HARDENING OF CAVE ENTRANCES AT BUNGONIA STATE RECREATION AREA, NEW SOUTH WALES

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Abstract

There are nearly 200 caves managed by the NSW National Parks and Wildlife Service (the Service) at the Bungonia State Recreation Area (Bungonia). These are amongst the most heavily used "wild" caves in Australasia. The heavy use, coupled with the topography, soils and climatic conditions, has led to very considerable degradation and instability of some cave entrances. An increasingly serious issue in the management of cave areas is the growing demand for access to a limited resource and highly vulnerable environment.

This paper discusses the problems that have arisen at a number of cave entrances at Bungonia. Some of the solutions that have been adopted for their management are discussed and illustrated. Ultimately a series of moderate-cost engineering approaches were implemented at a number of the sites.

INTRODUCTION

Australia has, by comparison with other continents, relatively few caves and cave areas (Jennings 1983). This underlies the need to provide high levels of protection to the resources that are available. In addition, there is the need to provide for the safety of users insofar as this might be possible in dynamic natural systems.

A number of authors (e.g. Webb 1984, Spate 1990, Eberhard and Spate 1995, and various comments on the ACKMA web pages) have drawn attention to the consequences of cave managers in modifying cave entrances. Often these actions are well intentioned but did not necessarily protect all aspects of the cave environment and in some cases may have had adverse consequences.

Bungonia State Recreation Area, in the Southern Tablelands of New South Wales, is one of the most heavily used cave areas in Australia. It has been used for recreational caving for approximately 170 years. On average, one third of visitors to the park camp in the campground. The overall trend for camping area use has been on an increase since 1992 when the figure doubled, following the Service assuming full control of the park. In 2000, there were perhaps as many as 30,000 cave visits annually. Visitor figures for the park are derived from pneumatic traffic counters and from camping fee receipts.

Numbers of cave visits are derived from an Activity Register which must be completed by all users before undertaking adventure activities including entering caves. Formal consent of the Director-General is required. The Service provides this at Bungonia by requiring people to sign in on the Register. It is a legal requirement and infringement notices can be issued if people do not complete the Register, which is provided on the office veranda 24 hours a day.

The Register provides information on the numbers of people within the park and what activities are being undertaken. It provides information for use in case of emergencies or if groups are overdue. The Register also has a space provided for public comments about the area or the activities they undertook and for any information on conditions (such as high carbon dioxide levels) in the caves. The Register also allows users to see which caves are in use and allows them to choose alternative caves or activities.

This information provides vital feedback on the use of the park but the records will always be under-estimates of actual cave visits as not all people sign in or change their chosen use subsequent to their visit to the Register.

Of the approximately 200 caves, there are around nine cave systems that have very high visitor levels. In order of decreasing usage they are:

- Grill Cave (B44)
- Fossil (B4) - Hogans (B5) system
- Blowfly Cave system (B16-51)
- Acoustic Pot (B22)
- Argyle Hole (B31)
- Hollands Hole (B35)
- College Cave (B84)
- Dinosaur Cave (B71-72)
- Canberra Hole (B7) - Steampipe (B14) system.

In addition, there is a permanent and heavily used abseiling training cliff above Hogans Hole.

The pattern of use of these caves has been remarkably consistent for many years. The use of these nine systems probably accounts for at least 95% of the use of all Bungonia Caves. Fossil-Hogans and the Grill are by far the most heavily used.

The level of cave use at Bungonia has risen enormously over the past four decades. Bungonia's caves are increasingly being used by:

- youth and school groups
- military and paramilitary (chiefly rescue services)
- licensed commercial adventure tour operators
- family groups
- casual visitors
- speleological groups
- scientific researchers
- other organisations.

Rescue services including ambulance, fire brigades, police and specialist cave rescue groups all use the area for rescue and confined space training. For other users, Bungonia provides access for adventure activities and recreation.

The caves are also used by family groups, casual visitors, speleological groups and scientific researchers. The Service manage the site under a regulatory system described by Spate et al. (2002). For the Service, the management of the caves at Bungonia is a balance between recreational/training opportunities, conservation requirements and scientific research.

THE ISSUES

The Bungonia karst environment is characterised by cave entrances opening from the base of large dolines, sometimes with large catchment areas. The caves often have deep vertical pitches, large caverns, horizontal crawl-ways and some are through caves. The dolines may contain deep soil and rock fills through which the caves drop steeply. The surface environment is dry and vegetation cover generally sparse. The rainfall is often of very high intensity causing flash run-off, locally known as 'gully rakers'. These events often mobilise large volumes of soil, rock and vegetation into the dolines, the cave entrances and through to the caves. These processes may choke caves or dramatically decrease the stability of entrances (e.g.: Shaduf Cave, B15).

Access to a number of caves at Bungonia was gained by cavers excavating or enlarging entrances. In some cases, this may have been in the late 19th century. Excavating or enlarging entrances will have changed the environmental regime in the affected caves, to an unknown extent. Service policy now strongly discourages digging for caves and the Service has introduced, in consultation with the Bungonia Recreational Activities Group (BRAG), Codes of Conduct for activities, that may disturb habitat or environments.

Coupled with these natural disturbance processes and excavated entrances out of environmental equilibrium, the intensive use of the caves has produced unstable and actively eroding surfaces. Areas around the entrances are further destabilised by inappropriate rigging methods and belay points including the ring-barking of trees by ropes and ladder traces. Service management attempts to encourage good caving practices that protect the cave environments, including the entrances, but the high levels of use is such that impacts will continue to occur in and around cave entrances.

At Bungonia there may be large numbers of people in any individual group. School and similar youth groups can average 20 people or more in a cave – despite the Service promoting safer and more environmentally friendly party sizes and student/teacher ratios. Groups with large numbers, result in people milling around the cave entrances and abseiling points, causing additional compaction and erosion problems.

Bushfires, heavy rainfalls, subsequent drought and further increase through usage in the 1990s exacerbated erosion problems around the cave entrances. By 1995, there were approximately 24,000 visitors annually (Bauer & Lake 1995). Soil erosion in some entrances threatened the stability of boulders which had the potential to block or collapse cave entrances and threaten the safety of cave users. In the past, stock grazing and inappropriate fire regimes had markedly increased erosion rates and slope instability. However Service management has reduced impacts from these sources.

The Service, in consultation with the Bungonia Recreational Activities Group, commissioned an investigation by experienced cavers with extensive knowledge of the area. The report addressed erosion control and regeneration around seven cave systems as follows:

- Putrid Pit (B1)
- Fossil-Hogans system
- Canberra Hole and Steampipe
- Shaduf (B15)
- Blowfly Cave
- Argyle Hole (B31)
- Dinosaur Cave.

These seven caves and eleven associated entrances are the most heavily used or were suffering the most impact. Other heavily used caves, such as Grill Cave and Drum Cave (B13), have naturally robust entrances and works are not currently required.

A further report and quote to undertake works was sought from an experienced caver highly conversant with the Bungonia environment and experienced in the building industry (Bauer 1995). The Bungonia Recreational Activities Group, other experienced cavers with expertise in engineering, anchor emplacement and environmental issues contributed to the development of the entrance hardening and rehabilitation strategy. Geotechnical consultants were also utilised.

As a result, the Service adopted a program of engineering and revegetating to stabilise cave entrances and to enhance public safety. Whilst the solutions may be regarded as heavy-handed, the problem was severe and lesser intervention would not have sufficed. If no stabilisation works had been undertaken, there would have been the type of difficulties and dangers as have been experienced at Shaduf Cave over three or more decades.

Access to Shaduf Cave has always been problematical on and off for a number of years due to the instability of the entrances. Access was gained by a large-scale digging exercise in the base of the inherently unstable doline fill in a large catchment which contributes high velocity water and sediment flows. The continued erosion and deposition has both further unstabilised the doline fill and blocked the cave on several occasions. It was included in the consultancy brief but due to a number of factors including safety, little use by cavers, over-whelming natural processes and cost of the works program, it was determined that it was not a priority. If any works were undertaken now to re-excavate the doline to provide safe access to the cave it would be impossibly expensive and possibly still hazardous to cavers.

Erosion may completely block cave entrances and passages. There are also significant dangers to cave users if cave entrances are subject to erosion removing support for boulders with the doline fills. This is especially so if the boulders are used as belays or if cavers are squeezing beneath them.

Sediments transported into caves may also produce problems. The duckunder in Grill Cave frequently blocks with sediment after rain. Even though there are three alternative routes the duckunder, when it is blocked by natural processes, is repeatedly re-excavated. In some cases, cave users could be exposed to additional dangers during severe rainfall events. For example, the B5 extension of Hogans Hole has sections which flood with water. Hence, there is signage in the reserve, advising visitors not to go caving if there is a risk of rain.

Vegetation destruction and erosion was particularly evident around eleven cave entrances at Bungonia. In addition, there are several surface sites used for single rope technique training and for abseiling as an adventure activity. Problems at these sites are similar to those at cave entrances and will be discussed as if they were cave entrances. Belay points at cave entrances at Bungonia have traditionally been trees or rock outcrops. Wire traces for ladders have severely damaged trees and rock surfaces. Whilst single rope techniques may alleviate damage to rock, the effects on trees can still be severe especially considering the level of cave usage at Bungonia. Death of trees and the up-rooting of shrubs by mis-directed ropes has further exacerbated soil instability.

A number of Codes of Conduct for Caving have been adopted at the reserve and promulgated to users to encourage users to “cave softly”. The Codes were written in consultation with the Bungonia Recreational Activities Group specifically for the environments encountered at Bungonia. Further, they refer cavers to the Australian Speleological Federation’s Codes of Safety, Minimal Impact Caving for more general information. The former Codes recommend against the use of trees as belay points and prohibits the use of wire, rope or tape directly on trees and require adequate padding to protect trees. Regardless of the type of belay point, ropes running from the belay into the cave disturbs the vegetation and soil leading to erosion of material into the cave, thus careful siting of artificial belay points (anchors) can minimise erosion.

Many of the caves at Bungonia do not have defined tracks leading to them. At these less accessible sites, fencing and signage have not as yet been required. However there are exceptions - one cave had 27 different access paths. Canberra Hole and Steampipe present a particular public safety hazard. Both of these caves have entrances, about two metres in diameter, each drop about 30 metres vertically, opening suddenly from a near horizontal surface. These two caves are only 15 metres apart, a few tens of metres from a road and public car park. Erosion of soil and damage to trees were additional problems at these two caves.

THE SOLUTIONS

The number of potential solutions to the problems outlined above were considered by Service staff and the Bungonia Recreational Activities Group. Matters discussed included increased rates of sediment delivery to caves, safety considerations for cavers and non-cavers, increased possibility of cave entrance collapse, potential increases or decreases of nutrient supply to support cave ecosystems, and aesthetic considerations. All solutions considered including ‘do nothing’, access restrictions, cave closure, and soft and hard engineering approaches, had both positive and negative ramifications.

The ‘do nothing’ approach obviously addressed none of the problems. This approach was clearly not appropriate for the responsible management of the eleven sites, although it may be more applicable to other cave entrances at Bungonia. The situation with other entrances is being monitored and further actions may be required in the future.

Considering the past use of the Bungonia caves, access restrictions would have been unacceptable to many cave users, difficult to implement and would have only slowed the degradation at best. Cave closure presents similar difficulties, not least the political impact. Both access restrictions or cave closure may have required engineering solutions - some large-scale - if any chance of success was to be guaranteed. In addition, there is a potentially serious switching of cave users to other, perhaps less robust, or safe, and less disturbed, caves at Bungonia or elsewhere in New South Wales. As an example, placing a gate in Wyanbene Cave, Deua National Park, in 1986 demonstrably influenced the pattern of cave use across southern New South Wales. The closure of Grill Cave, seasonally to protect bats, increases the usage of the Fossil–Hogans system and pushes some users onto the Wee Jasper caves.

The Service and the contractors who assisted with the design and construction of the cave entrance hardening at Bungonia attempted to replicate the cave entrance conditions while providing structures for caves to reduce the impact. “Soft” engineering solutions adopted at Bungonia include signage and fencing to warn the public to the presence of caves or vertical shafts and realignment, revegetation and, in some cases, hardening of access tracks to cave entrances.

"Hard" solutions utilised included provision of bolts, bollards and bars for belaying, crib walls constructed of treated pine, use of concrete and steel, installation of steps and stairways. Often these methods were augmented by the soft methodologies.
It was recognised that modifications to the entrance of a cave can have major impacts on the entire system. Nutrients often enter caves through entrances and can affect subterranean ecosystems. The hydrologic regime may be altered and thus can impact on the cave ecosystems and karst processes. Modifications can also significantly affect cave microclimates.

At Blowfly Cave, in particular, the entrance works allowed leaf litter and similar material to continue to enter the cave, hence maintaining the nutrient and water flows. At the same time, catchment management works away from the entrance have reduced run-off from an old fire trail which fed excess water into the entrance.

MATERIALS AND METHODS

The use of CCA-treated timber in some environmental regimes has not been considered appropriate by some authorities because of a potential for leaching of toxins. The consultants investigated these concerns with the Building Advisory Council and other bodies who provided assurances that there would be little or no leaching. Unpublished research by Comfort (1993) of the Tasmanian Parks Service was also consulted. This demonstrated limited impact on invertebrates and understorey vegetation. Weathered, treated pine was seen as an acceptable material at Bungonia as other materials had more severe impacts, construction difficulties or very considerably increased costs. Comfort (1993) and Spate et al (1998) emphasise the desirability of allowing CCA-treated timbers to weather before their use in environmentally sensitive situations to reduce any potential impacts.

Use of monolithic concrete was avoided because of high costs, the difficulties in placing it at the head of vertical shafts and because of the difficulty in removing it should this become necessary.

The use of galvanised products was also considered considering the concerns expressed by Spate et al (1998). Again the environmental downsides were recognised but the limited scale of use and the increased costs of other materials resulted in the decision to use this material.

Anchors

Research conducted for the 1995 Bauer report found that cavers prefer to use bollards rather than bolts as artificial anchors. Where possible in the quote for the works, both options were provided.

Bolts

The bolts used in all the works undertaken in this project were marine grade stainless steel eye bolts, also known as ring bolts. The standard in some climbing clubs is to use 10mm bolts (Bauer 1995) However, for caving, where there is a constant and uneven loading and the bolt is used for a rope or ladder, 12mm bolts were selected. The bolts were cemented in place using the Hilti Injection Technique in conjunction with a high performance masonry adhesive (HY150, Bauer 1995). A channel was cut at the top of the hole for the bolt to ensure that the eye would not rotate during use.

Bollards

The bollards were all grossly over-engineered, for safety and longevity, in consultation with Cottier and Associates (Cottier and Associates 1997). The U-shape design adopted is deemed safer, when used correctly, than a post. To ensure the U-shaped galvanised pipe could not pull out of the concrete block, rods were welded on to the pipe.

Retaining Walls, Shoring and Steps

Retaining walls, shoring around trees, and steps were constructed of treated pine. Treated pine logs, boards and sleepers are cheaper and longer lasting than hardwood, which was an alternative material.

Backfilling for retaining walls or shoring around trees used spoil heaps from within the Reserve (Bauer 1995).

Trackwork

Trackworks consisted of either revegetating or defining tracks. Many of the tracks that formed around and between the cave entrances, were the most direct route, but not necessarily environmentally appropriate. Where tracks where contributing to the erosion problems they were realigned along more appropriate routes and the old paths revegetated. Additional measures, where needed, included fencing and signage. In one location, Argyle Cave, a car park was closed and revegetated to redirect access more appropriately.

Revegetation and Mulching

All plants used were local species and provenances. *Bursaria spinosa* (native box thorn) was preferred due to the spiny foliage which would discourage people from disturbing the areas where it was planted. However this was not commercially available and *Dodonea viscosa* (hopbush) was used. Although eucalypts were used they are slow growing and will provide long term stability, whereas the acacias are short lived but fast growing so will quickly provide soil stability. Casuarinas were also used as they have an extensive root system and are able to soak up excess water. The fallen needles mesh together and form a protective layer over the soil to which aids in the reduction of erosion problems. The mulch was a fine hardwood (Bauer 1995).

Fencing

Fencing and gateways were used in some areas to direct traffic flows to entrances and, in the case of Canberra Hole - Steampipe, to provide a warning of potential dangers. Fencing was simple using "Waratah" steel posts, plain galvanised wire and white, woven plastic "Turbo" tape to provide visual deterrence.

DISCUSSION

As has been pointed out management actions around cave entrances can produce controversy. We expect that the Service activities at Bungonia will produce lively discussions. However, both the Service and its community-based advisers were faced with a series of difficult problems and hence decisions. Considerable financial constraints existed. The solutions adopted are by no means perfect but have alleviated a number of problems. Most cave users seem to accept both the necessity for, and utility of, the solutions adopted and many positive comments have been received.

There are a few caves within the Reserve for which access is restricted for scientific or safety purposes. This, while it may not be popular with many cavers, is deemed appropriate to maintain some caves in an impact-free state as pristine environments. Other caves have restricted numbers of people annually or are closed seasonally. Caves with restricted annual access are often used for scientific studies. The Service recognises the need for appropriate research into the caves and their environments to provide information to assist in appropriate management decisions. Caves at Bungonia are closed seasonally to protect 'staging', maternity and hibernating caves for bat species that use Bungonia caves.

Rather than refusing or restricting access to the popular caves at Bungonia, works were undertaken to maintain safe access to caves and to avoid shifting caving pressures to other locations such as Wee Jasper or Wyanbene cave systems.

The Service has accepted the responsibility for managing the caves in their care at Bungonia for many types of use. The Service has responsibilities for the environment, for providing recreational and research opportunities as well as ensuring public safety. To this end, it initiated and executed the cave entrance remedial works described above. These works are not the entire solution as the behaviour of users also contributes to environmental pressures. In spite of Codes of Practice and similar initiatives the sheer pressures of use and undesirable practices such as the use of wire traces or over-large group sizes continue.

For example, cavers are still using wire traces in spite of clear evidence of the damage to trees, limestone and even the steel pipes provided in the remediation works. The fact that wire traces are cutting into steel demonstrates that it is no surprise to see wire-cut grooves in the limestone at many sites.

It is important to note that the entrance hardening project at Bungonia developed with the assistance of the caving community and particularly the Bungonia Recreational Activities Group. As such, the project provides a model for community involvement and for practical and relatively low-cost approaches to the management of at least one aspect of “wild” cave management.

REFERENCES

Bauer J.A. and Lake M., 1995 *Report on Erosion, Access patterns and Flora around Specific Cave Entrances at Bungonia State Recreation Area, New South Wales*, unpublished report to the National Parks and Wildlife Service, June 1995.

Bauer P., 1995 *Quote and specifications on recommendations arising from Bauer JA and Lake M 1995*, unpublished report to the NSW National Parks and Wildlife Service, June 1995.

Comfort M., 1993, *Environmental and Occupational Health Aspects of using CCA Treated Timber for Walking Track Construction in the Tasmanian Wilderness World Heritage Area*, unpublished report to the Tasmanian Parks and Wildlife Service, Department of Environment and Land Management, Hobart.

Cottier and Associates, 1997 *Geotechnical Assessment of Erosion of Cave Entrances Bungonia State Recreation Area*, unpublished report to the NSW National Parks and Wildlife Service, May 1997.

Eberhard, S. and Spate, A.P., (1995) *Cave Invertebrate Survey: Toward an Atlas of New South Wales Cave Fauna*, report to the Department of Urban Affairs and Planning on NSW Heritage Assistance Program NEP 94 765, pp. 120.

Jennings, J.N., 1983. A Map of Karst Areas in Australia. *Australian Geographical Studies, 21*: 183-196.

Spate, A.P. and Hamilton-Smith, E., (1993) Cavers's impacts - some theoretical and applied considerations, *9*, pp. 20-30.

Spate, A.P., Hamilton-Smith E., Holland, E. & Little L., (1998) Best Practice & Tourist Cave Engineering, *Proceedings 11th Conference of the Australasian Cave Tourism & Management Association*, May 1997, pp. 97-110.

Spate, A.P., (1990) *Kubla Khan Cave, Mole Creek, Tasmania, Pilot Management Study*, A report to the Tasmanian Department of Parks Wildlife and Heritage.

Spate, A.P., Richardson, B.R. and Reilly, S. (2002) Management of “wild” caves in New South Wales, *Cave Management in Australasia* (this publication).

Webb, R., 1984, Drovers Cave, Western Australia: Cave destruction through management, in Pilkington, G. (ed), *Proceeding of the 14th Biennial Conference Australian Speleological Federation*., ASF Sydney pp. 41-48.