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SIGNIFICANCE AND MONITORING

POMEMBNOST IN MONITORING

R. ARMSTRONG L. OSBORNE¹

¹ School of Development and Learning, A35. UNIVERSITY OF SYDNEY, N.S.W. 2006, AUSTRALIA.
e-mail: a.osborne@edfac.usyd.edu.au

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Izvleček

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R.A.L. Osborne: Pomembnost in monitoring

Za vsak program monitoringa v jamah je nujno potreben predhodni popis vseh bistvenih lastnosti nekega procesa. Monitoring ni sam sebi namen, pač pa je del integriranega procesa, osnovanega na bistvenih lastnostih upravljalškega procesa. Nujno je, da vemo, kaj v jami je res pomembno, da poznamo pogoje, v katerih lahko to pomembnost ohranimo in, da so tako ohranjeni pogoji celota vseh pomembnih dejavnikov. Na primer, če ne poznamo mehanizma odlaganja blatnih sedimentov, potem monitoring stanja kapnikov ne bo preprečil ponovnega odlaganja blata, ki smo ga sicer odstranili s pranjem pod visokim pritiskom. Podobno nima nobenega smisla merjenje temperature, če je prah glavna grožnja pomembnim elementom. Edini način, po katerem spoznamo, da je monitoring uspešen je ta, da merimo značilnosti in celovitost pomembnih elementov. Sicer lahko zberemo veliko pomembnih podatkov, najpomembnejše oblike pa nam medtem propadejo. Zato se mora monitoring nanašati na nujne okoliščine, pri katerih še lahko ohranimo bistvene značilnosti ter na sprotno stanje in celovitost pomembnih značilnosti.

Gljučne besede: monitoring v jami, ohranjanje jam, možnosti monitoringa.

Abstract

UDC: 551.44.001.4

R.A.L. Osborne: Significance and monitoring

An inventory survey followed by a significance assessment process, are essential precursors to any cave monitoring program. Monitoring must not be seen as an end in itself, but as part of an integrated, significance-based management process. It is essential to know what is significant, the conditions necessary to maintain its significance and that the condition and integrity of significant elements are being maintained. For instance, if the significance of a mud deposit is not known, monitoring the condition of speleothems will not stop the mud deposit from being destroyed by high-pressure water cleaning. Similarly, there is little point in monitoring temperature if dust is the main threat to the significant elements. The only way to know that monitoring of environmental conditions is effective is to monitor the ongoing condition and integrity of the significant elements themselves. Without this, lots of interesting data could be collected while the most important features of the cave are lost. Monitoring should therefore address the conditions necessary for the maintenance of significance and the ongoing condition and integrity of significant elements.

Key words: cave monitoring, cave conservation, monitoring conditions.

INTRODUCTION

Caves, along with other natural features come under conservation and management regimes on the basis of their heritage significance. Heritage is made up of “the things we wish to keep” (Hope, 1974) and significance is the characteristic of a thing or place that makes us wish to keep or conserve it. The significance of places is assessed relative to national or international criteria such as those for the World Heritage List (Hogan & Thorsell, 2000). Management or conservation plans are developed to conserve the significant elements of heritage places.

An excellent guide to this process is provided by the Australian Natural Heritage Charter (Cairnes, 1996) and is summarised in the following diagram:

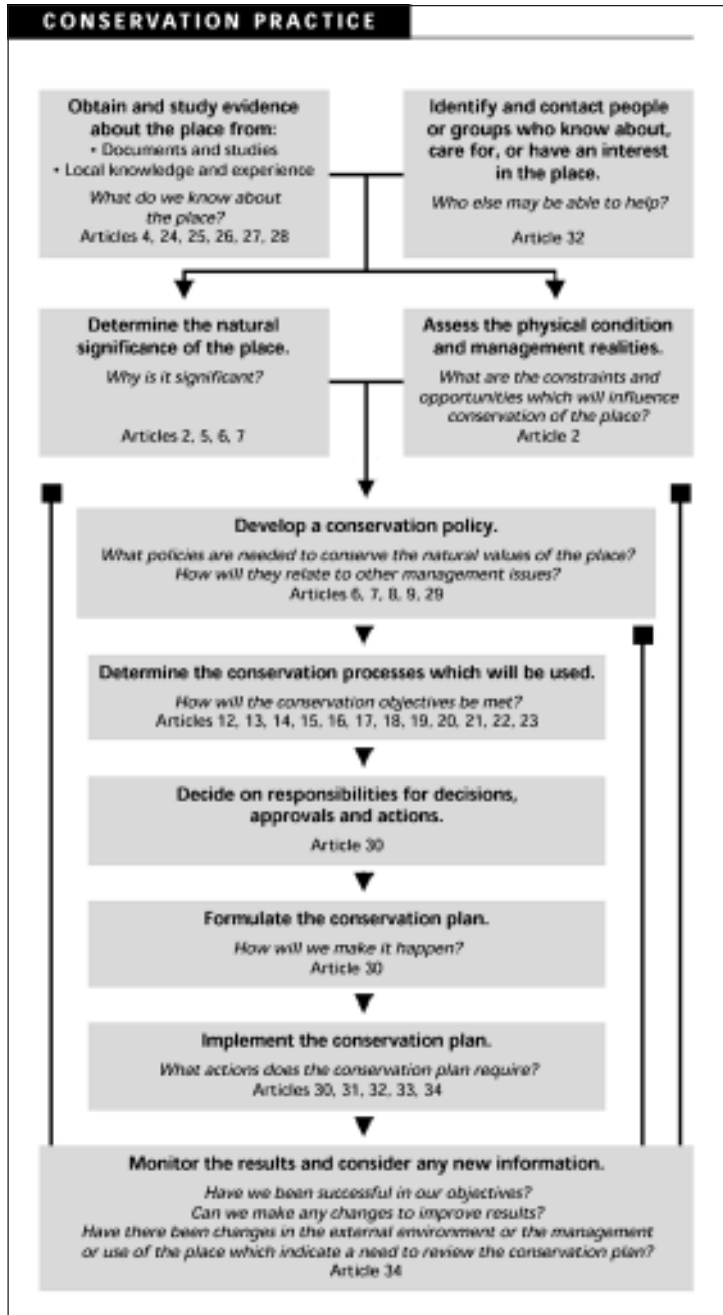


Fig. 1: Conservation Practice, after Cairnes (1996).

Significance-based conservation and management aims to identify, document and assess what is significant about a place and then develop and implement a management strategy which results in maintaining the significance of the various elements (individual features or components) that make up the place. The application of significance-based management to geoheritage places, including caves, is discussed by Osborne (2000).

The role of monitoring in this process is to ensure that the significance of the place is maintained. An excellent example of significance-based monitoring being applied to caves is provided by Bella et al. (2000) who identify the significant elements of Ochtiná Aragonite Cave, analyse the threat to them and use this as the basis for their monitoring.

Much cave monitoring however appears to be based on a quite different philosophy, derived from air and water pollution control practice. This, standards-based monitoring, aims to maintain environmental parameters within some specified range, or within a particular range from their “natural” value. Other monitoring approaches assume that the principal significance of caves lies in their microclimatic conditions.

There is frequently apparent confusion between recognition of what is significant in a cave and the role of monitoring. De Waele et al. (2000) stated that “the control of microclimatic parameters is a fundamental qualification for the environmental monitoring of show caves”. They then indicated that the main features of Zuddas Cave were its “marvellous and unique eccentric concretions”. No link however was made between the conservation of the “eccentric concretions” and the microclimatic measurements.

The aim of this paper is to outline and promote the development and use of significance-based monitoring by cave managers. It is acknowledged that monitoring for purposes other than heritage conservation is often required in show caves, particular examples being the monitoring of radon and carbon dioxide levels for occupational health and safety purposes.

THE DANGER OF NOT BASING MONITORING ON SIGNIFICANCE

Microclimatic monitoring is essential if it is determined that the microclimate of a cave is an element (i.e. an essential part of) of its natural heritage significance. Climatic monitoring will also be required if particular microclimatic parameters need to be maintained within particular limits to protect the condition and integrity of a significant element of the cave.

On the other hand, reliance on microclimatic or any other type of monitoring that is not directed to the maintenance of significance can result in degradation going unnoticed, or in the complete loss of some highly significant element. Atmospheric monitoring will not alert managers to the loss of significant mud deposits resulting from excessive use of water cleaning. Similarly measuring humidity and temperature will not alert managers to damage resulting from lint or dust accumulation.

For many significant features of caves the greatest threat is ignorance of their existence by management, contractors or workers. This is particularly the case with unobtrusive, fragile mineral deposits.

A SIGNIFICANCE-BASED APPROACH TO CAVE MONITORING

Significance-based monitoring, like significance-based conservation and management, is based on identifying the significant characteristics or components of a place. This is the most crucial step in any management program, as it will form the basis for all future action. While recognition of heritage significance is fundamental, in show caves other types of significance, in particular aesthetic significance, and issues of visitor safety, comfort and satisfaction also need to be managed and monitored.

The key components of a significance-based approach to monitoring are given in Figure 2, below:

Fig. 2: A SIGNIFICANCE-BASED APPROACH TO CAVE MONITORING

QUESTIONS	ACTIONS
1 What things (elements) are significant?	A Inventory Survey B Significance Assessment C Statement of Significance D Condition and Integrity Assessment
2 What conditions are required to maintain significance?	A Risk/Threat Assessment B Management/Conservation Plan C Management Action
3 How can we tell:	A Pre Monitoring Research B Monitoring Design
3.1 If appropriate conditions are being maintained?	C Procedure for Dealing with Adverse Data D Commence Monitoring
3.2 If significance is being maintained?	E Archive Data F Analyse and Interpret Data
4 What should be done?	A Inform Management B Management Decision C Management Action

Each of the questions in the table leads to a number of actions, which should be followed in a step-wise manner.

1 What things are significant?

1. A Inventory Survey

For many caves, including major show caves, our knowledge of their significant elements is quite poor. While pre-development inventory studies have become best practice for caves which have been developed quite recently (e.g. Bertolani et. al. 1991), for many established show caves the sum of available data is frequently only a map and sometimes not even that.

The first step in identifying significance is the inventory survey or study. This begins by collecting all available information from as many different sources as possible. Then a detailed survey of the cave and its surrounding environment is undertaken. Specialists from a great range of disciplines will be required for a comprehensive study. Bedrock geology, cave morphology, mineralogy, hydrology, water chemistry, meteorology, and various branches of biology will need to be investigated. For show caves there will need to be an assessment of aesthetic elements.

An inventory study is neither quick nor inexpensive and needs to be well co-ordinated. Inventory surveys frequently reveal previously unknown features, which may come to dominate the management of new show caves, or completely alter the management of existing ones.

1. B Significance Assessment

The next step after the inventory survey involves assessing the significance of the elements that have been identified. The Australian Natural Heritage Charter provides the following useful definition of natural significance: - "Natural significance means the importance of ecosystems, biological diversity and geodiversity for their existence value, or for present and future generations in terms of their scientific, social, aesthetic and life-support value." (Cairnes, 1996, p 6).

Significance assessment is usually achieved by the vote of an expert panel, or by measurement against a set of criteria, usually mediated by an expert, an expert panel or a series of panels. Often comparisons will be made with similar features at other places (e.g. how does the aragonite compare with that at Ochtiná or Lechuguilla). In some methodologies features are ranked as being of local, regional national or international significance, while in others something either meets the criteria and is significant, or doesn't meet the criteria and is not.

Significance criteria usually include terms such as:

- outstanding
- rare
- representative
- richness
- diversity
- unusual
- importance for ecological processes at a regional scale.

The World Heritage List requires that places be of "*outstanding universal value*".

While significance assessment may seem quite an arbitrary process to the outsider, World Heritage assessment is well respected and some national heritage assessment processes are required to be robust enough to withstand judicial review.

An inventory survey, followed by significance assessment will often produce surprising results; usually it is not the speleothems that are the most significant features of a cave, but an endemic species of aquatic invertebrate, an unusual mineral association, or speleogens indicating an unusual speleogenetic process. Interpreting results of this kind to both management and visitors is frequently challenging.

In the case of show caves and other major tourist areas it is important to consider the views of the visitors as well of those of experts. Tourists may value particular speleothems, the character of development, the contrast between a pristine speleothem and its muddy environment or in the case of Škocjanske jame the audible contrast between the Silent Cave and Svetinova dvorana.

An extreme example of dissonance between the view of experts and that of tourists is the Blue Mountains World Heritage Area in eastern Australia. While millions of tourists, including Charles Darwin, have visited the area to admire its cliffs, waterfalls and other incised sandstone plateau landforms, it is inscribed on the World Heritage List for its “diversity of eucalypt species”.

1. C Statement of Significance

It is good practice to prepare a Statement of Significance, which briefly outlines the significance of the place and can form a key part of planning and conservation documents.

1. D Condition and Integrity Assessment

Once the significant elements of a place have been identified an assessment needs to be made of their condition and integrity. A rare item in poor condition may be more important than an outstanding example of some common feature. A single intact or articulated fossil may be more important than a rich deposit of similar fossils that are fragmented. Also if the initial condition of a feature is not documented, it is not possible to tell if it is being successfully conserved and managed. Condition and integrity assessment is important both as an adjunct to significance assessment and as a source of basic information for future management.

2 What conditions are required to maintain significance?

2. A Risk/Threat Assessment

It is not possible to conserve something if the threats to its survival, condition and integrity are not understood. Wildlife for example may be threatened by hunting and/or by loss of habitat and/or by exotic competitors. To conserve a species it is necessary to know which are the significant threats and take action to control them.

The same logic applies to all of the elements of significance in a cave. Are speleothems at greatest danger from:

- physical damage
- and/or dehydration
- and/or lampenflora
- and/or re-solution
- and/or lint?

Knowing the threat allows management to take appropriate action to reduce and monitor it. Not knowing the threat will result in inappropriate management and monitoring and could result in a loss of significance. Unfortunately threats can come from unexpected sources. Loss of obvious fossil material from the Phosphate Mine at Wellington Caves, N.S.W., Australia does not appear to be related to visits by the general public, but to visiting scientists who are not working at the site and university students.

2. B Management/ Conservation Plan

The most important document in significance-based management is the management or conservation plan. This document should:

- include a description of the place

- include a statement of significance
- set out how the place is to be managed
- include a schedule of management actions to be taken
- provide for monitoring
- provide a process and timetable for review

Plans of management/conservation plans are a legal requirement for many types of conserved area and should be available to guide on-site managers.

2. C Management Action

Places are not conserved by plans, but by actions! The best plan and the best legislative protection will not conserve a place unless management has the funds, staff resources and willingness to take action.

With show caves, initial actions such as physical barriers or a path design that prevents physical damage, can be the most important protective steps.

3.1 How can we tell if appropriate conditions are being maintained?

This is the question which monitoring is usually designed to answer. With caves the monitoring will usually not be restricted to the caves themselves, but may need to consider the quality of sinking water, the environmental conditions in the catchment and the environmental conditions on the surface and in the epikarst above the cave. Air quality in the cave's atmospheric catchment may also be significant.

3.2 How can we tell if significance is being maintained?

Monitoring of the condition and integrity of the significant elements themselves is unfortunately less common in caves than environmental monitoring. Photo monitoring, with UV if lint is an issue, microerosion meters, population studies and a diary or "occurrence book" kept by the guides may all play a role.

3. A Pre Monitoring Research

A good understanding of the environmental processes in the cave, particularly those that influence the significant features, is required so a monitoring program can be designed. The type of questions that need to be answered could be:

- Where does the water in the pond with the rare invertebrates really come from?
- What are the crucial parameters required for stability of the rare mineral?
- Are the evaporative speleothems natural or an artefact of development?
- What is the frequency and scale of floods and/or droughts?

While the desirable quantity or quality of baseline data is rarely available, it is important to learn from historical data and local knowledge about the natural background variability of the environment in which the cave is located and about the likely range of parameters which may be encountered.

Trial measuring programs and surveys to determine the location of underground environmental boundaries (e.g. thermoclines, haloclines, evaporation/equilibrium precipitation, dark zones) will be required.

3. B Monitoring Design

The questions to be answered by monitoring will come from the Risk/Threat Assessment and the Monitoring Research. The design of the monitoring system will need to address:

- The parameters that need to be monitored
- The range of likely results
- The number and location of monitoring stations
- The frequency of measurement
- The methods of data collection/storage
- The methods of data analysis and interpretation
- The procedure for responding to adverse results

The technical problems in obtaining suitable instruments and setting them up in caves are well documented (Bertolani et. al. 1991, Massen et. al, 1996; Cigna, 1997). These need to be considered in detail before funds and time are wasted on systems that are unlikely to function adequately in the cave or produce reliable data.

3. C. Procedure for Dealing with Adverse Data

There is no point in monitoring if management is unprepared to receive or respond to adverse results. It is wise to develop some contingency plans before commencing monitoring so that adverse results can be responded to in an appropriate and least disruptive manner.

3. D Commence Monitoring

When the monitoring program is ready to be implemented, the real test of the planning and design process begins. There will be start up bugs, unexpected results etc, so a period of bedding in the equipment must be anticipated.

3. E Archive Data

Safe storage of data in a form that is accessible to future users is one of the most important issues to be addressed at the outset of any monitoring program. Given the tendency for electronic data storage methods to change rapidly, it is important to consider storing the most important data sets as both paper and electronic records, and to take advantage of the services of libraries and/or official archive services to store duplicate data sets.

3. F Analyse and Interpret Data

The data needs to be analysed and the results interpreted in a way that provides information that is useful to management, for example:

- How does the data compare with the background?
- Is the significance threatened or not?
- What are the rates of change?
- Are the changes reversible?
- Are natural forces at work, or are the changes a result of human intervention?

Information about rates of change or reasonable predictions about them are very important for the decision-making process.

4 What should be done?

While those in charge of the monitoring program receive and interpret the data, it is the role of management to respond to it with decisions and action.

4. A Inform Management

The monitoring process and those who operate it must have the ability to inform management of the results of their work and to interpret to management the implications of the results along with a range of possible responses.

The significance-based monitoring process allows strategies for dealing with adverse results to be developed quite early in the process, for instance at the Plan of Management stage. Consequently both the results of the monitoring and a series of optional responses will be readily available.

4. B Management Decision

Once informed of a threat to the significance of the place that they conserve, management has the responsibility to make an informed decision. The feedback between monitoring and action, particularly monitoring of the condition and integrity of the significant elements themselves, acts as a corrective mechanism if an incorrect decision is made.

4. C Management Action

Once a decision is made about the best way to ameliorate the identified threat to the cave's significance, action should be taken to implement it. This action should become part of a feedback loop to both the plan of management and the monitoring program. The changes brought about by the new action will themselves require monitoring. It is likely that different types of information may be required from the monitoring program as a result of changes flowing from the remedial action.

CONCLUSION

Significance-based monitoring is an approach that builds monitoring into a comprehensive heritage conservation and management program. It differs from standards-based monitoring in that its focus is on the maintenance of significance, rather than on maintaining environmental parameters within standard limits or within some range of "natural" levels.

Significance-based monitoring has the advantage that it ensures a direct focus on what is important, rather than relying on standards or changes from the norm. With significance-based monitoring there is a reduced risk that damage to caves will go unnoticed or that caves will be damaged from ignorance or neglect.

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POMEMBNOST IN MONITORING

Povzetek

Za vsak program monitoringa v jamah, je nujno potreben predhodni popis vseh bistvenih lastnosti nekega procesa. Monitoring ni sam sebi namen, pač pa je del integriranega procesa, osnovanega na bistvenih lastnostih upravljskega procesa.

Nujno je, da vemo, kaj v jami je res pomembno, da poznamo pogoje, v katerih lahko to pomembnost ohranimo in, da so tako ohranjeni pogoji celota vseh bistvenih dejavnikov. Na primer, če ne poznamo mehanizma odlaganja blatnih sedimentov, potem monitoring stanja kapnikov ne bo preprečil ponovnega odlaganja blata, ki smo ga sicer odstranili s pranjem pod visokim pritiskom. Podobno nima nobenega smisla merjenje temperature, če je prah glavna grožnja bistvenim elementom.

Edini način, po katerem spoznamo, da je monitoring uspešen je ta, da merimo značilnosti in celovitost bistvenih elementov. Sicer lahko zberemo veliko pomembnih podatkov, najpomembnejše oblike pa nam medtem propadejo.

Zato se mora monitoring nanašati na:

1. nujne okoliščine, pri katerih še lahko ohranimo bistvene značilnosti;
2. sprotno stanje in celovitost bistvenih značilnosti.

Ključne elemente pristopa na osnovi bistvenih lastnosti predstavlja spodnja tabela:

PRISTOP K MONITORINGU NA OSNOVI BISTVENIH ZNAČILNOSTI

VPRAŠANJA	POSTOPEK
1 Katere stvari (elementi) so značilne?	A Popis (inventarizacija) B Ocena pomembnih lastnosti C Ocena pogojev in celovitosti
2 Kakšni pogoji so nujni za ohranitev bistvenih značilnosti?	A Ocena tveganja/ nevarnosti B Načrt upravljanja C Delovanje upravljalcev
3 Kako lahko trdimo: 3.1. Ali so bili primerni pogoji ohranjeni? 3.2. Ali so bistvene značilnosti ohranjene?	A Raziskave pred monitoringom B Model monitoringa C Začetek monitoringa D Arhivski podatki E Analiza podatkov
4 Kaj je treba narediti?	A Obveščanje uprave B Odločitve uprave C Delovanje uprave

Monitoring, temelječ na pomembnosti, je torej tak način pristopa, ki omogoča njegov prehod v celostni program za ohranjanje dediščine in njeno upravljanje. Od standardnega monitoringa se

razlikuje v tem, da je usmerjen k ohranjanju najpomembnejših elementov, ne pa k ohranjanju standardnih parametrov v mejah standardov ali v nekih "naravnih" mejah.

Prednost monitoringa, ki temelji na pomembnosti, je tudi v tem, da omogoča neposredno usmerjanje na bistveno, ne pa da temelji na standardih ali odklonih od nekih norm. Tak monitoring zmanjšuje tveganje, da bi poškodbe v jamah ostale nezapažene ali pa da bi bile jame poškodovane zaradi neznanja ali nepazljivosti.