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FORUM

Robust study design is as important on the social as it is on the ecological side of applied ecological research

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Summary

1. The effective management of natural systems often requires resource users to change their behaviour. This has led to many applied ecologists using research tools developed by social scientists. This comes with challenges as ecologists often lack relevant disciplinary training.
2. Using an example from the current issue of *Journal of Applied Ecology* that investigated how conservation interventions influenced conservation outcomes, we discuss the challenges of conducting interdisciplinary science. We illustrate our points using examples from research investigating the role of law enforcement and outreach activities in limiting illegal poaching and the application of the theory of planned behaviour to conservation.
3. *Synthesis and applications*. Interdisciplinary research requires equal rigour to be applied to ecological and social aspects. Researchers with a natural science background need to access expertise and training in the principles of social science research design and methodology, in order to permit a more balanced interdisciplinary understanding of social–ecological systems.

Key-words: human behaviour, interdisciplinary science, law enforcement, social science, social-ecological systems, theory of planned behaviour, training

Introduction

Many applied ecologists are concerned with conservation and management of natural resources. Recent articles in the *Journal of Applied Ecology* and other similar journals demonstrate the strength of using state-of-the-art ecological methods in order to test hypotheses of relevance to management (Aing *et al.* 2011; Guichard *et al.* 2012). However, growing recognition that the management of natural systems is often more about influencing people's decisions and changing their actions than about altering ecosystem processes has led to calls for more research attention to be paid to the human side of applied ecology (Mascia *et al.* 2003; Balmford & Cowling 2006; Milner-Gulland 2012). This has resulted in increasing numbers of applied ecologists, without social science backgrounds, using tools and techniques developed by social scientists in their research. Often these techniques are used to evaluate how interventions influence human behaviour within dynamic social–ecological systems. In this article, we use the example of a study in the current issue of the *Journal of Applied Ecology* (Steinmetz *et al.* 2014) to reflect upon a larger issue: challenges to achieving a robust integrated understanding of humans-in-nature in a field which has traditionally been dominated by the natural sciences.

Social science covers many and disparate disciplines and methodological approaches, just as natural science does. Often ecologists need to work with disciplines concerned with studying the behaviour of individuals who interact most directly with ecosystems, for example through hunting or managing wildlife, and the institutions and societal processes which influence their behaviour. This means that the disciplines with which ecologists tend to interact most include sociology, economics, human geography and psychology. The trend for the increasing use of social science methods by applied ecologists is positive, yet it comes with challenges and pitfalls. Just as an untrained person is unlikely to master the intricacies of distance sampling ungulates in tropical forests to a high enough standard for subsequent publication in an ecological journal, similarly an untrained person is unlikely to

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develop a meaningful survey instrument to measure changes in social norms as a result of a conservation intervention. Perhaps because of the technical difficulties of ecological field research, a social scientist is unlikely to feel capable of estimating animal population sizes as an adjunct to their social survey. However, there are many examples of ecologically trained scientists adding social science research to their mainly ecological studies, with greater or lesser success (Heberlein 2012). Because applied ecology journals tend to have editors and reviewers with natural, rather than social science backgrounds, papers containing low-quality social science may get published, unlike papers containing low-quality ecological science. This perpetuates the problem, because researchers read publications in high-impact journals which validate the lower quality of social science being undertaken in these interdisciplinary studies. In the absence of a change in philosophy and practice, journals risk institutionalizing poor social science in interdisciplinary environmental research.

There are numerous commentaries on the difficulties faced by social and natural scientists working together, which propose various potential solutions (see Appendix S1, Supporting information). Common themes include methodological and epistemological challenges, disciplinary prejudices, communication and training. One option for improving the effectiveness of interdisciplinary collaboration is for people to obtain strong disciplinary training in the principles of ecology or social science research design and methods and then to work together in multidisciplinary teams. There are many challenges to multidisciplinary working, which are long-standing and difficult to overcome (Pooley, Mendelsohn & Milner-Gulland 2014). Large team projects are also slow and expensive and therefore may be unfeasible to convene. Another approach is to train people specifically in interdisciplinary science for natural resource management, so that they come out of postgraduate courses with a grounding in both the natural and social sciences, and an understanding of the strengths and pitfalls of each (Adams 2007; Fisher *et al.* 2009). In the long run, this may be the better way forward.

To illustrate some of these challenges, we now discuss the paper by Steinmetz *et al.* (2014). The study addresses two important topics in conservation science; the role of law enforcement vs. outreach activities in limiting illegal poaching and the application of the theory of planned behaviour (Ajzen 1991) to conservation. Steinmetz *et al.* (2014) is an example of excellent and rigorous interdisciplinary science, but the social science component could have been improved by stronger design in advance of the study. We give examples of other studies in which these topics are addressed either theoretically or empirically and argue that more training of researchers in the principles of social science research design and methodology could enable a more balanced interdisciplinary understanding of social–ecological systems to emerge.

Enforcement and compliance

In seeking to prevent environmentally harmful behaviour, conservation often involves the creation of rules, but rules are useless without enforcement (Rowcliffe, de Merode & Cowlishaw 2004). Studying law enforcement and illegal resource use is, however, fraught with challenges. Indirect measures of non-compliance such as satellite imagery assessing forest loss (Gaveau *et al.* 2009), market surveys gathering information on bushmeat hunting (Fa *et al.* 2014) and counting snares to assess poaching pressure (Wato, Wahungu & Okello 2006) tell us little about the characteristics of rule breakers. The inherent difficulties associated with studying illegal or otherwise sensitive topics directly has led to conservation scientists applying a variety of methods in an attempt to estimate and understand non-compliance. Some have sought specialized questioning techniques from the social sciences that reduce non-response and social desirability biases and used them to examine illegal resource extraction (Solomon *et al.* 2007; Nuno *et al.* 2013). Further, drawing on social psychology the utility of attitude as an indicator of involvement in illegal behaviour has been explored (St. John *et al.* 2012). More unusual sources of data, including diaries of consumption and recall data, have also been interrogated (Golden, Wrangham & Brashares 2013).

Steinmetz *et al.* (2014) assess the effectiveness of different approaches for stemming illegal poaching in Kuiburi National Park, Thailand. In addition to conventional enforcement patrols within the park, outreach activities designed to target social or psychological conditions (e.g. trust in park authorities and justification for conservation action) were conducted in communities neighbouring the park in an attempt to reduce tolerance for illegal poaching and poachers. At a time when conservation law enforcement is receiving increased attention, exemplified by recent pledges to combat wildlife poaching and trafficking (Goldenberg 2013; The White House 2013), Steinmetz *et al.* (2014) present interesting results; they found no evidence that patrols deterred illegal poachers; rather, poaching decline was attributed to outreach activities. Whilst this study makes an important contribution to our understanding of how interventions (enforcement and outreach activities) can influence conservation outcomes (species recovery), some important lessons on the application of methods from the social sciences to conservation can also be learnt.

The authors present an enviable ecological data set including sign-based occupancy surveys and camera traps monitoring six hunted mammal species for a 5-year period complemented by 4 years' worth of ranger patrol data, in addition to information on the quantity, type and location of outreach activities conducted over 4 years. However, people's perceptions of trends in illegal poaching were researched using just one questionnaire survey, conducted towards the end of the project: Whilst poaching pressure and wildlife abundance were monitored before, during

and after outreach activities took place, no baseline data were gathered from the people who were to be subjected to outreach activities (Steinmetz *et al*. 2014). When studies are carefully designed to gather information on the psychological constructs that project interventions are aiming to influence (e.g. attitudes towards illegal poaching), baseline social survey data can enable assessment of intervention effectiveness and help to clarify cause–effect relationships. Further, such data can be used to inform the design of project interventions so that they specifically target underlying beliefs associated with the behaviour of interest and the types of people most likely to hold such beliefs (St. John *et al*. 2012). As such, baseline data have the potential to increase project impact and efficiency. Crucially, an understanding of existing views serves to safeguard projects from introducing interventions that may erode existing beliefs which may be encouraging some form of positive resource management.

The sheer diversity of the types of data used in natural resource management makes it a fascinating science to work in, however, in order to avoid dangers of misinterpreting the insights that data provide, consideration must be given to potential sources of bias (Keane 2013). The only data Steinmetz *et al*. (2014) gathered from people focused on perceived trends in poaching-related behaviours (e.g. sale and consumption of wildlife within the village) and perceived reasons for those trends over the 5-year period coinciding with outreach activities and ranger patrols. Different sources of bias can influence such data. Whilst framing questions so that they do not refer to respondents' own behaviour may help reduce question sensitivity, data gathered using 'projective' or 'indirect' questioning (Fisher & Tellis 1998) are subject to an egocentric bias whereby respondents bias their estimates of others' behaviour in accordance with their own (Ross, Greene & House 1977). Data on sensitive topics are also vulnerable to social desirability bias, a systematic error in reporting resulting from respondents' desire to project a favourable image of themselves to the researcher (Fisher & Tellis 1998). However, questions do not have to be sensitive in order to

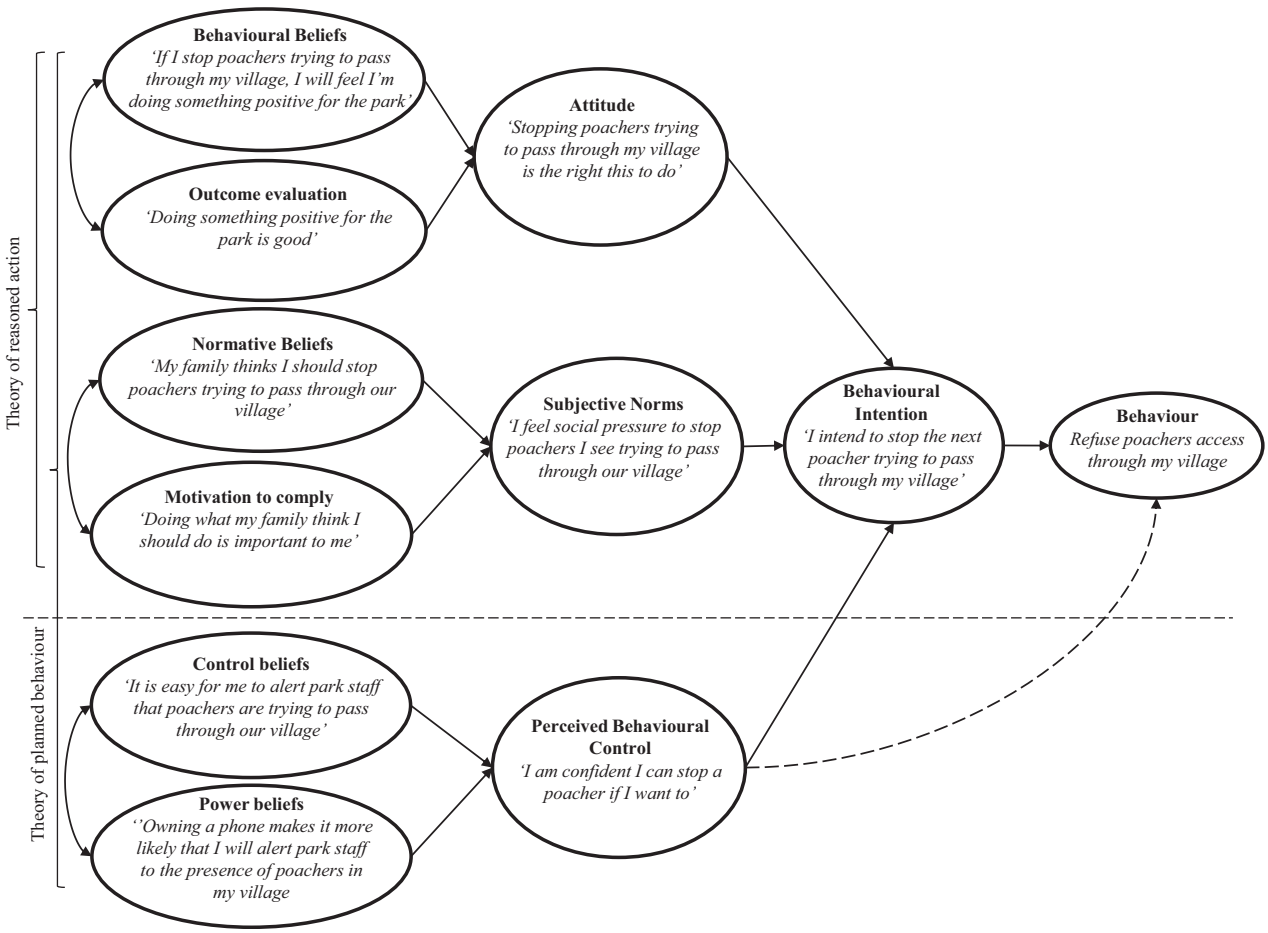

Fig. 1. The theory of reasoned action and the theory of planned behaviour with example statements for measuring each construct, based loosely upon the behaviour of interest in Steinmetz *et al*. (2014). Answers can be recorded using a five-point Likert type items which record respondents' level of agreement with each statement. The possible responses could be: strongly disagree, disagree, neutral, agree and strongly agree. All things held equal, the more positive a person's attitude (degree to which a person evaluates a behaviour or thing with a degree of favour or disfavour), subjective norm (perceived expectation of valued others) and perceived behavioural control (a function of the presence of resources and the power that these resources offer in facilitating behaviour), the greater a person's behavioural intention (immediate antecedent of behaviour) and therefore the likelihood that they will perform the behaviour.

be vulnerable to this bias; respondents' perceptions of a researcher's motivations and allegiances can also stimulate socially desirable responses. Further, the salience of the items being recalled may also bias responses (Keane 2013). Imagine attending a workshop encouraging you to recycle more often. Sometime later you are asked by the workshop facilitators themselves to identify, from a list of items including workshop attendance, which factors have influenced you to recycle more often. How likely do you think it is that you would tick this item, perhaps only to seem polite? To confidently identify the cause of any change in behaviour from self-reported data, it is necessary to take these biases seriously. No ecologist would draw conclusions about bird decline based solely on the populations in their front garden, because they know their observations are likely to be biased. Similarly, researchers should account for biases when it comes to social aspects of conservation.

Social psychological models of human behaviour

The theory of reasoned action (Fishbein & Ajzen 1975) and its extension, the theory of planned behaviour (TPB; Ajzen 1991) are frequently used by social psychologists to examine factors driving human behaviour and are an excellent example of the rich existing body of knowledge in the social sciences that conservationists can draw upon. The premise of the TPB is that interventions aiming to influence behaviour can be better designed by understanding the relative importance of people's attitudes (i.e. their personal evaluation of the positive or negative consequences of the behaviour), social norms (i.e. their perception of social pressure to perform or not perform the behaviour) and perceived behavioural control (i.e. their sense that they are able or not able to perform the behaviour; Ajzen 1991; Fig. 1). Despite their apparent value, however, neither theory has been widely applied within natural resource management (St. John, Edwards-Jones & Jones 2010). Steinmetz *et al.* (2014) state that they drew upon the TPB when framing their approach to outreach and that by designing activities to target different social or psychological conditions, their interventions aimed to influence attitude, subjective norms and perceived behavioural control. However, Steinmetz *et al.* (2014) do not collect any data on the social psychological beliefs of people living in the study area either before or after outreach activities took place. As acknowledged by the authors, this meant that it was not possible to examine the extent to which outreach influenced different constructs underlying people's behaviour towards illegal poachers. For example, one hypothesis might be that the behaviour of refusing poachers access through villages is more strongly affected by perceived behavioural control (perceived ease or difficulty of preventing poacher access) than by attitudes (the degree to which someone has a (un)favourable view of allowing poacher access), or subjective norms (perceived social pressure to (dis)allow poacher access) because people may perceive that alone, they have a limited ability to stop those engaging in a clandestine activity. Deliberately setting out to test such a hypothesis, in a rigorously designed study, would not only be a useful contribution to social science, but would also help in the better design of interventions to reduce illegal poaching. If the hypothesis was proved correct, then it is likely that outreach activities promoting actions local people could take against illegal poachers (e.g. alerting park staff) and ensuring people have the required resource to act (e.g. access to

Table 1. Reviews drawing on various social sciences disciplines which are written for a natural resource management audience

Authors	Topic
Papers	
Bruskotter & Wilson (2013)	*Hazard acceptance theory* The use of psychological theory and risk communication for promoting carnivore conservation
Raymond & Knight (2013)	*Social science techniques and conservation planning* Presents recommendations for integrating social research techniques into the theory and practice of conservation planning
Colyvan, Justus & Regan (2011)	*Game theory* Demonstrates how several real-world conservation problems can be modelled using game theory
Drury, Homewood & Randall (2011)	*Qualitative and quantitative social surveys* Contrasts questionnaire-based surveys with qualitative approaches to collecting social data
St. John, Edwards-Jones & Jones (2010)	*Social psychology – understanding human behaviour* Reviews theories of human behaviour and how they have been used in the context of conservation
Keane *et al.* (2008)	*Enforcement and compliance* Reviews approaches to understanding why people break rules and how optimal policy choices can reduce rule breaking
Books	
Heberlein (2012)	*Environmental attitudes* Details what attitudes are, how they change and what they have to do with people's behaviour
Newing (2011)	*Social science research methods and approaches* Provides a grounding in social science research methods for students and professionals
Clayton & Myers (2009)	*Conservation psychology* Introduces conservation psychology to an audience new to the topic

a phone), combined with law enforcement would be a more effective tool for controlling illegal poaching than either approach alone. The practice of developing and testing hypotheses within a rigorous theoretical framework is standard in applied ecological research, for example testing whether the application of a particular management regime on a farm increases or decreases bird diversity, by using previous studies and theory to guide sampling design (Doxa *et al*. 2010). In the social sciences, just as in ecology, theoretical frameworks are most powerful when used to guide study design and analysis, rather than just to guide variable selection.

Recent applications of the TPB in natural resource management have explored the impact of training on people's decision to cultivate a novel species, Xaté *Chamaedorea ernesti-augusti* in Belize (Williams *et al*. 2012) and landholders' decisions to conserve forest on the agricultural frontier of South American Gran Chaco (Mastrangelo *et al*. 2013). These studies demonstrate how powerful the TPB framework can be for teasing out the relative importance of alternative drivers of behaviour. Both of these studies follow the methodological steps outlined in TPB literature: Qualitative methods were initially used to explore perceptions and beliefs concerning the behaviour of interest. Then, drawing on this information, target-, action-, context- and time frame-specific statements capturing respondents' attitudes, subjective norms and perceived behavioural control were drafted, piloted and refined before data collection. Through their rigorous applications of the TPB, both Williams *et al*. (2012) and Mastrangelo *et al*. (2013) were able to identify the key variables driving behaviour, that is the factors most relevant to the design of conservation interventions. For example, increasing levels of technical knowledge and enhancing the power that individuals perceived they had to succeed in cultivating Xaté encouraged people to grow this overharvested plant. Whilst of limited importance in encouraging Xaté cultivation (Williams *et al*. 2012), social norms and attitudes were both important predictors of land-owners' intention to conserve forest (Mastrangelo *et al*. 2013). Therefore re-establishing social norms rewarding conservation behaviour was considered to be the most effective way of achieving long-term forest conservation on the agricultural frontier.

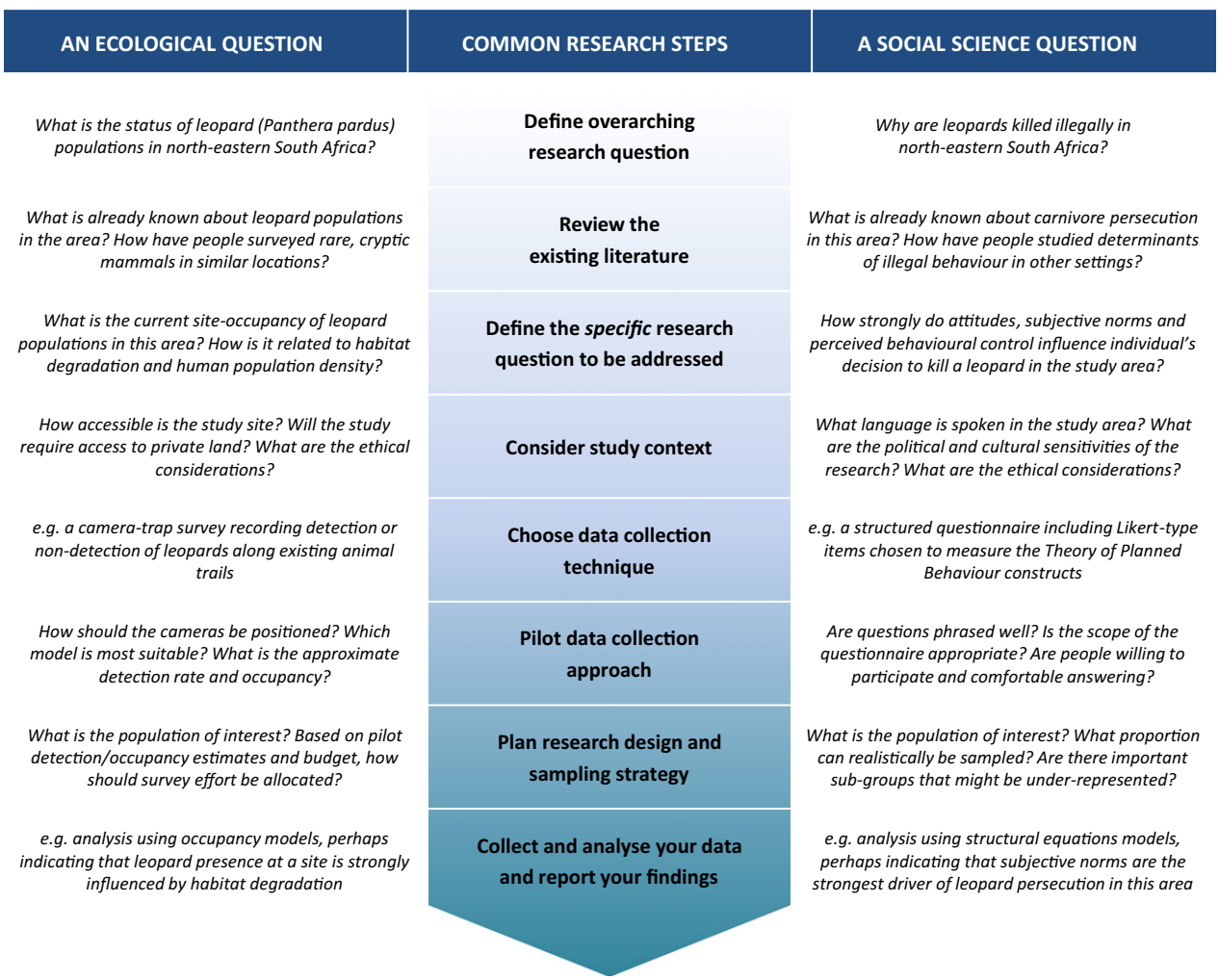

Fig. 2. Steps in study design illustrated with a social science and ecological example.

Ensuring research meets ethical standards

Just as ecological research that involves handling animals, invasive sampling or potential environmental damage is expected to meet stringent ethical standards, so disciplines whose research involves human subjects (e.g. medicine, sociology and anthropology) also have accepted standards of research ethics. As applied ecologists increasingly shift focus from ecology to wider social–ecological systems, many are carrying out research on people without having any formal training or even properly considering issues such as free, prior informed consent, anonymity and compensation. It is normal practice in universities, and increasingly within NGOs and government departments, for research to be scrutinized by an ethical review board. However, the ethics boards in biology departments usually only have expertise in the impacts of research on animals, whilst in conservation NGOs or resource management bodies the expertise of staff may be relatively narrowly focussed on the biological aspects of their work. Applied ecologists often work on issues concerning contested natural resources or even illegal behaviours, raising potentially serious ethical issues. It is important that there is the capacity within their organizations for independent ethics review of the social components of their work.

The way forward

Applied ecology does not need to create new tools and analytical frameworks to understand human motivations and behaviour, as they already exist in disciplines such as social psychology, economics, criminology, anthropology and sociology. Recent reviews and books offer an opportunity to easily access such information (Table 1). For example, Drury, Homewood & Randall (2011) review the context in which qualitative methods may be more effective than structured questionnaire-based surveys whilst Heberlein (2012) explains what attitudes are and how they relate to behaviour in the context of the environment. Our aspiration should be to apply these theories and methods rigorously so that conservation interventions are guided by data derived from strong conceptual and empirical foundations.

We believe that those researching natural resource management and social–ecological systems should apply the same level of care that they give to ecological research design to their research on human behaviour and the effects of interventions on human wellbeing. With respect to quantitative social surveys, this starts with careful study design, using a parallel approach to accepted practice in ecological science (Fig. 2). For example, defining overarching research questions is the first common step to designing both the ecological and social component of an interdisciplinary study aiming to quantify the status of a particular resource and understand why the resource is utilized by people. Qualitative social science is also gaining importance in applied ecological research, for example with the increasing emphasis on understanding the effects of conservation interventions on human well-being (Milner-Gulland *et al.* 2014). As the philosophical and methodological foundations of qualitative methods are far removed from the disciplinary training of most applied ecologists, even more care and attention is required when carrying out studies using these approaches.

Part of the burden for supporting researchers in making these changes lies with journal editors, who need to ensure that the social research methods used in papers submitted to journals are scrutinized with the same rigour as their ecological methods. This is increasingly happening, as natural resource management journals recruit social scientists to their editorial boards. Journals publishing interdisciplinary research can also help raise ethical standards by requiring an ethics statement in articles including social data. Journals should take every opportunity to highlight excellent examples of social science in their pages and to support authors to reflect openly in their papers on any limitations to their study design and methods and to present improvements for the future, as was done in the excellent paper by Steinmetz *et al.* (2014).

Data accessibility

This paper does not contain new data.

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Supporting Information

Additional Supporting Information may be found in the online version of this article.

Appendix S1. Challenges to the application of effective social science in natural resource management, illustrated by statements of problems encountered and potential solutions, as suggested by authors writing from a social science perspective.

