Effectiveness in Conservation Practice: Pointers from Medicine and Public Health

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Abstract: *Practical conservation activity is increasing globally and is being undertaken by many different government and nongovernmental organizations. In the majority of cases, justification for proposed actions is experience-based rather than evidence-based, action is often taken without monitoring or evaluation of effectiveness, and results are rarely widely disseminated. Conservation has been compared with medicine as a crisis discipline in which action is often required urgently in the absence of good information. The practice of medicine has recently gone through an effectiveness revolution that has improved the criteria upon which treatment strategies are based by progressing from reliance on personal experience to reliance on scientific evidence. We draw parallels between medicine and conservation and present a practical framework to encourage evidence-based conservation action. Our rationale is that conservation actions for which scarce resources are sought should be justified by good scientific evidence. In our view this will also encourage more research addressing practical issues in conservation management.*

Efectividad de la Conservación Práctica: Indicadores de Medicina y Salud Pública

Resumen: *La actividad de la conservación práctica está incrementando mundialmente y está siendo emprendida por muchas organizaciones gubernamentales y no gubernamentales. En la mayoría de los casos la justificación de acciones propuestas está basada en la experiencia y no en evidencias, la acción es frecuentemente tomada sin monitoreo o evaluación de la efectividad y los resultados son rara vez diseminados ampliamente. La conservación ha sido comparada con la medicina como disciplinas críticas donde la acción es frecuentemente requerida con urgencia en ausencia de buena información. Recientemente la práctica de la medicina ha atravesado una revolución de efectividad que ha mejorado los criterios sobre los cuales se basaban las estrategias progresando de la confianza en la experiencia personal a la confianza en la evidencia científica. Nosotros trazamos paralelos entre la medicina y la conservación y presentamos un marco de trabajo práctico para alentar acciones de conservación basadas en evidencias. Nuestro razonamiento es que las acciones de conservación para los cuales se buscan escasos recursos deberían ser justificadas por buenas evidencias científicas. En nuestra visión esto también alentaría más la investigación enfocada en asuntos prácticos de manejo conservacionista.*

Introduction

Conservation has won considerable support over the last few decades to the extent that it now appears on many political agendas. In many countries there are increasing funds for conservation action from government and nongovernmental sources. Projects marketed under the banner of conservation emanate from many and varied quarters and gain support from an increasingly sympathetic public. Along with the science of conservation biology, conservation practice has come of age. A significant gap remains between science and practice, however, which results in many actions being taken in the name of conservation that have not been tested or monitored, leaving questions about whether objectives have been achieved.

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Two consistent problems in conservation biology are the difficulty of converting scientific knowledge into conservation practice (Pickett et al. 1997) and lack of monitoring and evaluation of conservation actions, particularly management plans. As conservation biologists, we must be concerned that our actions are supported by the best available evidence. Conservation practitioners are commonly faced with situations where action is needed but where information about the system with which they are dealing is inadequate or conflicting. Equally, conservation practitioners may be unaware of or disinclined to search for available evidence. The result is that the majority of conservation actions are experience-based, in that they are based on personal experience or disseminated information illustrating that they have worked before, rather than evidence-based, or based on scientific experimentation indicating that they are effective. Experienced-based action is not necessarily bad, but it is less likely to be effective and does not provide a framework upon which knowledge can develop.

Unfortunately, making the relevant evidence available to the practitioner has proved part of the problem of moving from experience- to evidence-based practice. When scientific evidence is available, there is no framework to ensure that it is used in formulating management plans. There is no general mechanism by which managers are challenged to justify their plans by citing scientific evidence (although specific examples of this exist, such as the legal requirement under the U.S. Endangered Species Act). We put forward a possible framework, developed for the practice of medicine and public health, for encouraging the use of evidence-based management in conservation. This model can both improve standards of conservation action and encourage appropriate research.

Practitioner versus Scientist

Rogers (1997) views it as essential that the way scientists operate in ecology and the way managers operate in conservation must generate mutual understanding and respect. Ecologists operate within a rigid structure of hypothesis generation and testing rewarded through the peer-review system. This has led to development of ecological theory that has leapt ahead of (and all too often become irrelevant to) practical action and, in many cases, ahead of empirical data. The ecologist's view is far removed from the pragmatic approach of conservation managers who operate in a world of budgets, targets set out in action plans, and responsive action to avert crises.

There is no dispute that a gap exists between theory and practice in conservation, but it is disconcerting that a similar gap exists between scientists working directly in the applied field of conservation biology and conservation practitioners. Conservation needs both sets of people, and the challenge is to find a means to bridge the gap. Practitioners can hardly be blamed for carrying out management based on anecdotal evidence if the scientific research to identify the correct management action has not been done.

In the absence of evidence to the contrary, managers will inevitably fall back on "traditional" methods and personal experience. A good example of the problem is the operation of grazing management regimes for the conservation of calcareous grassland communities in Europe. These grasslands are seminatural ecosystems resulting from "traditional" agricultural practices. In the absence of good evidence on the best form of management—what stock to use, how many head of stock, and when to graze—managers rely for guidance on their interpretation of traditional practices. There are probably as many different interpretations as managers. Consequently, there is little or no consensus on effective grazing management for calcareous grasslands. Furthermore, the objectives of the traditional agriculturalist are unlikely to have been the same as today's conservation manager.

A second example of traditional management is the technique of coppicing of woodland blocks, which involves cutting trees at the base to harvest poles for fencing and basket making; the trees then regrow and are harvested on a regular cycle. Coppicing has been viewed as standard practice for maintaining open areas in woodland for the benefit of ground flora and sun-loving insects such as butterflies. The focus on these attractive but minority elements of overall woodland biodiversity has led to widespread use of coppicing, despite the fact that mature woodland contains greater species richness, especially of shade- and moisture-loving plants and saproxylic invertebrates (Southwood et al. 1979). The frequency of the coppice cycle and the distribution of coppiced patches are likely to be key factors in optimizing overall diversity within woodland blocks, but this is unlikely to figure in any current coppice management action plan because these plans are usually based on traditional, product-based cycles and patch sizes. Coppicing is even being imposed on some woodlands where it has never previously been practiced.

In an attempt to achieve consensus on such management practices in the United Kingdom, there has been increased dissemination of anecdotal (experience-based) evidence through magazines in which managers can share their experiences with management practices that usually involve a sample size of one with no control.

Effectiveness Revolution in Medicine

Because conservation is a crisis discipline it has often been compared with medicine in that decisions have to be made quickly, sometimes with incomplete knowledge of the situation or of the possible consequences of the action. Both disciplines often confront important moral

and ethical dilemmas. For centuries, because of the necessity for action, medicine has progressed by trial and error without sufficient knowledge of the human body and its diseases. The extent of medical research is vast compared with that of conservation biology, and the practice of medicine is far better developed and financially supported, yet the relationship between academic scientist and practitioner is the same. Medical practitioners seek to base their management of human health on the best available evidence.

So what can we learn from this field that can take conservation forward into a new era? In the last 20 years we have seen a revolution in the practice of medicine. This so-called "effectiveness revolution" has essentially been about the direct application to medical practice of research evidence about what does not work, what does, and at what cost (cost-effectiveness) (Stevens & Milne 1997). Such a revolution was long overdue in a profession where many commonly used treatments and procedures had never been rigorously evaluated and proven to be of "benefit." Some of the most commonly encountered concepts in this revolution are (1) efficacy—benefit (from a health care intervention) under ideal conditions; (2) effectiveness—benefit (from a health care intervention) under actual conditions of use; (3) cost-effectiveness—cost per unit benefit, where benefit is measured in units specific to the patient or population group in question; (4) cost-utility—cost per unit benefit where benefit is measured in generic terms; and (5) impact—the broad effects of a health care intervention assessed for policy purposes.

Cochrane (1972) advocated the routine use of "randomized controlled trials," (RCT) to assess the effectiveness of treatments and procedures. In an RCT, test subjects (patients) are randomly assigned to either the experimental group (new treatment) or a control group (either a placebo or the conventional treatment). Usually RCTs are performed "double blind" wherein neither the subject nor the observer knows to which group the subject has been assigned. This approach has since been widely accepted as the gold standard for such evaluation. Using this methodology whenever possible, medical academics and research funders responded with increased activity to rectify the "evidence deficit."

The next important phase of the revolution was the recognition that, despite a blossoming of appropriate research and a growing wealth of data, day-to-day medical practice in the United Kingdom was still not evidence-based. The next challenge was therefore to incorporate the results of medical research into medical practice. New institutions, journals, programs, and policy have been developed to do this. For example, the government-funded Centre for Reviews and Dissemination produces regular reports that are widely distributed among medical and public health scientists and practitioners, for example, *Effectiveness Matters* is distributed to all National Health Service (NHS) organizations. Due to the increased accessibility of such information, there are now many examples of evidence-based decisions and planning at the level of individual patient management, health services management, and local NHS policy.

Systematic Review

One important mechanism for getting to the evidence-based stage of practice is the "systematic review," a process whereby the quality and relevance of published (or unpublished) research is judged and translated into a usable format (Deeks et al. 1996; Stevens & Milne 1997). A systematic review takes the results of primary research and evaluates them. Research results (published and unpublished) on a specific topic are sought by the reviewer using a "search strategy" designed to locate as many sources of information as possible. Searching for unpublished data is important if the problem of publication bias is to be overcome.

Once a number of sources of data have been identified, they are assessed against preset criteria. One such criterion is study design. A "hierarchy of evidence" has been developed to help judge the quality of the research design (Table 1). Other criteria might relate to the way subjects have been selected (i.e., random or not) and recruited into the study and the way data have been collected and analyzed. Papers that satisfy the preset criteria are included in the review.

The systematic review is at its most straightforward when all the research studies on a particular topic have used high-quality RCT methodology (category 1). In these cases, the results of all the separate trials are combined and reanalyzed in a meta-analysis (Collins et al. 1987) undertaken with use of the raw data when available. At a minimum, the review summarizes and tabu-

Table 1. Hierarchy of quality of research evidence, judged on adequacy of experimental design (Stevens & Milne 1997).

Category	*Quality of evidence*
I	strong evidence obtained from at least one properly designed randomized controlled trial of appropriate size
II–1	evidence obtained from well-designed controlled trials without randomization
II–2	evidence obtained from well-designed cohost or case-controlled analytic studies, preferably from more than one center or research group
II–3	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
IV	evidence inadequate owing to problems of methodology (e.g., sample size, length or comprehensiveness of follow-up, or conflicts of evidence)

lates the main design features of comparable studies and their results. The reviewer notes where there is consistency or disagreement in the findings. The field has now advanced so much that there are rules for conducting systematic reviews (Deeks et al. 1996) and institutions dedicated to undertaking systematic reviews. The Cochrane Collaboration, an international network of scientists, undertakes systematic reviews using shared and agreed search strategies and "critical appraisal" checklists, and their findings are collated into the Cochrane Library database, which is widely available to both academics and practitioners.

The concepts of effectiveness and evidence-based practice have more recently spread from the discipline of medicine to the broader field of public health, which aims to promote health and prevent disease at a population level through collaboration between organizations and professional groups (Donaldson & Donaldson 1993). Thus the effectiveness revolution has now spread beyond clinical practice and affects public health policy at local and national levels. It is acknowledged widely that decision making, at the level of choice of treatment or of national policy making, should be based on high-quality research evidence of the effectiveness of the planned intervention and that evidence should be made accessible to all who need to consult it.

An Effectiveness Revolution in Conservation

We are all familiar with the prevalence of "try it and see" policies in conservation management, but we are also familiar with the way scientific research can often cloud rather than clarify issues of policy if it is not effectively communicated. Wherever the fault lies, there is a danger that lack of evidence of effectiveness undermines conservation practice and renders it difficult to argue for conservation action in the face of economic development. Because of the effectiveness revolution in medicine, we would no longer allow a doctor to embark on a new line of treatment based only on the fact that it worked on the last patient he or she tried it on. For the same reasons, we should no longer give unqualified support to conservation practices untested by proper scientific methods and justified purely on personal experience or anecdotal evidence. Experience clearly has its place in conservation and is a valued commodity, but there is a difference between using personal experience to increase the effectiveness of a specific action and promoting wider use of that action based on experience alone. The requirement for urgent action may necessitate the continuation of some experience-based practices, and achieving the highest level of evidence (Table 1) may be difficult when dealing with rare species or ecosystems, but the identification of such situations should help focus appropriate research on evaluating effectiveness. The argument that conservation activities are effective experiments in themselves does not hold if the experiment is poorly designed.

At first sight, it may appear that there are too many differences between the practices of medicine and conservation to make meaningful comparisons. The data available in medicine are much more voluminous and more focused toward a single species or system. Conservation is often about balancing a number of potentially conflicting goals when information on the best strategy is often unavailable. In fact, these are not fundamental differences in the practices but differences in scale and emphasis. Medicine also has to deal with conflicting goals, such as whether or not to use a treatment that has potentially serious side-effects. Public health deals with prediction of the effects of environmental factors on populations. Can the effectiveness framework for treatment of the human system be scaled up to provide effectiveness for the ecosystem? Can the framework be operated within current conservation infrastructures?

Analysis of the key changes brought about by the medical effectiveness revolution reveals a process by which to move conservation into an era of evidence-based action. The basic steps are as follows: (1) formulate a policy that action should be evidence-based; (2) develop and promote a method of systematic review with provision of funding; (3) identify priority areas for systematic review; (4) identify gaps in knowledge through the review process and prioritize these for research funding; (5) develop mechanisms to promote and maintain the concept of evidence-based practice among practitioners.

So how far into this process has the practice of conservation come? Good examples of reviews already exist in the literature, but they are few in number. Using the Institute for Scientific Information Science Citation Index from 1981 to 2000, we found no systematic reviews (in the strict sense given above) relating to conservation. We did find a small number of papers that contain some elements of a systematic review (Griffith et al. 1989; Dodd & Seigel 1991; Hobbs & Huenneke 1992; Bender et al. 1998; Hartley & Hunter 1998; Buckland et al. 2000; Menges 2000). We call for more systematic reviews to be undertaken and for journals such as *Conservation Biology* to encourage their publication. Furthermore, production of these reviews should be seen as good practice in government-based conservation bodies, particularly those in a position to fund conservation projects.

Conservation bodies involved in the management of land or species should examine their actions and identify priority areas for review and research by asking themselves the following questions: (1) On what evidence is this action based and in which category of quality (Table 1) does that evidence fall? (2) What is required to improve the quality of that evidence and thus the justification for the action?

So how might the encouragement of evidence-based management work in practice? Conservation managers

are not subject to the same sorts of regulation as medical or other public health practitioners, but most governments do have statutory conservation bodies that can set standards that others should follow. We use the example of English Nature in the United Kingdom, the government's conservation body for England (Scotland, Wales, and Northern Ireland have separate organizations). This organization acts as conservation manager through its ownership of nature reserves, as policymaker through its role as advisor to government, and as grant provider for both research and management. It is thus in a unique position to (1) formulate policy on evidence-based action; (2) identify priority areas for systematic review and provide appropriate funding; (3) commission appropriate research where evidence is found lacking by the systematic review process; and (4) set minimum standards of conservation practice for which English Nature grants are given and promote them among practitioners.

The last of these is the key element and should be implemented by requiring all applications for grants involving conservation action to include justification of that action by providing evidence for its effectiveness or by detailing plans to conduct proper experiments to evaluate the action. It may then be appropriate to send grant applications for some types of actions, including practical management, for independent scientific review. For similar reasons of rigor, Meffe et al. (1998) called for the establishment of an independent scientific review process to be established as part of the planning review in U.S. resource management.

Many current management activities carried out by government, charitable, and private conservation organizations lack clear scientific rationale. The activities are commonly continuations of accepted traditional practices (e.g., grazing, mowing, or coppicing) that deflect succession and retain early successional communities, often for a relatively few charismatic species. Although these actions might be appropriate, their benefit is rarely questioned and almost never evaluated. Operating within a framework that encourages actions to be evidence-based will simultaneously encourage appropriate research to provide such evidence.

Many government bodies in other countries are in a position to put this policy framework into practice and raise standards in conservation action. We propose that a significant start could be made if we applied these standards to all projects arising from government biodiversity action plans. The principle behind this is clear. Government money (or charitable donations) should not be provided for carrying out biodiversity action that has no scientific basis (or no evidence to support its effectiveness) unless appropriate trials and monitoring are built into the action. Having established this policy, government bodies like English Nature can and should promote the key elements of the framework as best practice for other grant-awarding bodies in the public and private sectors. Obviously there will be areas requiring compromise during an inevitably challenging transition phase, and the system should not be so rigid that urgent action is delayed for lack of evidence (just as in medicine), but the principle of evidence-based action should be established as a benchmark of professionalism in conservation practice.

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