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Application of Modified Threat Reduction Assessments in Lebanon

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Abstract: *Worldwide efforts have concentrated on developing monitoring methods that would enhance the assessment of progress toward achieving the 2010 conservation objectives of the Convention on Biological Diversity. Threat reduction assessment is one such method. It provides an indirect measure of the effects of a conservation project by evaluating changes in human-induced direct threats to protected areas. We applied modified threat reduction assessments and the 2008 International Union for Conservation of Nature standardized lexicon for classification of threats to Horsh Ehden and Al-Shouf Cedar nature reserves in Lebanon. Our goal was in part to test the suitability of this tool for improving monitoring and management effectiveness of protected forests in Lebanon. In Horsh Ehden, composite threats decreased by 24% from 1997 to 2002, and then increased from 2002 to 2009 by 78% in the core area of the reserve and by 118% in the reserve's buffer zone (surrounds core area, conservation and recreational activities allowed). In Al-Shouf Cedar reserve threats decreased by 51% from 2006 to 2009. Management teams from both reserves have integrated the use of this method to prioritize actions for new management plans. We believe that in Lebanon and other countries with limited resources and weak monitoring programs or that are experiencing political instability threat reduction assessments could be used to improve the effectiveness of protected areas management.*

Keywords: direct threats, forests, Lebanon, management effectiveness, monitoring, protected area, threat-reduction assessment

Aplicación de Evaluaciones Modificadas de Reducción de Amenazas en Líbano

Resumen: *Los esfuerzos mundiales se han concentrado en el desarrollo de métodos de monitoreo que pudieran enriquecer la evaluación del progreso en el cumplimiento de los objetivos de conservación en 2010 de la Convención de Diversidad Biológica. La evaluación de la reducción de amenazas es uno de esos métodos. Proporciona una medida indirecta de los efectos de un proyecto de conservación mediante la evaluación de cambios en las amenazas directas inducidas por humanos a las áreas protegidas. Aplicamos evaluaciones de reducción de amenazas y el lexicón estandarizado 2008 de la Unión Internacional para la Conservación de la Naturaleza para clasificar las amenazas a las reservas naturales Horsh Ehden y Al-Shouf Cedar en Líbano. En parte, nuestra meta fue probar la aplicabilidad de esta herramienta para mejorar la efectividad del monitoreo y manejo en bosques protegidos en Líbano. En Hosrh Ehden, las amenazas compuestas disminuyeron en 24% de 1997 a 2002, y luego incrementaron de 2002 a 2009 en 78% en la zona núcleo de la reserva y en 118% en la zona de amortiguamiento de la reserva (circunda la zona núcleo, se permiten actividades de conservación y recreativas). En la reserva Al-Shouf Cedar las amenazas disminuyeron en 51% de 2006 a 2009. El personal de ambas reservas ha integrado el uso de este método para priorizar acciones en planes de manejo nuevos. Consideramos que las evaluaciones de reducción de amenazas podrían ser utilizadas en Líbano y otros países con recursos limitados y programas de monitoreo débiles o que atraviesan por inestabilidad política para mejorar la efectividad del manejo de áreas protegidas.*

Palabras Clave: amenazas directas, área protegida, bosques, efectividad de manejo, evaluación de reducción de amenazas, Líbano, monitoreo

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Introduction

It has proven challenging to develop methods to measure progress toward specific conservation goals (e.g., Margules & Pressey 2000; Salafsky et al. 2002; Tucker et al. 2005). The debate concerning the best measures of intervention is ongoing (Margules & Pressey 2000; Margoluis & Salafsky 2001). One can measure either biological and social targets of conservation (e.g., Hockings et al. 2000; Schreckenberg et al. 2010) or threats to those targets (e.g., Salafsky & Margoluis 1999). Although it may be most informative to measure the status of both targets and threats, assessing threats to biodiversity is faster and more cost-effective than assessing biological targets, especially when there is a paucity of baseline biological information (Margoluis & Salafsky 2001; Anthony 2008). Consequently, various institutions developed management monitoring tools that incorporate threat indicators.

In 1997 the International Union for the Conservation of Nature (IUCN)-World Commission on Protected Areas (WCPA) developed a general framework for monitoring the effectiveness of management of protected areas (Hockings et al. 2000; WWF & WB 2003). In 1999 the World Wildlife Fund (WWF) based their method for rapid assessment and prioritization of protected area management, which focuses on budget allocation, on the IUCN-WCPA framework (Ervin 2003). The WWF-World Bank Alliance developed the Management Effectiveness Tracking Tool in 2003 (WWF-WB 2003). This tool was adopted by the Global Environment Fund and others to monitor effects of management of protected forests and was updated in 2007 (WWF 2007). Salafsky and Margoluis (1999) developed a method to measure the decrease in human-induced direct threats to protected areas (Margoluis & Salafsky 2001; Tucker 2005). The latter approach has been used to measure conservation interventions in North America, Asia, and Africa (Salafsky & Margoluis 1999; Persha 2001; Mugisha & Jacobson 2004). Anthony (2008) modified the threat reduction assessment method to more accurately evaluate cases in which new threats emerge or existing threats increase over time.

Conservation Efforts in Lebanon

Lebanon's 10,452 km^2 includes coastal, marine, and montane ecosystems and historically has relatively high species richness and abundance (Blondel & Aronson 1999). The quality of the wood of the cedar of Lebanon (*Cedrus libani*) is renowned and has been one of the country's primary trade items for centuries (MOE 1998*b*; Abu Izzeddin et al. 2000*b*). The tree is the national symbol of Lebanon and a cultural icon. Because of a long history of wars, conservation has received little attention in Lebanon. Lebanon's First National Report for the Convention on Biological Diversity highlighted the country's high population density and the unplanned and substantial increases in urbanization, and within the industrial, agricultural, and tourism sectors (MOE 1998*a*). These human activities have contributed to substantial declines in the country's forest cover. With almost 3/4 of the country forested over 8000 years ago, forest cover dwindled to just 7% in 1998 (MOE 1998*b*), but increased to 13% by 2005 due to reforestation efforts (UNDP 2005).

Official protection of endangered plant and animal species in Lebanon began with the country's signing of the Convention on Biological Diversity in 1992 (MOE 2006*b*). The few remaining cedar forests are now protected legally (MOE 2006*a*). The first three nature reserves designated by law by the Ministry of Environment under the Protected Areas Project were Horsh Ehden forest and Palm Islands in 1992 and Al-Shouf Cedar forest in 1996 (ECODIT 2009). The establishment of these protected areas was accompanied by development of management and monitoring plans in consultation with international organizations (e.g., Abu Izzeddin et al. 2000*a*, 2000*b*; MOE 2006*a*). The Ministry of Environment oversees management of the areas through a government-appointed committee of volunteers from municipalities, ministries, and nonprofit organizations which reports on management progress and supervises management teams. There are now seven nature reserves declared by law, of which the majority are forests (MOE 2006*a*). The four most recently designated (1998–1999) lack management and monitoring plans.

Initially, monitoring and evaluation of protected area management effectiveness consisted of mapping and of measurement of the status of a few species, which was assumed to provide information on ecological status more broadly (Jaradi 2000). The need for a more site-specific mechanism to evaluate management performance was identified in 2004 as part of the Stable Institutional Structure for Protected Areas Management project (Hagen & Gerard 2004; Bachir 2005). Although the Management Effectiveness Tracking Tool was adapted for use in Lebanon during this project (Hagen & Gerard 2004; MOE 2006*a*; MOE & ECODIT 2006*a*), its implementation has not been ratified by the government, leaving an important gap in the management of the protected-area system.

We combined a unified classification of threats (Salafsky et al. 2008) and the modified threat reduction assessment method (Anthony 2008) for monitoring management effectiveness of protected forests in Lebanon. Anthony's (2008) modified threat reduction assessment is cost-effective, does not require technical expertise, and incorporates new or worsening threats. Our objectives were to introduce the method to stakeholders, apply the method at selected sites, evaluate resulting information with stakeholders and, with stakeholders, assess whether the tool might be practical and informative over the long term.

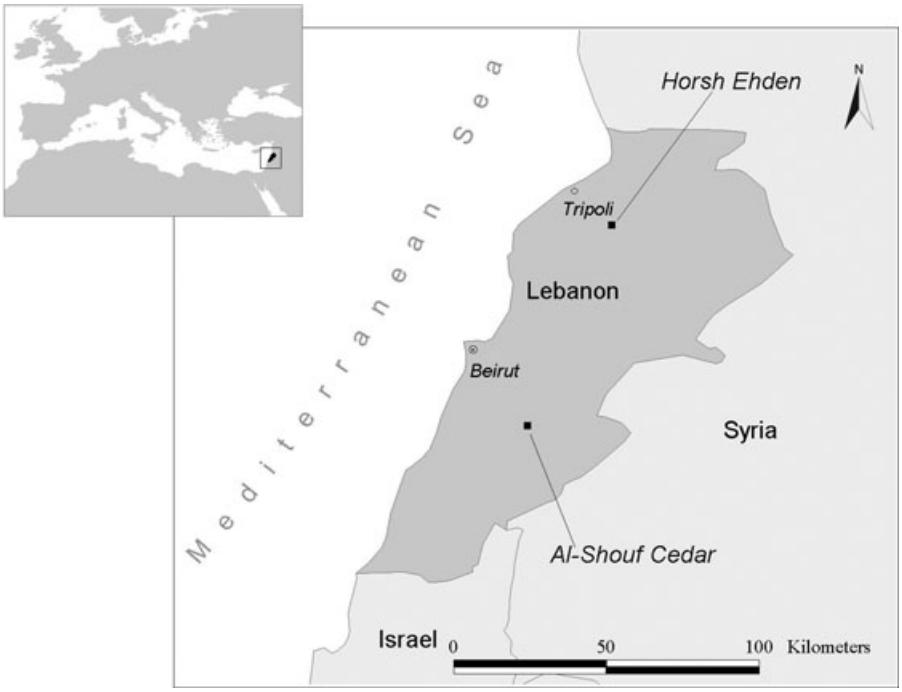

Figure 1. Map of Lebanon showing study sites.

Methods

Study Sites

We based our selection of study sites on three criteria: compliance with the IUCN's (1994) definition of a protected area, landscape is forested, and existence of a functioning management system for >5 years. Of the seven nature reserves in Lebanon, Horsh Ehden and Al-Shouf Cedar met these criteria (Fig. 1).

Horsh Ehden nature reserve was established in 1992 and covers 17 km^2 in the north Mount Lebanon chain of mountains (ECODIT 2009). The reserve has a core area (area of highest conservation value in the reserve in which conservation and research activities are allowed) and a buffer zone that surrounds the core area in which conservation and recreational activities are allowed. Despite its small area, Horsh Ehden has the highest species richness and abundance of any nature reserve in Lebanon (MOE & LU 2004*a*). It is the only existing mixed forest of cedar and fir trees in Lebanon and contains 537 flora species, of which 229 are endemic to the eastern Mediterranean or the Middle East. Twenty-one of the endemic species are globally or nationally threatened (Tohme et al. 2004). Horsh Ehden is particularly rich in migratory birds (156 species; 40% of those that occur in Lebanon) (MOE & LU 2004*a*), including the endangered eagles *Aquila heliaca* and *Hieraaetus fasciatus.* At least 27 mammals occur in Horsh Ehden, including three globally threatened species (Tohme et al. 2004). The reserve is managed by a team of seven to achieve "conservation through management intervention" which makes it an IUCN category IV protected area (MOE & ECODIT 2006*b*).

Al-Shouf Cedar, established in 1996, is the largest nature reserve in Lebanon (165 km^2). It is composed of a series of peaks (1200–1900 m) that extend north to south parallel to the sea in the central Mount Lebanon chain. There are four forests in the reserve: Ain Zhalta-Bmahray, Barouk, Maasser Al-Shouf, and Niha (UNDP 2005). Al-Shouf Cedar is divided into a core area and a buffer zone.

The Niha Mountain forest is the southern limit of the cedar of Lebanon and is the only place where natural reproduction of cedar is relatively high. The reserve's cedar forests account for a quarter of the remaining cedar forests of Lebanon, and some trees are more than 2000 years old (MOE & LU 2004*b*; SCR 2009). The reserve also has a variety of mixed oak (*Quercus* spp.) and juniper (*Juniperus* spp.) forests (SCR 2009). The flora includes diverse trees, shrubs, grasses, and endemic herbs (e.g. *Geranium libani, Acantholium libanoticum*). Al-Shouf Cedar reserve is one of the last remaining natural areas in Lebanon in which large mammals, such as the globally threatened wolf (*Canis lupus pallipes*) and the Lebanese jungle cat (*Felis chaus*), are present (SCR 2009). A substantial number of bird species use the reserve as a resting area during annual migrations. In 2005 Al-Shouf Cedar reserve and its surrounding villages were designated as a UNESCO Biosphere Reserve (SCR 2009).

The Al-Shouf Cedar reserve is managed by a team of 13 and has received substantial financial support from a local political leader. The reserve is managed primarily to maintain ecosystem integrity and for recreation and

is an IUCN category II protected area (MOE & ECODIT 2006*b*).

Identification of Stakeholders

To identify stakeholders involved in protected area management and individuals qualified for the threat reduction assessment exercise (required knowledge, history with reserve, etc.), we reviewed relevant project documents and conducted 12 open-ended interviews with MOE personnel from the department in charge of national strategies for protected areas, academic experts in ecology or conservation (e.g., ornithologists, botanists), a conservation specialist from the National Council for Scientific Research, private consultants involved in protected area management, members of a local nonprofit organization, and employees of an international nongovernmental organization. On the basis of these interviews, we identified the management teams of the nature reserves as the most appropriate people to apply the threat reduction assessment method because they were available, lived near the sites, had good knowledge of the sites, and wished to assess their management progress.

TRA Workshops

A threat reduction assessment is best implemented through discussion groups (Mugisha & Jacobson 2004; Anthony 2008). Prior to the workshops, participants were contacted and requested to choose a suitable assessment period. We conducted 1 workshop for Al-Shouf Cedar reserve and 2 for Horsh Ehden in April 2009 in which 14 staff participated. We gave participants four worksheets to complete: attendance sheet; a worksheet on which to evaluate the extent to which the area, intensity, and urgency of threats increased or decreased; a worksheet that defined threats and what participants would identify as a 100% reduction of each threat (Supporting Information); and a site map. The workshop consisted of an introductory presentation on the threat reduction assessment method, step-by-step guidance in application of the method (Margoluis & Salafsky 2001; Anthony 2008), and a discussion session. After each step, we collated the data on the worksheets for discussion by the participants. At the end of the workshops, we asked participants to provide a written assessment of the potential utility of regular application of the method (Supporting Information).

We used Anthony's (2008) modified threat reduction assessment method to evaluate management effectiveness. We defined threats as any human-related phenomena that negatively affect biodiversity (species richness, habitat condition and area, ecosystem functioning) of the area in question (Margoluis & Salafsky 2001). Additionally, we used the IUCN unified classification of direct threats (Salafsky et al. 2008) as a basis for classifying managers' conceptions of direct threats versus indirect threats.

We asked participants to rank threats according to their relative importance. They achieved this by considering the portion of habitat(s) in the site that the threat affects; effect or severity of the threat; and urgency or immediacy of addressing the threat (Margoluis & Salafsky 2001; Tucker 2005; Anthony 2008). A total threat score was computed after all the threats were ranked; the greatest threats had the highest threat scores.

We used a consensus-building exercise with the groups to assess the extent to which management activities had mitigated each threat. Scores were assigned on a percentage basis. After the ranking and scoring exercises, the total ranking scores for each threat were multiplied by the percentage of the threat met to yield a raw score for that threat. The threat reduction index (TRA-I) value was derived by dividing the sum of the raw scores for each threat by the total possible rankings of all the threats and multiplying by 100: (TRA-I = total raw scores/total rankings $\times$ 100) (Margoluis & Salafsky 2001). Thus, a positive threat-reduction index value indicated the combined threats responded positively to conservation efforts over the assessment period; conversely, a negative value indicated threats worsened over time. All calculations were done automatically with Microsoft Excel, and worksheets were projected on a screen so participants could visualize the method. Threat definitions, what would constitute 100% mitigation for each threat across all assessment areas, and detailed information on the source or type of threat was included in the worksheets (Supporting Information).

Results

TRA for Horsh Ehden Nature Reserve

Threats to the entire Horsh Ehden nature reserve decreased by 24% from 1997 to 2002 (Table 1). Of eight direct threats identified by participants, those that contributed most to the overall assessment of threat were intensive grazing by goats, sport hunting, and off-road vehicles. Threats from noise and light, recreational activities, and residential and commercial development increased. The greatest increase in threat was attributed to wild boars, which were categorized as a problematic native species. Major discrepancies in threat management effectiveness were reflected in the widely differing estimates of percent threat reduction, from a 98% decrease to 100% increase (Table 1).

In the second Horsh Ehden workshop, participants suggested that dividing the reserve into the buffer zone and core area would provide a more accurate evaluation of changes in threats from 2002 to 2009. Assessments yielded increases in threat of 78% for the core area and 118% for the buffer zone (Table 2). The only threat that

Table 1. Threat reduction assessment index 1 for Horsh Ehden Nature Reserve (spring 1997–spring 2002).

Threat[a]	*Criteria ranking*			*Total ranking*[b]	*Percent threat reduced*[c]
	area	*intensity*	*urgency*		
Grazing by goats	8	7	8	23	90
Recreational hunting	7	5	7	19	43
Garbage and solid waste	6	1	4	11	98
Noise and light	2	2	5	9	−75
Recreation	4	6	6	16	−83
Logging and wood harvesting by local community	5	8	2	15	97
Native wild boars	1	3	1	5	−100
Residential and commercial development	3	4	3	10	−30
Total	36	36	36	108	

[a] *For detailed description of threats considered see Supporting Information.*
[b] *Sum of relative rankings of area, intensity, and urgency.*
[c] *Estimated percentage of threat mitigation over assessment period (total threat reduction index* $= \Sigma bc/\Sigma b \times 100 = 24\%$*).*

decreased in the core area was livestock grazing, which was fairly low in 2002 (Table 1). Threats from sport hunting in both the core area and buffer zone, as well as goat grazing in the buffer zone, remained unchanged. A substantial increase in uncontrolled visits to Horsh Ehden organized by tour operators was the greatest threat in the core area, whereas the greatest increase in threat in the buffer zone was use of recreational off-road vehicles. The magnitude of 11 of the 16 threats identified for the reserve as a whole more than doubled from 2002 to 2009, whereas the magnitude of three threats remained constant (Table 2).

TRA for Al-Shouf Cedar Nature Reserve

For Al-Shouf Cedar reserve, threat levels decreased 51% between the summer of 2006, when a short war occurred in Lebanon, and 2009 (Table 3). The magnitude of all identified threats decreased with the exception of the threat posed by tourism, which increased marginally. The greatest threats were human-induced fire, grazing by goats, and roads. Workshop participants suggested the trend of these threats was affected directly by war. According to participants, sport hunting, grazing, logging and wood harvesting, and gathering terrestrial plants increased because during the war management of the reserve was not operating normally. They regained ability to manage effectively after the 2006 war. Nevertheless, fire occurrence increased from the baseline (2006) during the war and then deceased after the war. There was no tourism during the war, but it resumed thereafter and was not well controlled (Table 3).

Threat Reduction Assessment Evaluation

In addition to the discussion during the workshop, five of the nine participants in workshops responded to a written questionnaire. All five respondents indicated that the assessment method would be useful for planning actions, drafting new or updating existing management plans, and monitoring project effectiveness. Most mentioned that the method was practical, quantitative, and useful for threat prioritization, could be implemented rapidly, and was easy to implement (it focused on threats by definition). Three respondents indicated that ranking criteria and estimating "percent threat reduced" was subjective and therefore a weakness of the method.

Table 2. Threat reduction assessment index 2 for Horsh Ehden Nature Reserve in core area and buffer zone (in parentheses) (spring 2002–spring 2009).

Threat[a]	*Criteria rankings*			*Total ranking*[b]	*Percent threat reduced*[c]
	area	*intensity*	*urgency*		
Grazing by goats	2 (7)	5 (5)	2 (2)	9 (14)	98 (0)
Recreational hunting	3 (8)	4 (4)	6 (6)	13 (18)	0 (0)
Noise and light	4 (4)	1 (1)	4 (4)	9 (9)	−100 (−100)
Recreational use of off-road vehicles	5 (6)	6 (6)	5 (5)	16 (17)	−100 (−400)
Native wild boars	8 (2)	3 (3)	8 (8)	19 (13)	−100 (−100)
Residential and commercial development	7 (5)	8 (8)	7 (7)	22 (20)	−30 (−100)
Human-ingnited fire	1 (1)	7 (7)	1 (1)	9 (9)	−100 (−100)
Tourism	6 (3)	2 (2)	3 (3)	11 (8)	−300 (−100)
Total	36	36	36	108	

[a] *For detailed description of threats considered see Supporting Information.*
[b] *Sum of relative rankings of area, intensity, and urgency.*
[c] *Estimated percentage of threat mitigation over assessment period (total threat reduction index* $= \Sigma bc/\Sigma b \times 100 = -78\%$ *(*-118%*)).*

Table 3. Threat reduction assessment index for Al-Shouf Cedar Nature Reserve (summer 2006–spring 2009).

Threat[a]	*Criteria ranking*			*Total ranking*[b]	*Percent threat reduced*[c]
	area	*intensity*	*urgency*		
Recreational hunting	5	2	4	11	60
Grazing by goats	6	5	5	16	70
Logging and wood harvesting by the local community	4	4	2	10	80
Subsistence gathering of terrestrial plants	3	3	1	7	60
Roads	2	6	6	14	20
Human-ignited fire	7	7	7	21	50
Tourism	1	1	3	5	−10
Total	28	28	28	84	

[a] *For detailed description of threats considered see Supporting Information.*
[b] *Sum of relative rankings of area, intensity, and urgency.*
[c] *Estimated percentage of threat mitigation over assessment period (total threat reduction index* $= \Sigma bc/\Sigma b \times 100 = 51\%$*).*

Discussion

The three groups of workshop participants identified common reasons for failure or inability to deal with certain threats, such as limited enforcement of regulations, unclear demarcation of the protected area boundaries, and lack of sufficient or sustainable funds for research and project development. Other issues were more site specific. The management team for Horsh Ehden noted a lack of support from local authorities and institutions, and therefore a lack of management projects. For Al-Shouf Cedar reserve, by contrast, local support was the major driver behind the sustainability and development of the reserve. Because many projects existed at Al-Shouf to mitigate identified threats, the TRA method provided a relevant evaluation of current projects. Management teams for both reserves commented that the TRA method helped them identify threats and prioritize actions for their management plans.

TRA Tool Adaptability to the Lebanese Context

The participants appeared to demonstrate a high level of interest in learning and applying the tool during the workshops. Quantitative representation of management performance was mentioned as an "urgent need" by one participant from Horsh Ehden. Our study is consistent with previous research inferences that assessment of threats over time would be useful in management of protected areas in Lebanon (Hagen & Gerard 2004). Both participating teams expressed their intention to integrate the TRA method into their management plans, which are currently under revision. We believe that national use of the TRA would help Lebanon comply with Article 7c of the CBD to "have ongoing, systematic monitoring programs on [. . .] threats on biodiversity" (UNDP 2005, 115) and "move towards a monitoring strategy that is sustainable further than the duration of a project fund" (UNDP 2005).

The major drawback of the method is that estimates of threat reduction are subjective (Margoluis & Salafsky 2001; Persha & Rodgers 2002; Anthony 2008). We minimized subjectivity through documentation of threat occurrence in Al-Shouf Cedar reserve and did not observe exaggeration of positive threat mitigation mentioned by Margoluis and Salafsky (2001). Comparison of assessments between the two protected areas was not possible because the periods that were assessed were not synonymous. We suggest that the method may be effective for rapid evaluations and can be conducted for individual protected areas, but comprehensive management evaluations that address more than threats should complement its use (e.g., Management Effectiveness Tracking Tool).

Our initial study of the application of threat reduction assessment suggests that its use can improve the effectiveness of protected area management in Lebanon. We believe the method may be applicable to other protected areas in a range of ecosystems. On the basis of our experience, we recommend the following for future assessments.

1. To reduce subjectivity in estimates of threat reduction, regularly document occurrence of direct threats in a protected area.
2. Use the IUCN standardized lexicon and unified classification of direct threats as a reference document.
3. If direct threats vary spatially within a protected area, conduct assessments that correspond to those areas over identical assessment periods. This recommendation is consistent with that of United Nations Development Program-Global Environment Fund in East African forest protected areas (Persha & Rodgers 2002).
4. Continue to use software to make calculations. This allows governing authorities to standardize data from regular evaluations of different sites and to discuss results within protected-area networks.
5. Apply the threat reduction assessments within shorter time frames (e.g., 6 months) and link them to specific projects.

To the best of our knowledge, our work is the first attempt to combine the new IUCN standardized classification of threats and the modified threat reduction

assessment tool, which incorporates negative values with an unbounded scoring system (>100% or ≤100%). Our results suggest that the negative scoring system improves the method's ability to assess threats and that there is a need to standardize categories of threats.

Acknowledgments

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Supporting Information

The TRA worksheets (threats defined by participants) (Appendix S1) and the TRA feedback sheet (Appendix S2) are available as part of the online article. Queries (other than absence of the material) should be directed to the corresponding author.

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