**IMPERIAL COLLEGE LONDON**
**Faculty of Natural Sciences**

**Centre of Environmental Policy**

# An investigation into the conservation impact of research published in the scientific literature

**By**

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**A report submitted in partial fulfilment of the requirements for the MSc and/or the DIC.**

**September 2007**

5 ESSAYS

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Signature:

Name of student: ALISON CAMPBELL

Name of supervisor: E.J. Milner-Gulland
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# Abstract

The status of biodiversity is declining world wide, and there is a subsequent need for conservation action to be informed by solid science. The peer-reviewed scientific literature provides the main forum for this science and is constantly expanding, but there are questions concerning the degree to which the published research actually contributes to conservation action 'on the ground'. The conservation impact of research published in the scientific literature was examined by surveying authors of species-based research papers across five major conservation journals from 2000-2005, and conducting interviews with conservation practitioners. Factors facilitating the implementation of research findings in conservation action were identified through quantitative analysis of survey responses.

Although there is some evidence of implementation of research findings from the scientific literature, it does not seem that the research published in peer-reviewed journals is accessible to conservation practitioners. Whilst publication is important for the wider dissemination and credibility of research, findings must be disseminated in useable forms at a local scale if they are to be utilised in practical conservation action. Research was more readily implemented when undertaken with NGO and governmental collaborations, targeted towards a specific conservation management issue, and when recommendations were made for its use. The value of long term research is also emphasised.

A bias towards research based in developed countries was noted, and differences in the factors facilitating implementation of research in developing countries suggest a need for capacity building in these areas if conservation action is to be informed by science. It is also suggested that a large volume of conservation relevant information is currently not catered for in the scientific literature and is therefore inaccessible. It is recommended that more emphasis is placed on incorporating targeted and developing country research into the international conservation literature, better links between researchers and local stakeholders are established, and adequate forums for the dissemination of conservation relevant information are developed.

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# Contents

## Index of figures

## Index of Tables



## Index of Boxes

## Acronyms and abbreviations

| | |
|---|---|
| BC | Biological Conservation |
| BD | Biodiversity and Conservation |
| IUCN | World Conservation Union |
| CB | Conservation Biology |
| CBD | Convention on Biological Diversity |
| CITES | Convention on International Trade in Endangered Species |
| DEFRA | Department of Environment, Food and Rural Affairs |
| ESA | Endangered Species Act |
| Glm | General linear model |
| HCP | Habitat Conservation Plan |
| MA | Millennium Ecosystem Assessment |
| IPCC | Intergovernmental Panel on Climate Change |
| ISI WoK | ISI Web of Knowledge |
| NGO | Non-Governmental Organisation |
| O | Oryx |
| UK BAP | UK Biodiversity Action Plan |
| WWF | World Wildlife Fund for Nature |

5 ESSAYS

# 1. Introduction

## 1.1 Problem statement

There can be little doubt that the status of biodiversity is declining rapidly worldwide (Bini et al, 2005), as reported by the Millennium Ecosystem Assessment (MA, 2005) and WWF Living Planet Report (WWF, 2006). This has led to increased conservation efforts and the development of Multilateral Environmental Agreements such as the Convention on Biological Diversity (CBD) and the Convention on International Trade in Endangered Species (CITES), which in turn leads to formulation and implementation of management strategies from the government level to that of field based conservation managers (Pullin et al, 2004).

There is a subsequent need for conservation action to be informed by high quality science. The loose targets of the CBD, for example, have led to the creation of many national action plans, but are they suitably informed? This is not just a view held in the field of conservation, but for wider environmental issues such as climate change. The Inter-governmental Panel on Climate Change (IPCC) call for the use of the 'best available science' in their assessments (IPCC, 2001); a phrase explicitly coined in the US Marine Mammal Protection Act of 1972 (Tear et al, 2005) and one that has been subsequently been defined in legal terms in the US as involving the use of research subject to 'peer review and publication', widely accepted in the scientific community (Tear et al, 2005). Based on this assertion, the research that is published in peer reviewed conservation journals should be forming the basis of conservation action, but the degree to which it does this is largely unknown.

## 1.2 Introduction to the study

This research project will examine the actual conservation impact of research published in the scientific literature. Conservation science has grown rapidly over recent years, and the volume of literature attached to it is constantly increasing (Robinson, 2006). Similarly, there is evidence that scientists are becoming more involved in policy forums (Robertson & Hull, 2001). Although there are many issues surrounding the concept of 'best available science' and the peer review process (Conroy et al, 2006), it remains that conservation journals, as a channel through which assurance of research quality can be obtained through peer review

(Smallwood et al, 2000), are well placed to provide the forum for this science. As such, it is important that the rapidly expanding volumes of information contained within these pages be put to the best practical use

There can be no doubt that some key scientific papers have an enormous influence on conservation policy and action, obvious examples coming from Myers et al (2000) and the introduction of 'hotspots' into the policy arena, and Losey et al (1999) on the impact of the Bt gene on the Monarch butterfly, subsequently integrated into the Environmental Protection Act (Berenbaum, 2001). This highlights some issues with the notion of 'best available science', particularly in the field of conservation, as the implications are often open to interpretation. Indeed, many scientists believed that the impacts on the Monarch butterfly were exaggerated and widely misinterpreted by the general public (Berenbaum, 2001). Regardless, it is widely accepted that effective conservation decisions rely on practitioners and policy makers having all of the available information and knowing the costs and benefits of the different tools at their disposal (Salafsky et al, 2002).

Very few scientific papers, however, make such an obvious impression on the political arena (Sutherland et al, 2004), and there are those who believe that conservation journal pages are filled with academic research that is never translated into conservation action due to academic pressures favouring rapid dissemination of short-term research of little practical use (da Fonseca, 2003; Lomas, 1993; Whitten et al, 2001). On a similar note, it has been suggested that the peer review tools of judging credibility adopted by scientists are not strong factors for conservation managers (Lach et al, 2003). There are also concerns as to the degree to which the scientific literature is representative of conservation needs of species in terms of taxonomic representation (Levin & Kochin, 2004), type of research carried out (Linklater, 2003) and the geographical areas represented (Fazey et al, 2005).

Conservation biology exists as a discipline with the purpose of providing a scientific basis for conservation action (Fleishman et al, 1999), but this by its very definition will only occur when the design and execution of management plans is actually influenced 'on the ground' (Robertson & Hull, 2001; Thomas & Salwasser, 1989; Meffe, 1998). As such, given the amount of funding that goes into such research (Ferraro & Pattanayak, 2006) along with the general consensus that we are lacking in knowledge of biodiversity and species level processes

(Fazey et al, 2004; Olson et al, 2002), it is perhaps surprising that little analysis has been undertaken to determine the utility of the relevant literature that is purported to provide the source of scientific information on which conservation is based, or to identify factors that facilitate the use of research in conservation action.

### 1.3 Aims and Objectives

This study aims to investigate empirically the conservation impact of research published in the scientific literature from the perspective of both researchers and practitioners. This broad aim can be separated into six main objectives:

1) To establish the extent to which research findings published in the scientific literature contribute to species conservation action.
2) To identify the factors that facilitate implementation of research findings in order to inform the debate as to how scientific information can best be used to maximise conservation impact.
3) To investigate whether the journal in which the research is published, and the characteristics of the paper, have any impact upon implementation of findings into conservation action
4) To establish the forms of dissemination that facilitate implementation of research findings
5) To inform the policy advocacy debate by quantifying the role of recommendations in implementation of research findings
6) To assess the perceptions of conservation practitioners in relation to the role of published research in practical species conservation action, and establish the extent to which practitioners consult the scientific literature

## 2. Background

### 2.1 The role of research in conservation

Conservation is an applied science (Robinson, 2006) and involves the interaction of a variety of different sectors and issues, of which scientific research is only one branch (Salafsky et al, 2002). As an ideal, the role of research can be viewed as an iterative process by which conservation action is continually refined by research findings and monitoring, stimulating and promoting increasingly effective conservation measures (Fuller et al, 2003) (fig 1). This use of evidence of success and failures to refine techniques is known as adaptive management (Huetemman, 2005)

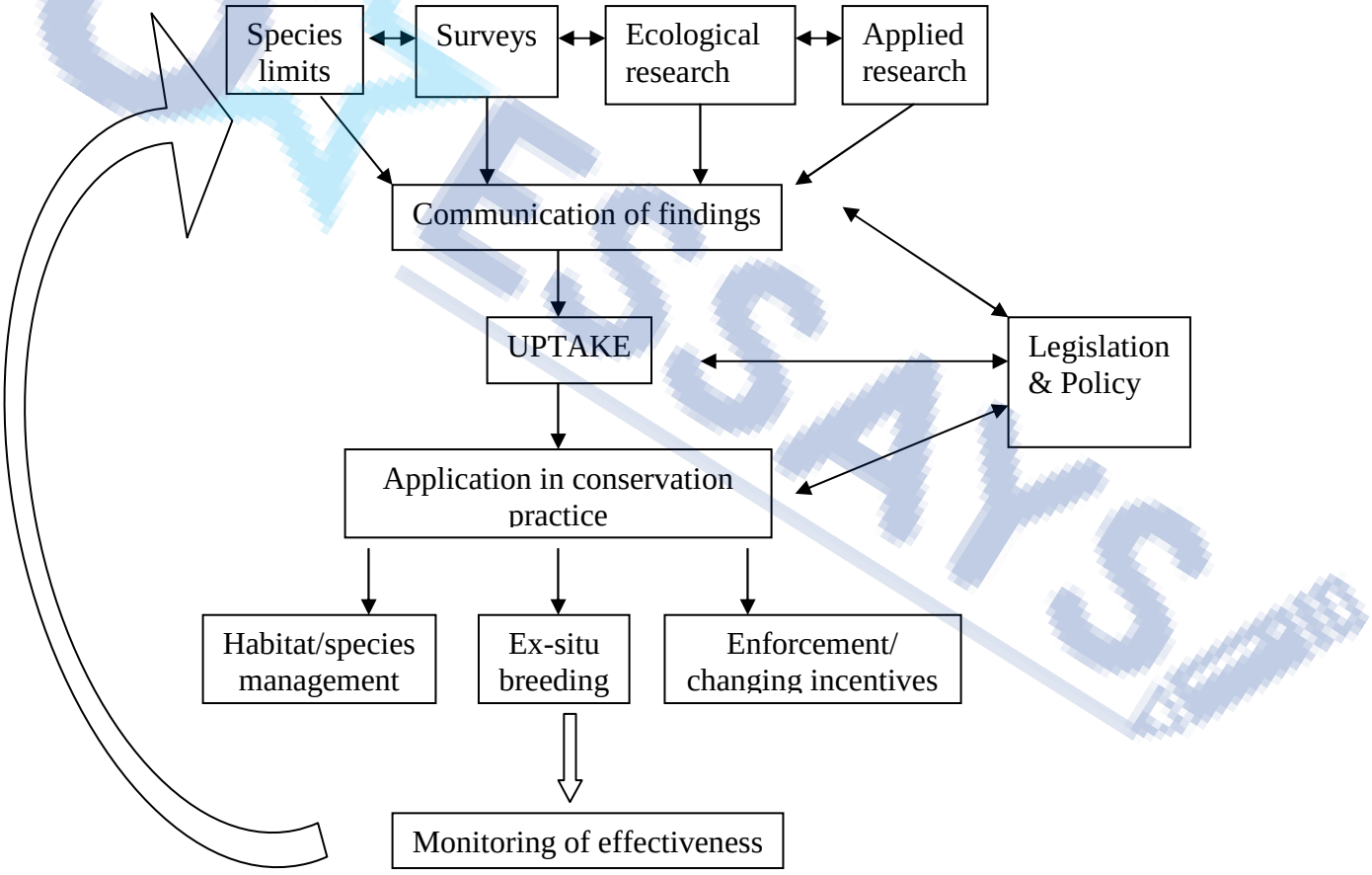


**Fig 1. A theoretical framework for the role of research in conservation planning, adapted from Fuller et al (2003), Salafsky et al (2002), and CCF (2007) depicting the ideal progression from research to conservation action.**

The aim of research is to provide the information base for conservation action, but will only do so if the findings are appropriately communicated and relevant to management (CCF, 2007).

The distinction between those who conduct the research and those who put it into practice is not always obvious (da Fonseca, 2003). However, at two ends of the spectrum are the pure conservation practitioners who have to deal with complex ecological and human processes, and seek to change the system often without trying to understand it; and pure researchers who aim to gain a broad understanding of the system and are successful if knowledge increases (Salafsky et al, 2002). Where the motivation of the researcher lies on this metaphorical scale can influence the extent to which the research is taken up into practice (Fleishman et al, 1999). It has been suggested that a greater level of collaboration is required between scientists and land managers is required to achieve favourable ecosystem (Di stefano, 2004) and species (McCleery et al, in press) management outcomes.

### *2.1.1 Issues with use of research in conservation*

Conservation has been labelled a 'crisis discipline' (Soule, 1985), and as such science can often be overshadowed, with immediate action required on an incompatible time frame with scientific research (Linklater, 2003; Healey & Ascher, 1995). There are many who believe that more 'on the ground action' is needed, rather than research (Ginsberg, 1999). Obviously, practitioners have to deal with the real world consequences of their actions and are more in tune with the implications (Salafsky et al, 2002); and factors such as institutional tensions and cultural needs can often preclude the effective use of science (Lach et al, 2003). Indeed, the growth in popularity of Integrated Conservation and Development Programs (ICDPs) underlines the importance of socially acceptable conservation actions (Wells et al, 1999), and there are concerns that poorly aligned research projects divert funds that could be better applied elsewhere (Sheil, 2001; Prendergast et al, 1999)

This raises another issue in the use of science in natural resource management. A purely scientific methodology for creating the roadless rule in the US led to innumerable tensions and its eventual withdrawal, as the other interacting factors were not considered (Turner, 2006), and there is a balance to be struck between the scientifically sound action and one that is

politically acceptable (Brown & MacLeod, 1996). Indeed, fisheries management has suffered from this to a certain extent, with sustainable yield quotas often reflecting political agendas rather than the scientific information on which they are purported to be based, leading in part to the collapse of fisheries such as cod in the North Atlantic, and Southern blue fin tuna (Rosenburg, 2003).

Despite these issues, it is generally accepted that we are often lacking in knowledge on which to base suitable conservation action (Fazey et al, 2004), a situation that can only be rectified through further research and the use of available information.

### *2.1.2 Information from outside the scientific literature*

There is an obvious role for the use of sources of information other than scientific literature, including knowledge and experience, especially as it is widely believed that practitioners cannot absorb the available scientific information on a time scale that allow it to assist species recovery (Karanth et al, 2003; Linklater, 2003). Kareiva et al (2002) found that the time taken between submittal and publication was longest for conservation journals, although the expansion of online publication is likely to have improved this. Relevant information is often also contained in grey literature, local reports, and expert knowledge, which should ideally be utilised in combination with quantitative data (Bojorquez-Tapia et al, 2003). The value of all conservation relevant information has been recognised, and there are websites being developed to facilitate its use (Conservation Evidence, 2007).

Many conservation organisations initiate actions based upon their own research, and whilst this is as important as the use of existing knowledge, there is a distinction to be made here. This was highlighted by Sutherland et al (2004), who gave the example of captive breeding survival at any particular zoo being only one ‘data point’, and the need to look at survival across many zoos to get the complete picture. This is to say that where knowledge exists, it is necessary to combine with the ‘in house’ research. An example of this can be given for the management of swamp wallabies in Australia, where international research provided vital information for the development of management strategies (Di Stefano, 2004). In the case of tigers, conservation measures are out of necessity initiated with incomplete knowledge, and the ‘Pugmark census’ method, widely accepted by practitioners in India as a tool for

estimating abundance, was later found not to be accurate. (Karanth et al, 2003). This emphasises the importance of peer review, as invalid data inhibits conservation action whereas lack of data can act as a stimulus (Karanth et al, 2003). It has been suggested that relying on the advice of others creates problems because the source of the information is not known or credited (Sutherland et al, 2004; Bojorquez-Tapia et al, 2003). Similarly, the 'entrenched management paradigm', where managers are not receptive to new research that contradicts old beliefs, has been noted to be an issue (McCleery et al, in press)

### *2.1.3 Utility of research*

There is as yet little empirical evidence that the quality of natural resource management decisions is improved by the use of scientific information (Lach et al, 2003). It is also worth noting that peer-review does not completely guarantee research quality, as was found for the Florida panther, where it is believed that unreliable conclusions undermined conservation efforts (Conroy et al, 2006; Beier et al, 2003). Indeed, there are some who urge caution in the use of science as a basis for action, because it can be interpreted in different ways (Sarawitz, 2004).

Conservation success in itself is difficult to quantify, and the parameters vary from project to project, depending on the context of the situation and how success was initially defined (Brooks et al, 2006). However, Boersma et al (2001) attempted to determine whether the presence of solid science was correlated with indicators of species recovery plan effectiveness and found that, in general, the more effective plans had clear links to species biology and recovery goals, and were practical but biologically valid. Similarly, an analysis of tiger conservation projects (Gratwicke et al, 2007) showed that strong scientific information was one of the factors associated with project success.

There are some fundamental questions, such as the viability of a population that can only be established through research (Pullin et al, 2004), especially as many underlying processes are not intuitive or obvious (Sutherland et al, 2004). To take such an example from China, research on a pheasant species showed that lack of breeding success was due to disturbance by mushroom pickers, allowing the correct action to be put in place, re-establishing a healthy breeding population (Fuller et al, 2003). Re-establishment of magpie robin populations, along

with those of the black robin and pink pigeon are also prime examples, as mis-diagnosis of the reasons for their decline due to intuition and coincidence had hampered recovery before thorough ecological monitoring and fieldwork identified the true limiting factors to enable appropriate recovery management (Caughley & Gunn, 1996). Likewise, appropriate conservation measures were only taken for the prairie chicken, Key Largo wood rat, and white tailed deer after a comprehensive analysis of the scientific literature on the species and habitat over a period of time (McCleery et al, in press). It has been suggested that the stakes are too high in endangered species conservation to take actions without the best scientific information (Smallwood et al, 2000).

It is clear that the chances of success of any conservation action will be increased when it is based upon solid evidence. It is widely believed that the 'evidence based' (Sutherland et al, 2004) conservation model should be taken a step further to incorporate 'adaptive management', a concept whereby research and action are combined, mixing evidence with experience, with the results of monitoring identifying the focus for further research or action and reporting failures for future improvement (Salafsky et al, 2002; Kleiman et al, 2000; Fazey et al, 2004; Huetmann, 2005), of which peer review is an essential component (Karanth et al, 2003).

**2.2 Current levels of uptake of research into conservation practice**

Despite the obvious utility of research in conservation action, many scientists believe that it often does not form the basis of conservation practice (Sutherland et al, 2004; Pullin et al, 2004). This has stimulated increasing debate over the perceived 'missing link' between scientific research and conservation (Meffe, 1998; Prendergast et al, 1999) with many believing that this has led to an over-reliance upon experience and anecdotal sources (Sutherland et al, 2004) rather than conservation practice being grounded in scientific theory (Pullin & Knight, 2005). These concerns are not held only in conservation; the lack of linkage between research and policy is also an issue in the field of development (Court & Young, 2003)

Whilst much theory has been written on the topic, very few studies have empirically investigated levels of uptake of scientific research into conservation practice. As the primary

mode of dissemination for conservation research findings amongst the scientific community, scientific peer-reviewed journals and the research published within them again lie at the centre of discourse. Research thus far has concentrated upon three main areas; the uptake of the literature from the perceptions of researchers, the use of literature by practitioners and institutions, and the incorporation of literature into policy and recovery plans.

### *2.2.1 Uptake from perceptions of researchers*

An editorial in the Journal of Applied Ecology (Ormerod et al, 2002) and a study in Conservation Biology (Flashpohler et al, 2000) have attempted to quantify the degree to which the studies published in these journals have had practical application; reporting uptake levels of 57% and 54% respectively. Whilst both of these studies provide an estimate of uptake and identify some interesting trends, they are largely qualitative and limited in scope. Both studies dealt with uptake of recommendations explicitly, rather than findings as a whole, ignoring the rather lively policy advocacy debate amongst scientists (section 2.5.3). Similarly, the research was restricted to a single journal and neither study attempted to quantify the role of publication in the implementation of research, nor the factors facilitating uptake.

### *2.2.2 Use of literature by practitioners and institutions*

The majority of studies to date have focused upon use of research from an institutional or policy perspective, and suggest that the figures generated by Ormerod et al (2002) and Flashpohler et al (2000) could be considered over-optimistic. Pullin et al (2004) investigated the use of scientific information by various conservation institutions in the UK. Evidence for consultation of primary literature was found in only 11% of management plans. Questionnaire respondents cited existing management plans and expert opinion as the most frequently used sources of information, with published scientific papers lagging at 23%, although it is worth noting that the ‘experts’ in question may have consulted the literature. However, 75% of respondents stated that experience based information (qualitative and expert opinion), rather than evidence-based (quantitative assessment and experimental analysis), was paramount. Comparing the use of information in the UK to that of Australian conservation organisations (Pullin & Knight, 2005) showed a much higher level of uptake of 69% in Australia, three times the level of uptake reported in the UK. That the conclusion of a low use of scientific

information in management plan design was generalised to both countries perhaps slightly weakens the position, and highlights the need for a wider assessment not limited to one particular group of organisations or political and bureaucratic climate.

Nevertheless, convincing statistics as to the lack of use of scientific research were presented, similar to the situation at Broadlands (an important wetland area in the UK), where only 2% of actions were based upon primary literature (Sutherland et al, 2004), and similar gaps have been identified in the design of nature reserves (Prendergast et al, 1999). There was also found to be little evidence collected or reported on the consequences of conservation actions to inform future action (Sutherland et al, 2004), a problem also identified by Pullin & Knight (2005).

### *2.2.3 Policy and planning documents*

A case study examination of Habitat Conservation Plans (HCPs) in the US (Noss et al, 1997) similarly concluded that science was not being properly utilised. A comprehensive and systematic assessment of the HCPs (Harding et al, 2001), however, concluded that in general good use was made of the available scientific information, issues only arising when information on basic biology and population status, critical in the development of the plans, was not available. Similarly, the US Endangered Species Act (ESA) recovery plans have undergone a wide assessment of their efficacy. Boersma et al (2001) assessed the incorporation of species biology into recovery plans by looking at the extent to which the recovery goals reflected the species' natural history and ecology, and found that generally good use was made of scientific information. Conversely, Gerber & Schultz (2001), Tear et al (1995) and Clark et al (2002) concluded that information on species biology was insufficiently used, and that making threats a primary focus of the recovery plans along with better monitoring of species status would improve the scientific basis of the plans (Clark et al, 2002). It was also found that the incorporation of academics into the authorship team of the plans increased the links to species biology, whereas those authored solely by federal employees were lacking (Gerber & Schultz, 2001). In a more global assessment, an analysis of the Rhino IUCN/SSC action plan showed only 25% of the references to be from peer-reviewed literature (Linklater, 2003), the majority coming from NGO and governmental reports. These studies suggest that it is difficult to draw definitive conclusions across a range of action plans.

Looking purely at the uptake of scientific information into policy, Turner (2006) reviewed the role of conservation science over 30 years of public-lands debates in the US. It was concluded that, despite the recent issues surrounding its retraction, science had successfully influenced and transformed public discourse on roadless area policy. Progress has also been made translating farmland bird research into Agri-environmental schemes and management in the UK (Smallshire et al, 2004), and DEFRA has acknowledged the need for integration of research into policy goals in a new five year strategy (DEFRA, 2005). Increased evidence of links between research and policy can also be seen with the creation of the UK Biodiversity Research Advisory Group, which aims to provide advice to both providers and users of research in order to meet the UK Biodiversity Action Plan (UK BAP) objectives set under the CBD (JNCC, 2007). However, the difficulty of incorporating scientific information adequately into policy has been noted (Healy & Ascher, 1995).

### *2.2.4 Translation of planning into action*

Lundquist et al (2002) and Fuller et al (2003) took the analysis a step further to establish whether species recovery plans and IUCN action plans respectively had actually been implemented, and how the information was used. Lundquist et al (2002) found that 70% of the plans had been partially or completely implemented, with greater levels of implementation amongst the charismatic vertebrates. In a more restricted investigation of the IUCN action plans for the Galliformes, Fuller et al (2003) also found good evidence for implementation. Whilst this study should be taken in context of a single group of species, it is an interesting indicator of the utility of IUCN action plans.

Despite the optimistic levels of implementation reported above, there was an obvious time lag between the development of the plan and implementation (Lundquist et al, 2002), suggesting that it cannot be assumed that incorporation into policy documents will lead to actual conservation action. Indeed, there are many who believe that conservation action would be better served by scientists and practitioners responding adaptively in the field than writing ‘out of date’ recovery plans (Conroy et al, 2006). As most of the studies to date have focused on the analysis of such plans, they must be interpreted with caution if the goal is to ascertain the levels of research that go into actual conservation action.

## 2.3 Geographical extent of scientific literature

The above discussion has largely focused on developed countries, as indeed has most of the literature on the topic to date. This begs the question as to how the science reported in the journals supports conservation action in developed countries, where a high proportion of the world's biodiversity is located (Myers et al, 2000), particularly as the main conservation journals are published in developed countries. In Tanzania for example, many conservation initiatives, such as the creation of Protected Areas are undertaken opportunistically to resolve local problems with little prior analysis (Fjeldsa, 2007). It had also been suggested that work by foreign researchers produces many results of relevance, but there are limited institutional mechanisms for ensuring input of science in shaping conservation practice (Bergerhoff Mulder et al, 2007). The lack of availability of published information is also an issue in less developed areas (Foster, 1993), as is language (Meijaard & Shiel, 2007) and lack of capacity (Durant et al, 2007). Indeed, it has been suggested that monitoring and research projects may hinder conservation in developing countries by diverting funding (Sheil, 2001); although quantitative analysis showed that a monitoring system in the Philippines led to the implementation of a variety of management actions (Danielson et al, 2005).

Fazey et al (2005) analysed research papers in three major conservation journals and found that most were conducted in affluent countries. Moreover, they found that less than half of the studies in lower income countries had primary authors from that country. Although secondary authors were found to be much better represented, this is a worrying statistic. Whilst this information is interesting in itself, it would be of greater interest to establish whether or not such biases have an impact when it comes to the level of implementation of research into conservation action. It has been suggested that local scientists in low income countries are vital because they understand the cultural context, can develop partnerships with communities, and are better placed to translate the information into policy and practice (Getz et al, 1999; Kremen et al, 1998; Foster, 1993). Local scientists also play a role in keeping the knowledge and expertise in the country (Fazey et al, 2005)

Similarly, a study on the contribution of scientific information to the conservation of freshwater biodiversity in Tropical Asia (Dudgeon, 2003) found that Asian scientists published only 6% of the available conservation biology literature on the topic. It was further

concluded that the work that does get published is not effectively implemented, as it is not accessible in the area it is most needed, again raising concerns over the 'global' scope of scientific journals.

Although it should always be the aim to use best available 'peer reviewed' science, it is important to acknowledge that this might not be possible in many circumstances where the research is either not being carried out or published, particularly in developing countries, and this is an issue in itself. Nevertheless, although there is some evidence to the contrary, there does seem to be a 'gap' between conservation science and practice that can to a certain extent be split into two areas: the type of scientific research that is being conducted relative to conservation needs, and the dissemination of information to the relevant parties

## 2.4 Type of research published in the scientific literature

There is a discourse in conservation biology over the extent to which scientific research provides the relevant information for conservation; with some believing that much of the published research is irrelevant because it asks the wrong questions (Linklater, 2003; Meijaard & Sheil, 2007). Concerns about this issue led Sutherland et al (2006) to provide a framework of 100 research questions of policy relevance, the outcome of which was a preference for broad rather than narrow questions. Although this perhaps seems counter-intuitive, it reflects the scale of the broader policy issues involved, and highlights the difference between policy and practice. One such question, 'How large should marine protected areas be, and where should they be located to protect biodiversity of the surrounding species?' is a good example because it is a huge question that requires many specific research projects as well as general research on the biology of the fish species, and interactions within the ecosystem

### *2.4.1 Applied versus basic research*

There are some who believe that 'applied' research is most effective for influencing conservation action, as it provides information directly required for management of a particular species, and can incorporate social, economic and cultural issues (McNeely, 2002; Meijaard & Shiel, 2007). Particular emphasis has been placed on the need for more research on threats to species (Meijaard & Shiel, 2007; Clark et al, 2002). Those advocates of 'applied'

research suggest that it is less likely to be published in peer reviewed journals (Fleishman et al, 1999), but this assertion has not yet been properly tested.

Others advocate the role of more 'basic' species biology and processes (Walters, 1997; Olson et al, 2002; Tear et al, 2005), and a lack of information on the basic biology of many species has been noted in species conservation planning in the US (Harding et al, 2001; Boersma et al, 2001; Beier et al, 2003). Similarly, it has been suggested that a bias towards applied research in developing countries (Fazey et al, 2005; Dudgeon, 2003) is reducing the capacity to understand underlying processes (Denny, 2001). The importance of information on behavioural ecology such as mating systems has also been emphasised (Berger, 1996).

A case study on the Rhinoceros (Linklater, 2003) highlighted the perceived mismatch between research and practice, concluding that research was poorly synchronised with management priorities; citing the example that despite the need for information on basic ecology and population status, the majority of research focused on ex-situ projects of limited relevance. Linklater (2003) clarifies the slightly circular debate by establishing that a mixture of both 'pure' and 'applied research is required, but that it should be viewed rather as a need for 'targeted' research rather than 'conceptual'. (Aplet et al, 1992; Linklater, 2003).

**2.5 Dissemination of research findings**

Regardless of the type of research that is published in the scientific literature relative to conservation needs, the matter of the extent to which the information published in journals reaches its target audience obviously influences whether or not there is any discernible action as a result (Linklater, 2003). Indeed, there are many who believe that a lack of knowledge is not the limiting factor; rather the failure to properly collate and distribute it (Pimm et al, 2001) with information 'flowing passively' through journals (Lomas, 1993). It is thought that more often than not it is down to the practitioners to locate the information and determine its utility (Fazey et al, 2004), and they are restricted in the time they can spend searching the volumes of literature (Brussard & Tull, 2007; Pullin & Knight, 2005), as well as by finance and accessibility (Sutherland et al, 2004)

### *2.5.1 Systematic review*

The process of systematic review (Pullin & Knight, 2005; Pullin et al, 2004; Sutherland et al, 2004) whereby all the information on a topic is brought together and reviewed independently has been suggested in order to address these issues, and to support decision making. This would involve a central database containing all information, both qualitative and quantitative, providing a flow of information between scientists and practitioners similar to the medicine framework (Pullin & Knight, 2005). Parallels have been drawn between conservation and medicine, as two 'crisis disciplines' in which research and practice are often separate elements of the same field conducted by two separate groups, with some overlap (Sutherland et al, 2004; Fazey et al, 2004). However, medical research is more experimental than conservation research (Fazey et al, 2004), and the practical application will not differ as much from case to case

Although medicine can perhaps be used as a model in developed countries, it is unlikely that the system would hold when transferred to developing countries, where conservation action is most needed. Indeed, it could be argued that systematic reviews would not address the problem in developing countries. In Tanzania, for example, scientists are limited in terms of influence on conservation action unless a forum for international research institutions to inform local institutions can be established (Bergerhoff Mulder et al, 2007). Whilst accessibility of information to practitioners in a usable format is a key problem (Pullin & Knight, 2005), systematic reviews would be a huge undertaking, and the degree to which such research would influence conservation post-publication has not yet been established.

It would perhaps be of greater relevance to establish the degree to which research published in the scientific literature influences conservation when disseminated in other forms, such as through local forums. It has already been established that information relevant to conservation can also be obtained through channels other than the scientific literature (section 2.1.2), but the relative contributions of forums such as the internet, grey literature, local journals, local reports, and personal communication networks for dissemination of findings have not been empirically analysed.

### *2.5.2 The IPCC model*

The IPCC has established itself as the world's authority on climate change, and whilst there are issues in terms of the balance between politics and science, it remains as the best example of global dissemination of research and collaboration of scientists and policy makers (Reid & Mace, 2003). It has been suggested that such a model should exist for the conservation of biodiversity, and indeed the MEA has gone some way towards filling this gap and needs to be based on the best scientific information (Reid & Mace, 2003). Whilst there can be questions as to the influence this would have on a local level, it would obviously be of benefit to facilitate wider use and collation of existing information, perhaps with an element of systematic review element incorporated.

### *2.5.3 The advocacy debate*

There is also a debate amongst conservation biologists as to how scientific information should be presented, and whether scientists should simply report and interpret their findings, or make recommendations for their use. Various authors have suggested that although advocacy is embedded in the scientific literature, it is not the role of scientists to involve themselves in policy as this ruins their credibility as a provider of information (Scott et al, 2007; Tear et al, 2005; Lackey, 2007). Others believe that the scientists are in the best position to interpret the results of their study (Ehrlich, 2002), but should do so without becoming 'politicised' (Lach, 2003). There are also those who believe that scientists need to interpret their findings and advocate a use for them (Freyfogle & Newton, 2002; Brussard & Tull, 2007), as scientific facts can easily be separated from preference.

Those who are against advocacy in science point out the need to separate science from feasibility (Tear et al, 2005). Whilst this is true to a certain extent (and issues with this have already been identified in section 2.1.1), conservation is a normative science (Meijaard & Shiel, 2007) and it is necessary to place the scientific findings in a practical context as this is likely the only way they can be used (Robinson, 2006). Perhaps the issue has become slightly polarised by this debate, and should be viewed more in terms of the fact that scientists should be making concrete recommendations for the use of their findings other than just for 'further research'. An analysis of the Indonesian literature (Meijaard & Sheil, 2007), for example,

showed a distinct lack of concrete recommendations that could realistically be put to practical use. Such recommendations for action would seem to be a way of facilitating the implementation of scientific research and it would be interesting to establish whether those scientists making concrete recommendations based on their findings are more likely to influence conservation practice.

# 3. Methodology

## 3.1 Introduction to methodology

The issues outlined in the previous chapter are important in determining how best to influence conservation action, but have not yet been put into context by empirical analysis of the factors that facilitate implementation of research findings in conservation. There has been little assessment of whether publishing in the literature is an appropriate form of dissemination, what forms of dissemination facilitate uptake, and if dissemination rather than research type is even the issue in the perceived lack of evidence based conservation. Indeed, there has been little analysis of whether peer reviewed research is providing the information required in conservation action, and if it is being implemented in the areas most needed. To add to this, much of the discussion of the mismatch between researchers and practitioners, in particular the advocacy debate, is based on comments and editorials rather than quantitative analysis.

All of the studies to date have addressed the issue from either the viewpoint of the researchers, or from an institutional perspective. This study will assess the issues introduced above by approaching the topic from both angles; through author perceptions as to the levels of implementation of their research, and through conservation practitioner interviews.

Firstly, an author survey of species-based research across five major conservation journals will address author perceptions as to the level of implementation of their research findings. Previous studies have addressed this using research from a single conservation journal, but a study by France & Rigg (1998) has proven there to be journal level differences in the type of research published, and it is therefore necessary to take a multiple journal approach to gain a sample adequate for assessing the conservation impact of research published in the scientific literature. Similarly, journals are often judged by their Impact Factor (Thomson Scientific, 2006) gained from an assessment of individual article citations over certain time periods, and it would be interesting to assess whether these indices have any real world application in terms of the utility of the research.

Secondly, interviews with conservation practitioners at Durrell Wildlife Conservation Trust will ensure a more rounded assessment of the issue, establishing whether those who

implement conservation action on the ground make use of the research published in the literature. Quantitative and qualitative research has been conducted in this area in the USA, UK, and Australia (Pullin & Knight, 2005; Sutherland et al, 2004); and in the design of action plans for particular species (Clark et al 2002; Boersma et al, 2001), but not with a selection of practitioners working in conservation in less developed countries.

This study will therefore examine the link between scientific research and application in conservation. The next important step, to determine the impact of a conservation action, requires monitoring of the situation (fig. 1) and is beyond the scope of this study. It cannot be concluded that there is always a direct or even definite correlation between the use of scientific research and conservation 'success', however you choose to define the latter. Information applicable to one situation may not be applicable to the other, and the research findings need to be applied according to context. However, it cannot be denied that conservation action based upon a solid research framework has better chances of success (taken in this case to mean an improvement in the conservation status of the species or system), as this allows for more informed decision making (Reid & Mace, 2003). This much is intuitive and as such it is legitimate, if not fundamental, to look at the process of conservation action as well as the outcome; particularly as this arguably provides the most insight into the mechanisms of conservation practice

### 3.2 Author survey

An online survey was sent to 1432 authors of species-based papers published in five major conservation journals; Animal Conservation, Biodiversity & Conservation, Biological Conservation, and Conservation Biology across a 6 year period, 2000-2005.

#### *3.2.1 Survey method*

There are obvious limitations to the method of approaching the topic from the perspective of the researchers themselves; such as the issues of author self-reporting, differing perspectives on what constitutes 'implementation', and bias in terms of response rates towards respondents who believe that their work has had an impact.

Similar issues, however, are also prevalent approaching it from the institutional side (Sutherland et al, 2004; Pullin & Knight, 2005), as practitioners may exaggerate their use of research in the same way, and the data collected must necessarily be from only a limited range of institutions. Similarly, examining the research that goes into action plans (Boersma et al, 2001; Harding et al, 2001) involves a certain amount of bias in that an action plan has to have been produced for the species in question in the first place, and such plans are largely tools used in the developed world or by specialist groups at a larger policy scale, with the level of actual implementation unknown (Fuller et al, 2003). These limitations are inherent in undertaking any self-reporting based assessment, and largely the reason as to why no study has properly contextualized the issue as yet.

Surveying the literature has the advantage of assessing the utility of the peer-reviewed literature across a wide range of situations and on a global scale. It also facilitates quantitative analysis of the factors facilitating uptake. Ideally, the respondent would provide exact details of the claimed implementation, providing information by which each response could be cross checked at source. Realistically, this is not possible and the results must naturally be treated with a certain amount of caution. Every effort was taken in the design of the survey, however, to ensure that responses could be validated (section 3.2.4)

### *3.2.2 Journal selection*

Five major international conservation journals; Animal Conservation (AC), Biodiversity & Conservation (BD), Biological Conservation (BC), Conservation Biology (CB), and Oryx (O) were selected for analysis. Each of the selected journals has a different focus and editorial policy, reflecting a range of research focuses (Fazey et al, 2005). CB, the 'most influential and frequently cited journal in its field' (Conservation Biology, 2007) has a wide research scope, AC (Animal Conservation, 2007) publishes papers with 'general implications for the scientific basis of conservation', and BD is multidisciplinary, encouraging contributions from developing countries (Biodiversity & Conservation, 2007). Only BC and O place an emphasis on 'the practical applications of conservation research' (Biological Conservation, 2007), and 'material that has the potential to improve conservation management' (Oryx, 2007)

Targeting specific journals will obviously influence results but it was necessary to only incorporate research aimed specifically at conservation, and such purposive sampling (Milner-Gulland & Rowcliffe, in press) is justified, as these journals provide a sample representative of the most widely read publications in the field of conservation (Fazey et al, 2005).

The six year period 2000-2005 was selected on the basis that previous surveys (Ormerod et al, 2002; Flashpohler et al, 2000) indicate that there is at least a time lag of at least one year before implementation, whereas levels of implementation are likely to decline as the time since publication increases due to decreasing relevance of the study to current conditions (Flashpohler et al, 2000).

### *3.2.3 Sample selection and collation*

Only species-based primary research papers were selected for inclusion in the sample. This was due to the fact that the conservation literature is extremely wide ranging in scope, and the implementation of research focusing on more general issues such as species richness, biodiversity patterns, and habitat fragmentation, whilst of importance, is likely to be more difficult to assess. A species-based approach is justified as it is widely recognised as an important conservation unit (Wilson, 2000)

However, due to the need for a large sample size to dampen biases integral to the survey method (section 3.2.1), 'species-based' was taken to incorporate papers with a focus on a group of species as long as the research was based in a defined geographical area. With previous response rates at 47% for a similar editorial survey (Ormerod et al, 2002), and 30% for authors of Conservation Biology (Flashpohler et al, 2000), restricting the survey to single species papers could have been limiting; particularly for journals with a wider focus such as CB and BC. Incorporated into the design of the survey was the option to differentiate between single species papers and others (section 3.2.4.1).

Each journal was searched by hand for papers meeting the criteria above, the citations for which were subsequently downloaded into Refworks (Refworks, 2007) and a field created in which the email and name of the corresponding author was entered. Corresponding authors were selected as respondents as their contact details were accessible, and it was thought that

they would be most likely to have been the driver of research. When the sample was complete, it was downloaded into an excel spreadsheet and sorted according to journal and year. Each individual paper was given an ID number. The database was then checked for duplicate authors (those with more than one paper), and these were removed and stored in a separate file. Only one paper from each of these authors was chosen at random for incorporation into the sample, in order to avoid potential pseudo-replication.

### *3.2.4 Survey design*

The survey (Appendix I) was designed in a closed question format so as to facilitate quantitative analysis of the data and online completion, with options for further comment. This gave the opportunity for respondents to validate previous responses and provide further qualitative information. Questions were multiple-choice, and many were also multiple-response due to the potential for more than one option to apply. Some questions involved ranking of options, providing more in-depth responses for qualitative comment rather than quantitative analysis. Although questions were closed out of necessity, options were carefully designed and the survey piloted (section 3.2.5) so as to avoid issues with researcher preconceptions (Milner-Gulland & Rowcliffe, in press). The design of the questionnaire drew upon the open-ended responses reported in Ormerod et al (2002) and Flashpohler et al (2000) and detailed questionnaires reported in Harding et al (2001), Boersma et al (2001), and CCF (2007),

The survey was designed so as to be applicable to all of the varying types of research paper identified, and some questions were answer-dependent. It was split into five main sections in which the questions were to be answered by all respondents. These contained questions addressing variables that could have an important impact upon the implementation of the findings, either as explanatory or confounding variables.

a) Background to the research project

This section addressed the nationality and institutional affiliations of the authors, involvement of funding bodies, the length and timing of the research project, whether or not the study was based in a particular area, and if the corresponding or co-authors were resident in the country

of study. It has been hypothesized that these factors could all influence the implementation of research findings (Fazey et al, 2005; Foster 1993; Durant et al, 2007)

b) Motivation behind the research and its publication

It has been suggested that the perceived success of the research project can be determined by the motivation behind it (Fleishman et al, 1999), and therefore it was important to establish the motivation of the researchers; if they had a more applied focus or were investigating a scientific research question. It was also important for the purpose of this study to make the distinction between motivations behind the actual research project and the publication of the research, identifying the intended target audience of the publication

c) Background to the type of research

This section classified the research into broad categories by establishing the focus of the research, the major threats to the species, the scale of potential application of research findings, methodological novelty, and whether the research findings took socio-economic factors into account. These variables were not hypothesised to have an impact on a large scale, but could all potentially influence the levels of implementation on a case-by-case basis (Linklater, 2003; Kleiman et al, 2000) and were incorporated as such.

d) Recommendations

It was important to establish whether or not concrete recommendations had been made as to the potential application of the research findings in each case. Respondents were asked specific questions to this effect and to provide a summary of their main recommendations for validation.

e) Dissemination

Respondents were asked to indicate the importance that they placed on the paper as a means of dissemination, and if they had disseminated their findings through other channels. Further questions were incorporated in order to identify the specific forms and recipients of dissemination that could potentially be correlated with conservation impact.

*3.2.4.1 Single species section*

Due to the wide interpretation of 'species based' papers it was necessary to separate out those research papers focusing on a single species. This enabled potentially important explanatory variables, such as the IUCN Red List (IUCN, 2007) status of the species at the time of research, as a global measure of threat to the species, to be included. It also allowed for an assessment of the current status of the species for a crude investigation into the contribution of implementation of research findings to conservation success.

*3.2.4.2 Use of findings in conservation action*

As the purpose of the survey was to assess the levels of uptake of research published in the scientific literature, the question as to whether or not the findings of the respondent had been used as a basis for conservation action acted as the main response variable. In order to resolve the issues of ambiguity and subjectivity of the survey, respondents had the option to answer 'yes', 'no', or 'unsure'. Each answer led the respondent down a separate path, in which qualifying questions were asked regarding the use of implementation, reasons for lack of implementation, and what was meant by 'unsure', respectively.

*3.2.4.3 Validation of a 'yes' response*

Respondents who believed that their findings had acted as a basis for conservation action were asked to further qualify their answer by stating exactly what 'action' they were referring to. This was split into three categories: practical implementation, integration into policy, and providing a basis for future action (Q22, Appendix I). Those respondents who answered 'yes' but then could only select options from the 'providing a basis for future action' category could then be modified to a 'no' response. Whilst this category has its own importance, it was not considered in this study to constitute a basis for conservation action. Similarly, this gave the option for the slightly dubious inclusion of 'incorporation into policy' as a 'yes' response (section 2.2.4) to be separated from actual 'practical implementation' of conservation action in further analysis. Open-ended responses were used to obtain details of the implementation, and further questions asked to identify factors facilitating the implementation.

Respondents were also asked about the role that their research played in any implementation, and if any discernible improvement had been made to the conservation status as a result of the action, a question adapted from Bini et al (2005). This was included to give a crude assessment of the 'success' or outcome of the implementation, and for use as a response variable for further analysis of factors facilitating conservation improvement.

*3.2.4.4 Validation of a 'no' response*

Respondents who did not believe that their findings had been used as a basis for conservation action were asked to identify the factors they believed to have acted as barriers to implementation. They were also given the option to state if their findings had been used as a basis for future action.

*3.2.4.5 Validation of an 'unsure' response*

Respondents who answered 'unsure' were given a choice of four options specifying what was meant by 'unsure' (Q34, Appendix I), each with further clarifying questions. This was designed to enable a post-survey assessment of whether 'unsure' was a 'yes' or a 'no'. This category was included to ensure that respondents did not select 'yes' if they were at all unsure, but did not wish to answer 'no'. It was thought that some respondents would not be sure, for example, if incorporation into policy or further research counted as 'a basis for conservation action', whereas some would assume that it did and answer 'yes'. It was therefore an attempt to separate out the perceptions of authors from the reality of implementation and allow modification of response according to a pre-defined procedure.

***3.2.5 Collection of survey data***

The survey was created online using the online questionnaire service provider SurveyMonkey (SurveyMonkey, 2007). It was piloted on 20 authors of species-based papers not included in the sample, and the questions were modified to resolve phrasing ambiguities and overlooked response options as required.

The link to the survey was sent to each of the corresponding authors in the sample through an email mail-merge. The email contained a short explanation as to the purpose of the study, along with the title of their individual paper and their author ID number. Respondents were asked to give their perceptions on the issue in relation to the research incorporated into the specific paper identified in the email. The editors of each journal were notified about the study, and this was also included in the email.

The link was sent to an initial 200 authors from a random sample of each of the five journals, and monitored for a week in order to gauge potential response rate and identify any problems. Two of the questions were modified slightly, but not in such a way so as to precluded the use of the data from the first respondents. When emails were returned as undeliverable, it was recorded on the spreadsheet and an effort was made to obtain the correct email address of the corresponding author of that paper.

### *3.2.6 Desk based research*

A number of explanatory variables were obtained not from the questionnaire but from desk based research. These included the species and country of study, and dates of submission obtained from each individual paper. In order to assess correlation between citation rate and practical implementation, the number of citations as identified by Google Scholar and ISI Web of Knowledge (ISI WoK) were recorded for each paper. ISI WoK is the main tool for academic citation analysis (Thomson Scientific, 2007) whereas Google Scholar is increasingly used for citation analysis and could potentially be a better indicator of real world implementation as it incorporates citations from grey literature and web pages (Google Scholar, 2007). The most recent Impact Factor (Thomson Scientific, 2007) for each journal was also obtained.

### *3.2.7 Data Analysis*

Responses from the online survey site were downloaded into excel spreadsheets, and matched up with the information obtained from the paper by the individual ID numbers. The data was checked, and in some cases validated or altered by the ‘further comments’ provided by the respondent. Responses of ‘other’ for all questions were checked to see if they could be re-categorised and if there were any recurring responses. Incomplete responses were deleted if

the respondent did not reach the question that formed the response variable, otherwise they were retained.

*3.2.7.1 Validation of response sample*

A random sample of 60 papers were selected from the response sample (20 from BC, 10 from each other journal) to validate survey responses where possible, such as whether the author had made concrete recommendations. A random selection of 100 papers from the full sample was taken to validate the characteristics of the papers in the response sample against those of the original full sample. The number of citations was recorded for each along with author affiliations and residence and whether it was a single species paper.

*3.2.7.2 Statistical analysis*

Analyses were carried out in the statistical computer program R (R Development Core Team, 2007). The questions were analysed univariately with the response variable in order to reveal any obvious patterns in the data, and chi squared contingency tables were used to test for significance between variables. TREE models in R were then used to select the most important explanatory variables for multivariate analysis. Data were represented in a series of box plots as they give proportional information of the relationship with the response variable (width of bar=N for each level of the explanatory variable).

Due to a mixture of categorical and continuous variables and a binary response variable, data were fitted to a general linear model (glm) with binomial errors (Crawley, 2002). For the multiple-response questions, each option had to be treated as a separate explanatory variable in the analysis. This was not feasible due to the number of explanatory variables, so all of the responses for each of these questions were first fitted to a glm and analysed against the response variable in order to determine the most important variables for inclusion in the model. Similarly, levels within each factor of the multiple choice questions were collapsed if the difference between them was non-significant or if they were highly correlated; as indicated by a similar slope in the glm.

The variables were tested for both main effects and interactions. The explanatory variables identified as most important were included in the model first, and further models were run with each different variable to be tested, with terms deleted manually in a step-wise manner if an ANOVA test determined non-significance. Any significant main effects or interactions were retained in order to obtain the minimum adequate model for explaining the variation around the response variable, and hence the most important predictors of the implementation of research findings.

### 3.3 Practitioner interviews

The question as to whether conservation practitioners consult primary literature when making management decisions was addressed qualitatively through semi-structured interviews (Drever, 2003) with conservation practitioners during a staff meeting at the Durrell Wildlife Conservation Trust in Jersey.

Although Durrell is a science-based conservation institution, the practitioners interviewed are involved in every day conservation action and have a 'real world' view of practical conservation. Although all interviewees were employees of the same institution, the meeting at Durrell offered a unique opportunity to obtain the views of practitioners based in various countries and with varying scientific backgrounds; some more involved in aspects of scientific research, and others more involved in conservation management. This is an example of a situation in which the lines between practitioner and researcher are blurred, but comparisons are no less valid, and indeed facilitated a more rounded analysis

It was important to get a wider view of the topic, rather than relying solely on the author perceptions; and to assess from the opposite viewpoint the issues of whether research is addressing the areas that practitioners believe to be most important, and how they believe it can best be disseminated.

#### *3.3.1 Interview structure*

A total of 10 practitioners from Durrell's conservation programmes in Mauritius, Madagascar, India, the Caribbean, and the Galapagos Islands were interviewed, along with staff members

based in the UK. They were involved in a variety of single species conservation actions, such as translocation, but also in wider biodiversity and legislative issues.

Questions were designed so as to complement the author survey, and with reference to similar studies (Pullin et al, 2004; Sutherland et al, 2004; Lach et al, 2003). General questions were asked initially, followed by a series of more focused prompts and probing questions to be asked dependent upon response (Drever, 2003)

The interviews (Appendix II) were approximately 15-30 minutes long and addressed three main areas:

1) The background of the interviewee and their role within the institution
2) Their views on the use and availability of scientific information
3) The reporting of information

Interviewees were asked what role research has to play in practical conservation action (a distinction was made between 'in house' research and external research), the type of research they found most useful in implementing conservation action, and what sources of information they consulted in the design or implementation of an action. They were asked in more detail about the role of publication in conservation action, and the particular journals that they read. They were then asked about their own methods of dissemination of conservation outcomes, and what forms of dissemination they felt, as conservation practitioners, were most useful in terms of influencing conservation action on the ground. Interviews were recorded using a Dictaphone and transcribed in full for qualitative analysis.

# 4. Results

## 4.1 Response sample

A total of 474 respondents were included in the analysis, of which 462 completed the survey fully. 16 respondents dropped out before reaching the response variable and were excluded from analysis. This gave a response rate of 45% excluding emails returned as undeliverable (otherwise 33%).

**Table 1 Response rate by journal**

| Journal | Original sample size | Response rate |
|---|---|---|
| AC | 113 | 45% |
| BC | 462 | 44% |
| BD | 147 | 38% |
| CB | 199 | 48% |
| OR | 128 | 51% |

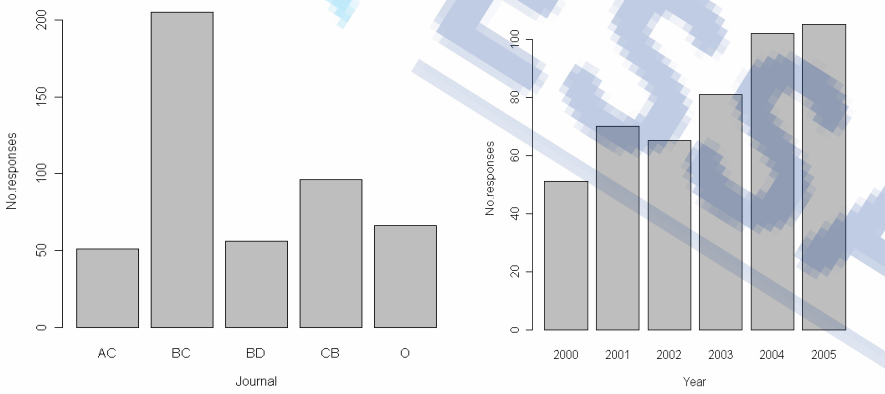


**Fig 2. The number of responses received (a) by journal (b) by year of publication. Increasing number of responses by year is a function of increased sample size**.

There was both an author residence and taxonomic bias. Responses were received from authors based in North America (39%), Europe (37%), Australasia (11%), Asia (5%), South America (4%), and Africa (3%); representing a wide range of species of mammals (31%), birds (23%), plants (16%) amphibians/reptiles (12%), invertebrates (12%), and fish (5%). A further 1% of the sample was classified as 'mixed', involving species from more than one of the groupings.

### 4.2 The use of findings as a basis for conservation action

Of the 474 respondents, 57% believed that their findings had been used in conservation action, 31% were unsure, and 13% did not believe that their findings had been used (fig. 3 (a)). Based on further responses, answers were adjusted to form a binary response variable of 'yes' and 'no' for analysis (fig.3 (b)). Upon examination of the 145 responses in the 'Unsure' category, 8 responses were adjusted to 'Yes' and the remainder re-categorised into 'No'. A total of 8 responses were moved from the 'Yes' to 'No' category, having failed to provide qualification of the yes response other than that their findings were used as a 'basis for future action'. Despite the alterations, the percentage of respondents who believed that their findings had been used in conservation action remained at 57%

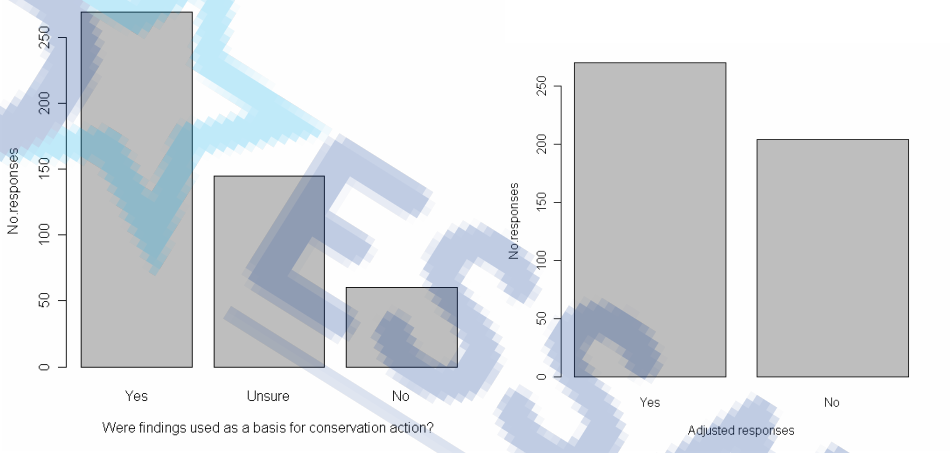


**Fig 3 (a) Original author responses to the question 'Have your findings been used as a basis for conservation action?' (b) Adjustment of findings into a binary response variable. (n=474)**

#### *4.2.1 'Yes' responses*

Of the 270 'yes' responses, 56% of findings had been used in both practical implementation (table 2) and policy (table 3). 27% stated that their findings had been used in practical implementation of conservation action only, and 11% stated that their findings had been incorporated into policy only. A further 6% did not provide any response. 59% of respondents qualified their answer in an open-ended response to provide evidence for the use of their findings (Box1; Box 2).

**Table 2. Forms of practical implementation of research findings (n=224)**

| Type of conservation action implementation | % response |
|---|---|
| Incorporation into an NGO/Govt action plan (implemented) | 52 % |
| Implementation by 'on the ground' practitioner | 51 % |
| Creation/design of a PA | 38 % |
| Increased participation of local stakeholders | 38 % |
| Increased enforcement of conservation measures | 34 % |
| Use in reintroduction/translocation programme | 23 % |
| Elimination/reduction of a specific threat | 22% |

**Box 1.** Examples of practical implementation of research findings from survey responses

1. A study by Rodriguez et al (2001) identified that an estuarine mollusc was threatened by habitat loss, which had not previously been known to be the case. This resulted in altered management practices to divert the Colorado River back into its former area.

2. Research by Roemer et al (2001) identified that feral pigs (indirectly) and golden eagles (directly) were causing the decline of island foxes on the Californian Channel Islands but this was not taken seriously by the manager until the research had been published in two journals. The management authorities subsequently began to remove these threats to the species and initiated a captive breeding programme.

3. A study by Morrogh-Bernard et al (2003) identified the largest contiguous orang-utan population in Borneo and led to the creation of a National Park in an area that was formerly land for logging, and is now widely recognised as an important area for orangutans.

4. A study identifying the important habitat for the critically endangered pale-headed brush finch in Ecuador (Oppel et al, 2004) led to the expansion of protected areas, better habitat management, and the removal of a threatening species. Subsequent monitoring has indicated an 80% increase of the population.

5. New protected areas for snow leopards were created in consideration of the habitat and range use requirements identified by McCarthy et al (2005)

6. Sikhote-Alin reserve focused poaching patrols on roads and some road closures in response to the findings of Kerley et al (2002) that there is higher survival of Amur tigers in roadless areas

**Table 3. Forms of action plans/policy into which findings were incorporated (n=180)**

| Policy document/listing findings incorporated into | % response |
|---|---|
| Govt action plan or policy document (yet to be implemented) | 63 % |
| NGO action plan or policy document (yet to be implemented) | 37 % |
| Advice of specialist groups (e.g. IUCN) | 29 % |
| National listing alterations | 19 % |
| IUCN Red listing alterations | 17 % |
| International policy document | 13 % |
| Change in legal status | 12 % |
| CITES listing alterations | 4 % |

**Box 2** - Examples of uptake of findings into action plans/policy

1. The BAP plans for two species of freshwater gastropod were amended on the basis of evidence provided in a study by Watson & Ormerod (2004)

2. A study by Baker & Johanos (2004) provided information on the importance of the previously overlooked main Hawaiian Islands for the Hawaiian monk seal, which has since been incorporated into the recovery plan for the species

### *4.2.2 Role of the specific research in implementation*

Respondents were asked to indicate the role that their research had played in any implementation. 42% thought it had played a major role, 42% some role and 15% a minor role All respondents (n=8) who were either unsure as to whether their research had played a role, or thought their research had played no role in the implementation, had already been re-categorised as a 'No' response.

The majority of authors (91%), even those who did not believe that their findings had been used as a basis for conservation action, believed that their findings were acting as a basis for future action; which although not of current benefit could improve understanding, motivation, and methodological techniques for future conservation actions.

### *4.2.3 Implementation of findings and conservation 'success'*

51% of respondents whose findings had been implemented into conservation action reported an improvement in conservation status (32% as a result of the specific conservation action,

19% said the role of a specific action was difficult to evaluate). 30% said it was difficult to measure/assess improvement, 12% reported no improvement, and 4% that the status had worsened. 2% were unaware of conservation status. This emphasises the fact that implementation does not confer success. Levels of reported conservation status improvement were only significantly higher when the findings had influenced creation/design of a PA ($z=2.11, df=168, p=0.03$), perhaps due to the identification of habitat loss as the major threat (section 4.3.4.2)

There was no significant difference in the reported consequences of the conservation action between those who stated that their findings had led to practical implementation and those who stated that their findings were taken up into policy only.

### *4.2.4 Author perceptions of the main reasons for implementation*

Involvement of a threatened species, involvement of stakeholders, and practical recommendations were the main reasons for implementation of findings according to the perceptions of authors (fig 4. (a)), but adequate dissemination of findings came out slightly on top in a weighted ranking of importance (fig 4. (b)).

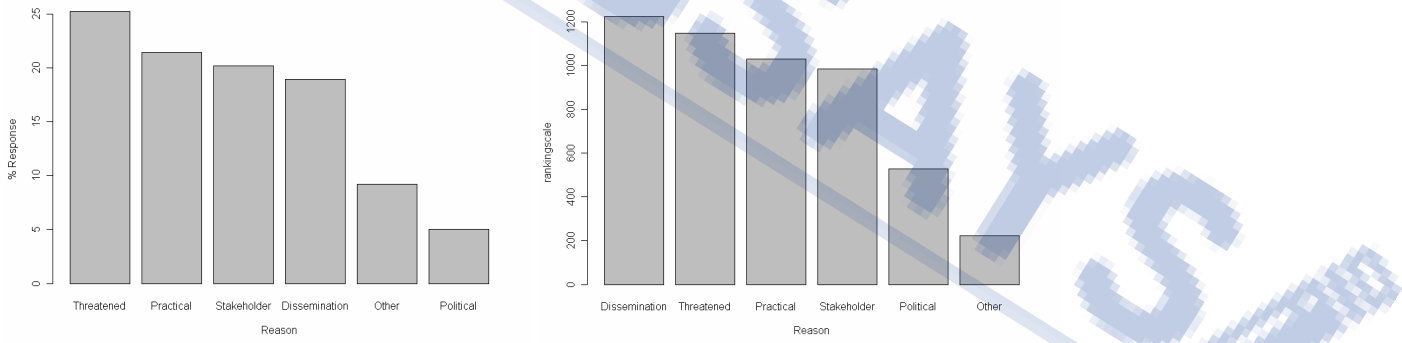


**Fig 4. (a) Author perceptions of most important reasons for implementation of research findings (n=270) (b) Reasons for implementation ranked on a scale of: 15=most important, 10=important, 5=somewhat important, weighted according to the number of responses in each category. Dissemination=appropriate dissemination of findings, Threatened=involvement of a threatened species, Practical=practical recommendations, Stakeholder=stakeholder involvement, Political=amenable political climate**

Those who identified involvement of stakeholders as being of any importance were asked to specify which stakeholders they were referring to. The involvement of conservation managers, local government, and local NGOs were most often selected, closely followed by local communities (fig. 5)

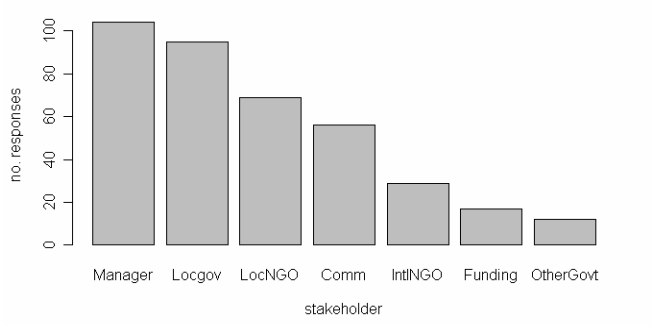


**Fig 5. Stakeholders believed to be important in implementation of conservation action (n=160). Manager=conservation manager, Locgov=local government, LocNGO=local NGO, Comm=local communities, IntlNGO= international NGO, Funding = funding body, OtherGovt=Government outside the study region**

### *4.2.5 'No' responses*

Respondents who did not believe that their findings had been implemented rated lack of concern amongst stakeholders as the most important barrier to implementation, followed by political climate. They were also the main barriers after weighted ranking of importance, with lack of involvement of communities placed higher up the scale of importance.

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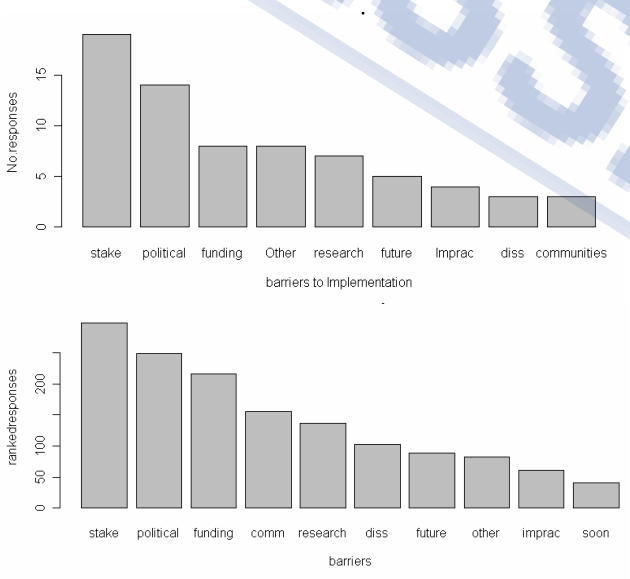



**Fig 6 (a) Factors believed to be the most important barrier to implementation (n=57) (b) Importance of barriers ranked on a scale of: 15=most important, 10=important, 5=somewhat important, weighted according to the number of responses in each category. stake=lack of concern amongst stakeholders, political=political climate, funding=lack of funding, comm=lack of involvement of local communities, research=further research required, diss=inadequate dissemination, future=for future use, imprac=impracticality of findings, soon=too soon for any action to be taken.**

## 4.3 Univariate analysis of factors influencing implementation

### *4.3.1 Journal level correlates*

There were significantly different levels of uptake between journals (fig.7).

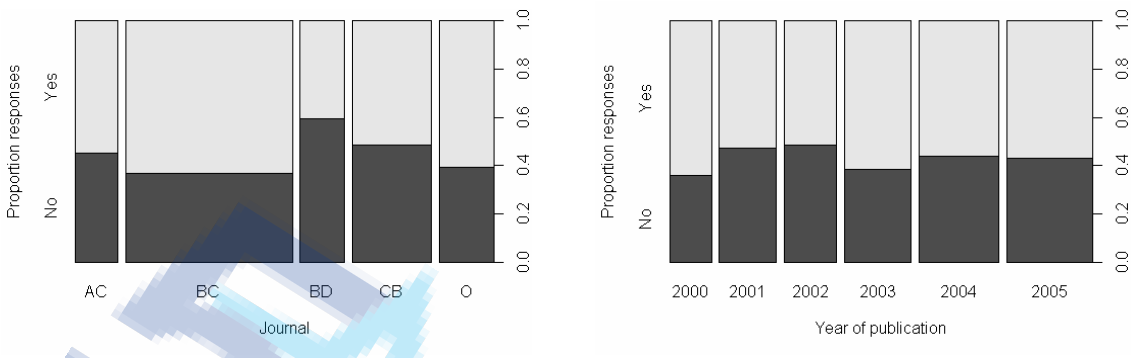



**Fig 7. (a) Journal differences in the uptake of findings were significant ($X^2$ = 10.53, df= 4, p= 0.03) BC and O had the highest levels of implementation. (b) There was no relationship between year of publication and uptake of findings.**

This suggests journal level influences on the implementation of research. However, logistic regression showed that only BD had significantly lower levels of implementation than the baseline (BC) (z= 2.66,df=427,p=<0.007).

*4.3.1.2 Citations and Impact factor*

The average number of citations per year for each paper from Google Scholar and ISI WoK were highly correlated (t = 40.01, df = 465, p= <0.001), and neither had a significant influence on the uptake of findings (fig. 8 (a)). To emphasis this, research with findings most applicable at the species level had a higher uptake of findings into conservation action ($X^2$=7.17,df=2,p=0.03) but a significantly lower citation rate, than papers applicable to multiple species (t=2.2,df=365,p=0.03).

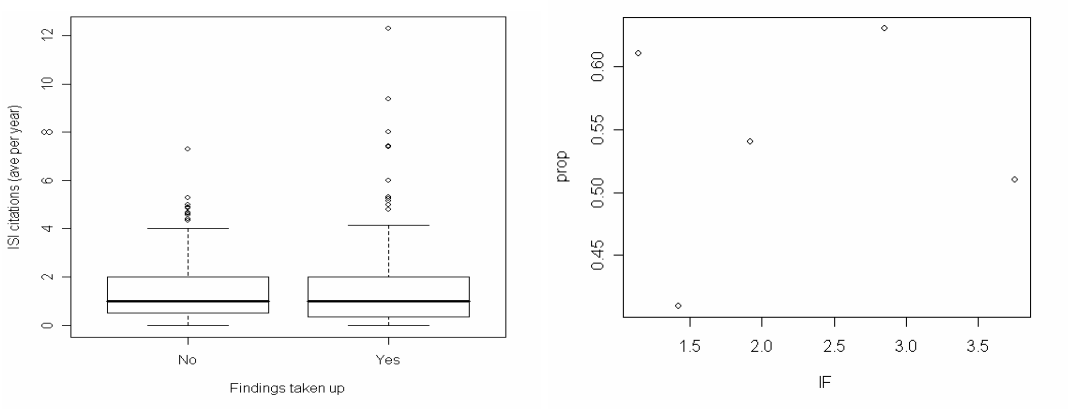



**Figure 8 (a) Average number of citations from ISI WoK was not correlated with implementation of findings (z=0.2,df=474,p=0.8). (b) 2006 Impact Factor of the journal and proportion of 'yes' responses were not correlated (t = 0.1787, df = 3, p-value = 0.86**)

The lack of correlation between the Impact Factor of the journal and the proportion of 'Yes' responses suggests (fig. 8 (b)) that Impact Factor is not an indication of the practical utility of research.

### *4.3.2 Background to the research project*

#### *4.3.2.1 Author residence and capacity*

Although there was no overall significant influence of corresponding author residence on the uptake of findings (fig. 9), marginally higher levels of implementation were reported from authors based in Australasia (z=2.12,df=459,p=0.04).

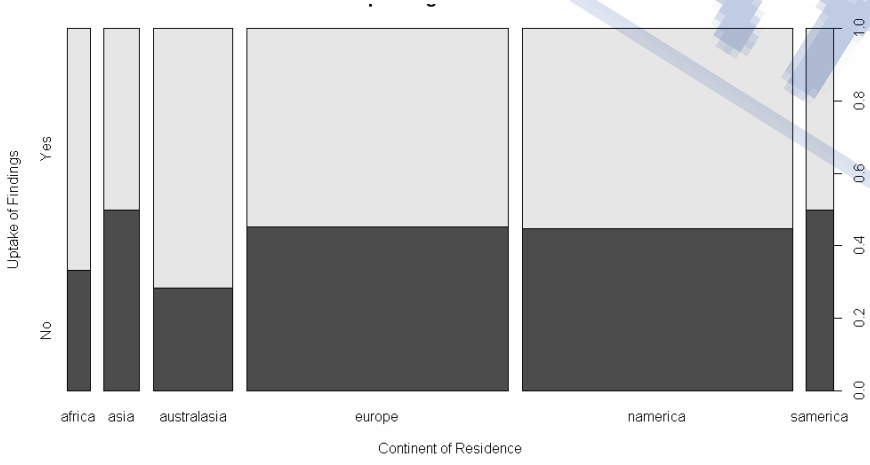



**Fig 9**. **Continent of residence of the corresponding author was not a significant determinant of uptake of findings ($X^2$=8.28,df=6,p=0.2)**

For multiple response questions, such as the professional affiliations of co-authors (Q3, Appendix I), each response was treated as a separate variable and examined with logistic regression. The only variable with significant explanatory power for the variation around the response variable was when co-authors were affiliated to a local NGO (z=2.89,df=403,p=0.004).

When co-author affiliations were regressed against corresponding author affiliations, there was an interaction between academic corresponding author and academic co-authors (p=0.03, df=403), showing that findings were less likely to be taken up when both corresponding and co-authors were academics. Similar slopes and non-significance between levels of uptake of findings for both corresponding and co-authors affiliated to a local NGO, international NGO or government body allowed these factors to be collapsed together into a single two level factor for further analysis; research papers in which authors had academic affiliations only (and independent researchers), and research papers for which at least one of the authors had an affiliation to an NGO or government body (fig. 10).

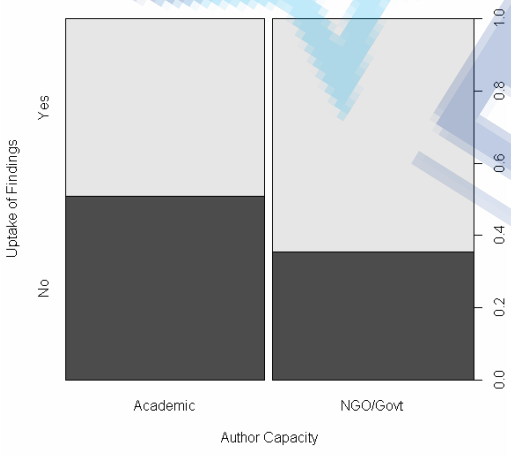



**Fig 10. Relationship between author affiliations and uptake of findings. There was a significantly higher proportion of findings implemented when at least one of the authors of the paper had NGO or government affiliations ($X^2$=10.8,df=1,p=<0.001).**

This suggests that NGO/government affiliations are important in the implementation of research findings.

*4.3.2.2 Funding*

Logistic regression of the multiple response question determining the organisation(s) that provided funding for the research showed that research funded by local (z=3.8,df=457,p=<0.001) or international (z=2.78,df=457,p=0.005) NGOs, and a government

body within the study region (z=2.78,df=457,p=0.01) were all positively correlated with uptake of findings (and therefore used in further analysis). Research funded by government bodies in a different region and academic institutions had a non-significant negative correlation.

*4.3.2.3 Geographical determinants*

Although there was no significant impact of the location of the study by continent (fig. 11(a)), the levels of implementation if the study was based in a developed country (according to United Nations (UN) classifications (UN, 2005)) rather than developing were marginally higher (fig. 11 (b)) which would perhaps be expected given the lower capacity of these countries.

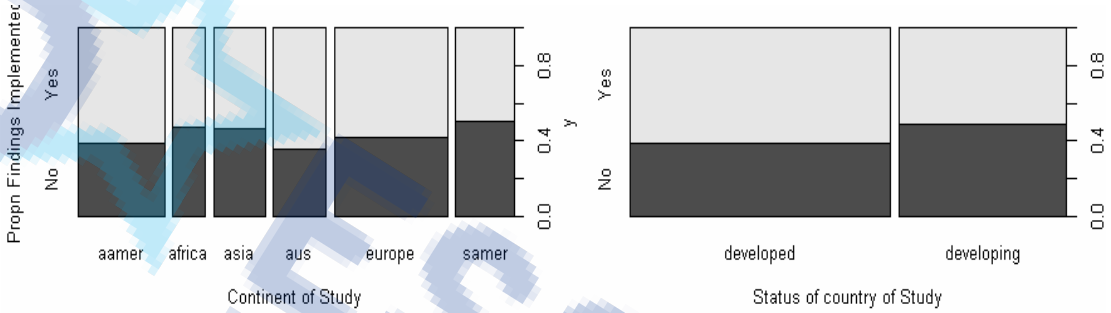



**Fig 11. (a) Proportion of findings implemented in relation to continent of study. Although there were lower levels of implementation in Africa, Asia, and South America this was not significant. (b) The relationship between status of the country of study and uptake of findings. There was a slightly lower proportion of findings implemented in developing countries than developed ($X^2$=4.32,df=1,p-value=0.04).**

Whether or not the corresponding author was resident in the country of study had no significant influence on the uptake of findings (fig. 12 (a)), but interestingly there were significantly higher levels of uptake if co-authors were resident in the country of study (fig. 12 (b)), This had greater significance than when the two variables were combined into a single variable of whether any of the authors were resident ($X^2$=5.48,df = 1,p=0.02).

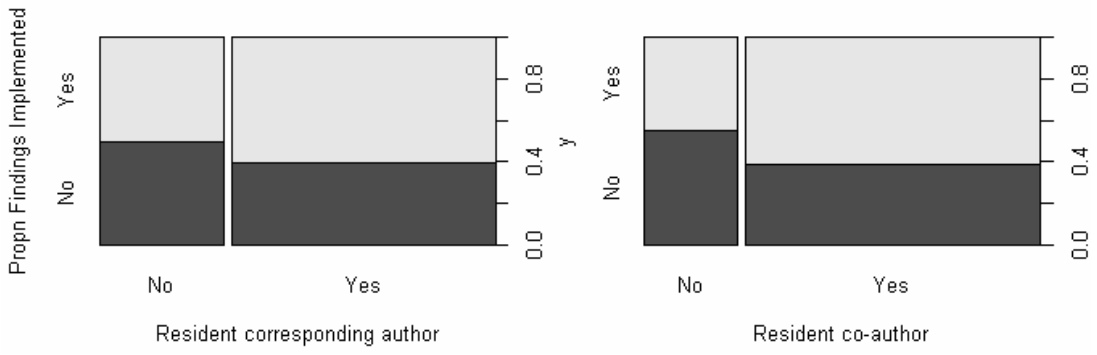



**Fig 12. Implementation of findings according to whether the corresponding authors (a) or co-authors (b) were resident in the country of study. There was no significance of corresponding author residence ($X^2$=3.24, df=1, p=0.07) but a higher proportion of findings implemented if a co-author was resident ($X^2$= 7.80, df = 1, p= 0.004).**

Further analysis showed this to be due to characteristics of research in which only the corresponding author was resident (fig. 13; section 4.6), possibly due to attributes of single author papers. Therefore, whether or not a co-author was resident in the country of study was the best predictor of uptake of findings and used in further analysis

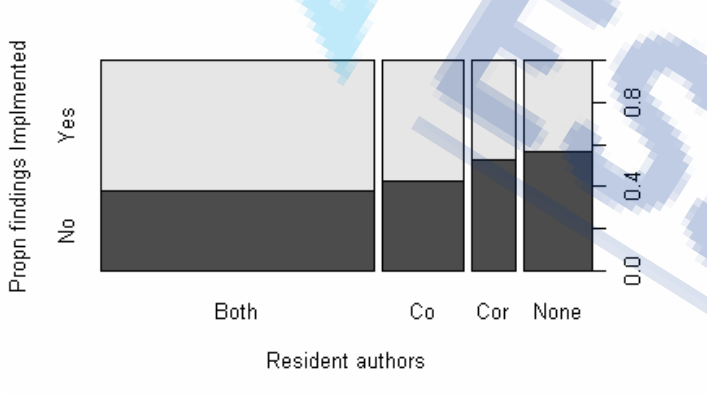



**Fig 13. Implementation of findings according to whether both authors (Both), co-authors only (Co), corresponding authors only (Cor) or no authors (None) were resident in the country of study. The levels of implementation were significantly higher when both co and corresponding authors were resident than when there was no resident author (z=2.75, df=453,p=0.005,), but when only the corresponding author was resident, there was actually a lower level of implementation than when both or co-authors were resident, and this was only marginally non-significant (z=1.76, df=453,p=0.07).**

*4.3.2.4 Species type*

There was no significance in proportion of findings taken up across species groups, and therefore no taxonomic bias in implementation

### *4.3.3 Motivation behind the research and publication*

There was a significant difference in levels of implementation for the motivation behind both the research project and publication (fig. 14).

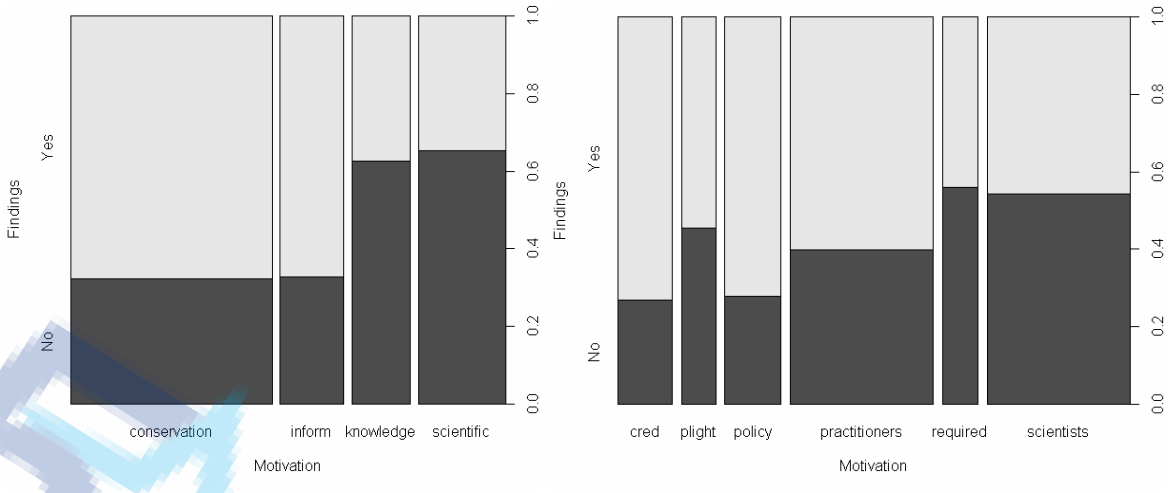



**Fig 14 (a) Relationship between implementation of findings and motivation behind the research project. Researchers undertaking research aiming to inform decision making (inform) and address conservation management issues (conservation) had higher levels of implementation than those who aimed to further knowledge of the species/system (knowledge), or address a scientific research question (scientific) ($X^2$= 42.18,df = 3,p=<0.001). (b) Relationship between implementation of findings and motivation behind the publication ($X^2$=20.78,df=5,p=<0.001).**

That those who published to give the research scientific credibility had the highest levels of implementation likely reflects the further comments added by many of these respondents that, although the most important thing was to inform practitioners, this had been done prior to publication. The influence of motivation behind publication of the research was further analysed in logistic regression (table 4), and suggests that publication in the literature is not the best form of dissemination to practitioners.

**Table 4. Glm model for motivation behind publication of the research with credibility as the baseline (df=455). Researchers who published for dissemination to scientists or as a requirement of the research project had significantly lower levels of implementation than those who published to give scientific credibility to the research.**

| Motivation behind publication | Pr(>\|z\|) | Direction of effect |
|---|---|---|
| To give the research scientific credibility | 0.001 (intercept) | positive |
| Dissemination to policy makers | 0.92 | positive |
| Publicise plight of species | 0.08 | positive |
| Dissemination to practitioners | 0.1 | positive |
| Dissemination to scientists. | 0.009 | negative |
| Requirement of the research project | 0.008 | negative |

Levels with similar slopes in relation to the response variable were collapsed together for further analysis; 'conservation' and 'inform', 'knowledge' and 'scientific', 'required' and 'scientists', and 'credibility' and 'policy'. These levels could be justifiably collapsed as there was an a priori reason for doing so based on the expected similarities of respondent characteristics for the collapsed responses.

### *4.3.4 Background research information*

#### *4.3.4.1 Type of research*

Whilst the majority of research was focused on threats to species, there was a relatively even distribution of the percentage of papers focusing on the various categories of research type; conservation status (18%), species biology (17%), threats (31%), determining priorities or strategies (20%), and evaluating efficacy of conservation measures (10%), and no significant differences between the categories and their influence on the uptake of findings (fig. 15)

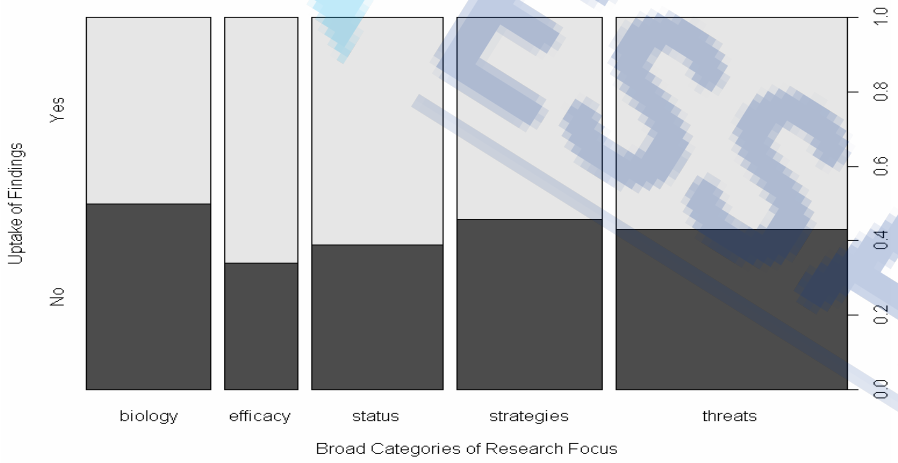



**Fig 15. Relationship between research type and proportion of findings taken up was not significant ($X^2$= 4.71,df = 5,p=0.45). Slightly higher levels of implementation can be seen for those focusing on efficacy of conservation measures than those investigating species biology, but this again was not significant (p=0.08)**

The majority of research papers (72%) took only species/system biology into account, but a significantly higher proportion of uptake was reported for those that also incorporated socio-economic factors (z=2.34,df=461,p=0.02). Although there appears to be significantly lower levels of implementation with only socio-economic factors taken into account (fig. 16), the sample size (n=10) was not large enough to determine significance.

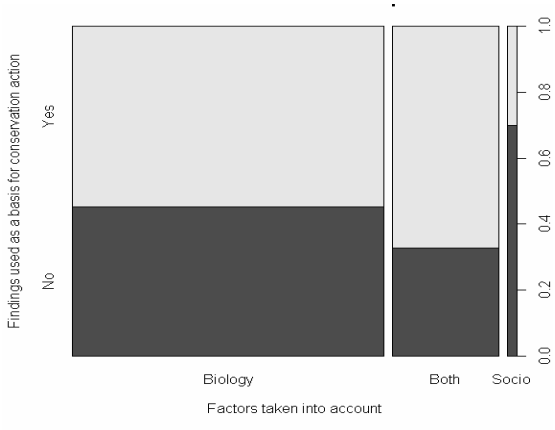



**Fig 16. The influence of incorporation of socio-economic factors into research upon the implementation of findings. There was a significant difference in levels of implementation depending on whether the research took into account only species/system biology (Biology), socio-economic factors only (Socio) or both biological and socio-economic factors (Both) ($X^2$=8.64,df = 2,p=0.01)**

*4.3.4.2 Threats*

65% of respondents identified habitat loss as the major threat to the study species/system, and a further 20% identified human influences or over-exploitation. Habitat loss also was the major threat identified in a ranking of the top three threats and over-exploitation was the second (fig. 17). All other categories were therefore grouped as 'other' for analysis. A higher proportion of respondents identifying exploitation and 'other' had their findings implemented than those who identified habitat loss as the major threat ($X^2$=9.03,df = 2,p= 0.01), perhaps suggesting that it is more manageable to remove a threat than to address the issues of habitat loss.

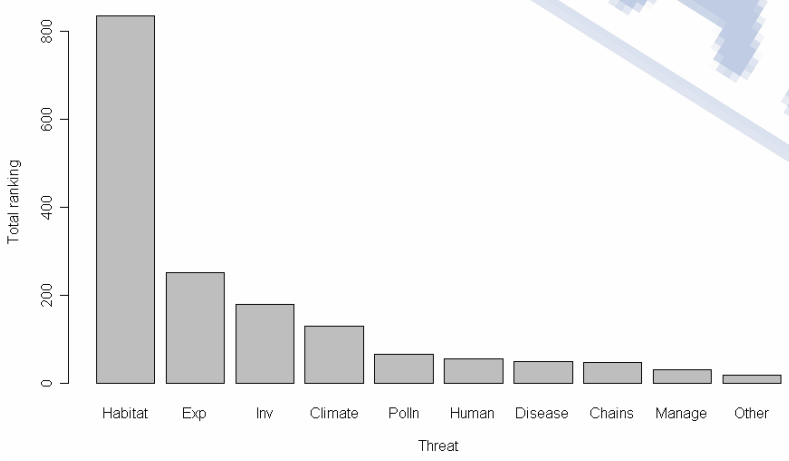



**Fig 17. Summation of rankings (top threat=3, second threat=2, third threat=1) for the categories identified as the top 3 threats to the species of research. Habitat loss was clearly the major threat for the sample of papers analysed (Habitat=habitat loss, Exp=over-exploitation, Inv=invasive species, Climate=climate change, Polln=pollution, Human=human influences (accidental), Chains=chains of extinction, Manage=unsuitable management practices)**

### *4.3.5 Recommendations and Dissemination*

72% of respondents made recommendations for conservation action or potential management strategies and had a significantly higher proportion of findings implemented than those who had not (fig. 18 (a)). 77% of respondents had disseminated their findings through forms other than the peer reviewed paper, and in these cases a higher proportion of findings were implemented (fig. 18 (b))

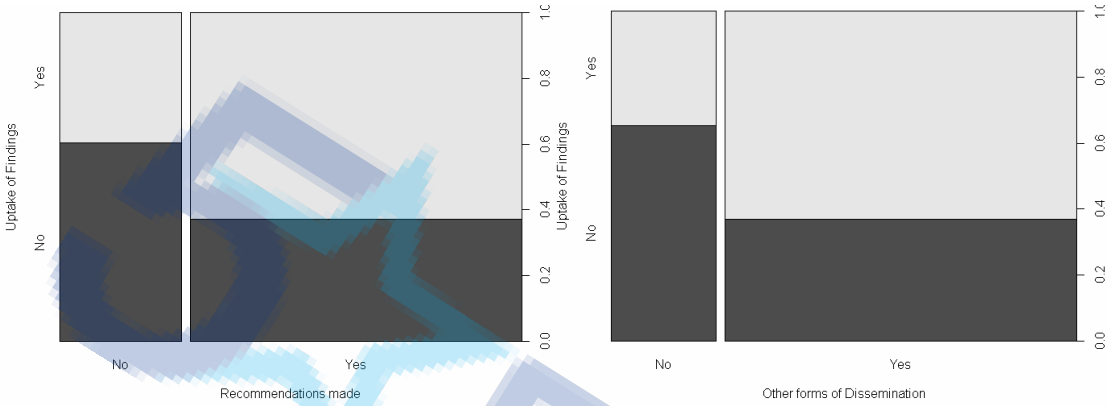



**Fig 18. The relationship between (a) recommendations for conservation action (b) further dissemination of research findings and implementation. There was a higher level of implementation when recommendations were made ($X^2$ = 18.44, df = 1, p= <0.001) There was a higher level of implementation when findings were further disseminated ($X^2$= 25.41, df = 1, p = <0.001)**

There were no significant differences in levels of recommendations made by journal, but BD had significantly lower levels of dissemination than the baseline (z=-2.63, df=449, p=<0.01) and was also the journal with the lowest levels of implementation (section 4.3.1).

Levels of dissemination were similar regardless of author capacity (fig. 19 (a)), but levels of uptake when findings were not further disseminated (fig. 19 (b)) suggest that further dissemination of findings is not as important to those with NGO/Govt affiliations, likely because those involved in the research have the capacity to influence conservation practice.

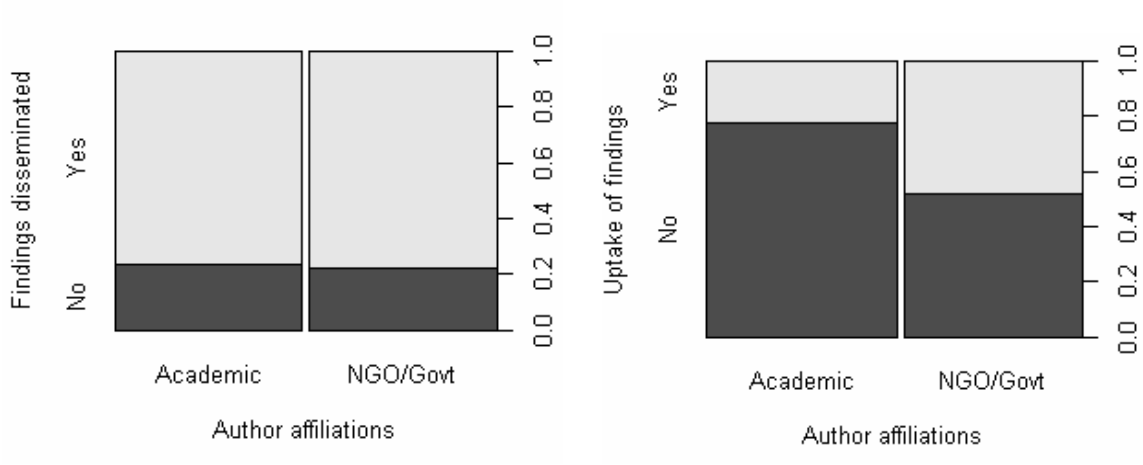



**Fig 19. Dissemination and author affiliations (a) Proportion of respondents who disseminated their findings further according to author affiliations (b) Levels of implementation amongst authors who had not disseminated their findings further were significantly lower amongst authors with only academic affiliations ($X^2$=6.52, df=1, p=0.01).**

27% of respondents identified publication of the research paper as the most important form of dissemination, 37% rated it as very important, and 30% as important. This had no significant relationship with the implementation of findings

### *4.3.6 Summary of univariate analysis*

It is clear that there are a number of factors that influence the uptake of research findings into conservation action (table 5). Multivariate analysis is therefore necessary to determine the most important determinants of this.

**Table 5. Summary of the variables included in univariate analysis, and their significance in relation to the implementation of findings in conservation action**

| Variable | Significance | Details |
|---|---|---|
| Journal | Yes | BD had lower levels of implementation |
| Year of publication | No | - |
| Citations and Impact Factor | No | - |
| Corresponding author residence | No | - |
| Author affiliations | Yes | Authors with NGO/Govt affiliations had a higher proportion of findings implemented than those with academic affiliations only. Those with NGO affiliations had the highest levels of implementation. |
| Funding | Yes | Higher levels of implementation when research funded by an NGO or local government body |
| Continent of study | No | - |
| Status of country of study | Yes | Slightly lower levels of implementation in developing countries than developed |
| Authors resident in country of study | Yes | Levels of implementation higher when co-authors resident in the country of study |
| Motivation behind the research | Yes | Higher levels of implementation when motivation was to address conservation management issues |
| Motivation behind publication | Yes | Higher levels of implementation when publication was to give scientific credibility to work and disseminate to policy makers |
| Type of research | No | - |
| Incorporation of socio-economic factors | Yes | Higher levels of implementation when research addressed socio-economic factors as well as species/system biology |
| Threats to study species | Yes | Lower levels of implementation when the threat is habitat loss |
| Recommendations made | Yes | Higher levels of implementation when recommendations made |
| Further dissemination | Yes | Higher levels of implementation when findings disseminated further |

### 4.4 Multivariate analysis of determinants of implementation

In a glm, the factor with the greatest explanatory power for the variation around the uptake of findings was the motivation behind the research project. There were higher levels of implementation when at least one of the authors of the paper was affiliated to an NGO or government, when the research was funded by a local NGO, if the research was still ongoing,

if the author made recommendations, and if the findings were otherwise disseminated (table 6). The level of application of findings also was a marginally significant factor, with findings applicable at a single species level having higher rates of implementation than at a multiple species level.

**Table 6. Minimum adequate model for factors influencing the implementation of research findings (logistic regression (df=423). Only the factor levels of significance are shown in detail P(>|z|), otherwise only the significance of the factor as a whole is represented P(>|Chi|)**

| Factor | Factor level | Direction | P(>\|z\|) | P(>\|Chi\|) |
|---|---|---|---|---|
| Dissemination | Yes | Positive | 0.32 | 3.572e-07 |
| Motivation (research) | Scientific | Negative | 3.58e-06 | 2.219e-09 |
| Author capacity | Academic | Negative | 0.63 | 0.02 |
| Recommendations | Yes | Positive | 0.003 | 1.453e-03 |
| Research ongoing | Yes | Positive | 6.72e-06 | 4.417e-06 |
| Funding local NGO | No | Negative | 0.008 | 1.871e-03 |
| Species level | Yes | Positive | 0.009 | 0.01 |
| Status of research country | Developed | Positive | 0.02 | 0.21 |
| Year | - | - | - | 0.46 |
| Author capacity:status | - | - | - | 0.04 |
| Dissemination:Year | - | - | - | 0.03 |

Although the year of publication had no significant impact on the uptake of findings in univariate analysis (table 5) or indeed as a main effect (table 6), there was a significant interaction on the uptake of findings combined with dissemination. In 2000, whether or not the results were disseminated had no impact on uptake of findings whereas in all other years, including 2005, there was a largely significant interaction between dissemination and uptake of findings (fig. 20). This could suggest a time lag in implementation of research findings directly from the research paper, but is more likely a function of smaller sample size in 2000, as levels of implementation in 2001 were statistically different from 2000, but not 2005.

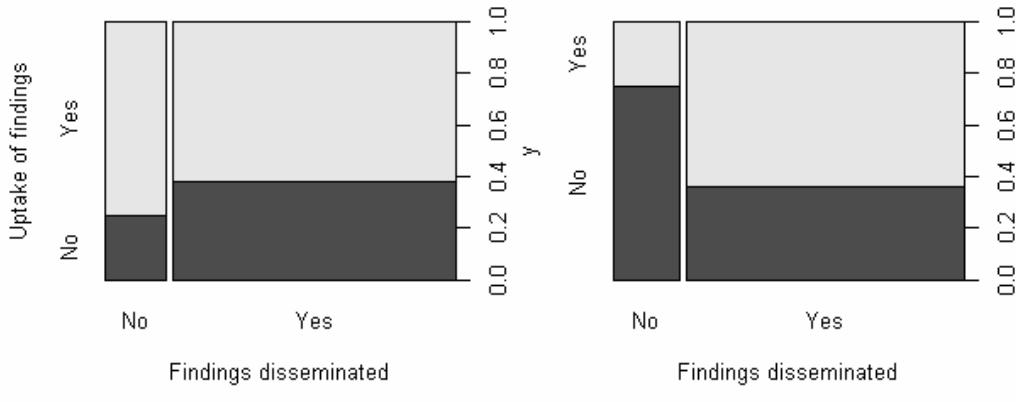



**Fig 20. Relationship between further dissemination and implementation of findings when the year of publication is (a) 2000 (b) 2005. There was a significantly lower level of implementation when findings were not disseminated in 2005 (z=2.209,df=423,p=0.02) but not in 2000.**

There was also a significant interaction between whether or not authors had non-academic affiliations and whether country of study was developing or developed (table 5). This interaction caused a large reduction in the explanatory power of author capacity as a main effect. Research findings from papers authored only by academics had a much lower level of implementation, but this was dependant upon whether the study was carried out in a developing or developed country (fig. 21). In developing countries, the professional capacity of the author does not appear to have as much of an impact, suggesting that there are other factors better explaining the variation around the response variable (section 4.6).

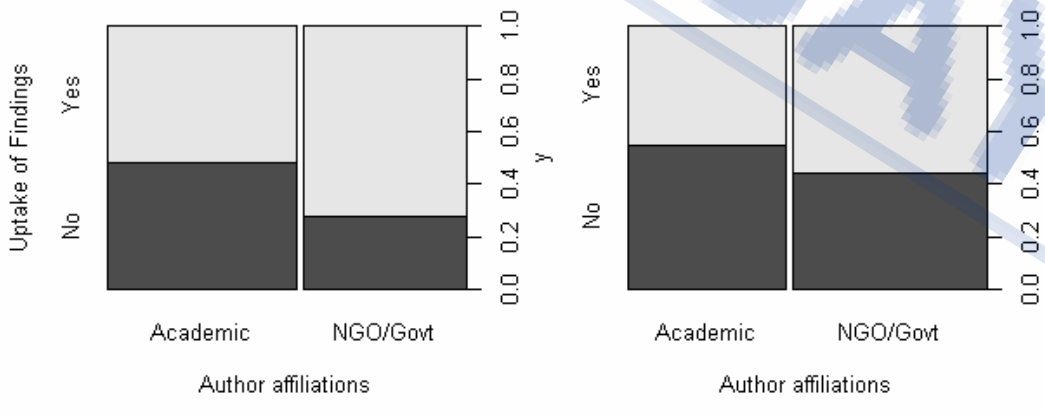



**Fig 21. The relationship between implementation of findings and author affiliations when the research is based in (a) developed countries (b) developing countries. In developed countries there is a much higher level of implementation if the authors do not have solely academic affiliations, whereas in developing countries, author affiliations have only a slight influence on implementation levels**

Some variables that had significant impacts upon univariate analysis did not have sufficient explanatory power to remain in the minimum adequate model or were reflecting other variables and therefore redundant. These were removed from the analysis, and included; journal, consideration of socio-economic factors, threat, author residence in relation to country of study, international NGO and local government funding bodies, single species research papers, and motivation behind publication.

Other variables with no significance in univariate analysis were included to control for confounding variables, but none were retained other than year of publication. These were; citations, type of research, species group, continent of author residence, and whether the findings were applicable to the area of study only or multiple ecosystem types.

### *4.4.1 Major determinates of practical implementation*

11% of 'yes' responses indicated that findings had been taken up into policy only (table 3) rather than in practical implementation (table 2) and were adjusted to a 'no' response to determine whether there would be any difference in the factors determining practical implementation of findings only (table 7). This left 47 % of respondents whose findings had been implemented. Only main effects were examined.

**Table 7. Minimum adequate model for factors influencing the practical implementation of research findings (logistic regression (df=429). Only the factor levels of significance are shown in detail P(>|z|), but the significance of the factor as a whole is represented P(>|Chi|)**

| Factor | Factor level | Direction | P(>\|z\|) | P(>\|Chi\|) |
|---|---|---|---|---|
| Journal | CB | Negative | 0.028 | 0.05 |
| | BD | Negative | 0.031 | - |
| Dissemination | Yes | Positive | 0.02 | 0.02 |
| Motivation (research) | Scientific | Negative | 0.0002 | 4.999e-07 |
| Motivation (publication) | Scientific | Negative | 0.030 | 0.05 |
| | Practitioners | Negative | 0.028 | - |
| Author capacity | Academic | Negative | 0.04 | 1.594e-04 |
| Recommendations | Yes | Positive | 0.001 | 7.227e-04 |
| Research ongoing | Yes | Positive | 6.95e-05 | 1.351e-05 |
| Funding local NGO | No | Negative | 0.01 | 8.025e-04 |

The model was very similar to that reported above, suggesting that the initial response variable is representative. However, journal differences became significant, with CB joining BD with

lower levels of implementation (fig.22 (a)), and findings applicable at the species level only was removed from the model. This could be due to journal differences reflecting this variable, as CB and BD have the lowest proportion of findings applicable at a species level (fig.22 (b)). Motivation behind publication also increased its explanatory power, with the purpose of publication to practitioners becoming significantly negatively correlated with the implementation of conservation action, further supporting the assertion that publication is not an adequate form of dissemination to reach conservation practitioners.

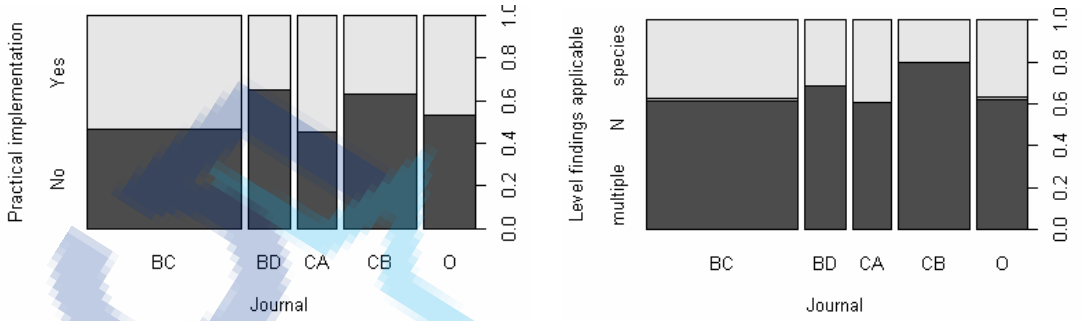



**Fig 22. Journal level differences (a) in practical implementation of research findings (excluding policy) (b) in proportion of papers with findings applicable at a species level. CB and BD have the lowest levels of both implementation and papers with findings applicable at the species level.**

## 4.5 Single species analysis

69% (n=324) of the research papers included in the analysis were focused upon a single species, and had marginally higher reported levels of uptake than those that were not ($X^2$=3.95,df = 1,p= 0.04). This was not significant upon multivariate analysis.

There were two more variables added to the analysis for single species papers: IUCN Red List status, and perceived importance of the species.

### *4.5.1 IUCN listing status*

IUCN listed species had a significantly higher level of implementation than non-listed species (fig. 23). Species for which the author was unaware of status had similar levels of implementation, but these responses mostly came from the USA and New Zealand where national listing is used over the IUCN Red List.

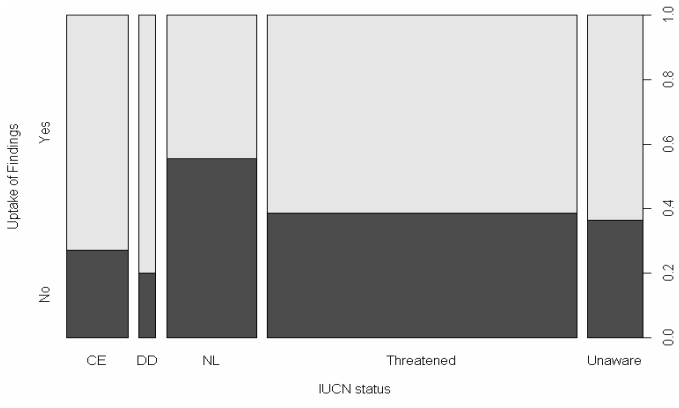



**Fig 23. Relationship between IUCN listing status and uptake of findings. Findings relating to listed species had a significantly higher proportion of uptake than those that were not listed ($X^2$=10.18,df = 4,p=0.04) CE=Critically Endangered, DD=Data Deficient, Threatened=any other category of threat, Unaware=author not aware**

### *4.5.2 Multivariate single species analysis*

Analysis of the single species data gave a similar minimum adequate model (table 8), but the significant interaction between recommendations and IUCN listing status of the species lowered the significance of the previous interactions and resulted in deletion of year, status of study country, and author capacity from the model. Involvement of flagship species (p=0.06, df=294) and endemic species (p=0.11, df=295) were marginally non significant.

**Table 8. Minimum adequate model for factors influencing the implementation of research findings in single species studies only (logistic regression (df=290). Only the factor levels of significance are shown in detail P(>|z|), otherwise only the significance of the factor as a whole is represented P(>|Chi|)**

| Factor | Factor level | Direction | P(>\|z\|) | P(>\|Chi\|) |
|---|---|---|---|---|
| Dissemination | Yes | Positive | 5.78e-05 | 8.853e-07 |
| Motivation (research) | Scientific | Negative | 6.41e-05 | 3.589e-05 |
| Recommendations | Yes | Positive | 0.32745 | 4.306e-04 |
| Local NGO funding | No | Negative | 0.00138 | 1.990e-03 |
| Research ongoing | Yes | Positive | 0.00113 | 1.220e-03 |
| IUCN listing | - | - | - | 0.26 |
| Recommendations:IUCN listing | - | - | - | 0.01 |

Although IUCN listing status was not significant as a main effect, there was an interaction with recommendations (fig. 24). Recommendations for use of findings had no impact if the

species was not listed or if the author was unaware of the listing, suggest that it is important for recommendations to be made, but this has no impact if the species is not considered threatened.

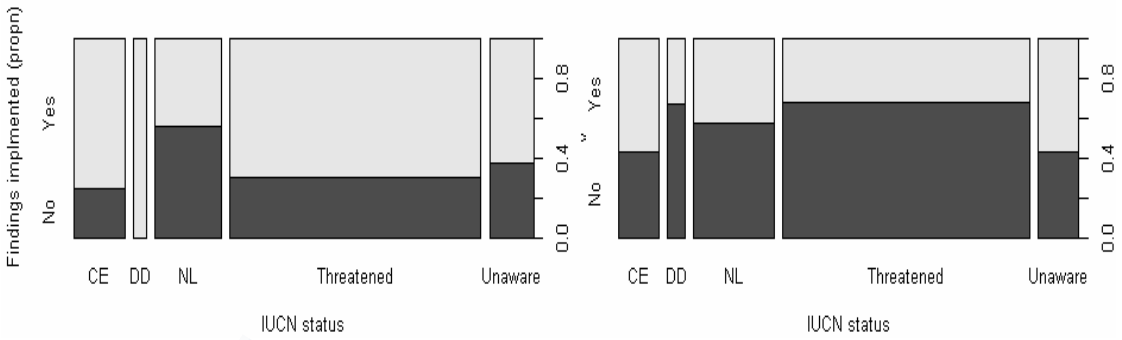
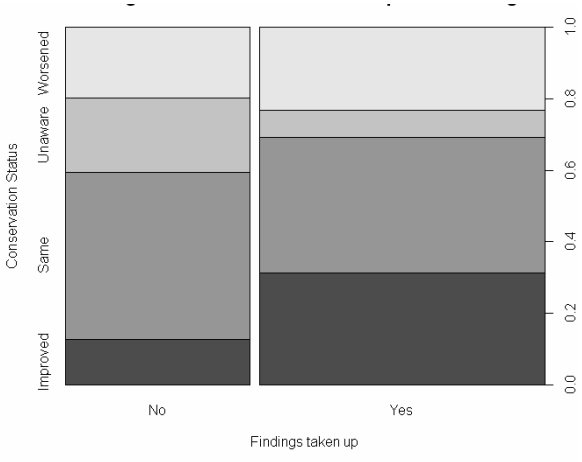



**Fig 24. The proportion of findings implemented according to IUCN listing status of the species (a) when recommendations were made (b) when recommendations were not made. In the 'threatened' category, there was a large decrease in the levels of implementation in the absence of recommendations. CE=Critically Endangered, DD=Data Deficient, Threatened=any other category of threat, Unaware=author not aware**

### *4.5.3 Conservation improvement*

Only 24% of respondents thought that the conservation status of the species had improved since they began their research, but whether the respondent had answered 'Yes' or 'No' to use of findings (fig. 25) was a significant predictor of this with a higher proportion reporting that conservation status had improved if the findings had been implemented. 73% of responses were further validated by open-ended comment.




Answer to question based upon:

| | |
|---|---|
| IUCN listing | 75 |
| CITES listing | 46 |
| Personal communication | 136 |
| Personal observation | 117 |
| Long term trends | 131 |
| The study in question | 41 |
| Follow up study | 62 |
| Research reported by others | 84 |

**Fig 25. The relationship between conservation status and uptake of findings. There was a significant difference in the conservation status depending on uptake of findings ($X^2$=23.4,df = 4,p= <0.001).**

### 4.6 Geographical determinants of implementation

The majority of research (60%) was carried out in developed countries. There was a highly significant difference between journals ($X^2$= 90.34, df = 8, p= <0.001) in the proportion of research that was carried out in developed and developing countries (fig. 26), but there was no significant difference in the levels of implementation in developing countries by journal.

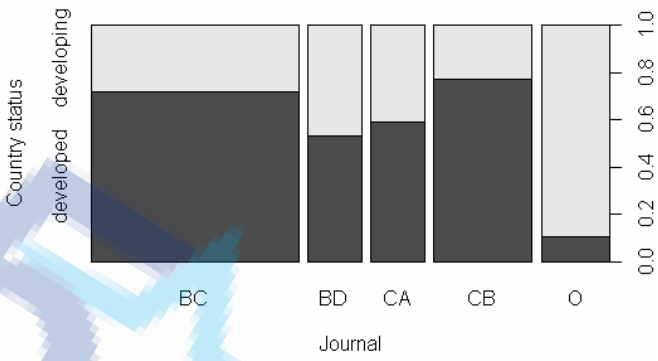



**Fig 26. Journal differences in the proportion of studies based in developing countries showed only Oryx to have a high proportion of developing country studies.**

Of the studies based in developing countries, 50% of respondents' findings had been implemented (n=179), (compared to 61% in developed countries), 44% in terms of practical implementation. 37% had a corresponding author resident in the study area, compared to 88% in developed countries. However, 70% of the papers based in developing countries had at least one author from the country of residence. There was no relationship between year of publication and the proportion of papers with resident authors.

Although residence of author did not have sufficient explanatory power to remain in the original model (table 6), it had been hypothesised that studies in developing countries would have higher levels of implementation if resident authors were involved in the research. This was not true for developing countries, with neither resident corresponding authors, nor whether there was any author resident, impacting upon levels of implementation (fig. 27).

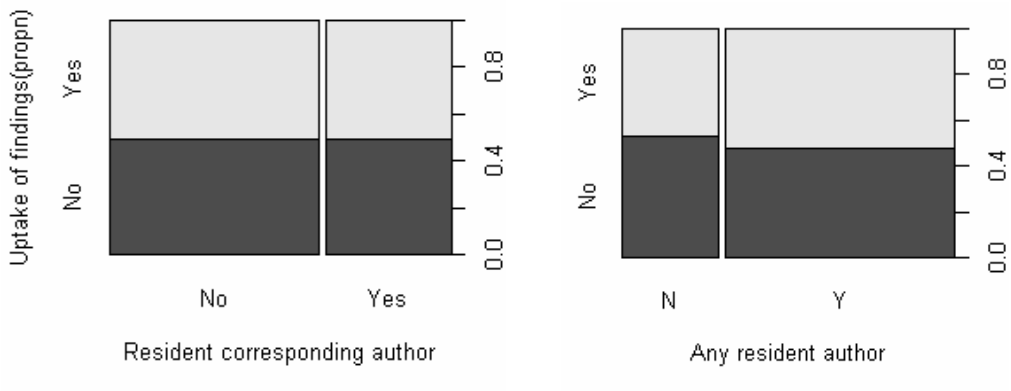



**Fig 27. Implementation of findings in developing countries according to author residence. There was no significant difference in proportion of findings implemented (a) with a corresponding author resident to the country of study ($X^2$ = 0.02, df = 1, p= 0.89) (b) with any author resident ($X^2$=0.22,df = 1,p=0.63)**

Further analysis, however, revealed a three way interaction between: status of the country, whether or not the authors were affiliated to NGO/government, and whether authors were resident in the country of study.

**Table 9. The interaction between country status, author affiliations, and author residence. Summarised output of logistic regression showing the significance of the three way interaction in the model**

| Factor | P(>\|Chi\|) |
|---|---|
| Country status | 0.03 |
| Author affiliations | 0.0003 |
| Author residence | 0.34 |
| status:affiliations | 0.22 |
| status:residence | 0.15 |
| affiliations: residence | 0.22 |
| status:affiliations:residence | 0.03 |

This was due to the fact that author affiliations and residence have more of an impact in developed countries than in developing. In developing countries, a high number of co-authors resident to the country had NGO or government affiliations (fig. 28 (a)), but this made no difference to implementation of findings. However, there were lower levels of implementation when only the corresponding author was resident to the country (n=10), even than when there was no author resident to the country (fig. 28 (b)).

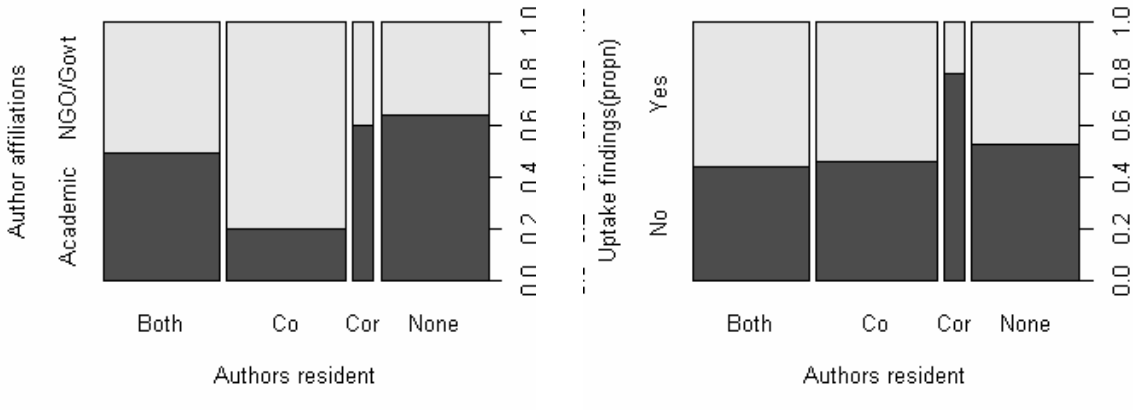



**Fig 28. (a) Author affiliations and (b) proportion of findings implemented, as a function of whether both (Both), co-authors only (Co), corresponding author only (Cor), and no authors (None) were resident in developing country studies. The majority of resident co authors had NGO/Govt affiliations, but this did not result in higher levels of implementation**

To highlight this, the few studies in developed countries in which neither author was a resident in the area actually had a significantly lower proportion of findings implemented than those in developing countries (fig. 29).

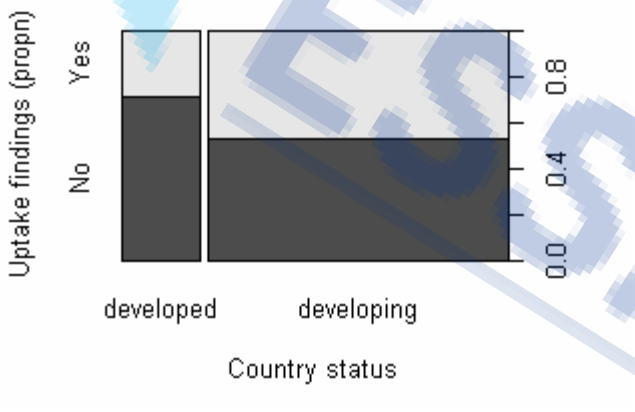



**Fig 29. Proportion of findings implemented in developed and developing countries when there was no resident author. Developed countries had lower levels of implementation.**

To further emphasise the reason for three way interaction, fig. 30 shows that NGO or government affiliations are likely to result in implementation of findings in developed countries when co-authors are resident to the country of study, but not in developing countries.

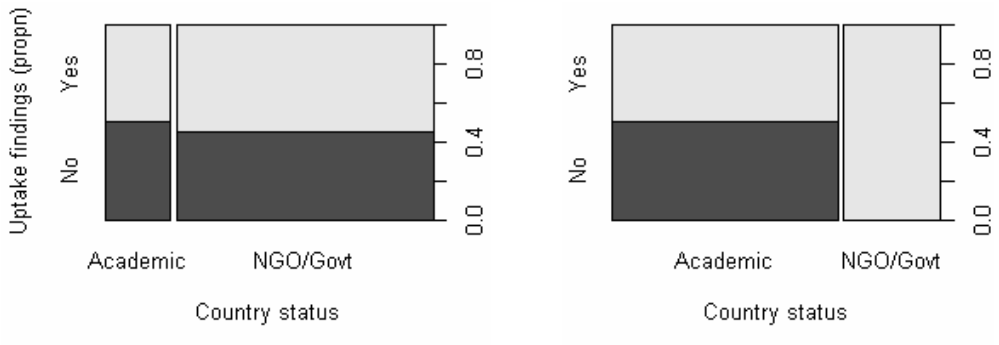



**Fig 30. Levels of implementation according to author affiliations when co-authors are resident to the country of study in (a) developing countries (b) developed countries. In developing countries, there is no difference in findings implemented dependant upon to author affiliations, but in developed countries NGO/Govt affiliations are an important predictor of implementation of findings.**

*4.6.1 Multivariate analysis of factors influencing implementation in developing countries*

The significant difference between developed and developing countries, and the interactions described above suggests that different factors govern whether or not findings are implemented in developing countries to developed (The same variables were significant upon multivariate analysis of developed countries as for the whole data set and the model is therefore not shown).

For developing countries, as suggested by the interactions above, whether or not the author was academic made no difference to implementation of findings. Also, when funding bodies were regressed against the response variable, there was no significance for local government as there previously had been, and funding by international NGOS was retained in the minimum adequate model. Only co-authors affiliated with a local NGO had an impact, but this was not retained in the model (table 10).

**Table 10. Minimum adequate model for factors influencing the implementation of research findings in developing countries only (logistic regression (df=170). Only the factor levels of significance are shown in detail P(>|z|), otherwise only the significance of the factor as a whole is represented P(>|Chi|)**

| Factor | Factor level | Direction | P(>\|z\|) | P(>\|Chi\|) |
|---|---|---|---|---|
| Motivation (research) | Scientific | Negative | 0.0006 | 0.0001 |
| Research ongoing | Yes | Positive | 0.0003 | 0.0002 |
| Funding local NGO | No | Negative | 0.049 | 0.012 |
| Species level | species | Positive | 0.11 | 0.046 |
| Recommendations | Yes | Positive | 0.006 | 0.002 |
| Dissemination | Yes | Positive | 0.02 | 0.007 |
| Funding international NGO | No | Negative | 0.048 | 0.047 |

None of the factors had the same level of significance as in the previous model, again suggesting that factors not controlled for in this study may influence implementation in developing countries, but the relative significance of both targeted and ongoing research remained high.

## 4.7 Forms of dissemination facilitating uptake

37% of those who disseminated their findings through a form other than the scientific paper did not have their findings taken up. It is therefore important to identify what forms of dissemination facilitate uptake and to which stakeholder groups

### *4.7.1 Media*

51% of those who had disseminated their findings did so through the media. Findings disseminated through the local media were significantly more likely to be implemented ($z=2.7, df=347, p= 0.005$) the most important predictor of which was the local newspaper ($z=2.93, df=345, p=0.003$). There was no significant impact of dissemination through international media on uptake of findings.

### *4.7.2 Direct communication with stakeholders*

All forms of dissemination had higher levels of implementation apart from the category 'other' which included forms such as website dissemination (fig. 31). Those that significantly explained the variation around the response variable upon logistic regression were; communication to local communities, local NGOs, international NGOs, and government bodies within the study region. Dissemination to practitioners was non-significant in the glm.

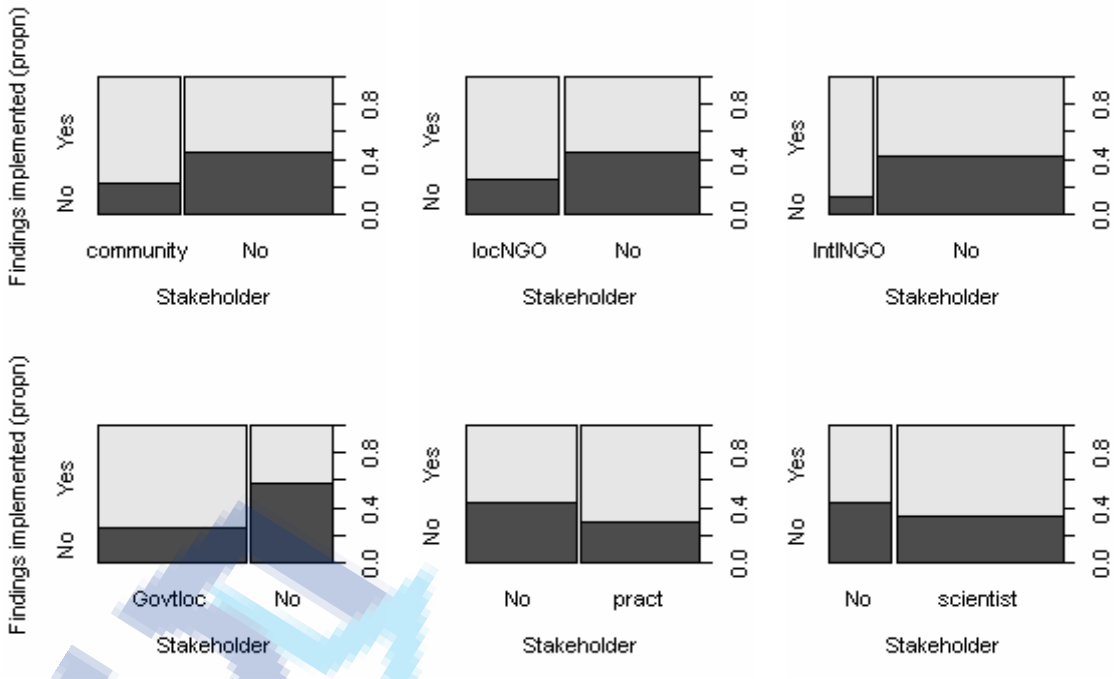



**Fig 31. Relative importance of dissemination to different stakeholders. Levels of implementation were significantly higher when findings were disseminated to local communities ($X^2$=15.7,p=<0.001), local NGOs ($X^2$=14.31,p=<0.001), international NGOs ($X^2$=20.01, p=<0.001) and local governments ($X^2$=34.9,p=<0.001). There were marginally higher levels of implementation following dissemination to practitioners ($X^2$=2.37,p=0.01) but not scientists. (In all cases, df=1)**

There were significant interactions between local community and local NGO (z=2.013, df=347,p=0.04), and international NGO and local Government (z=2.14,df=347,p=0.03), which made each factor insignificant as main effects. Further analysis of the interactions showed that if respondents answered either local community or local NGO, or both, the levels of implementation were high, whereas if they answered neither the implementation levels were significantly lower. Exactly the same pattern was seen for international NGO and local government, suggesting that dissemination to local communities or local NGOs serves the same purpose, and similarly for local governments and international NGOS, perhaps suggesting a level of communication between the groups.

### *4.7.3 Forms of direct communication*

Findings were more likely to be taken up if communicated in the form of a report (z= 3.5, df=347,p=<0.001) or public meeting (marginally,z=2,df=347,p=0.048). The two most important explanatory variables were personal communication (z=3.51,df=347,p=<0.001), and policy documents (z=4.18,df=347,p=<0.001).

### *4.7.4 Minimum adequate model for all dissemination variables*

Media, stakeholders, and forms of communication were combined to identify the most important predictors of uptake of findings (table 11).

**Table 11. Minimum adequate model for the main dissemination forms influencing the implementation of research findings (logistic regression (df=334). The factor levels of significance are shown in detail P(>|z|), and the significance of the factor in the model is represented P(>|Chi|)**

| Factor | Factor level | Direction | P(>\|z\|) | P(>\|Chi\|) |
|---|---|---|---|---|
| Communities (Q48R1) | Yes | Positive | 0.62 | 6.022e-06 |
| Local NGO (Q48R2 | Yes | Positive | 0.36 | 8.299e-04 |
| Intl NGO (Q48R3) | No | Negative | 0.08 | 3.371e-04 |
| Local Govt (Q48R4) | Yes | Positive | 0.28 | 3.518e-05 |
| **Personal Communication** | Yes | Positive | **0.047** | 0.03 |
| **Policy Document** | Yes | Positive | **0.002** | 2.123e-04 |
| **Q48R1No:Q48R2No** | No | Negative | **0.048** | 0.04 |
| **Q48R3No:Q48R4No** | No | Negative | **0.040** | 0.02 |

The significant explanatory variables of uptake of findings are: dissemination to communities, local and international NGOs, and local governments, and the most important forms of communication were policy documents and personal communication. Local media dissemination, public meetings, and reports no longer had sufficient explanatory power to remain in the minimum adequate model. This suggests that local forms of communication are most important to promote implementation of research findings.

### *4.7.5 Number of different forms of dissemination*

There was a significant relationship between the number of different stakeholders the information was communicated to (including media) and implementation of findings ($X^2$=81.6,df = 5,p=<0.001). The apparent anomaly that levels of implementation were lower with only one outlet of dissemination than when there was no dissemination (fig. 32) is perhaps due to the fact that further analysis of the data revealed most of these cases to be those in which findings were communicated to scientists only, which would not be expected to

facilitate dissemination of findings. After 3 forms of dissemination, there was no further significant increase in levels of implementation (fig. 32).

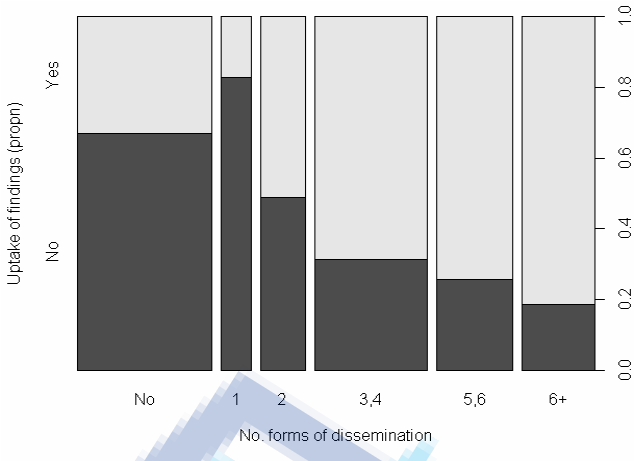



**Fig 32. The relationship between number of outlets of dissemination and uptake of findings shows a general increasing trend in implementation of findings with number of forms of dissemination. There was no significant difference when findings were disseminated to only one stakeholder (z=1.2,df=342,p=0.19), but the proportion of findings implemented increased significantly at 2 forms of dissemination (z=3.4,df=342,p=<0.001) and again at 3+ forms of dissemination (z=5.1,df=342,p=<0.001)**

### *4.7.6 Practical implementation response variable*

When practical implementation was taken as the response variable, the same variables remained in the model, but local communities was removed from its interaction with local NGOs and gained in significance (table 12). Local governments were more significant but still interacting with international NGOs, and the most significant form of communication became personal communication. This again emphasises the importance of dissemination to local stakeholder groups in accessible forms

**Table 12. Minimum adequate model for the main dissemination forms influencing the practical implementation of research findings only (logistic regression (df=333)). The factor levels of significance are shown in detail P(>|z|), and the significance of the factor in the model is represented P(>|Chi|)**

| Factor | Factor level | Direction | P(>\|z\|) | P(>\|Chi\|) |
|---|---|---|---|---|
| **Communities (Q48R1)** | Yes | Positive | 0.04 | 7.415e-05 |
| Local NGO (Q48R2) | Yes | Positive | 0.43 | 0.01 |
| Intl NGO (Q48R3) | No | Negative | 0.63 | 0.01 |
| Local Govt (Q48R4) | Yes | Positive | 0.17 | 6.796e-05 |
| **Personal Communication** | Yes | Positive | 0.009 | 0.01 |
| **Policy Document** | Yes | Positive | 0.03 | 0.02 |
| **Q48R3No:Q48R4No** | No | Negative | 0.008 | 4.755e-03 |

Although dissemination to practitioners increased in significance ($X^2$ = 7.59,df = 1,p=0.005) this again did not have sufficient explanatory power in regression with the other forms of communication.

### 4.8 Validation of response sample

In a validation of 60 author responses for whether 'recommendations' had been made, 14 had answered 'yes' in the survey but had not made recommendations that the author believed to be 'concrete'.

There was a slight yearly bias in the response sample, with responses received from only 23% of the 2000 sample compared to 32% in 2005. This is likely due to a higher proportion of changed email addresses from 2000, but there was no yearly difference in implementation (fig. 2 (b)). Authors in 49% of the non-response sample papers had academic affiliations only, as was also the case in the response sample. There were also similar percentages of corresponding authors resident in all continents apart from Asia, which appears to have been under-represented in the analysis. 72% of the non-response papers were single species, compared to 67% in the response sample. Average Google Scholar citations were also similar, 1.45 in the non response sample compared to 1.75 in the response sample. The response sample therefore seems to be representative of the sample as a whole in terms of attributes of the research paper.

# 5. Interviews with practitioners

## 5.1 Use of information

### *5.1.1 Role of Research in Conservation Action*

All practitioners interviewed believed that research plays a role in conservation action, but to varying degrees. The two interviewees most heavily involved in scientific research saw it as paramount, and emphasised the role of monitoring in conservation action. The eight respondents currently working as full time practitioners in the field thought that it was important to base conservation on good science and have a basic knowledge of the species, but that there is a certain point at which it can become research for research's sake, rather than research to inform conservation action. An example was given of an invasive fly threatening a study species, and the research concentrated on its exact impacts rather than how to eliminate the threat, when it has already been proven that it was detrimental. One respondent likened research to 'bullets in a gun', and gave an example of research proving that a bird species nested in the mangroves, which had not been previously known. Two other interviewees gave it a non-essential role in that it is only useful if translated into practical use, and emphasised that existing information should be used only as a guideline, but acknowledged its role in gaining funding.

### *5.1.2 Type of Research*

When asked what type of research was most useful in conservation action, responses were varied. The basic ecological research covering distribution, abundance, and trends was mentioned by five respondents. Three respondents placed most value in methodological research papers, and two mentioned habitat requirements of the species. When probed as to whether they thought applied or basic research was more important to them, two answered applied, two both and the rest that it depended upon the situation.

### *5.1.3 Routinely consulted sources of information*

All but one interviewee mentioned local sources, such as local communities and individuals who have information that is not available anywhere else. Five respondents specifically stated that this was the most important information source. Grey literature, reports, and local

scientists were also mentioned. Six interviewees regularly gained information through communication with experts and through networks. Internet searches for primary literature were mentioned by all interviewees, five of whom specifically mentioned Google. However, it was emphasised that this information was not always easy to obtain and that sometimes there was no relevant literature available. One respondent believed that the in house research was the most important information source.

### *5.1.4 Role of published research in conservation action*

Every interviewee believed that publication had an important role to play in practical conservation action. Publications were given a major role in generating funding and raising awareness of species, with key papers believed to have had a huge impact in this respect. One respondent said it was important to enable comparisons of their research findings with those of others

One respondent specifically answered that it depended upon the journal, and that they found the lower impact work more amenable to implementation in the field. Five further respondents similarly suggested that there is an issue in that some of the really relevant information, that may be more intuitive or speculative rather than based on robust sampling mechanisms, is not published in high impact journals, and that low impact journals are often more useful. One respondent suggested that national journals are a better forum for the low level management issues not published in peer-reviewed journals. Four practitioners suggested that there is a gap between the published 'high level' science and the lower level applied conservation research. It was suggested that if conservationists worked with the view to publishing their results, they would think more about the robustness of methodology and could bridge this gap to produce scientifically valid but applied research that needs to gain more importance in the conservation society.

The low capacity of developing countries was a common theme, with some emphasis placed on the issue that managers would often not understand the information presented to them in journal papers, and that there is often a language barrier. It was suggested that the key messages and issues need to be simplified and translated into practical guidelines. It was the general consensus that conservation should be based on evidence, but that it needs to be disseminated in a form more accessible to practitioners. Two respondents stated that publications are often not turned into documents for managing species on the ground, and that

when foreign researchers take data out of the country for publication, it rarely feeds back into the country. One interviewee felt that the 'publish and perish' syndrome could detract from conservation in the field, and another suggested that the goals of researchers were not aligned with those of practitioners, spending long periods writing publications when '99.9% of the managers' in their country do not read journals. It was suggested that researchers need to be trained to use the grey literature, and practitioners to use primary literature. It was also suggested that there was a bias of research towards temperate countries.

One interviewee suggested a role for publication in providing a solid scientific basis, but that it has to be practical, and suggested that 'fire fighting' was necessary rather than publishing. None of the other practitioners mentioned credibility, but when prompted they suggested that although it is a slightly academic viewpoint, governments will take it more seriously and it does provide validation. Five respondents said that it did not matter to them personally, and that fieldwork record is more important, but two respondents stated that they do feel comforted in the knowledge that there has been peer review. Most said it did not matter locally if the information was of peer review standard

### *5.1.5 How often is the scientific literature consulted?*

Two of the respondents (currently based in the UK) indicated that they read journals regularly. One respondent said that they glanced at abstracts every week to get an overview. Five said they only consulted journals when needed, and one said that they did a literature search only when needed but also had journal subscriptions. Another said it depended upon availability and time constraints. CB was mentioned six times, BC four, O four, and AC two. BD was not mentioned. One respondent did not read specific journals, but searched for relevant papers on the internet. Five respondents also listed specialised or local journals

Half of the interviewees only looked for research specific to their study species/system, whereas the other half read a wider range of research. No interviewees felt that they were able to get all of the available literature. One respondent felt starved of literature, another felt that they mostly relied upon contacting individuals and obtaining grey literature.

### *5.1.6 Implementation of research findings*

Seven of the interviewees said that implementation was mostly down to 'in house' research, supported by, but not necessarily based upon, existing information. It was emphasised that each situation is unique, and therefore action has to be adaptive in accordance with the complexity of the situation on the ground. Two said that it was important to have a research base, but that there was a time-lag, and that it is counter productive if a practitioner has to wait until publication rather than be informed of the research pre-publication. It was also pointed out that although they incorporate existing information, it was often not available for their study species. One interviewee suggested that the success of a conservation action would be determined more by the experience of the staff rather than the research basis.

## 5.2 Reporting of information

### *5.2.1 Target audience*

All of the practitioners interviewed reported the outcome/progress of the conservation action in some form. When asked about their target audience and main forms of reporting, all respondents cited the institutions involved in the conservation programme, with two respondents offering no further audience because the institution has its own mechanisms for dissemination. Funding agencies were also given high importance. Conservation programmes, practitioners doing similar work, and local communities were also mentioned frequently. As the main audiences were largely non-technical, reporting was achieved through direct communication, summary reports, media, workshops, school programmes, and newsletters. One respondent stated that the managers of parks were the most important group for dissemination, and that local journals were useful for this. Three respondents mentioned the need to inform the international community and other scientists through direct communication, journals, workshop proceedings and reports. One further suggested that the different issues involved need to be considered together, and that this required dissemination to multiple stakeholders.

All but two interviewees had been at least a co-author of a scientific paper at some point in their career, and three had published several. Motivation behind publication included; profile-raising of the organization, to be known in the scientific community, and to feed information

into the wider conservation world. One respondent noted that although he had seen the publication cited in policy documents and used to argue practical measures, he was unaware as to whether it was translated into conservation action. Most respondents indicated that they felt it important to publish information, but struggled to find the time.

### *5.2.2 Most important forms of dissemination to practitioners*

Six interviewees suggested that local forms of communication were most important, through; forums, direct communication, local guidelines, manuals, training of staff, workshops, seminars, contacts, and media, described by one respondent as 'practical tools informed by solid science'. Two respondents specifically stated that the publication of the paper allows them to locate the research, but that they still required direct communication if it was to be used. Three respondents mentioned that local and more specialised journals had a better chance of reaching practitioners.

Two practitioners felt that the internet, although not currently practical, would be the best form of dissemination because primary and grey literature reaches only a limited audience. One practitioner suggested that focused conferences were most important, and another the scientific literature.

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### *5.2.3 Barriers to personal use of scientific research*

All respondents felt that there was a gap between research and practice, with some suggesting that one of the major issues was the lack of publication of conservation failures. One respondent felt that the main barrier was the fact that much of the relevant information has not been published, rather than inappropriate dissemination of existing information.

Issues of accessibility and finance were mentioned by every respondent. Most also mentioned time lags, with the requirement for immediate action making it implausible to wait for publication of research. The enormity of searching was also a time issue. One respondent cited bureaucracy in their country as a barrier, with officials not open to new research.

# 6. Discussion

## 6.1 The conservation impact of scientific research

The levels of implementation reported in this study (57%) are remarkably similar to the figures reported by Flashpohler et al (2000) and Ormerod et al (2002) of 57% and 54% respectively. These estimates had previously been considered over-optimistic, particularly with reference to the low figures of institutional uptake of research findings reported by Pullin et al (2004) and Sutherland et al (2004) However, whilst it is likely that researchers would over-report rather than under-report the use of their findings, 60% of the 'yes' responses were qualified by relatively detailed further comments (Box 1). It should be emphasised that Pullin et al (2004) incorporated only the use of the actual literature, not the possibility that the research had been disseminated and incorporated in other forms, and more positive figures have been reported for species action plans in the US (Boersma et al, 2001; Clark et al, 2002). Interestingly, the levels of implementation were highest when the corresponding author was from Australasia, similar to the findings of Pullin & Knight (2005), suggesting that there are certain areas in which conservation managers are more amenable to the use of scientific literature.

It is also worth noting that the figures reported here constitute responses from only 33% of the appropriate literature included in the initial sample. This figure could therefore incorporate some element of respondent bias towards those whose findings had been implemented, rather than self reporting. However, validation of the author and research characteristics with a sample of non-respondent papers showed attributes to be similar (section 4.8).

It could be suggested that the 47 % of findings implemented in practical conservation action (table 2) rather than policy (table 3) is a more accurate figure, but there is justification for including these responses as a 'yes' in the majority of the analysis, as the findings taken up are being used to develop species action plans and policy, or by specialist groups such as the IUCN. Even if this is not immediate practical action, studies have suggested that this has practical use (Fuller et al, 2003; Boersma et al, 2001; Lunquist et al, 2002)

It is perhaps a sign of the scale of the issues surrounding conservation science that, given the current state of biodiversity (Bini et al, 2005) and taking into account that the research examined was from five of the major conservation journals over a six year period, a roughly 50% level of implementation could be seen as optimistic. These journals provide the main forum for the best quality conservation research, on which it is widely agreed that conservation actions should be based (Smallwood et al, 2000). Equally disturbing is that this figure has not increased since the studies by Ormerod et al (2002) and Flashpohler et al (2000), despite the increasing recognition of the need for better links between researchers and practitioners (Meffe, 1998; Fazey et al, 2004; Prendergast et al, 1999; Underwood, 1995; Pullin et al, 2004; Sutherland et al, 2004). It is also entirely possible that the research findings played less of a role in implementation that the authors are aware, and indeed 15% thought that it had played only a minor role.

### *6.1.1 Conservation success*

It should be stressed that the measure of conservation impact considers uptake of findings only, and is not a measure of actual improvement in the status of the species. Inclusion or upgrading on the IUCN Red List, for example, does not constitute actual action (and is often in fact a sign of worsening conservation status), although the results suggest that findings based on species in any category of threat are more likely to be implemented (fig. 23). That only 51% of those whose findings had been implemented believed that there had been an improvement in conservation status underlines this point, although many respondents felt it was too early to assess impact. However, for single species studies conservation status was more likely to have improved if the findings had been implemented (section 4.5), in line with the findings of Boersma et al (2001) and Gratwicke et al (2007) that use of science improved species conservation. Although this is perhaps subjective, and those whose findings had been taken up would be likely to either be more aware or report a positive impact, opinions were mostly based on evidence such as long term monitoring trends (fig. 25).

### *6.1.2 Journal level correlates*

That the two journals with the specific aim of influencing conservation practice, BC and O, (fig 7.(a)) had the highest levels of implementation, and that significantly lower levels of

implementation were seen for research from BD, suggests that journal differences in the type of research being published (France & Rigg, 1998) could influence implementation. However, BD also had significantly lower levels of dissemination; shown to be one of the main determinates of implementation of findings. This, coupled with the fact that journal level differences were not significant in multivariate analysis, suggests that other factors were involved in implementation rather than the characteristics of the journal.

It would also seem that neither Impact Factor of the journal, nor the number of individual paper citations had any reflection upon implementation of findings, suggesting that although citations are a measure of how widely read the research is in the scientific world, this is not representative of findings being implemented into actual conservation action. Indeed, these findings are supported by the interviews with conservation practitioners, who paid no regard to citations and Impact Factor; regarding them as academic tools and suggesting that they found the lower impact journals of greater practical use (section 5.1). Although citation analysis may have its merits (in terms of the communication of methodological techniques to improve the quality of conservation research for example, a factor not sufficiently controlled for in the study) it does not appear to reflect the utility of the research in the real world, not even at a policy level.

### 6.2 Factors influencing implementation

There are obviously a multitude of factors that can interact to either prevent or promote the implementation of findings in conservation action (Fazey et al, 2004; Fleishman et al, 1999), and these will differ on a case by case basis according to the complexities and context of the situation on the ground. This much is intuitive and evident from both the practitioner interviews (chapter 5) and the fact that very few factors had adequate explanatory power for the variation around the level of implementation of findings (table 6). Whilst it is impossible to identify empirically the factors that prevent uptake, that lack of involvement of stakeholders was identified by authors highlights the ‘gap’ between research and practice (Meffe, 1998). That political climate is placed so high stresses the complexity of such analysis, as there will be many situations in which the factors identified will have no impact whatsoever on implementation of findings. Indeed, practitioners can be involved from the start and the findings still not be implemented due to factors such as lack of hostility amongst local communities and bureaucracy (Fleishman et al, 1999). It was possible, however, to identify a

few key factors that can be generalised as influencing implementation levels of the data set as a whole. Regardless of the potential biases discussed in section 6.1, the sample size was sufficient to dampen down these down to enable a valid assessment of the factors facilitating implementation of scientific research into conservation practice.

### *6.2.1 Main factors facilitating implementation of findings in conservation action*

Findings were more likely to be implemented when at least one of the authors had NGO or government affiliations. This is not surprising, as NGOs and government bodies have greater capacity to initiate or influence a project on the ground (da Foncesca, 2003); emphasised by the finding that projects funded by such organisations had higher levels of implementation, and indeed funding by local NGOs was one of the main predictors of uptake of findings. To add to this, amongst those who did not disseminate in a form other than through the peer reviewed paper, a significantly higher proportion of research findings were implemented when authors had NGO or government affiliations rather than academic (fig. 19). These results support the assertion of Clark et al (2002) that scientists in academia need to co-operate with institutions such as NGOs and government agencies to achieve conservation management outcomes, and are similar to the findings from the opposite side that US species recovery plans (Boersma et al, 2001; Gerber & Shultz, 2001), and HCPs (Harding et al, 2001) were more effective and less likely to miss key scientific evidence respectively when scientists were part of the authorship team. This was not the case in developing countries, however, with the capacity of the author seemingly having less of an impact (section 4.6).

Findings that were further disseminated were more likely to be taken up than when the only form of dissemination was through the scientific literature, as was research addressing conservation management problems, ongoing research, and research that had been contextualised through solid recommendations. The value of long term research in terms of its impact in facilitating dialogue between scientists and managers, and on a broader policy scale, has been noted in Tanzania (Durant et al, 2007) and Borneo (Meijaard & Sheil, 2007), and was shown here to be highly correlated with the implementation of findings, particularly in leading to practical conservation action.

That many factors interact on a case by case basis to influence implementation (Fleishman et al, 1999) is also evident from the fact that variables such as; threats to species, status of the study country, involvement of resident authors, and the incorporation of socio-economic factors were all significant alone but not predictors of implementation. Similarly, there was no one factor that influenced uptake of findings dominantly over the rest.

Author perceptions that adequate dissemination, involvement of threatened species, practical recommendations, and involvement of stakeholders were important in the implementation of their findings (fig. 4; and similar to the findings of Flashpohler et al, 2000) were therefore corroborated by the survey analysis, as was the assertion that it was the local stakeholder groups who were most important in facilitating uptake (fig. 5), emphasising the need for local collaborations.

## 6.3 Geographical determinants of research and implementation

### *6.3.1 Is scientific research directed towards the areas in which it is most required?*

Of the studies included in the sample, only 40% were based in developing countries. Of the developing country studies, only 37% had a resident corresponding author, although 70% had at least one author resident to the area. This perhaps reflects the assertion by practitioners in countries such as Madagascar and India (section 5.1.4) that there is no importance attached to the publication of research locally, and that language barriers and finance inhibit local researchers (Foster, 1993; Dudgeon, 2003). This statistic does not appear to have improved over the six years of the survey period, despite increased recognition that this is an issue (Dudgeon, 2003; Dahbouh-Guebas et al, 2003).

The figures of authorship reported here are similar to those reported by Fazey et al (2005) and Dahbouh-Guebas et al (2003), suggesting that the sample was representative of the literature in this respect, although Fazey et al (2005) reported a lower percentage of studies in lower income countries (28%). This discrepancy could be due to the inclusion of Oryx in this sample, which had a large proportion of research based in developing countries (fig. 26), suggesting that the 40% figure is due to journal level attributes and could even be an underestimate of the literature as a whole. It would seem, therefore, that although there are

some exceptions, the scientific literature does not adequately cater for the research requirements of conservation in developing countries (France & Rigg, 1998; Dudgeon, 2003; Fazey et al, 2005).

### *6.3.2 Implementation of research in developing countries*

The slightly lower levels of implementation in developing countries (50%) suggest that the literature surveyed had some conservation impact in these areas, but not as much as would be anticipated in areas harbouring the majority of biodiversity (Fazey et al, 2005).

Although it has been hypothesised that conservation research in developing countries would benefit from the incorporation of resident authors with the capacity to build networks (Getz et al, 1999), and with knowledge of local socio-economic factors and information sources (Fazey et al, 2005; Kremen et al, 1998; Foster, 1993), a sentiment echoed by the practitioners interviewed; this was not reflected in the findings reported from the author survey. There were no differences in levels of implementation in developing countries when the corresponding author was non-resident or indeed when there was no resident author (fig. 27). Similarly, author affiliations had no influence on the uptake of findings. Whilst it is not surprising that different factors affect implementation in developing and developed countries, this is an interesting statistic. One potential explanation would be that NGOs have less of an influence in developing countries than developed, and that governments are less inclined or able to act. It is more likely the latter than the former, as there was still a significantly higher level of implementation when co-authors were affiliated to local NGOs in developing countries (although this did not appear significant in the minimum adequate model), whereas the influence of local government as a funding agency became non-significant (see section). NGOs have also previously been identified as the dominant force in such areas (da Foncesa, 2003; Foster, 1993)

The same study by Fazey et al (2005) identified that 80% of research in developing countries relied on some form of international funding. This perhaps suggests that it is beneficial to incorporate authors from affluent countries (Foster, 1993), as they bring with them funding, which is likely to influence levels of implementation when capacity is low. This is supported

by the finding upon further analysis that when only the corresponding authors were resident to the country, there was low implementation of findings (although the sample size was small). To add to this, although author capacity was not significant as a single variable in developing countries, there were significantly higher levels of uptake when the corresponding author was affiliated to an international NGO. Similarly, the lack of importance of local governments in implementation of findings, a decrease in importance of local NGO funding, and an increase in that of international NGO funding in multivariate analysis (table 10) lends further support to this. It is likely that in developing countries the issue of low local capacity outweighs the importance of author characteristics.

The best combination with regards to implementation in developing countries appears to be when the corresponding authors are international and co-authors resident, suggesting a need for capacity building in these areas in order to increase local researcher involvement (Foster, 1993; Durant et al, 2007) and enable them to attract international funding. Capacity building could therefore be an important role for international scientific researchers, and there was some evidence of this seen from the survey responses. A study by Frid (2001) led to the conversion of one former poacher involved in the research to a park warden, and an important part of the research by Seddon et al (2003) on the Arabian oryx was to train local co-workers and develop their ability to conduct and publish independent research (survey response).

The above discussion would suggest that there are different factors driving implementation in developing countries, such as lower capacity and political climate, not controlled for in this study. There was also support for the hypothesis that there is an added value for long term research in developing countries to build trust and networks (Bergerhoff Mulder et al, 2007; Durant et al, 2007; Meijaard & Shiel, 2007). It appears that NGOs, in particular international NGOs, drive the implementation of findings in developing countries.

### 6.4 Does the research published in the literature meet conservation needs?

It has been suggested that scientific research does not take into account the practicalities of implementation on the ground (Meijaard & Shiel, 2007), and that research diverts funds from conservation action (Sheil, 2001) and can be a low priority in the field (Linklater, 2003). A thorough assessment is therefore needed of the utility of the research that is currently being

conducted in relation to real world conservation needs. It has already been established that research is biased towards the developed world. The taxonomic bias towards mammals and birds (section 3.1) has also been seen in numerous other studies (Dudgeon, 2003; Bini et al, 2005; France & Rigg, 1998; Levin & Kochin, 2004), although there was no taxonomic bias in implementation of findings.

The lack of relationship between type of research and implementation of findings (fig. 15), supported in the interviews by the varying preferences of practitioners for the different kinds of research (section 5.1.2), is in line with the assertion that the type of information necessary in the implementation of a conservation action is very much situation dependent (Linklater, 2003). Arguments as to whether scientific research is providing the type of information that is needed could therefore be considered slightly circular, as it depends upon the level of current knowledge and the conservation needs of the species. This is given an extra dimension when information required by policy makers is considered, as broad questions are often favoured ahead of narrow (Sutherland et al, 2006) in contrast to information required by practitioners. An assessment of the type of research in relation to the species conservation needs is beyond the scope of this study. However, the main research focus reported here was upon threats, as Harding et al (2001) and Meijaard & Sheil (2007) have suggested is most needed in species conservation.

Research incorporating socio-economic factors as well as biology was less common and more likely to have been implemented, but perhaps surprisingly considering the growing relationship between conservation biology and social sciences (Kleiman et al, 2000; Brooks et al, 2006) and the need for practitioners to consider such factors (Salafsky et al, 2002) this was not a main explanatory variable. This was perhaps not accounted for adequately in the survey (Q13, appendix I), as recommendations may have been set in the context of socio-economic factors even though the research did not specifically take this into account.

### *6.4.1 Applied versus basic research*

To further take up the issue of ‘applied vs. basic’ research; the more applied research focus of ‘evaluation of the efficacy of conservation measures’ had a higher proportion of implementation than the more basic ‘investigating species biology for improved general

understanding', and this was only marginally non-significant (fig. 15). Again, the importance of each depends upon how much is already known about the species and the urgency of the situation. Assessments of HCPs in the US have identified a lack of knowledge of the basic biology of many species (Harding et al, 2001), and species distributions (Tear et al, 1995) and it is argued by some that no action should be launched without a basic knowledge and thorough assessment (Caughley & Gunn, 1996). However, the question as to 'how much is enough?' (Tear et al, 2005) is unanswerable.

It is perhaps more prevalent in a discussion of the utility of conservation science research, however, to think in terms of the concept defined by Linklater (2003) as 'targeted' research. This is similar to that referred to by one practitioner as 'applied science', and it was the consensus amongst the interviewees (section 5.1.1) that this middle ground is missing in conservation biology; encompassing studies incorporating any type of research with a sound scientific basis, but tailored towards an issue of direct conservation relevance.

This was addressed in the survey by the question of the motivation behind the research project. Research focused on management issues has historically been more difficult to publish in peer reviewed journals than general ecological research (Fleishman et al, 1999). However, there was a higher proportion of implementation amongst respondents who had either addressed conservation management issues or had the aim of informing decision making, and indeed this was one of the main explanatory variables (table 6). Academics are often incentivised to conduct research that has relevance on a wider scale (Fazey et al, 2004), but the results from the practitioner interviews, and the inclusion of species level research as a main determinant of uptake of findings, provides empirical support to suggestions that targeted and 'lower impact' research has more practical relevance and should be given more importance in peer-review science (Aplet et al, 1992; Sheil, 2001; Prendergast et al, 1999). This issue is particularly important in relation to the fact that conservation has limited funding (Ferraro & Pattanayak, 2006), which perhaps should be directed towards the research with practical application (Sheil, 2001).

The fact that the majority of studies addressed 'targeted' science suggests that this is necessarily gaining importance, but again this could be a function of a biased sample rather than the general state of scientific publication; made more likely by the fact that species based

studies will be by definition more targeted than the biodiversity and ecosystem based studies not controlled for in this analysis. However, if there was a bias in the sample towards those whose findings have been implemented, this would only serve to emphasise the importance of targeted research.

### *6.4.2 Inaccessible research and information gaps*

Two of the issues raised by conservation practitioners in discussions about the role of the scientific literature in species conservation were the missing gap between 'high level' science and extremely applied conservation research, and the bias towards positive results (section 5.1.1). It was a general concern that results of conservation action were not being reported because they were not quite of peer-review quality, and that intuition and ideas were not readily incorporated into the scientific literature. Indeed, an analysis of the success of tiger conservation projects suggested that the most crucial information was of little interest to academic journals (Gratwicke et al, 2007). Practitioners also felt that there was a wealth of knowledge available locally in journals, grey literature and unpublished reports that was currently inaccessible internationally, an assertion supported by Fazey et al (2005), Meijaard & Shiel (2007), and Dudgeon (2003). This information does not reach scientific journals due to lack of capacity (discussed in section 6.3), time conflicts (Fleishman et al, 1999) and language and financial barriers (Dudgeon, 2003).

Peer review evidently plays a role in keeping scientific research at a high quality (Smallwood et al, 2000), and although 'lower impact' research with a sound scientific basis and documentation of conservation failures should play a large role in this, it is difficult to envisage the incorporation of more qualitative or intuitive research without compromising the standard. However, it is also clear that there is a lot of relevant information that is not being published and there is currently no adequate forum for its dissemination. Although this issue is being increasingly recognised in conservation research (Sutherland et al, 2004, Pullin & Knight, 2005), it is clear that conservation could benefit from this information becoming more accessible internationally, particularly in an adaptive management framework, although a website with this purpose is being developed (Conservation Evidence, 2007).

Whilst this study did not adequately incorporate research reporting outcomes of conservation action, the views of practitioners, along with analysis by Fazey et al (2004) suggests this is lacking in the scientific literature, and needs to gain more prominence (Stem et al, 2005; Salafsky et al, 2002; Kleiman et al, 2000), particularly as this is valuable information that needs to be available to the wider conservation community.

## 6.5 Dissemination of scientific information

It has been suggested that the major issue in the lack of evidence based conservation is the inadequate dissemination of research findings (Pullin & Knight, 2005; Sutherland et al, 2004; Fazey et al, 2004), and that the key to implementation is communication between academics and practitioners (Meffe, 1998). This was supported by the results of this study, as there were higher levels of implementation when the peer-reviewed publication was not the only form of dissemination, suggesting that the publication does not reach conservation practitioners and policy makers. Although there was some suggestion of a time lag in the use of information directly from scientific publication (fig. 20), this is not efficient as conservation action is often critical. However, whilst it has been suggested that practitioners are often left to locate and synthesise information (Fazey et al, 2004), the high levels of dissemination reported here suggest that this may not be the case and that many authors are taking it upon themselves to disseminate their findings to relevant stakeholders (or that the publication of the information was only one output envisaged from the start).

### *6.5.1 Scientific publication as a form of dissemination*

There were lower levels of implementation when the purpose of the publication was to influence conservation practitioners than when the purpose was for scientific credibility and dissemination to policy makers (section 4.3.3). This could be because in the former case the respondents would likely be academics, whereas in the latter case they may themselves be practitioners. Regardless, it further emphasises that publication is not the best way to reach practitioners, an issue highlighted by further comments in the survey.

Although the practitioners interviewed did not themselves place much emphasis on publication as an indicator of the credibility of the research (section 5.1.4), as also found in a

study by Lach et al (2003), they indicated that this was important to influence funding bodies (Clark et al, 2002) and governments; the importance of whose involvement has already been established (section 4.3.2). An example of the importance of publication in giving research credibility was described in the survey, when a road project that would have been harmful to Spanish imperial eagles was withdrawn after a study by Bautista et al (2004) backed up work that had previously been dismissed as not scientifically sound. The EU blocked further attempts to build the road following distribution of the reprint (survey response). It is therefore perhaps not surprising that those highlighting credibility and dissemination to policy makers had similar high levels of uptake, as the two variables are not mutually exclusive; and again this suggests a role for the actual publication in influencing matters at the policy level rather than having immediate impact on the ground.

Whilst it is important to note that further dissemination was one of the main predictors of implementation of findings, 34% of those who did not disseminate their research further had findings implemented (20% when only academic affiliations), and 36% of those who had further disseminated did not. There therefore seems to be two main issues at stake. Firstly, how can the situation be improved so that those research findings imbedded in the literature be utilised in conservation; and secondly, how can research findings based on solid science that are of peer-review quality be best disseminated for practical implementation in conservation action.

### *6.5.2 Dissemination of findings reported in the scientific literature*

In terms of dissemination of findings to promote evidence-based conservation, most of the discourse to date has centred around developing means to collate and synthesise all of the information available in the literature to make it more accessible to, and usable by, practitioners (Pullin & Knight, 2005; Fazey et al, 2004; Sutherland et al, 2004). Indeed, the low levels of uptake reported in this study for findings not further disseminated, and the consensus amongst interviewed practitioners that they are not able to access all of the available literature, provides further empirical support that this is an issue in conservation.

The process of systematic review, similar to the system used in medicine, has been purported to be the potential solution (Sutherland et al, 2004; section 2.5.1). This would certainly help to

alleviate some of the issues identified by Pullin & Knight (2005), and cited by practitioners (section 5.2.3) as barriers to their use of literature of accessibility, time frames, and cost of journals. Indeed, two of the practitioners interviewed suggested that the internet would be the ideal way in which to disseminate findings. However, it would be a huge undertaking to assess all of the relevant information, and brings with it some of the problems of peer-review such as complexity.

It would seem that the development of such a mechanism would be beneficial in terms of making information available to the wider conservation community. This is important in its own right, particularly for widely applicable research with a methodological basis. However, it is perhaps not addressing the root of the problem in that it is debatable as to whether it would have any impact on the ground, particularly in developing countries where the situation is most critical. It is also doubtful that practitioners would be inclined to read lengthy reviews if there are time issues involved, and such a review would also exacerbate the time lag between publication and potential implementation.

### *6.5.3 Dissemination of findings for implementation*

It would seem that evidence-based conservation can best be promoted by dissemination of the findings by the researcher in forms other than the peer-reviewed literature, as other forms of dissemination are more likely to influence conservation action in terms of case specific conservation impact.

The results from the author survey suggest that dissemination of findings locally is important for the implementation of research findings (section 4.7), as has been noted by Meijaard & Sheil, (2007) and Bergerhoff Mulder et al (2007) and this was supported both by the views of conservation practitioners (section 5.2.2) and further comments of respondents. It is perhaps not surprising that local NGOs, government, and communities are major influences, as well as international NGOS. The importance of stakeholder collaboration has already been emphasised, and local communities and local governments in particular seem to be of paramount importance to ‘on the ground’ action.

Given that many respondents stated that their findings were implemented through uptake into policy, it is perhaps not surprising that policy documents was statistically the most important forms of dissemination. Regardless of this potential pseudo-replication, summarising the relevant information into a policy relevant document or action plan would be expected to facilitate uptake (Fuller et al, 2003). Personal communication also led to increased uptake of findings, particularly in terms of practical implementation, and the importance of this had also been emphasised by the practitioners interviewed (section 5.1.3).. That dissemination through reports and public meetings were also significant, but presentation of findings at conferences were not, only serves to suggest that the research findings from peer reviewed literature need to be simplified and presented on the level at which they are applicable if they are to be turned into practical tools for conservation. An increase in the implementation of findings as the number of outlets of communication increased (section 4.7), is probably indicative of the fact that multiple stakeholders are often involved in conservation action (Salafsky et al, 2002), and that research findings should be disseminated to as many stakeholders as possible.

### *6.5.4 Contextualising the advocacy debate*

It has often been suggested that scientists are not generally successful at putting their ecological research into a management context (Floyd, 2001). Conservation biology is a value laden science (McCleery et al, in press), and whether or not researchers made concrete recommendations for the use of their findings was a largely significant predictor of implementation, with a higher proportion of findings implemented when recommendations were made.

Obviously, recommendations do not determine whether or not research findings are taken up if they are not thought to be relevant or practical, as can be seen from the finding that recommendations have a significant impact on the uptake of single species research findings, but only if the species is threatened (fig. 24). It should also be noted that the tendency of an author to recommend action perhaps serves to judge the likelihood of their pursuing an action rather than a direct influence of the recommendation (Fleishman et al, 1999), and it therefore cannot be suggested that there is a direct correlation. Similarly, some recommendations in the sample were much more concrete (such as closure of a specific beach during turtle nesting season) than others (such as prevention of introduction of alien species). Indeed, in an analysis

of 60 papers for which respondents answered that recommendations had been made, 14 were too general to be considered concrete or practical, and such limitations and subjectivity need to be taken into account

However, there can be no doubt that contextualising findings into recommendations for practical use can facilitate implementation of findings. It has been suggested that species-based researchers should independently assess status and monitor efficacy, and that scientists should be removed from policy decisions and advocacy (Fuller et al, 2003). However, the results from this study have emphasised that scientists are best placed to interpret their own findings into management relevance, and should work with practitioners to integrate their results into management; similar to the role suggested in a study by Lach et al (2003). Any arguments of scientists losing credibility if they translate their results in value-laden language (Scott et al, 2007; Lackey, 2007) seem relatively unconvincing, especially considering that those researchers who did not make recommendations generally did not have their findings implemented, rendering this a moot point. Indeed, one practitioner noted when interviewed that advocacy for management decisions was essential to change practices entrenched in the bureaucratic system in his country

It is perhaps this apparent distinction between science and advocacy that widens the gap between scientists and practitioners, as the latter are often wary of the former in terms of their ability to apply results to real life situations and take stakeholders and context into account. That findings were more readily implemented when disseminated personally to stakeholders and targeted to a specific problem emphasises this, and although it should be noted that some of the authors were themselves practitioners with NGO and government affiliations, it is unlikely that stakeholders in any capacity would be receptive to a report of findings with no apparent conservation application.

### 6.6 Limitations of the study and further research

The limitations inherent in any self-reporting based assessment have already been emphasised, both for the issues of respondent bias, reliance of author perceptions, and over-estimation of the use of research findings. The study could have been improved in this respect by properly defining the ‘concrete’ recommendations made, and tying them in to the actions that were

implemented. There was also some element of subjectivity in the survey design identifying what constitutes conservation 'impact', and it was difficult to design a survey to be relevant to the wide range of publications. Further research could attempt to solidify the link between author perceptions and implementation by confirming the use of findings at source. Given that this study has identified geographical discrepancies in implementation and the factors influencing uptake, this could involve the analysis of focused case studies by geographical area, similar to work being done in the policy field (Court & Young, 2003), perhaps involving an analysis of the utility of specialised and local journals as a tool for dissemination. Similarly, research into the link between use of research and conservation success could provide further insights into the utility of research in terms of the factors promoting actual conservation improvement.

It would also be useful to examine the references of documents such as IUCN Red Lists and action plans as this could provide a useful measure of real world conservation impact. An analysis of the use of literature by CITES, as an important convention for species-based conservation, would also have been useful to contextualise the issue on a wider policy scale. This study also did not properly take into account how the research reporting conservation outcomes is utilised, and further research could focus on this important aspect.

It could be argued, however, that rather than further research in this area there should be more of a discussion on what the aims of peer-review publication are in conservation biology, and if it is to provide the science base for 'on the ground' species conservation there needs to perhaps be a change in the emphasis of the system towards research with more practical application.

### 6.7 Conclusions and recommendations

There are many circumstances in which conservation actions must necessarily be conducted with a certain level of uncertainty, and based on practical and intuitive action. There is also little empirical evidence that scientific evidence improves the quality of conservation action (Lach et al, 2003). However, where possible, implementation of conservation measures should be based on high quality scientific evidence, of which the scientific literature is the main source.

The levels of implementation reported in this study, and the views of practitioners, suggest that there is evidence for the use of science in conservation action, and that the research published in the scientific literature does have a certain degree of conservation impact. However, considering the need for research to inform conservation action, it is clear that this science is not having as much of an impact as it should or indeed could. This is particularly true in the context of the limitations discussed above, and with consideration of the fact that the conservation actions implemented according to author perceptions cannot be directly attributed to their research findings. It should also be noted that the levels of implementation reported here are for species-based research only, and much of the literature is devoted to wider scale biodiversity issues which would be expected to be more difficult to translate into practical action.

It is apparent from both the author survey and practitioner interviews that, although publication of research has a role to play in conservation, its limitations should be accepted. The role of the publication appears to be very much in terms of disseminating results to a wider audience and providing credibility, rather than forming the basis for implementation of actions on the ground. Although this is important in its own right for improving and refining research techniques, increasing knowledge, and incorporation into action plans and policy, the extent to which this is then transferred through to solid action is debatable, especially as Impact Factor does not seem to be an indicator of practical utility. Publication also has a role in attracting funding, which cannot be underestimated. However, it does not seem that practitioners have the appropriate access to the scientific literature, and they should not be the target audience of publication. Indeed, it would seem that given time-scale issues involved, the findings should be applied pre-publication, especially as practitioners place little emphasis on peer-review as a form of credibility.

In terms of factors facilitating the implementation of research; collaborations with government bodies and in particular NGOs, targeted and ongoing research, contextualisation of findings in recommendations for their use, and local dissemination of findings in a summary format or through personal communication have been identified to be of paramount importance and, aside from long term research, are all factors that can be incorporated into general practice

### *6.7.1 The peer review system*

With regard to the type of research that is published, high impact journals should put more emphasis on targeted research and less on the high level science that is currently rewarded in academia if the purpose is to publish research with conservation impact (although the importance of high level science on a wider scale is acknowledged). Conservation outcomes, in particular conservation failures, should also be published so that this can be fed into the international community as well as on a local scale

Similarly, there is a definite need to incorporate more research from developing countries, especially that involving local researchers, and to make the information in the literature more readily available. It does not seem that there is currently the capacity for conservation in these areas to be suitably informed by scientific evidence, and for outcomes of research from local sources to be published for this purpose. A requirement could perhaps be introduced that at least one co-author to the paper should be resident in the country of study to facilitate local links and capacity building, along with adaptive management.

Journals should encourage papers with collaborative authorship, as a mechanism both to facilitate implementation of findings, and to promote the publication of information from conservation organisations, much of which is currently inaccessible. Indeed, collaborations with NGOs and practitioners before commencing research in an area would appear beneficial to ensure that research is directed towards conservation needs, as this seems to have greater value than pure academic research in the context of practical implementation

### *6.7.2 Promoting a forum for dissemination of non peer-reviewed findings*

It is clear that a large body of research in conservation is not being catered for by scientific journals and is therefore currently inaccessible. Whilst the solution of systematic review is perhaps not yet plausible, a dissemination database could potentially cater for this, allowing all types of research at any level to be disseminated in the international arena (Fazey et al, 2004; Sutherland et al, 2004). It could be made clear what information had been peer reviewed, and what information had not in order to alleviate issues of quality assurance. This would alleviate the time and capacity issues that practitioners face in terms of publishing their own work, and

facilitate adaptive management (Pullin & Knight, 2005). The database could consist of species names, similar to the IUCN Red List format (IUCN, 2007), and habitat types; each with a list of all the available information, a summary of the relevant findings, and links to publications if applicable. Indeed, the IUCN has been identified as a potential umbrella organisation for any such undertaking (Fazey et al, 2004).

### *6.7.3 Use of research findings for conservation impact*

Whilst a forum for dissemination is important on an international scale, in terms of actual conservation impact it would seem that the best place to start is at a local level. Researchers should be encouraged to target their conservation research and disseminate their findings through local sources to multiple stakeholders including local communities. This should include dissemination through personal communication and summary reports, with explicit recommendations and guidelines for use of findings. This is particularly the case in developing countries. Indeed, the process could perhaps be improved if evidence of local dissemination was required by journals to demonstrate its relevance to conservation before acceptance of the paper. A non-technical summary of findings and recommendations for their use could also be submitted along with the paper, which could also incorporate any important information not deemed to be of peer review quality. Additionally, researchers should look to publish in local and more specialised journals as well as the high impact journals, because this will best serve the two different aspects of dissemination; that of communicating interesting findings to the scientific conservation community, and communication of the less novel research on a more local basis.

It is evident that species conservation would benefit from the use of all the available information in the formulation of conservation action. Currently, whilst there are some positive indications that many researchers are engaging with local stakeholders to translate research findings into action, conservation is lacking in this area. An emphasis on more conservation relevant literature is needed, along with both improved dissemination and improved links between researchers and local stakeholders on the ground if conservation biology is to form the basis of conservation practice.

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