are shrouded in mist and the Blackwood flows in flood through the dense fringing vegetation of flooded gums, paperbarks and tall sedges. Many rivers, which are too densely vegetated to canoe and are not flanked by road, can be walked and it is strange that more is not made of river walking as a form of recreation - a stroll in the footsteps of the Aboriginal people.

Finally there are river parks, where one can enjoy a community atmosphere down by the river. A long park winds its way along the Canning and Southern-Wungong Rivers and includes an amphitheatre at Gosnells. Balingup has a small park and football field on the floodplain of the Balingup Brook. There are river parks in the towns along the Avon River and the one at York has helped the town play host to an annual jazz festival. The town of Margaret River has a small heavily used little park with a grand view up the river, and a river walk along foreshores of tall karri forest. But the best is on the Denmark River opposite the town of Denmark. Here a small park under tall karri and paperbark trees is host to village fairs, concerts and plays. Nowhere is there a better example of what a south-west river has to offer to community life.

### 6.6 Fishing and Aquaculture

#### 6.6.1 Fishing

Humans are hunter gatherers by nature and it is therefore not surprising that, in spite of a bounteous supply of food, fishing is one of the most popular amateur pursuits in Australia. Unfortunately, inland fishing is very limited as the rivers of the south-west do not support a broad assemblage of native fish species suitable for fishing. The only large fish is the freshwater cobbler and it is not rated highly for its table or sporting qualities, at least not from a European cultural perspective. For this reason, the early settlers were very interested in introducing fish species which could offer the sort of ‘rod-and-line’ fishing to which they were accustomed. Chief among the fish most sought after were the ultimate in freshwater fishing species, the trouts. Rainbow trout and brown trout are held in high esteem by freshwater fishers, especially fly fishers, for their beauty, strength and not least (or perhaps least) for their eating qualities.

Interest in introducing trout to the south-west grew after locals heard of successful introductions in Tasmania in the 1860s (Coy 1979). Following an early crude attempt to place a small batch of brown trout ova in the cool waters near Albany in 1877, a trout hatchery was constructed on the Preston River in the early 1890s (Coy 1979). From there a number of south-west streams were stocked. However, serious introductions did not begin until the 1930s when the Pemberton Trout Hatchery on the banks of the Lefroy Brook began operation. This
facility has operated for over 60 years providing millions of ova, fry and fingerlings for stocking streams and farm dams throughout the south-west. In 1971 it was taken over by the government and is now operated by Fisheries Western Australia, which concentrates stocking in irrigation dams, farm dams and waterways that already support trout (Fisheries Dept. 1995a).

A second trout hatchery was opened on the Collie River South Branch in 1939, just upstream of the present day Schultz’s Weir. It was short lived however, burning down in 1945 and never rebuilt (Coy 1979); the concrete remnants can be found among regenerating forest at the upper end of the weir pool.

The success of trout in south-west streams is greatly limited by high summer water temperatures, as neither species can tolerate temperatures much above 20° C, and by a lack of gravelly stream beds needed for spawning (Fisheries Dept. 1995a; undated a). Some successful breeding does take place however, in some south-west streams and presumably the tributaries of some of the major Darling Range rivers, as there are long lived populations in these waters. Even though hatchery breeding has given rise to trout which can tolerate temperatures up to 23° C (Morrissy 1973), the best waters for trout are the cool waters of the south coast streams and the dams of the northern jarrah forest. In the case of the latter, only the irrigation dams, where water quality is not of paramount concern, may be legally fished (Fisheries Dept. 1995a).

Because the trout fishery is limited in size, it is tightly regulated by Fisheries Western Australia. A south-west freshwater angling licence is required (for all fish species) and the relevant literature should be consulted as to open/closed waters and seasons and legal sizes, bag limits and fishing gear. In the early 1990s about 8000 licences were taken out annually (Fisheries Dept. 1995a).

Other fish species have been introduced over the years, among them redfin perch, carp, tench, eels and large eastern state species, such as Murray cod, silver perch and golden perch. Of these only redfin perch has been widely successful; some would say too successful. Introduced in 1892, large catches were reported from a number of rivers by 1910 (Coy 1979), and since then the species has spread to virtually all south-west fresh waters. Today it is considered feral, producing large stunted populations of poor sporting and eating quality. Nevertheless, diehard seasoned redfin fishers continue to pursue the larger fish in the larger rivers, such as the Murray, Collie, Blackwood and Warren, while the smaller fish amuse young anglers and holiday makers.

6.6.2 Marroning

The most important inland amateur fishery in the south-west is not based on a fish species, but on the large nocturnal freshwater crayfish, marron. Since the early days of settlement, marron has been prized for its fine eating qualities and relative ease of capture using any one of a variety of methods, including baited drop nets, scoop nets and snares. Through the translocation of marron beyond its original range of the
streams of the jarrah and karri forests, both to extend the fishery and for aquaculture, it can now be found in river pools and farm dams from Geraldton to Esperance (Morrissy 1978; Fisheries Dept. 1995b).

Despite the abundance and broad distribution of marron, there are major concerns over the ability of stocks to withstand current levels of fishing pressure from a growing human population. To protect the fishery, controls have been put in place similar to those for trout, only more severe. For example, marron can not be caught from a boat and many waters are declared ‘snare only’. In 1995, 18,630 licences were issued for a short, less than two month season over January and February (Fisheries Dept. 1995b). Again, the relevant Fisheries literature should be consulted for current season’s regulations.

Marron may have an important ecological role to play in the health of river ecosystems and regulation of the fishery in the future may need to account for this role as well as the sustainability of the fishery.

### 6.6.3 Aquaculture

Aquaculture, or the farming of fish and crustaceans, is a growing industry in the south-west. The principal species involved are rainbow trout, brown trout, marron and the introduced crayfish, the yabbie (*Cherax albidus*). To achieve reasonable growth rates and marketable quantities, specially designed grow-out ponds are required for trout and marron (Fisheries Dept. undated a,b,c). Consequently, rivers are mostly only used in trout and marron aquaculture as sources of water and in some cases for the disposal of wastewater following treatment (Morrissy pers. comm). Often trout farms, such as the one on Treen Brook, offer pay fishing to tourists and thus make a useful contribution to recreational fishing (Fisheries Dept. 1995a). Similarly, some farmers in the cooler parts of the south-west stock their dams with fingerlings from the trout hatchery to offer pay fishing, creating what is called a ‘put and take’ fishery.

The yabbie was introduced into WA from the eastern states as early as 1932. It does not grow as large as marron, but still reaches a size considered reasonable for consumption and farming. Because the species is tolerant of higher water temperatures than marron, it is suitable for rearing in the larger farm dams of the wheatbelt (Morrissy 1995; Fisheries Dept. undated c). Over the years yabbie farming has become lucrative for farmers with the right kind of dams. To develop the industry Fisheries Western Australia maintains a small research facility at Beverley. In an effort to protect forest stream ecosystems from invasion by the yabbie, farming of the species is limited to the agricultural area east of a boundary drawn from Perth to Albany and which runs along the inland margin of the State forest (Fisheries Dept. undated c).
6.7 SCIENTIFIC AND EDUCATIONAL USE

River systems are of considerable scientific and education interest because they are ‘focal points for concentration of indigenous flora and fauna, vivid representation of geomorphic and geological forms, indicators of regional and local water quality and important media for reproductive processes in the biota’ (Patrick Coffey 1990). The very nature of rivers, together with their catchments, brings their ecological, physical and hydrological processes into collision with human activities, the results of which inevitably attract researchers. Drake (1995) noted that streams (and wetlands) which were the subject of scientific investigations or had the potential to be so, had significant unique features such as a rare species (e.g. the pouched lamprey); were near-pristine and thus offered the unique opportunity to study natural processes; presented the opportunity to study long-term climatic or catchment changes; had been previously studied and provided a good basis for further work; or by chance were related to the specific interests of scientists and funding bodies.

It follows that, because rivers provide a wide range of uses and services, they become water resources that need to be managed. Management requires that the community knows a great deal about the nature of rivers and knowing about rivers, like anything else, requires that knowledge gained through research is passed on to other people through education.

Research and monitoring

Not all scientists are agreed on what constitutes research. Some believe that only the testing of hypotheses with rigorous statistically valid experiments is research and that the rest is mere descriptive science or natural history which does little more than develop the models which need to be ‘researched’, to prove whether or not the models are valid, and thus can be applied in management (Underwood and Chapman 1995). Whatever the opinion, research in south-west rivers can be divided into short-term investigations which may last a few weeks to as long as five years, and long-term monitoring which may last many decades.

The most important research carried out on south-west stream ecosystems is the largely descriptive work carried in the 1980s and 1990s at the School of Zoology, University of WA, and led by Drs Stuart Bunn and Peter Davies. The results of this pioneering work are described in Chapter 3. As an example of experimental research, Drs Ivor Gowns, Kerry Traylor and Jenny Davis, from Murdoch University’s School of Biological and Environmental Sciences, investigated the impact of logging on karri forest streams over the late 1980s and 1990s. Their work involved descriptive studies, hypothesis generation and properly replicated sampling of stream invertebrates from streams in logged areas and unlogged areas (see Chapters 3 and 7). Since the mid-1970s, a fish research group, under the supervision of Professor Ian Potter from the same School has been conducting research on the primitive pouched lamprey. This work has been both ecological and physiological in nature, as the study of the primitive physiological and biochemistry of
the lamprey helps in the understanding of the biology of more advanced animals, including humans. In the 1980s, the fish group moved on to study the natural history of the south-west’s small suite of endemic freshwater fishes (see Section 5.1.6).

The Water and Rivers Commission, in conjunction with CALM, Agriculture WA, CSIRO and some landowners, maintains a number of research catchments throughout the south-west looking at the effect of short and long-term clearing and subsequent revegetation on groundwater movements and saline discharge. This work has contributed significantly to our understanding of catchment hydrology, as outlined in Section 2.2.

The Water and Rivers Commission also maintains 585 streamflow gauging and water quality monitoring stations throughout the State (Muirden pers. comm.). These stations usually take the form of a small concrete weir and raised metal or concrete shelter in which the measuring equipment is housed. Presently about 240-365 stations are in operation. The research which utilises these facilities is an example of long-term monitoring, in this case needed to gain an understanding of streamflow variation in relation to climate and catchment changes. Armed with this information the Commission can direct water supply development; and water suppliers, such as the Water Corporation, can be confident that they have sufficient supplies of suitable quality water to meet projected demands, especially in times of prolonged drought. Main Roads Western Australia also uses the information to calculate the necessary size of road culverts and bridges so that flooding seldom damages roads.

Stream monitoring is also done to determine nutrient and sediment loads, providing essential information for catchment management and planning. By monitoring a number of streams over a long period of time, sub-catchments and particular catchment activities which yield high loads can be identified and targeted for management. For example, stream monitoring identified the Ellen Brook catchment, on the outskirts of the Perth metropolitan area, as a major source of nutrients for the lower Swan River (SRT 1998). Over the years, monitoring will show whether or not catchment management in this rapidly developing part of greater Perth is effective in reducing nutrient and sediment loss from catchments.

**Research and development**

A second phase of research involves taking the results and developing technologies which can be applied to solve particular problems; hence the phrase ‘research and development’ or ‘R & D’. To promote R & D on environmental technologies the Federal Government has set up the Land and Water Resources Research and Development Corporation (LWRRDC) to sponsor R & D programs in conjunction with government agencies, community groups and private businesses. In the 1990s, LWRRDC ran two programs of relevance to river management: the Rehabilitation and Management of Riparian Lands Program and the National Eutrophication Management Program, both in partnership with State government agencies and community groups. Environment Australia is implementing two nationwide programs: the Monitoring River Health Initiative
whereby a range of streams, both near-pristine and degraded, are sampled for invertebrates by local universities and State government agencies in a search for regional biological indicators which can be used to monitor stream ecosystem condition; and the National River Health Program to sponsor research into environmental water requirements.

**Education**

Many schools, TAFE colleges and universities make use of rivers and creeks (and wetlands) in their teaching courses. Since teaching sessions in schools and TAFE colleges may last an hour or less, access is an important factor in determining whether or not a local stream is regularly used, as is the permanency of the creek’s flow of water (Drake 1995). For example, the Barlee Road Footbridge on the Capel River is within walking distance of the Capel Primary School which makes regular use of the river for its biological programs. Even better, Winter Creek near Narrogin, runs through the Agricultural College and is used as part of College’s land use and landcare studies (Drake 1995). More distant streams tend to be used for day long course work or extended camping trips. For example, Geenyulgup Brook, near Yallingup, has been used by the Margaret River Senior High School for its annual geography studies for over ten years.

Since 1989, the link between school studies and river systems has been broadened and deepened by a WA program known as Ribbons of Blue, which is part of the Commonwealth Government’s nationwide Water Watch Program (see Section 9.4). Ribbons of Blue operates out of the Water and Rivers Commission and assists many schools and community groups to carry out water quality and macro-invertebrate monitoring of local streams in various catchments around the south-west. In this way education embraces research and develops a keener understanding by local school students and older community members of scientific methods, stream processes and land use impacts. This program, described in greater detail in Chapter 9, involved 185 groups in 1997 and is invaluable in raising local community awareness of the need to protect and manage river systems.

**Future use**

As the human population of the south-west grows over the coming decades, the demands placed on rivers will increase. More water will be needed to support human activities, the demand for rivers to provide for recreation and lifestyles will rise and river systems will be called upon to drain more and more water from the land, much of it containing sediments, nutrients, salt and other pollutants. The use of rivers, and of the catchments that sustain them, is taking its toll on river health, and of wetlands generally. As a result, the capacity of the rivers of the south-west to provide for existing needs, let alone those of the future, is declining. The degradation of south-west rivers and their catchments is the subject of the next chapter.
Chapter 6
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