J. Nat. Conserv. 11, 83–90 (2003)

http://www.urbanfischer.de/journals/jnc

Journal for
Nature Conservation

Support for decision making in conservation practice: an evidence-based approach

Andrew S. Pullin[1,*] & Teri M. Knight[2]

[1]School of Biosciences and [2]Health Services Management Centre, The University of Birmingham, Edgbaston, Birmingham B15 2TT, UK; e-mail: a.s.pullin@bham.ac.uk

Abstract

Conservation managers are challenged with the task of compiling management plans in which they have to decide on appropriate actions to meet specific objectives. We argue that support for such decision-making is poor and that decision-makers have little opportunity to capture and evaluate the evidence for effectiveness of alternative management options. The result is that decisions are often made without access to the best quality evidence thus increasing the probability that inappropriate management options will be adopted. The aim of this paper is to propose a mechanism for increasing support by improving information flow to decision-makers within an evidence-based framework. The model of evidence-based practice in medicine and public health is used to explore possibilities for parallel practice in conservation. The processes of management plan and action plan formulation are used as examples of how this model provides opportunities to enhance information flow between scientists and practitioners and to encourage formation of productive partnerships and decision support systems, thereby improving effectiveness. Accessibility of evidence is a key issue addressed through the production of systematic reviews and their results being actively disseminated, in a usable format, to the point of need. The role of funding bodies and particularly governments in catalysing this process is seen as key to achieving more evidence-based conservation practice.

Key words: Conservation management, conservation policy, biodiversity management, decision support, evidence-based practice.

Introduction

In Europe and increasingly in other continents, conservation action seeks to maintain communities characteristic of semi-natural and disturbed habitats, resulting from long-term human occupation of the land (Spellerberg et al. 1991). This strategy requires active management of landscapes, reserves, habitats and species. Consequently, a key element of the conservation process has been the Management Plan (we use this term in a broad sense here to include Species and Habitat Action Plans as well as Reserve Management Plans) in which objectives are set for the subject of the plan and actions are proposed to meet those objectives, often within a specific time frame. Site-based managers are often the key decision-makers in this process, deciding on appropriate actions based on the information and experience available to them.

In the absence of appropriate scientific evidence or of realistic management alternatives, the dominant approach has been to mimic (or at least attempt to) the traditional management practices, such as grazing regimes, harvesting and coppice rotations, that created the communities of conservation concern. The development of conservation practice has thus been largely experienced-based in that management actions or regimes have been passed on from individual to individual as the accepted traditional method of maintaining a habitat

*corresponding author

1617-1381/03/11/02-083 $ 15.00/0

or species. Whether or not this management is optimal for the conservation objectives is an issue that the manager rarely has the opportunity or information to address. It is widely recognised that these traditional practices were not originally undertaken for conservation objectives but were usually for agriculture, forestry or game management. Nor have they been static, but have evolved over time and are still evolving as land managers continue to find new methods and technologies as well as new objectives (Harvey 1995).

The basis for making decisions may not be of significance if the management objectives are being met, but we are increasingly faced with a world of rapid change and conservation management is unlikely to be an exception. We will be more frequently faced with difficult management decisions in which it will be vital to know what works and what doesn't in terms of delivering objectives. Sutherland (2000) has pointed out that practical conservation is not well supported by background knowledge and is largely based on anecdotal evidence. This leads to development and acceptance of dogma that can be wrong, for example in reedbed management (Cowie et al. 1993; Ditlhago et al. 1993) and winter flood management for wading birds (Ausden et al. 2001) and this inhibits the development of scientific management and effective project planning. A similar problem results from the misuse of a management concept when its application is interpreted too generally. This has been the case with the planning and formation of wildlife corridors (Simberloff et al. 1992).

Despite the above examples, it is not our contention that experience-based practices are necessarily inadequate but, in order for decision-makers to properly evaluate their practices and choose the best options, they require the supporting information to be made readily available to them in a useable format.

Clearly, a related issue is whether any substantial relevant information exists at all. A support mechanism for decision-making also needs to identify inadequacy of information, highlighting where evidence needs to be acquired through appropriate research and monitoring practices. The Biodiversity Action Plan (BAP) process arising from the Convention on Biological Diversity (1992) seeks to develop national strategies or plans for the conservation and sustainable use of biological diversity. This process has been rapidly implemented and gathered pace in some countries such as the UK (UK Government 1994), but research providing scientific evidence for the effectiveness of proposed actions has lagged far behind. A five-year review of the UK Biodiversity Action Plan identified additional research and survey as the top priority aid to Action Plan implementation (UK Government 2001). Requirement for research was identified in 87.5% of UK Habitat Action Plans and 83.2% of Species Action Plans. Species and Habitat Action Plan formats encourage the gathering together of the literature on the relevant ecology and conservation but they do not explicitly require the compilers to justify their proposed actions by citing evidence for their effectiveness. The formidable resource constraints within conservation have meant that managers and their organisations have concentrated on short-term continuity of action rather than assessing their long-term effectiveness. This is partly because the scientific information is lacking or inaccessible, but also because the link between science and practice is not formalised. This may be set to change as the success of Action Plans in achieving their targets is reviewed. The five-year review (UK Government 2001) concludes that the BAP process is already a short-term success but that these successes could be replaced by long-term failure if the scientific evidence to underpin effective management is lacking.

Müssner & Plachter (2002) have argued for the development of methodological standards in nature conservation using the example of landscape planning. In this paper we argue that the evidence-based framework, as used successfully in medicine and public health, provides a methodological standard for decision-making, providing significant benefits both in efficient provision of existing information and in identifying areas where further research is required. We detail a mechanism for improving information provision that incorporates and evaluates, through the systematic review process, the sources of evidence that currently inform conservation practice and for actively disseminating the results to the point of need.

Decision support through the evidence-based framework

Pullin & Knight (2001) introduced a framework for evidence-based conservation, derived from that established in medicine and public health. The evidence-based framework relies on; (a) the production of systematic reviews of the primary literature, which evaluate the evidence (including its quality) for the effectiveness of alternative actions in achieving stated objectives and then (b) making this information available to decision-makers through active dissemination.

The basic steps that the decision-maker follows within this framework are thus;

- ask an answerable question;
- appraise the evidence provided for them (instead of searching for it themselves);
- modify action in response to the evidence;
- monitor and evaluate the new action;
- actively disseminate knowledge and share learning.

Superficially, this may seem little different from the established 'adaptive management' approach widely used in ecosystem and natural resource management (Walters 1986), the principle of which is to treat all management as an experiment, evaluate the results and adapt your action accordingly. The additional value of evidence-based practice is that it provides information on which to base the initial decision thus reducing the 'learn by your mistakes' element. It therefore adds more structural support to the adaptive management model. Evidence-based practice also embraces, through its systematic review process (see below), the many and varied sources of information that currently exist and is not in conflict with current management systems that already explicitly use scientific evidence in the planning process.

There are two compounding problems of information flow that inhibit progress toward evidence-based conservation practice that find their solution in the way that evidence-based practice has developed in medicine and public health (the EBM model).

- Problem 1: delivering scientific evidence into practice, arises when good quality evidence does not reach and get incorporated into the management decision-making process; and
- Problem 2: information flow from managers to scientists and funding bodies, arises when management problems or needs are not highlighted as subjects for future research in a formal framework that commits anybody to action to provide the relevant evidence.

To solve these problems, mechanisms are needed to bring scientists and practitioners closer together and to increase the flow of information in both directions. Practitioners need to be able to tell scientists what their most pressing problems are and scientists need to be able to effectively communicate possible solutions. Evidence-based practice within medicine and public health provides a sophisticated system for dissemination of research evidence of effectiveness, designed to get evidence into practice, management and policy-making. The EBM model thus supports the practitioner and manager and encourages the use of evidence, when available, in the decision-making process. Complementary to this process, practitioners and managers identify where evidence of effectiveness is lacking, be this for a medical treatment, surgical procedure or public health intervention. Funders prioritise these and thus research is commissioned which seeks to address these questions. The application of the EBM model in conservation is explored in detail below.

Delivering scientific evidence into practice

The arrival of the systematic review was a major step forward in 'getting research into practice' within medicine. Systematic reviews seek to obtain good quality data from rigorously conducted scientific research into the effectiveness of a specific action and to combine the findings in an appropriate way so as to provide a sound basis for decision-making. A systematic review will have an explicit 'search strategy' for locating relevant research, both published and unpublished and will then follow strict criteria for assessing the quality of the

Table 1. Hierarchy of quality of evidence based on the type of research undertaken. Modified from Stevens and Milne (1997) for conservation use.

Category	Quality of evidence – Medical	Quality of evidence – Conservation
I:	Strong evidence obtained from at least one properly designed; randomised controlled trial of appropriate size.	Strong evidence obtained from at least one properly designed; randomised controlled trial of appropriate size.
II-1:	Evidence from well designed controlled trials without randomisation.	Evidence from well designed controlled trials without randomisation.
II-2:	Evidence from well designed cohort or case-controlled analytic studies, preferably from more than one centre or research group.	Evidence from a comparison of differences between sites with and without (controls) a desired species or community.
II-3:	Evidence obtained from multiple time series or from dramatic results in uncontrolled experiments.	Evidence obtained from multiple time series or from dramatic results in uncontrolled experiments.
III	Opinions of respected authorities based on clinical evidence, descriptive studies or reports of expert committees.	Opinions of respected authorities based on qualitative field evidence, descriptive studies or reports of expert committees.
IV	Evidence inadequate owing to problems of methodology e.g. sample size, length or comprehensiveness of follow-up or, conflicts of evidence.	Evidence inadequate owing to problems of methodology e.g. sample size, length or comprehensiveness of monitoring or, conflicts of evidence.

data in each study – a process called 'critical appraisal' (Dawes 2000). A 'hierarchy' of evidence is commonly used for such appraisal, where the findings of studies using strict experimental designs are accorded greater weight than those that have no comparison or 'control' elements. We have modified this hierarchy for use in conservation in Table 1. Studies that do not meet the required quality standards are likely to be excluded. The data from acceptable studies are then combined in a meaningful way, the result being a more powerful and reliable assessment of the effectiveness of the action than might be obtained from a single study or non-systematic review. An impressive infrastructure for systematic reviews has developed within the health field and central to this is the Cochrane database of systematic reviews (e.g. www.cochrane.de/). This is an essential element in the active information dissemination system referred to above. Various groups around the world, many in the UK, undertake systematic reviews of specific topics and the results of these are entered into the Cochrane database. Results are also disseminated through other means such as the 'Effectiveness Bulletin' series of reports and other publications that are delivered to managers and practitioners. The strategy is one of providing 'push access' to information, rather than the more traditional 'pull access', that relies on the manager actively seeking the information. The effectiveness loop is closed when policy-makers require managers and practitioners in public health and medicine to prioritise spending of public money on actions of proven effectiveness. The production of systematic reviews and dissemination of the findings is funded by government agencies and other bodies but it is notable that the Cochrane Collaboration which began the process was and still is, very much a voluntary endeavour, driven by the desire of practitioners to do the best job they can.

In conservation, scientific evidence is often available, but the framework is not there to ensure that it is used in the planning process. There is no general mechanism by which managers are encouraged to justify their plans by citing scientific evidence, although specific examples exist such as the legal requirement under the U.S. Endangered Species Act. Prendergast et al. (1999) take the example of reserve selection to emphasise the abundant theory and sophisticated tools that exist, in contrast to the obvious lack of its use in practice, largely because the potential end users are unaware of its existence. Their proposed solution is an improvement in communication and therefore understanding of the issues.

We see no significant barrier to the dissemination of conservation information following the medical model in the form of a web-based information system. Similar systems already exist in conservation such as the UK's National Biodiversity Network and the majority of conservation managers now have easy access to web-based information. News of new developments and reviews could be disseminated in newsletters (the equivalent of 'Effectiveness Matters' or 'Bandolier' in healthcare). 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 is the same way.

Information flow from managers to scientists and funding bodies

Practitioners as decision-makers are faced with questions to which they would like to see answers but are these questions the same as those being asked by scientists who might seek to find the answers? Swain et al. (1996) compared the questions being asked by Florida conservation managers with the sorts of questions addressed in papers published in the journal Conservation Biology. There was a clear mismatch between the two with more questions asked by practitioners on the nature of threats and ecological processes compared with the subject of scientific papers on reserve selection and design and management of small populations. Of particular note was the practitioner's need for information on the management of semi-natural systems (ranching, silviculture and old field management), a sentiment that would almost certainly be echoed in Europe (grazing, coppicing and mowing).

Management plans could be pivotal to this process of prioritising of research as they are most commonly produced for species, habitats or reserves and set out the course of action over a specified period and the monitoring necessary to evaluate progress in achieving objectives. Just as it is the construction and approval process of management plans that offers the best opportunity for achieving evidence-based conservation practice (see below) it is also an opportunity for identifying areas where scientific research is required. Most action plans contain statements on future research and monitoring requirements but most are not (fully) costed or assessed for feasibility so that it is unlikely that the research will be possible under current circumstances.

NGOs are action-oriented and there is pressure on them to show that they are doing something with the supporter's money. Longer-term research and monitoring inevitably take a back seat. The evidence-based framework encourages the identification of research needs within management plans since greater access to information enables easier identification of information

deficiency. Most management plans also contain an 'Objectives and Targets' section. These have to date primarily been used to set conservation targets but, in our view, these should also contain targets for accumulation of evidence where more is clearly needed (this is almost always). The evidence-based framework requires, within planning process, identification and costing of research needs and the feedback of this requirement to potential funders and the research community. Using the framework will therefore help those proposing action to deal with lack of evidence and set objectives to obtain the evidence, rather than simply carrying on with the *status quo*. Just as importantly, it should encourage formation of working partnerships between scientists and practitioners and ensure that more actions taken in the absence of evidence are evaluated in a properly controlled experiment so that a future review of the plan can assess the outcome and make appropriate revisions. Development of established computer database packages for conservation managers, such as the Conservation Management System (CMS), could help significantly in this process. The CMS encourages managers to record their actions and monitor the outcomes (www.cmsp.co.uk). If research needs of a large number of managers could be systematically compiled and fed back it would form a useful database on which to base future research priorities.

Development of two way information flow into productive partnerships

Realising better support mechanisms for decision making requires concerted action on a national or international level to ensure the evidence-based framework is implemented. So what body should oversee this process? This will clearly vary across nations and we only use the UK as a national example. In the UK the conservation action is increasingly driven through the BAP process, organised at government level through the Department of Environment, Food and Rural Affairs (DEFRA). DEFRA provides advice and guidance to encourage the production of action plans for priority habitats and species and the identification of a Lead Partner for each. The guidance and approval process could be relatively easily modified to promote evidence-based conservation practice. A direct strategy might be to encourage organisations that fund conservation action (governmental and non-governmental) to promote evidence-based practice as a methodological standard and use it as a criterion when deciding on allocation of resources. Many governmental organisations, such as English Nature, manage for conservation through their ownership of nature reserves, act as policy maker through their role as advisor to government, and as grant provider for both research and management. Pullin & Knight (2001) suggest that these and equivalent organisations are thus in a unique position to do the following:

1) formulate policy on evidence-based action;
2) identify priority areas for systematic review and provide appropriate funding;
3) commission the appropriate research where evidence is found to be lacking by the systematic review process; and
4) set minimum standards of conservation practice for grants given and promote this among practitioners.

Many non-governmental organisations with conservation objectives seek grants and agreements with the statutory bodies to fund their actions. A clear policy promoting evidence-based practice could encourage such organisations to justify their actions by citing evidence, particularly if flow of resources for the plan was consequent on the above. But this strategy is unlikely to be effective unless the funding organisations first put in place the framework to support evidence-based decision making. The support for change in practice must come first. This should be a consultative process and thus open, constructive and supportive.

A stepwise process for the production of a generalised action plan that encourages evidence-based practice is shown as a flow diagram in Figure 1. This is presented as a generic and adaptable process that can form the basis for many types of action that may look very different in their final form (e.g. Reserve Management Plans, Species and Habitat Action Plans). The first three steps are straightforward and unchanged from most current action plans in identifying the subject, the need for action and objectives. A key addition is the fourth stage where evidence for the action's effectiveness is assessed through systematic review and made available to potential users. With this information the compilers must decide if there is sufficient evidence to simply undertake this action or, if there is insufficient evidence of effectiveness, how the action will be pursued so as to test its effectiveness (usually in the form of a research programme or experiment; see below). Crucially the latter does not mean that the actions are delayed as long as they are judged to be the best option, only that they should be undertaken in a provisional and precautionary way until their effectiveness has been demonstrated. Proper monitoring and evaluation of the actions can then lead to the progression to the next stage of actions through a periodic review process.

The need to include a research element in actions plans and find somebody to do it can lead to more substantial collaborations. A possible output is for the scientific community to provide a decision support system (DSS) to practitioners providing information that

will help them make decisions both in formulating action plans and also in the management process during the operation of the plan. A DSS is a well-established management tool that supports decision-making in complex systems. Broadly defined, it is an interactive computer-based system that helps decision-makers use data and models to solve unstructured or ill-structured problems (Sprague & Carlson 1982). In conservation applications it can act as an interface between the scientist and the practitioner. The scientist feeds information into the DSS as it becomes available and the practitioner uses the DSS as a tool kit in making decisions

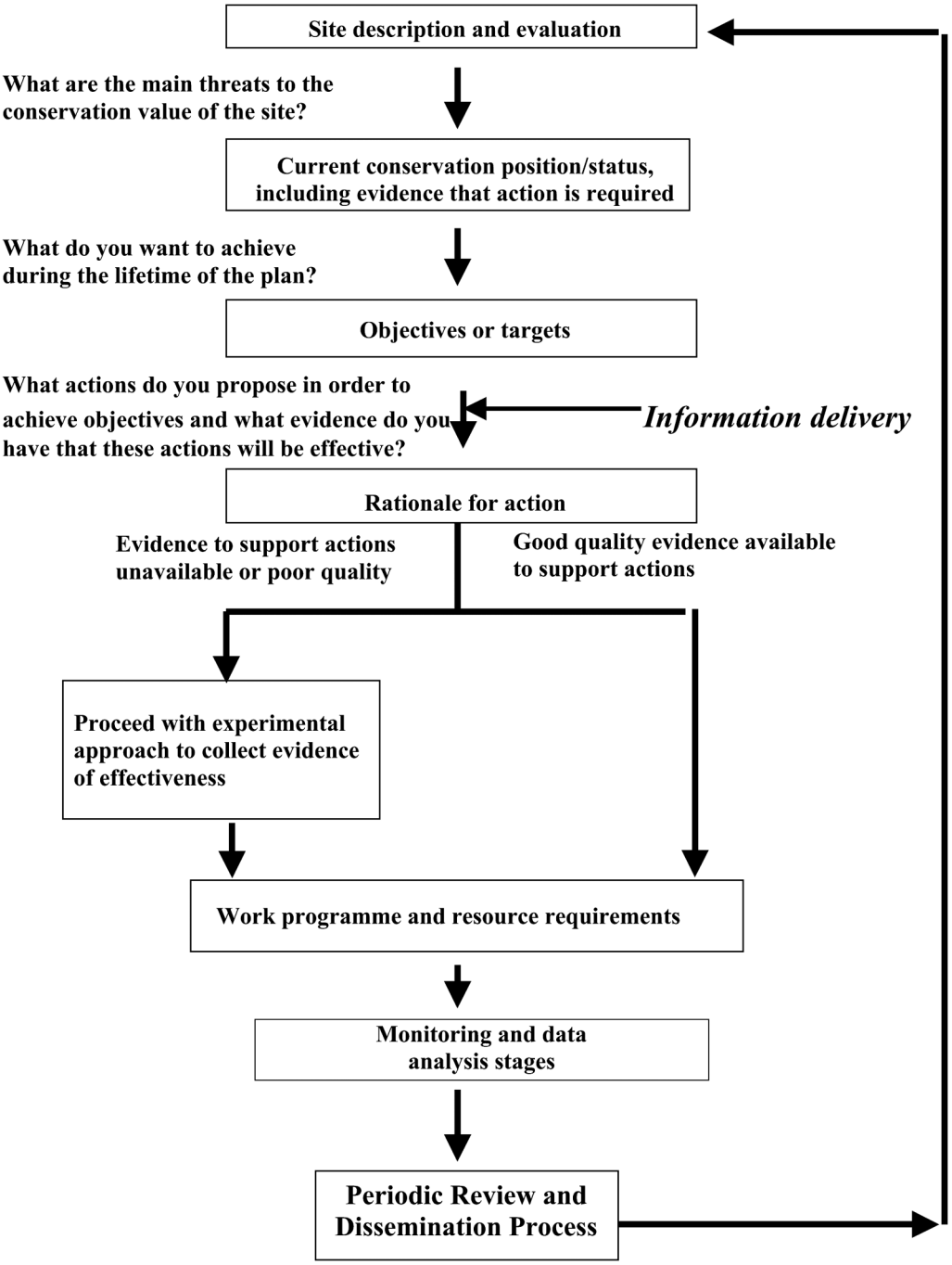

Figure 1. A flow chart summarising the steps in the process of constructing an action plan using an evidence-based approach. The process involves evaluation of evidence delivered to the decision-maker through systematic review and active dissemination (information delivery) and encourages collection and recording of evidence when it is found to be lacking.

and solving problems in everyday management. This type of approach is being used in the Kruger National Park in South Africa in their Kruger Rivers Programme. Here the challenge is to be able to predict and monitor effects of changes in river hydrology on the biodiversity in different sections of the river catchment. A DSS has been constructed that feeds ecological information in to the process of management at all key stages of decision-making. The DSS is used to help in the key areas of setting objectives for management, predicting the outcomes of management actions and in monitoring the response of the system to management actions and natural events (Rogers 1997). This approach has considerable strengths but it does assume that partnerships between scientists and practitioners have already been formed around a common challenge. The requirement for a two-way flow of information in the formulation and review of action plans will in itself form partnerships that can enable such plans to develop into a DSS.

Conclusions

A large and rapidly growing body of scientific evidence is available to inform conservation practice but as yet this has had a limited influence due to the lack of a framework that supports decision-making by delivering information in an integrated and accessible way. The evidence-based practice model not only provides the mechanism to overcome this problem but also facilitates a two-way flow of information that could encourage more appropriate targeted research to meet the needs of decision-makers.

As Müssner & Plachter (2002) have pointed out, the proposed introduction of methodological standards will result in arguments such as; 'nature is too complex for such standardisation', including both moral and cultural interpretations, and; 'the skills of practitioners are sufficient to ensure the standard of conservation actions'. We echo their response in that evidence-based practice does not seek to standardise nature but

Table 2. The possible paradigm shift of conservation practice enabled by an evidence-based approach. Adapted from the paradigm shift experienced in health care (Walshe & Rundall 2001).

	From	To
Research strategy	No national leadership of conservation research; funding fragmented across many research funders with poor communication and coordination.	Strategic leadership at a national level; coordination of research activity and funders resulting in a more coherent research agenda.
Research direction	Researcher-led; tied to academic agendas; little coordination.	Needs-led; tied to conservation priorities; well coordinated.
Research quality	Much ad hoc, piecemeal, small scale, variable quality research, sometimes repetitive; not well managed.	Coherent research programs made up of well-planned and funded research projects of high quality.
Research outputs	Publication in peer-reviewed academic journals seen as researchers' primary goal.	Changes in conservation practice seen as primary reason for research with publication as one step toward that goal.
Dissemination of research findings	Journals, textbooks, expert opinions and narrative reviews.	Online databases, summaries of evidence, management guidelines, systematic reviews.
Mode of access to research findings	'Pull' access, reliant on decision-makers seeking information by accessing libraries, journals, databases etc.	'Push' access, with relevant research findings delivered to decision-makers proactively.
Decision-makers understanding of research findings	Dependent on integration of information from individual research studies.	Provided by meta-analyses and systematic reviews of relevant appraised research.
Decision-makers attitudes to research	Relatively uninformed, often suspicious of methods and motives and/or lacking time for research appraisal and interpretation.	Informed, accustomed to using and participating in research and applying it to own practice.
Major influences on conservation practice	Personal experience, precedent, tradition and expert opinion.	Empirical evidence, ecological research.
Responsibility for implementing research findings.	Left to individual decision-maker with little corporate involvement.	Seen as key organisational function, supported by investment in information resources with corporate involvement in decision-making.

simply to standardise methodology, and, although we do have a very skilled and dedicated workforce in conservation, that workforce still requires the best support we can provide and in a conservation arena of rapidly expanding and diversifying actors we need to ensure that appropriate standards of practice are maintained.

A common criticism of methodological standards is that they create hurdles of bureaucracy that inhibit or delay action. In contrast, the evidence-based framework will help speed up decision-making by providing the best quality information to the decision-maker. Clearly the absence of good information should not inhibit the production of a Management Plan or the taking of action and the evidence-based framework does not encourage this, but searching for information that does not exist may well delay action, a scenario that the framework seeks to avoid.

There are undoubtedly significant challenges in embracing the evidence-based model in conservation, but these challenges are mostly positive ones related to support for decision-making, establishing greater links between science and practice, undertaking research that is more relevant to the needs of managers and establishing methods of making information more accessible. Additionally, the benefits of the paradigm shift that has been achieved in medicine would also bring significant benefits for conservation practice. Some benefits are detailed in Table 2 and summarise many of the points made in this paper. Perhaps the most significant are the shift to more needs-led agendas and the greater emphasis on provision of information resources to proactively feed evidence to decision-makers.

Conservation management is a continuous process that needs to constantly adapt to changing conditions and new challenges (Mace et al. 1998). A framework within which a two-way flow of information is inherent in the formulation of management plans and helps to build partnerships to support future evidence-based actions could in our view produce substantial gains in the effectiveness of conservation. Perhaps most importantly, evidence-based conservation provides a methodological standard in conservation that will increase credibility with funders and policy formers.

Acknowledgements: The authors would like to acknowledge the support of English Nature under contract CST40/05/008.

References

Ausden M, Sutherland WJ & James R (2001) The effect of flooding lowland wet grassland on soil macroinvertebrate prey of breeding wading birds. Journal of Applied Ecology 38: 320–338.

Cowie NR, Sutherland WJ, Ditlhago MKM & James R (1993) The effects of conservation management of reed beds: II the flora and litter disappearances. Journal of Applied Ecology 29: 277–284.

Dawes M (2000) Evidence Based Practice. Health Service Journal Monographs No. 1: Emap Public Sector Management Publications, London.

Ditlhago MKM, James R, Laurence BR & Sutherland WJ (1993) The effects of conservation management of reed beds: 1 the invertebrates. Journal of Applied Ecology 29: 265–276.

Harvey HJ (1995) The National Trust and nature conservation: prospects for the future. Biological Journal of the Linnean Society 56(suppl.): 231–248.

Mace GM, Balmford A & Ginsberg JR (1998) Conservation in a Changing World. Cambridge University Press, Cambridge.

Müssner R & Plachter H (2002) Methodological standards for nature conservation: case-study landscape planning. Journal for Nature Conservation 10: 3–23.

Prendergast JR, Quinn RM & Lawton JH (1999) The gaps between theory and practice in selecting nature reserves. Conservation Biology 13: 484–492.

Pullin AS & Knight TM (2001) Effectiveness in conservation practice: pointers from medicine and public health. Conservation Biology 15: 50–54.

Rogers KH (1997) Operationalizing ecology under a new paradigm: an African perspective. In The ecological basis of conservation, (eds STA Pickett, RS Ostfeld, M Shachak & GE Likens): 60–77. Chapman & Hall, New York.

Simberloff DS, Farr JA, Cox J & Mehlman DW (1992) Movement corridors: conservation bargains or poor investments? Conservation Biology 6: 493–505.

Spellerberg IF, Goldsmith FB & Morris MG (eds) (1991) The Scientific Management of Temperate Communities for Conservation. Blackwell, Oxford.

Sprague RH & Carlson ED (1982) Building Effective Decision Support Systems. Prentice-Hall. New Jersey.

Stevens A & Milne R (1997) The effectiveness revolution and public health. In Progress in Public Health (ed G Scally): 197–225. Royal Society of Medicine Press, London.

Sutherland WJ (2000) The Conservation Handbook: Research, Management and Policy. Blackwell, Oxford.

Swain HM, Gordon DR, Brennan LA & Fitzpatrick JW (1996) Ecologists as problem solvers? Well what are the important problems? Developing priorities for conservation biology research in Florida. Supplement to the Bulletin of the Ecological Society of America 77: 432.

UK Government (1994) Biodiversity: The UK Action Plan. HMSO, London.

UK Government (2001) Sustaining the Variety of Life: 5 Years of the UK Biodiversity Action Plan.Department of Environment, Transport and Regions, London.

Walters CJ (1986) Adaptive Management of Renewable Resources. Macmillan, New York.

Walshe K & Rundall TG (2001) Evidence-based management: from theory to practice in health care. The Millbank Quarterly 79: 429–457.

Received 19. 08. 02
Accepted 02. 12. 02