

The need for evidence-based conservation

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Much of current conservation practice is based upon anecdote and myth rather than upon the systematic appraisal of the evidence, including experience of others who have tackled the same problem. We suggest that this is a major problem for conservationists and requires a rethinking of the manner in which conservation operates. There is an urgent need for mechanisms that review available information and make recommendations to practitioners. We suggest a format for web-based databases that could provide the required information in accessible form.

The past few decades have seen a revolution in medical practice. Thirty years ago, Archie Cochrane [1] concluded that 'commonly used procedures and therapies were not always the most efficacious' and that 'a not insubstantial amount of practice had not been well evaluated'. Others have pointed out that the introduction of new medical technologies has been influenced more by professional, commercial and public pressures than by a coherent policy for assessing their relative value (e.g. [2]). One consequence is that clinical practice can vary for no justifiable reason [3]. Research comparing recommendations drawn from a systematic and objective review of research findings to those from 'conventional expert wisdom' has highlighted the 'dreadful mistakes that traditional reviews, relying on expertise and not a systematic review of the evidence, can make' [4]. For example, thrombolytic therapy (clot-busting drugs) was widely recommended in acute myocardial infarction (heart attack) only in 1986, although the benefits of the therapy would have been clear in 1975 had available research been reviewed systematically and meta-analyzed [5]. Thousands of lives might have been saved in this interval. Such revelations stimulated the examination of the extent to which medical practice was based on research evidence of effectiveness and led to the conclusion that radical change was required. The result was the development of an infrastructure to support 'evidence-based practice', which has transformed medical practice and is now a routine part of medical training. We believe that conservation needs a similar radical revolution.

Is there a problem?

Current conservation practice faces the same problems as did old-fashioned medical practice. For example, most decisions are not based upon evidence, but upon anecdotal sources (Box 1). Furthermore, very little evidence is collected on the consequences of current practice so that future decisions cannot be based upon the experience of what does or does not work. Much accumulated experience is solely in the memory of individual practitioners, and the collection of information in a form that could be used by others is very limited.

A problem with using the advice of others or secondary sources is that it is difficult to find the source of the information. It is difficult to tell whether widespread beliefs are based upon the summation of a range of studies, from a well-designed experiment, from experience in one site, or simply from someone using their best guess as to the best approach. It is our experience that it is

Box 1. What information do conservation practitioners use?

Broadland in eastern England is an internationally important wetland with the highest statutory protection under European law. We interviewed site managers from four statutory and non-statutory agencies and responsible for 2996 ha about the evidence-basis of their fen management. In 61 management actions, 170 knowledge sources had been used, which we categorized into seven types (Table 1). In total, 77% of sources were anecdotal ('commonsense', personal experience and speaking to other managers), whereas only 2% were based upon verifiable scientific evidence.

We also questioned managers about data collection. Although some monitored key species, habitat responses to management were generally not monitored. At many sites, nothing at all was recorded, giving no evidence by which to judge outcomes.

Table 1. Sources of information used by practitioners in Broadland, UK

Source of information	Number	%
Common sense	55	32.4
Personal experience	37	21.8
Speaking to other managers in region	34	20.0
Other managers outside region	4	2.4
Expert advisers	17	10.0
Secondary publications	19	11.2
Primary scientific literature	4	2.4

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remarkably difficult to determine the basis of these beliefs. Much of conservation is thus based upon myths. Alternative approaches might be simpler, more cost-effective or give a better outcome, but the inertia of myth-based beliefs can prevent managers from testing or adopting alternative practices.

Why should we be worried about this? After all, what is wrong with using your experience if it achieves the right result, as attested by successful reserves, restoration projects and species recovery programmes? But failure to evaluate can lead to the acceptance of dogma that can be wrong. For example, although burning reed beds is a very effective means of restoring them, it is usually not allowed because of a supposed effect on soil invertebrates. A randomized, replicated and controlled experiment that was established to determine how long it was before the soil invertebrates recovered, discovered that there were absolutely no effects on them. By contrast, flooding, which is widely encouraged, had devastating impacts on the invertebrates [6,7]. As another example, winter flooding of grasslands is widely considered to be beneficial for wading birds and is encouraged by governmental grants. However, detailed analysis [8] showed that, although flooding previously unflooded grasslands provided soft mud and bare soil that was suitable for foraging, it also killed the invertebrates upon which the birds fed. The optimal solution is likely to be a mosaic of flooded and unflooded grasslands [9], but this, of course, requires testing.

Some will argue that science has always underpinned conservation, so evidence-based conservation is nothing new (evidence-based medicine faced and conquered the same criticisms). This is true, but the consequences of conservation actions are rarely documented [10]. Neither are the results of research routinely reviewed systematically nor actively disseminated. Consequently, as shown in Box 1, evidence plays a small part in the decision-making process.

Before the evidence-based revolution in medicine, 'experts' produced guidelines for the management of particular conditions, which were sometimes based on research evidence, but could also be based entirely on an individual experience or opinion. We are guilty of providing similar advice in conservation [11]. We would expect that many guidelines are right, whereas others are not. For example, Karanth and co-workers found that the 'pugmark census method' advocated for monitoring abundance of tigers in India over the past 30 years does not work [12]. The real problem is that there is no way of distinguishing with the current systems between guidelines or using the experience of individuals to improve future management.

A major thrust of much recent conservation work has been to incorporate socio-economic development, but many of the practices seem based upon faith and a political agenda rather than on the benefits to biodiversity. As examples, does clarifying who owns the property rights to each area result in long-term sustainable development or overexploitation? Does providing alternative sources of income (such as schemes for producing honey) reduce the need to exploit natural resources, act as an additional activity with neutral effects, or provide the extra income

that enables investment, such as purchasing a chainsaw or vehicle, that further accelerates resource loss? Does using reserve profits to provide facilities, such as schools, reduce conflict by increasing the respect for the reserve or increase the pressure by making that particular village especially attractive to live in? These are key issues in global conservation. In practice, however, even obtaining project reports is often very difficult.

Most aspects of conservation would benefit from the explicit use of evidence, including release schemes, habitat management, restoration, and education programmes. Policy measures should also be based on evidence. Are management plans effective? What determines whether a given scheme, such as a fishing regulation, is adhered to? What works in altering political decisions?

Support for decision making in conservation could benefit from following the medical model through the production of systematic reviews of evidence on the effectiveness of interventions in achieving stated objectives [13]. Evidence could then be disseminated in a form similar to the web-based database of systematic reviews on effectiveness in medical practice (<http://www.cochrane.org/>). A good systematic review would follow strict criteria for assessing the quality of the data in each study – a process called 'critical appraisal'. A 'hierarchy' of evidence is commonly used within medicine, where the findings of studies using strict experimental designs are accorded greater weight than those having no comparison or 'control' elements. But, herein lies the problem. Medicine differs markedly from conservation in that research can be more straightforward and is much better resourced. An analysis can be based upon large sample sizes of several hundred patients and there are more randomized controlled trials upon which to base decisions. Conservation does have its equivalent research, but there is far less of it and there are far more conservation options (e.g. there are thousands of invasive species). Although much of current practice lacks controls or replicates, the accumulated knowledge of all individuals could be extremely useful. The essence of the problem is that each individual only has limited experience of the outcome of an intervention. Each of these experiences can be thought of as a single data point. The experience of each individual is minuscule compared with the total experience of all practitioners.

A good example of how this type of evidence can be applied to conservation comes from captive breeding. Zoos collate information regularly about breeding success and survival, but the problem is that each zoo exhibit is a single data point only. A keeper with a single exhibit will find it difficult to determine the requirements of the species. A meta-analysis comparison [14] across all Humboldt penguin *Humboldt spheniscus* exhibits in the UK showed considerable differences in breeding success and survival. These differences were related to differences in management. The analysis showed that adult survival was greater if there was no chlorination and if the penguins were kept in single-species exhibits. The chick productivity per pair was also shown to be higher if there were more pairs, if the pool was large, if the enclosure was concrete and if sand/gravel was provided as a nesting material rather than twigs or vegetation. This example illustrates the

importance of bringing together all the information because the collation of information from numerous individuals can be used to assess patterns that are impossible for an individual alone to assess. The problem is to collate the results of individual experience in a form that can be used both directly by other practitioners and in systematic reviews.

Suggested solutions

Our main suggestion is for a central database (Box 2) of the information on conservation practice. This database would include information from any level, from randomized, replicated and controlled experiments to the response to a single uncontrolled intervention. The former are scarce in conservation biology and most information will comprise a given treatment and a description of the outcome. The outcomes will sometimes be quantified, but qualitative information will also be used. One way in which this database would be used would be for individuals to examine all the cases in which others had dealt with a similar problem. In practice, when given informal advice, it is usually difficult to check the source. Surely, it is beneficial to be able to examine all cases and form a judgement as to which are similar and assess the generality of the outcomes. Another way in which the database would be used is as a source for systematic reviews of evidence on a particular management intervention. Qualitative evidence is incorporated increasingly in systematic reviews in subject areas in the social sciences, where quantitative evidence is scarce (e.g. see <http://www.campbellcollaboration.org/>) Collating individual experience into a substantial dataset effectively combines experience to form a body of evidence that could be used in this way.

Effective use of evidence will require a fundamental restructuring of practices. A change in attitude is also required so that the documenting of practices and the

evaluating of effectiveness is an integral part of all conservation projects. If every conservation practitioner were to annually document, say, two activities and their outcome and make this information available, then we would rapidly acquire an invaluable database. Conservation organizations could then make this documentation a standard part of expected practice and incorporate it within work plans and staff assessment.

Our experience from discussions with conservation organisations is that there is an appreciation of the need to make greater use of evidence, and thus they are likely to support and fund such websites.

Evidence-based conservation also needs to be incorporated within policy. Our second suggestion is that Biodiversity Action Plans and management plans should incorporate the process of collating and reviewing evidence as a fundamental component. Moving closer to an evidence-based model is challenging and, in our view, requires the commitment of statutory and charitable organizations just as it did in medicine. Many non-governmental organizations with conservation objectives seek grants from, and agreements with, the statutory bodies to fund their actions. A clear policy within statutory organisations of promoting evidence-based practice would encourage non-governmental organizations to justify their actions by citing evidence. The production of systematic reviews could either become a function of statutory bodies or be commissioned. Evidence-based medicine has spawned centres for the production and dissemination of systematic reviews and the support mechanisms for conservation could develop in the same way. New developments and reviews could be disseminated in newsletters (the equivalent of 'Effectiveness matters' in medicine). This method of making the requisite connections between science and practice has been shown to be highly effective in medicine and public health.

Concluding remarks

Considerable sums are being spent on conservation and there are proposals for considerable investment in habitat restoration. Not being able to show that there is sufficient knowledge of effectiveness, combined with not testing whether the management works, must weaken the case for investment greatly. We believe that a greater shift to evidence-based conservation would not only be highly effective, but is also likely to result in enhanced funding by actively demonstrating this effectiveness to funders and policy formers. However, our proposals require a radical shift in the way that much conservation work is carried out, and whether these proposals will work depends upon whether organisations and site managers are prepared to make the assessment of effectiveness a routine part of the way they work.

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Box 2. Suggested structure for evidence-based websites

The execution of a shift to collating evidence is probably best achieved by the establishment of a website, or perhaps a series of sites, covering different aspects such as habitat management, control of introduced species, captive breeding and integrated conservation development projects. The site that we envisage for habitat management would comprise a searchable database including the following fields:

- Country
- Site name (leading to a file describing site)
- Name and organization of contributor
- Major habitat category (from menu)
- Habitat detail (e.g. dominant plant species)
- Type of problem (menu)
- Species involved
- Broad conservation action (menu)
- Detailed description of action (including description of any replication and controls)
- Consequences of action, including problems. This could be data and analyses or simply a subjective opinion.

The easiest way to establish this website would be by extracting results from papers and reports using the systematic review process, and then by speaking to practitioners and encouraging them to use the website and contribute.

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