WESTERN SWAMP TORTOISE

RECOVERY PLAN

ANNUAL REPORT

2003

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for

The Western Swamp Tortoise Recovery Team

NATURAL HERITAGE TRUST PROJECT 023175

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SUMMARY

Progress continued towards implementing the actions contained in the Western Swamp Tortoise Recovery Plan and implementation of most recovery actions continues to be on schedule. Highlights of the year included:

- A significant event was the capture of an unmarked juvenile Western Swamp Tortoise of 142.5g in the dam of NE-swamp at Twin Swamps Nature Reserve on 25 December 2003. This juvenile hatched 1997 or 1998. It did not correspond to the features of any of the captive-bred hatchlings released from 1995 to 1998 or to hatchlings from monitored nests of 1995/96. None of the re-introduced, captive-bred females were mature at that time. It must, therefore, be an offspring of one of the old Twin Swamps females. This is the first time since the early 1980s that natural recruitment into the Twin Swamps population could be demonstrated.
- The capture of a hatchling of 2003 with a body mass of 23.2g on the Midland Brick land directly to the West of Ellen Brook Nature Reserve. This demonstrates that there must have been a breeding female on the block in 2002 and further underlines the suitability of this area for the Western Swamp Tortoise.
- Perth Zoo currently holds 161 tortoises comprising 22 breeding males, 23 breeding females and 116 other tortoises comprising hatchlings, juveniles, sub-adults and non-breeding adults. Forty-two hatchlings were obtained in 2003 from eggs laid in 2002.
- 2nd captive breeding facility at Adelaide Zoo was set up with two, two year old tortoises transferred from Perth Zoo to Adelaide.
- Groundwater was pumped to North West Swamp, Twin Swamps Nature Reserve during winter 2003, as winter rains were insufficient to fill the swamps. The volume pumped was 4417 kL. The rate of bore production has declined with a declining regional groundwater level.
- 10 survivors from the December 2002 fire at Mogumber spent the summer and autumn recovering at Perth Zoo and were then released at NW swamp at Mogumber in August 2003.
- Fifty-two predominantly juvenile tortoises were released into the three Nature Reserves. 42 juveniles were released into Mogumber Nature Reserve (including 10 survivors from the 2002 fire that had been recovering at the Perth Zoo), four hatchlings and one adult were released at Twin Swamps Nature Reserve and five hatchlings were released at Ellen Brook Nature Reserve.
- A rat control program at Twin Swamps Nature Reserve was continued during 2003.
- Prescribed burning was undertaken in one cells of Twin Swamps Nature Reserve in spring to minimise the area of the reserve burnt in a wildfire and the risk of significant numbers of tortoises being killed.
- An additional 40 artificial aestivating tunnels were installed at Mogumber and 108 tunnels were installed at Twin Swamps Nature Reserve to encouraged tortoise to aestivate below ground and reduce the risk of being killed in a wildfire situation.
- A third edition of the Recovery Plan for the period January 2003 to December 2007 was prepared and approved by the Western Australian Minister for the Environment.

Of continuing concern is the lack of further translocation sites to release captive-bred tortoises. The Recovery Team's preferred site, Perth Airport, was the subject of a hydrological study by Westralia Airports Corporation during 1999 and 2000 to clarify whether future runway extensions may deleteriously affect the target swamps. Westralia Airports Corporation advised the recovery team that they were not prepared to agree to a translocation to this area. The recovery team asked them to reconsider, but received no response. The Team has also investigated another possible site at Caversham, owned by the Department of Defence.

In 2003 another possible translocation site at Moore River Nature Reserve was investigated. This site shows significant promise, although some habitat manipulation would be required to make it suitable for the tortoise. More detailed investigations will be undertaken in 2004 to ascertain its suitability as a translocation site and the feasibility of undertaking any habitat modification.

1. 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 2003 Team membership was:

Mr Lyndon Mutter, CALM's Swan Coastal District Nature Conservation Coordinator, Chair
Professor Don Bradshaw, School of Animal Biology, The University of Western Australia
Dr Andrew Burbidge, Research Fellow, CALM Science Division
Mr Dean Burford, Perth Zoo
Dr Terry Fletcher, Perth Zoo
Dr David Groth, Department of Biomedical Science, Curtin University of Technology
Dr Gerald Kuchling, School of Animal Biology, The University of Western Australia
Mr Rod Martyn, CALM's Swan Coastal District
Ms Raquel Carter, National Threatened Species Network, World Wide Fund for Nature Australia
Mr Damien Crilley, Swan Catchment Council
Mr Terry Morley, Adelaide Zoo
Mr Stefan de Haan, CALM's Swan Coastal District, Executive Officer

During 2003 an invitation was extended for representatives of the Swan Catchment Council and the Adelaide Zoo to join the team, with both parties accepting.

During 2003 the Team met twice: in July and December. While the Team works together on many projects, primary responsibilities have been established as follows:

Management of Nature Reserves and rehabilitation of habitat	Stefan de Haan, Lyndon Mutter and Rod Martyn, CALM's Swan Coastal District
Population monitoring data analysis	Andrew Burbidge
Reserves water depth and quality	CALM's Swan Coastal District
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	Stefan de Haan and Gerald Kuchling

2. RECOVERY PLAN AND FUNDING

During 2003 the Western Australian Minister for the Environment approved a third edition of the Western Swamp Tortoise Recovery Plan for the period January 2003 to December 2007. It had been prepared and approved by the Executive Director of the Department of Conservation and Land Management and the Conservation Commission of WA in 2002.

This edition replaced earlier editions. A management program was developed in 1990 (Burbidge *et al*. 1990) and was launched by the world President of World Wide Fund for Nature, Prince Phillip, in November 1990. Its aim was to ensure that the Western Swamp Tortoise persists by creating at least two viable populations in the wild. The management program provided for the establishment of a recovery team and this first met in December 1990. In 1992 the management program was rewritten as a recovery plan, and following further minor revisions this was published in 1994 (Burbidge and Kuchling 1994). 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 nature reserves were vested, also endorsed it. The Plan was formally endorsed by the Minister for the Environment and was published by the Department during 1994.

This Recovery Plan was given administrative acceptance by the Commonwealth Minister of the Environment (the Commonwealth *Endangered Species Protection Act 1992* did not allow adoption of recovery plans for species that occur on both Commonwealth and State lands). The Plan was formally adopted under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* in 2001. A second edition, covering the period 1998-2002 inclusive, was prepared in 1998 and had been updated as an unpublished draft until the preparation of the 2003-2007 Recovery Plan.

The objective of the first and second edition of the Recovery Plan was 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 the plan did not expect 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 the Department. 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. In October 1997, the Recovery Team prepared a review of the Plan over the first five-year period and the revised second edition Recovery Plan for 1998-2002. In 1998, the Commonwealth Minister for the Environment arranged for an independent review of the implementation of the Plan to be carried out. Dr Hal Cogger (John Evans Fellow, Australian Museum, Sydney, and Conjoint Professor Faculty of Science and Mathematics, University of Newcastle), whose report was dated 14 April 1999, conducted the review. 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 provided in the 1999 Annual Report.

In May 1999, Environment Australia advised that continued funding would be provided under the NHT to support the implementation of the recovery plan. The amount provided for 1999/2000—$50,000—was significantly less than the amount requested by the Recovery Team. In 2000/2001 and 2001/2002, $100,000 was provided each year for implementation of the Recovery Plan**.** Funding under NHT1 expired in 2002/03 and in 2002, the Department of Conservation and Land Management applied for continuing funding as a priority project under the Swan Catchment Council's Regional bid under NHT2. This was supported at the State/Commonwealth Investment Committee level and the application for funding for the 2003/2004 period was successful. The Recovery Team received $119,500 towards the implementation of the Recovery Plan for this period.

2.1 Recovery Plan 2003-2007

The objectives of the third edition of the Recovery Plan - January 2003 to December 2007 are to decrease the chance of extinction of the Western swamp tortoise by creating at least three wild populations and increasing the total number of mature individuals to more than 50.

Criteria for successful achievement of the Objective are:

- Complete extension of the Ellen Brook Nature Reserve to the west to include Western Swamp Tortoise habitat currently within private properties.
- An increase in the number of adult, sub-adult and juvenile (> 2 years old) tortoises at Ellen Brook Nature Reserve to more than 50 by 2007.
- Persistence of a population of more than 40 adult, sub-adult and juvenile (> 2 years old) tortoises at Twin Swamps Nature Reserve and reproduction (egg laying) of re-introduced tortoises demonstrated by 2007.
- The creation of a population from captive-bred animals at Mogumber Nature Reserve of more than 35 adult, sub-adult and juvenile (> 2 years old) tortoises by 2007.
- The maintenance of a captive population of at least 12 breeding adults producing at least 20 two-year-old animals each year.
- The creation of a second captive colony at another accredited Zoo in Australia.
- The creation of a semi-captive 'insurance' colony of at least 20 tortoises at the Harry Waring Reserve of UWA or some other site.
- The selection by the Recovery Team and endorsement by relevant authorities of a third suitable translocation site.

The criteria for failure to achieve the objective are:

- A decline in numbers of the Western Swamp Tortoise in the wild.
- Cessation or significant reduction (to less than 10 hatchlings per year) in captive breeding.
- The maintenance of more than 50% of the non-hatchling world population of *P. umbrina* in a single captive colony.

3. RECOVERY PLAN IMPLEMENTATION

Progress with the actions laid down in the third edition of the Recovery Plan is as follows.

3.1 Employment of Chief Investigator

A contract between the CALM and The University of Western Australia, to allow the continued half-time employment of Dr Kuchling, has continued on a yearly-renewable basis.

3.2 Management of Ellen Brook, Twin Swamps and Mogumber Nature Reserves

3.2.1 Management of Ellen Brook Nature Reserve

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

Four 1080 baiting programs were undertaken. Development of two large artificial ponds occurred on the southern portion of the reserve.

The system of strategic firebreaks was maintained. No fires occurred on the reserve in 2003.

Minor repairs involving skirt replacement in wetter areas were made to the vermin proof fence. The Ellen Brook vermin proof fence is not as robust as the Twin Swamps vermin proof fence,

and requires considerably more maintenance.

Control of the weed *Watsonia* within the Vermin Proof compound continued. Control of the weed Tambookie Grass also took place within the Vermin Proof compound. Slashing of African Lovegrass occurred in areas adjoining Great Northern Highway to reduce the risk of fire entering the reserve from the highway.

3.2.2 Management of Twin Swamps Nature Reserve

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

Five 1080 fox baiting programs were conducted.

No raven control / scare program was undertaken at North West Swamp as the area retained water until later in the year.

A rat-baiting program continued. The program was initiated in response to previous data indicating possible predation of juvenile tortoises by rats. One hundred and forty baiting stations are placed in lines on the northern section of the reserve, which is most heavily used by the tortoises.

Prescribed burning was undertaken in one cell (approximately 18 hectares) of the nature 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 and the risk of significant numbers of tortoises being killed. Burning is undertaken in spring when tortoises are located in the ponds and not threatened by the fire. Strategic external and internal firebreaks were maintained. No wildfires occurred on the reserve during 2003.

Cape Tulip was controlled on all external and internal firebreaks. Control was extended into vegetation immediately adjoining the northern firebreak. Cape Tulip control is required by the Department of Agriculture as part of a local control containment strategy.

One hundred and eight artificial aestivating tunnels were installed on the reserve.

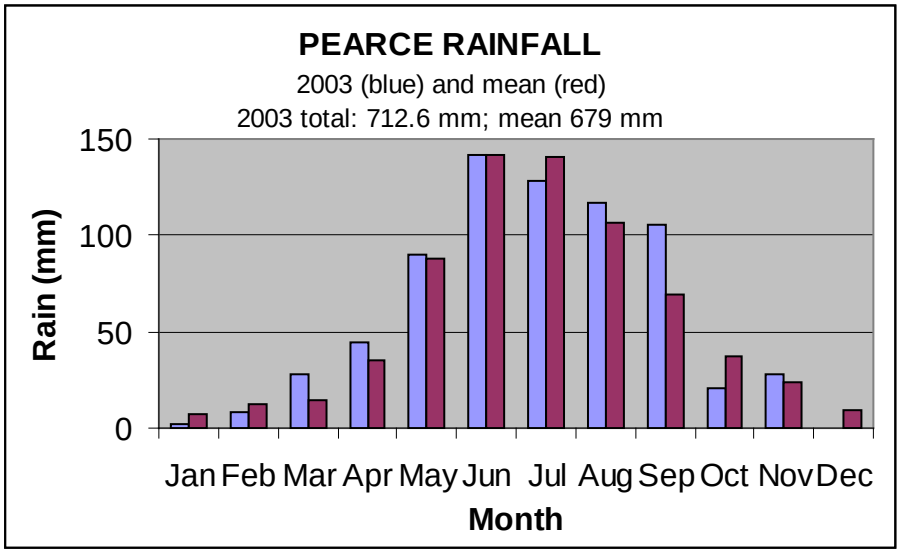
Electrical repairs were undertaken on the groundwater-pumping bore.

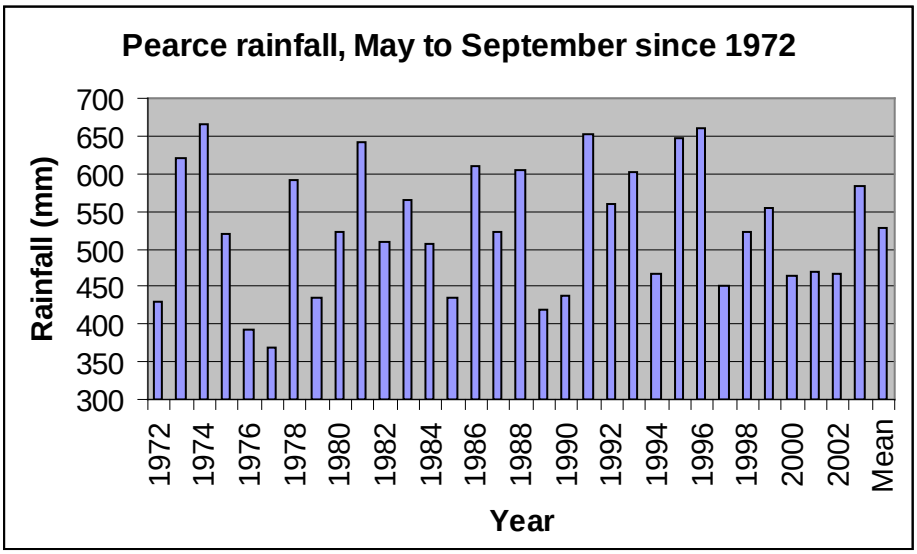
Minor maintenance of the vermin proof fence was undertaken. Two reserve signs were replaced at the nature reserve boundary.

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

2003 was a year of above average winter rainfall. The nearest rainfall station currently keeping records is at Pearce RAAF base, where records have been kept since 1937, although they are incomplete. Records indicate:

- Annual average precipitation 1937 to 2003 = 679 mm.
- Mean winter rainfall (May to September inclusive) 1937 to 2003 = 545.9 mm.
- Mean winter rainfall from 1937 to 1971 inclusive = 571 mm
- Mean winter rainfall 1972 to 2003 inclusive = 527.8 mm (Figure 2).
- In 2003 the total precipitation was 712.6 and the May to September rainfall was 582.4mm Figure 3).





The two new dams (constructed in May 2003) and the five older dams along the fence at TSNR dams provided at least some water until late November/early December 2002, and one, at NE swamp had water into January 2004. The dam of the firebreak channel between N and NE swamp had been built up in May 2003 and NE swamp had water from mid August to early November. NE-swamp had remained totally dry in the very dry years of 2001 and 2002. Without water draining in from NW-swamp and N-swamp along the modified firebreak NE swamp may also have remained dry in 2003.

SE-swamp remained totally dry in 2003. Water was maintained at NW swamp by groundwater pumping until late November.

3.2.3 Management of Mogumber Nature Reserve

Baiting of the reserve with 1080 baits continued on a monthly basis through out 2003 to control foxes.

An additional forty artificial aestivating tunnels were installed to encourage tortoises to aestivate below ground and reduce the risk of them being killed in a wildfire. The entire reserve was burnt

by a large wildfire under extreme conditions on 20 December 2002. The impact on the population was significant and is discussed further in section 3.4.

Replacement of rural fencing that was damaged in the December 2002 fire occurred.

The hydrological monitoring begun in 2002 was continued to determine whether the claypans are at risk from increasing salinity and to develop a water balance model. Adjacent areas to the east of the reserve have been affected by salinity in recent times. The monitoring, carried out by a consultant, was funded by the State Salinity Strategy.

Water levels and the period of inundation continue to be monitored to determine the reserve's long-term suitability for the tortoise.

3.2.4 Monitoring of water depths and water chemistry

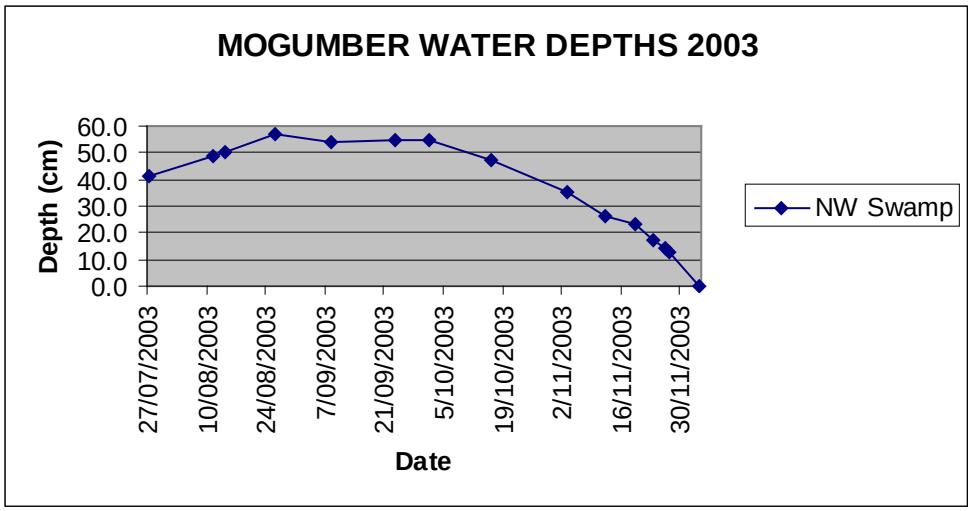
Water depths have been recorded at Ellen Brook and Twin Swamps Nature Reserves on an *ad hoc* basis since 1972. Depths have been recorded, when possible, at Mogumber since 2000.

Water samples were collected at Twin Swamps and Ellen Brook on the 8 September 2003 and analysed by the WA Chemistry Centre. Analysis data are stored in a microcomputer database at the Department'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 since 1992. In summary, the analyses show few problems with water quality. Relatively high nitrogen and phosphorus levels exist 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.

Bradie Durell, an Honours student at UWA's School of Animal Biology, compared water chemistry and the invertebrate communities in winter/spring 2003 at various sites on EBNR, TSNR, Mogumber NR and Harry Waring Marsupial Reserve (HWMR) as part of his Honours project. He took water and invertebrate samples at eight constructed swamp sites in the southern part of EBNR as well as at the two main swamp areas in the main reserve (near gauges 1 and 2). At TSNR samples were taken at five artificial ponds and at NW swamp, which is supplemented with ground water. At HWMR three artificial ponds at Melaleuca swamp were sampled in early August, early September and late September. He sampled the three main swamps (NW, SW, and E) at Mogumber Nature Reserve in early September and early October. Swamps showed pronounced variations in the invertebrate communities among the reserves as well as among various sites at EBNR and TSNR, with the community groupings also changing between early and late September. The swamps at Mogumber seem to group closest with swamps at EBNR.

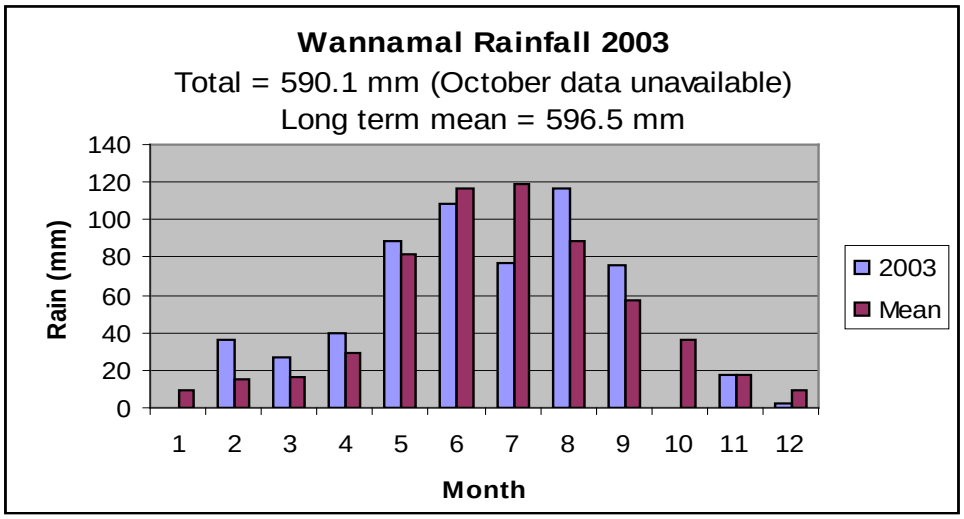
Swamp water levels at Mogumber Nature Reserve were only recorded at NW swamp in 2003, the depth gauge at SW swamp was burned during the fire in December 2002. The following levels were measured (in cm):

27/07/2003	41.4
11/08/2003	49
14/08/2003	50.3
26/08/2003	57
8/09/2003	54.1
23/09/2003	54.5
1/10/2003	54.7
16/10/2003	47
3/11/2003	35.2
12/11/2003	26.1
19/11/2003	23.6
23/11/2003	17.5
26/11/2003	14.4
27/11/2003	12.7
4/12/2003	Dry



Rainfall in 2003 was slightly below average, but some standing water was available until mid November. Compared to 2002 the swamps retained water for about a month longer. As Gerald Kuchling was away for June and most of July 2003 it is not possible to confirm when the swamps first started to fill. Given that the Wannamal area experienced some good rainfall in May and June 2003 it is possible that as well as retaining water longer in 2003 the swamps may have also started to fill slightly earlier.

Rainfall at Wannamal (the closest rainfall station to Mogumber Nature Reserve) shows that the area received 590.1 mm, slightly below the mean of 596.5 mm. Higher than average falls in Autumn and Winter contributed to the year's total; the winter (May to September) rainfall was 467.3 mm, slightly greater than the mean of 462 mm.



3.4 TORTOISE POPULATION MONITORING

Morphometric and locational data from animals captured or radio-tracked are entered onto cards or into notebooks in the field and transcribed to a card index and 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 (1968) and Manly (1969). Population structure data (adults, juveniles, hatchlings) are added manually. Population estimates calculated for 2003 are shown in Tables 1 and 2 and in Figures 1 and 2.

3.4.1 Ellen Brook Nature Reserve

Population data for Ellen Brook Nature Reserve suggest a gradual increase in the number of adult tortoises between 1981 and 1994. The fox-proof fence was constructed in 1990, so the increase commenced before fencing.

Between 1995 and 1997, the data suggest a decline in numbers, followed by an increase until 2000. Data since 2000 are unreliable due to our inability to sample more than a small proportion of tortoises each year. The decline between 1995 and 1997 may be an artefact of low sample size in 1996 and 1997; however, as several years have now passed increasing the chance of animals present at that time being captured in the following years, there is a distinct possibility of a real decline. The reason for such a decline is not clear.

In 2003 the activities at EBNR focused on recapturing tortoises for the population estimates, on further evaluation of the suitability of the rehabilitated area (Reserve A42126) for Western Swamp tortoises, and on comparing operational environmental temperatures between the Ellen Brook and Mogumber Nature Reserves.

Since two of the four females which had been released with radio-transmitters into the new block Reserve (A42126) in the winter of 1999 had been returned to Perth Zoo during the spring of 1999, and an adult female (#341) found at the Midland Bricks property during late October 2000 had also been temporarily transferred to the Zoo (until the acquisition and protection of that area is accomplished), the same number of captive bred hatchlings as that obtained from the 2002 eggs of those females (five), was released into a newly created swamp area of the new block on 01 September 2003. Three of those were recaptured on 25 October 2003 with a mean body mass of 46g (±3.2SD). At release those three had a mean body mass of 38g

(±3.5SD). They gained about 1g/week, a satisfactory growth rate during that time of the year. Two of the hatchlings released in 2002 were also recaptured on 25 November weighing 52g and 76g respectively. One hatchling each of the releases in 2001, 2000 and 1999 were also recaptured during November with body masses >100g. This demonstrates that growth rates are satisfactory in the new, rehabilitated reserve area.

A hatchling of 2003 with a body mass of 23.2g was found on the Midland Bricks block to the west of Ellen Brook Nature Reserve near swamp gauge 3 on 5 November 2003. This demonstrates that there must have been a breeding female on the block in 2002 and that the swamp is suitable for hatchlings to grow up. Since this habitat area is not yet protected, the hatchling was released near gauge 1 inside Ellen Brook Nature Reserve. The capture of the hatchlings underlines the significance of the habitat on private properties to the west of Ellen Brook Nature Reserve for Western Swamp Tortoise conservation.

In addition to the recaptured tortoises that were translocated during 1999, 2001, 2002, and 2003 and in addition to the wild hatchling from the Midland Bricks block mentioned above, 17 resident tortoises were handled at Ellen Brook Nature Reserve during 2003. Three males and one juvenile were equipped with radio-transmitters and miniature temperature loggers (Thermochron iButton temperature dataloggers) during September and tracked for some weeks during spring for comparison with tortoises at Mogumber. The results are discussed in the Mogumber section. Three different males and one juvenile were equipped with miniature temperature loggers without transmitters during November to record temperatures during aestivation over the summer of 2003/04.

3.4.1.1 Long-necked Tortoises at EBNR

A male long neck tortoise *Chelodina oblonga* (910g, 206mm carapace length) was found in an artificial pond inside the fox-proof fence at Ellen Brook Nature Reserve on 1 September 2003. It has presumably tried to leave the fenced area to move towards the Ellen Brook. It was moved outside the fox-proof fence and into the adjacent Ellen Brook.

3.4.2 Twin Swamps Nature Reserve

At Twin Swamps Nature Reserve, population data show a long and serious decline in tortoise numbers from 1964 to 1993. The increase in numbers from 1994 reflects the re-introduction of captive-bred animals from Perth Zoo. Data since around 1998 are unreliable because of the typical low sampling success due to the considerable difficulty in capturing Western Swamp Tortoises.

In 2003 the focus at TSNR was on monitoring the tortoises that were re-introduced in previous years and on comparing operational environmental temperatures with tortoises at Mogumber Nature Reserve. No tortoises were radio-tracked at TSNR over the summer of 2002/03 due to various technical problems with radio-transmitters.

A significant event was the capture of an unmarked juvenile Western Swamp Tortoise of 142.5g in the dam of NE-swamp at Twin Swamps Nature Reserve on 25 December 2003. This juvenile (#730) hatched 1997 or 1998. It does not correspond to the features of any of the captive-bred hatchlings released from 1995 to 1998 or to hatchlings from monitored nests of 1995/96. None of the re-introduced, captive-bred females were mature at that time. It must, therefore, be an offspring of one of the old Twin Swamps females. This is the first time since the early 1980s that natural recruitment into the Twin Swamps population could be demonstrated.

In addition, twenty tortoises of previous releases were recaptured during 2003, plus the old resident female #77. Five juveniles and sub-adults were radio-tracked and equipped with miniature temperature loggers for various periods during the spring of 2003 for comparison with tortoises at Mogumber. The results are discussed in the Mogumber section. In addition, the resident female #77 and two sub-adults were equipped with miniature temperature loggers and radio-transmitters during November/December to record temperatures during aestivation over the summer of 2003/04. Two water-filled tortoise copper models were also equipped with temperature loggers and one placed into an artificial aestivation tunnel and the other under leaf litter under a dense *Regelia* bush.

No predation or mortality was recorded at TSNR during 2003.

Aestivation - summer 2003/2004

Four tortoises were radio-tracked and temperatures were recorded when NW swamp dried and they moved to their aestivation sites during November. The transmitters and loggers of those tortoises were removed once they started to aestivate. Two additional tortoises were equipped with transmitters and temperature loggers in November and one in December while active in water. Those will be tracked over the whole aestivation period.

Of the four tortoises tracked until 24 and 25 November, one had entered a rabbit warren, two were in smaller holes about 10 and 13 cm underground, and one was in a shallow depression under a branch on the ground of a dense *Regelia* bush. It is not clear if this was already a final aestivation site. All four tortoises were in areas with *Regelia* bushes.

Of the three tortoises which will be tracked over the summer, two had entered rabbit warrens and one stayed in a hole about 15cm underground, all three in *Regelia* bushland.

Thus, six of seven tortoises (86%) at TSNR had entered holes immediately when they started to aestivate.

Table 1. Ellen Brook Nature Reserve, Western Swamp Tortoise Population Estimates 1963 - 2003.

Year	No. captured	Manly & Parr estimate	Manly & Parr Standard Error	KTBA Adults	KTBA juveniles	KTBA hatchlings	Total KTBA
1963	4	-	-	16	6	0	22
1964	10	53	23.2	17	6	0	23
1965	3	48	37.9	12	4	2	18
1966	4	21	5.6	11	5	1	17
1967	2	30	20.5	11	5	0	16
1968	5	20	3.9	10	6	1	17
1969	1	16	0	10	6	0	16
1970	3	-	-	11	6	1	18
1971	0	-	-	10	6	1	17
1972	6	20	3.1	10	7	1	18
1973	0	-	-	10	7	3	20
1974	2	40	27.6	11	9	1	21
1975	3	30	11.6	11	9	1	21
1976	9	23	3.2	10	10	0	20
1977	3	19	0	10	8	1	19
1978	8	34	10.5	10	9	2	21
1979	4	21	0	8	10	3	21
1980	8	28	4.8	8	13	2	23
1981	8	29	3.2	8	13	5	26
1982	10	34	6.0	8	17	2	27
1983	5	68	35.6	11	13	6	30
1984	10	93	42.6	11	17	7	35
1985	7	54	16.6	12	19	3	34
1986	2	32	0	13	18	1	32
1987	6	38	6.4	14	18	1	33
1988	5	55	19.1	13	19	3	35
1989	17	37	2.5	15	18	2	35
1990	11	36	2.9	17	17	0	34
1991	21	34	1.5	20	13	0	33
1992	23	41	4.3	20	11	3	34
1993	25	50	5.8	19	11	10	40
1994	35	56	5.0	21	13	13	47
1995	18	44	5.6	21	12	2	35
1996	11	36	5.5	22	7	0	29
1997	5	26	0	20	5	0	25
1998	22	48	7.5	23	5	6	34
1999	32	69	10.9	23	9	15	47
2000	38	58	5.5	21	16	11	48
2001	37	56	6.0	17	27	2	46
2002	25	100	34.6	16	24	0	40
2003	28	-		13	10	6	29

Notes:

1. KTBA - known to be alive. KTBA is significantly lower than actual population size for at least the most recent five (or so) years because of low sample size. The figures for those years are not a reliable estimate of actual population size.
2. Animals with carapace length > 110 mm are assumed to be adults
3. Juveniles are one or more years old.
4. 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 '-'

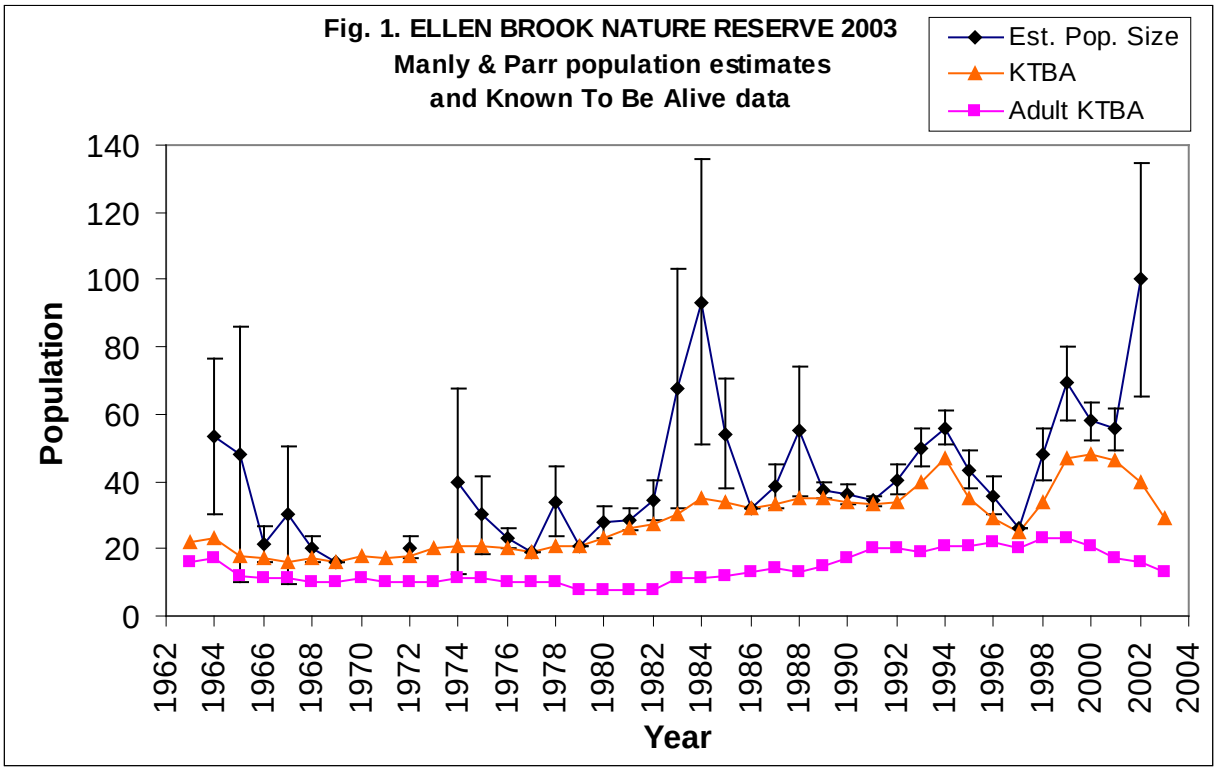


Figure 1 Population Estimates at Ellen Brook Nature Reserve

Table 2. Twin Swamps Nature Reserves, Western Swamp Tortoise Population Estimates 1963 – 2003.

Year	No. captured	Manly & Parr estimate	Manly & Parr Standard Error	KTBA adults	KTBA juveniles	KTBA hatchlings	Total KTBA
1963	1	-	-	38	10	5	53
1964	4	288.0	247.7	37	15	21	73
1965	9	273.0	126.6	36	36	25	97
1966	65	126.7	9.0	34	58	10	102
1967	27	159.3	36.4	30	46	0	76
1968	17	66.9	5.1	28	31	2	61
1969	8	91.2	23.9	27	32	1	60
1970	26	69.8	6.6	26	31	1	58
1971	27	70.2	9.5	27	24	0	51
1972	15	55.0	9.9	24	15	0	39
1973	13	56.3	14.8	26	7	0	33
1974	8	88.0	51.4	22	4	2	28
1975	8	32.0	7.6	19	3	1	23
1976	3	20.0	0.0	17	3	0	20
1977	9	25.5	4.8	18	2	0	20
1978	9	29.3	9.1	15	2	1	18
1979	6	20.0	6.8	10	3	0	13
1980	2	10.0	0.0	8	2	0	10
1981	3	10.0	0.0	8	2	0	10
1982	3	11.0	0.0	8	2	1	11
1983	5	15.0	4.5	8	3	0	11
1984	3	12.0	4.2	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	1	0	7
1989	0	-	-	6	1	0	7
1990	2	12.0	7.7	6	1	0	7
1991	0	-	-	5	1	0	6
1992	1	-	-	5	1	0	6
1993	0	-	-	4	1	0	5
1994	14	23.3	7.6	4	12	0	16
1995	41	75.2	19.1	8	26	12	46
1996	33	40.1	3.4	6	27	3	36
1997	37	98.7	29.1	4	41	2	47
1998	32	136.0	55.6	3	38	4	45
1999	58	95.3	13.9	2	65	1	68
2000	57	72.8	6.6	4	60	0	64
2001	30	47.1	5.5	7	32	0	39
2002	23	41.4	6.6	5	27	0	32
2003	26	-	-	8	14	4	26

Notes:

1. KTBA - known to be alive. KTBA is significantly lower than actual population size for at least the most recent five (or so) years because of low sample size. The figures for those years are not a reliable estimate of actual population size.
2. Animals with carapace length > 110 mm are assumed to be adults
3. Juveniles are one or more years old.
4. 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 '-'

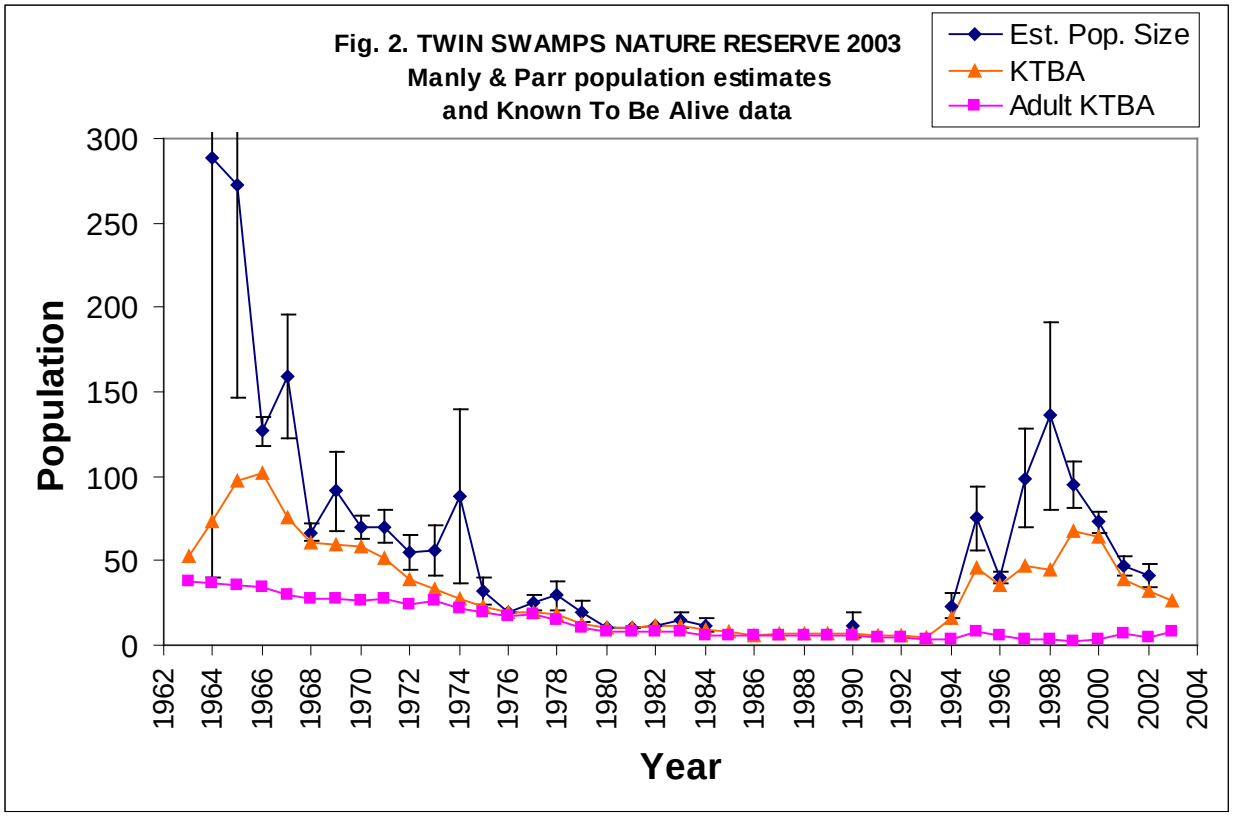


Figure 2 Population Estimates at Twin Swamps Nature Reserve

3.4.3 Mogumber

KTBA and Manly and Parr population estimates have not been calculated for the Mogumber population, as it is too soon since introductions commenced for meaningful figures to be produced.

Due to the fire at Mogumber in December 2002 no tortoises were radio-tracked in the first half of 2003. The ten survivors of the fire out of the 20 radio-tracked tortoises spent the summer and autumn in the captive colony at Perth Zoo. All of them recovered. Since about half of the radio-tracked tortoises survived the fire, it can be assumed that also about half of the non-tracked tortoises (also about 10 out of 20) may have immediately survived the fire. However, apart from those ten that recovered at the zoo none of the tortoises released prior to the fire were recaptured during 2003. This suggests that the post-fire mortality during the summer and autumn may have been very high. This assumption is supported by the fact that some of the tortoises, which were recovered after the fire, were severely dehydrated. They might not have recovered without the water that was available to them at the zoo. The tortoises at Mogumber did not have this advantage. Those that may have survived the fire but were not recovered had no shade and leaf litter available and the summer sun would have heated the ground. The fire at Mogumber in December 2002 was certainly a catastrophic event for the fledgling tortoise population.

Aestivation - summer 2003/2004

The water at Mogumber NW swamp disappeared in late November. Of 20 tortoises tracked on 04 and 05 December, six (30%) had entered relatively small holes and 14 (70%) were shallow buried under leaf litter or under branches at the base of bushes or under grass tree leaves on the ground. By 19 and 20 December, 22 tortoises were tracked, 8 of which were under leaf litter etc. (36%), four in holes deeper than 12 cm and one in an artificial aestivation tunnel (together 23%), six in small holes <12cm deep (27%), two were in farm dams in the water (9%) and one was found walking on the ground. At that stage, eight of the tortoises (36%) had left the reserved area and were staying on adjacent private properties.

This preliminary result, when compared to that of TSNR, indicates two potential problems with aestivation at Mogumber in the current season: first, after the fire late last year, there is not much shade and cover available and tortoises have a tendency to move out of the reserve in search of aestivation sites. Second, even though about 50 artificial aestivation tunnels were available in 2003, only one tortoise out of 22 entered such a tunnel. It could be that the released tortoises were not used to aestivate in holes, but under leaf litter. A review of aestivation management at Perth Zoo revealed that, in the last few years and as opposed to the past, the new aestivation enclosures did not anymore offer holes in the ground, but only branches and leaf litter on the ground. Thus, the recently captive-raised tortoises have not learned how to aestivate in holes and may prefer leaf litter. Although this is an adequate aestivation strategy at the zoo, it can cause problems under the much harsher conditions in the wild and in particular during and following fires. Perth Zoo immediately addressed this potential problem by installing in the aestivation enclosures artificial aestivation tunnels that resemble those in the nature reserves.

Preliminary results of temperature measurements August to November 2003

The Thermochron iButton temperature dataloggers were provided by Kristine Grayson, a Watson Fellow and graduate from Davidson College in North Carolina who worked from August to December as volunteer with the Western Swamp Tortoise programme. Due to the problem with the AVM radio-transmitters the results were more limited than planned. Tortoises utilized microclimates ranging from 10 – 34 C. Tortoises used microhabitats within 3 C of the maximum environmental temperature available fifty to sixty percent of the time during late winter and early spring. Basking was documented both by observation and thermal data, which indicated that basking was predominately restricted to the early morning (06:00 – 10:00). The mean temperatures did not differ significantly between Mogumber, EBNR and TSNR during September and October, although temperature fluctuations were slightly higher at Mogumber.

3.4.3.2 Long-necked Tortoises at Mogumber

A male *Chelodina oblonga* (665g, 184.2mm carapace length) was found at NW-swamp of Mogumber reserve on 03 September and a second male (665g, 161.8mm carapace length) on 23 November. This type of seasonal clay swamp does not seem to be good *C. oblonga* habitat, the tortoises were possibly on the move to other wetlands. Both were moved to farm dams in the vicinity of the reserve.

3.5 CAPTIVE BREEDING

3.5.1 Breeding season

The same dynamics were evident this year as last in that a high proportion (63.6%) of eggs

produced by 6 immature females were not viable as opposed to only 22.4% of mature females eggs not being viable. This had the overall effect of reducing the hatching rate to 70%. This trend is expected to continue in the medium term.

Of the 20 females to lay, 4 reproduced for the first time. The seventh double clutching since the project began occurred when, for the first time, a long term captive (Z3) ovulated twice in the season. Double clutching among founder or zoo-bred animals has not previously been recorded.

TABLE 3: Perth Zoo Captive Breeding

F/M I.D.	STATUS	EGGS PRODUCED	EGGS HATCHED
CZ1	OLD CAPTIVE WILD CAUGHT	4	3
CZ2	OLD CAPTIVE WILD CAUGHT	3	2
Z3	OLD CAPTIVE ZOO BRED	3	3
4	WILD CAUGHT FULLY MATURED	4	2
70	WILD CAUGHT FULLY MATURED	5 (2 clutches)	4
77	WILD CAUGHT FULLY MATURED	4	4
164	WILD CAUGHT SEMI-MATURED	3	2
184	WILD CAUGHT FULLY MATURED	2	2
196	WILD CAUGHT FULLY MATURED	4	1
199	WILD CAUGHT SEMI-MATURED	3	3
207	ZOO BRED 1ST CLUTCH	2	0
221	ZOO BRED IMMATURE	2	1
256	WILD CAUGHT FULLY MATURED	4	4
286	ZOO BRED 1ST CLUTCH	2	0
302	ZOO BRED 1ST CLUTCH	2	2
318	ZOO BRED 1ST CLUTCH	1	1
324	ZOO BRED IMMATURE	2	0
341	WILD CAUGHT FULLY MATURED	4	4
380	WILD CAUGHT FULLY MATURED	3	2
387	WILD CAUGHT SEMI-MATURED	3	2

TOTAL = 20		60	42

3.5.2 Releases

Sixty-four, predominantly juvenile, WST were released into 4 nature reserves (See table 2). Of these, 10 were re-released after returning to the zoo for treatment or observation when bushfires swept through Mogumber at the end of 2002.

An adult female whose genes were required for captive breeding was returned to TSNR with the equivalent number of hatchlings she produced in the zoo. The hatchlings were from a more common bloodline.

So far fifteen tortoises have attained the weight required for release in 2004.

TABLE 4:

RESERVE	# RELEASED	STATUS
Mogumber	42	Juveniles
Harry Waring	12	Hatchlings
Twin Swamps	5	Hatchlings/ 1 adult
Ellenbrook	5	Hatchlings
TOTAL	64	

3.5.3 Deaths

Two deaths occurred during the year.

1st death (#577): 3 years old. Was the first to occur during aestivation. Cause not known. Only skeletal remains recovered indicating death occurred early in aestivation, probably from a pre-existing condition.

2nd death (#689): 8 days old. Suffering from several abnormalities at birth and later a pro-lapsed intestine that vets were unable to internalize.

3.5.4 Transfers

Establishment of a second captive colony began with the transfer of two, two-year-old tortoises to Adelaide Zoo where they are now on public display. Construction of a small breeding and aestivation facility will commence soon and when completed, mature tortoises will be transferred.

3.5.5 Status of captive colony

AGE/STATUS	NUMBER
03 Hatchlings	27
02 Hatchlings	31
01 Hatchlings	16
00 Hatchlings	9
99 Hatchlings	3
98 Hatchlings	11
Juveniles from land adjacent to EBNR	5

Zoo-bred sub-adults retained for breeding	13
Non-breeding adult females	1
Breeding males	22
Breeding females	23
Total	159

3.5.6 Security

As a result of information received security was reviewed and upgraded. The breeding facility is now alarmed with a 24-hour security system and relevant authorities have been alerted to potential security risks.

3.5.7 Establishment of additional captive colonies

Harry Waring Marsupial Reserve

A project in 2000/2001 used GIS data and other remote sensing information to identify areas between Mogumber and Pinjarra that may be suitable for Western Swamp tortoises and their translocation. This activity identified the Melaleuca swamp at Harry Waring Marsupial Reserve as possible suitable habitat. The swamp is too small and isolated from other suitable habitat to allow the establishment of a wild *P. umbrina* population. However, the GIS modelling suggest that this small, but potentially suitable habitat could be a good site for a semi-captive assurance colony of the species.

The Western Swamp Tortoise Recovery Plan prescribes to trial the experimental establishment of a semi-captive 'assurance' colony at Melaleuca Swamp of HWMR that is managed by UWA. The HWMR already has fox-proof fencing and a caretaker onsite. The swamp seems to be too dry in below average rainfall years. The general idea is to create some artificial swamps as refuges in dry years at the margins of Melaleuca swamp and to surround the whole swamp area with a tortoise proof fence.

Three artificial swamps of about 7x16m were created at Melaleuca swamp in late May 2003 to evaluate if hatchlings and juveniles can be raised under extensive conditions (without food supplementation, as opposed to the intensive management at Perth Zoo). About 60 cm of soil was removed and the holes lined with polyethylene sheets that were then covered with about 30 cm of the topsoil. These depressions filled naturally by rainwater in early July. Branches of trees and shrubs were placed at the swamp margins as cover. For this trial only two of the artificial swamps (not the whole Melaleuca swamp) were enclosed by 50 cm high black 10mm plastic mesh, buried about 15 cm into the ground and held upright with steel stakes. A 15cm wide polyethylene strip on the inside top of the fence ensured that tortoises could not climb over the fences.

The trial was conducted by Bradie Durell as a Zoology Honours Project. Twelve captive-bred hatchlings from Perth Zoo (mean body mass 36.0g ± 1.2SE, mean carapace length 54.2mm ± 0.6SE) were transferred into the two enclosures on 31 August 2003. At recapture on 16 September 2003 the twelve hatchlings had a mean body mass 36.9g ± 1.1SE and a mean carapace length 55.2mm ± 0.7SE. Unfortunately, netting through the swamps on 14 October produced only eight of the hatchlings, with a mean body mass 44.5g ± 1.5SE and a mean carapace length 59.3mm ± 0.8SE. Further netting sessions on 15 October, 28 October, 14 November, 01 December and 09 December did not produce any tortoises. Thus, in accordance with the conditions of the translocation approval regarding the loss of hatchlings, the eight recaptured hatchlings were transferred back to the captive colony at Perth Zoo.

The recapture rate of the released hatchlings at HWMR (eight out of 12, or 66%) was comparable to recapture rates of hatchlings during the spring of their release at EBNR: of

twelve released hatchlings in 2001 and 2002, seven (58%) were recaptured in the same season in both years. In 2003, three out of five released hatchlings (60%) were recaptured. The growth of the hatchlings at HWMR demonstrated that the artificial swamps, even though they were newly constructed, provided sufficient natural food for the tortoises. The water quality and invertebrate community data (part of the Honours thesis) also demonstrated the suitability of the HWMR site to establish a semi-captive assurance colony of Western Swamp Tortoises. However, hatchling survival at HWMR may not be better than in the wild population at EBNR.

3.6 TRANSLOCATIONS

3.6.1 Re-introduction to Twin Swamps Nature Reserve and Mogumber

Twin Swamps

Re-introduction was limited to four captive-bred hatchlings, to replace hatchlings produced from eggs laid in 2002 by the old resident female #77 which were incubated at Perth Zoo. They were released at NW Swamp without radio-transmitters on 11 August 2003. None of them was recaptured.

Mogumber

The ten fire survivors plus 32 other captive-bred juvenile tortoises were released at NW swamp at Mogumber on 11 August 2003. All ten survivors were equipped with new AVM radio-transmitters and miniature temperature loggers. Although the transmitters were supposed to work for >12 months, all of them stopped working in four weeks. Only two transmitters could be recovered while dying and the tortoises could be equipped with alternative transmitters. A third, dead, transmitter was recovered when the tortoise was recaptured in mid October and an alternative transmitter was used. Most of the tortoises shed their scutes in early November and two of working transmitters were shed with the scutes. Thus, only one tortoise could be tracked by early November. The temperature loggers and their stored data were lost with the other seven transmitters. The project will never again order transmitters from AVM.

Major searches for tortoises were organised on 23 and 26 October and 23 tortoises could be recaptured. All of them were equipped with new radio-transmitters (Holohil) and twelve in addition with miniature temperature loggers. Two water-filled tortoise copper models were also equipped with temperature loggers and one placed into an artificial aestivation tunnel and the other under leaf litter under a low, dense bush. The last additional AVM transmitter stopped working by early December and one Holohil transmitter was shed by mid December. Thus, by the end of 2003 a total of 22 tortoises were radio-tracked at Mogumber.

All 24 recaptured/tracked tortoises available in late November had grown well, they increased their body mass by over 20%, from a mean of 114.9g (±14.3SD) on 11 August to 138.8g (±13.8SD) by late November. This demonstrates the suitability of the swamp life at Mogumber for Western Swamp Tortoises.

3.6.2 Translocation to additional sites

3.6.2.1 Selection of suitable translocation sites

Caversham

The water levels of the swamps at the RAAF Caversham property were not regularly surveyed during winter and spring 2003. Only the water level of the NW swamp was occasionally recorded in spring, but the depth gauge from 1999 had disappeared. The swamp was more or less full by 25 October, but the water had nearly disappeared by 05 November 2003, although

there was still some water on the northern firebreak. It seems that the blockage of the drainage system has deteriorated and that the swamp now loses water relatively quickly once water stops draining in from the north. Still, the duration of swamp life would have been suitable for Western Swamp Tortoises.

Moore River

The Chief Investigator (GK), Andrew Burbidge and Rod Martyn (CALM) undertook a field visit to Moore River Nature Reserve and National Park looking for suitable habitat for a WST translocation in Spring 2003. This site shows significant promises although some habitat manipulation would be required to make it suitable for the tortoise. More detailed investigations will be undertaken in 2004 to ascertain its suitability as a translocation site and the feasibility of undertaking any habitat modification.

3.7 EDUCATION, PUBLICITY AND SPONSORSHIPS

3.7.1 Education and publicity

Gerald Kuchling was invited speaker at the General Meeting of the Turtle Survival Alliance (TSA) in Orlando, Florida from 18-19 August 2003 and gave a presentation on the Western Swamp Tortoise Recovery Programme.

3.7.2 Sponsorships

The School of Animal Biology, The University of Western Australia, funded through its Honours programme the study "Establishment of a semi-captive population of Western Swamp Tortoises (*Pseudemydura umbrina*) at the Harry Waring Marsupial Reserve" by Bradie Durell. Earth Watch contributed financially to and HSBC volunteers helped with the construction of three artificial ponds at HWMR. Kristine Grayson was supported by a Watson Fellowship to work for five months (August-December 2003) as research volunteer on the temperature availability project at EBNR, TSNR and Mogumber NR.

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