AQUATIC ROOT COMMUMITY OF CAVES OF THE SWAN COASTAL PLAIN

RECOVERY PLAN

ANNUAL REPORT

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by

Aquatic Root Mat Community of Caves of the Swan
Coastal Plain (Yanchep) Recovery Team

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SUMMARY

The continuing decline of the Gnangara Groundwater Mound has caused the majority of the Yanchep National Park Cave streams and pools to dry. Of the approximately one hundred species associated with the Yanchep Cave Stream Root Mat Community, up to thirty species of invertebrate are only known from the Yanchep caves (although this number is to be revised following a proposed taxonomic study). There is a strong possibility that many of the cave stygofauna will become extinct if the current decline is not arrested.

The Recovery Team which was established in 1997 completed a number of recovery actions in 2005, based on the Interim Recovery Plan. The key strategies for 2005 were:

- Unfortunately on 6 January 2005 a devastating wildfire has burnt more than 70% of Yanchep National Park and burnt vegetation above all of the cave systems that containing the root mat community. This wildfire was lit by an arsonist. There was widespread damage to mature tuart trees, power poles and possibly the cave systems themselves. The fire delayed the ability of CALM staff and experts to access the caves for 4-7 days (powerlines and dangerous trees required assessment and felling prior to access being allowed). There was extensive damage to above-ground infrastructure, including the small cave rewatering systems. These have since been repaired. There was only a small level of impact on the cave systems and underground limestone structures. Following above average rainfall during 2005, regeneration of Tuart trees and plant communities in general was extremely good. All damaged infrastructure associated with the caves has been repaired and/or replaced.

- Work on the full-scale caves water recharge project, the 'Yanchep Caves Recovery Project', was begun in November 2004 with the construction of a bore near the CALM settlement on Yanchep Beach Road. Six kilometres of pipeline was installed between the bore and the six caves. This project, a collaboration between CALM, the Water Corporation and the Department of Environment, was budgeted at $1.125 million dollars. In June 2005 the system was completed and run for four weeks to all seven caves. Water quantities to each cave have been calculated. The trial indicated that the bore could provide adequate water to each of the caves, the piping and delivery system work well and the cave streams could be reinstated. Unfortunately a red iron precipitate accumulated within the caves during this trial and this necessitated the system being turned off until a solution was developed. The aim is to create artificial ground water mounds under the root mat community caves, and to re-flood the ponds and streams of the caves. It is anticipated that the life of this project is 10 years, by which time other measures to restore the ground water levels are expected to have had a positive effect (eg. removal of the pine plantation to the east).

- Iron precipitation from the water discharged into the caves as part of the rewatering project resulted in the bore being turned off only a few weeks after it was first turned on. Dr Chris Barber, consultant water chemist, was employed to assess the iron precipitation problem. Dr Barber identified that water from the Leederville aquifer was being drawn through the shale layer and was the source of the iron in solution. Dr Barber also found that once the water was discharged into the caves the aeration caused the iron to come out of solution. The technical sub-group then determined that a number of trials should be undertaken to fix the problem while more complex and expensive engineering solutions were investigated. Dr Barber also assisted with the assessment of these trials. The first trial, a reduced yield trial to reduce the abstraction from the Leederville aquifer, was found to be untenable. A second trial investigating variable pumping was abandoned due to concerns that the iron precipitation may clog the pipeline and bore head. In 2006 trials of the more expensive engineering solutions will be undertaken.

- An $80,000 NHT2 grant was received for the root mat community for 2003/04, 2004/05 and $40,000 in 2005/06. In 2005 these funds were used on recovery actions such as the supplementation scheme pipeline and completing ongoing hydrological investigations.

- The annual monitoring of cave fauna is funded by the DoE as part of the Ministerial Conditions associated with environmental impacts of water extraction on the Gnangara Mound. Since 1999 Dr Brenton Knott and Dr Andrew Storey from University of WA have undertaken the annual monitoring of Yanchep cave fauna. In October 2004 Dr Barbara Cook, also from UWA, undertook the invertebrate monitoring. There was no evidence of a decline in water quality of the cave streams. Dr Cook concluded that as in recent years the aquatic macro invertebrate fauna of the cave streams was characterised by a low diversity and abundance, with the number of species collected ranging from 1 to 9. Dr Knott and Dr Storey undertook the annual monitoring in October 2005 and also found a low level of diversity of cave invertebrates/stygofauna compared to earlier years.

- A full upgrade of the small in-cave rewatering systems occurred in 2004, using NHT funding, including replacement of the liners, installation of a solar battery powered system and pump upgrades. The January 2005 wildfire within the park destroyed the above ground cabling and solar panels resulting in all of the systems failing. The systems were reinstated and fully functional within 7 days of the fire. The pumping systems have been monitored regularly to ensure they continue to function as designed. A trial system was placed in Cabaret Cave in 2004 to check if a remote camera system could be used in caves that may be dangerous or difficult to access.

Future management:

- Finalisation of the 'Yanchep Caves Recovery Project' and starting to pump water back into the root mat community caves after the iron precipitation problem has been dealt with. CALM initially committed $1.125M over two years to sink the bore, develop the piping systems and monitor the outcomes. Further funds have been requested by CALM to purchase appropriate filtering systems to remove the iron precipitation problem. It is hoped that the bore will be able to be returned to full production before the summer of 2006/07.
- Taxonomic characterisations and descriptions are required for many of the stygofauna known from the aquatic root mat TEC. Dr Brenton Knott and postdoctoral fellow Dr Danny Tang from UWA propose to undertake a morphological and genetic investigation into the cave stygofauna. This will be published in an international scientific journal.

The current situation:

- Five of the seven occurrences of the Critically Endangered 'Aquatic Root Mat Community of Caves of the Swan Coastal Plain (Yanchep)' have now completely dried up. Water Cave still has a pond of standing water, although this has substantially declined in the past years (Fiona Felton CALM, personal observation). The ground water level is now over 1 metre below the floor of most caves.

- The decline in groundwater levels is believed to be due to a combination of pine plantations reducing recharge, private abstraction for horticulture, public abstraction by the Water Corporation, and an extended period of dry climatic conditions.

- Small in-cave watering systems have been installed in an attempt to sustain the occurrences but the health of the community is dramatically declining. The watering systems have been updated several times since to improve their capacity and reduce the risk of failure.

- Recent hydrological modelling indicates a natural rise in groundwater sufficient to re-establish cave streams is not likely to be achievable in the next ten years regardless of pine thinning, even if there is a return to wetter climatic conditions. Investigations and trials have been conducted by CALM, the Water Corporation and the Department of Environment over the last two years to develop a longer term strategy involving abstracting water from the west of the Park and piping it to each of the six occurrences for recharge to create a rise in groundwater sufficient to recreate the streams and pools that support the community.

- Annual monitoring undertaken by the Department of Environment (previously the Waters and Rivers Commission) since the end of 2001 indicates that the health of the root mats has significantly declined, and the number and diversity of animals recorded has dramatically reduced.

1. INTRODUCTION

The continuing decline of the Gnangara Groundwater Mound has caused the majority of the Yanchep cave streams and pools to dry. Of the approximately one hundred invertebrate species associated with the Yanchep cave root mat community, up to thirty are only known from the Yanchep caves (though this number is to be revised following a proposed taxonomic study). Many are new to science. There is a strong possibility that many of the species will become extinct if the decline of the community is not arrested.

Recovery Team Established

- Of the 315 caves known in Yanchep National Park, 46 are known to contain pools or seeps, with 10 - 15 containing permanent water. Seven of these permanent streams support the aquatic root mat community. Each contains 30 to 40 invertebrate species, with about 100 in total in all caves. Approximately 30 of these species are only found in the Yanchep Caves and cannot survive drying.

- Drying of a number of Yanchep caves started to occur in the early 1990s. In 1996 one of the seven caves containing the root mat community dried completely. The community was assessed by CALM to be Critically Endangered, and a Recovery Team for the community was established in 1997. The team has representatives from CALM, the University of Western Australia, Department of Environment, Water Corporation, the WA Speleological Group and the City of Wanneroo.

- The Recovery Team developed an Interim Recovery Plan in November 2000 and implemented recovery actions for the community. Key strategies have been to reduce the density of the pine plantation within the cave's catchment, augment drying root mats and fauna with watering systems, and monitoring the invertebrates on an annual basis.

Small-scale Emergency Rewatering Systems Established

- All seven occurrences of the Critically Endangered Aquatic Root Mat Community of the Swan Coastal Plain have dried in the last few years (though Water Cave still has a pond of standing water that is rapidly declining).

- From 1998 as cave streams containing root mats stopped flowing, CALM, in consultation with the Recovery Team, installed small-scale emergency systems to prevent complete drying of pools and root mats. All five caves with extant root mat communities now have these augmented watering systems. The systems are made up of lined pools with water pumped from soak wells installed in the base of the caves over the summer period until streams flow again in winter. The design of these has required great ingenuity because the occurrences tend to be small in size and are located in tight sections of caves which are difficult to access. The systems have been monitored and maintained regularly to ensure they continue to function and have been updated several times to improve their capacity and reduce the risk of failure.

- It is not known whether inaccessible refuges exist elsewhere underground which might allow the future re-colonisation of the root mats that have lost species when stream flow is re-established after the completion of the recharge project.

Root Mat Invertebrate Community Monitoring

- Annual Monitoring of the root mat community has been undertaken by Dr Brenton Knott and Dr Andrew Storey of the University of WA on behalf of the DoE. In 2000 the monitoring indicated the watering systems were successfully maintaining the fauna in the root mat community caves. However groundwater levels continued to fall, and by 2001 some streams were staying dry all winter. With no natural flow the root mats were only sustained by the watering systems. The fauna monitoring undertaken at the end of 2001 indicated that the health of the root mats had significantly declined, and the number and diversity of animals recorded was dramatically reduced. CALM upgraded the systems to supply more water, reduce the risk of the systems failing, and reduce the risk of injury to rangers who maintain the systems.

Primary Causes of Groundwater Decline

- The decline in groundwater levels is believed to be due to a combination of pine plantations reducing recharge, private abstraction for horticulture, and public abstraction by the Water Corporation, and an extended period of dry climatic conditions (the latter being the primary cause). There is uncertainty about relative contributions of these factors to the groundwater decline at Yanchep National Park. Prior to 2002/2003 the DoE's groundwater monitoring program indicated that the decline was due to a combination of a period of lower than average rainfall and the influence of pine plantation to the east of the National Park. The DoE program at the time was

not able to show any influence of private abstraction from nearby horticulture, groundwater use within Yanchep National Park, nor from the Public Water Supply groundwater abstraction scheme. It was believed that because there was no public superficial abstraction near the National Park that public abstraction was not contributing to the decline. It was also believed that public abstraction from the deeper Leederville and Yarragadee aquifers would not affect the superficial aquifer.

In 1999 the Waters and Rivers Commission and the Forest Resources Division of CALM (now the Forest Products Commission or FPC) developed a Memorandum of Understanding (MOU) and program for thinning the Pinjar Pine Plantation upstream of the caves over a three-year period to achieve greater recharge. This agreement required maintenance of the pines to keep the density at the agreed level.

By 2002 the FPC were on target to achieve most of the initial thinning required. In 2002 a State Agreement for the Wesbeam Laminated Veneer Lumber Plant superseded the MOU regarding thinning and now guides the level of harvesting and removal of the pine plantation. While 200 ha of pines was clearfelled upstream of the Yanchep Caves to promote recharge, the FPC have indicated they have no capacity to undertake further clearfelling or significant thinning within the cave catchment, as this will prevent the State from meeting its contractual timber volume with Wesbeam.

- The analysis also indicated that recharge in native woodland is increased for several years following a fire. The Department has undertaken a number of strategic autumn prescribed burns in the National Park and surrounds since the autumn of 2002 in an attempt to help increase or hold local groundwater levels until a more permanent rise in regional levels can be achieved. The selection of these areas was based on their proximity to the caves, period since last fire, and the provisions of the Park's management plan in relation to fire regimes.

Consultant Hydrologist Support to Recovery Team

- The local hydrology in the Yanchep karst system is complicated. The Department has contracted the services of a senior consultant hydrologist (Dr Adrian Peck) since 2002 to help review the hydrological work and work with DoE staff in trying to model actual impacts of nearby private abstraction, the pines, rainfall, and deep aquifer abstraction, and provide advice to the Recovery Team.

2. INTERIM RECOVERY PLAN AND FUNDING

The current Interim Recovery Plan (IRP) covers the period 2000 – 2003. The IRP's objective is to maintain or improve the overall condition of the aquatic root mat community and reduce the level of threat, with the aim of reclassifying it from Critically Endangered to Endangered or Vulnerable.

This objective is not being achieved. As a result of the continuing decline of groundwater levels, and the need to artificially supply water to exposed root mats, the condition of the root mat community has actually significantly declined. Recent monitoring has demonstrated a decline in the health of the root mat community, and a decline in the number of invertebrate species recorded.

Since 2003 CALM's Swan Coastal District has received annual funding from the Natural Heritage Trust to implement recovery actions on nine Critically Endangered TECs on the Swan Coastal Plain. Funds from this NHT grant and from CALM was used in 2005 to implement actions from the Critically Endangered 'Aquatic Root Mat Community of Caves of the Swan Coastal Plain (Yanchep)' IRP as directed by the Recovery Team.

3. RECOVERY PLAN IMPLEMENTATION

The Recovery Team have implemented the following recovery actions in the IRP with specific reference to tasks undertaken in 2005:

1. **Establish a Recovery Team.**
   The Recovery Team was established in 1997 and has been in place since that time (thus this action has been completed). The Recovery Team meets on average twice a year. At the end of 2005, Recovery Team members were as follows:

   Paul Brown, CALM, Swan Coastal District, District Manager (Chair)
   Leigh Sage, CALM, Swan Coastal District, Conservation Officer (Executive Officer)
   Wayne Bartley, Water Corporation, Senior Project Manager

Andrew Paton, Department of Environment, Environmental Officer
Lex Bastian, Speleologists Association
John Blyth, CALM Threatened Species and Communities Unit, Manager
Dr Brenton Knott, Professor of Zoology, University of Western Australia
Dr Andrew Storey, Research Scientist, University of Western Australia
Dr Adrian Peck, Hydrological Consultant, Peck & Associates

In 2005 the Recovery Team met twice: in March and June. In June 2005 John Blyth retired from CALM and the Recovery Team. He was replaced by Jill Pryde.

A technical sub-group of the Recovery Team was established in mid-2003 to progress emergency actions associated with the trial groundwater rewatering program in and near the caves. It subsequently has been progressing the large rewatering project. This sub group met three times during 2005. At the end of 2005, invited attendees to the technical sub group were:

Paul Brown, CALM, Swan Coastal District, District Manager (Chair)
Leigh Sage, CALM, Swan Coastal District, Conservation Officer (Executive Officer)
Mark Garkaklis, CALM, Swan Coastal District, Regional Ecologist
Fiona Felton, CALM, Swan Coastal District, Conservation Officer
Wayne Bartley, Water Corporation, Senior Project Manager
Dr Chris Barber, Consultant Water Chemist
Dr Adrian Peck, Hydrological Consultant, Peck & Associates
Dr Ray Gordon, Consultant Geologist

2. **Monitor cave fauna and respond to results of monitoring as appropriate.**
The annual monitoring of cave fauna is funded by the DoE as part of the Ministerial Conditions associated with environmental impacts of water abstraction on the Gnangara Mound. Since 1999 Dr Brenton Knott and Dr Andrew Storey from University of WA have undertaken the annual monitoring of Yanchep cave fauna. In October 2004 Dr Barbara Cook, also of UWA, undertook the invertebrate monitoring. There was no evidence of a decline in water quality of the cave streams. Dr Cook concluded that as in recent years the aquatic macro invertebrate fauna of the cave streams was characterised by a low diversity and abundance, with the number of species collected ranging from 1 to 9.

Dr Knott and Dr Storey undertook the annual monitoring in October 2005 and also found a low level of diversity of cave invertebrates/stygofauna compared to earlier years.

3. **Urgently implement recommendations in Management Plans for Yanchep National Park likely to benefit root mat communities.**

A Yanchep National Park Cave Management Committee has been established and determines public access requirements and management of individual caves. This committee is facilitated by CALM and has a number of Speleologist Association members represented on it (including Recovery Team member Lex Bastian). The Committee meets three times a year and they are kept informed of Recovery Team actions and proposals. All of the root mat community caves are restricted access caves, and most have gated entrances. Access and gating issues are dealt with by this Committee rather than the Recovery Team.

Yanchep National Park has a Community Advisory Committee that is also kept informed of recovery and provides comments on recovery actions.

4. **Survey likely areas for additional occurrences of the community, especially caves on private land in the Yanchep area.**
Searches in 2004 conducted by Lex Bastian from the WA Speleologists Association, and CALM Yanchep National Park staff identified two other caves with occurrences of the root mat community (YN61 and Orpheus Caves). These caves have been included in the monitoring program for 2004 and 2005 to determine their conservation status. These caves currently have standing water but are under threat from the continuing ground water decline.

5. **Disseminate information about the community.**
In early 2005 a media release on the rewatering project was released and the story taken up in the Wanneroo Times, Sunday Times and Yanchep local newspaper. Leigh Sage also conducted radio

interviews on 6PR and ABC Regional Radio.

The Yanchep National Park has an extensive school activity program and visitor tours. All tours into Crystal Cave (four times a day) discuss the Yanchep cave root mat community and the recovery actions being undertaken.

6. **Undertake research.**
Refer to Recovery Action 20.

7. **Review data monthly from transect bores near areas of private abstraction.**
This in being carried out by the DoE.

8. **Continue to assess the adequacy of the bore network.**
This action is being carried out by the DoE though the CALM in-cave bores were upgraded to industry standard in 2003 by CALM and DoE. There is also a widespread system of monitoring bores around Yanchep National Park established by DoE and the Water Corporation to monitor groundwater levels across the Gnangara Mound. These all have data-loggers and are used for the detailed groundwater modelling systems being developed by these agencies. Data is made available to CALM

9. **Manage water levels in likely catchment areas for cave streams.**
In 2002 the State Wesbeam Laminated Veneer Lumber (LVL) Plant Agreement superseded the previous Memorandum of Understanding. Under this Agreement 200 hectares of pine plantation closest to the caves were clear felled to assist recharge.

In 2005, and into 2006, much larger areas of thinning and clearfell were undertaken in the nearby Yanchep plantation to supply the LVL plant. This is expected to continue in years to come and may eventually have a positive effect on groundwater recharge.

The impacts of prescribed burning are discussed under Recovery Action 19.

10. **Monitor water levels in cave streams that contain the root mat community, and initiate short-term management solutions where necessary.**
CALM monitors water levels using the observation bores within the caves with the root mat community on a weekly basis to establish long-term trends. A National Park staff member takes these measurements manually in each cave. It is proposed to purchase data loggers for all the bores and download the data every few months. In 2005 water temperature data loggers were purchased and are in place in the caves (this is discussed in Recovery Action 12 below).

By December 2005 a first draft of the monitoring manual was produced by Fiona Felton. This manual is to be used by CALM staff involved in the management of the caves and to ensure a standardisation of data collection. The manual will be finalised during 2006.

11. **Design and establish a semi-permanent system for remote monitoring and watering of caves.**

Small in-cave supplementation systems
A full upgrade of the small in-cave rewatering systems occurred in 2004 using NHT funding. This included replacement of the liners, installation of a solar battery powered system and pump upgrades. The January 2005 wildfire within the park destroyed the above ground cabling and solar panels resulting in all of the systems failing. The systems were reinstated and fully functional within 7 days of the fire.

The pumping systems have been monitored regularly to ensure they continue to function as designed. A trial system was put into Cabaret Cave in 2004 to see if a remote camera system could be used in caves that may be dangerous or difficult to access.

Yanchep Caves Recovery Project
The aim is to create artificial ground water mounds under the Root Mat Community caves, re-flooding the ponds and streams of the caves. It is anticipated that the life of this project is 10 years, by which time other measures to restore the ground water levels should have had a positive effect (eg. removal of the pine plantation to the east).

Work on the full-scale caves water recharge project, the 'Yanchep Caves Recovery Project', was begun in November 2004 with the construction of a bore near the CALM settlement on Yanchep Beach Road. Six kilometres of pipeline was installed between the bore and the six caves. This project, a collaboration between CALM, the Water Corp and the DoE, was budgeted at $1.125 million dollars. In June 2005 the system was completed and run for four weeks to all seven caves. Water quantities to each cave have been calculated. The trial indicated that the bore could provide adequate water to each of the caves, the piping and delivery system work well and the cave streams could be reinstated. Unfortunately a red iron precipitate accumulated within the caves during this trial and this necessitated the system being turned off until a solution was developed.

Iron precipitation from the water discharge into the caves from the rewatering project resulted in the bore being turned off only a few weeks after it was first turned on. Dr Chris Barber, consultant water chemist, was employed to assess the iron precipitation problem. Dr Barber identified that water from the Leederville aquifer was being drawn through the shale layer and was the source of the iron in solution. Dr Barber also found that once the water was discharged into the caves the aeration caused the iron to come out of solution. The technical sub group then determined that a number of trials should be undertaken to fix the problem while more complex and expensive engineering solutions investigated. Dr Barber also assisted with the assessment of these trials. The first trial, a reduced yield trial to reduce the abstraction from the Leederville aquifer, was found to be untenable. A second trial investigating variable pumping was abandoned due to concerns that the iron precipitation may clog the pipeline and bore head. In 2006 trials of the more expensive engineering solutions will be undertaken.

12. **Investigate water quality requirements of the root mat community.**
Baseline analysis of the water quality requirements of the Root Mat Community was undertaken by Dr Edyta Jasinska for CALM in the mid 1990s. Additional work was undertaken for CALM by Dr Chris Barber in 2003, specifically in relation to the recharge project. Dr Barber recommended that water quality samples be taken, properly constructed piezometers be installed in the caves, monitoring of the caves for limestone degradation occur, an assessment on the impact of cave stability and that groundwater from the Tamala limestone be the preferential source. The DoE assisted CALM with the installation of new piezometers in 2003.

Water quality and temperature within the cave water has remained relatively constant over the past decade. There is no indication that groundwater feeding the cave streams and ponds has been polluted.

In 2005 further water quality and temperature investigations were undertaken in association with a baseline study prior to the rewatering project (see section 11).

13. **Manage water quality in likely catchment areas for cave streams. Management strategy to be included in full Recovery Plan for the community.**
Although water quality within the catchment does not appear to be affecting the cave streams, CALM and DoE maintain water quality monitoring and strictly manage operations with potential to pollute the groundwater. For example, within the National Park herbicides and fertilisers are not used within the vicinity of the caves.

CALM has identified that horticulture directly south of the National Park may have potential to adversely impact the quality of the groundwater.

14. **Determine if water in cave streams is connected only to groundwater or associated with perched water tables.**
This work was undertaken in previous years. A surveyor was contracted to survey the levels of the root mat caves. This information was used by Dr Edyta Jasinska and the then Water and Rivers Commission (now DoE) to confirm that water feeding the caves was supplied by the regional Gnangara Mound and was not a perched water table.

15. **Ensure land use planning and development control processes effectively safeguard against potentially adverse impacts upon the cave systems.**
This action is ongoing. Land use changes and developments are assessed by CALM for potential impacts on cave and cave streams. CALM negotiationed with the City Of Wanneroo to ensure that a rural subdivision on a private property adjoining the National Park did not impact on caves or hydrology. See Recovery Action 21 outlining the Government commitment to land management on the Gnangara Mound.

16. **Determine location of trees with roots in caves, and monitor and protect them**
This action was carried out in 2003 by Paul Tholen (CALM Yanchep National Park Ranger) and UWA researcher Dr Edyta Jasinka. Their main recommendations were to protect the Tuarts above the caves, including no prescribed burning and implementing weed control, a Tuart planting program if required and research into the root mat potential of *Agonis flexuosa*. No action on these recommendations has been implemented in 2005.

17. **Develop and implement a Tuart regeneration program if monitoring indicates the need.**
As mentioned above, in their 2003 report to CALM Paul Tholen and Dr Jasinka recommended that a Tuart replanting program be undertaken. There is some evidence of decline in the Tuart canopies across Yanchep National Park and its greater distribution. In 2005 CALM constructed a new nursery for Yanchep National Park with fire recovery funding. In 2004 and 2005, the Yanchep Volunteer group with CALM support grew several thousand Tuart seedlings (from local seed stock) and use this within rehabilitation areas in the park. This program will continue over the coming 5 years. The January 2005 wildfire has also promoted widespread Tuart regeneration.

18. **Wherever possible create a buffer between the caves and any tracks or trails.** This is taken into consideration in the day to day workings of the national park and where appropriate tracks not required have been closed and rehabilitated. All upgrade of roading includes full assessment of all underlying cave systems.

19. **Manage fire regimes**
On 6 January 2005 a devastating wildfire burnt more than 70% of Yanchep National Park and burnt vegetation above all of the cave systems that contain the root mat community. This wildfire was lit by an arsonist. There was widespread damage to mature tuart trees, power poles and possibly the cave systems themselves. The fire delayed the ability of CALM staff and experts to access the caves for 4-7 days (powerlines and dangerous trees required assessment and felling prior to access being allowed). There was extensive damage to above-ground infrastructure, including the small cave rewatering systems. These have since been repaired. There was only a small level of impact on the cave systems and underground limestone structures. Following above average rainfall during 2005 regeneration of Tuart and plant communities was extremely good. All damaged infrastructure associated with the caves was repaired and/or replaced.

The fire regime within the Yanchep National Park Management Plan is managed in such as way as to avoid damage to the Tuart trees above and around the caves with the root mat community and also to assist in ground water recharge. In the past four years prescribed burning has specifically targeted areas upstream of the caves within the groundwater catchment in an attempt to promote greater recharge and assist in increasing or maintaining local groundwater levels until a more permanent rise in regional levels can be achieved.

In 2005 two strategic burns were undertaken in the native woodland in the Yanchep cave groundwater catchment that may assist with recharge (two were undertaken in 2003 and three in 2004). In pine needle-bed burning was also undertaken in Yanchep and Pinjar pine plantations east of the caves.

20. **Report on success of management strategies for cave communities.**
During 2005 the following reports were received and/or prepared by the Recovery Team:

- 2004 Annual Report for the Yanchep Caves Recovery Team, by Leigh Sage & Paul Brown
- Environmental Monitoring Yanchep Cave Stream Invertebrates, by Dr B.A. Cooke and B.G. Janicke
- Monitoring Manual for the Yanchep Caves, by Fiona Felton
- Investigation on the source of iron in the water recharging the Yanchep Cave System, by Dr Chris Barber
- Incidents of iron oxidising bacteria in Yanchep Caves receiving pumped groundwater, by Simon Toze *et al.*
- Reduced yield trial, by Fiona Felton & Dr Chris Barber

It is proposed that in 2006 CALM will prepare full documentation of the Yanchep cave rewatering trials

and large rewatering project.

21. **Identify and liaise with additional landholders/ land managers.**
There is extensive whole of Government liaison on the declining groundwater levels on the Gnangara Mound with all key agencies (the Water Corporation, DoE, FPC, Department of Planning and Infrastructure (DPI), CSIRO, the Agriculture Department and the Department of Premier and Cabinet). This liaison is facilitated through the Gnangara Coordinating Committee, Gnangara Directors Group and Gnangara Technical Working Group, as well as direct liaison between key representatives in each of the various agencies. The reduction of rainfall, thus recharge of groundwater and surface water public drinking sources, is a major state and national issue. The effective management of the environmental values, water resources and land use on the Gnangara Mound is a critical element of Western Australia's water resource strategy. CALM is involved with research into management of the Gnangara Mound and with seeking to increase recharge to assist in raising the ground water levels and therefore help the root mat community and other water dependent ecosystems to survive.

3. FUTURE RECOVERY ACTIONS AND DIRECTION IN 2006

This includes:

- Finalisation of the 'Yanchep Caves Recovery Project' and starting to pump water back into the root mat community caves after the iron precipitation problem has been dealt with. CALM initially committed $1.125M over two years to sink the bore, develop the piping systems and monitor the outcomes. Further funds have been requested to purchase appropriate filtering systems to deal with the iron precipitation problem. It is hoped that the bore will be able to be returned to full production before 2006/07 summer.

- Taxonomic characterisations and descriptions are required for many of the stygofauna known from the aquatic root mat TEC. Dr Brenton Knott and postdoctoral fellow Dr Danny Tang from UWA propose to undertake a morphological and genetic investigation into the cave stygofauna. This will be published in an international scientific journal.