WESTERN SWAMP TORTOISE

RECOVERY PLAN

NATURAL HERITAGE TRUST PROJECT 6447

ANNUAL REPORT

1999

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for

The Western Swamp Tortoise Recovery Team

Natural Heritage Trust

Helping Communities Helping Australia

Department of Conservation and Land Management

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Summary

It is a pleasure to report that during the past year there has been continuing progress towards implementing the actions contained in the Western Swamp Tortoise Recovery Plan and that implementation of most recovery actions continues to be on or ahead schedule. Highlights of the year included:

- Monitoring of the population at Ellen Brook Nature Reserve continues to suggest a gradual increase in the number of tortoises over the past decade, but most of these are juvenile animals. The increase has been sustained since the fox-proof fence was constructed around the tortoise habitat in the reserve in 1990.
- Perth Zoo currently holds 157 tortoises comprising 7 breeding males, 10 breeding females and 140 other tortoises comprising hatchlings, juveniles, sub-adults and non-breeding adults. Forty-one hatchlings were obtained in 1999 from eggs laid in 1998.
- Groundwater was pumped to North West Swamp, Twin Swamps Nature Reserve early July until the third week of November. The winter of 1999 produced a higher rainfall than in 1997 or 1998; however, some pumping was still necessary.
- Forty tortoises, bred and raised to about 100 g body weight at Perth Zoo, were released at Twin Swamps Nature Reserve, in August 1999.
- The raven control program commenced in 1998 was again carried out in 1999 during the week in which the last swamp dries at Twin Swamps Nature Reserve. A rat control program at this nature reserve was initiated during 1999.

Of concern is the lack of a new translocation site to release captive-bred tortoises in 2001 and succeeding years. The Recovery Team's preferred site, Perth Airport, is now the subject of a hydrological study by Westralia Airports Corporation to clarify whether future runway extensions may deleteriously affect the target swamps. The Team is investigating other possible sites at Caversham and Wannamal.

During the year, an independent review of the implementation of the WST Recovery Plan, commissioned by the Commonwealth Minister for the Environment, reported that 'the Recovery Plan was well planned and has been implemented so successfully that many of its 2002 goals have already been achieved. Logistical and ecological problems have arisen in the course of the project, and most have been appropriately and successfully addressed. The Recovery Team has operated effectively and has provided expertise critical to the success of the program.' Following the review, the Commonwealth Government agreed to continue to fund the Plan's implementation. However, funding provided for 1999/2000 is significantly below that requested.

INTRODUCTION

The Western Swamp Tortoise Recovery Team first met in December 1990. It grew from the very successful Western Swamp Tortoise Captive Breeding Management Committee, which was set up in 1987 and which was a runner-up for the IBM 1990 Conservation Award.

At the end of 1999 Team membership was:

Dr Andrew Burbidge, CALM, WA Threatened Species and Communities Unit, Chair
Professor Don Bradshaw, Zoology Department, The University of Western Australia
Mr Dean Burford, Perth Zoo
Dr Terry Fletcher, Perth Zoo
Mr Phil Fuller, CALM Science and Information Division
Dr David Groth, Department of Biomedical Science, Curtin University of Technology
Dr Gerald Kuchling, Zoology Department, The University of Western Australia
Mr Rod Martyn, CALM Perth District
Mr Lyndon Mutter, CALM Perth District
Ms Sandra McKenzie, National Threatened Species Network, World Wide Fund for Nature Australia

During 1999 the Team met twice: in July and December. Although the Team works together on many projects, primary responsibilities have been established as follows:

Management of Nature Reserves and rehabilitation of habitat	Lyndon Mutter and Rod Martyn, CALM Perth District
Reserves water depth and quality and population monitoring	Phil Fuller & Andrew Burbidge, CALM Science & Information Division
Ecological studies and translocation	Gerald Kuchling, UWA Zoology Department
Captive breeding	Dean Burford, Perth Zoo, with advice from Gerald Kuchling
Conservation genetics	David Groth, Curtin University
Proposed translocation sites	Andrew Burbidge and Gerald Kuchling

RECOVERY PLAN AND FUNDING

During 1991 a Recovery Plan for the Western Swamp Tortoise was prepared, based on the Management Program published in 1990. The Recovery Plan covers a ten year period from 1993 to 2002 and lists actions necessary to ensure the species' continued recovery. In July 1993, CALM's Corporate Executive formally endorsed the Recovery Plan and in December 1993 the National Parks and Nature Conservation Authority, in which the three nature reserves are vested, endorsed it. The Plan was formally endorsed by the Minister for the Environment and was published by CALM during 1994 and has been given administrative acceptance by the Commonwealth Minister of the Environment (the Commonwealth *Endangered Species Protection Act 1992* does not allow adoption of recovery plans for species that occur on both Commonwealth and State lands).

The objective of the Recovery Plan is to decrease the chance of extinction of the Western Swamp Tortoise by creating at least two wild populations and doubling the total number of individuals. Because of the species' low fecundity, slow growth rates and long time to sexual maturity it will not be possible to achieve up-listing from Endangered (old IUCN categories) or Critically Endangered (new IUCN categories) within the 10 year time frame of the Recovery Plan.

Four actions were prescribed in the Recovery Plan:

1. Management of Ellen Brook Nature Reserve, and wild population.
2. Captive breeding.
3. Re-introduction to Twin Swamps Nature Reserve.
4. Education, publicity and sponsorship.

Implementing the actions was estimated to cost a total of $1 676 000 over the Recovery Plan's ten year

period. Funding has mainly come from Environment Australia through the Natural Heritage Trust's Endangered Species Program, Perth Zoo and CALM. Several sponsors have assisted with various aspects.

Funding from the Endangered Species Program was for five years and this period concluded at the end of 1997. The Recovery Team prepared a review of the success of the Plan over the first five-year period in October 1997. A revised draft Recovery Plan for 1998-2002 was prepared at the same time and attached to the review. In 1998, the Commonwealth Minister for the Environment arranged for an independent review of the implementation of the Plan to be carried out. This review was conducted by Dr Hal Cogger, John Evans Fellow, Australian Museum, Sydney, and Conjoint Professor Faculty of Science and Mathematics, University of Newcastle, whose report is dated 14 April, 1999. Dr Cogger stated *inter alia* 'In summary, the Recovery Plan was well planned and has been implemented so successfully that many of its 2002 goals have already been achieved. Logistical and ecological problems have arisen in the course of the project, and most have been appropriately and successfully addressed. The Recovery Team has operated effectively and has provided expertise critical to the success of the program.' Dr Cogger's recommendations to the Commonwealth Minister were:

1. That because the existing program is achieving, ahead of schedule, a primary objective of increasing the number of Western Swamp Tortoises to a level which moves it from the IUCN category "Critically Endangered" to that of IUCN Endangered, it continue to be supported by the Australian Government through relevant programs for the conservation of threatened species.

2. That the second edition of the Recovery Plan be formally adopted as a basis for action until 2002, and its performance criteria regularly monitored against projected achievements.

3. That to ensure that successes to date are not put in jeopardy, special priority be given to (a) the monitoring of the existing wild populations, (b) the establishment of a third wild population and (c) the establishment of a second captive breeding facility. As the preferred site for the third wild population is on Commonwealth land at Perth Airport I further recommend that the Commonwealth facilitate the cooperation of the Airport's management authority.

In May 1999, Environment Australia advised that continued funding would be provided under the NHT to support the implementation of the recovery plan; however, to date no funds have been received. Late in 1999, Environment Australia advised that they would enter into a Financial Agreement with CALM to provide these funds and funds for 1999/2000; however, the amount offered for 1999/2000 was significantly less than the amount requested by the Recovery Team. The terms and conditions of this agreement had not been finalised by the end of 1999. Lack of Commonwealth funding during 1998 and 1999 has made implementation of the Recovery Plan difficult. The cut in funding for 1999/2000 will limit the Team's ability to implement fully the recovery actions in the Plan.

RECOVERY PLAN IMPLEMENTATION

Progress with the actions laid down in the revised Recovery Plan is as follows.

3.1 Employment of Chief Investigator

A contract between CALM and The University of Western Australia, to allow the continued half-time employment of Dr Kuchling, has been finalised.

3.2 Management of Ellen Brook and Twin Swamps Nature Reserves

3.2.1 Management of Ellen Brook Nature Reserve

Routine management of the nature reserve continued as in past years. Three 1080 baiting programs were undertaken. The system of strategic firebreaks was maintained. No fires occurred on the reserve.

Minor repairs were made to the vermin proof fence. The Ellen Brook vermin proof fence, the first attempt at a vermin proof fence by CALM, is not as robust as the latter Twin Swamp vermin proof fence, and requires considerably more maintenance. The fence will need to be replaced section by section over the next 5 years.

There was continued control of the weed Watsonia targeting any plants in the vicinity of the vermin proof compound. Paterson's Curse and Cape Tulip control was also undertaken on a priority basis. Patterson's Curse has invaded a section of pasture under revegetation. Further control will be undertaken in 2000 to contain and control this infestation. Summer control of African Lovegrass was undertaken in areas adjoining Great Northern Highway following slashing to reduce the risk of fire entering the reserve from Great Northern Highway.

3.2.2 Management of Twin Swamps Nature Reserve

Reserve management of the nature reserve continued as in past years.

Two 1080 fox baiting programs were conducted.

An intensive raven control/scare program was undertaken again this year at northwest swamp. CALM staff patrolled the perimeter of the swamp each day from sunrise to sunset for a week after the pump was switched off until it dried at the end of November. The program was successful with no mortalities observed this year.

No prescribed fuel reduction burning was undertaken in the reserve this year. Two blocks are proposed for burning in 2000, consistent with the Interim Management Guidelines for the reserve. The fuel reduction program involves one third of the reserve, burnt on a 10 year rotational basis to establish internal low fuel areas to minimise the area of the reserve burnt in a wildfire. Burning is undertaken in spring when tortoises are located in the ponds and not threatened by the fire. No wildfires occurred on the reserve. Firebreaks were maintained.

Cape Tulip was controlled on all external and internal fire breaks and on a buffer of 5 metres adjoining breaks. Cape Tulip control is required by the Agriculture Department as part of a local control containment strategy.

The vermin proof fence did not require any maintenance.

A trial rat-trapping program was initiated late in 1999. This was in response to data indicating predation of juvenile tortoises by rats (see below) and recent trapping of rats by an Edith Cowan student studying bandicoots. The program involved placing lines of baiting stations developed for rat eradication where non-target species are present. Follow up rat trapping will be undertaken inside and outside baited areas in April-May 2000. If baiting appears to reduce rat numbers and predation of tortoises, the bait station grid will be extended.

3.3 Population and environmental monitoring

3.3.1 Tortoise population monitoring

Morphometric and locational data from animals captured or radio-tracked are entered onto cards or field note books in the field and transcribed to a microcomputer database. Mark-and-recapture data are used to calculate the number of tortoises known to be alive (KTBA) each year and estimates of population size are made using the procedure of Manly and Parr. Population estimates calculated for 1999 are shown in Tables 1 and 2.

Table 1. Ellen Brook Nature Reserve, Western Swamp Tortoise Population Estimates 1963 - 1999.

Year	No. captured	Manly & Parr estimate	KTBA Adults	KTBA juveniles	KTBA H + 1	Total KTBA
1963	4	-	15	6	0	21
1964	9	48	16	6	0	22
1965	3	48	12	6	0	18
1966	4	21	11	6	0	17
1967	2	30	11	5	0	16
1968	5	20	10	6	1	17
1969	1	16	10	5	1	16
1970	3	-	13	5	0	18
1971	0	-	11	5	1	17
1972	6	20	11	5	2	17
1973	0	-	11	5	4	20
1974	2	40	12	5	4	21
1975	3	30	11	8	2	21
1976	9	24	11	8	2	21
1977	3	20	10	8	2	20
1978	8	36	10	9	3	22
1979	4	22	8	9	5	22
1980	8	29	8	12	4	24
1981	8	30	8	13	6	27
1982	10	37	8	14	7	29
1983	5	73	9	15	8	32
1984	10	100	9	16	12	37
1985	7	58	10	20	6	36
1986	2	34	11	19	4	34
1987	6	41	14	19	2	35
1988	5	58	14	19	4	37
1989	17	40	15	16	5	37
1990	12	41	18	16	2	36
1991	21	35	21	13	0	34
1992	23	44	21	11	4	36
1993	25	50	19	8	13	40
1994	35	59	21	9	16	47
1995	18	43	18	11	3	32
1996	11	40	*	*	*	24
1997	5	18	*	*	*	18
1998	22	40	*	*	*	27
1999	31	-	*	*	*	31

Notes:

1. KTBA - known to be alive. KTBA is significantly lower than actual for at least the most recent five years because of low sample size. For this reason, adult, juvenile and H+1 KTBA not calculated for last four years (shown as *).
2. Animals with carapace length > 110 mm are assumed to be adults
3. Juveniles are two or more years old.
4 H+1 are hatchlings and one-year-old tortoises.
5. Manly & Parr estimates not possible in the first and last year of sampling and in some other years due to small number of animals captured, estimate shown as '-'

Table 2. Twin Swamps Nature Reserves, Western Swamp Tortoise Population Estimates 1963 - 1999

Year	No. captured	Manly & Parr estimate	KTBA adults	KTBA juveniles	KTBA H+1	Total KTBA
1963	1	-	37	7	8	52
1964	4	288	37	10	28	75
1965	9	273	36	15	46	97
1966	65	127	34	34	34	102
1967	26	156	31	44	1	76
1968	17	68	29	31	2	62
1969	8	93	28	30	3	61
1970	26	72	27	31	1	59
1971	27	72	28	24	0	52
1972	15	57	25	15	0	40
1973	13	59	27	7	0	34
1974	8	92	23	4	2	29
1975	8	34	20	2	2	24
1976	4	27	18	3	0	21
1977	9	26	18	2	0	20
1978	9	29	15	2	1	18
1979	6	20	10	2	2	13
1980	2	10	8	2	0	10
1981	3	10	8	2	0	10
1982	3	11	8	2	1	11
1983	5	15	8	2	1	11
1984	3	12	6	3	0	9
1985	2	-	6	2	0	8
1986	0	-	6	0	0	6
1987	0	-	6	0	1	7
1988	0	-	6	0	1	7
1989	0	-	6	1	0	7
1990	2	12	6	1	0	7
1991	0	-	5	1	0	6
1992	1	-	5	1	0	6
1993	0	-	4	1	0	5
1994	14	23	4	12	0	16
1995	40	72	8	25	12	45
1996	33	45	*	*	*	36
1997	37	80	*	*	*	43
1998	32	160	*	*	*	39
1999	57	-	*	*	*	57

Notes:

1. KTBA - known to be alive. KTBA is significantly lower than actual for at least the most recent five years because of low sample size. For this reason, adult, juvenile and H+1 KTBA not calculated for last four years (shown as *).
2. Animals with carapace length > 110 mm are assumed to be adults
3. Juveniles are two or more years old.
4 H+1 are hatchlings and one-year-old tortoises.
5. Manly & Parr estimates not possible in the first and last year of sampling and in some other years due to small number of animals captured, estimate shown as '-'

Population data for Ellen Brook NR continue to suggest a slow but gradual increase in the number of adult tortoises since the fox-proof fence was constructed. At Twin Swamps NR, the data reflect the re-introduction of captive-bred animals from Perth Zoo.

Apart from the tortoises that were translocated during 1998 and 1999 and apart from the new juvenile found on private land to the west of the reserve (see below), 14 resident tortoises were handled at Ellen Brook Nature Reserve during 1999. Those included three of the five hatchlings marked in November 1998. They were recaptured in November 1999 and had about doubled their body mass. Two new 1999 hatchlings were found with 22 g and 30 g body mass during November, indicating good growing conditions at Ellen Brook Nature Reserve during 1999. Another notable recording was that female #191 which had hatched in 1988 had two oviducal eggs as assessed by ultrasound scanning on 21 November, probably the first clutch of that eleven year old female.

OTHER STUDIES

In 1999 the activities at EBNR were not limited to recapturing tortoises for the population estimates, but included also the experimental repatriation of some of the tortoises in the captive colony which were originally collected on Reserve A42126 (when it was still privately owned) or on private property close by. The fence between the new block and the old fenced area at Ellen Brook Nature reserve was removed in autumn 1998. Four male tortoises, equipped with radio transmitters, were released into the new block during the spring of 1998. During the winter of 1999, four females were also released with radio-transmitters into the new block. These females had originally been earmarked for release in 1998, but due to a delay of their release they were already gravid when release was imminent and they were left at Perth Zoo to avoid any stress during the transfer. To counterbalance the resulting unplanned increase in hatchling production at Perth Zoo in 1999, the same number of captive bred hatchlings as that obtained from the 1998 eggs of those four female, eleven, was also released into the new block. The purpose of these experiments was to evaluate the suitability of the area for Western Swamp tortoises, although the land is still under rehabilitation (see 1.7 strategy for recovery (v) and recovery action 3.6).

Radio-tracking

Due to problems with radio-transmitters, only one of the four adult male *P. umbrina* which had been released into the new, rehabilitated part of Ellen Brook Nature Reserve during October 1998 was tracked at the start of 1999. This male was aestivating in a rabbit warren, but unfortunately his radio-transmitter, too, stopped working during the summer. During the winter of 1999, two of those males were recaptured in and close to the new block and equipped with new transmitters. However, transmitter problems re-occurred and both transmitters stopped working again during spring. All transmitters had been in use for several years and may, thus, have lost their reliability.

The four females were released with radio-transmitters on 21 July 1999 and stayed during winter at the new block or in the adjacent area of the old reserve. The transmitter of one female stopped working in early September. Ultra-sound scanning showed that all three still radio-tracked females were gravid by early October. One female was found outside the reserve on private land to the west (White family property) on 5 October 1999 and returned to Perth Zoo. A second female was found on 19 October at the same property and also returned to Perth Zoo. The third female had shed her radio-transmitter together with her carapacial scutes by 19 October, the transmitter was found in the main swamp of the Midland Brick property to the west. Unfortunately the female could not be found. Thus, all three radio-tracked females had left the fenced reserve once they were gravid.

None of the radio-tracked males had been located directly at the western fence during spring and early summer of 1998. However, both recaptured males spent some time at the western fence during winter 1999. More than half of the location data of the radio-tracked females during the 1999 winter was directly at or very close to the western fence, even before they were gravid. This suggests that the areas to the west may be particularly important for females. It is possible that, in the past, their nesting areas were outside the reserve and that they tried to return to these locations.

Both females and the shed radio-transmitter were found in areas that are earmarked for acquisition and future inclusion into Ellen Brook Nature Reserve (see under 1.6.3 Extension of nature reserves in the

Recovery Plan). This demonstrates the significance of these still unprotected areas for the Western Swamp Tortoise population at Ellen Brook Nature Reserve. The significance of these unprotected areas is further supported by the capture of an unmarked, juvenile swamp tortoise (#553, 104 g body mass) at the Midland Bricks property on 16 November 1999. This juvenile suggests that these areas may be important for reproduction and recruitment of the southern sub-population at Ellen Brook Nature Reserve. The animal was equipped with a radio-transmitter and released in the main swamp area at Ellen Brook Nature Reserve. Unfortunately, this radio-transmitter (an old one) also stopped working in late 1999.

The eleven captive-bred hatchlings were released on 21 July 1999 into the main swamp area of the new block. Three of them were recaptured during intensive searching on 26 November 1999, just before the swamp dried out. Those three increased their mean body mass from 22.2g in July to 43.3g in November, demonstrating a satisfactory growth rate during winter and spring similar to that of wild hatchlings in the old swamps at Ellen Brook Nature Reserve or hatchlings at Perth Zoo. This suggests that the swamps under rehabilitation at the new block offer suitable food and environmental conditions for the growth of hatchlings.

During the same intensive search on 26 November one of the released males (#429) was also recaptured and showed a severe case of spreading shell necrosis on the carapace and plastron. This problem had not been obvious in August 1999 when #429 had also been found and examined. Although localised necrotic shell conditions have been observed in the past in some wild as well as captive *Pseudemydura*, similar cases of large scale, obviously spreading necrosis over most shell areas were unknown. The male was taken to the animal hospital at Perth Zoo, shell samples and swabs were collected to investigate the cause of the disease and the animal was treated for two weeks with antibiotic and antifungal medication. Since we do not know if the diseased male may infect other tortoises, the male was transferred into isolation in an aestivation enclosure at UWA's Zoology Department .

Despite the unfortunate problems with the radio-transmitters, the results of the experimental repatriation of adult tortoises and hatchlings to the new block suggest that the new, rehabilitated area now offers swamps of an adequate quality for Western Swamp Tortoises. Two adult males of the resident Ellen Brook Reserve population were also recorded at the new block during 1999. However, the results also demonstrate that the area is obviously too small to be of significant value to the Ellen Brook population. Adult females of the southern sub-population at Ellen Brook Nature Reserve also require, possibly for nesting, privately owned areas outside the reserve. They would rather negotiate the fox-proof fence to reach those areas than move to other places inside the reserve fence. Males may be more flexible in area utilisation. This observation also reinforces the significance of the one-way tortoise gates that were installed into the fence and tested during 1997, which allow tortoises outside the fence to enter the reserve. However, in the long term tortoises that also utilise unprotected areas outside the reserve may be subjected to high mortality. The acquisition and protection of these areas is, thus, critical for the viability of the southern sub-population at Ellen Brook Nature Reserve.

3.3.2 Monitoring of water depths and water chemistry

Water samples were collected in September 1999 and analysed by the WA Chemistry Centre. Analysis data are stored in a microcomputer database at CALM's Wildlife Research Centre. Analyses have been carried out since 1972 at four sites within TSNR and one site within EBNR. An additional four sites within land added to EBNR and proposed to be added to EBNR have been monitored 1992. In summary, the analyses show few problems with water quality. There are relatively high nitrogen and phosphorus levels in two swamps in TSNR that have catchments partly outside the nature reserve, but these levels do not appear to have had any detrimental effects on the tortoises or their aquatic invertebrate food. Analyses of heavy metals and other possible contaminants (fluoride, mercury, zinc, cadmium, lead and selenium) do not show any significantly elevated levels.

3.4 Captive breeding

3.4.1 Existing captive-breeding colony

The captive-breeding colony over the past few years has been operating with 12 adult females contributing to the number of eggs produced. Four of these were acquired outside the fox-proof fence at EBNR and subsequently transferred to Perth Zoo until extensions to the fence took in their home ranges. The recovery team decided that, when the extensions were completed, these tortoises could be returned to EBNR. This plan was delayed when a female aborted her clutch of eggs. The revised plan was to release these females together with any offspring they produced, however, two of them were returned to the zoo after being recaptured outside the fence. This resulted in the potential number of females that could be bred from this year being 10. Of these 1 did not ovulate. A total of 33 eggs was produced by 9 females.

Earlier in the year, 41 of 46 eggs hatched from last year's clutch. One of these hatchlings was in poor condition and died after several months. A further 11 offspring produced by the four females mentioned above were released into EBNR.

In July the largest translocation so far was undertaken when 40 juvenile WST were released into TSNR (see below). This reduced the overcrowding problem that was beginning to develop within the breeding facility.

Since the beginning of the captive-breeding project some tortoises have been retained in captivity according to their bloodlines. The number of these tortoises is now approaching 30 and some are now sub-adults. Ultra-sound scanning has shown that in at least two females the reproductive cycle has begun so these could be expected to begin contributing to the expansion of the project and gene pool in the next two to three years.

The current number of WST at Perth Zoo is seven breeding males, ten breeding females and 140 other tortoises made up of hatchlings, juveniles, sub-adults and non-breeding adults, for a total of 157.

3.4.2 Establishment of second captive breeding facility

During 1999, Perth Zoo contacted several zoos in eastern Australia seeking expressions of interest in obtaining Western Swamp Tortoises and establishing a second breeding colony. Only Adelaide Zoo has shown interest in having Western Swamp Tortoises and they are seeking six animals, three of each sex, but are not planning to breed them. The Team agreed that negotiations with Adelaide Zoo should proceed with the aim of developing a draft agreement.

3.5.1 Re-introduction to Twin Swamps Nature Reserve

3.5.1.1 Release and post-release monitoring

In 1999 the focus at TSNR was on monitoring the tortoises that were re-introduced in previous years and on further re-introductions.

Aestivation - summer 1998/99

Ten captive bred juvenile *Pseudemydura umbrina*, plus one adult females were radio-tracked at the start of 1999 when all those animals were in holes underground, mainly rabbit warrens (7) or smaller diggings by rabbits and other animals (4). The aestivation sites of seven juveniles and of the female were in *Regelia* shrubland, two were in *Banksia* woodland and one was in a small hole in the wall at the edges of the northern firebreak. An additional eleventh juvenile was radio-tracked in December 1998, but its radio-transmitter had obviously stopped working in late December. The radio-transmitter of the female stopped working in early 1999. At a check on 4 May 1999, eight of the ten remaining juveniles were still in holes, one was at the surface under vegetation and leaf litter and dry shell remains of the last were found together

with its transmitter at the surface about 1 m from its previous aestivation hole at the northern firebreak wall. In early June, eight of the nine remaining juveniles were hiding on the surface under vegetation and leaf litter some meters from their aestivation holes and their radio-transmitters were removed. At that time the swamps were still dry. The disintegrated shell remains of the last animal were found together with its transmitter in the old rabbit warren in *Regelia* shrubland in which it had been since early December 1998, about 25 cm underground.

Translocation 1999 and population monitoring

On 21 July 1999, 40 juvenile, captive-bred Western Swamp Tortoises (>95 g) were released at NW Swamp, four of them equipped with radio-transmitters. Budget problems and the simultaneous need for radio-transmitters at Ellen Brook Nature Reserve did not allow for a larger number to be tracked during winter and spring. On 24 August the radio-transmitter was removed from one juvenile to be used on a re-captured female (#70). A further transmitter stopped working in late August and another one was shed with carapacial scutes in late October. The same happened to the last transmitter during November. During the time they were tracked, all juveniles had stayed in NW Swamp in the water. Female #70 also shed and lost her transmitter during November.

During intensive searches mainly during November, 20 of the 40 juveniles released in July 1999 were recaptured and 18 of them equipped with radio-transmitters during the second half of November. In addition, three juveniles of the 1998 release (all now equipped with radio-transmitters), one of the 1997 release (now equipped with radio-transmitter), two of the 1995 release (one now equipped with radio-transmitter) and three of the 1994 release (two now equipped with radio-transmitters) were also recaptured. In addition to above recaptures of juveniles which were released with >95g body mass, two juveniles were recaptured which had been released as (slightly head started) hatchlings, one in 1998 and one in 1995 (now equipped with radio-transmitter). Thus, by the end of November 1999, 26 juveniles were radio-tracked.

The recaptured juveniles demonstrated that growth rates are generally good at Twin Swamps and comparable to old data of wild juveniles and growth rates of juveniles at Perth Zoo. This includes the animals released as hatchlings. However, all three juveniles of the 1994 release showed signs and scars of gnawing by predators, presumably rats, on various parts of the shell and on soft parts (feet and in one case also neck). They have obviously survived rat attacks. One of those animals, #212, had already lost its right front foot due to a raven attack in late 1995. A further juvenile of the 1995 release had healed bite marks on its shell, presumably caused by a fox or cat. This demonstrates that predation, in those cases unsuccessful, still impact on juvenile Western Swamp Tortoises at Twin Swamps.

All of the radio-tracked juveniles had left NW Swamp by late November and started to aestivate. By the second half of December, 16 stayed in (sometimes old and abandoned) rabbit warrens and nine in smaller animal diggings/ holes. Twelve were in *Regelia* shrubland, twelve in *Banksia* woodland, and one in an area of *Melaleuca viminea* and *Calothamnus lateralis* (flooded during winter). One of the radio-tracked juveniles (#406, released 1999) was found dead and already dry, hidden under a *Regelia* bush, close to the north-eastern margin of NW Swamp on 21 December. Its left front foot and the right part of its lower jaw was partly ripped out and twisted (jaw dislocated), injuries which are consistent with a raven attack. About 2½ m away, in an open area under some grass, the remains of a second juvenile (#462, released 1999) was also found, lying on its back. No remains of its head, left front foot and right hind foot could be found. The set up of the scene suggests that a raven may have first attacked #406 and ripped out its left front foot and dislocated its lower jaw, but was then distracted by #462, which allowed #406 to escape under the nearby *Regelia* bush and die hidden away while the raven killed and partly ate #462 out in the open. This may have happened in late November, during the movement of the juveniles from NW Swamp to the aestivation areas. Although #406 had been located and seen on 30 November at the exact place where its remains were found on 21 December, it had not been picked up and examined and the injuries were, thus, not detected. The close by remains of #462 were overlooked on 30 November, since they were hidden under dense grass which had been dry three weeks later.

Summary of predation and mortality

The following Table summarises the recorded mortalities and injured survivors of predation attempts of released, captive bred juvenile Western Swamp Tortoises at Twin Swamps Nature Reserve from 1994 to 1999:

year	number released	recorded mortalities, active period	rec. mortal. at start of aestivation, at surface	rec. mortal. during aestivation in holes	rec. injuries, possibly by raven	rec. injuries, possibly by rat	recorded injuries, poss. by fox/cat	total deaths and injuries
1994/95	10	0	0	0	0	0	0	0
1995/96	18	3	0	0	1	0	0	4
1996/97	7	1	0	1	2	0	0	4
1997/98	25	5	2	0	0	0	0	7
1998/99	18	0	0	2	0	0	0	2
1999/00	40	0	2		0	3	1	6
total	**118**	**9**	**4**	**3**	**3**	**3**	**1**	**23**

Of all recorded mortalities:

13 occurred in between 12 months after the juveniles were released;
2 occurred in the 2nd year after the juveniles were released;
1 occurred in the 3rd year after the juvenile was released.

This suggests that, in general, "experienced" juveniles may be slightly less prone to predation than freshly released animals. It is likely that all mortalities during the active period were due to raven attacks. The same seems to apply to the mortalities during the start of aestivation (December, January) where corpses were found at the surface under vegetation. Those animals seem to have been injured while moving from the swamp to aestivation sites and were still strong enough to hide under bushes and vegetation before dying, but not strong enough to search for a suitable aestivation hole.

It is more difficult to reconstruct the cause of death of the three animals whose remains were found in aestivation holes (or close by, but which had aestivated in holes), particularly since their shell remains were generally dislocated when recovered and skeletal parts were missing. Since two juveniles recovered during the 1995/96 aestivation period despite their right front feet having been ripped out by ravens in late 1995, it is clear that some animals injured by ravens were still able to find suitable aestivation holes. It is therefore possible that some similarly injured tortoises may not have recovered, but died during the summer inside the holes.

However, the fact that three surviving juveniles carry scars which were obviously inflicted by rats point to the possibility that rats may predate aestivating tortoises inside their aestivation holes. It is interesting to note that of the three animals that died inside aestivation holes, one was released more than one year and one more than two years before their death. Of the 16 recorded mortalities only three took place more than 12 months after the release of the juvenile. This indicates that, if a tortoise dies in an aestivation hole, the general bias towards "naive", freshly released animal does not apply. The mortalities inside aestivation holes seem to occur independently of experience in the wild (in fact, one adult, wild male, #63, also died possibly due to predation inside an aestivation hole in 1995), suggesting that other causes than raven attacks may be responsible, since raven attacks are clearly biased towards naive, freshly released juveniles. Scars of rat attacks on surviving juveniles, however, were only found on animals which had spent several years in the reserve, suggesting that naivety does not play a role in attacks by rats. This combined evidence indicates that deaths inside aestivation holes may, at least partly, be caused by rat attacks.

The healed fox (or cat) bite marks of one individual indicate that these predators, when negotiating the

fence, remain threats to tortoises. However, the low incidence of these injuries demonstrates the general success of the fox-proof fence and fox and cat control at Twin Swamps Nature Reserve.

The 1999 breeding season

The only female found and radio-tracked at TSNR during winter and spring 1999, #70, did not have any vitellogenic follicles (as revealed by ultra-sound scanning) and did not breed during 1999. This indicates that she may have experienced environmental constraints during the previous year(s) that caused her not to initiate a vitellogenic cycle in 1999. She had not been radio-tracked since the end of 1996 (when she nested) and it is not known where she had spent the time since, but she was walking along the eastern fence when found on 24 August 1999. Past radio-tracking results of females at Ellen Brook and Twin Swamps indicate that females which try to get through fences often do not produce eggs.

No nests are, therefore, being monitored from the 1999 breeding season.

Long-necked Tortoises at TSNR

On 16 July the shell of a juvenile long necked tortoise was found entangled in the western fence near W Swamp. The animal had tried to get from the inside to the outside of the reserve, its shell had fitted through the larger mesh of the cyclone fence, but not through the finer mesh of the ground skirting mesh which is fitted on the outer side of the cyclone fence. It may have died through desiccation or over heating. Although no Western Swamp tortoise has yet been found in a similar situation, in future fence constructions it will be advisable to attach the finer skirting mesh to the inside to avoid such traps.

The following live *Chelodina oblonga* were found at Twin Swamps during 1999 and moved to the outside of the reserve: a juvenile of 111.1mm Cl on 01 November at NE-swamp; a juvenile of 105.2mm CL on 16 November at SW-swamp; a juvenile of 94.4mm Cl on 22 November at NW-swamp; and a subadult female of 138.3mm CL at NE-swamp on 30 November, This last animal had shell necrosis obviously spreading in a similar condition to the *Pseudemydura umbrina* male #429 which was found in late November at Ellen Brook Nature Reserve (see above). It was also taken to the Perth Zoo animal hospital for investigation and was then euthanased by the vets.

Thus, the number of *C. oblonga* recorded at Twin Swamps Nature Reserve since 1994 stands at 22.

The Effect of Earthworks at Twin Swamps Nature Reserve in 1999

All five dams constructed along the fence at TSNR provided at least some water from about the middle of June until late November, and one (at NE Swamp) has still water end of January 2000. These dams, thus, fulfilled their purpose - to provide water from about June to November.

The earth dam along the firebreak at the fence at NE-swamp improved the water level in that swamp. Once water overflowing from NW-swamp and N-swamp drained in along the modified firebreak, NE-swamp had in 1999 the best water level ever recorded. The following Tables provide the water levels of NW-swamp together with those of the preliminary depth gauges along the northern boundary (N1-N4) and in NE-swamp since 1996 (before the earth dam was constructed). NE1 is located in the deepest western portion of NE-swamp, NE2 near the dam at the western margin of NE Swamp. During February 1997 the earth dam was constructed and, since then, water can drain into NE Swamp: when NW-swamp is overflowing, water drains from there to N4, then on to N3, then on to NE1 and further on to NE2.

1996 was a year with reasonable rainfall at TSNR and NE had water until the second half of November. It is, however, noteworthy that the adjacent N-swamp area (N3) fell dry about 4 weeks earlier:

1996	NW	pump	N4	N3	N2	N1	NE1	NE2	water drains fr. W - NW	water drains fr. N3 - NE1
02/09	22+	-	22.0	20.1	30.0	11.0			+	-
06/09	22	-	21.5	19.5	29.0	16.5	22.0		+	-
12/09	24+	-	24.0	22.8	32.0	23.3	26.0	22.0	+	-
20/09	22+	-	22.0	20.0	29.0	19.5	27.5	23.5	+	-
02/10	22	-	21.1	20.0	28.8	18.5	29.0	25.0	±	-
06/10	20	-	16.2	14.5	21.0	9.8	26.5	23.5	-	-
08/10	19-	-	12.5	7.5	12.5	5.0	25.0	21.2	-	-
11/10	16+	-	12.5	7.1	2.5	3.6	24.5	20.2	-	-
21/10	16+	-	9.5	4.3	4.5	1.3	20.4	9.6	-	-
30/10	15-	-					19.0	dry	-	-
04/11	11-	-					12.2	dry	-	-
17/11	15+	+	dry	dry	dry	dry	6.0	dry	-	-

The winter of 1997 was very dry, TSNR-NE would normally have remained totally dry. Due to the fact that the pump into NW kept running throughout winter and spring, water eventually drained into the channel and over the natural NE-swamp shore into NE-swamp.

3.5.1.2 Pumping groundwater to maintain swamps and monitoring of food in swamps

The pump was used to supplement NW Swamp from late June until early August because of the dry opening to winter. It was run again for about ten days in early November.

The four dams constructed on the reserve boundaries functioned well providing a water source for any tortoises walking along the fence from early winter until early summer.

The bunding put in place in 1997 and strengthened in 1998 continued to function well, redirecting the flow of water leaving NW swamp to NE swamp rather than being lost from the reserve. Some periodical maintenance of bunds will be required every few years.

Invertebrate samples were collected during 1999; however, the report on this work was not available at the time of writing.

3.5.2 Translocation to additional sites

3.5.2.1 Selection of suitable translocation sites

Progress with obtaining agreement to translocate Western Swamp Tortoises to a third site is slow. A summary of the sites and future plans is provided at the end of this report. Possible sites and comments on them follow:

Perth Airport—Westralia Airports Corporation have arranged a groundwater study of the swamps at the northern end of Perth Airport with the aim of predicting whether future runway extensions may affect swamp levels. Results will be available in 2000 and further discussions with Westralia Airports are then required to decide whether the area is available.

Caversham RAAF land—With Defence Estates Organisation (DE0) approval, CALM and UWA blocked the drains currently affecting the swamps on this property and installed depth gauges. Monitoring of the depth gauges during the 1999 winter and spring demonstrated that swamps in the northern end of the land were suitable as a WST translocation site. DEO have indicated that the Department of Defence was moving to sell the land for housing. CALM has written to Environment Australia, indicating our interest in the area. Further investigations into planning and

zoning restrictions in the area are underway. The Recovery Team will seek to have the northern half of the land dedicated to the Western Swamp Tortoise.

Drummond Nature Reserve—No further action as the area is deemed not to be suitable and costs would be high.

Dobaderry Swamp (within Wandoo Conservation Park)—No further action as the area is deemed to be unsuitable.

Gnangara Park—Planning for the development of this area has commenced and the Recovery Team is discussing whether it may be possible to use part of the area as a WST introduction/breeding site with the planners.

Banganup Lake—This area is well outside natural WST range; however, it may have potential as a free-range breeding site. UWA is to further investigate this area as a possible juvenile rearing area..

Wannamal area—This is an area of private property offered for sale to the government as a conservation reserve. It contains three clay swamps, which are similar to those at Ellen Brook NR and are surrounded by Banksia woodland. During 1999, the swamps held water until early December—longer than those at Twin Swamps Nature Reserve; however, rainfall at Wannamal was well above average in 1999. CALM has given approval for negotiations to purchase the land to commence. It was agreed that, if the purchase goes ahead, the area would be fox-baited and a trial translocation utlising sub-adult captive-bred tortoises would proceed in 2000 or 2001, subject to the necessary approvals.

3.5.2.2 Preparation of new translocation site(s)

3.5.2.3 Release and post-release monitoring

No work as yet.

3.6 Rehabilitation of purchased land and creation of additional habitat on existing Ellen Brook Nature Reserve

Four thousand seedlings propagated from seed collected from the nature reserve were planted. The revegetation prescriptions used this year were modified as a result of experience in 1998. This year the program involved the planting of seedlings only and the use of weed suppressing mats to control weeds around the seedlings. Herbicides were only used in summer to control Kikuyu, not in winter when the area is waterlogged. The density of weeds will gradually decrease as revegetated areas mature with shading and build up of leaf litter, as has been observed in Acacia regrowth areas on the reserve.

The next stage of plantings will be undertaken in 2000 with the assistance of a Greencorp training program. Seed collection has continued this summer with the assistance of Greencorp trainees.

3.7.1 Education and publicity

No major activities were undertaken this year.

3.7.2 Sponsorships

The WA Water Corporation sponsored the Western Swamp Tortoise exhibit and the captive-breeding program by funding the construction of new aestivation pens. This was the end of a three-year funding program at Perth Zoo.

PLANNING TRANSLOCATIONS OF WESTERN SWAMP TORTOISES, 1999-2003

AS AT DECEMBER, 1999

	1999	2000	2001	2002	2003
Twin Swamps NR	continue reintroduction	continue reintroduction, decide when to stop	monitor	monitor	monitor
Perth Airport	groundwater study, negotiate	negotiate after finalisation of hydrology study	construct fence, reintroduce	reintroduce	reintroduce
Caversham RAAF land	assess, measure water depths	attempt to acquire northern half	attempt to find funds to fence, if acquired		
Drummond NR	no further action				
Dobaderry	assess, measure water depths and temperature	no further action			
Gnangara Park	inspect and assess	assess			
Banganup Lake	inspect and assess	assess			
Wannamal	inspect and assess	experimental introduction if possible[1]	assess, continue introduction if monitoring shows success is likely		
Adelaide Zoo	negotiate	negotiate	transfer animals?		

Notes:

1. Wannamal will require purchase negotiations to be finalised, and fox baiting in place.