Conservation strategies for remnant turtle populations: the Western Australian Swamp Turtle *Pseudemydura umbrina* Recovery Programme

G. KUCHLING

Abstract

The Western Australian Swamp Turtle *Pseudemydura umbrina* is one of the world's rarest freshwater turtles. Two small nature reserves were set aside for the species in the early 1960s, but by the late 1980s the turtles had nearly disappeared from one of them and the world population counted less than 50 individuals. After a successful captive breeding operation was established for *P. umbrina* in the late 1980s, a recovery team was formed in 1991 and a recovery plan was published in 1994. Conservation actions include the construction of fox-proof fences for the exclusion of foxes and dogs from turtle habitat, captive breeding and re-introduction, supplementing bore water into one swamp during dry winters and springs to extend the duration of swamp life, changes of the drainage patterns of several swamps to increase flooding; and fire management. The fencing of the turtle populations had some unintended side effects, including increased numbers of ravens and rats which also predate *Pseudemydura umbrina*. The intensive management of small remnant turtle populations requires careful monitoring to recognise any unwanted side effects as well as the flexibility to re-adjust the programme quickly to new emerging problems.

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Introduction

Why is there a chapter on an Australian turtle in an Austrian book on the European pond turtle *Emys orbicularis*? Is there an Austrian-Australian connection in regard to swamp turtles? Certainly not in systematic terms, since swamp turtles in Austria and most in Australia belong to different suborders, the Cryptodira and the Pleurodira, respectively. Nonetheless, conservation strategies are generally applicable to turtle populations regardless of systematic relationship. The Western Australian swamp turtle *Pseudemydura umbrina* is one of the world's rarest freshwater turtles and the focus of intensive conservation action. The experience gained with the Australian *P. umbrina* recovery programme is also relevant for conservation of freshwater turtles on other continents.

Apart from that reason for the inclusion of the chapter, Austrian turtle experts worked, and are still working, on south-western Australian freshwater turtles, thus providing a connection. Two of the three freshwater turtle species of that region (and one of the two genera, *Pseudemydura*) were described by the Austrian herpetologist Friedrich SIEBENROCK and the type specimens are in the Natural History Museum in Vienna: *Pseudemydura umbrina* SIEBENROCK 1901 and *Chelodina steindachneri* SIEBENROCK 1914 (the third species is *Chelodina oblonga* GRAY 1841). Last but not least the author of this chapter moved from Austria to Perth in Western Australia in 1987.

In the following I will give a short overview of the history of the discovery of *P. umbrina* and of its biology. I will then outline the early conservation efforts which could not halt the decline of the species and the conservation strategies which I initiated after my arrival in Western Australia. In addition I will discuss some unforeseen side effects of an important conservation action for *P. umbrina*, the fencing of its populations to exclude introduced predators from their habitat, in order to highlight the importance of monitoring, assessment and corrective actions during intensive conservation management.

History

For a long time *P. umbrina* remained an enigmatic taxon. The type specimen had been acquired by the Vienna Natural History Museum in 1839 from the collector Ludwig PREISS with the locality designation "Nova Hollandia". For over a century the type was the only specimen known, until some further turtles were found (in 1953 about 30 km north-east of the centre of Perth) and described as a new species (*Emydura inspectata* GLAUERT 1954). On the basis of written information provided by Josef EISELT (Vienna), WILLIAMS (1958) eventually demonstrated the synonymy of that new taxon with *P. umbrina*.

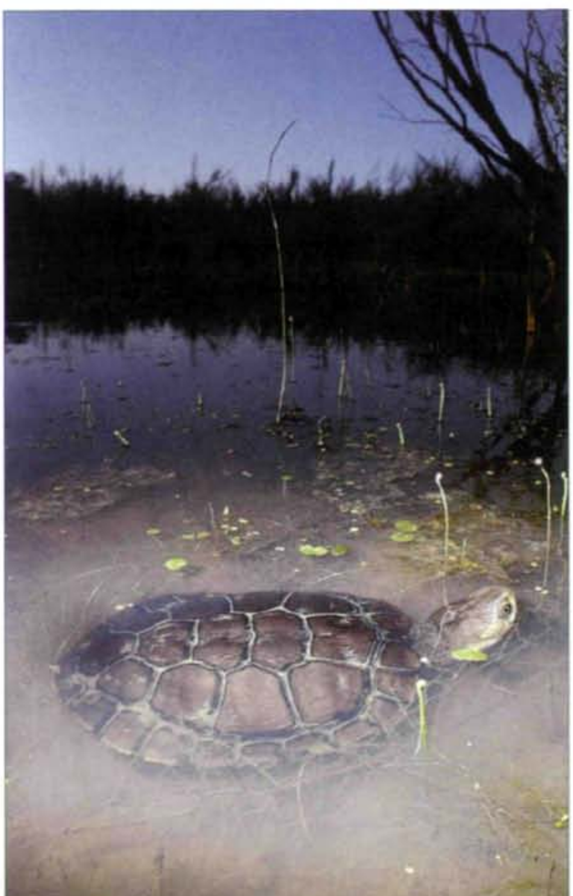
A relict species, apparently little changed since the Miocene, *P. umbrina* (Fig. 1-3) is the only member of its genus, and has no close relatives among other members of the Chelidae

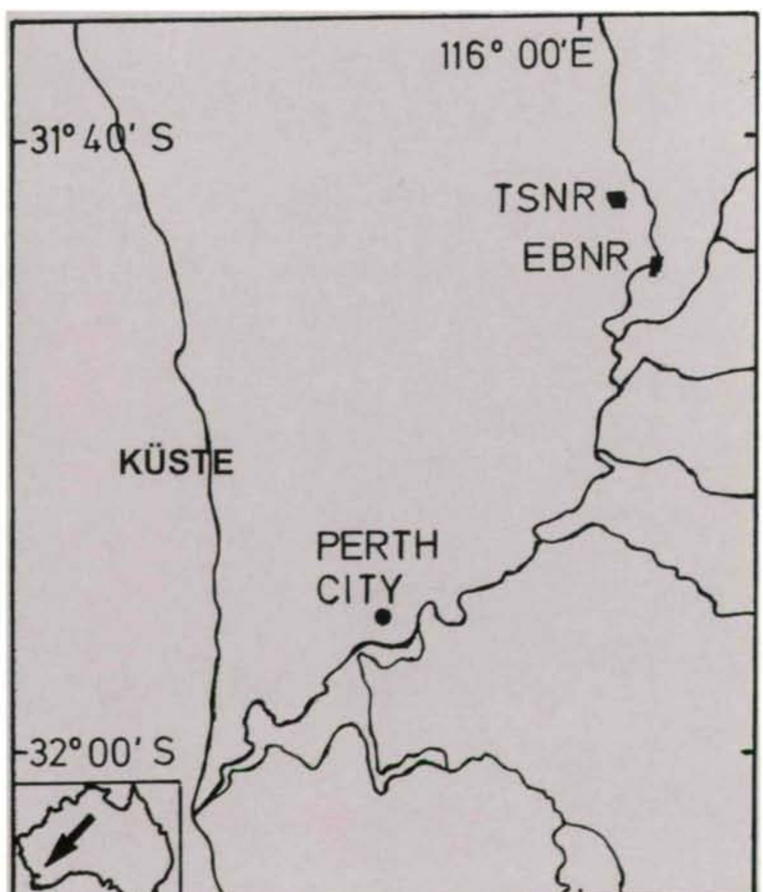
Fig. 1: ***Pseudemydura umbrina* at Ellen Brook Nature Reserve.**

(BURBIDGE et al. 1974, GEORGES et al. 1998). The only fossil records of *Pseudemydura* are a portion of a skull and a pygal bone from the early Miocene Riversleigh deposits of northwest Queensland, which show only slight differences from modern specimens (GAFFNEY et al. 1989). *Pseudemydura umbrina* has been recorded exclusively from scattered localities in a narrow strip (3 to 5 km wide, 30 km long) of the Swan Coastal Plain on the outskirts of Perth (Fig 4). This strip is characterized by largely alluvial soils. Anecdotal information (BURBIDGE 1967, 1981) suggests that the turtles' stronghold was the clay soils of the Swan Valley, the first part of Western Australia developed for agriculture. Almost all of this land is now cleared and either urbanised or used for intensive agriculture or the extraction of clay for brick and tile manufacture.

Fig. 2, 3:
Pseudemydura umbrina **at Ellen Brook Nature Reserve.**

Fig. 4:
The location of Ellen Brook Nature Reserve (EBNR) and Twin Swamps Nature Reserve (TSNR).





Pseudemydura umbrina only inhabits shallow, ephemeral, winter-wet swamps on clay or sand over clay soils (Fig. 5). These swamps are characterised by a high invertebrate species richness and biomass and a diverse flora. After the swamps fill in June or July the turtles can be found in water. *Pseudemydura umbrina* is carnivorous, eating only living food such as insect larvae, small crustaceans, worms, and tadpoles. Food is only taken under water, feeding is therefore restricted to winter and spring. When the swamps dry out in late spring *P. umbrina* moves from the low swamp areas into slightly elevated bushland to aestivate during summer and autumn in naturally occurring holes and under leaf litter (BURBIDGE 1967, 1981).

Fig. 5: **Aerial view of *Pseudemydura umbrina* swamp habitat at Ellen Brook Nature Reserve during July (winter). Shallow sink holes in the clay soil under a low canopy of *Melaleuca lateritia* bushes retain water of 10-40 cm depth**

Conservation from the 1960s to the 1980s

The very small area distribution and the rather precarious status of *P. umbrina* were recognised by researchers of the Western Australian Museum in the late 1950s and by students of the Department of Zoology of the University of Western Australia in the early 1960s (LUCAS 1963, BURBIDGE 1967). During the 1960s to 1980s two populations of *P. umbrina* were monitored in Twin Swamps Nature Reserve (TSNR, 155 ha) and in Ellen Brook Nature Reserves (EBNR, 65 ha). These reserves were created to protect the habitat of the species in 1962. Much of the suitable habitat outside the reserves disappeared, but also the preserved habitat experienced various disturbances and changes which continue to have a negative influence on *P. umbrina* populations. Disturbances and threats impacting on turtle numbers included road traffic, influx of polluted water from intensive livestock farming, increased frequency of bush fires, a lowering of the ground water table, and introduced predators like foxes, dogs and cats. Thus, despite the protection afforded to their habitat, *P. umbrina* numbers declined from over 200 in the late 1960s to about 30 surviving wild individuals in the mid 1980s (BURBIDGE & KUCHLING 1994). The major decline to near extinction took place at TSNR, whereas the population at EBNR remained relatively stable at very low population size. The decline of *P. umbrina* seems to have been caused by the combination of a very limited natural range, habitat loss, and environmental degradation (including increased predation). Although *P. umbrina* had been maintained in captivity at Perth Zoo and at the Western Australian Wildlife Research Centre since

1964, in the past captive breeding success was low and egg production ceased between 1980 and 1987. By 1987, only 17 individuals remained in captivity and the world population of *P. umbrina* counted less than 50 individuals (KUCHLING & DEJOSE 1989).

The author arrived in Western Australia in 1987 and initiated a rescue programme for the species. Its first focus was to set up a captive breeding operation (KUCHLING & DEJOSE 1989). With so few individuals left, it was necessary to develop new, non-invasive approaches to monitor reproductive activity, especially egg production. A major breakthrough was the introduction of ultra-sound scanning (KUCHLING 1988), a method which minimises risk and optimises information gain in assessing reproductive condition in female chelonians (KUCHLING 1998, 1999). Some initial problems in captive breeding were solved and by 1990 a successful breeding programme was under way at Perth Zoo. This programme produced enough hatchlings and juveniles to allow to re-focus on recovery actions in the wild (KUCHLING et al, 1992, KUCHLING 1997).

Conservation in the 1990s: the recovery plan

A management programme for *Pseudemydura umbrina* was developed in 1990 (BURBIDGE et al. 1990) with the aim of ensuring that the species persists by creating at least two viable populations in the wild. The recovery team first met in late 1990, with members from the Western Australian Department of Conservation and Land Management, Perth Zoo, the Zoology Department of the University of Western Australia, School of Biomedical Sciences of Curtin University and the World Wide Fund for Nature and Environment Australia (Federal Government). In 1992 the management programme was rewritten as a 10 year recovery plan which was revised and published in 1994 (BURBIDGE & KUCHLING 1994). A revised second edition was drafted in 1998 and will run until the end of 2002. The recovery team meets every six months. The organisational structure allows the team to raise the necessary funds and to co-ordinate the research and management actions required for the recovery of the species. Six primary strategies are pursued concurrently:

(I) develop and implement management guidelines for the nature reserves (EBNR and TSNR);

(II) monitor the turtle populations in both nature reserves;

(III) acquire some land adjacent to EBNR, restore the habitat and include it in the reserve;

(IV) continue with captive breeding to produce turtles for re-introduction;

(V) re-introduce turtles to TSNR and to other suitable sites;

(VI) disseminate educational and publicity material about *P. umbrina* and raise funds for its conservation.

Management of the nature reserves includes fencing habitat to exclude exotic predators, in particular foxes; fire management; improvement of water levels in swamps by changing drainage conditions; and pumping of ground water into one swamp at TSNR during dry winters in order to maintain a certain water level (BURBIDGE & KUCHLING 1994). A major emphasis of the programme is to allow the last naturally persisting *P. umbrina* population at EBNR to increase on its own by improving reserve management and by expanding the area of suitable habitat in order to increase the carrying capacity. More drastic manipulative actions like ground water supplementation into swamps and re-introduction of captive bred turtles are only used to re-establish additional wild populations, first of all at TSNR where the population was near functional extinction in the late 1980s (KUCHLING 1996).

The turtle life history characteristics of longevity, delayed reproduction and iteroparity determine that population stability is most sensitive to changes in adult, subadult and larger juvenile survival and much less sensitive to changes in fecundity and nest survival (CONGDON et al. 1993). The introduced European red fox increased to high densities in south-western Australia during the 1970s, about the time of the drastic decline of *P. umbrina*. Foxes predate all life stages of

P. umbrina including adults and may have been a major cause for the population crash, particularly at Twin Swamps (BURBIDGE & KUCHLING 1994). This was the rationale for fox control and for enclosing the reserves with fox-proof fences.

Fencing turtle populations: some lessons

The fenced habitat area at EBNR was 29 ha from 1990 to 1998, when it was extended by an additional 5 ha. At TSNR an area of 150 ha (the whole reserve) was fenced in 1994. The fence (comp. Fig. 8, 60-70 cm of the fence is buried into the ground) has a mesh size at ground level through which turtles older than about two years cannot fit. In order to monitor the effects of the fences, several adult and juvenile *P. umbrina* (about 10-15 at any one time) have been radio-tracked from 1991 to 1994 at EBNR, and since 1994 at TSNR (Fig. 6). The fences are successfully excluding the foxes. Occasional intrusions are dealt with by regular poisoning with "1080 compound" inside the fences. Still, two tortoises were injured by foxes at EBNR and one at TSNR since the reserves were fenced, but no mortalities were recorded, demonstrating the effectiveness of the fences.

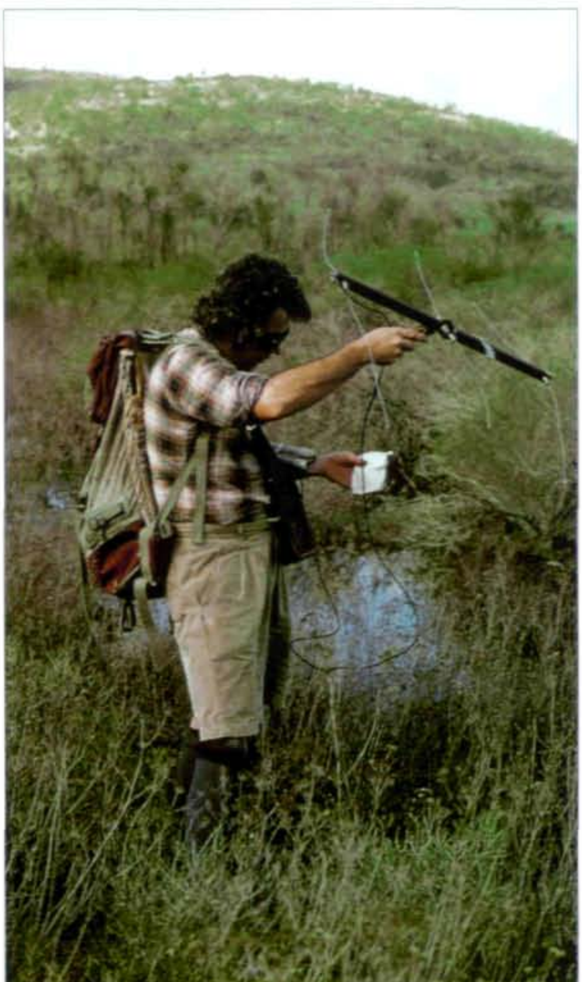


Fig. 6: The author, radio-tracking turtles at Ellen Brook Nature Reserve. Photo by Terry E. GRAHAM.

Occasionally some turtles try to trespass the fences to the outside of the reserves (Fig. 7). One reason could be that particular individuals established home ranges which included sites outside of the reserves and simply want to reach those areas. Another reason could be that *P. umbrina* is attracted to areas of open water, for example artificial farm dams on adjacent properties, in particular when the swamps inside the reserves fall dry in late spring. Turtles that persistently walk along fences (often for many days) are prone to overheating and desiccation. One subadult female died at the fence of EBNR in the spring of 1991 and an adult female at the fence at TSNR in the spring of 1995. A necessary remedial action was, therefore, the construction of small (3x1.5m) artificial ponds along the fences, in particular in corners and at places where farm dams are located on the outside of the fence (Fig. 8). These ponds now have to be filled with water by a fire truck from October until the end of the year. Since this is labour intensive, we constructed larger, artificial depressions at critical spots at the TSNR fence. These depressions now naturally contain water from June to early December.

A critical parameter for recruitment of hatchlings (Fig. 9) into the wild *P. umbrina* populations is the size to which hatchlings grow at the end of their first season. In order to survive their first summer aestivation, it is critical for hatchlings at EBNR to grow from about 4-5g when they hatch in autumn to at least 18-20g by late spring (BURBIDGE & KUCHLING 1994). The length of the growth period and, thus, the body mass hatchlings can reach depends on the availability of standing water. With the fence at EBNR, a new impact on the hatchling growing period suddenly emerged. The breeding success of the common Pacific Black Duck (*Anas superciliosa*) in the reserve was suddenly boosted by the exclusion

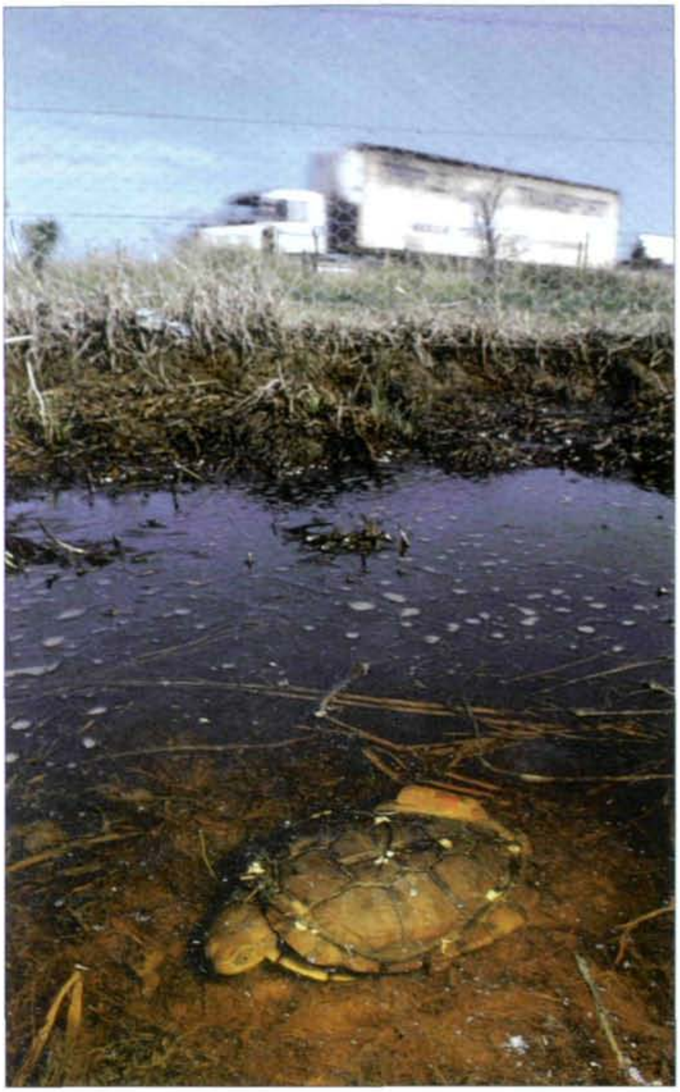


Fig. 7:
Pseudemydura umbrina with radio-transmitter close to the fence at Ellen Brook Nature Reserve.

Fig. 8:
Plastic-lined pond at fence at Ellen Brook Nature Reserve.

Fig. 9:
Pseudemydura umbrina hatchlings during late winter at Ellen Brook Nature Reserve.

of foxes and at the time in spring when the swamps dried, hordes of ducklings inside the reserve could not escape (as their mothers eventually did) and perished. However, before perishing, they concentrated in the last pools, consumed all potential turtle food and polluted the water (Fig. 10). This reduced the potential feeding period for *P. umbrina* hatchlings in spring by about two weeks. Ducklings even seem to have attacked and damaged some hatchling *P. umbrina*. For several years we tried to control ducklings by pricking holes into duck eggs, but the solution came when the adjacent 5 ha block with an old farm dam on it was joined to EBNR. Since then, mother ducks move with their ducklings to the dam which holds water longer than the swamps.

Fig. 10:
Ducklings had stripped most food from the last water puddles at Ellen Brook Nature Reserve and then perished. Some *Pseudemydura umbrina* hatchlings were still active in the puddle, 01 November 1992.

When the fence was built in 1994 at TSNR the number of Western Grey Kangaroos (*Macropus fuliginosus*) fenced in was larger than the carrying capacity of the reserve, which caused a die off of the kangaroos over the next few years. With no foxes, dogs and cats in the reserve to clean up the carcasses, large numbers of the native ravens *Corvus coronoides* were attracted to the reserves. This also happens after occasional die offs of rabbits (*Oryctolagus cuniculus*) due to myxomatosis. Ravens were found to kill juvenile and subadult *P. umbrina*, mainly during the time when swamps dry out and the turtles move from the swamp areas to higher bushland to aestivate. This problem is now addressed by volunteer raven shooters patrolling the area during critical times (usually about one week in spring) to scare ravens away.

A new, only recently recognised problem are non-native rats (*Rattus rattus* and *R. norvegicus*) which attacked and killed some aestivating juvenile turtles at TSNR. The rat density may have increased with adjacent agricultural land use and with the exclusion of foxes and cats. In order to reduce rat numbers at TSNR, the Department of Conservation and Land Management trials.

Since late 1999 rat poison stations which allow rats, but not native bandicoots, possums and skinks to reach the poison baits (Fig. 11).

A further problem caused by fences is that, from time to time, some turtles escape of the fenced areas and are found walking along the outside of the fence, trying to get back in. During these efforts they are not only prone to overheating and desiccation, but also exposed to the predators which the fence excludes. The solution to this problem was the development of one way-gates which were built into the fence and which allow turtles, but not foxes or cats, to enter the reserve (GUYOT & KUCHLING, in press).

Conclusions

The example of the *P. umbrina* recovery programme demonstrates that, in order to be successful, the intensive management of small remnant turtle populations in disturbed habitats requires careful monitoring to recognise any unwanted side effects of conservation actions as well as the flexibility to re-adjust the programme quickly to new emerging problems. Although, for example, fencing small habitat areas can be an effective conservation action, it can cause unpredictable chain reactions in the complex interplay of various species and may impact in unforeseeable ways on the target turtle population. The intensive management and monitoring is expensive in money and time. It is clearly preferable and cheaper to start conservation measures before a species or population is on the brink of extinction and to conserve species in larger tracts of functioning habitats and ecosystems.

Fig. 11:
Rat poisoning station at Twin Swamps Nature Reserve. Animals have to climb up the bucket and enter through the holes in the lid to reach the bait, a system developed by the Western Australian Department of Conservation and Land Management which reduces the poisoning of non-target species.

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Zusammenfassung

Die Westaustralische Schildkröte *Pseudemydura umbrina* ist eine der seltensten Wasserschildkröten der Welt. In den frühen Sechzigerjahren wurden zwei kleine Naturreservate für die Art geschaffen, doch in den späten Achzigerjahren war sie aus einem der Reservate beinahe verschwunden und weniger als 50 Individuen überlebten. Nach dem Aufbau eines erfolgreichen Gefangenschafts-Nachzuchtprogrammes für *P. umbrina* Ende der Achziger Jahre bildete sich 1991 ein „Recovery Team" und 1994 wurde ein „Recovery Plan" publiziert. Schutzaktionen für die Art inkludieren: Das Einzäunen des Schildkrötenhabitates mit fuchssicheren Zäunen, um Füchse und Hunde fernzuhalten; Gefangenschaftszucht und Wiederansiedelung in einem der Reservate; das Pumpen von Grundwasser in einen der Sümpfe in trockenen Wintern und Frühlingen um das Sumpfleben zu verlängern; die Änderungen der Wasserabflußbedingungen in einigen Sümpfen um die Wasserüberflutungsperiode auszudehnen; und Feuer-Management. Das Einzäunen der Schildkrötenpopulationen hatte einige unerwartete Nebeneffekte, unter anderem eine Zunahme von Raben und Ratten die ihrerseits Predatoren von *Pseudemydura umbrina* sind. Um mögliche Nebeneffekte intensiver Managementmaßnahmen rechtzeitig zu erkennen, ist eine genaue Überwachung der kleinen Schildkröten-Restpopulationen notwendig, ebenso wie genügend Flexibilität, das Programm rasch an neu auftauchende Probleme anpassen zu können.

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Anschrift des Verfassers:

Dr. Gerald KUCHLING
Department of Zoology
The University of Western Australia
Nedlands, WA 6907, Australia
email: kuchling@cyllene.uwa.edu.au