Open access • Journal Article • DOI:10.1890/090020

Conservation in the dark? The information used to support management decisions

Carly N. Cook, Marc Hockings, Rodney William Carter

Institutions: University of Queensland, University of the Sunshine Coast

Published on: 01 May 2010 - Frontiers in Ecology and the Environment (Ecological Society of America)

Topics: Evidence-based conservation, Resource management and Scope (project management)

Conservation in the dark? The information used to support management decisions

Carly N Cook[1*], Marc Hockings[1], and RW (Bill) Carter[2]

The management requirements for protected areas are frequently complex and urgent; as a result, managers often need to act quickly and make decisions with limited supporting evidence at their disposal. Despite demands for high-quality information, it is unclear how much of this evidence conservation practitioners use to assist with their decision making. We investigated the information used to manage protected areas, based on the evidence reported by practitioners when evaluating their management performance. We examined the management of over 1000 protected areas run by two Australian conservation agencies – Parks Victoria and the New South Wales Department of Environment and Climate Change – an unprecedented scope for this type of study. We found that very few conservation practitioners use evidence-based knowledge to support their management. The evidence used varies with the management issue, reserve type, and reserve size. Around 60% of conservation management decisions rely on experience-based information, and many practitioners report having insufficient evidence to assess their management decisions. While experience plays an important role in conservation management, the apparent lack of evidence-based information to support decision making in the reserves has the potential to compromise outcomes and jeopardize the investment made in protected areas for conservation.

Front Ecol Environ 2010; 8(4): 181–186, doi:10.1890/090020 (published online 4 Aug 2009)

Successful conservation outcomes depend on effective management of protected areas. Conservation practitioners must therefore choose from a range of alternative actions, including inaction. Because these choices can materially affect the resource being managed, we might expect that decisions regarding the best course of action would be based on rigorous evidence. While protected-area management agencies espouse the precautionary principle and use of the best available knowledge in reserve management, we rarely know what evidence is used to support management decisions.

Sutherland *et al.* (2004) reported that only 2% of conservation actions for a wetland in England were based on verifiable evidence, while 77% of such actions were entirely experience-based. A study of conservation planners revealed that they tend not to use published research when developing management plans (Pullin and Knight 2005). Instead, they value experience-based evidence over research, and report that the published literature is difficult for them to access (Pullin and Knight 2005). The implication is that relevant information exists in the literature – an assumption that has been largely untested – although there is some evidence to the contrary (Fazey *et al.* 2005). As conservation actions are linked to conservation outcomes, it is important to understand the evidence practitioners use in their choice of actions. In this study, we examined the evidence conservation practitioners use when making judgments about the effectiveness of their management efforts.

The Convention on Biological Diversity commits signatories to report on the effectiveness of protected-area management (CBD 2004). Data are often absent in reserves, because of the prohibitive cost of monitoring (Hockings 2003); consequently, most methods for assessing management effectiveness are based on conservation practitioners' experience. In recent years, two Australian protected-area management agencies – the New South Wales Department of Environment and Climate Change (NSW DECC – formerly the New South Wales Department of Environment and Conservation) and Parks Victoria – measured and reported on the effectiveness of their management activities (NSW DEC 2005; Parks Victoria 2007). These evaluations use practitioners, as the experts in the management of reserves, to rate their management against a set of management standards (Hockings *et al.* 2009a). Practitioners are asked to base their assessments on the best information available, whether that be research and monitoring data, planning documents, or personal experience. The assessments encompass many management issues and record the supporting evidence. This provides a unique dataset with which to examine the evidence used by conservation practitioners to inform their management.

While the evidence conservation practitioners use to determine the success of their management actions (examined here) and that to support their management decisions might not be identical, considerable overlap is probable because management decisions are likely to be made on the basis of a subset of evidence used to understand overall management performance. We also analyze whether this evidence varies with the attributes of reserves and the management issues being evaluated. In this way, practitioners can

[1]*School of Integrative Systems, University of Queensland, St Lucia, Australia* [*]*(cook@uq.edu.au)*; [2]*Sustainability Research Centre, University of the Sunshine Coast, Maroochydore, Australia*

Beyond the Frontier: Listen to Carly Cook discussing this research on *Frontiers*' monthly podcast, at www.frontiersinecology.org.

Table 1. Evidence categories developed to describe the data sources used in State of the Parks assessments

Evidence category	*Description*	*Common examples*
Experience-based	Observational or anecdotal data from conservation practitioners, community members, or local specialists	Experience managing the reserve and/or personal communications from others
Intermediate	Knowledge derived from plans, point data, or ad hoc monitoring and/or mapping	Management plan, wildlife sighting records, invasive plant mapping
Evidence-based	Knowledge derived from research, monitoring, and/or formal assessment	Student research, site-level monitoring, gray and peer-reviewed literature

determine whether they have adequate support to be able to evaluate the consequences of their conservation actions. Without this support, the likelihood of achieving and recognizing successful conservation outcomes is reduced.

Methods

State of the Parks assessments

The State of the Parks (SoP) assessment tools are based on the framework for evaluating management effectiveness developed by the World Commission of Protected Areas; this is part of the best practice guidelines series published by the International Union for Conservation of Nature (Hockings *et al.* 2006). The assessment tools are system-wide evaluations of protected areas (Hockings *et al.* 2009a). Practitioners rate their management achievements against criteria, which act as the standards for management (Hockings *et al.* 2009a). A justification for the rating is sought, along with the evidence used to inform the assessment.

Practitioners who believe they have insufficient evidence to rate the effectiveness of their management for a particular issue can abstain from making an assessment. In such cases, the evidence used in decision making is not reported. Several processes for oversight and standardization are used to promote accuracy, including completing assessments in a workshop environment to limit the influence of individual biases and a formal review process for all assessments to standardize individual variations and prevent deliberate misrepresentations (Hockings *et al.* 2009a).

Management agencies

Parks Victoria and NSW DECC are state-level government agencies charged with protecting biodiversity and culturally significant sites, as well as facilitating tourism. The agencies are responsible for state-level reserves, such as national parks, nature reserves, and recreation reserves. Parks Victoria oversees 2973 reserves in the state of Victoria, totalling 3.96 million ha, or 17% of the state. NSW DECC is responsible for 780 reserves in the state of New South Wales, totalling over 6.5 million ha, or 8% of the state.

Data preparation

Data were compiled from 1064 protected areas managed by the two agencies. The proportion of practitioners reporting insufficient evidence to make an assessment for their reserve was calculated. While practitioners do not report the evidence used when abstaining from making an assessment, these data indicate the number of practitioners actively managing their reserves, despite feeling ill-equipped to assess their management. By allowing practitioners to abstain because of insufficient information, we assumed that those who assessed their management felt there was adequate evidence to do so.

Assessment questions addressed 11 management issues that were common to both SoP protocols (NSW DEC 2005; Parks Victoria 2007) and, where management performance was assessed, the reported evidence was extracted from these assessments. The two agencies used slightly different approaches to classify evidence sources, so each assessment was recoded to one of three evidence categories (Table 1).

As practitioners are the experts in the management of their reserves, experience-based evidence is treated as expert opinion, which is widely used as evidence across many disciplines (Alho 1997; Liao 2005; Pearson *et al.* 2007). Observations may be sufficient to assess management performance, especially where an effect size is large; for example, a doubling in the area covered by an invasive plant is readily observable, even if site visits are infrequent. However, experience-based judgement can be susceptible to bias (Burgman 2001). SoP questions ask practitioners to determine trends in management and conditions across potentially large reserves. Under these circumstances, assessments may be heavily influenced by frequently visited areas or the practitioner's level of experience. The variable nature of experience-based evidence is better suited to the assessment of some management issues and circumstances (Hockings *et al.* 2009b).

Intermediate evidence includes a mixture of data sources (Table 1). Planning documents may synthesize

the best research but can also be based on personal experience (Pullin and Knight 2005). Wildlife location data bring together records from various sources, including researchers, practitioners, and visitors. The quality of observations varies, and is biased toward popular destinations, roads, and hiking trails. The potential for multiple sources of information to be synthesized, despite their variable quality, means that intermediate evidence should also be treated cautiously.

The evidence-based category is used to describe site-level research and monitoring data (Table 1) from unpublished reports up to peer-reviewed literature. Although these data are generally considered more rigorous, they are also potentially subject to uncertainty as a result of poor sampling designs (Regan *et al.* 2002). High-quality data may also be extrapolated inappropriately to different spatial or temporal scales, and so the confidence placed in this evidence may be greater than is warranted. Ideally, the evidence will meet the standards outlined in the evidence quality hierarchy developed by Stevens and Milne (1997), but the quality of the datasets reported by practitioners is not recorded.

Data analyses

Using the evidence categories described above, we combined the SoP datasets for analysis. The proportion of respondents who indicated insufficient evidence to make an assessment was calculated for each management issue. Where sufficient information was available, the proportions of evidence types used were calculated for each management issue. The proportion of responses reporting the different evidence types (response variable) for each management issue (explanatory variable) was then evaluated using analysis of variance.

Different types of protected areas have different levels of protection and various management objectives (IUCN 1994). These differences are often reinforced by local legislation and can change the emphasis given to knowledge gathering. As such, contingency tables, with a chi-squared test of significance, were used to examine the levels of evidence by reserve type.

Reserve size can influence practitioners' ability to gather high-quality evidence about management effectiveness. The influence of reserve size (response variable) on the level of evidence (explanatory variable) was therefore also analyzed, using analysis of variance and $\log_{10}$ transformed data, because of the prevalence of small reserves. While many attributes may influence the evidence used to support decision making within protected areas, the management issue and reserve type and size were identified as the three factors with the greatest potential to explain variation.

Results

Overall, 26% of practitioners reported insufficient evidence to assess the effectiveness of their management for at least one management issue; however, this figure varied (11–43%) among the management issues assessed (Table 2). Practitioners were more likely to refrain from answering questions relating to the management of cultural values and the condition of reserves.

Five times as many assessments relied on experience-based knowledge as relied on evidence-based knowledge to assess management performance (Figure 1). Three times as many assessments used intermediate evidence than relied

Table 2. The evidence used to support assessments of management effectiveness for each management issue, sorted by the proportion of assessments not completed due to insufficient evidence

		Sufficient evidence (%)		
Management issue	*Insufficient evidence (%)*	*Experience-based (%)*	*Intermediate evidence (%)*	*Evidence-based (%)*
Condition of indigenous cultural heritage	43	72	17	11
Management of indigenous cultural heritage	34	41	42	18
Condition of non-indigenous cultural heritage	32	64	18	18
Condition of natural values	27	60	25	15
Management of non-indigenous cultural heritage	26	39	42	20
Managing invasive animals	19	49	40	12
Managing impacts of visitors	17	57	37	6
Managing invasive plants	11	43	45	11
Indigenous community consultation and involvement	na	69	28	4
General community consultation and involvement	na	70	27	3
Provision of visitor education material and programs	na	80	18	2

Note: the proportions of experience-based, intermediate, and evidence-based assessments are based on practitioners who indicated they had sufficient information to assess their management. na = not available.

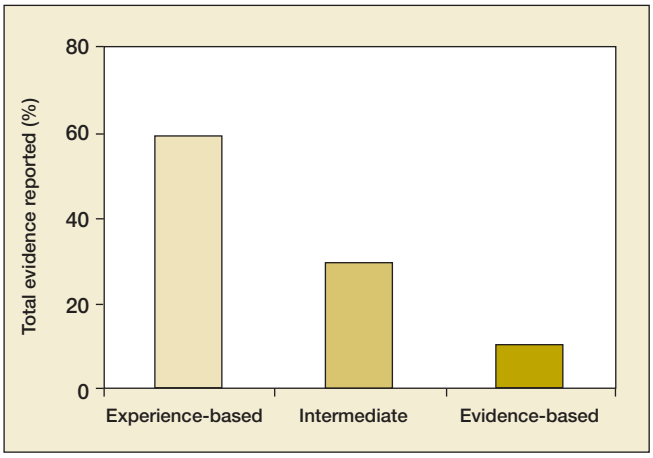

Figure 1. *The data sources reported for all questions within the State of the Parks dataset.*

on evidence-based knowledge. In total, 90% of all assessments were made without evidence-based knowledge (60% experience-based, 30% intermediate; Figure 1). There were significantly higher levels of evidence-based knowledge used to address some management issues ($F_{10, 7508}$ = 49.21, P < 0.001; Table 2). For example, 18–20% of practitioners had data addressing the management of indigenous or historic heritage. In contrast, only 6% used evidence-based knowledge when considering the impacts of visitors on their reserve; 80% of practitioners relied solely on experience-based evidence to assess the effectiveness of their efforts to educate visitors.

Practitioners more often reported insufficient evidence to assess their performance for the same management issues in situations where higher levels of evidence-based knowledge were used to support assessments (ie management of cultural heritage and condition of natural values). While evidence-based knowledge was used more commonly by practitioners to assess these management issues (or insufficient information prevented assessments), the majority of practitioners were still willing to make an assessment without evidence-based knowledge (Table 2). This suggests variability in the types of evidence practitioners are willing to use to support their assessments.

Practitioners managing some reserve types had significantly more evidence-based knowledge than others (χ^2 = 75.74, P < 0.001; Figure 2). Indigenous heritage reserves used the least amount of evidence-based knowledge, although levels were low for all reserve types. Overall, the use of experience-based evidence was high for most reserve types, except for historic reserves, where this constituted approximately one-third of the evidence used.

Practitioners reported the availability of significantly more evidence-based knowledge for larger reserves ($F_{2, 7498}$ = 19.18, P < 0.001), while smaller reserves relied more heavily on experience (Figure 3). A relationship does exist between park type and size: national parks are significantly larger than other reserve types, and cultural heritage reserves are significantly smaller ($F_{4, 7499}$ = 904.77, P < 0.001).

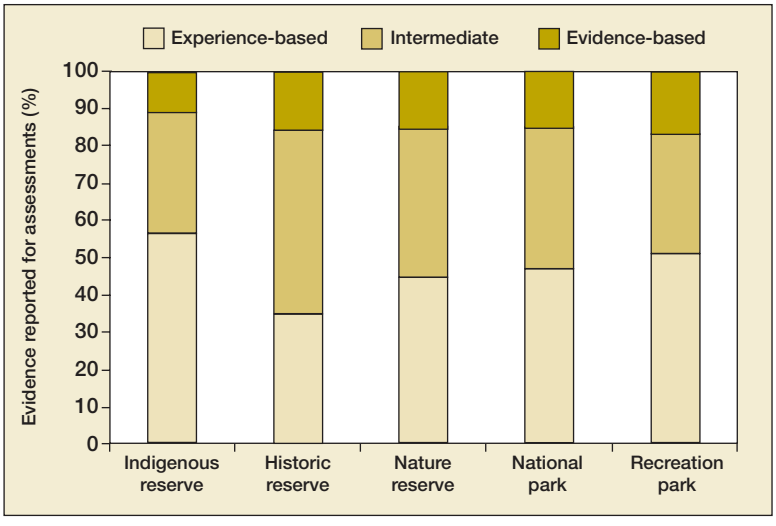

Figure 2. *Data sources used by conservation practitioners to inform their assessments of management performance, displayed by the type of reserve they manage. From left to right, the first three reserve types protect specific values, while the last two represent multi-use reserves.*

Discussion

Protected areas are the cornerstones of conservation, yet in 25% of management effectiveness assessments, practitioners reported insufficient evidence to assess their management performance. Although lacking sufficient knowledge about their reserves, these practitioners must still make management decisions in accordance with the precautionary principle. Where practitioners did report sufficient information, generally they had very little data to support their management strategies; 60% of assessments relied solely on experience to judge the success of management approaches. Experience can contribute substantially to the development of expertise (Johnson 1983) and should not be undervalued as a source of knowledge; most conservation practitioners are clearly comfortable making decisions using only experience-based evidence (Pullin and Knight 2005). While this lack of evidence-based knowledge may have been suspected for some time, this research represents the first attempt to quantify the evidence used by practitioners on a program-wide scale, across two management agencies.

The evidence used by practitioners varied across management issues and among reserves of different types and sizes. Practitioners tended to use evidence-based information to assess management issues that related to the status and trends of reserves and pressures (such as the condition of reserves), concepts more suited to the application of research and monitoring data (Hockings *et al.* 2009b). However, many practitioners relied on their experience to assess the success of their approach to these issues. It is likely that experience is often the basis of assessments where the management of a reserve is not

complex, and so management outcomes can be more readily observed based on experience alone.

The evidence-based knowledge used by practitioners for management assessments was chiefly concentrated within large, multi-use parks, rather than smaller reserves focused on specific values, particularly cultural heritage values. This appears to be a pragmatic allocation of limited resources, because multi-use parks tend to be large, have complex management objectives, and protect important biodiversity and cultural heritage, all of which must be balanced with visitor enjoyment and safety. This complexity may make evidence-based information desirable, in addition to practitioner experience, when examining the outcomes of management decisions. In contrast, small reserves, including cultural heritage reserves, often have less complex management requirements, and so experience may be adequate to understand the success of management.

Most conservation practitioners in Australia are apparently willing to evaluate management based solely on experience-based evidence – probably as a result of the daily necessity of decision making in the absence of evidence-based knowledge, and because they have confidence in their personal judgements. However, there are some management issues and contexts well suited to the use of experience-based evidence (Hockings *et al.* 2009b). Although experience can make a valuable contribution to the assessment of these management issues, the reasons for a greater reliance on evidence-based knowledge have been enumerated elsewhere (see Pullin and Knight 2001; Sutherland *et al.* 2004; Ferraro and Pattanayak 2006). Investing heavily in the permanent protection of reserves, while not sufficiently equipping practitioners with the information necessary to make decisions, compromises their ability to achieve conservation outcomes. There is clearly a need to shift the balance between the evidence types used by practitioners, focusing evidence-based information toward management issues that address the status and trend of values in large, multi-use reserves. A risk-based framework, such as that now employed by Parks Victoria, can assist in prioritizing the areas where data will be most valuable.

Conservation is a crisis discipline (Soulé 1985), operating under limited resources (Balmford *et al.* 2003). Compared to protected areas in most other countries, those in Australia are comparatively well resourced, although still well behind those of North America (Balmford *et al.* 2003). Even so, many practitioners report insufficient information or no evidence-based knowledge to support their management strategies. When well-resourced, developed nations are so far from implementing the evidence-based approaches to conservation being advocated (Sutherland *et al.* 2004), the situation for practitioners in the developing world – where many of the biodiversity hotspots are located – must be considerably worse.

While the experience of practitioners should never be undervalued, the lack of evidence-based knowledge to support decision making is nevertheless worrying. Australia is a large country, with diverse environments and comparatively well-resourced protected areas, yet features an unenviably high rate of species extinction. The use of evidence-based knowledge elsewhere in the world is likely to be similar at best, and we therefore strongly suggest that comparable studies be undertaken elsewhere, to examine this pattern.

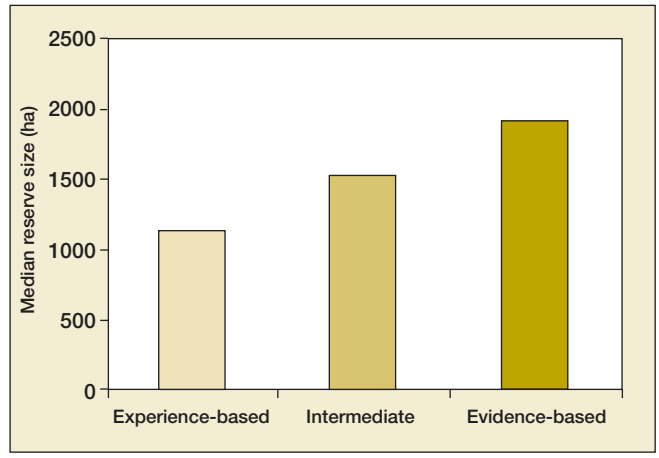

Figure 3. *The median size of parks, in hectares, with different evidence types.*

To protect the investments made in protected areas, existing research needs to be interpreted for practitioners (Gibbons *et al.* 2008), and new research should be targeted at important management issues through stronger links between conservation research and practice (Fazey *et al.* 2005). In addition, funding bodies would be wise to devote a portion of their investment in protected areas to gathering evidence-based knowledge at high-priority sites (eg large, multi-use, high-risk sites, and those where practitioners report insufficient evidence), because it is a false economy to protect natural areas while failing to adequately support the practitioners trying to manage them. Without sufficient evidence to support decision making by conservation practitioners, it is optimistic to believe the best conservation outcomes will be achieved.

Acknowledgements

CNC is funded by an Australian Research Council Linkage Grant. The authors wish to thank H Possingham, E Nicholson, L Joseph, and D Marshall, whose comments substantially improved earlier versions of this manuscript. Thanks also go to the conservation agencies who consented to their data being used in this study.

References

Alho JM. 1997. Scenarios, uncertainty and conditional forecasts of the world population. *J Roy Stat Soc A Sta* **160**: 71–85.

Balmford A, Gaston KJ, Blyth S, *et al.* 2003. Global variation in terrestrial conservation costs, conservation benefits, and unmet

conservation needs. *P Natl Acad Sci USA* **100**: 1046–50.
Burgman MA. 2001. Flaws in subjective assessments of ecological risks and means for correcting them. *Aust J Environ Manage* **8**: 219–26.
CBD (Convention on Biological Diversity). 2004. Programme of work on protected areas. www.biodiv.org/decisions/default.aspx?dec=VII/28. Viewed 26 May 2009.
Fazey I, Fischer J, and Lindenmayer DB. 2005. What do conservation biologists publish? *Biol Conserv* **124**: 63–73.
Ferraro PJ and Pattanayak SK. 2006. Money for nothing? A call for empirical evaluation of biodiversity conservation investments. *PLoS Biology* **4**: 482–88.
Gibbons P, Zammit C, Youngentob K, *et al.* 2008. Some practical suggestions for improving engagement between researchers and policy-makers in natural resource management. *Ecol Manage Restor* **9**: 182–86.
Hockings M. 2003. Systems for assessing the effectiveness of management in protected areas. *BioScience* **53**: 823–32.
Hockings M, Cook CN, Carter RW, *et al.* 2009a. Accountability, reporting, or management improvement? Development of a State of the Parks assessment system in New South Wales, Australia. *Environ Manage* **43**: 1013–25.
Hockings M, Stolton S, Dudley N, *et al.* 2009b. Data credibility – what are the "right" data for evaluating management effectiveness of protected areas? *New Dir Eval* **122**: 53–63.
Hockings M, Stolton S, Leverington F, *et al.* 2006. Evaluating effectiveness: a framework for assessing management effectiveness of protected areas, 2nd edn. Gland, Switzerland: IUCN.
IUCN (International Union for Conservation of Nature). 1994. Guidelines for protected area management categories. Gland, Switzerland and Cambridge, UK: IUCN and World Conservation Monitoring Centre.
Johnson PE. 1983. What kind of expert should a system be? *J Med Philos* **8**: 77–97.
Liao SH. 2005. Expert system methodologies and applications – a decade review from 1995 to 2004. *Expert Syst Appl* **28**: 93–103.
NSW DEC (New South Wales Department of Environment and Conservation). 2005. State of the Parks 2004. Sydney, Australia: NSW Department of Environment and Conservation.
Parks Victoria. 2007. Victoria's State of the Parks report. Melbourne, Australia: Parks Victoria.
Pearson A, Wiechula R, Court A, *et al.* 2007. A re-consideration of what constitutes "evidence" in the healthcare professions. *Nurs Sci Quart* **20**: 85–88.
Pullin AS and Knight TM. 2001. Effectiveness in conservation practice: pointers from medicine and public health. *Conserv Biol* **15**: 50–54.
Pullin AS and Knight TM. 2005. Assessing conservation management's evidence base: a survey of management-plan compilers in the United Kingdom and Australia. *Conserv Biol* **19**: 1989–96.
Regan HM, Colyvan M, and Burgman MA. 2002. A taxonomy and treatment of uncertainty for ecology and conservation biology. *Ecol Appl* **12**: 618–28.
Soulé ME. 1985. What is conservation biology? *BioScience* **35**: 727–34.
Stevens A and Milne R. 1997. The effectiveness revolution and public health. In: Scally G (Ed). Progress in public health. London, UK: Royal Society of Medical Press.
Sutherland WJ, Pullin AS, Dolman PM, *et al.* 2004. The need for evidence-based conservation. *Trends Ecol Evol* **19**: 305–08.

