AQUATIC ROOT COMMUMITY OF CAVES OF THE SWAN COASTAL PLAIN

RECOVERY PLAN

ANNUAL REPORT

2004

by

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

Leigh Sage (Executive Officer and Paul Brown (Chair)

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DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA

Department of Conservation and Land Management
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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 Tuart Root Mat Community, up to thirty species of invertebrate are only known from the Yanchep caves ~~.~~(though this number is to be revised following a proposed taxonomic study). ~~(Leigh, it would be worth checking with WATSCU whether this statement regarding the number of species only known from Yanchep is still accurate)~~ It is likely that at least some of these species have become extinct. There is a strong possibility that many of the remainder will become extinct if the decline is not arrested.

- Five~~All six~~ of the six 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, though this has substantially declined in the past years (Gerald Drummond, CALM, pers.comm.) ~~(does this include Water Cave). to the where~~ T~~t~~he ground water level is now over 1 metre below the floors 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.

- Yanchep National Park staff have installed small in-cave watering systems in an attempt to sustain the occurrences~~them~~ but their health is dramatically declining. The 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 occur 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 ~~DCLM~~CALM, the Water Corporation and the DOE ~~Waters and Rivers Commissi(DOE)~~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 supporting the community.

- Annual monitoring undertaken by Dr Brenton Knott and Dr Andrew Storey of the University of WA (UWA) on behalf of the Department of Environment (then the Waters and Rivers Commission) (DOE) since 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.

The Recovery Team, established in 1997, has undertaken~~implanted~~ a number of recovery actions in 2004 for~~on~~ the community, based on the Interim Recovery Plan. The key strategies this year are:

- To complete the fourth of the rewatering trials in Crystal Cave. Based on the positive results of the rewatering trails to prepare for the full-scale recharge scheme (the 'Yanchep Caves Recovery Project'), gain the $1.15M funding and successfully develop the main bore for the project.

- To upgrade the current small in-cave watering systems and trial remote camera systems

- To commission UWA to undertake a pilot stygofauna survey and a preliminary taxonomic review of the root mat invertebrate fauna.

- CALM has undertaken~~has~~ a~~undertaken~~ ~~one~~ strategic ~~spring~~ prescribed burning program within~~in~~ the National Park as outlined in the Yanchep National Park

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Management Plan. Unfortunately, on 26 December 2004 a large wildfire burnt 70% of the National Park and over all caves containing the root mat communities. Extensive rehabilitation and monitoring work is programmed for 2005.

- CALM received an $80,000 NHT2 grant for the root mat TEC for 2003/04 and 2004/05.

1. INTRODUCTION

The continuing decline of the Gnangara Groundwater Mound has causing the majority of the Yanchep Cave streams and pools to dry. Of the approximately one hundred invertebrate species associated with the Yanchep Cave Stream Tuart 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). ~~(Again check with WATSCU)~~Many are new to science. It is likely that at least some of these species have become extinct. There is a strong possibility that many of the remainder will become extinct if the decline 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. Six of these permanent streams support Aquatic Tuart Root Mat Communities. 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 1990's. In 1996 one of the six 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 the CALM, the University of Western Australia (UWA), Department of Environment (DOE), Water Corporation, the WA Speleological Group and the City of Wanneroo.

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- The Recovery Team ~~has~~ developed an Interim Recovery Plan in 1998 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 monitor the invertebrates on an annual basis.

~~The key strategies this year has been to prepare for the full-scale recharge scheme (the 'Yanchep Caves Recovery Project'), upgrade the current system and to undertake a pilot stygofauna survey. In 2003 CALM's Swan Coastal District/Region was awarded Natural Heritage Trust funding to implement recovery actions on nine Critically Endangered TEC's on the Swan Coastal Plain. Money from this project has been used in 2003 and 2004 to implement sections of the above key strategies.~~

Small-scale Emergency Rewatering Systems Established

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

- All six 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

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sections of caves, which are difficult to access. The systems have been monitored and maintained regularly to ensure they continue to function. The systems have been updated several times since to improve their capacity and reduce the risk of failure.

- ~~At this point in time the Forest Product's Commission have indicated they have no capacity to undertake further clearfell or significant thinning of the Yanchep Plantation within the cave catchment, as this will prevent the State from meeting its contractual timber volume with Wesbeam.~~
- ~~From 1998 as cave streams containing root mats stopped flowing, CALM, in consultation with other members of 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 pumping systems have been monitored several times a week since being installed. They have been regularly maintained, liners have been replaced, and batteries and pumps upgraded. Water level probes were installed in the most dangerous caves at risk of collapse. This allowed water levels in the ponds to be read from outside the cave, reducing the number of visits required and minimising the danger to the rangers who maintain the systems.~~

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

~~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.~~

Root Mat Invertebrate Community Monitoring

- Annual Monitoring of the root mat communities has previously been undertaken by Dr Brenton Knott and Dr Andrew Storey of the University of WA on behalf of the DOE~~Department of Environment~~. In 2000 the monitoring indicated the watering systems were successfully maintaining the fauna in the Aquatic Root M~~a~~a~~m~~t 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.

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Primary Causes of Groundwater Decline

- The decline in groundwater levels is believed to be due to a combination 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 to~~the fall of~~ the groundwater decline~~level~~ ~~(GWL)~~at Yanchep National Park from these factors~~by the trend ofsupply~~. Prior to 2002/2003 t~~T~~he DOE's groundwater monitoring program indicated that the cause of 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 ~~DCLM~~ CALM (now the Forest Products Commission or FPC) developed ~~ana~~ 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 ~~Forest Product's Commission~~ 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 ~~Forest Products Commission~~ 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.

- New analysis by the Water Corporation and the DOE ~~WRC~~ in 2002 indicted that it is not only the pine plantation and drier climatic conditions causing the groundwater decline, but that private horticultural abstraction, and public water supply abstraction from the deeper Leederville and possible Yarragadee aquifers are also contributing.

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- 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

- ~~Both methods of analysis indicate 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.~~
- The local hydrology in the Yanchep karst system is complicated. The Department has contracted the services of a senior consultant hydrologist (Dr Adrian Peck) to help review the hydrological work and work with DOeE 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 Executive Director of the Department of Conservation and Land Management; the Conservation Commission of WA; and the Minister for the Environment and Heritage approved the plan. A new plan is due to be released in 2005.

The IRP's objective is maintain or improve the overall condition of the aquatic root mat communities and reduce the level of threat, with the aim of reclassifying them 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, and a decline in the number of invertebrate species recorded.

In 2003 CALM's Swan Coastal District was awarded Natural Heritage Trust funding to implement recovery actions on nine Critically Endangered TEC's on the Swan Coastal Plain. Money from this NHT2 grant and from CALM has been used in 2003 and 2004 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 of the IRP with specific reference to tasks undertaken in 2004:

1. **Establish a Recovery Team.**
   The Recovery Team was established in 1997 and has been running continuously since (thus this action has been completed). The Recovery Team meets on average twice a year. At the end of 2004 Recovery Team membership of the 'Aquatic Root Mat Community of Caves of the Swan Coastal Plain' was:

   Paul Brown, CALM, Swan Coastal District, District Manager (Chair)
   Leigh Sage, CALM, Swan Coastal District, Conservation Officer (Executive Officer)
   Wayne Bartley, Water Corporation, Senior Hydrologist
   Tracey Calvert, Department of Environment, Senior Environmental Officer
   Lex Bastian, Speleologists Association
   John Blyth, CALM Threatened Species and Communities Unit, Manager
   Dr Brenton Knott, University of Western Australia
   Dr Andrew Storey, University of Western Australia
   Dr Adrian Peck, Hydrological Consultant, A. J. Peck & Associates

   In 2004 the Recovery Team met twice: in May and October. 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 five times during 2004.

2. **Monitor cave fauna and respond to results of monitoring as appropriate**.
   The annual monitoring of cave fauna is funded by the DOoE 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. ~~is~~ In mid-2004 the Department of the Environment put this contract out to open tender and Dr Barbara Cook, also of UWA, was awarded the contract. Dr Cook undertook this years cave fauna survey in late 2004.
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 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 and asked for their comments on recovery actions. In 2004 the Advisory

Team were taken on a field visit to the cave rewatering trails and fully briefed on the proposed large rewatering project. Cedric Jacobs, an Aboriginal Elder on the Committee, was specifically consulted about the rewatering program.

4. **Survey likely areas for additional occurrences of the community, especially caves on private land in the Yanchep area.**
Searches have been conducted by Lex ~~Bastian from~~Bastian, from the WA Speleologists Association, and ~~DCLM~~CALM Yanchep National Park ~~Ranger~~ staff. Thi~~sese~~ work has~~ve~~ identified two other caves~~several other~~ with occurrences of ~~aquatic~~ the root mat community (YN61 and Orpheous Caves) that will be included in future recovery actions and the monitoring program. These caves currently have standing water but are under threat from the continuing ground water decline.~~which are now included in the Recovery Program?~~

~~**5.Disseminate information about the community.** As part of the NHT project in 2004, a community information leaflet was produced and included information on the root mat community. This leaflet is due to be distributed to CALM offices and national parks, local community groups, shire offices and other stakeholders. Leigh how about all the visits by various groups, your media articles, radio interviews etc,~~

~~6.~~5. **Disseminate information about the community.**
As part of the NHT2 project, a community information leaflet on the nine critically endangered TECs on the Swan Coastal Plain was produced in July 2004 and included information on the Root Mat Community. This leaflet will be distributed to CALM offices and national parks rangers, local community groups, shire offices and other stakeholders.

In 2004 the ABC science program "Quantum" ran a story on the Root Mat Community and the Yanchep Caves Recovery Project. This story was aired early in 2004 and highlighted the efforts to save the Root Mat Community and the overall water problem in Western Australia. Dr Brenton Knott (UWA), Dr Andrew Storey (UWA) and John Blyth (CALM) were interviewed.

In June 2004 the ABC program "7.30 Report" ran a story on the water "crisis" in Australia and interviewed Alan Walker (CALM Regional Services Director) in Crystal Cave (a Root Mat Community cave).

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. In 2004 there has been a new activity program developed along the shoreline of Lock Mcness discussing the water cycle in the national park and the Gnangara groundwater mound. Associated with this activity a series of sculptures have been commissioned to illustrate the water theme.

~~7.~~6. **Undertake research.**
~~**(Stygofauna survey again, Pecks work etc)**~~ CALM, in association with the recovery team, allocated NHT project funds to undertake a pilot stygofauna survey within a 10km radius of Loch McNess. Zoologists Dr Brenton Knott and Sarah Goater undertook the survey and the report will be received early in 2005. The survey found three potentially undescribed species of stygofauna but none of the animals were endemic to the Root Mat Community of the caves. It is envisaged that this pilot survey will be refine the methodology for a larger proposed stygofauna survey of the entire Mound.

Talks were also undertaken with Dr Knott, in regard to publishing his taxonomic descriptions of the endemic invertebrates of the Root Mat Community. It was agreed that the amphipods and then the copepods would be the groups looked at and the work would include morphological and genetic analysis.

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Dr Adrian Peck, a consultant hydrologist, continued his work for CALM in 2004 primarily looking at hydrological monitoring for the recharge project. His valuable work included finding that it was indeed possible to create an artificial mound under the caves using the recharge system (in collaboration with the DOE), he determined the amount of water required to bring the cave ponds back to their original level, assessed water quantity requirements from the new bore and how deep the pipeline would need to be buried to prevent the water temperature increasing.

~~8.~~7. **Review data monthly from transect bores near areas of private abstraction.** This in being carried out by the DOE~~oE~~.

~~9.~~8. **Continue to assess the adequacy of the bore network.**
This action is being carried out by the DOE~~oE~~.

~~10.~~9. **Manage water levels in likely catchment areas for cave streams.** ~~Large areas on "The Knoll" are of the Yanchep Plantation were clear- felled prior to 2004 to assist in water recharge to the mound. One strategic prescribed burn was undertaken in 2004 to assist in recharge of ground water in Yanchep National Park and thereby assist in flow into the caves.~~
Pine plantations in the Cave Catchment area were thinned between 1999 and 2002 by ~~DCLM~~CALM (then CALM Forest Products Division and now the FPC) according to the ~~and then by the newly created the Forest Products Commission under a~~ Memorandum of Understanding with CALM~~DCLM~~ and DOE (then the Water and Rivers C~~R~~ommission). In 2002 the State Wesbeam Laminated Veneer Lumber Plant Agreement superseded the MOU. Under this Agreement 200 hectares of pine plantation closest to the caves were clear felled to assist recharge. However the FPC indicated there was no additional capacity to undertake further clear felling or thinning in the target area in the immediate future, as this would compromise the ability to achieve the supply of one resource required under the agreement.

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

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~~11.~~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 in 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 the bores and download the data every few months. 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. This all have data loggers and are used for the detailed groundwater modelling systems being developed by these agencies. Data is available to CALM.

~~12.~~11. **Design and establish a semi- permanent system for remote monitoring and watering of caves.**
A full upgrade of the small in-cave rewatering systems occurred in 2004, using National Heritage Trust funding, including replacement of the liners, an installation of a solar battery powered system and pumps upgraded. The pumping systems have been monitored regularly to ensure they continue to function as designed. Water level probes were installed in the most dangerous caves to allowed water levels in the ponds to be read from outside the cave, reducing the number of visits required and minimising the danger to the rangers who maintain the systems. ~~Monitoring of the root mat communities is undertaken annually by Dr Brenton Knott and Dr Andrew Storey of the University of WA on behalf of WRC. The November 2000 fauna monitoring report were successfully maintaining the fauna in the root mat caves. However, groundwater continued to fall. 2001 was an extremely dry year~~

~~and some streams are now staying dry throughout winter. The Department 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.~~

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. If this system proves to be useful and reliable then similar setups will be installed in all of the target caves

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 will be installed between the bore and the six caves. This project, in~~a collaboration~~ collaboration between CALM, the Water Corp and the DOE, is budgeted at $1.125 million dollars and is due for completion in mid 2005. 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 have had a positive effect (eg. removal of the pine plantation to the east).

~~13.~~12. **Investigate water quality requirements of the root mat community.**

An analysis of the water quality requirements of the Root Mat Community was undertaken by Dr Edyta Jasinska for ~~DCLM~~CALM for the early planning for a major artificial recharge scheme. Additional work was undertaken 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. These recommendations were carried in 2003 and 2004. The DOE assisted with the installation of new piezometers. ~~---- (Leigh if you check with Adrian Peck or look through the emails and reports during the recharge study investigations, one of Adrian's fellow consultants did an analysis on the suitability of water quality for the caves, and I think Brenton also gave his opinion)~~

~~14.~~13. **Manage water quality in likely catchment areas for cave streams. Management strategy to be included in full Recovery Plan for the community.**

Within the National Park herbicides and fertilisers are not used within the vicinity of the caves. A proposal to bait ants in Boomerang gorge to assist the establishment of a biological control agent for Bridle Creeper, was carefully assessed and managed to ensure it was not a risk to the Boomerang Gorge Root Mat Community. This work is ongoing.

~~15.~~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 the water ~~feeding the~~feeding the caves was supplied by the Regional Gnangara Mound and was not a perched water table.~~not carried out in 2004.~~

~~16.~~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 ~~DCLM~~CALM for their impacts on cave and cave streams. Negotiations were held 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~~work was not carried out in 2004~~. See Recovery Action 21 outlining the across Government commitment to land management on the Gnangara Mound.

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~~17.~~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 ~~a~~ UWA researcher Dr Edyta Jasinka. Paul and Dr Jasinka main recommendations were to protect the Tuarts above the caves, including weed control, no prescribed burning, 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 2004.

~~(Leigh, it would be good to state Edyta's conclusion or any summary point)~~

~~18.~~17. **Develop and implement a Tuart regeneration program if monitoring indicates the need.** ~~Leigh you might like to refer to any statements Edyta made in her study she did with Paul above. Also worth mentioning the research burn done by Robert Archibald for the Tuart.~~ ~~This~~~~strategy. This work was not carried out in 2004~~
As mentioned above, Paul Tholen and Dr Jasinka, in their 2003 report to CALM 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 2004, the Yanchep Volunteer group with CALM support have established a nursery in the Park and are starting to rehabilitate degraded areas close to the caves, including replanting of locally sourced tuart stock. This program will continue over the coming 5 years. Hopefully the 26 December 2005 wildfire will also promote widespread tuart regeneration.~~.~~

~~19.~~18. **Wherever possible create a buffer between the caves and any tracks or trails.**
This is taken into consideration in the day to day working 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.

~~. (Probably one we need to look at some stage.)~~

~~20.~~19. **Manage fire regimes.**
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 containing the Root Mat Community and also to assist in ground water recharge. In the past three 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 holding local groundwater levels until a more permanent rise in regional levels can be achieved.

In 2004 three strategic burns were undertaken in the native woodland in the Yanchep cave groundwater catchment for recharge (two were undertaken in 2003). In addition, 2 200 ha of needle-bed burning was undertaken in Yanchep and Pinjar pine plantations east of the caves.

Unfortunately on 26 December 2004 a major wildfire burnt more than 70% of Yanchep National Park and has burnt the vegetation over all of the cave systems containing the root mat community. This wildfire was lit by an arsonist with devastating results. There is widespread damage to mature tuart trees, power poles and possibly the cave systems themselves. This delayed the ability of Ranger staff and experts accessing the caves for 4-7 days (powerlines and dangerous trees required assessment and falling prior to access being allowed). There has been extensive damage to above ground infrastructure, including the small cave rewatering systems. These are being repaired. However, there appears to be limited impact on cave systems and underground limestone structures.

~~21.~~20. **Report on success of management strategies for cave communities.** ~~Isn't this the point of this~~ ~~This~~~~report~~
In Winter 2002, an article on the "Threatened wildlife of the Yanchep caves" was published in CALM's Landscope magazine. In 2004, no publications were produced with this annual report recording recovery actions for the year. It is proposed that in 2005 CALM will prepare full documentation of the Yanchep cave rewatering trials and large rewatering project. In early 2005 the reports of the pilot stygofauna

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monitoring and preliminary stygofauna taxonomy will be presented to the Team by UWA.~~was not carried out in 2004.~~

~~22.~~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 political issue. The effective management of the environmental values, water resources and landuse 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 how 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 2005

This includes:

- Completion of the 'Yanchep Caves Recovery Project' and the beginning of pumping water back into the root mat community caves. CALM has committed $1.125M over two years to sink the bore, develop the piping systems and monitor the outcomes. It is hoped that this project will be established and functional by 1 July 2005.

- The devastating wildfire on 26-28 December 2004 has impacted 70% of Yanchep National Park and has burnt over all of the root mat community caves. There will be a need to assess and meliorate the damage as it relates to the cave communities and rewatering infrastructure. The impacts include loss of power to the rewatering systems for up to 7 days, widespread loss of mature tuart trees, loss of the above ground infrastructure, possibility of erosion and possible destabilisation of cave limestone. There should be positives associated with increased winter groundwater recharge above and close to the cave communities, and the regeneration of tuart. It will take most of 2005 to determine these impacts and to initiate post-fire recovery actions.

- Based on the findings of the pilot stygofauna survey undertaken in 2004, determine methodologies, cost and seek funding (estimate $520k) for a full scale stygofauna survey of the Gnangara Mound. This survey will include a PhD scholarship and will compare stygofauna collected in the groundwater across the Mound with those recorded from the cave root mat communities.

- There remains an urgent need to clarify the taxonomy of the stygofauna, specifically the amphipods and copepods, of the root mat community. This will include a morphological and genetic investigation and be published in an international scientific journal. This work can only be done by the team at UWA.