WESTERN SWAMP TORTOISE

RECOVERY PLAN

ANNUAL REPORT

2005

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for

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NATURAL HERITAGE TRUST PROJECT 033119

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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:

- Fifty four captive bred tortoises were released into reserves in 2005. Thirty two juveniles were released into Mogumber Nature Reserve, nine into Twin Swamps Nature Reserve, and thirteen hatchlings were released at Ellen Brook Nature Reserve.
- There is a trend over the last decade that population numbers at EBNR are gradually increasing
- At Twin Swamps Nature Reserve (TSNR), population data show a long and serious decline in tortoise numbers from 1964 to 1993. A rapid increase in numbers from 1994 reflects the re-introduction of captive-bred animals from Perth Zoo.
- Captive-bred tortoises have been released at Mogumber Nature Reserve since 2000 to establish a third wild population. A fire in 2002 significantly impacted population numbers however tortoises have continued to be released at the reserve on an annual basis. Due to the short time span of the release programme it is unknown at this stage how well the tortoises are established.
- Midland Brick have agreed to transfer 5.97 hectares of their land containing existing Western Swamp Tortoise habitat for inclusion into the Ellen Brook Nature Reserve as one of their commitments for the environmental management of a clay mining project (not located near the Western Swamp Tortoise Nature Reserves). The transfer will be completed in mid-2006 and the area will be fenced with a fox proof fence prior to winter in 2006.
- Perth Zoo currently holds 196 tortoises comprising 21 breeding males, 23 breeding females and 151 other tortoises comprising hatchlings, juveniles, sub-adults and non-breeding adults. Seventy one hatchlings were obtained in 2005 from eggs laid in 2004.
- The Friends of the Western Swamp Tortoise undertook a range of initiatives including the installation of artificial aestivating tunnels at Mogumber Nature Reserve, habitat rehabilitation and revegetation works at Twin Swamps and Ellen Brook Nature Reserves, educational activities, development of interpretational signage and materials, and promotion of the Recovery Program. The group have a representative on the Recovery Team.
- Negotiations continued with the Westralian Airports Corporation regarding investigating the suitability of wetland areas within a zone designated for conservation at the northern portion of Perth Airport land, for translocation of tortoises. Hydrological monitoring was conducted in winter 2005 to assess the suitability for translocation of tortoises and to establish whether artificial hydrological maintenance is required. Two swamps within the northern conservation zone were inspected by the Recovery Team Chief Investigator and found to be suitable for the tortoise.
- A second captive breeding facility at Adelaide Zoo was established and once facilities are deemed suitable, two pairs of breeding age tortoises will be transferred from Perth Zoo to Adelaide.
- Rainfall in 2005 was above average. Compared with 2004 the swamps retained water for longer.
- Groundwater was pumped to North West Swamp in Twin Swamps Nature Reserve from late October to late November 2005 as rainfall was sufficient to sustain adequate water levels until that time.
- Rat control baiting stations at Twin Swamps Nature Reserve were activated and the program was expanded to include a further 50 stations in 2005.
- Prescribed burning was undertaken in the north east corner 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 60 artificial aestivating tunnels were installed at Mogumber Nature Reserve with the assistance of the Friends of the Western Swamp Tortoise to encourage tortoises to aestivate below ground and reduce the risk of being killed in a wildfire.
- Approximately 1 km of fence was replaced at Mogumber Nature Reserve. Additional funding has been provided by the Department of Conservation and Land Management for a replacement fence at Ellen Brook Nature Reserve, which will be erected in early 2006. This fencing includes the recently acquired Midland Brick addition.
- In 2005 the possible translocation site at Moore River Nature Reserve was further investigated and monitored to ascertain its suitability as a translocation site and the feasibility and environmental acceptability of undertaking any habitat modification.

There are a number of issues of concern, discussed below, for the Recovery program to address over the next three years.

1. Areas of habit are becoming increasingly arid, particularly at Twin Swamps Nature Reserve,

where water supplementation has been required in most recent years to support the tortoise. The rate of bore production has been decreasing with a declining regional groundwater level. However above average rainfall was received in 2005 and conditions at Twin Swamps were more favourable for the tortoise with comparatively little supplementation required. Hatchlings have yet to be recorded at Twin Swamps although some adult translocated tortoises are known to be laying eggs. It is possible that hatchlings are perishing after hatching, prior to the swamps filling with winter rains. As a result, if required artificial supplementation will be started earlier in the season to determine if this assists hatching survival. There is a need for a major hydrological study at Twin Swamps Nature Reserve, and consideration of future supplementation requirements. Funding was not available in 2005.

2. Given the vulnerability of existing habitats, the Recovery Team considers there is a need to have five established populations to secure the species future. The lack of suitable habitat is of concern. The potential fourth site identified for translocation at Moore River Nature Reserve has undergone further investigation. Hydrological modification to retain water onsite currently lost via adjoining drains will be required. A potential fifth site at Perth Airport also requires further investigation. Significant management costs to establish the populations, maintain suitable habitat, and control predators is likely.

3. Monitoring and research requirements are increasing as the new translocation sites are established. This monitoring and research is critical to address issues requiring adaptive management.

To achieve recovery additional funding is required for the next two to three years. Additional funding is being sought from both the Commonwealth and State Governments for this period.

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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 2005 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 Helen Robertson, Perth Zoo
Dr David Groth, Department of Biomedical Science, Curtin University of Technology
Dr Gerald Kuchling, Chief Investigator. School of Animal Biology, The University of Western Australia
Mr Rod Martyn, CALM's Swan Coastal District
Ms Jacqui Maguire, CALM's Swan Coastal District, Executive Officer
Ms Kat Miller, National Threatened Species Network, World Wide Fund for Nature Australia
Mr Terry Morley, Adelaide Zoo
Mr Rosalind Murray, Swan Catchment Council
Ms Jess Cochrane, Friends of the Western Swamp Tortoise

During 2005 the Team met twice. While the Team works together on many projects, primary responsibilities have been established as follows:

Management of Nature Reserves and rehabilitation of habitat	CALM's Swan Coastal District (Rod Martyn, Jacqui Maguire, Lyndon Mutter)
Population monitoring data analysis	Andrew Burbidge
Reserve's water depth and quality	CALM's Swan Coastal District
Ecological studies and translocation	Gerald Kuchling, UWA Zoology Department
Captive breeding	Dean Burford & Helen Robertson, Perth Zoo, with advice from Gerald Kuchling
Conservation genetics	David Groth, Curtin University
Proposed translocation sites	CALM's Swan Coastal District, Gerald Kuchling and Andrew Burbidge

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.

The objective of the first and second editions 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 uplisting from Critically Endangered within the 10-year time frame of the Recovery Plan.

Four actions were prescribed in the first and second editions of 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. 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. $119,500 was provided under NHT2 for each of 2003/2004, 2004/2005, and 2005/2006 towards the implementation of the Recovery Plan for this period.

A significant increase in funding is required for the next two to three years to achieve Recovery and address the issues of:

- increasing aridity of habitat areas (especially Twin Swamps Nature Reserve). The need to undertake a major hydrological study at Twin Swamps Nature Reserve and achieve future supplementation requirements,
- the need to establish and develop a fourth translocation site at Moore River Nature reserve,
- to investigate the establishment of a translocation site on Perth Airport land,

An application for NHT2 funding for $240 000 in 2005/2006 was submitted to the Regional Swan Catchment Council. The Council has only been able to support $120 000 of the bid. The State Government provides approximately $150 000 to the program via the Department of Conservation and Land Management (CALM) and Perth Zoo. CALM has committed an additional $130 000 to replace the Ellen Brook fox proof fence and fence the section of Midland Brick property being added to the reserve.

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. Given the vulnerability of populations to increasing aridity, the Team has set an additional objective of establishing five wild populations. This objective will be reflected in the next Recovery Plan when the existing plan is reviewed.

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.

The reserve was regularly baited for foxes. Additional habitat rehabilitation works were undertaken. Strategic bunding was installed to provide additional wetland habitat in a degraded section of the reserve. The Friends of the Western Swamp Tortoise group assisted CALM in the planting of over 600 tube stock plants in both Ellen Brook and Twin Swamps Nature Reserves.

The system of strategic firebreaks was maintained. No fires occurred on the reserve in 2005.

Ongoing maintenance of the aging fox proof fence was undertaken. Funding has been committed to replace the entire fence at Ellen Brook Nature Reserve, which will include fencing the recently acquired additional area of approximately 6ha. This work will commence in March 2006 and will be completed prior to winter rains.

Control of the weed *Watsonia* within the Nature Reserve continued with a major control program undertaken on the northern portion of the reserve, outside the vermin proof fence. Control of the weed Tambookie Grass was undertaken 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.

3.2.2 Management of Twin Swamps Nature Reserve

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

One 1080 fox baiting program was conducted.

The rat-baiting program continued funded by the Tiwest Joint Venture. The program was initiated in response to previous data indicating possible predation of juvenile tortoises by rats. Two hundred and ten baiting stations have been placed in lines on the northern section of the reserve, which is most heavily used by the tortoises.

Prescribed burning was undertaken in the north-east corner in the spring of 2005. 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 2005.

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.

A further sixty artificial aestivating tunnels were installed on the reserve in 2005 bringing the total number of tunnels to two hundred and twenty eight.

Raven control was conducted by CALM on the reserve in 2005, which included shooting and baiting.

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

Although 2005 was a year of above average winter rainfall, some pumping of groundwater to north west swamp was required to support the tortoise population at the end of winter. Refer to section 3.2.4 for rainfall graphs and data.

The Effect of the Groundwater Pump and of Earthworks at Twin Swamps Nature Reserve

Six artificial dams along the fence at Twin Swamps Nature Reserve (TSNR) provided water from at least 22 May until mid December 2005. The groundwater pump into NW Swamp was only running from 24 October until 30 November 2005 and water was available at NW Swamp until early December. Water flowed over from NW Swamp and N Swamp into the firebreak channel and then into NE swamp from late June to early November. NE Swamp had at least some water from mid-June to late November 2005, which was its longest period of standing water since 1996 when recording of the NE swamp levels started. This demonstrates the success of the channeling and bunding earthwork at TSNR.

3.2.3 Management of Mogumber Nature Reserve

The reserve was baited with 1080 baits on a monthly basis to control foxes.

An additional sixty 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.

Approximately 1 km of fence was replaced on the eastern boundary of the nature reserve

The hydrological monitoring which commenced in 2002 to determine whether the claypans are at risk from increasing salinity and to develop a water balance model was completed. Adjacent areas to the east of the reserve have been affected by salinity in recent times. The study has determined that the habitat is not under any immediate threat of salinisation, but ongoing monitoring is required. The monitoring, carried out by a consultant, was funded by CALM.

Swamp 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 Water depth; water quality and invertebrate sampling

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.

A project "*Invertebrate communities and water quality of wetlands significant for Western Swamp Tortoise conservation*" was approved for funding under CALM's Wetland Conservation Program 2004/05. The project leader is Dr Andrew Storey of UWA's School of Animal Biology. This project

analysed samples collected in 2004 with all available data from previous years. No samples were collected in 2005. Although all the samples have been processed, the analysis of the data and the historical overview is still under way. Preliminary results from Twin Swamps indicate that pH at NW Swamp has been rising since 1999 and by 2002 was higher than ever recorded before pumping.

As in previous years water samples were collected at all three reserves in September 2005 and chemical analysis of the samples was completed in December.

3.2.4.1 Water depth and rainfall data for Ellen Brook and Twin Swamps Nature Reserves

Swamp water levels at Ellen Brook Nature Reserve were recorded from 8 water depth gauges in 2005 and the following levels were recorded (in cm):

Date	1	2	3	4	5	6	7	8
14/05/2005	dry	0	dry	dry	7	27	dry	dry
22/05/2005	32	15	37	75	24	57	42	35
28/05/2005	-	-	-	57	21	52	-	30
13/06/2005	47	30	49	83	68	66	55	99
2/07/2005	46	29	45	78	65	66	52	95
27/07/2005	44	27	42	77	65	65	52	95
21/08/2005	46	29	47	80	67	65	54	98
19/09/2005	46	29	44	80	67	65	53	97
6/10/2005	45	28	42	74	62	64	51	91
17/10/2005	40	23	34	61	53	55	38	81
1/11/2005	35	18	24	47	42	49	13	67
8/11/2005	32	16	20	42	38	47	dry	63
17/11/2005	25	4	0	29	28	41	dry	46
21/11/2005	20	dry	dry	21	22	38	dry	38
23/11/2005	17	dry	dry	16	19	36	dry	33
25/11/2005	14	dry	dry	12	17	34	dry	30
28/11/2005	10	dry	dry	-	-	-	dry	-
30/11/2005	7	dry	dry	dry	12	32	dry	20
1/12/2005	4	dry	dry	dry	-	-	dry	-
2/12/2005	dry	dry	dry	dry	10	30	dry	16
7/12/2005	dry	dry	dry	dry	5	27	dry	dry
9/12/2005	dry	dry	dry	dry	1	26	dry	dry
14/12/2005	dry	dry	dry	dry	-	18	dry	dry

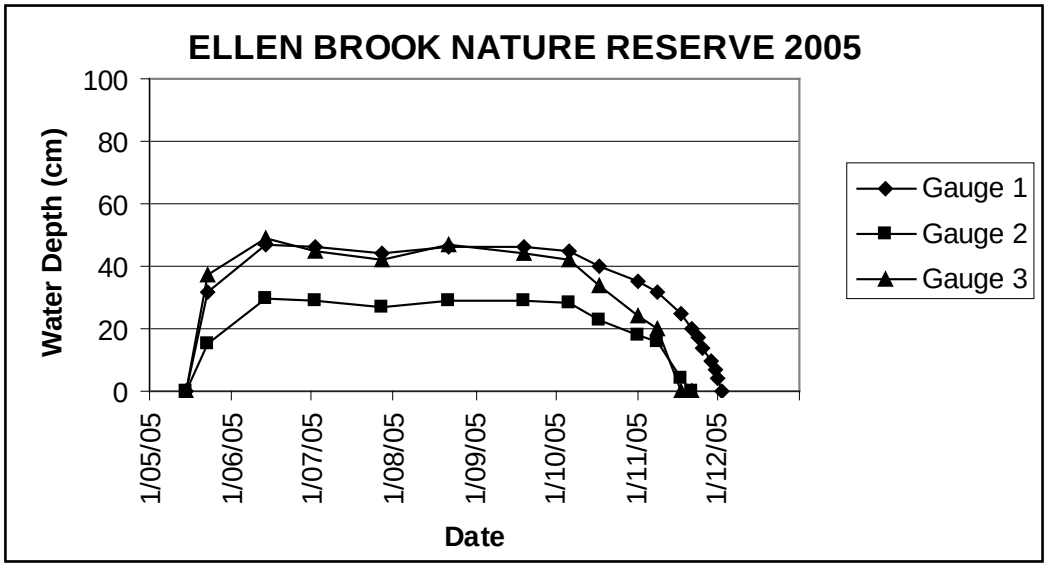

Figure 1. Water Depths at Gauges 1 - 3 within Ellen Brook Nature Reserve 2005

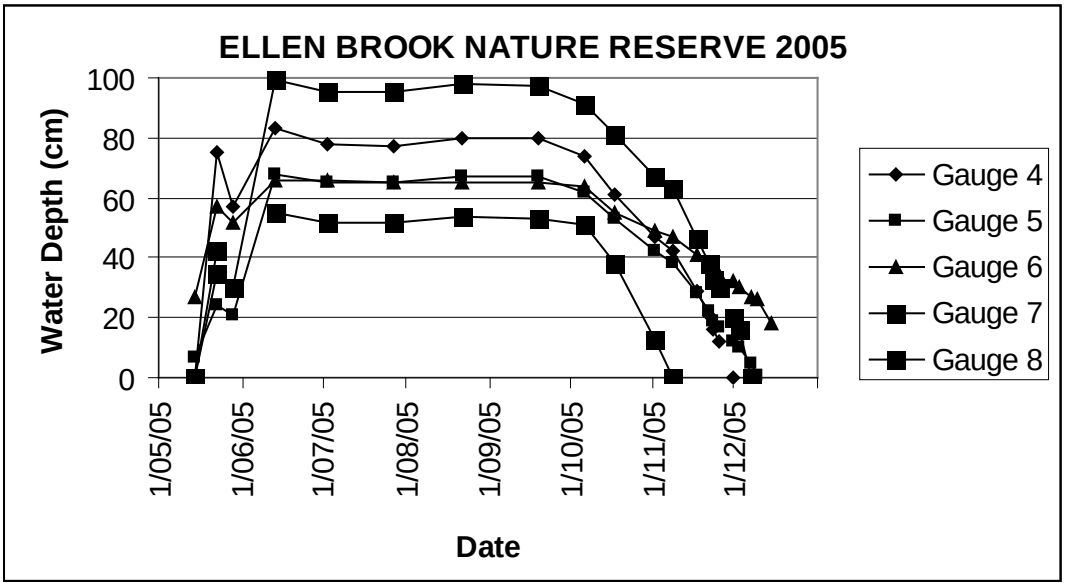

Figure 2. Water Depths at Gauges 4 - 8 within Ellen Brook Nature Reserve 2005

Swamp water levels at Twin Swamps Nature Reserve were recorded from 9 swamps in 2005 (the gauge N1 has disappeared) and the following levels were recorded (in cm):

Date	NW	SW	E	SE	NE1	NE2	N1	N2	N3	N4
22/05/2005	dry	dry	3	dry	-	-	-	-	dry	-
12/06/2005	11	5	20	dry	8.3	dry	-	22.4	dry	18.8
2/07/2005	20	12	14	dry	19.7	dry	-	22	21.3	19.5
27/07/2005	21	15	8	dry	22.5	dry	-	23.1	24.5	19.8
21/08/2005	22	20	18	0	47.6	42	-	41.6	39.2	20.7
19/09/2005	23	26	17	4	50.3	44.7	-	43.1	41.5	21.2
6/10/2005	23	28	12	3	47.4	41.8	-	44.6	39.2	20.9
17/10/2005	18	24	0	dry	41.7	36	-	36.6	33.5	9.6
24/10/2005	15	22	0	dry	38	32.3	-	31.6	29.8	dry
1/11/2005	16	19	dry	dry	34	28.2	-	25.7	26	dry
11/11/2005	13	16	dry	dry	28	22.4	-	12.5	11.8	dry
17/11/2005	11	11	dry	dry	22.5	14.9	-	dry	dry	dry
23/11/2005	8	5	dry	dry	15.5	dry	-	dry	dry	dry
25/11/2005	-	3	dry	dry	-	dry	-	dry	dry	dry
28/11/2005	6	0	dry	dry	dry	dry	-	dry	dry	dry
1/12/2005	5	dry	dry	dry	dry	dry	-	dry	dry	dry
2/12/2005	2	dry	dry	dry	dry	dry	-	dry	dry	dry
3/12/2005	0	dry	dry	dry	dry	dry	-	dry	dry	dry

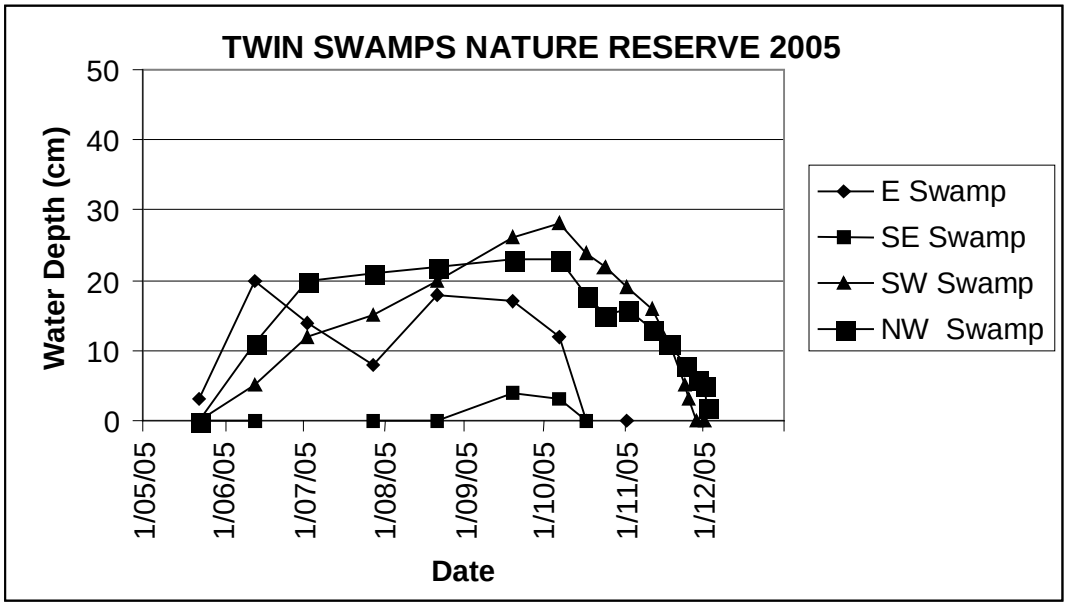

Figure 3. Water Depths at 4 Swamps within Twin Swamps Nature Reserve 2005

The nearest rainfall station currently keeping records is at Pearce RAAF base, where records have been kept since 1937, although they are incomplete. 2005 was a year of above average annual rainfall and records indicate:

- Annual average precipitation 1937 to 2005 = 675mm.
- Mean winter rainfall (May to September inclusive) 1937 to 2005 = 522.7 mm.
- Mean winter rainfall from 1937 to 1971 inclusive 576.6mm
- Mean winter rainfall 1972 to 2005 inclusive = 549.0mm (Figure 4).
- In 2005 the total precipitation was 733.2mm and the May to September rainfall was 592.4 mm (Figure 5).

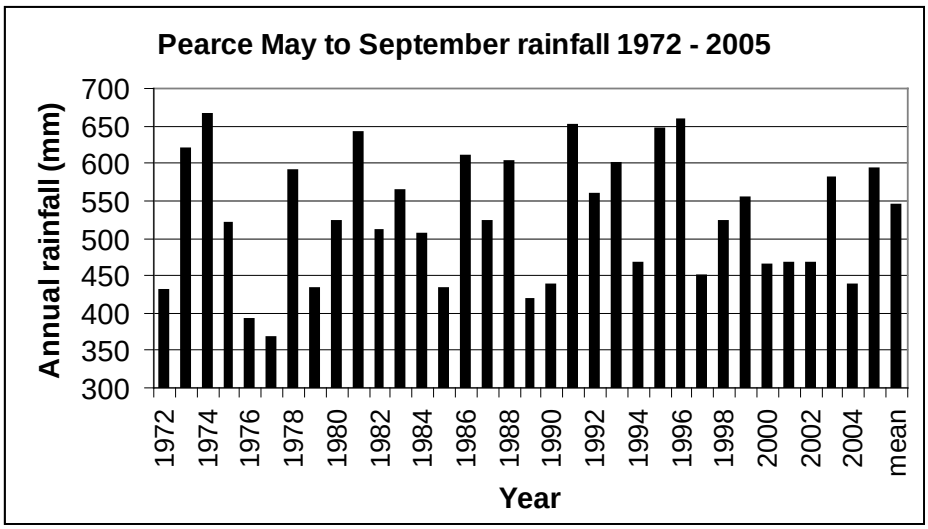

Figure 4. Mean winter rainfall 1972 to 2005 inclusive

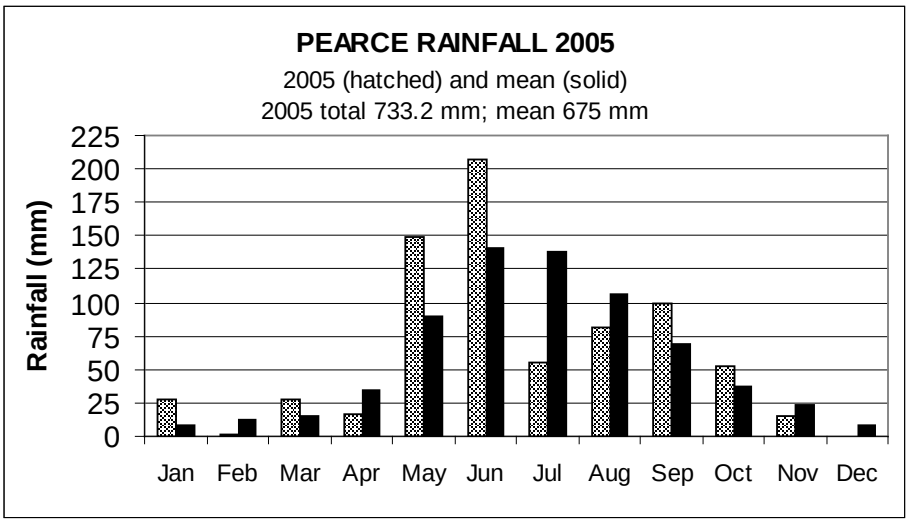

Figure 5. Total and mean precipitation for Pearce Rainfall Station 2005

3.2.4.2 Water depth and rainfall data for Mogumber Nature Reserve

Swamp water levels at Mogumber Nature Reserve were recorded at NW, SW and E swamps in 2005 and the following levels were recorded (in cm):

Date	1-NW	2-SW	3-E
14/05/2005	22.1	24.8	20.1
27/05/2005	26.3	23.5	22.1
11/06/2005	34.7	30.8	28.6
8/07/2005	41.9	35	35.2
24/07/2005	43.8	36.7	36.1
22/08/2005	52.8	42.5	41.2
25/09/2005	51.2	41.8	39.4
1/10/2005	50.7	41	38.7
17/10/2005	45	35.7	29.8
3/11/2005	36.2	26.6	24.7
12/11/2005	29.5	18.8	19.2
19/11/2005	21.6	8.8	8.2
22/11/2005	16.5	dry	dry
24/11/2005	13.2	dry	dry
26/11/2005	8	dry	dry

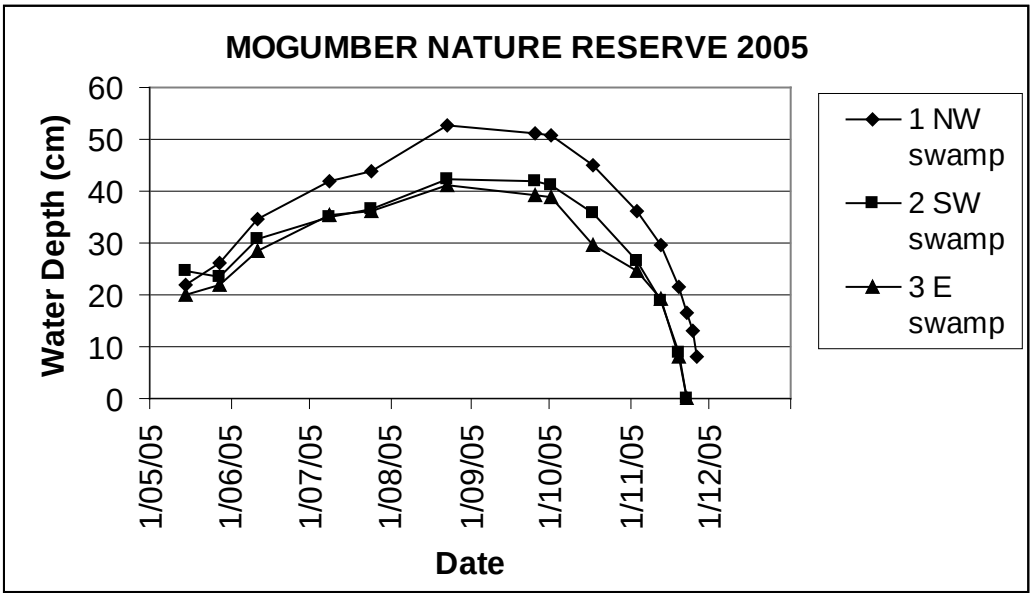

Figure 6. Water Depths at three swamps within Mogumber Nature Reserve 2005

Rainfall in 2005 was above average, with standing water available until late November. Compared with 2004, the swamps retained water for about three weeks more.

Rainfall at Wannamal (the closest rainfall station to Mogumber Nature Reserve) shows that the area received 619mm, which is above the mean of 595mm (See figure 7).

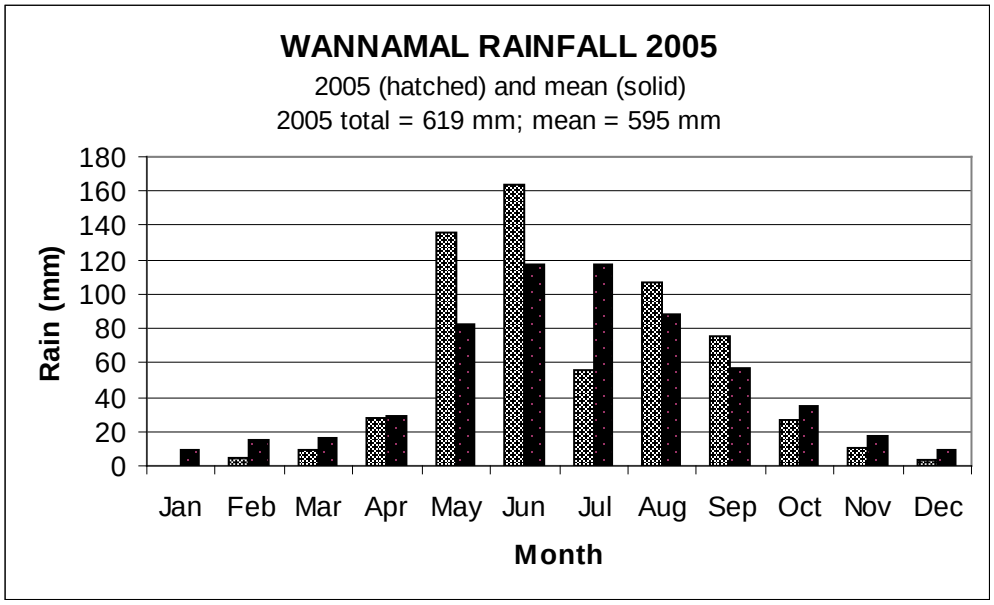

Figure 7. Total and mean precipitation for Wannamal Rainfall Station 2005

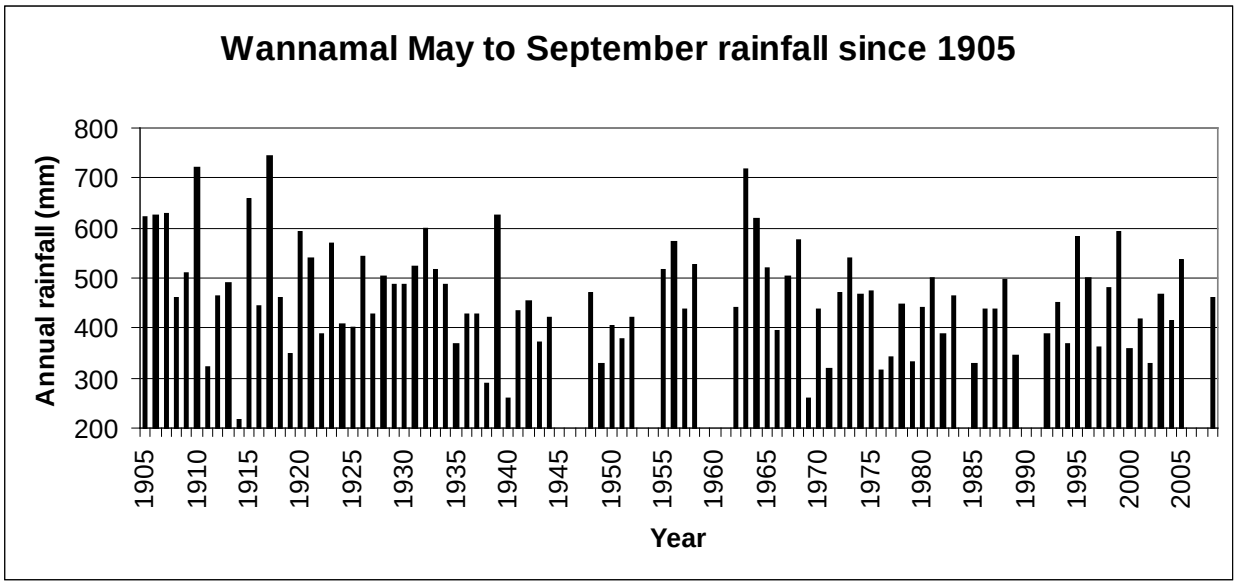

Figure 8. Rainfall from May to September for Wannamal since 1905

3.3 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 2005 are shown in Figures 9, 10 and 11.

3.3.1 Ellen Brook Nature Reserve

In 2005 the activities at Ellen Brook Nature Reserve (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 during the aestivation period. There is a trend over the last decade that population numbers at EBNR are gradually increasing (see Figure 9.)

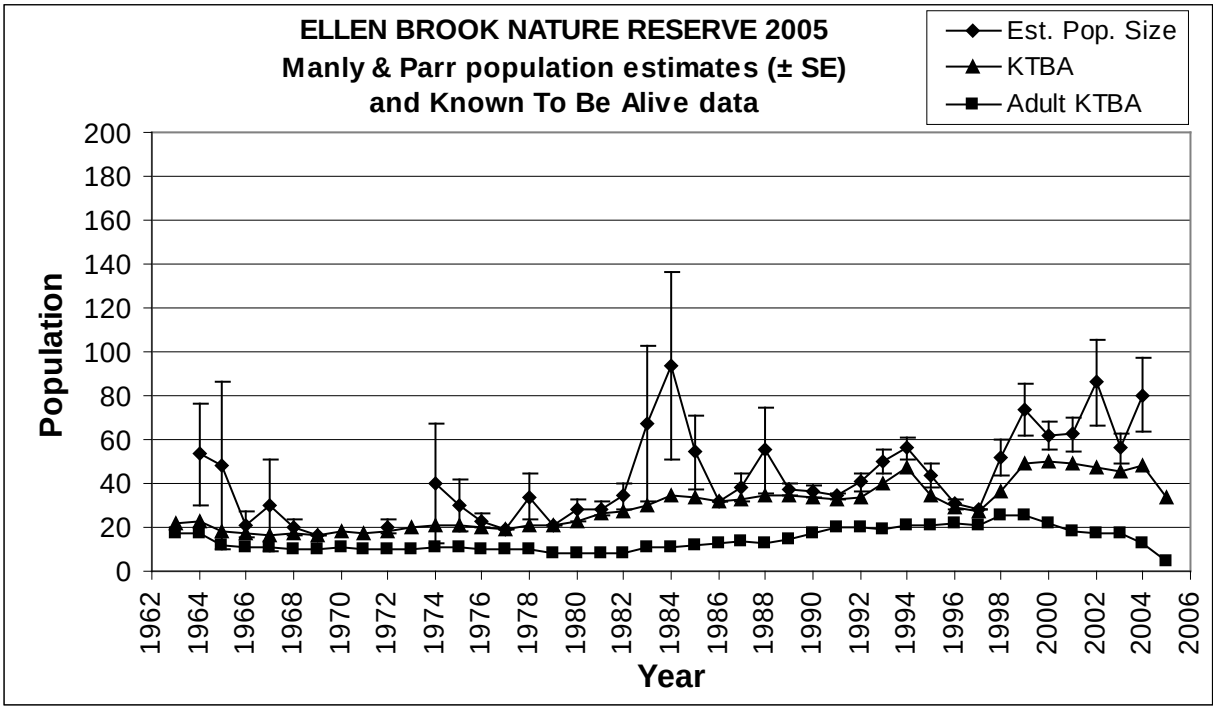

Figure 9. Population Estimates at Ellen Brook Nature Reserve

Note: 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.

Aestivation - summer 2004/2005

Of the five juvenile *P. umbrina* radio tracked and equipped with Thermochron iButton temperature data loggers over the summer of 2004/2005, four had moved into water by 28 May 2005 and the transmitters and loggers were removed. The last one was in water on 05 June 2005 and the transmitter and logger was removed.

Translocation 2005 and population monitoring

To compensate for the reproductive output of EBNR females still kept at Perth Zoo (until the acquisition and protection of the habitat at the Midland Brick's bock is accomplished), 13 captive bred hatchlings (mean body mass of 21.7g (±4.0 SD)) were released at the southern block of EBNR on 09 July 2005. Four of those were recaptured on 23 November 2005 with a mean body mass of 57.5g (±7.2 SD). Two of the three hatchlings released in 2004 were also recaptured in late November/ early December 2005 with 76.5g and 93.5g. They approximately doubled their mass during 2005. This demonstrates very good growth of juveniles in the new, rehabilitated reserve area during 2005.

A juvenile with a body mass of 56g that hatched in 2004 was found on the Midland Bricks block to the west of Ellen Brook Nature Reserve near swamp gauge 3 on 21 November 2005. This demonstrates that there must have been a breeding female on the block in 2003 and that the habitat is suitable for hatchlings to survive aestivation and to grow up. Since this habitat area is not yet protected, the hatchling was temporarily moved to Perth Zoo. The capture of the juvenile underlines the significance of the habitat to the west of Ellen Brook Nature Reserve for Western Swamp Tortoise conservation.

No wild hatchlings from 2005 were found at EBNR during that year.

Two mortalities of *P. umbrina* were recorded at EBNR during 2005:

On 25 November 2005 the dry carcass of the juvenile # 555 (hatched 1999) was found on dry ground not far of gauge # 2 under a *Melaleuca lateritia* bush in an area which was flooded during winter and early spring. It was probably dead for two weeks. All scutes were still attached to the carapace, but some plastral scutes were loose and approximately 10 cm from the back of the animal on the ground. Although dry skin flaps were present in the inguinal and axillary pockets, no traces of limbs, head or

neck could be found. The only visible damage to the shell was some tooth marks on the rim of the first left marginal scute. This tortoise had last been recorded on 13 June 2005 with a body mass of 104g.

On 28 November 2005 at 6.30 pm the empty shell of an unmarked, dead juvenile *P. umbrina* (# 867, carapace length 54.3 mm), which had hatched in 2004 was found on a heap of sedge leaves under a *Melaleuca lateritia* shrub just beside the water near gauge 1 which showed a level of 10 cm. The posterior lobe of the plastron was missing, the left pectoral was damaged and the left bridge was broken (plastron separated from carapace). The carapace showed gnawing on the supracaudals, the nuchal and the first and second left marginals. No traces of limbs, head, neck, shoulder and pectoral girdles, internal organs and muscles could be found, but some more or less fresh skin flaps were in the inguinal and axillary pockets. Some very small fly maggots were under a skin flap. The tortoise was most probably dead for less than 24 hours.

Despite the fact that, for the last 17 years, intensive searches were performed every year around gauges 1 and 2 at the time just before the water disappeared, no carcasses were ever found during these searches until 2005. The conditions of both carcasses suggest predation by rats.

Aestivation - summer 2005/2006

Five juveniles (including two that were tracked in 2004/2005) from the southern rehabilitated block of EBNR, were again equipped with radio-transmitters and Thermochron iButton temperature data loggers during late November/ early December 2005 to record temperatures during aestivation over the summer of 2005/06. By December all five aestivated in tunnels or rabbit warrens.

3.3.1.1 Long-necked Tortoises at EBNR

Long neck tortoises are rare in the *P. umbrina* habitat at EBNR. An adult male long neck tortoise *Chelodina oblonga* (1050g, Cl 217.9mm) was found in an artificial plastic-lined pond inside at the fox-proof fence at Ellen Brook Nature Reserve on 01 November 2005. It had probably walked along the fence, trying to get to the Ellen Brook. Its carapace was covered by long, filamentous algae, which suggests that it had spent the summer of 2004/2005 in water and, therefore, outside the fox proof fenced area. Due to its size it could not have entered the fox proof fence through a one way tortoise tunnel. It is probable that someone may be a member of the public, put the tortoise over the fence into the fox-proof area, possibly believing that this is helpful for conservation. The tortoise was moved outside the fox-proof fence and into the adjacent Ellen Brook.

Another adult male long neck tortoise *Chelodina oblonga* (555g, Cl 176mm, a size that could just fit through a tortoise tunnel) was found in an artificial plastic-lined pond inside at the fox-proof fence at Ellen Brook Nature Reserve on 14 December 2005. It had probably also walked along the fence, trying to get to the Ellen Brook. It was also moved outside the fox-proof fence and into the adjacent Ellen Brook.

The public information panels at the Gull station in Upper Swan should probably include an appeal not to move any long neck tortoises into the fox-proof fenced area of EBNR.

3.3.2 Twin Swamps Nature Reserve

At Twin Swamps Nature Reserve (TSNR), 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 at TSNR since around 1998 are unreliable and not reflective of the true population size because of the typical low sampling success due to the considerable difficulty in capturing Western Swamp Tortoises. (See Figure 10)

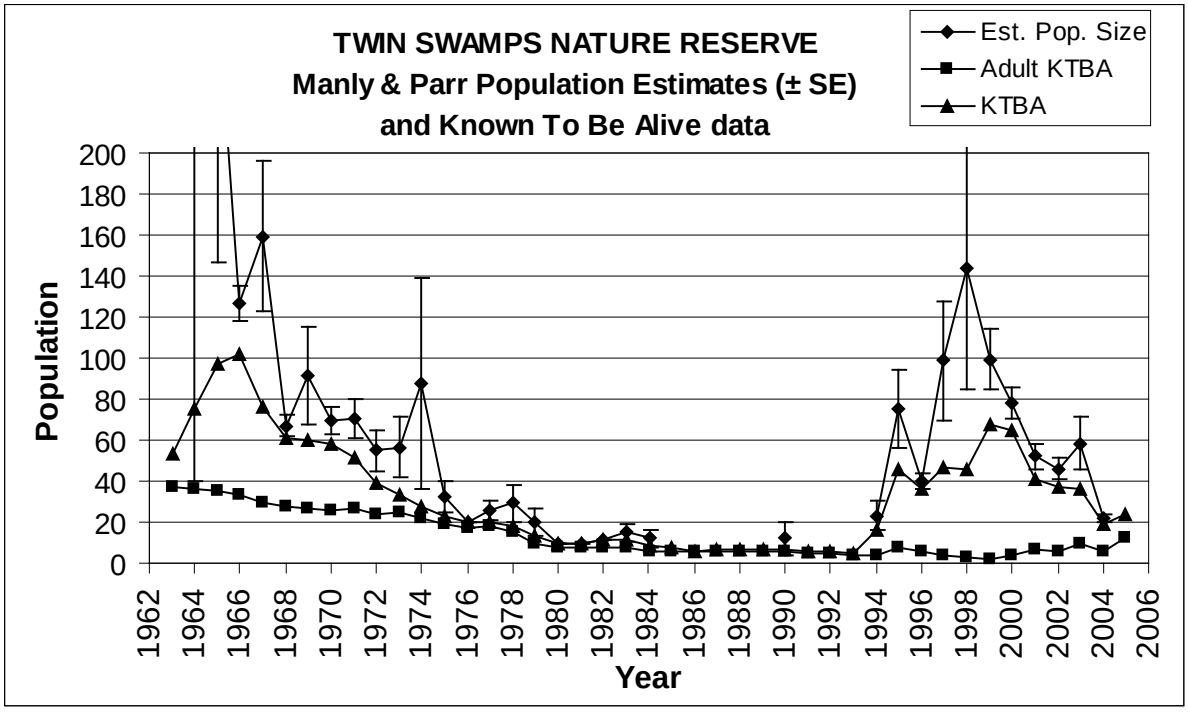

Figure 10. Population Estimates at Twin Swamps Nature Reserve

Note: 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.

Aestivation - summer 2004/2005

All eleven *P. umbrina* equipped with transmitters and temperature loggers (logging the temperature every three hours) stayed in rabbit warrens under *Regelia* bushes in January/February 2005. By 07 April, six had moved to the surface and stayed in between a few meters of the holes under branches or leaf litter. One tortoise was at the entry of the hole in the process of coming out. By 28 May, two tortoises were still inside the holes, four were under Regelia branches, four had entered the water and one was at the fence in the NE corner of the reserve. By 12 June, four additional tortoises were in the water, two in holes and the same one still at the fence. On 02 July, one from the hole had entered the water. Of the other one shed transmitter only was recovered from the hole. All transmitters were removed as soon as the tortoises were found in water, with the exception of one that stopped signalling before it could be removed and was, therefore, lost.

Translocation 2005 and population monitoring

Nine captive-bred *P. umbrina* were released at TSNR-NW on 09 July 2005, four adult males, four adult females and one subadult female. All of them represented rare genetic lines of the captive-bred stock and were released to widen the genetic variability of the re-introduced population at TSNR.

Apart from the tortoises radio-tracked over the summer of 2004/2005 and apart of the released ones, five additional tortoises of previous releases were recaptured during 2005. One of those plus one of the previously radio-tracked ones plus one of the released ones were equipped with miniature temperature loggers and radio-transmitters during November/December to record temperatures during aestivation over the summer of 2005/06. 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.

Aestivation - summer 2005/2006

On 14 December 2005 one radio-tracked tortoise was inside a rabbit hole in *Regelia* bushland, one was dug in head first in a small hole in *Regelia* bushland and one was still on the surface under a *Regelia* bush.

3.3.3 Mogumber

Aestivation - summer 2004/2005 at Mogumber

By late December 2004, 14 tortoises were radio-tracked at Mogumber, two of which stayed in artificial aestivation tunnels. An additional four were transferred into artificial aestivation holes by Christmas 2004.

By mid February 2005, only one of the tortoises remained in the artificial hole were it was in December, all others had left the tunnels. Two had moved back to more or less exactly the same site were they had been prior to the transfer into the artificial hole and stayed again under leaf litter; one had shed and lost the transmitter while moving away; and two stayed in small holes. Of the 13 tracked tortoises, five stayed under leaf litter, three were in shallow holes, three in relatively good and deep holes, and one was in an artificial tunnel and one under a heap of logs.

By 07 April 2005, none of the tortoises remained in an artificial hole, only three were in good and deep natural holes and eight of the 13 stayed under leaf litter. But the tortoises generally have a tendency to move to the surface during April and May. By late May 2005, only one remained in a hole. By 11 June 2005 one of the 13 tracked tortoises was in the water at NW Swamp; one had shed its transmitter; the transmitters of the other eleven tortoises were removed and the tortoises were moved into the water at NW Swamp.

It is likely that the transfers caused the tortoises to move more extensively during the hot dry summer months and to settle later than normal into aestivation sites that were often sub-optimal. However, only one of six tortoises transferred during aestivation into artificial holes lost more body mass than those tortoises that were not interfered with:

Table 1: Body mass changes of radio-tracked *P. umbrina* during aestivation at Mogumber:

	n	Body mass Nov. 2004, mean ± SD	Body mass June 2005, mean ± SD	Loss of mass
Not transferred during aestivation	6	144.9 ± 35.5	122.5 ± 30.9	15.5%
Transferred into artificial hole, Nov. 2004	2	134.3 ± 12.3	122.5 ± 12.5	8.8%
Transferred into artificial hole, Dec. 2004	3	133.2 ± 8.7	116.8 ± 7.0	12.3%
Transferred into artificial hole, Dec. 2004	1	145.5	102.0	29.9%

In conclusion, the transfer of tortoises which aestivate at suboptimal sites into artificial aestivation tunnels during late spring and early summer did not show positive results, since only one out of 11 tortoises transferred into artificial holes during November/ December 2004 stayed there during January/ February 2005, the hottest time of the year. This demonstrates the importance of providing underground aestivation sites during captive rearing to train the tortoises to aestivate underground prior to release into the wild.

No mortality was recorded over the summer of 2004/2005. This may reflect the regeneration and regrowth of the vegetation after the fire of December 2002, which provides more shade and better aestivation conditions than in the summers of 2002/2003 and 2003/2004.

Translocation 2005 and population monitoring

Thirty two captive-bred juvenile tortoises were released at NW Swamp at Mogumber on 08 July 2005. Major searches for tortoises took place on 19, 22 and 24 November 2005 and on 09 and 18 December. Seventeen of the released tortoises were recaptured, plus 15 tortoises from previous releases. Thirty of those were equipped with radio-transmitters and with miniature temperature loggers for tracking over the summer of 2005/06. 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 (same sites as in the last two summers).

The 17 released tortoises which were recaptured had grown well; they increased their body mass by 24.7% in 19 weeks, from a mean of 108.6g (±9.6 SD) on 08 July to 135.4g (±12.5 SD) by late November. Of the tortoises recaptured and measured in November 2004, eight were again recaptured in November 2005. Their body mass had increased by 7.8% from 134.3g (±9.3 SD) to 144.8 (±9.8 SD). This demonstrates the suitability of the swamp life at Mogumber for Western Swamp Tortoises.

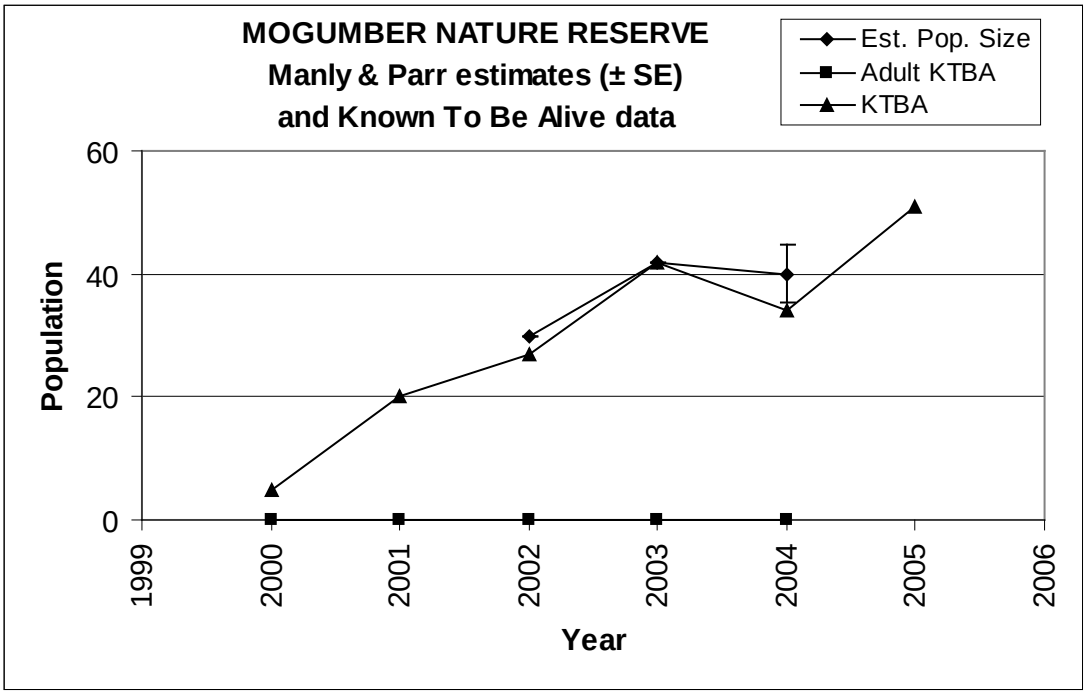

Figure 11. Population Estimates at Mogumber Nature Reserve

Aestivation - summer 2005/2006

Of the 27 tortoises equipped with radio transmitters during November, by 05/06 December 18 were staying under leaf litter, six were in rather shallow holes (mainly goanna holes), two were in deeper holes (at least 20cm underground), and one stayed in an artificial tunnel.

One tortoise was found in the last water in a road ditch at the Purser property on 09 December 2005 and equipped with a radio transmitter. By 18 December it has moved into a rabbit warren under the concrete slab of a farm shed.

Three more tortoises were found in a farm dam on Purser's property just outside the SW corner of Mogumber reserve, one of them had been released in July 2005. Two were equipped with radio transmitters and returned into the dam.

3.4 CAPTIVE BREEDING

3.4.1 Breeding season

In total, 23 females laid eggs, which produced seventy one hatchlings in 2005. The information recorded on the viability of eggs produced in 2005 was divided into two categories to display variations between the immature and mature breeding females. The viability of eggs produced in younger females rose from 47% to 62% in 2005 while in older tortoises it rose from 76% to 86%. As expected the viability of the mature female eggs was higher than the immature females and remained approximately the same as last year (See Table 1). Overall the hatchling rate increased from 69% in 2004 to 79% in 2005. This trend is expected to continue in the medium term.

Of the twenty-one females to lay, two females reproduced for the first time. In contrast to the upward trend of females double clutching (ovulating twice in the season) in previous years, no females did so this year. In the previous 11 years eight females have produced thirteen double clutches.

Table 2. Perth Zoo Captive Breeding

F/M I.D.	STATUS	EGGS PRODUCED	EGGS HATCHED
CZ1	Reproducing > 3 years	3	1
CZ2	"	7 (2 Clutches)	6
Z3	"	4	3
4	"	5	5
70	"	5 (2 Clutches)	3
164	"	3	3
184	"	6 (2 Clutches)	5
196	"	8 (2 Clutches)	8
199	"	3	3
221	"	4	3
256	"	3	3
341	"	3	2
380	"	6 (2 Clutches)	6
387	"	4	4
TOTAL		**64**	**55 (86%)**
207	Reproducing < 4 years	3	2
245	"	3	3
261	"	4	3
272	"	2	0
286	"	1	0
302	"	3	1
318	"	4	4
324	"	3	3
439	"	3	0
TOTAL		**26**	**16 (62%)**

3.4.2 Releases

Fifty four Western Swamp Tortoises were released into three nature reserves in 2005. (See table 2 below)

Table 3. Number of WST releases into reserves 2005

RESERVE	# RELEASED	STATUS
Mogumber	32	Juveniles
Ellen Brook	13	Hatchlings
Twin Swamps	9	Adults
TOTAL	**54**	

3.4.3 Health

Male tortoise Z5 (estimated to be around 70 years old) had a lung infection in September, but recovered quickly with antibiotic treatment.

Male tortoise 205 (16 years old) suffered a prolapsed cloaca in March. The prolapse was returned by vet staff and the tortoise gained weight and remained healthy after this.

3.4.4 Deaths

Four deaths were recorded in 2005.

#743. Hatchling from 2004 aged 10 months. This tortoise suffered a prolapsed intestine which was returned by vet staff but in the subsequent six months it failed to gain any weight and was euthanased.

#763. Hatchling from 2004 aged 1 yr 5 months. This tortoise had a very low hatching weight of only 3.1g and had buoyancy problems from hatching; it gained weight only slowly and eventually was unable to dive at all. It died 2 days after being unable to dive at all although it was in a treatment tank with plenty of live food on the water surface.

#842. Hatchling from 2005 aged 8 months. Cause of death unknown.

#844. Hatchling from 2005 aged 1 month. Found dead trapped under a log shelter in the pond likely from drowning.

3.4.5 Transfers

No captive bred animals were transferred in 2005.

Two pairs of breeding age tortoises are planned for transfer to Adelaide Zoo in 2006 on the completion of the breeding and aestivation facilities.

3.4.6 Aestivation

Aestivation tunnels were once again placed in the pens this season in addition to the normal leaf litter. All pens have at least three tunnels in each. It is still hoped the tortoises will then be more familiar with them and increase the likelihood of their use in the reserves. Of all the aestivating tortoises returned to ponds this year only three were found to be in tunnels.

Banksia leaves were utilised as leaf litter, for those tortoises destined for release at Mogumber next year, for the first time this aestivation period. Two species of leaves were used (*Banksia grandis and B.attenuata*) and built up to a depth of 150mm. This type of leaf litter is commonly found in the reserves. It is hoped that an increased familiarity with the leaves will help the tortoises settle into aestivation easier in the reserves.

3.4.7 Status of Captive Colony

AGE/STATUS	NUMBER
05 Hatchlings	58
04 Hatchlings	42
03 Hatchlings	10
02 Hatchlings	16
01 Hatchlings	8
00 Hatchlings	4
99 Hatchlings	1
98 Hatchlings	5
Juveniles from land adjacent to EBNR	5
Zoo-bred sub-adults retained for breeding	6
Non-breeding adult females	1
Breeding males	21
Breeding females	23
Total	196

3.5 TRANSLOCATIONS

3.5.1 Re-introduction to Twin Swamps and Mogumber Nature Reserves

In 2005 the focus at TSNR was on the re-introduction of nine sub-adult and adult, captive-bred *P. umbrina*, on monitoring the tortoises which were re-introduced in previous years and on comparing operational environmental temperatures with Mogumber Nature Reserves.

Apart from the tortoises radio-tracked over the summer of 2004/2005 and those that were released, five additional tortoises of previous releases were recaptured during 2005.

Thirty two captive-bred juvenile tortoises were released at NW Swamp at Mogumber on 08 July 2005. Major searches for tortoises took place on 19, 22 and 24 November 2005 and on 09 and 18 December. Seventeen of the released tortoises were recaptured, plus 15 tortoises from previous releases.

3.5.2 Translocation to additional sites

3.5.2.1 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 2005. Only the water level of the NW Swamp was occasionally recorded, but the depth gauge from 1999 had disappeared. The swamp was dry on 05 June, but some water was standing on the northern firebreak. On 12 June 2005 NW Swamp had more or less reached its maximal water level. On 17 November NW Swamp was approximately ½ full. The water had more or less disappeared by 21 November 2005, although there was still some water on the northern firebreak. By 25 November the NW area was totally dry. The duration of swamp life would have been suitable for Western Swamp Tortoises.

Moore River National Park

The preliminary gauges installed in the SE Swamp and NE Swamp during 2004 were broken off by 4WD traffic during the summer of 2004/2005. The gauge at W-swamp was dry on 14 May 2005, but some puddles were nearby and frogs were calling. However, water level readings could not be taken during 2005.

Apart from some puddles on firebreaks, SE Swamp and NE Swamp were more or less dry on 19 October 2005. Thus, at that stage the duration of standing water in the swamps seems to be suboptimal for Western Swamp Tortoises, in particular in spring. A reason for this seems to be that water drains out

of the reserve towards cleared land to the east.

Perth Airport

Negotiations continued with the Westralian Airports Corporation regarding the proposal to translocate tortoises within a zone designated for conservation at the northern portion of Perth Airport land. Hydrological monitoring was undertaken over winter 2005 to assess the suitability for translocation of tortoises and to establish whether artificial hydrological maintenance is required. An inspection of the target area by the Recovery Team's Chief Investigator found two swamps with adequate water to support the tortoise in 2005.

Moore River Nature Reserve

In 2004/2005 a possible translocation site at Moore River Nature Reserve was investigated and monitored. This site shows significant promise, although some habitat manipulation, including establishment of bunds, may be required to make it suitable for the tortoise. The site also contains a vulnerable Threatened Ecological Community (TEC) which may be impacted by any bunding proposal. A proposal document will be prepared for submission to the TEC Scientific Committee in 2006 outlining the hydrological modifications required to determine acceptable impacts to the TEC. There is scope for a trial release at Moore River Nature Reserve if the bunding proposal is approved in 2006.

3.6 EDUCATION, PUBLICITY AND SPONSORSHIPS

3.6.1 Education and publicity

Gerald Kuchling was invited speaker at the Annual Meeting of the German Herpetological Society (DGHT) in Lörrach in September 2005 and gave a presentation on the Western Swamp Tortoise Recovery Program.

The Friends of the Western Swamp Tortoise (FoWST) Group undertook a range of initiatives in 2005, which included organising educational activities, development of interpretational signage and materials, and promotion of the Recovery Program.

Lyndon Mutter conducted a presentation on the WST at a community education evening at Bullsbrook.

The Southern Gazette and Midland Times newspapers published stories on proposals related to the re-introduction of WST at the Perth Airport.

The FoWST installed an interpretive panel at the Gull Service Station near Ellen Brook Nature Reserve.

3.6.2 Sponsorships

Sponsorships for 2005 included:

- a Wetlands Conservation Grant from Tiwest for $18 000, which was used for revegetation, aestivation tunnels, rat bait stations and interpretation material.
- The Friends of the WST received a $5000 Ministerial Grant for on-ground works, including seedlings and revegetation projects;

ACKNOWLEDGEMENTS

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Heritage Trust through the Swan Catchment Council, and by the Department of Conservation and Land Management and Perth Zoo. Funding has also been provided by Tiwest, World wide fund for Nature, and the Friends of the WST. Midland Brick have agreed to transfer an area of habitat into Ellen Brook Nature Reserve as an environmental offset for the development of another proposal at a different site. The Recovery Team thanks Alex Errington for his hard work in acquiring this additional land adjacent to Ellen Brook Nature Reserve. Additional support is provided by World Wide Fund for Nature, the University of Western Australia's School of Animal Biology, the Friends of the Western Swamp Tortoise, and Curtin University of Technology's School of Biomedical Sciences. Without this support, implementation would not be possible, and the recovery team thanks all organisations and individuals who have continued to support the recovery of this critically endangered species. Rainfall data were kindly provided by Brian Kowald, Bureau of Meteorology.