Contributed Paper

Reorienting Systematic Conservation Assessment for Effective Conservation Planning

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Abstract: *Systematic conservation assessment (an information-gathering and prioritization process used to select the spatial foci of conservation initiatives) is often considered vital to conservation-planning efforts, yet published assessments have rarely resulted in conservation action. Conservation assessments may lead more directly to effective conservation action if they are reoriented to inform conservation decisions. Toward this goal, we evaluated the relative priority for conservation of 7 sites proposed for the first forest reserves in the Union of the Comoros, an area with high levels of endemism and rapidly changing land uses in the western Indian Ocean. Through the analysis of 30 indicator variables measured at forest sites and nearby villages, we assessed 3 prioritization criteria at each site: conservation value, threat to loss of biological diversity from human activity, and feasibility of reserve establishment. Our results indicated 2 sites, Yiméré and Hassera-Ndrengé, were priorities for conservation action. Our approach also informed the development of an implementation strategy and enabled an evaluation of previously unexplored relations among prioritization criteria. Our experience suggests that steps taken to ensure the closer involvement of practitioners, include a broader range of social data, encourage stakeholder participation, and consider the feasibility of conservation action can improve the relevance of assessments for conservation planning, strengthen the scientific basis for conservation decisions, and result in a more realistic evaluation of conservation alternatives.*

Keywords: biodiversity prioritization, conservation practice, feasibility, *Pteropus livingstonii*, systematic conservation assessment, systematic conservation planning, threat, Union des Comores

Reorientación de la Evaluación Sistemática de la Conservación por la Planificación Efectiva de la Conservación

Resumen: *La evaluación sistemática de la conservación (proceso de recopilación y priorización utilizado para seleccionar foci espaciales de iniciativas de conservación) a menudo es considerada vital para los esfuerzos de planificación de la conservación, sin embargo las evaluaciones publicadas raramente han resultado en acciones de conservación. Las evaluaciones de conservación pueden conducir más directamente a acciones efectivas de conservación si son reorientadas para informar a la toma de decisiones de conservación. Hacia esta meta, evaluamos la prioridad relativa de conservación de 7 sitios propuestos para las primeras reservas forestales la Unión de las Comoros, un área con altos niveles de endemismo y con cambios rápidos en el uso de suelo en el Océano Índico occidental. Mediante el análisis de 30 variables indicadoras medidas en sitios forestales y aldeas cercanas, evaluamos 3 criterios de priorización en cada sitio: valor de conservación, amenaza de pérdida de diversidad biológica por actividad humana y la factibilidad del establecimiento de reservas. Nuestros resultados indicaron que 2 sitios, Yiméré y Hassera-Ndrengé, eran prioritarios para acciones de conservación. Nuestro método también informó el desarrollo de una estrategia para la implementación y permitió la evaluación de relaciones entre los criterios de priorización no exploradas previamente. Nuestra*

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Paper submitted May 28, 2010; revised manuscript accepted February 10, 2011.

Conservation Biology, Volume 25, No. 4, 688–696

DOI: 10.1111/j.1523-1739.2011.01697.x

experiencia sugiere que los pasos tomados para asegurar un mayor involucramiento de los practicantes, incluir un rango más amplio de datos sociales, estimular la participación de los sectores interesados y considerar la factibilidad de acciones de conservación pueden mejorar la relevancia de las evaluaciones para la planificación de la conservación, reforzar las bases científicas de las decisiones de conservación y resultar en alternativas más realistas para evaluar alternativas de conservación.

Palabras Clave: amenaza, evaluación sistemática de la conservación, factibilidad, planificación sistemática de la conservación, práctica de la conservación, priorización de la biodiversidad, *Pteropus livingstonii*, Unión des Comores

Introduction

Conservation planning, the structured process of identifying priorities and developing a strategy for implementing a suite of actions designed to meet conservation goals in the context of stakeholder participation (Bibby & Alder 2003; Knight et al. 2006), provides a critical foundation for effective implementation of conservation actions. Systematic conservation assessment, an information-gathering and prioritization process used to select the spatial foci of conservation initiatives, is increasingly seen as a key component of conservation planning (Sarkar & Illoldi-Rangel 2010). Systematic conservation assessment (hereafter, assessment) was developed as a means to replace ad hoc or expert-knowledge-driven approaches to reserve selection and design with scientifically defensible, quantitative methods that identify spatial priorities on the basis of data (Margules & Sarkar 2007). Despite the difficulty of quantifying complex factors that influence conservation priorities and the often limited availability of relevant data, robust priorities that maximize the representation and persistence of native species and communities can often be identified through the use of explicit assumptions and constraints, variables (surrogates) that indicate prioritization criteria, and a growing set of analytical techniques and software (Margules & Sarkar 2007).

Despite their important contributions to identifying areas of conservation priority, however, published assessments have rarely resulted in conservation action (Prendergast et al. 1999; Knight et al. 2008), in part because the assessments often are not sufficiently integrated with other aspects of conservation planning or implementation processes (Knight et al. 2006; Knight et al. 2008). The frequent disconnect between assessment and action (Cowling et al. 2004) is part of the broader research-implementation gap in conservation biology (Knight et al. 2008). This gap is characterized by the failure of conservation biology research to translate into tangible conservation gains (Knight et al. 2006; Meffe et al. 2006; Knight et al. 2008). The research-implementation gap is conceptualized by Knight et al. (2006) as resulting from 2 distinct challenges. The first, referenced by Knight et al. (2006) as the "assessment-planning gap," is moving from the identification of spatial priorities for conservation action (i.e., assessment) to the identification of specific conservation objectives, methods, actions, and actors (i.e., the implementation strategy) during conservation planning. The second challenge, referenced by Knight et al. (2006) as the "planning-action gap," is moving from conservation planning to the implementation of effective conservation action. Both are components of the research-implementation gap, but we focused on the assessment-planning gap.

The gap between assessment and other aspects of conservation planning results from at least 3 pervasive factors. First, although the conservation of biological diversity (defined here as the full range of life, including the compositional, structural, and functional attributes of genes, populations, species, communities, and landscapes [Noss 1990]) is a shared goal of conservation scientists and practitioners, a lack of clear communication and close collaboration between them often reduces the relevance of assessments and hinders practitioners' acceptance of these assessments (Prendergast et al. 1999; Roux et al. 2006) during the development of implementation strategies. This situation results from cultural differences in focus, terminology, tradition, and in some cases training and is reinforced by separation within or among institutions (Francis & Goodman 2010). Such differences may lead to assessments completed on spatial extents that dwarf those at which typical conservation projects can operate (Roux et al. 2006) or that are otherwise difficult to operationalize (Knight et al. 2006). A greater involvement of practitioners in the assessment process, however, may ensure that assessment results are relevant to and fully incorporated in implementation strategies (Roux et al. 2006).

Second, the biological focus of most assessments conflicts with the highly interdisciplinary environment in which conservation projects are implemented (Prendergast et al. 1999). Whereas assessments have often focused on identifying sites on the basis of biological criteria (and sometimes the extent of human-caused threats to biological diversity), effective conservation practice also requires a clear understanding of the drivers of threat and the means to conserve those sites, which in turn are largely dependent on social context and local stakeholders' perspectives of nature and conservation (Mascia et al. 2003). Conservation scientists have therefore called repeatedly for integration of biological and social science methods and data to improve assessment (e.g., Knight & Cowling 2007; Margules & Sarkar 2007;

Knight et al. 2008) and conservation of biological diversity (e.g., Berkes 2004; Balmford & Cowling 2006; Meffe et al. 2006). Recently, advances have been made in incorporating social data, such as economic costs (Naidoo et al. 2006) and human population density (Valenzuela-Galvan et al. 2008), into assessments. However, few specific or concrete examples have appeared in the assessment literature of how to evaluate other factors critical to conservation effectiveness, such as stakeholders' relationships, ecological understanding, attitudes, perspectives, commitment, or capacity (Cowling & Wilhelm-Rechmann 2007; Sarkar & Illoldi-Rangel 2010). Furthermore, although local stakeholders may provide crucial, otherwise unavailable information on biological trends and social context (Huntington 2000) and may be key collaborators during subsequent stages of conservation planning and implementation (Ban et al. 2008), such local knowledge and the identification of resources important to stakeholders are often overlooked during assessment. More complete integration of social science methods and data into assessment might provide data to inform conservation decisions and engage stakeholders in the planning process.

Third, assessments often do not consider the likely effectiveness of conservation alternatives (Cowling et al. 2004; Knight et al. 2008). This may partly result from the differing cultures in which conservation scientists and practitioners sometimes operate: conservation scientists often receive few rewards for engaging in implementation (or are not in a position to engage), and practitioners must act in situations where optimal solutions cannot be implemented realistically (Roux et al. 2006; Francis & Goodman 2010). As a result, many assessments are not practical and many implementation strategies do not take full advantage of scientific methods and data. This situation means that conservation actions at sites designated as high priority may fail or that conservation opportunities may be overlooked (Guerrero et al. 2010). Explicit evaluations of the feasibility of conservation alternatives, however, can inform decisions about not only where to conserve (e.g., Knight et al. 2010), but also when and how to engage in conservation action (Knight & Cowling 2007). Nonetheless, although feasibility criteria have long been evaluated in other disciplines (e.g., triage and palliative care in medical science), feasibility is rarely considered in conservation assessments (Hobbs et al. 2003).

To help bridge the assessment-planning gap, therefore, we propose that previously published protocols (Margules & Sarkar 2007; Sarkar & Illoldi-Rangel 2010) for assessment be reoriented to: improve communication and collaboration between conservation scientists and practitioners; incorporate social data and encourage stakeholder participation; and explicitly consider the feasibility of implementation. To illustrate how these elements can increase the relevance, utility, and realism of assessment, we present an assessment designed to inform land-protection decisions for the forests of the Union of the Comoros.

Methods

Study Area

The Union of the Comoros (12° S, 44° E), formerly the Federal Islamic Republic of the Comoros, comprises 3 mountainous oceanic islands of volcanic origin (Louette et al. 2004) situated 300 km from both Madagascar and Mozambique in the western Indian Ocean (a fourth island in the archipelago, Mayotte, is currently administered by France). The human population of the Union of the Comoros (hereafter, the Comoros) is 700,000, is increasing 2.4% per year, is 72% rural, and produces an annual per capita gross domestic product of US$824 (UNDP 2010). The forests of the Comoros archipelago have been delineated as an independent ecoregion due to their geographic separation from other western Indian Ocean islands and eastern Africa and their distinct species assemblages (Olson et al. 2001; World Wildlife Fund 2001). The principal native ecosystem in lowland and montane regions is moist broadleaf forest with a dense semievergreen canopy (hereafter, forest). Although the forests of the Comoros have high levels of endemism (Caldecott et al. 1996), they are poorly studied, have received little conservation attention (A.F.A. Hawkins, D. Knox, A. Rambeloson, & D. Rogatschnig, unpublished), and are not protected. Due to the cumulative effects of agricultural clearing at small extents and firewood harvest (Weightman 1987; B.J.S., personal observation), these forests are being cleared at a rate of 3.9% per year, the highest rate of any country (UNDP 2007). This deforestation threatens the persistence of endemic species that are dependent on the native forest, such as the endangered fruit bat, Livingstone's flying fox (*Pteropus livingstonii*) (IUCN 2009). Invasive species are a secondary threat to endemic species (Vos 2004).

Consultation with Practitioners

We sought to assist conservation practitioners of Action Comores Anjouan, a Comorian nongovernmental organization focused on the conservation of Comorian biological diversity, to identify priority actions that could meet their conservation goals. We consulted at the outset and regularly thereafter with members of the organization. In our initial set of consultations, we asked members to articulate their conservation goals, identify conservation opportunities and constraints, describe an important conservation decision they faced and the criteria they would use to make the decision, and identify key information needs. We conducted additional consultations prior to data collection to present a proposal for our site-prioritization approach, seek feedback, and modify our approach to better suit the organization's information needs. During data collection, we regularly updated the organization on our progress, and after data collection we presented our prioritization results and offered recommendations.

The conservation goals of Action Comores Anjouan were to effectively conserve Livingstone's flying fox, a flagship species for protection of forests (Trewhella et al. 2005), and other elements of biological diversity on the Comorian islands of Anjouan and Mohéli. To address these goals, we focused on land protection, due to its importance for conserving Livingstone's flying fox (Sewall et al. 2007) and tropical biological diversity (Bruner et al. 2001). Because of the highly disjunct distribution of remaining patches of forest, the large role of villages in land-use decisions through a traditional land-tenure system (Sewall et al. 2011), and few government resources available for conservation, we focused on identifying and implementing a network of comanaged forest reserves (Sewall et al. 2011), with reserve management to be led by village-level institutions and assisted by island and national governments and local nongovernmental organizations. Constraints on funding, training, and institutional capacity suggested to us that only 1–2 reserves could be established at a time, however. Thus, the Action Comores Anjouan practitioners had to decide which sites to prioritize for reserve establishment, and they identified 3 criteria (hereafter, decision criteria) on which to base their decisions: degree to which conservation action at each site would enable meeting conservation goals; probability that the status of the site would decrease without conservation action, and ease of implementing conservation actions at a site.

Selection of Prioritization Criteria and Variables

To further define and quantify factors likely to affect the practitioners' land-protection decisions, we converted the practitioners' decision criteria to the following 3 criteria (hereafter, prioritization criteria): conservation value of the site (i.e., the extent to which the site contains elements of biological diversity that, from the perspective of the practitioners, are most desirable to maintain), level of threat to a site (i.e., the probability of a decline due to human activity of the desired elements of biological diversity at the site if no conservation action were to be taken), and feasibility of conservation action at the site (i.e., the probability that conservation actions at a site would be effective and the relative ease of implementing such actions at the site). On the basis of consultations with the practitioners on the elements of biological diversity they most wanted to maintain, we considered sites had high conservation value if, once protected, they were likely to maintain larger populations of Livingstone's flying fox and other rare and threatened species, a relatively intact forest structure and composition, and a greater diversity of native species over time. This conservation-value criterion is similar to the value criterion described by Hobbs et al. (2003) and analogous to the irreplaceability criterion described by Margules and Pressey (2000). We considered sites with high levels of threat those with a greater likelihood of near-term changes in land use, more wood collection, more extensive colonization by invasive species, and those where more native species had recently declined substantially in abundance. This threat criterion is similar to the threat criterion described by Hobbs et al. (2003) and the vulnerability criterion described by Margules and Pressey (2000). For the feasibility criterion, although many types of conservation action were possible, for simplicity we focused on reserve establishment at a site. We considered sites with high feasibility those where reserve establishment would negatively affect relatively few stakeholders; relatively less restoration would be needed to reestablish habitat for rare and threatened native species; natural regeneration of native vegetation would be likely if the site were protected; existing ecological knowledge and capacity for conservation action were high; and reserve establishment had stronger support from local stakeholders. This feasibility criterion is similar to the probability-of-success criterion described by Hobbs et al. (2003).

To quantify differences among sites, we selected 30 variables that would accurately indicate to what extent prioritization criteria were met and that could be measured feasibly in the Comoros (Table 1). Rationales for selection of the variables we used as indicators are presented in the Supporting Information. Before collecting or compiling data, we discussed prioritization criteria and variables with practitioners and modified them accordingly until they were satisfied that the results of the prioritization would accurately represent their decision criteria and inform their land-protection decision. Because few relevant data on these variables existed for the candidate sites, we collected biological and social data before beginning the prioritization.

Candidate Sites

Because of the need for extensive data collection, we focused on 7 candidate forest sites (Supporting Information) on the Comorian islands of Anjouan and Mohéli; these are considered critical roost habitat of Livingstone's flying fox because they contain the largest colonies on the 2 islands and collectively harbor more than half the population of the species (Sewall et al. 2007). Each candidate site was 20–50 ha, 200–1000 m in elevation, and 1.5–8 km in a direct line from its nearest neighbor. The establishment of forest reserves at these sites may improve the probability of persistence of Livingstone's flying fox over the long term because this species of bat exhibits strong roost fidelity; bats have roosted continually

Table 1. Variables[a] and prioritization criteria used to evaluate forest sites in the Comoros for conservation.

Conservation value	*Threat*	*Feasibility*
Livingstone's flying fox colony size[b]	human population of nearby villages[c]	number of land claims beneath roost[c,d]
Species richness of native trees[b]	distance from center of closest village (km) [b,c,d]	number of land claims within buffer[c,d]
Species richness of native birds[b]	elevation gain from center of closest village (m)[b,c,d]	extent of restoration to reestablish native tree composition and structure[b,d]
Species richness of rare and threatened trees[b]	slope (°)[b,d]	connectivity to large primary forest (% of perimeter of buffer)[b]
Species richness of rare and threatened birds[b]	proximity to canopy removal (m)[b,d]	past exposure to environmental education (number of events)[c]
Canopy cover (%)[b]	proximity to understory removal (m)[b,d]	number of conservation actors[c]
Absence of human-caused understory disturbance (% of plots)[b]	species richness of invasive plants (plot average)[b]	start date of participation in monitoring of Livingstone's flying fox[c,d]
Abundance of non-native trees (% of all trees)[b,d]	changes in abundance of Livingstone's flying fox from 1999–2002 to 2006–2007[b,d]	views of Livingstone's flying fox (difference in number of benefits and number of harms named)[c]
Abundance of non-native birds (% of all birds)[b,d]	declines in abundance of native plants and animals (number of species)[c]	views of forest importance (difference in number of ecosystem services and number of ecosystem goods named)[c]
Views of reserve rules difference in proportions favoring nonconsumptive and consumptive uses[c]	population losses of native plants and animals (number of species)[c]	number of conditions named on which reserve acceptance is contingent[c,d]

[a] *Ranks assigned in descending order (i.e., a site with high values for a variable received high ranks; 1, highest rank) unless otherwise noted. Rationales for the inclusion of each variable are provided in Supporting Information.*
[b] *Variable measured during biological surveys.*
[c] *Variable measured during social surveys.*
[d] *We assigned ranks in ascending order (i.e., sites with low values of these variables received high ranks, and vice versa).*

at one site (Yiméré) since at least 1977 (M.D. Bacar, personal communication). Each site was also embedded in, adjacent to, or near relatively large patches of primary forest.

Biological and Social Surveys

We collected data from the 7 sites December 2005–February 2006. We concentrated our efforts at the central cluster of roost trees and within an area extending 150 m beyond the cluster (hereafter, buffer)—a distance that, if protected as forest, may minimize edge effects on the bat colony (Sewall et al. 2007). At each site, we examined 9, 10-m radius plots ($n = 63$). In each plot, we measured variables associated with conservation value (species richness of native trees, species richness of rare and threatened trees, canopy cover, absence of human-caused understory disturbance, abundance of non-native trees), threat (slope, species richness of invasive plants), and feasibility (extent of restoration to reestablish native tree composition and structure). We measured 3 additional conservation-value variables (species richness of native birds, species richness of rare and threatened birds, abundance of non-native birds) at 5, 50-m radius plots ($n = 35$) 100 m apart at each site. To sample birds, we conducted 1, 8-min point count (Reynolds et al. 1980) at each plot at a site between 0530 and 0730. We classified species as rare if they were present in <10% of all plots at all sites. We classified species as threatened if they appeared on either the national list of integrally protected species (République Fédérale Islamique des Comores 2001) or the international list of threatened species (IUCN 2009).

We counted bats at roosts to determine colony size and evaluated changes in the abundance of Livingstone's flying fox over time by comparing our data with data collected from 1999 through 2002 (Sewall et al. 2007). We used an altimeter and a geographic positioning system to determine elevation gain and distance from each village to each site. Distance and elevation differences were measured between the center of the closest village (Supporting Information) and the center of the roost tree cluster of the bat colony. We measured the distance from the center of the roost tree cluster of the bat colony to the nearest understory or canopy removal to determine the proximity of human-caused disturbance to the site. To determine connectivity to large primary forest, we evaluated the percentage of the perimeter of the buffer that was connected via continuous tree canopy to primary forest.

During December 2005–January 2007, we surveyed all villages ($n = 10$) (Supporting Information) within 3 h one-way walking distance of the 7 sites. We conducted semistructured group interviews (Rietbergen-McCracken & Narayan 1998) with several small groups of people per village (5–9 groups per site; $n = 43$) to ensure that we would have a diversity of villager perspectives and because organized groups are highly active and influential in Comorian villages (Sewall et al. 2007). We conducted interviews orally in Comorian. Interviews lasted about 1 h and typically included 10–20 participants. We asked a series of standardized, open-ended questions (Supporting Information) designed to provide insight into the number of population losses and declines in abundance of native plants and animals near sites; local attitudes (views on Livingstone's flying fox, on forest importance for provisioning ecosystem goods or services), and local perspectives on the environment and conservation (number of conditions named by respondents on which reserve acceptance was contingent, views on potential reserve rules for consumptive and nonconsumptive uses).

We visited the sites accompanied by local residents to determine the number of land claims beneath the roost tree cluster and within the buffer. We used reports of conservation activities from governmental and nongovernmental organizations (Supporting Information) to determine the past exposure of each village to environmental education, number of conservation actors in each village, and start date of participation in a long-running citizen-science program led by Action Comores Anjouan to monitor Livingstone's flying fox populations. We used government census data to determine village population size (total population at villages neighboring a site ranged from 386 to 6485, average 2456; Union of the Comoros 2004).

Analyses

We converted data on all variables (Table 1) into relative ranks (1, highest rank for values of variables associated with high conservation value, threat, or feasibility; 7, lowest rank). For tied values, we used the mean of the tied ranks. We weighted all variables equally.

We used a Friedman's rank-sum test to examine differences among sites in mean rank for each of the 3 prioritization criteria. Although this test is conservative (i.e., subject to type II error), it is appropriate for diverse variables and small sample sizes because it is not based on assumptions of normality, homoscedasticity, or equal-interval scale of measurement (Zar 1984; Lowry 2010). We also calculated the overall rank of a site by averaging the mean ranks of the site for the 3 prioritization criteria.

To evaluate the effect of any given variable on the overall rank of a site, we conducted a sensitivity analysis by measuring the change in mean rank of a site resulting from the exclusion of any one of the measured variables. To examine correlations among the variables, we calculated Kendall's coefficient of concordance with a Bonferroni correction for all pairwise comparisons of variables within each criterion. We used Spearman's rank correlation coefficient to examine relations among the 3 prioritization criteria. We completed all statistical analyses with JMP (version 8.0, SAS Institute 2008) and R (version 2.6.0, R Development Core Team 2007) software.

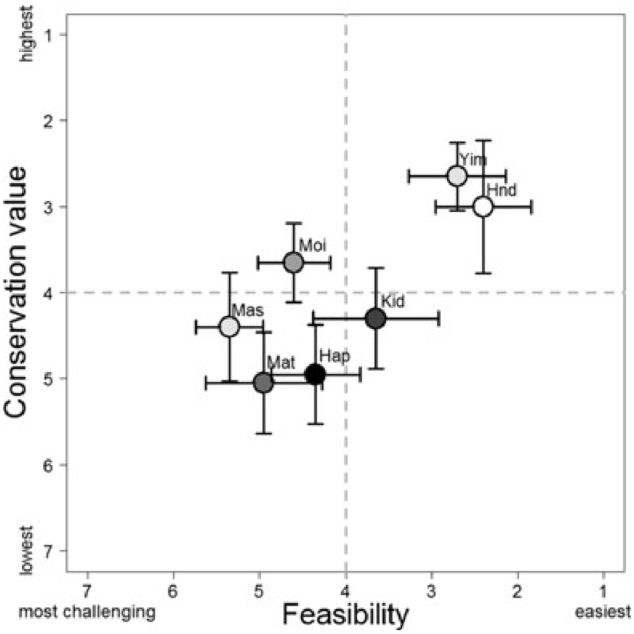

Figure 1. Mean ranks (SE) for conservation value versus feasibility (dotted lines, mean ranks for each prioritization criterion; top right quadrant, high rank for both prioritization criteria; the darker the shading the higher the threat; abbreviations are sites: Yim, Yiméré; Mat, Matulabi; Moi, Moihajou; Hap, Hamoigne-Panga; Mas, Massakini; Hnd, Hassera-Ndrengé; Kid, Kidogo-Basse). (Other relations examined in the study are shown in Supporting Information.)

Results

Site Rankings

We ranked each site for each variable (Supporting Information). Sites differed marginally in conservation value ($\chi^2 = 11.6$, df $= 6, p = 0.07$); mean rank ranged from 2.7 (SE 0.4) at Yiméré to 5.1 (SE 0.6) at Matulabi (Fig. 1 & Supporting Information). Sites varied significantly in threat level ($\chi^2 = 16.3$, df $= 6, p = 0.01$); mean rank ranged from 2.5 (SE 0.4) at Hamoigne-Panga to 5.2 (SE 0.5) at Hassera-Ndrengé (Fig. 1 & Supporting Information). Feasibility also varied significantly among sites ($\chi^2 = 16.6$, df $= 6$, $p = 0.01$); mean rank ranged from 2.4 (SE 0.6) at Hassera-Ndrengé to 5.4 (SE 0.4) at Massakini (Fig. 1 & Supporting Information). Overall mean ranks for the 3 prioritization criteria were Yiméré 3.5, Hassera-Ndrengé 3.5, Kidogo-Basse 3.7, Hamoigne-Panga 4.0, Moihajou 4.1, Matulabi 4.4, and Massakini 4.9.

Sensitivity Analyses and Correlations

The rankings of sites on the basis of prioritization criteria were robust to the exclusion of any single variable from the analysis. Systematic exclusion of one variable per criterion resulted in changes (range 0–0.46; average 0.16) in a site's rank on the basis of that criterion that were small compared with the uncertainty in measurement of mean ranks of a site (range 0–0.83; average 0.28 of the width of the standard errors on mean ranks of a site presented earlier, in Fig. 1, and in Supporting Information). There were no significant correlations among the variables. However, 2 pairs of prioritization criteria were correlated. Conservation value had a moderate ($r_s =$ –0.65) negative correlation with threat (Supporting Information) and a moderate positive correlation ($r_s = 0.71$) with feasibility (Fig. 1). Threat and feasibility were weakly correlated ($r_s =$ –0.27, Supporting Information).

Discussion

Our results indicated that Yiméré and Hassera-Ndrengé ranked highest for both conservation value and feasibility, whereas Hamoigne-Panga ranked as most threatened. No one site ranked highest according to all 3 prioritization criteria. However, the means of the ranks of the 3 prioritization criteria suggest that Yiméré and Hassera-Ndrengé represent the highest overall priorities for reserve establishment.

Relations among Prioritization Criteria

The relation between conservation-value and threat criteria has been the central relation in several past assessments of priority sites (e.g., Myers et al. 2000; Pressey & Taffs 2001). In our analysis, however, these 2 prioritization criteria were negatively correlated (Fig. 1 & Supporting Information), a result that complicates prioritization because trade-offs will be necessary. Such a negative correlation appears especially likely to occur in areas with ongoing effects of human activity on the structure and composition of native plant and animal communities.

In the absence of studies on the relation between threat and feasibility, conservation professionals have developed divergent theories on the role of threats in prioritization schemes (Brooks et al. 2006). Some assessments (e.g., Myers et al. 2000; Hoekstra et al. 2005) prioritize areas that are highly threatened because biological diversity could be reduced quickly if no action is taken. Other assessments prioritize areas with low threat levels (e.g., Sanderson et al. 2002; Cowling et al. 2003) on the assumption that threatened areas may be more difficult to conserve. Although it seems logical that imminent threats may complicate implementation, concerns about increasing threat could also lead local people to favor stronger conservation intervention. In our data, threat and feasibility were weakly correlated (Fig. 1 & Supporting Information). This result suggests that threat is not a proxy for feasibility.

Few studies have been conducted that examine the relation between conservation-value and feasibility criteria (Hobbs et al. 2003), despite the centrality of both criteria for the development of practical implementation strategies (Hobbs et al. 2003; Knight et al. 2008; Guerrero et al. 2010). We observed a positive correlation between conservation value and feasibility (Fig. 1), a finding that enables identification of sites where conservation action may result in relatively greater conservation returns and be relatively easier and more effective.

Integrated Approach to Assessment

Besides its utility in prioritizing sites for conservation attention and in understanding the relations among prioritization criteria in assessment, our integrated approach to assessment yielded several other concrete benefits. Our focus on practitioner goals, constraints on implementation, and decision criteria increased the probability that our results would be relevant to other aspects of conservation planning, such as decisions on scheduling sites for conservation intervention and the development of an implementation strategy. Our approach is adaptable to other contexts and can meet the needs of conservation practitioners with differing conservation goals or approaches to conservation through the selection of different prioritization criteria, selection of different sets of variables, or use of different variable weights.

Our use of social data provided a broad range of information on stakeholder perspectives and social context that are often lacking in assessments. For example, interview data indicated the number of conditions on which reserve acceptance was contingent (Supporting Information), and the specific responses given in interviews (indicating, e.g., that affected stakeholders should be compensated if agricultural use of land within a reserve were restricted and that the reserve proposal should be adopted through a formal process of local community engagement) further suggested potential mechanisms driving patterns in social variables and provided insight into the kinds of conservation actions likely to be supported by local communities.

Our inclusion of the feasibility criterion in the assessment ensured that difficulties in implementation and opportunities for stakeholder participation were considered from the earliest stages of conservation planning. Because feasibility is a central concern in conservation decisions by practitioners and the development of an implementation strategy with stakeholders (Knight & Cowling 2007), feasibility results from assessments connect directly with other aspects of the planning process.

Overall, our assessment addressed information needs of practitioners, clarified the social context of potential conservation decisions, and suggested where and how implementation might most effectively proceed. Thus, it provided a strong basis for conservation planning and, after further discussions with practitioners and stakeholders in each village, led to the Comoros Community Forest Reserves Plan (Sewall et al. 2011), an implementation strategy that recommends specific conservation objectives and priority actions and identifies potential conservation partners for each site.

Our approach to assessment should be applied carefully. First, like most assessments, we compared sites on the basis of prioritization criteria evaluated at one point in time (Cowling et al. 2003) rather than conducting monitoring and ongoing adaptive management, yet conservation value, threat, and the feasibility of reserve establishment at each site may change over time. Second, whether specific variables reliably allow inference to prioritization criteria (i.e., are effective indicators) depends on the context in which they are considered. Third, the integration of biological and social data may make assessments more difficult to conduct because varied expertise is needed.

We have focused on bridging the assessment–planning gap to improve the effectiveness of conservation planning, but ensuring that assessment ultimately leads to effective conservation action also requires attention to the planning-action gap (Knight et al. 2006). To effectively address the latter, additional effort will be needed to enhance stakeholder participation, establish new institutional structures and support existing ones, foster cross-scale collaboration, build trust among collaborating groups, increase training, and develop leadership capacity (Berkes 2004; Folke et al. 2005).

Acknowledgments

We are grateful to the village residents, the Environment Ministries of Anjouan and Mohéli, the government of the Union of the Comoros, and the Centre National de Documentation et de Recherche Scientifique. We appreciate assistance from Action Comores Anjouan, our village teams, Conservation International, Action Comores International, Durrell Wildlife Conservation Trust, and Bristol Conservation and Science Foundation. We also thank D. Van Vuren, J. Durbin, F. Hawkins, and A. Halidi for advice and support, and D. Van Vuren, D. Kelt, A. Sih, A. Knight, E. Fleishman, S. Brechin, E. Main, and an anonymous reviewer for comments on previous versions of the manuscript.

Funding source: Funding was provided by the Conservation Leadership Programme, Conservation International, and the Switzer Foundation.

Supporting Information

Additional methods, site-specific data, maps, and relations among the prioritization criteria are available online (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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