# MORE TURTLES

River Murray Turtle Protection Manual

South Australian experiments
in turtle habitat protection

# did you know?

## The River Murray Turtle is under threat

Foxes take 93% of turtle eggs from their nests
Human disturbance and driving over nests destroys more eggs
Only 4% of eggs survive as hatchlings to reach the water's edge

Turtles are an important link in the ecological chain but at present turtle births are not keeping up with deaths so local populations are declining dangerously

Turtles can be used as an indicator of the changing health of the ecosystem

Evidence of problems with turtle health or population profile points to wider issues that may be affecting many other species of flora and fauna, and interrupting the delicate ecological balance between all the components of the River Murray system

Protecting turtle nesting sites and controlling foxes to reduce predation is critical to give the turtles a chance to build up a strong population again

# you can help!

## You can help restore the balance and save the turtles by

Identifying turtle nesting sites and monitoring them for signs of predation and hatchling survival rates

Working with community groups to establish protection projects

Keeping human activities such as camping and 4WD access away from turtle nesting habitats

Restoring and revegetating nesting habitats

Providing interpretive signage and education about turtles

Experimental fencing projects are already underway in the Riverland, but more needs to be done to protect turtles and help restore the natural balance

The River Murray Turtle Protection Manual shows how communities can become involved in helping to save the turtles

**River Murray Turtle Protection Manual**

Prepared for the
**Riverland Animal and Plant Control Board**

by

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# Contents

# 01


*The Riverland within the Murray Darling Basin*


*Lake Bonney in the Riverland*

This manual is designed for use by park rangers and open space managers in state and local government agencies, by local community groups involved in environmental rehabilitation and conservation, and by local landowners.

The manual can be used as an overall set of guidelines, or it can be used as a reference for individual items of practical advice, such as information on barrier fencing or habitat rehabilitation.

Throughout the manual the term turtle is used. This has become the accepted terminology for what was previously commonly known as the freshwater tortoise of the River Murray. The term tortoise is now reserved for land-dwelling species. It seems a paradox that Australia, one of the driest continents, has aquatic turtles only, and no tortoises.

**Aims**

The aims of this manual are to:

- Provide a set of guidelines and a standard for the protection of turtle nesting habitats
- Encourage greater survival rates for hatchlings to reach the water (river, lagoon, billabong) through establishment of safe nesting habitats from land-based predators
- Increase the number of juveniles to assist with redressing the imbalance of the population profile
- Use turtles as an indicator of the health of the ecosystem, including river and floodplain

**Setting the Scene - Location**

The area of study covered by this manual is the River Murray in the Riverland region of South Australia. This includes the lake system of Lake Bonney and associated lagoons and billabongs that make up the River Murray waterway.

Since the weirs in the Lower Murray region were built between 1922 and 1937 water bodies such as lagoons, and lakes including Lake Bonney, have been subjected to a permanent water level instead of the seasonal fluctuation ranging from floods to dryness. The now common sight of the beautifully sculptural trunks of drowned River Red Gums is a stark reminder of this newly imposed static water level.

# Using this Manual

*Permanently flooded trees at Lake Bonney*

*Unrestricted camping at Lake Bonney*

This permanent water level has changed the habitats along the river's edge and also the aquatic ecosystems within the river and associated lagoons and lakes, thus affecting species such as turtles (Walker 2001).

The three species of turtle found in this section of the river are:
- *Chelodina expansa* (Broad-shelled Snake-necked Turtle)
- *Chelodina longicollis* (Eastern Snake-necked or Long-necked Turtle)
- *Emydura macquarii* (Murray Short-necked Turtle)

The River Murray turtles are species that can be used as indicators of the changing health of the ecosystem, including the river and the floodplain. Evidence of turtle health or population profile problems points to wider issues that may be affecting many other species of flora and fauna, and interrupting the delicate ecological balance between all the components of the River Murray system.

**Lower Murray Situation - Issues**

The three species of turtle are not currently endangered in the River Murray itself, but are at risk in areas such as the associated lakes and lagoons that have become unnaturally permanent water bodies. For instance, turtle population surveys have shown that in Lake Bonney there are very few juveniles within the ageing population (Thompson 1983). These statistics indicate that a population crash could occur in the future, with very little chance of recovery.

This critical situation can be difficult to recognise, as the presence of ageing or mature turtles can give a false sense that the particular species is common. However these adults will all die within a relatively short space of time, and with no replacements coming on the population could crash.

The population profile is unbalanced due to a complex array of reasons, put simply:
- Predation in the nesting habitat, mainly by foxes
- Habitat loss by human activities, such as vehicle damage and camping
- Excessive salt levels and high turbidity in lakes and lagoons, causing loss of habitat and food sources

The broad-shelled turtle is rare in the Lower River Murray, especially in lakes and lagoons. Recent work has shown that isolated communities do occur in parts of the Riverland and seem to be surviving well. The long term viability of this species is a concern, as it is not distributed throughout the region, and predation is occurring in the breeding and nesting habitat in the isolated communities.

# 02

**Three Species**

In the Lower Murray River three species of turtle occur:

- *Chelodina expansa* (Broad-shelled Snake-necked Turtle)
- *Chelodina longicollis* (Eastern Snake-necked or Long-necked Turtle)
- *Emydura macquarii* (Murray Short-necked Turtle)

Anecdotal evidence suggests that the broad-shelled turtle only appeared in the Lower Murray after the major flood of 1956. This observation from a number of independent sources suggests that the broad-shelled turtle was washed down from Victoria and established itself in small numbers. This would account for its current relative scarcity in the region.

Female turtles need to build up their fat reserves before breeding, so flooding can assist in providing ample food, however flooding can also destroy eggs in their burrows. The hard-shelled, oblong shaped eggs are laid in a shallow burrow near water. Eggs are usually laid during or after rain, when soil is softer for digging. Once the eggs are laid the burrow is immediately covered with mud.

The high mortality of eggs and young is mostly attributable to foxes. Young turtles are also vulnerable to predatory fish and birds, so a plentiful food supply allows them to grow quickly to a size where they are safe from most predators. Turtles generally live for about 20 years, but can survive for 50 to 70 years.

The three species have some particular breeding characteristics, and the diet of each species reflects their habitat preferences and physical differences. The three species are described briefly.

*National Photographic Index of Australian Wildlife: Reptiles*

**Broad-shelled Snake-necked Turtle**

*Chelodina expansa* (kee'-loh-dee'-nah ex-pan'-sah: broad little tortoise). Commonly called the broad-shelled turtle.

This is the largest of the three species and also the largest long-necked turtle in the genus *Chelodina*, with its carapace length up to 48 cm. It has the longest neck, with juveniles having head and neck a little longer than the shell, and in adults these total about 83% of the shell's length.

The broad-shelled turtle is a selective and specialised predator. Juveniles and adults hide in the mud of river channels or dense mats of submerged or floating vegetation to strike at passing fish, yabbies and other aquatic animals and insects. Large adults may submerge almost completely in muddy sediment, with their nostrils reaching the surface to breathe.

The female lays two clutches of eggs in autumn, with the eggs hatching in spring. At least in Victoria, females lay 9 to 17 hard-shelled eggs between mid-March and mid-May. Nests are made in almost any type of soil. Some females even puddle their eggs into a mud formed in the nest chamber from a mixture of soil and cloacal fluid. The chamber is capped with moistened soil and the hatchlings emerge up to 325 days later.

# Turtle Biology

*National Photographic Index of Australian Wildlife: Reptiles*

**Eastern Snake-necked or Long-necked Turtle**
*Chelodina longicollis (kee'-loh-dee'-nah lon'-jee-kol'-is: long-necked little tortoise).* Commonly called the long-necked turtle.

This species, also belonging to the genus *Chelodina*, has scent glands that secrete an unpleasant smell to protect it from predators. The carapace measures up to 25 cm long and it is distinguishable by the black seams of the belly plates.

The long-necked turtle is omnivorous, able to catch fish and yabbies at close quarters, but not large or quick enough to catch them in faster flowing rivers. It is better suited to billabongs and ephemeral water bodies where invertebrates are more available. It creeps slowly over the bottom and near the shallow edges, and when an aquatic insect, shrimp-like crustacean, fish, tadpole or frog is seen, it approaches with the neck held sideways near the shell, then thrusts its opening mouth at the prey to grasp it. If the prey is larger than can be swallowed, the front claws are used to shred and dismember it; the same technique is used on carrion, including the remains of carp.

In the latter half of summer (particularly after rain), individuals may make long overland treks in search of water bodies, and will quickly colonise new artificial pondages. In drought conditions, individuals bury themselves under litter or loose soil, or in the mud at the lowest point of a billabong or dam.

The female usually nests on a rainy or overcast day in spring or summer, with 8 to 24 hard-shelled eggs carefully laid and positioned in the soil nesting chamber. The soil is then pulled over the eggs with the hind feet and tamped down by frequent raising and dropping of the rear part of the body. A female may nest up to three times in one season. After 105 to 150 days the hatchlings emerge, usually following or during rain that softens the nest plug. The young wait for darkness before leaving the nest for water.

*National Photographic Index of Australian Wildlife: Reptiles*

**Murray Short-necked Turtle**
*Emydura macquarii* (em'-ee-due'-rah mak-wo'-ree-ee: Macquarie tailed-tortoise). Commonly called the short-necked turtle.

The combined head and neck length of species of the *Emydura* genus is less than that of the carapace. The carapace measures up to 30 cm in length. The musk odours of these turtles are not offensive to humans.

The under-surface of the short-necked turtle is bone coloured or very pale yellow, and there is no indication of an upper head stripe extending backward from the eye in adults, although some juveniles may have this stripe. Juveniles and adults may bask on emergent logs or weedy banks and adults bask in the warmer surface layer of still, deeper water.

The short-necked turtle is an omnivorous scavenger and grazer, with a powerful jaw for tearing up plant and animal foods including vertebrate carrion. The diet includes crustaceans, molluscs, fishes, tadpoles and aquatic vegetation. Adults may have up to 95% vegetation in their stomach contents.

Females nest from late October to late December after moderately heavy rain, usually on overcast or rainy warm evenings. From 13 to 25 eggs are laid per clutch and up to three clutches are laid in a season. Eggs take from 66 to 85 days to hatch and emergence occurs in the first half of February.

# 03

The three species co-exist and share elements of a common habitat, but each species has developed its own particular requirements for their habitat. These general habitat requirements are summarised below, followed by nesting habitats and issues relating to changing habitats.

**Broad-shelled Turtle**
Broad-shelled turtles hide in the muddy sediments of river channels and dense mats of submerged or floating vegetation to strike at passing fish and fast-swimming aquatic insects. Thus their preferred habitat is permanent water such as rivers or deep water lakes, with an abundance of snags to provide cover for capturing their prey.

**Long-necked Turtle**
Long-necked turtles are best suited to shallow lakes, the highly productive flood plain billabongs, and ephemeral water bodies with invertebrate populations. They have the ability to move over land to find water. The decrease of flood frequency has reduced the availability of the floodplain habitat, as has the agricultural use of the floodplain.

**Murray Short-necked Turtle**
Short-necked turtles, like the broad-shelled, are dependent on permanent and stable water levels. They are omnivorous scavengers and grazers, and feed off aquatic plants and vertebrate carrion. They are able to scrape periphyton from submerged logs. This tells us that their preferred general habitat is permanent, relatively calm water with a good supply of underwater snags.

*Predated nest under samphire bush*

**Nesting Habitats**
Female turtles prefer to deposit their eggs above high water level, however nesting habitats have a range of variables including: distance from water, proximity to the next nest, closeness to trees, and the soil type. These variables have been observed at many sites and are generalised as:

- Nests that are close to the shoreline and close to trees are usually heavily preyed upon
- Nests constructed in sand are less likely to be destroyed by predators
- Nests constructed in sandy substrates have a reduced clutch success rate compared to clutches incubated in more dense substrates

It has been observed that when predators such as foxes are removed female turtles alter their behaviour and construct nests away from the water. The nests become less dense and are further away from trees. So the ideal nesting habitat should be above high water mark, in an area of no trees, that is in shrubland, with sandy soil but a with a denser substrate.

Observations of nest sites in the Lake Bonney area reveal a preference to locate nests at the base of the grey samphire *Arthrocnemum halocnemoides*. A possible connection could be related to shading and softness of soil, and possibly the root structure and soil profile associated with this particular plant. It is possible for the grey samphire to have a deep root system that taps into the ground water table, which provides extra leaf growth that shades the soil, thus being more friable to dig into for nesting. The grey samphire is located in a particular zone on the low dune, indicating a preference for that micro climatic condition. More research is needed to explain this relationship so that other degraded habitat sites in the Lower Murray can be revegetated in such a way that turtles are given more opportunity for successful nesting.

# Turtle Habitats

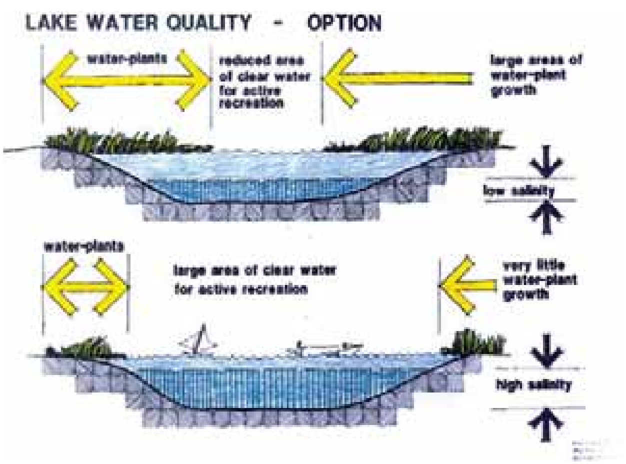
**Habitat Changes**

As described earlier, the short-necked and broad-shelled turtles are quite dependent on permanent and stable water levels, but the long-necked turtle is more tolerant of changing water conditions. It can semi-hibernate, and move out onto the floodplains to find water. The decrease in flood frequency due to river regulation, and the increased agricultural development of the floodplain has decreased the floodplain habitat available. The compaction of floodplain soils by stock makes it more difficult for all these turtle species to bury their eggs, and increases the risk of egg predation.

Increased turbidity, and removal of snags from rivers changes the habitat that turtles depend on for hunting and hiding from predators. Turtles are relatively weak swimmers, so need snags for support in swift-flowing currents. In contrast, construction of farm dams has probably provided additional habitat for the long-necked turtle.

Changing salt levels and turbidity in the river, and especially in the lakes and wetlands, has a major effect on aquatic plant growth. An increase in salinity and turbidity in the water reduces the aquatic plant populations, thus reducing the food source of the short-necked turtle and the habitat cover for all turtles. The turtle population can be used as an indicator of the salinity of the water, especially with the short-necked turtle being omnivorous.

The marked increase of salt levels in the ground water due to past farming practices has a direct relationship to the existing endemic vegetation. The higher salinity of ground water, the less vegetation cover in the nesting grounds, and the higher the soil temperatures as a result of the reduced vegetation. This increased soil temperature affects the incubation time of turtle eggs.




*Effect of salinity on recreational options and access to nesting sites*

**Water/Land Interface – Issues**

With the introduction of the lock system in the River Murray, the Lower Murray has become a series of ponds. These ponds have relatively stable water levels, thus the annual rise and fall of the river and lake levels does not occur, except in major flood events. This has affected the vegetation at the water and land interface.

Lakes such as Lake Bonney that were once ephemeral are now permanent water bodies. This changes the interface ecosystem, where aquatic and emerging plants grow continuously in a permanent zone instead of seasonally progressing and retreating up and down the bank in a transitional zone. This permanent vegetation zone is becoming a barrier to the movement of turtles from water to land. This zone is also an indicator of the health of the ecosystem, including the river or lakes, with the type of vegetation growing reflecting the water quality.

At Lake Bonney a dense growth of water couch *Cynodon dactylon*, an alien species to this area, forms a physical barrier of up to 300 mm high. It has been observed that turtle nests are located opposite the water edge where it is a gentle slope, more like a beach. In other areas where wave erosion and water couch causes a physical barrier, no turtle nests are found, presumably because the barrier is too hard to negotiate. Wave action can form a small vertical cliff edge of 300 to 600 mm high, impeding turtle movement onto land.

*Water couch restricting turtle access at Lake Bonney*

The natural habitat of the turtle and its predators is restricted into a relatively permanent zone due to the stable water level, and this provides predators with a concentrated population of laying turtles, eggs and hatchlings to prey upon.

**Background Studies**
A scientific study of turtles along the River Murray in South Australia, including at Lake Bonney, showed that 96% of eggs were predated in the nest, with only 3% of this total by endemic predators and the remaining 93% by foxes (Thompson 1983). This means that only 4% of eggs laid survive to the stage of juvenile turtles.

It is suggested that at Lake Hume on the River Murray the predation rate by foxes is 93%, with a small proportion of nesting adult females also being killed (Spencer 2001). Adult shells with unlaid eggs inside have been found and photographed recently at Gurra Gurra lagoon, possibly supporting this suggestion of females being predated while in the process of laying their eggs.

*Shell of female turtle with unhatched egg at Gurra Gurra*

The fox is the major predator, as identified by Thompson and Spencer. There appears to be an intense fox population in the Lower Murray area, given the ample food supply, such as rabbits and horticultural produce including grapes from nearby vineyards. Foxes are mobile animals and can travel considerable distances during the night. Exceptional movements of over 300 kilometres have been recorded in North America and 100 kilometres in Europe (Saunders et al 1995). Mean dispersal distances are much smaller than this, ranging from 2.8 to 43.5 kilometres for males and 1.8 to 38.6 kilometres for females (Saunders et al).

In Australia, in central Victoria, a mean dispersal distance of 11 kilometres, based on a study of 13 dispersing animals, has been documented (Saunders et al). With this sort of movement baiting can only remove residential foxes, with new ones moving into the area quickly to replace the baited animals.

Other significant studies on Lower Murray turtles include those of Chessman, particularly on diet and distribution, and Thompson's work related to the physiology of egg incubation.

**Site Observations**
Riverland Animal and Plant Control Board officer Phil Reddy has conducted experiments in fox baiting near Lake Bonney, with a good success rate. Three to four months after baiting he observed the first hatchlings that anyone has seen since the mid 1980s reaching the lake from their sand nests. Reddy noted that nesting takes place in spring, particularly after rain, and observed that hatching of juveniles occurs after rain and close to a full moon. Significantly he has also noted that once the breeding cycle of foxes is broken through baiting the next generation do not automatically know how to find the eggs. His observation is that they need to be shown by older adults or to learn by chance.

As mentioned, water couch *Cynodon dactylon* has formed a barrier at Lake Bonney by growing out over the water in a healthy dense sward. This is an alien species to this site so some management options should be tried. For instance it could be mowed, whipper-snipped or sprayed with herbicide (such as Roundup) prior to the nesting and hatching season, to reduce the physical barrier and widen the potential breeding site. Even the construction of low, wide timber ramps over the water couch might provide easier access for the turtles.

# Turtle Predation

The removal of the vegetation barrier would allow easier and quicker movement for the young hatchlings to reach the water. This would reduce the time they are exposed to bird predation. It has been observed in a nearby nesting site to the Lake Bonney site that after fox removal there was an increase of bird predation because of the greater number of hatchlings surviving.

**Human Disturbance**

There are a number of factors affecting turtle habitats, and therefore habitat protection requires a multi-faceted approach.

At Lake Bonney the level of salt in the lake directly affects its function and potential usage. The higher the salt level, the less the aquatic plant life such as ribbon weed for the turtles to feed on. On the other hand the reduced aquatic vegetation provides for greater recreation usage for boating, skiing and so on, but also creates a dangerous environment for the turtles' habitat.

The vegetation on the flat flood plains around Lake Bonney was completely destroyed and removed during the mid nineties by an activity common in inland rural communities, land surfing on an old car bonnet. A bonnet is towed behind a 4WD vehicle and driven in large circles through the low saltbush and samphire vegetation. This flattens the plants and cover to the breeding area. The Berri Barmera Council constructed barriers to stop this activity because it was a danger to the nearby nudist beach. Subsequently however unauthorised people removed the barriers, and people continue to access the area for fishing and sightseeing.

*Vehicle damage to fragile soils*

*Unrestricted vehicle access at Lake Bonney*

Where protected from vehicle access the vegetation recovers and grows back to a density more appropriate for turtle habitat. Other human activities that damage habitat include regular pedestrian movement along the water's edge and associated dog activity that disturbs the habitat.

In summary, the three species of turtle are not endangered in the total River Murray Basin but are at risk on the Lower Murray local level, such as at Lake Bonney and other traditional nesting sites disturbed by human activities and heavily predated by foxes.

*Plastic netting useful in water, but at risk of foxes chewing through*

*Floppy top fence to prevent foxes or cats climbing. Wire apron 600mm wide at base of fence prevents rabbits and foxes digging*

*This gap would allow a fox to push through*

**Need for a System**

Fox baiting has been shown to be effective in the short term. A more long term solution than seasonal baiting is to construct a physical barrier or fence to exclude foxes, while allowing turtles to move in and out of the area. Natural barriers such as water are relatively effective barriers to foxes but not a complete answer, as foxes do swim and wade in shallow lagoon environments. Foxes are opportunist feeders and would need a ready food source to tempt them into swimming for their food. However, foxes have been observed to cross water bodies, and fox scats containing grape seeds have been found in areas where the only vineyards were on the opposite side of a water body.

**Fencing**

A review of the effectiveness of exclusion fences for foxes (Coman & McCutchan 1994) concluded that most of these fences provided a barrier to foxes, but not a complete barrier. It was suggested that a successful barrier requires good fence maintenance and frequent monitoring for the presence of foxes. The review also concluded that exclusion fencing remains an important tool in the management of threatened or endangered species. Keeping foxes out is 'difficult due to the agility of the animal…foxes can scale electrified fences' (Saunders et al 1995).

The fox has the ability to squeeze through small holes and gaps. If it can get its head through a gap it can probably get the rest of its body through. In the UK a young fox was observed squeezing through a 70mm gap between a gate and its post (Long & Robley 2004).

The type of netting material used is important as foxes have powerful jaw muscles that allow them to chew through plastic mesh or polythene twine to create holes large enough to squeeze through (Long & Robley). The netting must therefore be made from a robust material such as galvanised metal netting.

There is a large range of exclusion (fox proof) fences and levels of effectiveness of these fences, starting with the simple wire-netting fence that is rarely effective, regardless of height. Fences that incorporate a roof or overhang are more effective. Successful high netting fences with unstrained overhanging tops, such as at Warrawong Earth Sanctuary in the Adelaide Hills, prevent foxes climbing over the floppy top part of the fence.

# Barrier Systems

It has been observed that most animals that encounter a fence will first attempt to push under or through it. As a result the lower part of the fence needs to be built in a thorough manner, especially at corners (less than 120°) where foxes are able to brace themselves, or jump from one panel to another.

The temptation for animals, especially foxes, to dig under fences can be combated by providing a wire netting apron as part of the fence structure. It has been shown by research in New Zealand that most digging occurs in the first 200 to 400mm and only 1.5% occurs further than 400mm out from the fence. Horizontal aprons have been shown to be more effective than vertically buried wire netting barriers directly under the fence.

Access gates are an integral part of the fencing system and the same design principles as for the exclusion fence should apply. The size of any gaps in, below or between the gates must be no larger than the netting size in the fence. One common failure is wheel ruts under the gate. All gates must have a solid plinth directly under the gate and a wire apron to prevent digging.

Electrified fences are effective if they are designed correctly with particular attention to the height of the electric wire and use of outriggers to deter the fox from using the electric shock to catapult over the fence. A popular solution is the combination of netting and electrified wires, which can be useful, but again the position of the electrified wires is critical.

The down side of fencing an area is the effect it has on the overall ecology of the enclosed area, as 'fences can interfere with the movement of non-target animals' (Saunders et al).

**Existing Systems**

There is a variety of existing fencing systems designed to protect native species from predation by foxes and cats. The following is a small sample, not necessarily totally related to turtle protection.

**Example 1: Venus Bay Conservation Park**

This fence extends for 2 km across the neck of Weyland Peninsula at Venus Bay, south of Streaky Bay on Eyre Peninsula. National Parks and Wildlife Service installed the fence to protect the bettongs and bilbies that have been reintroduced to the park. It is constructed with pine posts and galvanised steel wire, with plastic mesh extending into the bay. It is 2.5m high, with two electric wires parallel to each other at 1.75m, and is solar powered. There is a wire apron on both sides to prevent rabbits digging under and a floppy overhang on top about 60cm long. The plastic section extends about 50m into the bay, with a tee section to discourage foxes at low tide.

There is ongoing baiting outside the fence as a buffer to cats and foxes. Salt spray at the cliff end requires the galvanised mesh to be replaced every 3 to 5 years. The fence is constantly monitored and has been very successful in keeping cats and foxes out.

This fencing system would be relatively expensive to install and maintain.

**Example 2: Arid Recovery Project at Roxby Downs**

This fence is 1.8m high, with a 60cm floppy top and 30cm foot netting. The droppers are around 6m apart, depending on the substrate being fenced over, ie droppers are closer together over dunes and widely spaced on rocky swales. The main posts are 100m apart, and are metal. Wooden posts are not used as cats use them to climb. There are 7 support wires in the fence, all 30cm apart, the first one being on the ground. The mesh for the bottom half of the fence and foot netting is 30mm diameter holes of 1.4mm gauge wire. The mesh is 120cm high with the lower 30cm buried in a shallow depression (a depression was graded, then the foot netting put on and graded dirt laid back over the top of it).

Over the dunes problems were experienced with the sand blowing off and exposing the foot netting and allowing things to get under it, so heavy black rubber matting was laid over the netting on dunes (conveyer belt salvaged from the mine). The top half of the fence has mesh of dimensions 50mm diameter holes of 1.6mm gauge wire, with a total width of 150cm, with 90cm vertical, then the upper 60cm extending out as a floppy top. This is held up by 1m lengths of 4mm high tensile spring steel, which holds it in place but allows it to flop if a cat climbs on it, so it can't get a foothold to spring off. There are 2 electric wires, 30cm apart, level with the 5th and 6th wires, at 120cm and 150cm. Electric wires are less than 8cm from the fence to prevent cats from squeezing between the fence and wires.

This fence is relatively moderate in cost because of the total length being far greater than one for turtle protection would be. This fence is costed at about $1,350 per metre, including the cost of electrifying wires at about $350 per metre.

**Example 3: Yookamurra Earth Sanctuary**

This fence surrounds a wildlife sanctuary established in a remnant mallee environment in the Riverland region. This is a very substantial fencing system with a heavy reliance on electrified wire fencing. The fence has foot netting which continues up to about 1.2m high. Above this are single electrified wires about 100mm apart. There are outrigger electric wires at the base of the fence as well as the top of the wire netting. This fence uses steel and concrete posts to prevent cats from using them for climbing.

This would be a relatively expensive fencing system and requires constant monitoring and regular maintenance.

More detailed information on fence design is available online in the National Heritage Trust publication prepared by Long and Robley (refer to references at end of this manual).

# 06


Seed germinating through wire apron


Fencing into water to form a V section


Proprietary strainer box assembly

**What is it?**
The biofence system is protective habitat fencing that combines biological control measures with standard mesh fencing materials. The system does not require electricity, but uses endemic plants as part of the fencing system.

**Development**
In 2001 the Lake Bonney Recreation Study identified the issue of a turtle nesting site at Pelican Point on Lake Bonney and the unsustainable predation by foxes at this location. Over the next couple of years Fifth Creek Studio continued research and development of protective fencing for this turtle habitat site, in collaboration with the Riverland Animal and Plant Control Board, and with some financial assistance for the eventual design from The Berri Barmera Council.

The fence needed to be built on flood prone land (within the 1956 flood level) so the fencing system would need to withstand occasional inundation. This ruled out the use of electric fencing.

Research included the various fencing styles used successfully by Earth Sanctuaries, Roxby Downs and National Parks and Wildlife Service. Observation of fox behaviour was also instrumental in developing an effective fencing system. For instance it has been found that loose netting on the top section of fencing discourages foxes from climbing by not allowing a secure foothold. It has also been observed that foxes avoid walking across country with prickly burrs or thorns, rather choosing to walk in the cleared tracks of vehicles.

The research was finally consolidated into the design of a fencing system that uses endemic thorny plants at the base of the fence to create a barrier against foxes attempting to jump onto the wire. Jumping from further away from the fence, before they tread onto the prickles means a fox would land lower down on the fence and be less able to scramble to the top. Floppy wire mesh at the top of the fence creates further instability for a fox to climb over. At the base of the fence the wire mesh is extended 600mm out along the ground and pegged down. This discourages foxes and rabbits from digging under the fence. Thorny plants planted into this wire mesh extension are an added discouragement to digging.

Two experimental sites have been established; one on Crown Land at Pelican Point on Lake Bonney, and the other at Gurra Gurra lagoon on private land.

**Case Study 1: Lake Bonney**
*Location:* South of Pelican Point, a section of lake edge including a low dunal system within the 100 year flood level.

**Project Overview**
This was a known nesting site that has high fox predation levels and damage from human activities. A section of lake edge and flood plain was fenced off, an area of 300m long x 100m wide.

The fence was extended 20m into the lake and 20m back to shore to form a V. This was to confuse the foxes from swimming around the end of the fence.

**Regulations**
As the fence was located on the flood plain (within the 100 year level) this structure could be deemed to be development, under Section Three of the Development Regulations 1993:
- A fence exceeding two metres in height in a flood plain or zone; and
- A chain mesh fence in a flood zone and flood plain.

If the fence does not exceed two metres and is not a chain mesh fence then it is considered not to be development under the Development Act 1993 and does not require Council approval.

As this fence was located on Crown Land advice had to be sought from the Department of Environment and Heritage in its relationship to Native Title. It was sought and approval was granted to proceed.

**Construction**
The fence was constructed from 2.7m x 200mm diameter treated pine posts at 50m intervals with strainer box assemblies at change of directions. The posts were 1550mm out of the ground plus a vertical 450mm height floppy netting, giving a 2m height, which is within the Council regulations for no formal approval.

The strainer box assembly was replaced with a proprietary strainer assembly that was suitable for sandy conditions.

Two widths of rabbit proof netting were used. The first was an 1800mm wide roll that had a 600mm apron pinned to the ground on the outside of the fence and the remainder clipped to strained

# Biofence System

*Planting band at base of fence*

*Gate threshold with buried treated pine log*

*Fence at Gurra Gurra*

wires at 300mm centres. The second roll was 900mm, with the top 600mm forming the floppy top. This floppy wire was supported on spring steel at 50m centres.

A band of planting was seeded around the perimeter of the enclosed area extending out to 1500mm from the wire fence. The species chosen was Pale Poverty Bush *Bassia divaricata.*

An access gate was constructed as part of the fencing. This was a 3m wide gate taking the configuration of the fence construction. The threshold had a treated pine half log buried to stop any excavation under the gate.

**Documentation**
Plan FCS-60-1B provides design detail and siting of the Lake Bonney fence.

**Case Study 2: Gurra Gurra Lagoon**
*Location:* A long thin peninsula jutting out into a lagoon on private farm land.

**Project Overview**
This site showed evidence of nesting and heavy predation of nests and female mature turtles. The site was also heavily over-grazed by cattle during the drought and dry summer, causing concentrated soil compaction and nests being destroyed.

A narrow section of the peninsula was fenced off with one end built into the water in a V shape. The other end was connected to an existing fence in the lagoon.

**Regulations**
As the fence was below 2 metres high and not a chain mesh fence no approvals were required. Also the fence is located on private land therefore Native Title did not apply.

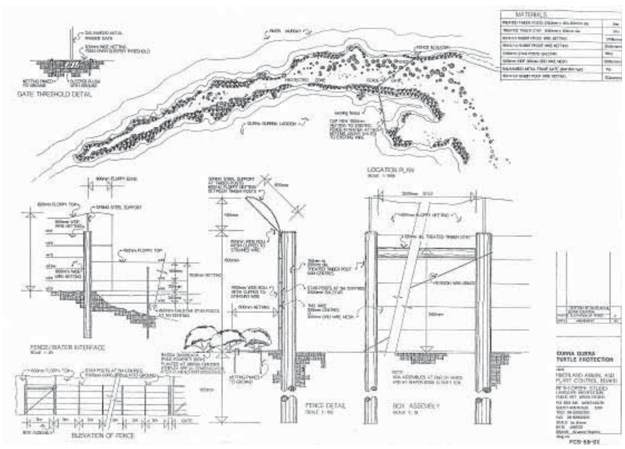
**Construction**
Treated timber posts 2.7m x 200mm diameter were spaced at 50m intervals. A galvanised steel gate was included for access and possible cattle grazing as a management tool in the future. The gate threshold was 600mm wide netting fixed over a hardwood sleeper placed under the gate. This fence was further developed and refined for the Pelican Point fencing at Lake Bonney.

The Gurra Gurra fence is 1950mm high, including 600mm at an angle floppy top, and has 600mm foot netting. Timber main posts are at 50m centres and droppers are at 5m centres. There are six main wires 300mm apart as designed, but were replaced by cattle hinge wire, which made it easier to attach the netting. The bottom half of the fence mesh is 180/4/1.4 rabbit proof wire netting.

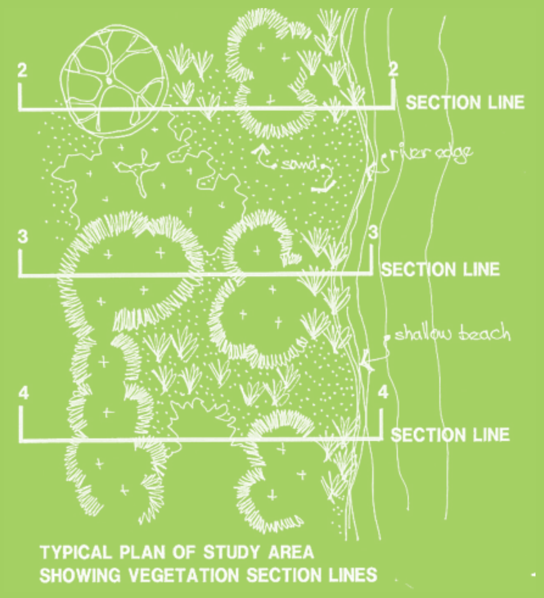
The 600mm wide foot netting is enough to discourage foxes and rabbits from burrowing under the fence. Within a one metre width zone at the base of the fence, and including the 600mm wide footing netting, a vegetation barrier was planted.

This barrier along the fence base was more diverse than at Lake Bonney. Pale Poverty Bush *Bassia divaricata* and the Bladder saltbush *Atriplex vesicaria* communities were planted. The mixing of suitable plant species, rather than a monoculture, provides a greater chance of survival from insect or pest attack.

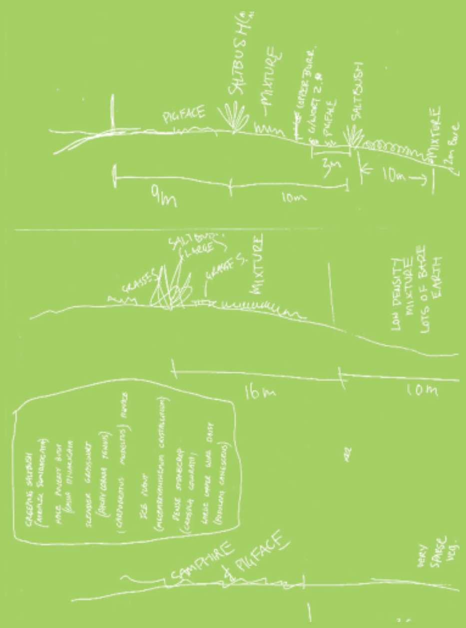
**Documentation**
Plan FCS-59-01 provides design detail and siting for the Gurra Gurra fence.



# 07




*Example of vegetation section lines*




*Example of field notes for vegetation survey*


*Example of typical site level method*

Most sites along the river have had some disturbance or alteration to the original natural ecosystem. Therefore some form of restoration and rehabilitation is required, but only the appropriate endemic vegetation mix should be planted. Fencing off nesting sites or potential sites from stock and vehicles is often a simple method for regeneration to occur.

**Vegetation Survey Methods**

Any nesting site or potential site should have a vegetation survey, with data on all species collected and noted. If species are not known then samples should be taken so that they can be professionally identified.

There are a number of methods used by professionals, but a simple method that any community group or individual can do is the cross section method.

The cross section method is a series of vertical cut lines through the land starting at the water's edge and extending inland at right angles to the water body. This is simply achieved by setting out a string line or tape along these cross section lines. There should be a series of these cross sections, at about 10 metre intervals. A record should be kept of all plants that occur on the cross sections and at what distance from the water's edge.

Illustrated here is an example of field notes taken at the Lake Bonney site. A grid of 10m was used and the cross sections can be identified as markers (2$^{nd}$ marker, 4$^{th}$ marker, etc.). Plants are identified and measured from the water's edge. This information was transferred onto a plan and bands of species were observed.

# Habitat Restoration

In addition to the species record, taking levels of each cross section can be useful. These levels can indicate certain species growing at different locations in the topography as well as showing where nesting burrows are located relative to the water and high water mark.

At the Lake Bonney site detailed levels were taken along each of the vegetation survey cross sections and these were plotted onto the vegetation plan. This showed that certain species only grew at certain levels on the low sand dune. This suggested that soil type, moisture, fertility or salinity affected the growth of different species, and may explain why turtles select one plant species to nest under.

**Vegetation Communities**

The indigenous vegetation formation that would be expected at turtle nesting sites varies from low shrubland, to the river swamp community. These plant communities are usually highly modified by human interaction, either by grazing, clearing, or by vehicle and pedestrian movement pressure.

- Low shrubland – *Atriplex vesicaria* – *Kochia sedifolic* communities
- River swamp vegetation – *Eucalyptus camaldulensis*, *E. largiflorens*, *Muehlenbeckia florulenta* (formerly *M. cunninghamii*) communities

The predominant plant community in nesting sites encountered so far in our research is the low shrubland formation with saltbush-bluebush communities, with shrubs up to 2 metres high. The plants are well-spaced with a foliage cover of 10-30%. Dwarf shrubs such as Copperburr *Bassia* spp. are commonly associated with these shrubs. After rain ephemeral plants and grasses germinate, flourish and seed.

Through field observations nesting does occur in the river swamp vegetation zone but is not the favoured site because of the potential predation threat by birds, water rats and goannas in this habitat. The River Red Gum *E. camaldulensis* and Lignum *M. florulenta* occur along the river's edge, whereas *E. largiflorens* occurs along higher ground usually at the limit of the flood levels, with some nesting occurring at this bank height. If foxes are present evidence has shown that turtles will choose to nest in the riverine strip to lessen the time spent out of the water at risk of predation (Spencer).

**Planting Techniques**

There are two planting techniques that can be applied to the revegetation of nesting sites. They are: spot planting, and direct seeding. These sites are often affected by rising salinity in the ground water so endemic species should be used, as well as salt tolerant sub-species that have been cultivated or have evolved naturally. Seed collected from the site should be propagated and grown in tube containers for planting out when required.

**Spot planting**

This is the process of planting individual container plants. The only practical sized container plants to use are tubestock. This small size gives the plant a greater chance of survival and to develop into a strong specimen. It is also cheaper to purchase than larger pot sizes.

**Direct seeding**

There are two main methods of direct seeding, with some variation within these methods:

**1. Mechanical device**

a) By plough that directs seed into plough furrow and is covered in one operation. The problem with this method is that it introduces a rigid row of planting into a natural sparse spread and mix of species.

b) By hydroseeding, with or without blown mulch cover. This has the advantage of seed being deposited in a more natural layout.

**2. By hand**

a) By hand broadcast.

b) By coating the seed with mulch, forming a ball of mulch and then hand or machine broadcasting. This method allows the balls containing the seeds to roll into natural depressions that would help germination because of the extra moisture collected in these depressions.

**Erosional Control**

The Riverland nesting sites that have been observed so far show signs of both wind and water erosion.

**Wind Erosion**

With the vegetation providing only sparse cover a considerable proportion of soil surface is exposed to erosional forces. This is exacerbated by human or animal movement over this unprotected surface, and by rabbit infestations loosening the surface so that wind can carry the topsoil away. Revegetation can increase the cover and protection of the soil surface.

**Water Erosion**

As the water level is relatively stable this has encouraged the occurrence of eroded edges caused by wave action. This can be overcome by vegetation planted along the edge to absorb the wave energy.

# 08

*Identifying and observing turtle habitat*

**How to Establish a Project**

As each community and each location has its own character and particular strengths and differences each turtle habitat protection project needs to be tailored to suit the particular circumstances. However there are some general common steps to be followed:

- Locate a turtle nesting site that is under threat or a site that is degraded
- Carry out observations of site for current or past nesting and predation
- Form a small working group
- Develop a history of observations
- Develop an audit of physical features such as landform, soil structure and vegetation types and densities
- Contact local organisations for assistance, such as the Local Action Planning Group and the Animal and Plant Control Board
- Call a meeting of like-minded people or a general public meeting to form a committee to steer the project
- Contact research organisations such as universities and their environmental biology departments for the latest information and possible student research
- Meet with local authorities to research the relevant regulations, and canvas possible assistance as in-kind support and relevant grants

# Community Projects

**Professionals and Services Needed**
Once initial site observations have been completed the project may be developed using community expertise or professional services for gathering and interpreting information. These services may be donated or paid for by grants. Professional services may be needed for the following tasks:

| | |
|---|---|
| • Vegetation survey | A B C |
| • Contour plan | A D |
| • Control of nest site predators | B C |
| • Barrier system design | A |
| • Revegetation plan | A B C |
| • Interpretive signage | A |
| • Coordinate barrier system construction | A B |

A - Landscape Architect
B - Animal & Plant Control Board
C - Ecologist/Botanist
D - Surveyor

**Agencies and Grant Opportunities**
It is important to involve government agencies right from the beginning of a project, so that any potential problems can be identified before they arise. Collaboration between the community and government will result in greater success for the project. Government agencies can support community initiated projects through grants, sponsorships or in-kind support. This manual cannot provide detailed advice on relevant agencies or specific grants, so it would be advisable to contact your local LAP officer as a first point of call. You could also contact the agencies listed below or search for relevant information on the Internet for further assistance.

Relevant agencies include:
- Local Council
- Regional Animal and Plant Control Board
- River Murray Catchment Water Management Board
- LAP Committee

In general, potential opportunities for grants to assist with turtle habitat protection include:
- Revegetation programs
- Animal and pest control programs
- Protection of endangered species
- LAP water quality projects

**Monitoring of Fence Effectiveness**
Once a protective fence has been installed it needs to be continually monitored to ensure that it is working effectively and that foxes are not getting inside. A plan for ongoing monitoring should be established during the project planning stage. A baiting program should be developed inside the fence as a safe measure and control station, and monitored by an Animal and Plant Control Board officer. Any necessary repairs to the fence should be conducted on a regular basis, and potential for upgrading or improving the fence design should be noted for future projects.

Community or educational groups such as schools can undertake monitoring of the fence and the breeding program. There may be potential for a university research project to work with the community in monitoring the site and effectiveness of the barrier. Detailed information is available to assist in the monitoring of habitats and biological sites, such as the online National Technical Manual by Waterwatch Australia (refer to references at end of this manual).

**Monitoring of Hatchling Survival Rate**
Monitoring the survival rate of hatchlings is vital to assessing the effectiveness of the protection system in place. There may be other predators such as birds of prey and crows, whose impact on hatchlings will be unaffected by a fence, so protection from foxes is critical. Observing and recording the number of hatchlings that survive to reach the water will provide some indication of the population numbers.

Hatchling monitoring could be incorporated by local schools into their environmental programs, or could possibly be included in a university research project. For instance, the effectiveness of the Lake Bonney experimental fence will be monitored through an Australian Research Council ARC Linkage project, with a partnership between the University of Canberra, the South Australian Museum and others.

**River Murray Turtle Protection Manual – Summary**
The South Australian experiments in turtle habitat protection described in this manual are ongoing. Effectiveness will be determined over time, but initial indications are that providing a suitable fencing system to protect turtle habitats from human disturbance and to exclude predators, in particular foxes, is playing a critical role in maintaining the fragile biodiversity of the Riverland.

If other turtle habitats are protected in a similar way perhaps this special symbol of the River Murray will thrive and continue to play its part in the ecological diversity of the nation's greatest water basin.

*Chelodina expansa, Chelodina longicollis* and *Emydura macquarii* need our help!

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**Websites**


Arthur Rylah Institute for Environmental Research, including the Freshwater Ecology Group
**www.austehc.unimelb.edu.au/asaw/biogs/A001134b.htm**

Cooperative Research Centre for Freshwater Ecology
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National Heritage Trust
**www.nht.gov.au/index.html**

Australian Government Envirofund
**www.nht.gov.au/envirofund**

River Murray Catchment Water Management Board
**www.rivermurray.sa.gov.au**

Trees For Life
**www.treesforlife.org.au**

Waterwatch Australia, including National Technical Manual
**www.waterwatch.org.au/index.html**

WetlandCare Australia
**www.wetlandcare.com.au**



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