

Is wildlife research useful for wildlife conservation in the tropics? A review for Borneo with global implications

Erik Meijaard · Douglas Sheil

Received: 11 October 2006 / Accepted: 30 January 2007
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Abstract The urgency of the tropical biodiversity crisis continues to be a major justification for wildlife research and its funding. To examine the benefits of this research for on-the-ground conservation, we focused on Borneo, where conservation has a long history and we have direct experience. We compiled, categorized and evaluated 284 publications from a broad variety of sources, 153 from peer-reviewed journals. We found that few studies address threats to species and fewer still provide input for or guidance to effective management. We consider various reasons for these shortcomings. Research is seldom judged on its relevance to pragmatic problem solving. Furthermore, many research programs lack the necessary long-term vision and organizational structure for useful applied research. We consulted conservation leaders about our conclusions and all responses suggest that our concerns are not unique to Borneo but reflect wider problems. We conclude that conservation research across most of the tropics is failing to address conservation needs. We make a number of recommendations based on our findings. Conservation biologists should place a higher priority on addressing practical conservation needs and goals.

Keywords Applied research · Critique · Priorities · Research Funding · Wildlife

Abbreviations

IUCN World Conservation Union

NGO Non-governmental organization

USAID US Agency for International Development

E. Meijaard (✉)

The Nature Conservancy-East Kalimantan, Jalan Gamelan No.4, Komp. Prefab, Samarinda,
East Kalimantan, 75123, Indonesia
e-mail: emeijaard@tnc.org

E. Meijaard

School of Archaeology and Palaeoanthropology, Australian National University, Bld 14,
Ellery Crescent, Canberra, Australia

D. Sheil

Center for International Forestry Research, PO Box 6596 JKPWB, Jakarta, 10065, Indonesia

Introduction

Conservation biology aims to develop practical approaches to preserving biodiversity, ecological integrity and environmental values. These aims are served in large part by identifying declining or threatened components of biological diversity, the characterization of the cause-effect relationships underlying these trends and threats, and the clarification and enhancement of means to counter such declines. In a more general context, conservation biology provides scientific input into conservation and land use policy and management. Several authors have written about aspects of the mismatch between scientific research conducted in the name of conservation biology, and what managers and other field practitioners need to do to achieve better conservation (e.g., Pullin et al. 2004; Sheil 2001; Sutherland 2006; Sutherland et al. 2006; Terborgh 2004; Whitten et al. 2001). The gap between academia and practice has been attributed to many causes, such as asking the wrong questions, poor communication, and flawed reward systems. In this paper, we explore the utility of a large body of conservation research to clarify what might usefully be done differently. By focusing on one specific area of high conservation importance, we identify concrete examples of what academic research provides versus what is actually required. Our study shows that most research has limited value to conservation because it pursues the wrong questions.

We select Borneo for our case study because it is a globally recognized area of exceptional species diversity and longstanding conservation concern, and we feel well placed, based on our experiences in the region, to evaluate the literature regarding its species and their threats or conservation. We focus on vertebrate studies, which represent the bulk of all papers concerning conservation in Borneo.

Here, we investigate how much wildlife research has offered to better conservation. Specifically, our study consists of a broad review of available information concerning Borneo and its vertebrate wildlife. Our initial reason for doing this was not to critique this literature but rather our desire to summarize, synthesize and build upon it (see Meijaard et al. 2005; Sheil and Meijaard 2005). It was only subsequently that we became concerned and critical. This article sets out to draw constructive implications from what we learnt.

Borneo

Conservation significance

Borneo supports the largest expanse of rainforest in the Indomalayan Realm, with ~375,000 km² of tropical forest remaining (Anonymous 1999; Fuller et al. 2003; McMorrow and Talip 2001). Although it covers only ~0.5% of the earth's land surface, it harbours exceptional species diversity: e.g., 4% of the world's flowering plant species (with 10% of its orchids and 40% of its pitcher plants), 6% of the world's bird species, and 6% of the world's mammal species (MacKinnon et al. 1996). At least 37 birds, 44 mammals and about 5,000 plant species are presumed endemic (MacKinnon et al. 1996). Borneo also contains important populations of more widely distributed but threatened species such as the Clouded Leopard (*Neofelis diardi*) and the Malayan Sun Bear (*Helarctos malayanus*). The island is of global

conservation importance, and safeguarding its species against extinction is an important conservation task.

History of wildlife and conservation research

Before the 18th century, writers like Marco Polo (13th century) and even Ptolemy (c. 150 A.D.) had occasionally mentioned Borneo, but its wildlife was virtually unknown. Specimens and observations increased as trade and colonial enterprise advanced, leading writers to increasingly comment on Borneo's fauna (e.g., Beeckman 1973 [n.b. originally 1718]). When did 'wildlife research' emerge as a modern scientific discipline in Borneo? Wallace (1869), a 'collector' who sought and focused on facts, while seeking ecological explanation, provides a pragmatic milestone.

Research emphasis varied in a manner typical of most tropical regions. Early studies were mainly descriptive and addressed morphology and taxonomy, distribution, habitats, and behaviour (e.g., Banks 1931; 1949; 1978; Chasen 1940; Medway 1977; Müller 1839–1844; Smythies 1957), although some (e.g., Coomans de Ruiter 1932; Nederlandsch-Indische Vereeniging tot Natuurbescherming 1939) started to recognize the conservation needs of Borneo's wildlife.

Gradually research became more ecological, emphasizing relationships between species and their environments. This ultimately generated enough knowledge for a sizeable monograph on the ecology of the island (MacKinnon et al. 1996). During the final quarter of the 20th century, awareness grew that many of Borneo's species were threatened, and conservation was increasingly emphasized (Bodmer et al. 1991; Eaton 1989; FAO 1981; MacKinnon 1974; McCarthy 1991; Mittermeier 1982; van Strien 1974). Several wildlife research projects were established and research efforts were accelerated. A significant international effort to address Borneo's pressing conservation needs appeared to be underway.

Methods

Our search for published and unpublished documents.

We sought taxa-centric studies of wildlife conducted in Borneo. We did not limit ourselves to the 'academic' literature. We did not reject any document found, or brought to our attention, that included species-specific information or that drew on such information. In our final analysis we do not include the general literature on protected areas and resource management that lacks species-specific wildlife information, nonetheless we are familiar with this literature and consulted many such documents during our searches. Our search involved formal bibliographic searches as well as numerous consultations with local, national and international experts, NGOs and local civil servants (based in Indonesia and Malaysia) to identify all potentially relevant documents they possessed in any language. We are confident that few if any readily available documents on species-centric threat analysis were missed.

We sought out government and NGO documents, including various reports written to influence governments, policy makers and other local stake-holders. We included documents found, or suggested, regardless of language. We are concerned with the *available* literature; other documents may exist, but these were not

identified by our broad search and consultation and therefore appear unlikely to have much technical influence in the region (we acknowledge some caveats below).

We reviewed all these documents and many others. Here we shall ignore those which fail to fulfil the criteria we have selected for this overview (these include studies of species occurring in Borneo but performed elsewhere, as well as many other documents from Borneo and the region that had initially appeared of potential relevance). The results of our review, focusing on the implications for integrating wildlife conservation with forest management and timber production practices, is available in book form (see Meijaard et al. 2005, 2006, which is free to download from the internet in English and Indonesian, see literature cited).

Gauging wider significance

To investigate the broader relevance of our findings and their implications, we queried 20 conservation practitioners, who are either senior conservation scientists or hold senior management positions in international conservation or research organizations, including the Wildlife Conservation Society, World Wide Fund for Nature, Conservation International, the Global Environmental Facility of the World Bank, the World Conservation Union (IUCN), Oxford University, Flora and Fauna International, Zoological Society of London, African Wildlife Foundation, and The Nature Conservancy.

Results and evaluation

Overview of publications and reports

We found 284 documents on wildlife studies in Borneo that met our criteria. One-hundred and fifty-three accounts (54%) were published in peer reviewed journals or newsletters, 50 (18%) of the accounts were books or book sections, and 81 (29%) were unpublished reports or theses.

119 (42%) were based on fieldwork in Kalimantan (Indonesian Borneo), 129 (45%) in the Malaysian states of Sabah and Sarawak, 9 (3%) in Brunei, while the remainder referred to research across the island. Most documents were in English, only four were in Indonesian (Dutch, $n = 7$; French, $n = 2$; German, $n = 2$).

We divided these documents into six categories: 1. Descriptive (taxonomy, species checklists, surveys, morphology); 2. Autecological (movement, feeding behaviour, breeding behaviour etc. of single species); 3. Synecological (focus on ecological interactions within species groups or between species and their environment); 4. Threats (explicitly consider threats to species); 5. Cause-effect studies (investigating population changes in relation to particular factors); and 6. Integrated studies that address most of the above issues. Each document was placed under the highest number warranted, i.e., a study qualifying under 1 and 2 is placed in category 2.

146 (51%) of the publications fell into category 1; 50 (18%) in category 2; 24 (8%) in category 3; 25 (9%) in category 4; 35 (12%) in category 5; and 4 (1%) in category 6 (see Table 1 for an overview of the publications). There is thus a bias towards studies that focus on describing species' characteristics without looking at threats; i.e., almost 80% of all publications (categories 1–3). The majority of reports in category 4 involved research on wildlife hunting and trade, with some studies addressing issues

Table 1 Counts of publications and reports on Bornean wildlife research, and their main research focus as defined by six categories (note the 1884–1975 time period is much longer than the subsequent ones)

Period						
Category	1884–1975	1976–1983	1984–1990	1991–1997	1998–2004	Total
1	24	18	16	41	47	146
2	1	4	16	12	17	50
3	2	4	2	9	7	24
4	0	1	2	12	10	25
5	0	3	2	7	23	35
6	0	0	0	1	3	4
Total	27	30	38	82	105	284

such as fires and drought, wildlife disease, or deforestation; none of these, however, quantitatively assessed how these factors affected wildlife population densities. Only the publications in categories 5 and 6 provided some insight in species' population trends in relation to various interventions and threats. The category 5 and 6 publications were focused on a relatively narrow set of species, with 12 assessing the effects of timber harvest and hunting on orangutans (*Pongo pygmaeus*) and others primates, and the remainder on Malayan sun bear (3), civets (Viverridae) (2), ungulates (4), treeshrews (Tupaiaidae) (1), Bornean elephant (*Elephas maximus*) (1), general mammals (4), general birds (5), woodpeckers (2), amphibians (3), reptiles (1) and fish (1).

Threatened and endangered species

We anticipated that the literature would deal with the many threatened and endangered vertebrate species of Borneo. We were wrong. Among the 6 Critically Endangered (CE) and 14 Endangered (E) species (IUCN 2006) of Borneo, only one, the orangutan (*P. pygmaeus*) was represented in a category 5 or 6 publication (e.g., Rijkssen and Meijaard 1999; Morrogh-Bernard et al. 2003).

Evaluating the most relevant studies

We evaluated the 15 research papers (i.e. excluding reviews) falling in categories 5 or 6 which were published as full technical accounts in peer-reviewed journals. Most claimed their own merit and justification by appealing to conservation needs: nine (60%) expressed an explicit aim, which can be paraphrased as “providing tools to prevent further wildlife declines. These are papers that should be useful for conservation by virtue of their self-proclaimed intent and topic of study. We assessed the technical merits of the papers and the nature and source of any practical recommendations offered.

Technically the papers were of a good standard but of short duration. Most made good and appropriate use of statistical methods to quantify uncertainties. The average duration was however only nine months (minimum one month, maximum 19 months, SD = 7.2). None address the multi-annual cycles of food availability that characterize Borneo's forests and are strongly suspected of controlling the species abundances of many wildlife species (e.g., Curran et al. 1999; Whitmore 1984;

Yasuda et al. 1999). While longer studies exist (e.g., Curran et al. 1999, Curran et al. 2000), they were not classified as a category 5 or 6 study.

Did these studies yield useful results or recommendations? Most of these publications considered species densities in logged and unlogged forest, without providing possible mechanistic insights as to the cause of these and whether they are indeed caused directly by logging, or by other factors (e.g., hunting, forest fragmentation). Few accounts included any efforts to determine or evaluate cause-effect relationships concerning species declines. Only four provided specific recommendations derived explicitly from their findings while only one offered anything beyond familiar recommendations that are readily stated even without detailed local studies (e.g., more protected areas; more law enforcement).

Useful studies and tangible impacts

We did identify valuable studies scattered amongst the various published and unpublished documents. These include the work of Lammertink (2004) on woodpeckers that shows how understanding habitat requirements can be addressed, and some recent research on mammals such as orangutans, leaf monkeys, civets, mouse-deer, sun bear, and Tupaiidae aimed at defining direct relationships between threats and conservation status.

Two bodies of work stand out not only as relevant, but as demonstrably influential. The long-term work of Bennett, Gumal and colleagues in Sarawak (e.g., Bennett and Gumal 2001; Bennett and Dahaban 1995; Bennett et al. 1997; Bennett et al. 2000) and especially the Sarawak Wildlife Action Plan (Bennett et al. 1996) have led to major changes in and implementation of local wildlife laws in Sarawak. Faunal surveys detailed by (Davies and Payne 1981) helped establish two protected areas in Sabah. These scientifically authoritative documents recommended advances in local wildlife policy, legislation, and/or land use controls. Their proposals were adopted. These cases are instructive. While various additional efforts and favourable circumstances doubtless contributed, the impact of these studies underlines that people can and sometimes do take notice of useful recommendations.

Gaps or omissions?

The inclusion of only four Indonesian language documents in our review is striking. Does it imply we did not look carefully or that there are really only four relevant Indonesian language documents? When presenting our provisional conclusions to local colleagues there is agreement that good Indonesian language material is scarce. While further searches will likely uncover additional documents, they will be obscure. Such omissions likely include Indonesian (and Malay) language theses and project documents of which we managed to locate only a small number. We doubt that a more systematic accounting would substantially alter our conclusions. Our consultations suggest that most local language theses and documents have lacked wider conservation impact (and potential for impact) for similar reasons to the international literature—even if such documents are often better suited to local audiences.

We made specific efforts to identify documents targeted at local policy makers, practitioners, trainers and educators as we anticipated that these would be disproportionately rich with applied recommendations. Thirty-six of our texts are targeted

at a non-research readership. Despite the exceptions noted in the previous section (above) the research content in most of these documents is limited, with no indications of influential studies omitted in our search of more academic accounts.

Researchers recognize that local practitioners rarely have access to (or interest in) the academic literature. Perhaps efforts to achieve influence are sought via alternative channels. Certainly some conservation biologists are involved in local workshops, committees, advisory groups, and NGOs or write letters to the papers and engage in other forms of lobbying. These efforts are hard to quantify, but our informal poll amongst colleagues would suggest that such activities are generally increasing. We applaud such efforts. But we still highlight our question about what we offer as researchers. Are we offering the scientifically well founded guidance that we ourselves so often claim is needed?

A wider concern?—the views of international conservation leaders

Ten of the 20 conservation leaders whom we contacted gave detailed replies to our request for comments on the results and conclusions from the Borneo study and their wider relevance. Nine agreed to the main message of our paper. One was more circumspect but acknowledged that our “general point that academic research often doesn’t meet the needs of conservation practitioners is widely valid”. Four explicitly said that the findings applied globally, while one respondent thought that the mismatch between research and conservation may be especially marked in Borneo (though no explanation was suggested); five respondents did not comment on this issue. Two respondents suggested that additional valuable information could be available in the ‘grey literature,’ but here we repeat that our evaluation for Borneo *includes* available grey literature (i.e., 81 unpublished reports and theses).

The respondent who appeared least convinced suggested that by focusing our focused analysis on only the best 15 studies (of 284) we likely overlooked the various valuable material hidden in the rest. We point out here that insofar as such nuggets exist we found them when reviewing these documents (see Meijaard et al. 2005).

So why, if they are so whole-heartedly sceptical about its general relevance to conservation, do these conservation leaders support and endorse conservation research? One answer may be optimism—after all; there *are* some good studies and contrary to public perceptions conservationists are often optimists (e.g. motivated by the belief that *we can make a difference*). Another answer may be public relations and the need (and competition) for credibility. Those raising support for conservation use appealing pictures and stories about animals and they project the implications that they are familiar with and close to these animals, and uniquely well qualified to address their problems. If this explanation is true the value of conservation research depends principally not on its research outputs but on its appeal as window dressing.

Distortions, distractions and prejudice

Distorted research priorities may arise from academic prejudices (Sayer and Campbell 2004; Sheil and Lawrence 2004). The endless search for generality is not the emphasis needed to solve the specific. More troubling perhaps is the inherent quest for objectivity in what is in reality a normative science. For many researchers it is

preferable to ‘objectively’ observe problems (e.g. count animals) than to make the normative (i.e. value laden) judgements involved in solving them (Sheil 2002). This prejudice is also less political as there is less need to point the finger of blame. Unsurprisingly then our discussions with colleagues also suggests that similar distortions arise due to influences from donors, external agencies, and political engagements. For example donors too shy away from some ‘sensitive’ questions that can generate bad press coverage or lead to conflict with other agencies. There are certainly various issues here that need to be reflected upon, and that might benefit from greater transparency, but we have never heard of research permission for wildlife research being withheld because ‘the planned research was too applied’.

Suggestions

It is possible the failings we observe result from a sense of resignation: biologists can seldom address the real drivers of the changes we are dealing with (because they are not biological), so we fail to try (Whitten et al. 2001). Certainly we cannot ‘solve’ such issues while ‘being biologists’. But we can (a) clarify on-the-ground impacts of these forces on wildlife and their habitats, (b) clarify how these forces and impacts might be guided, modified or constrained to be less damaging, and (c) make a concerted effort to present and explain such improvements to those who might implement them. In the next three sections we consider how research might be improved, how observations should be gathered, and the challenge of making research results accessible in a relevant form to researchers and other users.

Improving research

Conservation research should directly inform conservation needs and opportunities. Some contributions are beyond the control of biologists working alone (see Sayer and Campbell 2004; Sheil and Lawrence 2004). But our results suggest that biologists could improve their specific role too. Our research will be ignored while its practical relevance remains obscure.

We call for more applied wildlife studies with focus on characterizing and countering particular threats. Such research does not inevitably require more time or funding per researcher than more fundamental research. It does, however, require the development of long-term applied research programs and associated funding mechanisms.

Obtaining detailed ecological insights in species and their interactions with their (disturbed) environments requires multi-year research projects, and thus more time than is generally available to an individual researcher. Finding ways to support longer-term studies would be helpful. Those that coordinate in-country research programs could focus more on the development of long-term applied conservation research programs and identify sub-projects suitable for graduate students. The financial and logistical viability of such programs will depend on researchers’ willingness and ability to convince donors and academic institutions of the importance of these goals.

Every day in Borneo, roads are being planned, new concessions are being opened, oil-palm schemes are being expanded. For the most part conservation is being ignored. But we cannot expect all this to stop. If we accept that these processes are

likely to continue we could help to guide them: influencing where roads, concessions and oil palm plantations should better go or not go, or about characteristics they should have or avoid having. At least this would be helping make the best of our situation—this is what conservation biology should now be striving to achieve. Often quite specific information would be useful.

The type of specific questions that need addressing but have typically been neglected in Borneo are:

- What is the effect of barriers (which animals cross roads or deforested lands and under what conditions?). Can these effects be reduced?
- Which animals are particularly targeted by hunters and for what reason? What restrictions might reduce the vulnerability of such species?
- What influences the movement of particular species into post-harvest forest?
- How does forest fragment size relate to typical species compositions? Can we recommend minimum forest sizes for retaining particular species or species compositions?
- Are there specific sites in the landscape (e.g., salt-springs, caves, sandy river banks) that play a key role in maintaining certain wildlife species (and could be protected)?
- What species survive in or can make limited use of oil palm plantations (an unresolved discussion between NGOs and the oil palm industry)? (Similar questions arise for rubber, acacia, teak or other plantation crops).
- Are there specific species in the landscape (e.g., figs [*Ficus* spp.], pitcher plants, termites) that play a key role in maintaining certain wildlife species (and could be actively protected)?
- What is the importance of tree holes, which animals use them and how is this affected by timber harvest?
- What is the impact of understorey slashing on terrestrial and fossorial species?
- What changes are needed in such silvicultural treatments to minimize impact on species diversity?
- Are invasive and exotic species a threat to Bornean wildlife? Are any of these particularly dangerous, and, if so, how can they be controlled?
- How is vertebrate survival affected by river siltation, and what can we do about it?

Answers to these, and many similar research questions could provide information directly applicable to the arena in which most conservation decisions are made.

Influence demands strategy. We need to answer the right questions. Some important research questions may initially appear trivial. For instance, although Indonesian legislation prohibits killing of protected species, it is still possible to destroy the habitat of such species outside protected areas (Meijaard 2007); apparently one excuse for this oversight is that no one has yet demonstrated that those destroying habitat are responsible for species loss. Obvious as it seems, scientific information is needed on this topic to help the government develop laws that truly protect species. By selecting and answering the right questions land use planning and management can be modified to benefit conservation.

On a more pragmatic basis conservation researchers could usefully work with logging companies, and other land-users, to identify which user-practices can and should most realistically be adapted to bring about conservation benefits in what circumstances, and to clarify what is required to ensure implementation.

Why did or didn't the Bornean Peacock Pheasant cross the road?

Finally, With the full benefit of hindsight, it would seem that projects could have established extensive data sets on how species react to particular threats. Such data could have been based on simple observations, such as, 'at 3.30 pm, after a two hour rain shower, a Bornean Peacock Pheasant (*Polyplectron schleiermacheri*) crossed a 3 m wide logging road with a bare clay surface in mixed dipterocarp forest [lightly logged 1994] fringed by scrub, in an area without frequent hunting and over 10 km from the nearest settlement'. Compiling such information can contribute significantly to understanding conservation needs of poorly known and rarely encountered species and giving management recommendations (see Duckworth et al. 2007). Ironically, these types of observations are often routinely recorded as part of regular research work, but are rarely used. If a multitude of such observations on particular species are combined some ecological requirements of these species would become clear. Certainly such observations may not provide publishable (unbiased) density estimates but they can determine whether a species will cross roads (narrow or wide) and if they occur at all. Researchers will debate density estimation techniques endlessly, but whether or not animals readily cross roads remains a key basic unknown for most of Borneo's wildlife. Also, recently developed remote technologies, such as camera traps (e.g., O'Brien et al. 2003) or video cameras (Yasuda and Kawakami 2002) add much information on wildlife behaviour, but most of the potentially relevant details remain unpublished. We suggest that such compilation should be integral to wildlife research projects, and shared as a Borneo-wide data base.

Improving communication

The dearth of Indonesian language information about wildlife ecology failed to draw our comment in a previous draft of this paper. However, as one reviewer rightly admonished us it is shocking and demands attention. Research results, however 'useful' will never achieve impact while failing to reach (prospective) users.

For most national researchers the wider academic literature is already difficult to access and use. Needless to say local decision makers and field practitioners are even further removed from this knowledge: to all intents and purposes, it is not available.

Biologists and conservationists—from students to senior researchers—in countries like Indonesia have to be given the access, tools and skills to better harness the global literature (which as we have already argued should be better geared to their needs). Useful literature (published and grey) should be widely available and familiar, and translated or summarized in local languages. Other end-users (local politicians, loggers, concerned citizens, etc.), should be carefully targeted using suitable means: posters, videos or summary documents in simple non-technical local language may prove helpful. Researchers will often need to seek support and guidance to achieve this.

As an example of our own efforts, we have recently published and we are now actively promoting an Indonesian language book that synthesizes all the information reviewed in this paper (and more). Through the support of various donors (see acknowledgements) this book is now available free (both in print and via the internet: Meijaard et al. 2006).

Conclusions

The biodiversity crisis is real, and when it is invoked by conservation biologists it should be a powerful catalyst for building consensus for action. However, at present it seems much of this value is being dissipated: few zoologists are communicating their hard won research conclusions to those who make decisions on forest landscapes—or perhaps as our review suggests the conclusions are too seldom useful.

Solving the biodiversity crisis in Borneo requires marked changes in the behaviour of governments, private enterprises and others to address legal, political and economic aspects (e.g., Aiken 2004; Doolittle 2004; O'Connor 2004). We are not seeking to apportion excessive blame to researchers—we are no more innocent than anyone else—but we are hoping to share the lessons we have learnt.

We are not against academic research but we are critical when such research claims its legitimacy from an urgent conservation need, and fails to address this. This erodes the limited funding available for developing better conservation guidance in two ways: first, by competing with more legitimate and well conceived conservation research, and second by ultimately undermining donor faith that such research is worth supporting. In contrast more useful research can encourage wider support.

This review has focused on shortcomings, but we also note some substantial research achievements and signs of positive trends. The increasing proportion of (category 5 and 6) studies in Table 1 suggests that researchers are increasingly reporting useful research. We hope that this trend will be encouraged and that our suggestions for research approaches and information sharing may help clarify what is required.

We need a new era of increased collaboration between wildlife researchers, conservation NGOs, and donors resulting in more relevant conservation research. Certainly, we biologists do not bear the real blame for the declining state of the World's natural resources. Responsibilities lie elsewhere—but we biologists could do more to help others do things differently. As wildlife researchers, we have a moral obligation to return something significant to conservation, especially when we use our research to access research grants and permissions.

Acknowledgments This study was carried out as a part of the project on *Forest, Science and Sustainability: Bulungan (Malinau) Model Forest*, PD12/97 Rev. 1 (F) funded by the International Tropical Timber Organization (ITTO) and implemented by the Center for International Forestry Research (CIFOR) and the Forest Research and Development Agency (FORDA) of the Ministry of Forestry of Indonesia. Additional support was provided by a grant from the EC and by UNESCO to CIFOR. Many thanks to the many colleagues who helped us search for and identify potentially relevant literature—especially Kuswata Kartawinata, Levania Santosa Nining Liswanti, Barry Rosenbaum and the CIFOR and BIOTROP library staff. Many thanks too to the Australian National University for allowing EM access to their library as a visiting scholar. We thank Andy Plumptre, John Robinson, Jeff Sayer, Wes Sechrest, Mike Hoffmann, Peter Kareiva, Leon Bennun, Glyn Davies, and Paul Jepson for responding to our request for input, and Russ Mittermeier for discussing this with one of us. Finally, we are grateful to Peter Kareiva, Vincent Nijman, Gabriella Fredriksson, and four anonymous reviewers, for their extensive comments on an earlier draft of this paper.

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