Mapping Human and Social Dimensions of Conservation Opportunity for the Scheduling of Conservation Action on Private Land

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Abstract *Spatial prioritization techniques are applied in conservation-planning initiatives to allocate conservation resources. Although typically they are based on ecological data (e.g., species, habitats, ecological processes), increasingly they also include nonecological data, mostly on the vulnerability of valued features and economic costs of implementation. Nevertheless, the effectiveness of conservation actions implemented through conservation-planning initiatives is a function of the human and social dimensions of social-ecological systems, such as stakeholders' willingness and capacity to participate. We assessed human and social factors hypothesized to define opportunities for implementing effective conservation action by individual land managers (those responsible for making day-to-day decisions on land use) and mapped these to schedule implementation of a private land conservation program. We surveyed 48 land managers who owned 301 land parcels in the Makana Municipality of the Eastern Cape province in South Africa. Psychometric statistical and cluster analyses were applied to the interview data so as to map human and social factors of conservation opportunity across a landscape of regional conservation importance. Four groups of landowners were identified, in rank order, for a phased implementation process. Furthermore, using psychometric statistical techniques, we reduced the number of interview questions from 165 to 45, which is a preliminary step toward developing surrogates for human and social factors that can be developed rapidly and complemented with measures of conservation value, vulnerability, and economic cost to more-effectively schedule conservation actions. This work provides conservation and land management professionals direction on where and how implementation of local-scale conservation should be undertaken to ensure it is feasible.*

Introduction

Spatially explicit techniques to identify protected areas are being applied increasingly in conservation-planning initiatives (Pressey 2002). These spatial prioritizations typically are based on only ecological data, although nonecological data are now being included (Polasky 2008). Three types of nonecological data influence the spatial arrangement, cost-effectiveness, and target achievement of areas identified as important for achieving conservation goals. First, data on vulnerability—the likelihood or imminence of loss of valued nature from current or future threatening processes (Wilson et al. 2005)—is complemented with data on conservation value when defining conservation priority (Pressey & Taffs 2001). Second, economic data are being applied to improve the cost-effectiveness of proposed conservation actions (Naidoo et al. 2006). Third, data on human activities that could compromise conservation interests, such as human population density (Williams et al. 2003) and the development potential of land (Polasky et al. 2005), have been included in spatial prioritizations. We call such factors "reactive" because these data are used to plan a response to destructive human activities and so avoid spatial prioritizations recommending conservation action in areas where conservation and development interests will conflict.

Although spatial-prioritization approaches that apply ecological, and more recently, economic-cost data have advanced rapidly (approaches for mapping vulnerability remain overly simplistic; Wilson et al. 2005), the relative importance of ecological data for directing conservation investment has been overstated (Knight et al. 2007; Grantham et al. 2008; Perhans et al. 2008). Many regions of high conservation value are dominated by production landscapes in complex social-ecological systems (Briggs 2001) and have been subdivided into small management units with numerous owners who have diverse land-management goals. The choices made by managers of these lands (those responsible for making day-to-day decisions on land use), not simply the spatial patterns of nature, determines the effectiveness of conservation-planning initiatives (Cowling & Pressey 2003). Accordingly, a thorough understanding of the human and social factors that drive the decision-making processes of land managers is essential data for spatial prioritizations, which aim to be usefully translated into effective conservation action. Furthermore, the results of recent studies show rapidly diminishing returns on investments for collecting ecological data (Grantham et al. 2008) and that the most heterogeneous data, which may not be ecological data, should receive the greatest investment when conducting spatial prioritizations (Perhans et al. 2008).

Despite regular calls for human and social data to be applied in spatial prioritizations to enhance the proactive implementation of effective action (Tans 1974; Wright 1977; Williams et al. 2003; Knight & Cowling 2007), conservation planners have been slow to incorporate these data. Recent recognition of the importance of human and social factors in defining effective conservation action has led to the emergence of the concept of conservation opportunity (Cowling & Knight 2007). Spatial prioritizations that map conservation opportunity, as opposed to simply conservation priority, move beyond where and when conservation resources should be allocated toward how specific actions can be implemented most effectively. Mapping conservation opportunity provides an understanding of the factors that contribute directly to effective actions (i.e., a complementary suite of integrated instruments, incentives, and institutions) and improves identification of candidate areas where conservation action can be implemented feasibly (sensu Hobbs et al. 2003). Failure to include human and social data may render inevitable the need to repeat a spatial prioritization if it is to be translated into effective conservation action (Margules & Pressey 2000) because planners will find they have identified areas of biological importance, but that a proportion of the areas identified are unlikely to be

feasibly implemented. For example, land managers unwilling to participate in private-land conservation initiatives will be identified for involvement when human and social data are not applied. Inclusion of mapped human and social data avoids conflict and aligns the values of stakeholders in a positive and optimistic process. This minimizes the slow progress and wasting of time, funding, and resources that result from engaging land managers who are unwilling to or are incapable of participating, and allows targeting of capacity building to facilitate implementation. Influential land managers (champions) can be preferentially targeted for involvement, which lends credibility to initiatives and improves rate of uptake and levels of commitment in the land managers approached subsequently. This rapid initial progress helps build credibility with stakeholders, satisfies funders, and promotes leveraging of further funding.

The currently popular approach of applying ecological, vulnerability, and economic data to spatial prioritization analyses provides useful direction for implementing effective conservation action only when set in the context of the human and social capital available to collectively mobilize people (Rodriguez et al. 2006; Knight & Cowling 2007). Spatial prioritizations must provide spatially explicit direction on appropriate types of conservation actions that have a high likelihood of long-term success (Knight & Cowling 2007; Wilson et al. 2007). Accordingly, opportunity and constraint data should be included in spatial prioritizations. Such data should reflect the multiple (and often conflicting) realities, values, and management goals of land managers (Curtis et al. 2001; Winter et al. 2007) and be related to the specific conservation instruments to be employed for implementation (Young et al. 1996; Knight et al. 2006*a*; Wilson et al. 2007). The instruments should, in turn, be selected according to the characteristics of individual planning regions and land managers (Ostrom et al. 2007).

We are unaware of any study in which human and social factors defining conservation opportunity for inclusion in a spatial prioritization have been mapped. In contrast to conservation science's sound understanding of the limitations of ecological data (Pressey 2004), little is known about what human and social data to gather or how to include these data in a spatial prioritization. We present a local-scale approach to spatial prioritization that maps the human and social dimensions of conservation opportunity on private land in a production landscape of regional conservation importance. First, we defined human and social factors hypothesized to influence the individual and collective conservation effectiveness of land managers. Second, we assessed the extent to which it is possible to identify a robust subset of questions that provide reliable human and social data so as to reduce the time it takes to interview land managers. Third, we mapped conservation opportunity, defined as human and social capital characteristics of land managers who support and enhance effective conservation action on private land, for the suite of conservation instruments identified as appropriate by the land managers of the planning region.

Methods

We recognize five dimensions of conservation opportunity for effective allocation of conservation resources: conservation value, vulnerability, economic cost, human capital, and social capital. We assessed only factors of the human and social dimensions (Table 1). There was little practical purpose in assessing conservation value, vulnerability, and cost data at the local scale for three reasons. First, the planning region lies in a regional-scale corridor essential for achieving biome-wide conservation goals (Knight et al. 2003; Rouget et al. 2006), meaning a scheduling (i.e., ranking of proposed sites for implementation), rather than area selection, analysis is required. Second, land-use pressures are uniformly low because vegetation clearing is rare and commercial grazing is typically conducted sustainably. Third, the economic costs of establishing voluntary conservation agreements on private land (e.g., negotiating the contract, extension officer's travel)—the stakeholder-endorsed conservation instrument of choice (Knight et al. 2003)—are relatively uniform and not a function of land area.

We identified 12 factors defining the human and social dimensions of conservation opportunity from literature on bioregional planning, conservation-planning, local-scale conservation initiatives, and natural resource management, and from our personal experience in conservation planning (e.g., Knight et al. 2006*b*; Table 1). Human capital was defined by land-manager characteristics hypothesized to be factors that positively influence the effective implementation of conservation action. We assessed seven factors of human capital: conservation knowledge, conservation behavior, entrepreneurial orientation, local champion traits, and peer regard of local champions. Willingness to participate in conservation initiatives was assessed by investigating which conservation instruments land managers were willing to adopt. We also assessed willingness to sell land because landowners leaving the planning region changes the pool of human and social capital. We defined social capital as the structural and cognitive dimensions of the relationships between people that influences both positive and negative conservation actions. We assessed five factors of social capital: local sense of belonging, confidence in government, membership in local and broader networks (sensu Grootaert & van Bastelaer 2001), and willingness to collaborate with specific implementation organizations.

We gathered data through semistructured, face-to-face interviews with 48 land managers from June to November 2006. A draft interview questionnaire was

Table 1. Preliminary human and social factors hypothesized to define local-scale conservation opportunity as identified from an extensive literature review.

Factor	*Measure*	*Rationale*
Human capital		
conservation knowledge	knowledge of nature conservation and ecologically sustainable land management issues and processes	Knowledge comprises the cognitive component of the tripartite model for describing attitudes (Bohner & Wanke 2002). Land managers with better knowledge of conservation theory and practice may be more likely to adopt conservation practices (Sanz & Grajal 1998; Rhodes et al. 2002; Holmes 2003; Steinmetz et al. 2006).
conservation behavior	participation in conservation-friendly activities, such as alien invasive plant removal	Behavior comprises a component of the tripartite model for describing attitudes (Bohner & Wanke 2002). Behavior is a better reflection of values than attitudes (e.g., a strong stewardship ethic is not linked to increased adoption of best practice land management) (Curtis & de Lacy 1998). Land managers already practicing conservation-friendly activities may require fewer incentives maintain these practices.
entrepreneurial orientation	characteristics of entrepreneurship exhibited by land manager	Skills and traits required to initiate a small business are probably useful to initiate private land conservation (e.g., ability to recognize and seize opportunities, be self-motivated, innovative, and/or are prepared to take calculated business risks) (Lumpkin & Dess 1996).
local champion—personal	characteristics of leadership and drive exhibited by a land manager	Champions are fundamental to leading private land conservation initiatives (Cowling et al. 2002; ten Kate et al. 2004; Shanley 2006) and for mainstreaming conservation into other sectors (Cowling & Pressey 2003; Knight et al. 2006*b*).
local champion—PEERS	land manager well regarded by his/her peers	A champion must be capable of building social capital and promoting collective action among peers if landscape-level conservation is to be effective.
willingness to participate	identifies the conservation instruments and incentives a land manager will and will not engage, and the level of reduced production they will accept	Private-land conservation initiatives are often voluntary and so rely on incentives and encouragement, rather than coercion or enforced involvement (Young et al. 1996; Byron & Curtis 2002), which requires a better understanding of the social and economic factors that underpin land managers willingness to engage land management initiatives (Curtis et al. 2001).
willingness to sell	identifies land manager to engage and agency or organizations	Conservation agencies have funds available for land acquisition; however, land manager willingness to sell is heterogeneous (Tans 1974; Meir et al. 2004).
Social capital		
local sense of belonging	land managers level of trust and the strength of norms of reciprocity and sharing	Land managers who trust and have confidence in each other will probably work more effectively together and will likely require less input to foster collective action.
confidence in governance	land managers level of trust in governance systems	Civil and political liberties, political stability and the absence of political violence, and measures of contract enforcement, expropriation risk, corruption, and the quality of government bureaucracy affect economies (Grootaert & van Bastelear 2001). Land managers willingness to invest in a conservation initiative may reflect confidence in these components.
local networks	land managers level of involvement in community institutions and organizations, and his/her social networks.	Effective private-land conservation initiatives will probably require common property resource management, where multiple land managers manage their properties collectively (Ostrom 1990; Briggs 2001; Grootaert & van Bastelear 2001; Brunckhorst et al. 2002).
broader networks	land managers “connectedness” with regional, provincial, or national institutions and networks	Local-scale conservation initiatives may derive significant benefits from people and resources found beyond the local area, whose access may be enhanced through a local contact.
willingness to collaborate	identifies the agencies or organizations a land manager will and will not engage and their preparedness to work with them	Collaboration is fundamental to effective conservation (Wondolleck & Yaffee 2000). Some land managers are disillusioned with government or may have had negative experiences with other land-management organizations and nongovernmental organizations. To be effective, conservation initiatives must be sure with whom land managers are prepared to collaborate.

reviewed by researchers with interview experience, piloted, and refined. Questions comprised Likert statements (Babbie 1989), closed-ended statements, and open-ended statements. We did not ask land managers' about their financial situations because earlier work indicated their sensitivity to this topic (Cumming 2007). A priori lack of contact details precluded stratification of land managers, who were identified from telephone directories or during interviews through "snowballing" (Goodman 1961). Generally, interviews were conducted in the land managers' residences and lasted 3 h (range 2–6 h). In a small number of cases, both the husband and wife managed the property and were interviewed together.

Indices and scales that represent summaries of data are similar, but different, measures for ranking factors composed of multiple questions (Babbie 1989). We constructed indices for human and social factors through the simple accumulation of scores assigned to individual factors. Scales for human and social factors were constructed through the assignment of scores to patterns within factors and accounted for differences in the intensity of responses to questions (Babbie 1989). We constructed indices or scales, as appropriate, for each of the 12 factors assessed. Each factor was constructed using a different number of questions, from which a subset of questions were identified that were internally consistent (i.e., quantified the specific factor intended) and reliable (i.e., the degree to which the subset of questions captured the informational content for the full set of questions for a factor).

We measured three coefficients to identify subsets of internally consistent questions: Cronbach's alpha ($\acute{\alpha}$) (Cronbach 1951), Revelle's beta (β) (Revelle 1979), and McDonald's omega ($\acute{\omega}_b$) (McDonald 1999). Cronbach's $\acute{\alpha}$ is the most widely applied coefficient of internal consistency in the psychometric literature. Nevertheless, it overestimates the proportion of variance displayed by scores when questions asked reflect multiple (as opposed to single) dimensions of a factor being measured (Zinbarg et al. 2005). This results in overestimation of internal consistency and hence overestimation of the validity of a scale (Zinbarg et al. 2005). Thus, we also measured McDonald's $\acute{\omega}_{\mathrm{h}}$ because it is the most reliable coefficient of internal consistency (Zinbarg et al. 2005), and equivalence between Cronbach's $\acute{\alpha}$ and McDonald's $\acute{\omega}_{\mathrm{h}}$ varies significantly and holds only under highly restrictive conditions (Zinbarg et al. 2005). Finally, we complemented Cronbach's $\acute{\alpha}$ with Revelle's β because the quality and homogeneity of question responses only can be judged together (Revelle 1979).

We identified internally consistent factors by calculating β and $\acute{\omega}_b$ values for alternative combinations of subsets of questions for each factor, which balanced the compromise between internal consistency and the smallest number of questions. Selecting a small subset of questions for each factor aimed to reduce the overall number of questions required in an interview and, ultimately, the time it took to gather data time and cost. Acceptable thresholds of internal consistency depend on whether applications of the research are theoretical or applied (Nunnally 1978). We are unaware of published thresholds for $\acute{\omega}_b$, but suggest values of 0.60 are acceptable. Coefficients above 0.70 are sufficient for theoretical research in which $\acute{\alpha}$ is used (Nunnally 1978). Acceptable thresholds are $\acute{\alpha} = 0.80$ and $\beta = 0.70$ in applied contexts (Rossiter 2002). Subscales (i.e., a lack of internal consistency) may be present if $\beta < 0.50$ (Revelle 1979).

We assessed the reliability of individual factors by calculating an RV coefficient (Robert & Escoufier 1976) for the best subset of questions (i.e., a small number of internally consistent questions). This measures the degree to which the subset of factors represents the informational content of the full set of questions for a factor. In identifying the best subset of questions defining a factor, we traded off the number of questions in the subset against the RV coefficient and aimed for subsets of questions that provided high coefficients for both $\acute{\omega}_b$ and RV (Table 2). We also calculated an RV coefficient for the sum of the questions from all individual factors relative to the full set of questions, subjecting the outputs of multiple correspondence analyses of both data sets to co-inertia analysis to identify the similarity between the subset and the full set of questions (Legendre & Legendre 1998).

Land managers that had similar values for the different factors were hypothesized to require similar investments to encourage them to implement effective conservation action. For example, those willing to sell their land could be approached to sell, whereas those unwilling to sell but willing to enter a voluntary agreement could be targeted accordingly. We identified clusters (groups) of land managers with similar index and scale values for individual factors with the subset of questions that provided the best combination of $\acute{\omega}_b$ and RV coefficients to ensure consistency and reliability of land managers' responses. Clustering was accomplished with Horn-Morisita's index of dissimilarity and Ward's minimum variance method of agglomeration (Legendre & Legendre 1998). We ranked individual factors according to their perceived contribution toward the effective implementation of private-land conservation initiatives. Clusters were then ranked on the basis of dominant factor(s) in individual clusters and mapped in GIS to spatially depict conservation opportunity. We do not present a map of our results, however, so as to preserve the anonymity of individual land managers.

We conducted analyses with the R open-source environment for statistical computation and graphics (R-core 2007). Specifically, we used: psych (Revelle 2007) for calculating $\acute{\alpha}$, β, and $\acute{\omega}_b$ and to produce ICLUST plots displaying the full tree of values for these coefficients, which we complemented with Rgraphviz (Gentry

Table 2. Results of analyses for internal consistency and reliability for factors of conservation opportunity for 48 land managers in the Makana Municipality, Eastern Cape, South Africa.

Factors	*Question reduction*[a]	*Internal consistency* $\acute{\alpha}$[b]	β[c]	$\acute{\omega}_h$[d]	*Reliability (RV)*[e]
Human capital conservation knowledge	11 to 4	0.71	0.55	0.66	0.71
Conservation behavior	8 to 4	0.62	0.50	0.62	0.75
Entrepreneurial orientation	25 to 7	0.81	0.68	0.68	0.68
Local champion, personal[f]	12 to 4	0.69	0.53	0.56	0.70
Local champion, peers[g]	1 to 1	ns[h]	ns[h]	ns[h]	ns[h]
Willingness to participate[g]	20 to 4	0.85	0.72	0.78	0.73
Willingness to sell	5 to 2	0.90	0.90	ns[h]	0.79
Social capital local sense of belonging	10 to 3	0.77	0.58	0.81	0.73
Confidence in governance	13 to 3	0.79	0.73	0.79	0.75
Local networks[g]	25 to 6	0.69	0.45	0.65	0.57
Broader networks[g]	11 to 3	0.64	0.57	0.65	0.69
Willingness to collaborate[g]	24 to 4	0.88	0.85	0.84	0.75
Total	165 to 45				

[a] *The first number represents the original number of questions used to gather data for a factor, whereas the second number represents the reduced number of questions providing internally consistent and reliable factor values.*
[b] *Cronbach's $\acute{\alpha}$ (alpha).*
[c] *Revelle's β (beta).*
[d] *McDonald's $\acute{\omega}_h$ (omega).*
[e] *Robert and Escoufier's RV-coefficient, which represents the degree to which the subset of questions captures the informational content of the full set of questions.*
[f] *Excluded from the subsequent cluster analysis to identify land managers who provide a conservation opportunity because the factor coefficients were low.*
[g] *Factors calculated as an index (not a scale) by summing the positive responses to questions (i.e., using the full set of questions), rather than using the subset of questions, because this provided more relevant results.*
[h] *No solution computable.*

et al. 2007) and Graphviz to produce figures; subselect (Cerdeira et al. 2007) for calculating RV coefficients; stats (R-core 2007) for cluster analyses; and ade4 (Chessel et al. 2004) for the multiple correspondence analysis, coinertia analysis, dendograms, and the standardized table of question responses.

Results

Land Managers

Almost all land managers were white English-speaking married men, with an average of two children and an average age of 48 years. Their properties had been managed by their families for, on average two, but up to six, generations. Most land managers were primarily goat or sheep pastoralists who raised more than one type of stock and owned the properties they worked. Typically, the majority of their income was generated from on-farm activities. Some land managers supplemented income with small-scale ecotourism or hunting ventures, whereas a small number of land managers used their land exclusively for ecotourism.

Question Reduction

Our identification of question subsets for individual factors was highly effective; 165 questions were reduced to 45 (73% reduction). Co-inertia analyses of the complete and reduced set of questions, following multiple correspondence analyses of each set, showed that the reduced set of questions captured a high proportion of informational content of the complete set of questions (RV coefficient = 0.89). Most land managers responses deviated only marginally when the question subsets were used. Internal consistency of the 12 factors was generally good (Table 2). Willingness to sell was highest for $\acute{\alpha}$ and β coefficients (both 0.90) ($\acute{\omega}_h$ was not calculated because only two questions were available to use) and had the highest RV coefficient (0.79). The factors for local and broader networks ranked low ($\acute{\omega}_h = 0.65$), but were included because all questions were summed to calculate the index, which negated the importance of reliability. Entrepreneurial orientation had a low RV coefficient, possibly because our interview protocol structured questions as distinct subsets that corresponded to subscales identified by an earlier author (Hermansen-Kobulnicky & Moss 2004). The local champion—peers factor was included (despite no coefficient values) because internal consistency was assured (i.e., there was only one question). Two factors were excluded (conservation behavior and local champion—personal) because both had low $\acute{\omega}_h$ coefficients.

Identifying Patterns of Conservation Opportunity

Patterns between land managers for individual factors varied, sometimes markedly (Supporting Information).

Conservation knowledge was generally low and entrepreneurial orientation was high. Four land managers were prominent local champions: LM05, LM04, LM07, and LM18 (in rank order from highest to lowest). The subfactors of social capital of local networks and broader networks were low and very low, respectively. Confidence in governance was very low for local government and relatively high for national government. Local sense of belonging was relatively high. The indices of the willingness-to-collaborate factor varied widely from very low to very high, but was generally positive. The subscales used to assess willingness to participate (willingness to adopt conservation measures, engage in incentive schemes, and forgo production activities) all had high values.

Nine distinct clusters of land managers were identified (Fig. 1). The four primary factors influencing clustering were (in rank order from first to fourth) willingness to sell, conservation knowledge, local champion—peers, and broad networks. Removal of willingness to sell produced similar results. We removed willingness to sell because land managers who provide opportunities for private-land conservation do not necessarily provide opportunities for land acquisition, and private-land conservation was earlier identified as land managers' most desirable model of landscape management (Knight et al. 2003). The heterogeneity of index and scale scores between individual land managers varied within clusters (Fig. 1b). Clusters were ranked on the relative importance of individual factors for implementing a practical initiative for private-land conservation. The top four land-manager clusters were ranked for implementation of conservation action because the remaining clusters were likely to present significant implementation challenges and so probably constitute constraints to implementing region-wide conservation action. Two champions (i.e., land managers widely well regarded by their peers as effective land managers) comprised cluster 1 (i.e., highest opportunity) because their influence was deemed important for securing the interest and trust of other land managers, and this factor was influential in the clustering process. Land managers in cluster 2 rated strongly as champions also and had strong willingness to participate and willingness to collaborate values. Managers in clusters 3 and 4 generally had higher than mean values for willingness to participate, willingness to collaborate, and local networks factors. Over half the land managers surveyed did not represent strong opportunities for involvement.

Discussion

Although other researchers have gathered "reactive" socioeconomic data on areas to avoid when designing candidate protected-area networks (e.g., areas of high population density, predicted threats, or costs imposed on resource managers), ours is the first spatial prioritization we are aware of that includes data on the human and social factors that define areas of conservation opportunity. Mapping human and social capital presents similar, but distinct, challenges compared with mapping of ecological data. People's values are idiosyncratic, which makes reliable prediction of human and social factors that influence effective implementation of conservation action challenging. In addition, face-to-face techniques such as interviews, social mapping, and participatory rural appraisal are time consuming and expensive to implement. Nevertheless, similar techniques have been used effectively to gather socioeconomic data for other local-scale spatial prioritizations (Richardson et al. 2006; Klein et al. 2008) and are probably no more challenging to implement than ecological surveys. As a cost-effective alternative, techniques such as mailed surveys are relatively inexpensive and have been used effectively (Curtis et al. 2001); however, they often deliver poor response rates compared with interview techniques (Babbie 1989). The effectiveness of our subsampling (73% reduction in the number of questions) coupled with high reliability ($RV = 0.89$) of our subset of questions, demonstrates the potential cost-effectiveness and utility of our approach. The time and cost of gathering data can be substantially reduced, with interviews being conducted in 30–40 min rather than up to 6 h.

Ranking land managers on the basis of their likely participation in a private land conservation initiative (Fig. 1) is a complex process and should not be limited to cluster analysis (Revelle 1979). Statistical analyses are no substitute for common sense when identifying factors defining dimensions of a person's character. The heterogeneity of values for the factors among individual land managers within individual clusters demands that clusters be ranked by context and individual land manager characteristics, as well as by values. Clustering, however, provides the advantage of identifying specific opportunities and constraints across groups of individuals. For example, of the 46 private land managers we surveyed (two of the 48 land managers managed government land, which cannot be sold), only 11% were willing to sell their land to conservation organizations and 11% were very unwilling to collaborate with either the provincial nature conservation agency or nongovernmental conservation organizations, due to negative past experiences or concerns about their motives. Nevertheless, 90% and 41% of land managers, respectively, were willing to engage in voluntary or binding conservation agreements. Given, that opportunities for land acquisition and private-land conservation are both spatially dispersed and do not often overlap, mapping conservation opportunity clearly allows specific conservation instruments and institutions to be matched to individual land managers. This

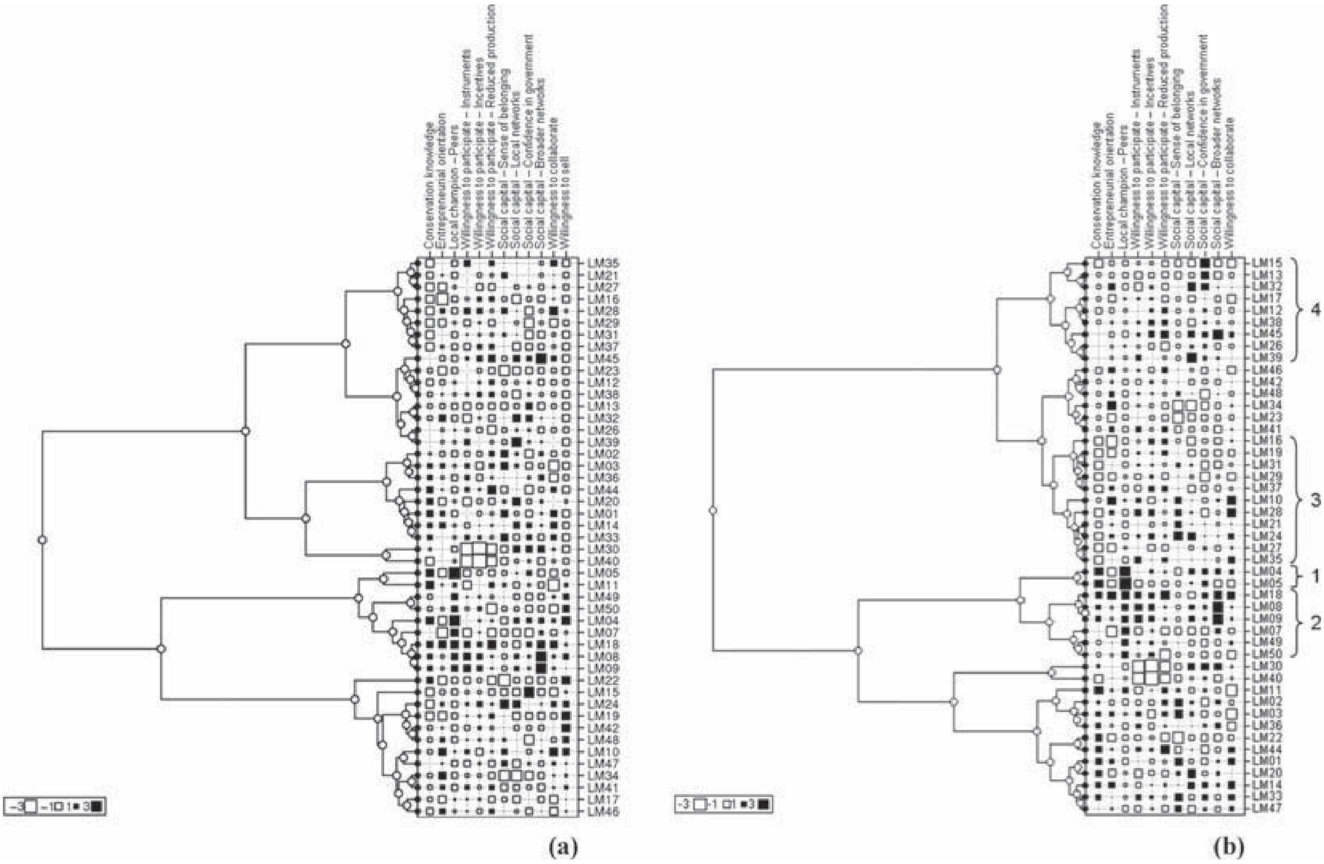

Figure 1. Cluster analysis of land managers through the use of internally consistent human and social factors of conservation opportunity: (a) full set of factors of conservation opportunity (Supporting Information); (b) set of factors of conservation opportunity excluding willingness to sell, which is not of direct relevance when assessing conservation opportunity in the context of private land. These results were mapped spatially, but a map is not presented so as to preserve the anonymity of individual land managers. Values in the keys represent standardized value deviations from the mean; no value equates to the mean value.

substantial improvement on previous spatial prioritization approaches requires that conservation instruments be selected for use according to the spatial arrangement of patterns of conservation opportunity and relevance of the instruments to priority species, habitats, ecological processes, and existing protected areas.

We recommend targeting two land managers for a pilot program for a private land stewardship initiative; both are prominent local champions with other positive conservation characteristics (LM04, LM05; Fig. 1b Cluster 1). Effective involvement of these two champions should provide a positive example for other land managers and trigger involvement of land managers in cluster 2. Cluster 2 land managers are strong in willingness to participate and collaborate. Involvement of land managers in clusters 3 and 4 should follow once an initiative is running strongly, but would depend on the ability of implementing agencies to service and manage the conservation agreements. A large proportion of land managers represented poor conservation opportunities and would require substantial investments to persuade them to implement effective conservation action (Knight et al. 2003; Rouget et al. 2006). For example, managers in cluster 3, who had relatively poor conservation knowledge and moderate willingness to participate, might be targeted for strong extension support to promote managers' competency and trust—prerequisites for effective implementation (Curtis et al. 2002). This targeted approach, which matches people to instruments, avoids panacea solutions to conservation-planning problems, which are rarely successful (Ostrom et al. 2007). A landscape-management model with an optimal mix of instruments, incentives, and institutions (Young et al. 1996) must be developed before undertaking a spatial prioritization nested within a broader conservation-planning initiative (Knight et al. 2006*a*).

There is a need for a greater understanding of the general applicability of our human and social factors to other regions and for development of techniques for extrapolating these data from local to regional scales. Meta-analyses of similar data sets (e.g., Winter et al. 2007) and the modeling of predictive factors (Guerrero et al.

unpublished data) are two possible ways forward. Further research into the relative importance of ecological, vulnerability, economic, and human and social data when mapping conservation opportunity and on techniques for transitioning between local and regional scales (e.g., Perhans et al. 2008) would also be useful.

Our work here marks a distinct conceptual and pragmatic shift in the focus of spatial prioritization analyses and in conservation-planning initiatives generally. This shift firmly embeds social research as a mechanism for bridging the research-implementation gap (Knight et al. 2008). Conservation planners should conduct social assessments to assist them in deciding on the appropriate investment when gathering and analyzing data on ecological, vulnerability, economic, human, and social capital before undertaking spatial prioritization. In some cases, for example, in hotspots (Cowling et al., unpublished data) or when scheduling local-scale action within broader regional priority areas as we have done here, it may not be necessary to gather and analyze ecological data. The data-gathering process can then be integrated with stakeholder collaboration activities to empower stakeholders and further reduce costs.

Although the techniques we applied have been long established in the disciplines of psychometry, human geography, and the management and organizational sciences, they are new to most conservation professionals. Degree courses in conservation biology fail to prepare students with all the skills required to be an effective conservation professional (Jacobson & McDuff 1998); instruction in social research skills are particular lacking. Conservation-planning initiatives must cease paying lip-service to the notion of interdisciplinarity and proactively integrate social research theory and practice throughout all the stages of conservation-planning operational models (e.g., Knight et al. 2006*a*). This will require conservation professionals to embrace the practice of consilience—the fusion of knowledge traditions—and to courageously acknowledge they do not have all the skills required to effectively implement conservation-planning initiatives. This requires that we stand by the ethics publically promoted by the Society for Conservation Biology, sacrifice our personal power, and engage in truly collaborative conservation-planning processes that are democratically led within networks of professionals with complementary expertise from a diverse suite of disciplines, not all of them scientific. In so doing, we recast ourselves as facilitators (Sayer & Campbell 2004), practicing the quiet leadership that serves the common good (Beier 2008).

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Supporting Information

Index and scale values for factors of conservation opportunity are available as part of the online article (Appendix S1). The authors are responsible for the content and functionality of these materials. Queries (other than absence of the material) should be directed to the corresponding author.

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