WHAT THE *Tortoise* TAUGHT US

by Andrew Burbidge

"When we were little," The Mock Turtle went on... " we went to school in the sea. The master was an old Turtle - we used to call him Tortoise -"

"Why did you call him Tortoise, if he wasn't one?" Alice asked.

"We called him Tortoise because he taught us," said the Mock Turtle angrily: "really you are very dull!"

(Alice's Adventures in Wonderland *by Lewis Carroll*)

There is no simple method for conserving all endangered species, no strict formula for success. In this article Andrew Burbidge looks at the problems and possible long-term solutions for the successful conservation of the world's rarest tortoise. The lessons learned may help with the conservation of other endangered species.

Of all well-studied vertebrate animals in Australia, the western swamp tortoise is considered the most threatened with extinction. With only about 25 to 30 animals remaining in the wild plus 48 captives, it is the rarest tortoise or turtle on earth. How has this situation come about and what can be done to reverse its trend towards extinction?

In 1901 the western swamp tortoise was named *Pseudemydura umbrina* from a specimen in the Vienna Museum, which had been sent to the Museum in 1839 by the collector J.A. Ludwig Preiss and labelled simply 'New Holland'. No further specimens were collected until 1953, when two were found between Upper Swan and Bullsbrook, only 30 km north-east of the centre of Perth.

Following the interest generated by the rediscovery of a presumed-extinct species so close to Perth, the Government of the day, aided by a public appeal for funds, created two Class A nature reserves that protected much of its remaining habitat. These are Ellen Brook Nature Reserve of 65 ha, situated on the west side of Highway One, two kilometres north of Upper Swan, and Twin Swamps Nature Reserve of 155 ha, located on the south side of Warbrook Road, about 5 km north-west of Ellen Brook Nature Reserve. Research studies commenced shortly after rediscovery, increased in intensity in 1963 and have continued to the present day.

However, despite habitat protection and research the tortoises have become increasingly rare, being reduced in number from about 150 in 1964 to fewer than 50 by 1988. Although some tortoises still remain in their natural habitat at Ellen Brook, the population at Twin Swamps was extinct by 1985. Did something go wrong or was rediscovery too late?

UNUSUAL LIFE STYLE

The western swamp tortoise is the smallest of its family, reaching a maximum of 15.5 cm shell length and 550 g in weight. The tortoises live in and around ephemeral (temporary) swamps with a clay or sand-over-clay soil. They have been recorded only from scattered localities in a narrow 30 km strip of the Swan Coastal Plain, roughly parallel to the Darling Scarp, from near Guildford to near Bullsbrook.

Previous page: A young western swamp tortoise, unaware of its endangered status, searches for food.
Photo - Babs and Bert Wells

Swamps at Twin Swamps Nature Reserve are shallow and contain dark, coffee-coloured water.
Photo - Babs and Bert Wells ▲

Clutch of oblong tortoise eggs dug out and destroyed by a fox.
Photo - Jiri Lochman ▶

Their stronghold was probably the clay soils of the Swan Valley, the first part of Western Australia developed for agriculture following European settlement of Perth in 1829. Almost all this land is now cleared and drained, being urbanised, used for intensive agriculture or the extraction of clay for brick and tile manufacture.

In June or July the swamps fill and the tortoises are found in shallow water, feeding when water temperatures are above 14°C. They are carnivorous, eating only living food such as insect larvae, small crustaceans and young tadpoles. As the swamps warm in spring, the tortoises' food intake increases and fat supplies are laid down for the forthcoming summer. When the swamps are nearly dry and water temperatures rise above 28°C, usually in November, the tortoises leave the water to aestivate until the next winter. Aestivation (dormancy during summer) refuges vary with the soil type: at Ellen Brook Nature Reserve they are naturally occurring holes in the clay, while at Twin Swamps Nature Reserve most tortoises hid under banksia leaf litter or fallen branches.

Females lay three to five hard-shelled eggs of about 35 x 20 mm in an underground nest in November or early December. Only one clutch per year is produced. In most other Australian tortoises multiple clutching is usual and clutches are much larger: the oblong tortoise, for example, lays two or three clutches of eight to eighteen eggs each spring and summer. The hatchlings of the western swamp tortoise emerge the following winter, about 180 days after laying; hatching is triggered by a lowering of incubation temperature, presumably caused by the first winter rains. Hatchlings weigh only about 5 g. Growth in juveniles

is slow and varies considerably from year to year. This depends on seasonal conditions; for example, the lower the winter rainfall the shorter the swamp life and the slower the growth. Consequently, age to sexual maturity varies from six-and-a-half to more than 15 years, with a mean of about 12 years. It is not known how long western swamp tortoises can live, but animals more than 50 years old are still producing eggs.

Hatchling survival rates are low, especially in drought years. Unless hatchlings grow to at least 25 g before the swamps dry, desiccation during the following summer causes death. Growth to a suitable size requires at least five months' standing water. Research suggests that two (or perhaps three) good rainfall years in a row were necessary for young to enter the population at Twin Swamps - one (or two) years for egg production and one year for hatchling survival. Swamp life is more reliable at Ellen Brook and egg laying and hatching seems to happen in most years; nevertheless very few animals survive.

Foxes, which are abundant in both Ellen Brook and Twin Swamps nature reserves, are known to predate western swamp tortoises. Tortoises were more prone to predation at Twin Swamps, where aestivation refuges are mostly on the ground's surface. At Ellen Brook, where aestivation refuges are underground, the species is better protected, but the very small population size means that even occasional predation can have a significant effect.

Since the mid-1960s, Perth has had many years with significantly reduced winter rainfall, resulting in short swamp life at Twin Swamps Nature Reserve. This, combined with high levels of fox predation, is thought to have led to the extinction of the tortoise population at Twin Swamps.

RECOVERY PLAN

A recovery plan for the next ten years has been developed by the Department of Conservation and Land Management (CALM) and was launched by the President of World Wide Fund for Nature, Prince Philip, in November 1990. Its aim is to ensure that the western swamp tortoise persists by creating at least two viable populations in the wild. A 'recovery team', with members from CALM, Perth Zoo, the University of Western Australia, Curtin University of Technology and the Australian National Parks and Wildlife Service, has been set up to implement the plan.

Available knowledge of the tortoises' biology and ecology suggests that if certain critical factors can be ameliorated or manipulated by wildlife managers, recovery should be enhanced.

These critical factors are: the inadequate area of habitat in protected areas; the poor quality habitat in existing protected areas, especially relating to a short period of swamp life; predation by the European red fox; low fecundity (the capacity to produce young) and high juvenile mortality, leading to low recruitment; very low total numbers, thus increasing the chance of extinction; and only one wild population.

The following strategies have been developed to deal with these factors.

Additional suitable habitat: Purchase by CALM of suitable land adjacent to Ellen Brook Nature Reserve is under way, and plans are being developed to rehabilitate the areas purchased and deepen some swamps on the existing reserve. Identification of other areas of habitat suitable for purchase will continue.

A young tortoise at Ellen Brook Nature Reserve.
Photo - Gerald Kuchling

Success!
Photo - Gerald Kuchling ▲◄

A radiograph (X-ray image) reveals four eggs. Western swamp tortoises lay only one clutch of up to five eggs each year.
Photo - Andrew Burbidge ▲

Extending swamp life: The swamps on Ellen Brook Nature Reserve contain water for about five months in most years and no action is planned to manipulate existing deeper swamps (those greater than 25 cm) at present. Swamp life at Twin Swamps Nature Reserve is far too short during most years, and extending the life of the swamp by pumping from groundwater is currently being investigated with help from the WA Water Authority.

Controlling exotic predators: Fox control has been carried out on Ellen Brook Nature Reserve since 1979, but the technique available at that time proved to be inadequate. Predator control was stepped up in 1988 by CALM's Metropolitan Region staff using new fox control techniques developed by Dr Jack Kinnear and colleagues (see *LANDSCOPE*, Spring 1990). But much of Ellen Brook Nature Reserve is under water for up to six months of the year and using Compound 1080 under such conditions can be ineffective, because of its high solubility in water (see '1080: The Toxic Paradox' by Dennis King and Jack Kinnear in this issue of *LANDSCOPE*). Furthermore, the tortoises are most likely to be eaten by foxes during the wet months when they are not aestivating.

Another problem is that the reserves are small and re-invasion of them by foxes from surrounding land is rapid.

It was considered that these problems could be largely solved by the construction of a fox-proof fence. In 1989 CALM got a $24 000 grant for this purpose from the Australian National Parks and Wildlife Service under their Endangered Species Program. The remainder of the cost (approximately $45 000) was met by CALM itself. Construction commenced late that year, but was delayed because of unseasonal heavy rains during the summer of 1989-90. The fence was finally completed in December 1990.

Captive Breeding: The extremely small size of the population and its continued decline in the wild means that captive breeding is essential if the species is to recover in numbers and range. Captive breeding was attempted in a low key, non-interventionist way ever since western swamp tortoises were first kept at Perth Zoo in 1964. Success was, however, very low with only four animals still being alive from the 26 that hatched between 1966 and 1977.

In 1979 the three adult females from the Zoo population were transferred to CALM's WA Wildlife Research Centre for more intensive husbandry and the use of artificial techniques for obtaining and incubating eggs. About 20 eggs were obtained and incubated during 1979 and 1980. Some hatched, but all hatchlings died within a few months. No further eggs were produced until 1987.

In 1987 Dr Gerald Kuchling came to WA from Austria to study tortoise reproduction with Professor Don Bradshaw at the University of Western Australia (UWA) and started to assist CALM with captive breeding. The use of ultra-sound scanners for the examination of the female reproductive tract enabled studies to be made of egg development for the first time. Previously it was not known whether eggs were being developed until ovulation had taken place and the shell had been laid down. Husbandry was also changed and improved.

In 1987 seven eggs were obtained from two of the three females then in captivity. All these eggs were incubated artificially, but none hatched, the embryos dying at an early stage of development. The reasons for this are not clear: recent research suggests that the most likely explanation is poor quality eggs due to inadequate nutrition of the females that produced them.

Also in 1987 CALM and UWA's Zoology Department developed a budget for a two-and-a-half year captive breeding project. Funds were sought and obtained from the World Wide Fund for Nature Australia, the Australian National Parks and Wildlife Service, and CALM. The project has been carried out by Dr Kuchling while based at UWA. CALM has supported the project with extra funds and staff time, and UWA has provided facilities and financial administration. Perth Zoo has provided staff support, and obtained sponsorship for the construction of new facilities for the captive tortoises and hatchlings.

The new breeding management is based on an improved and better balanced diet as well as on new enclosure designs, feeding patterns and aestivation management, which reflect more closely the conditions in the wild.

This project has been successful. In 1988, 12 eggs were obtained from three females and 11 of these hatched between February and April 1989. Because of past difficulties in raising hatchlings, husbandry difficulties were expected and did arise; in particular the hatchlings developed an infection of the skin, which extended to the eyes and toes. The infection proved hard to combat. Five of these hatchlings are still alive and now responding well to treatment. Nursery facilities and food have been continually improved and growth rates are now approximating those in the wild.

In 1989, 13 fertile eggs were obtained from five females; two eggs had thin shells and cracked when being laid, the remaining 11 were incubated, and all hatched during April 1990. The health difficulties that arose with the 1989 hatchlings have not recurred. Experiments to determine the most effective method of raising hatchlings will be continued by Perth Zoo and the University of Western Australia.

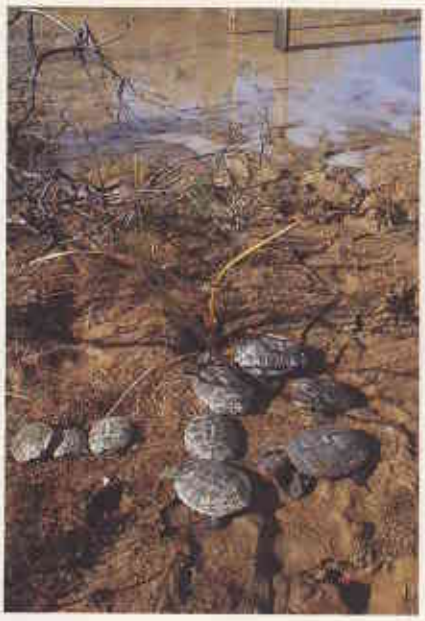
In late 1990, 20 eggs were obtained. Eighteen of these began developing, but two embryos died early in incubation. In April 1991, 16 eggs hatched, including the first two from a tortoise bred in captivity in Perth Zoo in the 1960s. Captive breeding will continue, with Perth Zoo taking full responsibility for the project this year.

Re-introduction to the wild: The Recovery Plan lays down procedures for the re-introduction of western swamp tortoises to Twin Swamps Nature Reserve, thus creating two populations in the wild. The reserve appears to have offered good habitat during periods of average to above average rainfall (e.g., the mid-1960s) when the tortoises reproduced successfully and grew much faster than those at Ellen Brook. However, the population did not fare well during periods of drought; this was possibly due in part to nearby drought refuges outside the nature reserve having been destroyed. Predation by foxes is thought to have been a significant factor in the decline of the Twin Swamps population. Both these factors will need to be addressed, the first by swamp management (probably by pumping groundwater into the swamps), and the second by more effective fox control, possibly including the construction of a fox-proof fence.

The timing of translocations and the number of tortoises released will be dependent on the continued success of captive breeding and on the implementation of remedial measures at the reserve. Dr Kuchling will continue to work part-time with CALM on the re-introduction project and will also be available to help Perth Zoo with captive breeding.

WHAT HAS THE TORTOISE TAUGHT US?

The near-extinction of the western swamp tortoise was due to two depressingly familiar causes: habitat destruction and introduced predators.



Some of the 13 western swamp tortoises captured in one afternoon at Ellen Brook Nature Reserve - the most ever caught there at one time.
Photo - Gerald Kuchling ▲

Western swamp tortoises eat live food such as these small crustaceans.
Photo - Babs & Bert Wells ▼

Perth Zoo has built specially-designed pens to raise tortoises bred in captivity.
Photo - Gerald Kuchling ▼▼

The lessons for the future are that conservation action must not be delayed until species are approaching extinction. The later action is taken, the more difficult and expensive it will be.

As is the case for most critically threatened species, only a concerted and continuing effort can result in the recovery of the western swamp tortoise. Because of its extreme rarity, the slow production of its young and its long generation time, its recovery will be slow. For the project to have any chance of success, a long-term commitment is required by conservation and funding agencies, and careful monitoring of progress will be necessary. ⊡

To protect the last wild group of western swamp tortoises CALM has built this fox-proof fence around their habitat.
Photo - Stephen Kelly ▶

The oblong tortoise, known locally as the long-necked tortoise, is common in freshwater wetlands in the south-west of Western Australia.
Photo - Marie Lochman ▼▶

The western swamp tortoise bends its neck sideways to gain some head protection from its shell.
Photo - Gerald Kuchling ▼▼▶

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Come crown my brow with leaves of myrtle
I know the tortoise is a turtle
Come carve my name in stone immortal
I know the turtoise is a tortle
("Carnival of the Animals" by Ogden Nash)

The common names of many Australian animals have been derived from similar-looking species from England, even though they may not be closely related to them. Thus Australian magpies and northern hemisphere magpies are unrelated - their black-and-white colouring is all they share. Australian robins are not closely related to English robins; they got their name because some species have red breasts. Even when confronted by animals totally unlike European ones the early settlers still gave them familiar, English-sounding names, such as 'native cat' for the chuditch and 'banded anteater' for the numbat. Similar problems exist with the common names of many other Australian animals and plants.

Tortoises and turtles belong to the reptile order Testudines, which has two living sub-orders, the Pleurodira and the Cryptodira. The Pleurodira (side-necked families) are unable to withdraw their necks into the shell but are able to gain some protection for the head by bending the neck side-ways between the upper and lower parts of the shell. There are only two living families within this group. With the exception of marine turtles, the Cryptodira (hidden-necked families) are able to withdraw their heads into the shell by bending the neck in an 'S' bend. But because this bending takes place within the shell it gives the impression that the head is being withdrawn without the neck being bent at all. Most living species belong to this group.

In English-speaking parts of the northern hemisphere the land-dwelling, herbivorous species are usually called 'tortoises'. In England, freshwater-dwelling species also are usually called 'tortoises' (sometimes 'marsh tortoises'), but they are called 'terrapins' or 'turtles' in north America.

In Australia, and elsewhere in the English-speaking world, 'turtle' is always used for marine species, which have flippers rather than toed or clawed feet, while 'tortoise' has usually been used for the freshwater species. All our 'tortoises' belong to the Pleurodiran family Chelidae, which is restricted to Australia, New Guinea and some adjacent islands, and South America. One additional freshwater species, the unusual pig-nosed turtle of Arnhem Land (also New Guinea), belongs to the Cryptodira.

So Australian 'tortoises' are only distantly related to any of the northern hemisphere families. They are as different from northern hemisphere freshwater turtles as marsupials are from eutherian (non-pouched) mammals. Perhaps we should develop our own Australian name for them.

After its rediscovery, the western swamp tortoise was generally known to Western Australians as the short-necked tortoise to distinguish it from the oblong tortoise *Chelodina oblonga*, a long-necked species, which is the only other tortoise in the South West. The name used today was proposed many years ago for Australia-wide usage, since there are many other 'short-necked' tortoises in three other genera that occur in northern and eastern Australia.

LANDSCOPE

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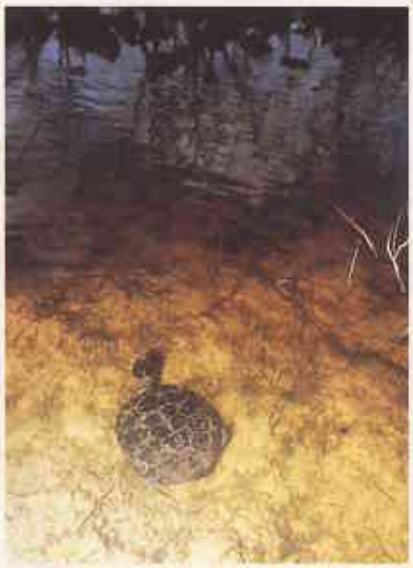
Cloud-capped Bluff Knoll, majestically brooding sentinel of the Stirling Range. Does it hold a secret in its stony heart - perhaps the answer to the missing mammal mystery? See story on page 9.

Mulga and fire - at best an uneasy relationship - sometimes symbiotic, sometimes disastrous. Find out when and where on page 20.

The Kimberley's rugged grandeur is deceptively fragile. Additional reserves managed by CALM help protect the region's delicate, complex and diverse ecosystems. See page 35.



A western swamp tortoise (Pseudemydura umbrina). *Could this be one of the last to be photographed? Not if CALM's ten-year recovery plan succeeds. See page 28 for details.*

An uncommon dragon, Caimaniops amphiboluriodes *inhabits mulga shrubs. Many other dragon lizards prefer harsher habitats such as rock-piles and salt lake beds. See page 51.*

FEATURES

REGULARS

COVER

Central netted dragon (Ctenophorus inermis), *one of the more than 60 species of dragon lizard that inhabit the arid and semi-arid parts of Australia. The acute eyesight and swiftness of dragon lizards are essential in order to avoid predators and to capture food. See page 51.*

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