Interdisciplinarity in biodiversity project evaluation: a work in progress

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Abstract

Decision-makers and managers responsible for biodiversity conservation need to prioritise between competing objectives. Summative *ex post* evaluations can provide important information on what works and what does not, and can also distinguish between actions that are cost-effective and those that are not.

Over the last 25 years, a range of methodological frameworks has been established to assist decision-makers with evaluations, but their uptake has been limited. Some researchers suggest a lack of research interest as being one factor contributing to the lack of more rapid progress in the area. In particular they suggest that interdisciplinary approaches to biodiversity project evaluation are infrequent, despite the insights that such approaches can bring.

We evaluate this assertion by examining the provenance of current research in this area. Specifically, we examine the reference lists of three recent papers concerning the summative evaluation of biodiversity conservation projects, two published in a conservation journal and one in an interdisciplinary journal. We find that, of 63 papers cited across all three focal papers, only two were cited in common by two of the three papers, and no paper was cited in common by all three papers.

Our results suggest that research in biodiversity project evaluation is currently developing along at least three, relatively distinct, pathways rather than as a genuinely interconnected research theme. This is likely to hinder progress in

research but also in practical application of the techniques, in terms of reducing the likelihood of identifying inadequate, inappropriate or inefficient conservation investments.

There is still considerable opportunity for further collaboration in the areas of biodiversity evaluation between researchers in a range of disciplines, including ecology, economics, statistics, forestry, wildlife management. Biodiversity conservation evaluation is a growing field, but its potential is unlikely to be fulfilled unless biodiversity researchers seek to develop a more integrated community, and particularly to learn from researchers in other disciplines where evaluation has a longer history.

The need for prioritisation and evaluation in biodiversity conservation

Management of biodiversity is a significant challenge for many nations and globally. The IUCN lists more than 65,000 species on its Red List, of which more than 20,000 are threatened with extinction (IUCN 2012). Approximately US$0.10-0.15 billion is spent annually on the conservation of terrestrial biodiversity (McCarthy et al. 2012), but it is estimated that protecting and managing all terrestrial sites of global biodiversity importance would cost US$76.1 billion annually (McCarthy et al. 2012). Current levels of global conservation expenditure are at least an order of magnitude short of the amount required to halt biodiversity loss. It is therefore essential that we use to best effect the limited resources that are available for biodiversity management.

Decision makers and managers concerned with biodiversity need to consider carefully where to apply the limited resources available to them given that they have an explicit goal to pursue. The papers in this Special Issue of Wildlife Research focus on aspects of that question. As Cullen (2012) notes, researchers during the last 25 years have devoted large efforts to development of methods, datasets, software, and analysis to help inform decision makers on biodiversity prioritisation. It seems clear that considerable progress has been made by this research effort and decision makers can now choose from a range of prioritisation approaches and tools to ensure their decisions are based upon best available information and are made following coherent, logical steps.

Of course the application of today's best prioritisation methods are heuristics and there are no guarantees of success or predictable outcomes. Biodiversity managers typically have incomplete information about the species, habitats and ecosystems, and the threats to the biodiversity, and conservation decisions need to be made on this basis (Grantham et al. 2012). The effectiveness of management actions can be influenced by many factors including weather, timing, level and quality of contractor effort, human and other species interventions. In short, there are chronic risk and uncertainty issues in biodiversity management. Managers and decision makers in many cases can benefit from summative evaluations that assess just how effective, and cost effective, biodiversity management actions have been. Without rigorous *ex post* expenditure evaluation, we have little basis for judging what works and what does not work, which actions are cost effective and which are not, and which provide benefits that are at least as great as their costs.

These seemingly obvious points have received inconsistent attention and support in biodiversity research and amongst biodiversity management providers. Two oft-cited publications make this point. The Millennium Ecosystem Assessment stated: "Few well-designed empirical analyses assess even the most common biodiversity conservation measures" (Millennium Ecosystem Assessment, 2005, 122). Ferraro and Pattanayak (2006, p.482) suggest that "if any progress is to be made in stemming the global decline of biodiversity, the field of conservation policy must adopt state-of-the-art program evaluation methods to determine what works and when." It is worth checking if it is true that evaluation rarely occurs, and what actions are needed to achieve both greater support for and implementation of

evaluation. To answer those two questions we need first to review what is entailed in biodiversity project evaluation.

Biodiversity project prioritisation is an example of formative evaluation – it aims to inform us before, or at various point during implementation how we can better target effort to achieve the designated biodiversity objectives. Summative evaluation occurs after a project or programme has been implemented and typically aims to inform us how successful a project or programme has been in delivering on its designated objectives. There are a number of aspects of a project or programme that can be evaluated including design, implementation, and delivery. Laboratory experiments often permit control of many variables of interest, but few biodiversity projects are designed or implemented in ways that allow control of many variables, hence alternative evaluation approaches are required. Assessment of a project or programme outcomes might be achieved by way of comparison of outcomes with targets, by comparison with similar projects or programme outcomes, or by comparison with counterfactual, which may include 'no treatment'. Which evaluation approach to use in any situation is not always obvious, and completing a useful evaluation can be challenging.

In a recent paper, Possingham (2012) observed the importance of evaluation and the valuable, often unexpected insights it can provide (Sutherland et al. 2004; Walsh et al. 2012). He also declaimed the reluctance of many young ecology researchers to tackle evaluation, but noted there were some signs that some biodiversity evaluation is occurring. These are reasonable points, but the last of Possingham's

four points warrants some comment. A Web of Science search using the terms 'biodiversity', 'project' and 'evaluation' brings up 304 records since 2000 and 340 since 1990. Clearly there is quite a bit of biodiversity evaluation going on and a little digging reveals that biodiversity evaluation has been conducted since at least 1991 (Tisdell, 1991), although there has been a steady increase in research in the area in recent years (Figure 1).

The role of interdisciplinarity in biodiversity project evaluation

Researchers from many fields, as well as from ecology, can and do complete evaluations of biodiversity projects and programmes. However, researchers who do not look beyond their own discipline may fail to see how much evaluation is occurring or the opportunities that provides. Many of the methodological advances in biodiversity evaluation over the last decade have occurred at the interface between the disciplines of ecology and economics. Ecology has a long history of interaction with other disciplines (Lowe et al. 2009), but the urgency for more effective interdisciplinary integration has accelerated over the last decade in recognition of the increasing multifaceted nature of environmental problems. Indeed, this has been reflected in the trend for some mainstream applied ecological and conservation journals to include increasing numbers of papers which incorporate methodology from other disciplines. Over the last few decades, ecology and economics have become increasingly interlinked in relation to questions of biodiversity conservation and sustainability (Costanza and Daily 1992; Daily and

Ehrlich 1999; Baumgaetner et al. 2006) and a new integrative discipline of ecological economics has emerged, served by its own interdisciplinary journal.

In a rapidly-expanding research area such as biodiversity project evaluation, which specifically pits ecological outcomes against economic inputs, the benefits to be gained from adopting an interdisciplinary approach should be substantial. However, some of the observations made by Possingham (2012) and other papers in the same volume contend that such interdisciplinary integration in this area is still rather limited. Although conservation biology as a discipline has been one of those areas within ecology which has increasingly looked to the social sciences, it may be that the sub-discipline of conservation evaluation is not so outward-looking as it could be in this regard.

Analysis of interdisciplinarity in biodiversity evaluation research

An indication of the historical provenance of a piece of published research is provided by its reference list. The reference list defines the starting points for the work and the academic 'stable' from which is has emerged. To test the extent of interdisciplinarity in the area of biodiversity project evaluation, we therefore examined the reference lists of three recent papers concerning the summative evaluation of biodiversity conservation projects. Two of these papers (Howe and Milner-Gulland 2012a; Walsh et al. 2012) appeared in a conservation journal, *Animal Conservation*, and were highlighted by Possingham (2012) in the same volume as providing excellent examples of evaluation using historical data. The other paper (Laycock et al. 2011) appeared in the interdisciplinary journal *Ecological Economics*.

We extracted from the reference lists of each of these three papers all citations to other papers that were listed in the Web of Science database. References to unpublished reports were excluded, as were references of a purely statistical nature, such as to software used or specific analytical routines, which had no direct bearing on the evaluation methods used. Following this selection process, we categorised each cited paper according to its Subject Categories provided in Web of Science. This ensured that the assignment of categories was objective and not subject to researcher bias.

The three papers together cited references that covered 15 Subject Categories in Web of Science. These Subject Categories are assigned on a journal basis and were: biodiversity conservation; ecology; biology; zoology; evolutionary biology; genetics and heredity; biochemistry and molecular biology; chemical analysis; energy and fuels; business; economics; geography; environmental studies; multidisciplinary sciences; and environmental sciences. For each paper, we assigned every cited reference a score up to a value of 1 according to its subject categories. Where a paper belonged to more than one Subject Category, its score for each Subject Category was weighted as appropriate. Hence, a paper categorised under three Subject Categories would score 0.33 for each of these categories. Once all the cited references had been assigned scores, we then added up the scores under each of the 15 Subject Categories for each of the three papers, to produce a 15 total Subject Category scores for each of the three focal papers. These were then weighted by the

number of cited references within each paper that met our original selection criteria to allow direct comparisons between the three papers (Table 1).

Comparison of the three papers revealed an expected dominance of Subject Categories most closely aligned with ecological science (Figure 2). However, there were different patterns of provenance in the three papers. Howe and Milner-Gulland (2012a) was the most restricted in terms of disciplinary provenance and its citations were dominated by other papers in the biodiversity conservation literature. The Laycock et al. (2011) and Walsh et al. (2012) papers displayed very similar overall patterns of disciplinary provenance. Both had a relatively more diverse distribution of disciplinary provenance than Howe and Milner-Gulland (2012a) and ecology sources were the most numerous cited references in both papers. The Laycock et al. (2011) and Walsh et al. (2012) papers diverged in disciplinary provenance only for the less commonly-cited disciplines, with the Laycock et al. (2011) paper citing more papers from the social sciences, including economics and environmental studies. Perhaps surprisingly, despite the similarities in disciplinary provenance of these two papers, they cited just one paper in common (Murdoch et al. 2007). Laycock et al. (2011) also cited one paper in common with Howe & Milner-Gulland (2012), which was Salafsky and Margoluis (1999). No papers were commonly cited by Howe and Milner-Gulland (2012a) and Walsh et al. (2012). Thus, of 63 papers cited across all three focal papers, only two were cited in common by two of the three papers, and no paper was cited in common by all three papers.

The status of evaluation as a research theme in biodiversity conservation

In their editorial to support a number of featured papers on biodiversity conservation evaluation in a recent edition of *Animal Conservation*, Howe and Milner-Gulland (2012b) observed that conservation lags behind many other fields in both the quantity and quality of evaluations. A number of contributory reasons for this are discussed by these authors, including the fact that the outcomes are frequently subtle, difficult to measure and take a long time to come to fruition. The authors also point out that the impact of external factors can complicate the interpretation of evaluations. Although evaluation of conservation projects is increasing, at least among the research community, we agree with these authors that there is some way to go in terms of reliable and commonly-accepted methodology. Based on our analysis, we would also suggest that the development of evaluation as a research field within biodiversity conservation is also being restricted by a relative lack of interdisciplinary knowledge exchange. There is an increasing number of relevant papers in the literature, both within the area of biodiversity conservation and outside. Both quantitative and qualitative approaches are used and they include case studies (Shwiff et al. 2005), survey research (Scofield et al. 2011), statistical analysis (Laycock et al. 2009), and model building (Busch and Cullen 2009; Honey-Roses et al. 2011). Notwithstanding these developments, the field of evaluation has yet to come together as a genuinely interconnected research area. That the three papers we selected for our analysis shared only two cited references which were common (and even then, only common to two of the three) suggests

that the area of evaluation is currently developing along at least three, relatively distinct, pathways rather than as a fully-integrated theme.

The multi-stranded pattern of development of the area of biodiversity evaluation has a number of implications. From a research perspective, overall progress is likely to be slower than if the different sub-areas were working better together. Against a backdrop of continuing declines in biodiversity (Butchart et al. 2010), the lack of a coherent research effort on conservation evaluation may have significant consequences in terms of failing to highlight inadequate, inappropriate or inefficient conservation investments if it is not addressed urgently.

Progress in understanding of evaluation is one thing, but for conservation evaluation to have an impact in the real world, it needs to be adopted by practitioners and policy-makers. This depends on it being seen as an integral and core part of conservation rather than as an add-on. The translation of interdisciplinary research into policy and practice is a three stage process (White et al. 2009). The first involves interaction between researchers from different disciplines working together to formulate and address research questions, refine methodologies and develop a conceptual framework. In the second stage, those involved in the research work in a dialogical manner with policy makers and other stakeholders to formulate more applied research questions and translate results into policy. The final stage involves the sharing of this information (or knowledge exchange) among stakeholders including managers and policy-makers to translate it into practice. In the most effective integrative research, researchers engage actively with policy makers and

various other stakeholders from the outset of a research project, from the design of the project and setting of objectives, through contributions to the design and methodology, interpretation of the results and dissemination of the conclusions (Reed, 2008; Phillipson et al. 2012). In the area of conservation evaluation, there is no doubt that some of this is occurring, but it is doing so in a very piecemeal way, and there is evidence to suggest that much more can be done to integrate activities, even between the researchers themselves, let alone between the researchers and policy-makers.

Conservation evaluation has developed by borrowing from other disciplines and fields of research. However, as our analysis has showed, interdisciplinarity in conservation evaluation is limited and there is still plenty of opportunity for further collaboration between researchers in a range of disciplines (including ecology, economics, statistics, forestry, wildlife management). Collaboration across disciplines can pool resources, make use of comparative advantages, enable cross fertilisation of ideas, disperse knowledge more widely about what works and what does not work, and contribute to better use of scarce biodiversity management resources (Murdoch et al. 2007). As pointed out by several other researchers in the field (Possingham 2012, Howe & Milner-Gulland 2012b), biodiversity conservation evaluation is a growing field with many opportunities for research, but we do not believe that the potential can be fulfilled without a more positive effort at integration, both within the discipline and with other disciplines.

The future for conservation evaluation

Given the constraints on spending, and the reality that resources for conservation will never be adequate to protect all biodiversity, conservation evaluation needs to be at the heart of natural resource management into the future. What is needed for this transition to occur? Some microeconomics is helpful here, since we need to understand how we can match up demand and supply. We therefore need to understand where the demands for evaluation will be, who will fund its development, and who will take note of the outcomes. However motivated the researchers are to contribute and apply effort and skill to complete research, unless there is a demand for evaluations and uptake of the information they provide, little will be gained by their completion (Pullin et al. 2004).

Research funders and biodiversity project managers can play important roles signalling what types of research is required (Cook et al. 2010; Bottrill et al. 2011), and ideally this should be done in an integrative manner with the researchers, to ensure that the products of the research are fit for purpose. Despite the assertion of Ferraro and Pattanayak (2006) above, evaluations need not use state-of-the-art methods in all cases, but they do need to strive to provide answers to key questions including: (i) what works; (ii) where it works and under what circumstances; (iii) does it provide a cost-effective solution; and (iv) does it represent an efficient use of conservation resources? Across projects, evaluation needs to allow us to identify a number of aspects including: (i) which projects or suite of projects work best to

produce specific outcomes; (ii) which projects deliver greatest benefits per dollar invested; and (iii) which delivery mechanisms are most appropriate.

These are all laudable objectives, but nevertheless, a word of caution should be expressed here. No-one likes to be evaluated, and whilst strategic decision-makers should be expected to look favourably upon the benefits that project evaluation can bring, those individuals or organisations responsible for the delivery of individual biodiversity projects may have a different perspective (Innes et al. 2012; Scofield and Cullen 2012). Individuals seeking to carry out evaluations may be met with suspicion by those being evaluated and there is a risk that outcome data based on perceptions may be biased. An evaluation culture is very unlikely to be unanimously popular with the conservation lobby. However, better conservation evaluation is a necessity and education concerning the wider benefits of evaluation should help to ameliorate some of these barriers. Biodiversity researchers have the capacity to supply the necessary methodological frameworks, but the full potential for evaluation can only be realised if biodiversity researchers seek to develop a more integrated community, working collaboratively and in a participatory manner with other researchers and decision-makers, and embrace the lessons learnt from those working in other areas with a wealth of evaluation expertise already behind them.

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Table 1. Summary statistics of analysis of cited references from the three focal papers

	Paper		
Authors	Howe and Milner-Gulland (2012)	Walsh et al. (2012)	Laycock et al. (2011)
Journal of publication	Animal Conservation	Animal Conservation	Ecological Economics
Total number of cited references	26	47	41
Number of cited references meeting selection criteria	14	27	25
Number of Web of Science Subject Categories covered in cited references	7	12	10
Variance of weighted Subject Category proportions	0.012	0.009	0.007

Figures.

Figure 1. Trend in papers published on biodiversity project evaluation since 1990, as listed in Web of Science.

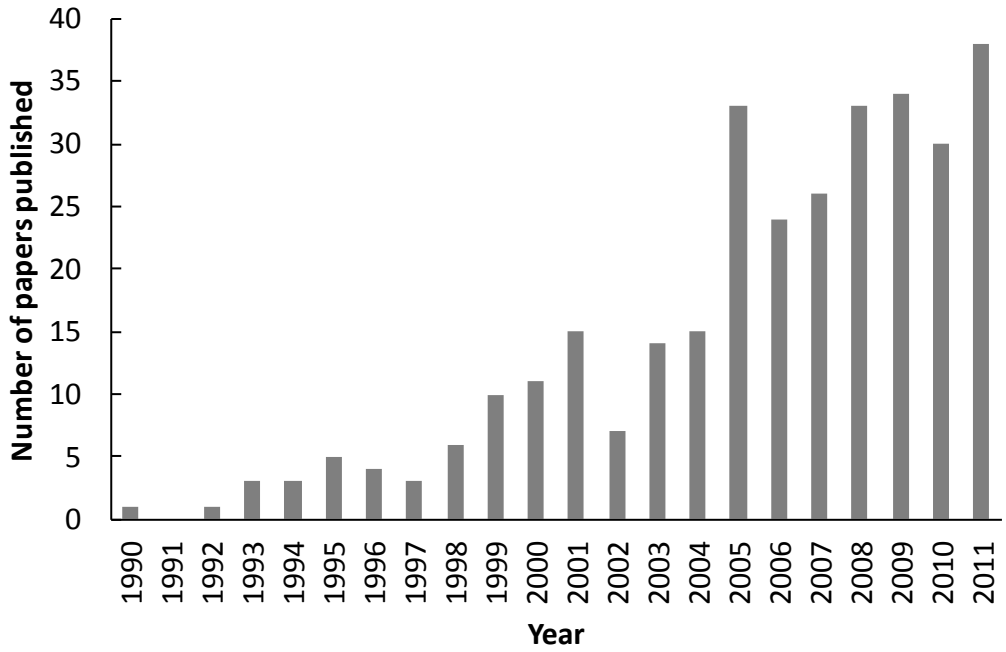

Figure 2. Radar chart showing the relative prevalence of different Subject Categories among the cited references from each of the three focal papers. Howe & Milner 2012, solid line; Laycock et al 2011, dashed line; Walsh et al 2012, dotted line.