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Research article

Management effectiveness evaluation in protected areas of southern Ecuador

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ABSTRACT

Protected areas are home to biodiversity, habitats and ecosystem as well as a critical component of human well-being and a generator of leisure-related revenues. However, management is sometimes unsatisfactory and requires new ways of evaluation.

Management effectiveness of 36 protected areas in southern Ecuador have been assessed. The protected areas belong to three categories: Heritage of Natural Areas of the Ecuadorian State (PANE), created and funded by the State, Areas of Forest and Protective Vegetation (ABVP), created but no funded by the State, and private reserves, declared and funded by private entities.

Management effectiveness was evaluated by answers of managers of the protected areas to questionnaires adapted to the socio-economic and environmental characteristics of the region. Questions were classified into six elements of evaluation: context, planning, inputs, processes, outputs and outcomes as recommended by IUCN. Results were classified into four levels: unsatisfactory, slightly satisfactory, satisfactory and very satisfactory.

The PANE areas and private reserves showed higher management effectiveness levels (satisfactory and very satisfactory) than ABVP areas, where slightly satisfactory and unsatisfactory levels prevailed. Resources availability was found as the main reason behind this difference. The extension, age and province of location were found irrelevant. Outputs, inputs and processes require main efforts to improve management effectiveness. Improving planning and input in the PANE areas and inputs and outcomes on ABVP areas is necessary to obtain a similar result in all areas.

1. Introduction

Protected areas are the cornerstone of biodiversity, habitats (Craigie et al., 2010; Pandit et al., 2015; Venter et al., 2014) and ecosystem services conservation (Coad et al., 2008; Geldmann et al., 2015; Klein et al., 2007; Naidoo et al., 2006; Rodrigues, 2006; Scharlemann et al., 2010). In 2012, a total of 130,709 protected areas of various types were established globally, covering 24,236,479 km^2 of terrestrial (67%) and marine (33%) habitats (IUCN and UNEP-WCMC, 2012).

Protected areas are impacted by unprecedented global losses of biodiversity, habitats and ecosystem services mainly due to pressure from human activities (Craigie et al., 2010; Geldmann et al., 2014, 2013; Laurance et al., 2012; Zhang et al., 2016). Thus, management and effectiveness evaluation of protected areas are key factors for long-term sustainability (Joppa et al., 2013). Management effectiveness evaluation in protected areas is carried out in over 100 countries using over 50 different tools (e.g. approximately 5% of the world's protected areas have been evaluated so far) (Leverington et al., 2010). Evaluations have often been carried out because protected area founders (typically governments and non-government organizations) want to find out whether their investments in management have had the expected outcome.

The International Union for Conservation of Nature (IUCN) has developed a framework for assessing management effectiveness. This allows to develop specific evaluation methodologies for a particular location with a global and consistent approach

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(Hockings, 2003; Hockings et al., 2006). In this framework, management effectiveness is evaluated by questionnaires answered by managers of protected areas. The questionnaires measure management inputs and outputs of protected areas to assess the strengths, weaknesses and management needs (Mascia et al., 2014).

The concept of protected area has evolved during the last decades. They are now considered not only important from an ecology point of view (Calado et al., 2016; Chape et al., 2005), but also as a critical component of human well-being (Bonet-García et al., 2015; Romagosa et al., 2015) and a generator of leisure-related revenues to sustain local economies (Ervin et al., 2010; Nyaupane and Poudel, 2011). Protected areas are the focus of increasing recreational and tourism interest and they are prime destinations for nature-based tourism due to their unique biological, natural and cultural features (Whitelaw et al., 2014). Protected areas constitute an important component of the global tourism industry (Nyaupane and Poudel, 2011). They were a key attraction for over 20% of the 990 million world tourists in 2011 (Buckley, 2009).

Developing countries in Southeast Asia, Africa and South America, have among their priorities the reduction of poverty and the supply of food and commodities to their citizens. Thus, in many cases, the conservation of protected areas is not a top priority for some governments (Satumanatpan et al., 2014). However, developing a tourism industry based on protected areas presents a golden opportunity for developing countries to grow their economy. For instance, Ecuador has excellent conditions to become an important tourist destination while protecting its ecosystems. It is one of the most biodiverse countries in the world and much of its territory makes up some of the 34 global hotspots (Myers et al., 2000).

This paper proposes a methodology to assess the management effectiveness of 36 protected areas in southern Ecuador. Also, it aims to identify protected area management strengths and weaknesses and test whether management effectiveness is impacted by the type of area, extension, age and location of the protected area. Thereby, this paper is intended to improve the management effectiveness of protected areas in southern Ecuador.

2. Materials and methods

2.1. Study area

In this paper, 36 protected areas in southern Ecuador (Fig. 1) were studied. Six areas belong to the Heritage of Natural Areas of the Ecuadorian State (Patrimonio de Areas Naturales del Estado, PANE, in Spanish). 23 areas belong to Areas of Forest and Protective Vegetation (Áreas de Bosque y Vegetación Protectora, ABVP, in Spanish) and seven are private reserves. The PANE areas were declared so and owned by the State and are managed by a public entity that funds them. PANE areas belong to one of the four subsystems of the National System of Protected Areas, run by the Ecuadorian State. The ABVP areas are created by the State but may have different owners: public, private or public-private entities and communities. Most belong to private owners and do not have a public entity that manages and funds them. Private reserves are declared and owned by private agencies that fund their management.

The southern region of Ecuador has an extension of 27,113 km^2 and 1,144,471 inhabitants. From west to east, the provinces of El Oro (coast), Loja (Andes) and Zamora Chinchipe (Amazon) are located within this region. Loja is the largest with an area of 11,100 km^2 (400–3000 masl), followed by Zamora Chinchipe (10,454 km^2, 1000–3000 masl), and El Oro (5792 km^2, 0–3600 masl). The population density differs in each province. El Oro has the highest density (90.77 inhab./km^2; 600,659 inhabitants), followed by Loja (38.26 inhab./km^2; 448,966 inhabitants) and Zamora Chinchipe (7.3 inhab./km^2; 91,376 inhabitants).

The southern Ecuador holds diverse ecosystems: island and marine-coastal areas, mangroves, dry forests, rainforests (pacific, montane and amazonic), moors, sandstone plateaus and semi-natural ecosystems, such as traditional policrops. It also overlaps two world biodiversity hotspots: Tumbes-Chocó-Magdalena and Tropical Andes (Mittermeier et al., 2005; Myers et al., 2000) and is home to 22 Important Bird Areas (IBA) (Birdlife International, 2005).

2.2. Methodology

The methodology used to evaluate management effectiveness in the three types of protected areas (PANE, ABVP and private reserves) was based on those proposed by the IUCN (Hockings et al., 2000), Stolton et al. (2003) and Ervin (2003). A modified version of the questionnaire proposed by Stolton et al. (2003) was used. This questionnaire was adapted to the socio-economic and environmental characteristics of the region. The questionnaire (Table 1) included 38 multiple choice questions classified into six elements of evaluation: context (14), planning (8), inputs (4), processes (5), outputs (5), and outcomes (2). Each question had four possible answers. The interviewee was only allowed to choose one answer and each answer was assigned a score from 0 to 3. A score of 0 represented the worst management effectiveness and 3, optimal effectiveness. Six management effectiveness evaluation indices were calculated as a percentage of the maximum possible score. The management effectiveness score was calculated as the average of the six evaluation management effectiveness indices, following Hockings et al. (2000), Stolton et al. (2003) and Ervin (2003). Senior staff, usually high level managers, of 36 protected areas were interviewed from January to March 2012. Usually, these senior staff had degrees in forestry.

The six management effectiveness evaluation indices and the management effectiveness scores were interpreted according to the scale suggested by Ulloa and Tamayo (2012). This interpretation classifies the results into four categories based on the percentage of the maximum possible score: <25%, unsatisfactory; 25–50%, slightly satisfactory; 50–75%, satisfactory; 75–100%, very satisfactory. Unsatisfactory indicates that the protected area has no guaranty of long-term permanence. Slightly satisfactory means that the protected area is highly vulnerable to the confluence of external factors and its permanence is not guaranteed in the long-term. Satisfactory indicates that the protected area has deficiencies which prevent an effective management, but the management objectives are partially met. Very satisfactory indicates that the permanence of the protected area is guaranteed and management objectives are fully meet.

2.3. Statistical analysis

SPSS version 20 software was used to calculate the coefficient of determination (R^2) among extension, age, province of location and management effectiveness scores. SPSS was also used to carry out ANOVA tests. The latter determines whether there are significant differences between groups and allows drawing conclusions about management effectiveness.

3. Results and discussion

3.1. Management effectiveness scores by type of area

Fig. 2 shows the results in management effectiveness. The highest values (average ± standard deviation) in management effectiveness scores corresponds to private reserves (72.6% ± 6.9, satisfactory), followed by PANE (68.4% ± 9.7, satisfactory) and ABVP areas (40.7% ± 15.1 slightly satisfactory). However, there are only significant differences ($p < 0.05$) between the ABVP areas and the rest. Between private reserves and PANE areas there is no significant difference ($p > 0.05$).

Among private reserves, the highest management effectiveness score corresponds to San Francisco (78.8%, very satisfactory) and the lowest to El Madrigal (61.7%, satisfactory). In PANE areas, values range from 83.5% (very satisfactory) for Yacuri, a National Park, to 55.26% (satisfactory) for Arenillas. Among ABVP areas, the highest value is for Dr. Servio (65.0%, satisfactory), followed by Petrificado Puyango (62.8%, satisfactory) and El Bosque (62.2%, satisfactory). For this kind of protected area, Susuco (18.2%, unsatisfactory) shows the lowest value.

Table 2 lists the results of management effectiveness scores. Private reserves dominate the top positions for management effectiveness. However, the protected area with the highest management effectiveness score corresponds to a PANE area, Yacuri (83.5%, very satisfactory), followed by three private reserves: San Francisco (78.8%, very satisfactory), Jorupe (77.5%, very satisfactory) and Utuana (77.1%, very satisfactory). The ABVP areas occupy the last places. The lowest management effectiveness score corresponds to Susuco (18.2%, unsatisfactory), followed by Ingenio Santa Rosa (19.5%, unsatisfactory) and El Guabo (20.3%, unsatisfactory).

Regarding the categories of the protected areas, all private reserves achieve a very satisfactory ($n = 4$) and satisfactory ($n = 3$) management effectiveness. The same occurs in PANE areas, with 1 very satisfactory area and 5 satisfactory areas. Results differ in the ABVP areas, where management in 35% of the areas ($n = 8$) is satisfactory, 43% is slightly satisfactory ($n = 10$) and 22% is unsatisfactory ($n = 5$).

These results can be explained by the difference in resources in each kind of protected area. While private reserves and PANE areas have private and/or public resources, they are scarce in most of the ABVP areas. Within private reserves, San Francisco receives investments in equipment and personnel thanks to research carried out in the reserve at the San Francisco Research Station. Jorupe and Utuana reserves are dedicated to bird watching, which helps their funding. Within the ABVP areas, the three areas with the highest management effectiveness score also have resources available. Dr. Servio and El Bosque have private support, while Petrificado Puyango has public support from several local governments. Our results suggest that management effectiveness score is higher when resources are available, regardless of whether these funds come from public or private sources.

These results agree with those found by other researchers in nearby protected areas. Mayorquín et al. (2010) found that Riomanso and Cabaña-La Esperanza private reserves in Colombia, had very satisfactory and satisfactory management effectiveness scores. The Ecuadorian Ministry of the Environment evaluated the effectiveness of management in PANE areas such as the Machalilla National Park (73.5%, satisfactory) (Ecuadorian Ministry of the Environment, 2007a) and the Cotacachi Cayapas (76.9%, very satisfactory) (Ecuadorian Ministry of the Environment, 2007b). The effectiveness scores found in this study (13.3–65.6%) are similar to those found by Ganzenmüller et al. (2010) in eight ABVP areas of the Choco-Manabi conservation corridor (northwestern Ecuador).

3.2. Management effectiveness evaluation indices

The averages of the management effectiveness evaluation indices for the six elements of evaluation, i.e., context, planning, inputs, processes, outputs, and outcomes (Fig. 2) show significant differences ($p < 0.05$) between the ABVP areas and the other two areas (private and PANE). However, no significant differences ($p > 0.05$) are found in any of the indices between PANE and private reserves. These results agree with those obtained for the management effectiveness scores.

Management effectiveness evaluation indices can be divided into two groups according to its averages (Fig. 3). Context (62.2% ± 14.9), planning (60.9% ± 20.2) and outcomes (58.3% ± 33.9) show the highest averages. Processes (46.7% ± 18.9), inputs (43.8% ± 26.9) and outputs (37.2% ± 18.8) show the lowest averages. The first group show no significant differences within its elements of evaluation ($p > 0.05$). The same applies to the element of evaluation with lower average. However, there are significant differences ($p < 0.05$) in most evaluation indices of the high average group compared to the low averages. Only between outcomes and processes (those with closer averages) the difference is not significant ($p = 0.272$). Thus, it can be concluded that action is needed primarily on outputs, inputs and processes to improve the management effectiveness scores.

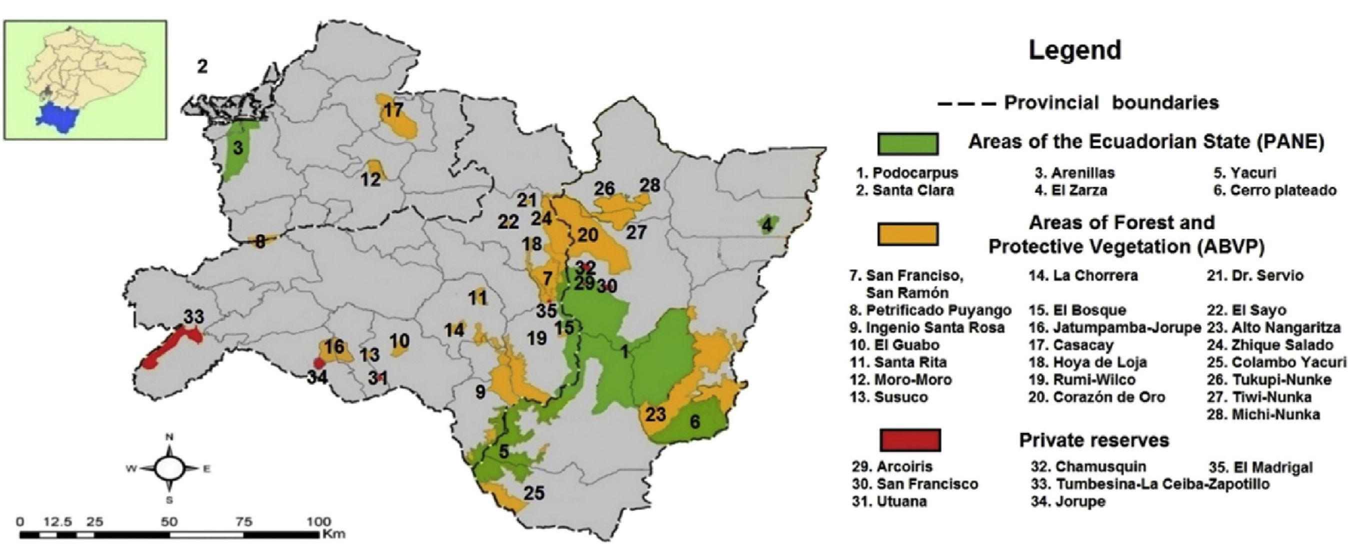

Fig. 1. Protected areas studied in southern Ecuador. (Heritage of Natural Areas of the Ecuadorian State (PANE), green; Areas of Forest and Protective Vegetation (ABVP), orange; Private reserves, red). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 1
Elements of evaluation, themes and topics included in the questionnaire for management effectiveness evaluation.

Elements of evaluation	Themes	Topic of question
Context	Threats	Agriculture
		Cattle raising
		Civil construction
		Deforestation
		Tourism
		Mining
		Forest fires
		Flora and fauna
		Invasive species
	Socioeconomics	Economic development
		Socio-environmental conflicts
	Politics	Government support
		Support from other Entities
		Local communities
Planning	Protected area design	Shape
		Connectivity
		Zoning
		Boundaries
	Objectives	Objectives
	Legal	Protected area creation
		Management and exploitation of natural resources regulations
		Regulations enforcement
Inputs	Staff	Full-time employees
		Additional staff
	Funding	Budget
	Logistics	Equipment and infrastructure
Processes	Planning	Local development plan
		Management plan
		Annual operative plan
	Research and monitoring	Research and monitoring
	Activities	Environmental education and communication
Outputs	Planning results	Achievement of objectives of management
		Penalties to users and employees
	Training	Employees
	Facilities	Visitors infrastructure
	Control mechanisms	Access to Protected Area
Outcomes		Tourism
		Surrounding communities

The difference between the average of management effectiveness score in private reserves (highest) and PANE areas is 4.1%. In the case of ABVP areas, it is 31.9%. The PANE areas show better management effectiveness in context (0.7%) and outputs (0.2%) than private reserves. However, differences are above 5% in planning (7.4%) and inputs (9.7%).

In the case of ABVP areas, the difference compared to private reserves is lower in context (20.9%) and higher in inputs (46.4%) and outcomes (37.6%). It is a priority to improve the planning and input indices in the PANE areas and inputs and outcomes in ABVP areas to achieve similar effectiveness of management in all types of protected areas.

The highest score reached in the questionnaire corresponds to mining (context). Only in Santa Rita and Alto Nangaritza there is illegal mining in the area. In all other protected areas the situation is optimal, there are no concessions within the protected area.

Regarding tourism as an outcome, it shows an average score in the questionnaires. The Ecuadorian Ministry of the Environment reports that over 2,000,000 people visited PANE areas in 2015 (Ecuadorian Ministry of the Environment, 2016a). Around 100,000 during the Carnival holidays (Ecuadorian Ministry of the Environment, 2016b). However, PANE areas in southern Ecuador are among those with fewer visitors. It is probably due to several reasons: being located far from the biggest cities of Ecuador (Quito and Guayaquil) and the best known protected areas in the country, such as those in the Galapagos Islands and in the northern half of the Ecuadorian Andes (including Chimborazo and Cotopaxi). It is also affected by a lower proportion of coastal protected areas, whose beaches attract many visitors. Thus, it is recommended to promote tourism in protected areas of southern Ecuador through advertising to tours organizers and visitors, and improving roads. It is also interesting advertising in the city of Cuenca, Ecuadorian third biggest city and relatively close. Furthermore, Cuenca has a high proportion of foreign tourists and residents who, in many cases, are attracted by eco-tourism. In fact, Cajas National Park, very close to the city, registers an intermediate number of visits compared to other PANE areas. The question with the lowest average score is that referred to visitor infrastructure. According to the responses, there is an obvious lack of infrastructure for visitors. Thus, improving this infrastructure is also important to increase the number of visitors and improve their experience.

Deforestation shows one of the lowest average scores in the questionnaires. Ecuador loses annually between 60,000 and 200,000 ha of native forests and their primary forests decrease at 1.8% per year, the highest rate in Latin America (FAO, 2016). Among other reasons, deforestation is the result of illegal logging, pressure from oil and mining companies and expansion of crops (favored by the recent rise in corn prices).

Food security can be achieved through agricultural intensification and measures such as social protection, rather than through the expansion of agricultural areas at the expense of forests (FAO, 2016). Linking agricultural incentives to environmental criteria,

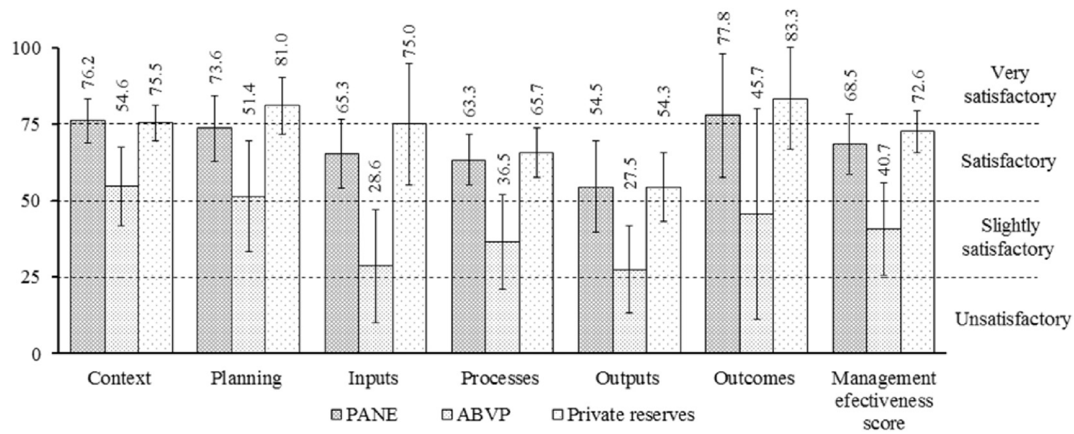

Fig. 2. Management effectiveness scores (%) and element of evaluation (%) by type of protected area: Heritage of Natural Areas of the Ecuadorian State (PANE), Areas of Forest and Protective Vegetation (ABVP) and private reserves.

Table 2
Basic characteristics, evaluation areas and management effectiveness scores for the protected areas studied. Heritage of Natural Areas of the Ecuadorian State (PANE), Areas of Forest and Protective Vegetation (ABVP) and private reserves.

Type of protected area	Area name	Basic characteristics			Management effectiveness evaluation areas (%)						Management effectiveness score (%)
		Extension (ha)	Creation year	Main province[a]	Context	Planning	Inputs	Processes	Outputs	Outcomes	
Heritage of Natural Areas of the Ecuadorian State (PANE)	Podocarpus	146,280	1982	Zamora	69.1	50.0	50.0	66.7	33.3	50.0	55.3
	Santa Clara	5	1999	El Oro	76.2	58.3	58.3	53.3	40.0	66.7	61.6
	Arenillas	17,082	2001	El Oro	66.7	66.7	66.7	66.7	66.7	66.7	66.7
	El Zarza	3643	2006	Zamora	78.6	66.7	66.7	66.7	66.7	83.3	71.4
	Yacuri	43,090	2009	Loja	81.0	66.7	66.7	53.3	53.3	100.0	72.2
	Cerro Plateado	26,114	2010	Zamora	85.7	83.3	83.3	73.3	66.7	100.0	83.5
Areas of Forest and Protective Vegetation (ABVP)	San Francisco, San Ramón	30,621	1970	Loja	33.3	0.0	0.0	33.3	13.3	0.0	18.2
	Petrificado Puyango	3917	1987	Loja	42.9	16.7	16.7	13.3	6.7	0.0	19.5
	Ingenio Santa Rosa	12,326	1987	Loja	42.9	8.3	8.3	20.0	13.3	16.7	20.3
	El Guabo	2319	1988	Loja	50.0	0.0	0.0	26.7	6.7	0.0	21.5
	Santa Rita	2141	1988	Loja	47.6	8.3	8.3	33.3	13.3	16.7	24.1
	Moro-Moro	3131	1992	El Oro	28.6	25.0	25.0	26.7	26.7	33.3	29.6
	Susuco	103	1992	Loja	42.9	25.0	25.0	20.0	26.7	33.3	30.2
	La Chorrera	2051	1993	Loja	45.2	16.7	16.7	40.0	20.0	33.3	32.1
	El Bosque	2233	1994	Loja	47.6	25.0	25.0	40.0	20.0	33.3	34.6
	Jatumpamba – Jorupe	8027	1996	Loja	52.4	25.0	25.0	26.7	26.7	33.3	35.7
	Casacay	12,577	1997	El Oro	52.4	25.0	25.0	46.7	33.3	16.7	36.7
	Hoya de Loja	10,752	1998	Loja	52.4	41.7	41.7	66.7	26.7	0.0	39.6
	Rumi-Wilco	26	2000	Loja	59.5	25.0	25.0	46.7	6.7	50.0	41.0
	Corazón de Oro	54,143	2000	Loja	59.5	50.0	50.0	20.0	40.0	50.0	44.2
	Dr. Servio	73	2000	Loja	59.5	25.0	25.0	46.7	26.7	50.0	44.4
	El Sayo	124	2000	Loja	57.1	25.0	25.0	46.7	46.7	66.7	52.2
	Alto Nangaritza	128,867	2001	Zamora	71.4	33.3	33.3	20.0	33.3	100.0	54.8
	Zhique-Salado	85	2001	Loja	71.4	33.3	33.3	20.0	33.3	100.0	54.8
	Colambo Yacuri	79,731	2002	Loja	73.8	33.3	33.3	26.7	33.3	100.0	56.3
	Tukupi-Nunke	6378	2008	Zamora	69.1	33.3	33.3	46.7	33.3	100.0	56.8
	Tiwi-Nunka	6976	2008	Zamora	73.8	50.0	50.0	53.3	33.3	83.3	62.2
	Micha-Nunka	1613	2008	Zamora	52.4	83.3	83.3	66.7	53.3	66.7	62.8
Private reserves	Arcoiris	10	1996	Zamora	69.1	50.0	50.0	53.3	60.0	66.7	65.1
	San Francisco	1100	1997	Zamora	69.1	50.0	50.0	53.3	60.0	66.7	61.7
	Utuana	350	1998	Loja	69.1	58.3	58.3	66.7	40.0	66.7	64.7
	Chamusquin	41	2002	Loja	71.4	75.0	75.0	80.0	40.0	83.3	71.5
	Tumbesina-La Ceiba-Zapotillo	17,350	2005	Loja	81.0	58.3	58.3	66.7	66.7	100.0	76.7
	Jorupe	3000	2005	Loja	76.2	91.7	91.7	66.7	53.3	100.0	77.1
	El Madrigal	305	2005	Loja	78.6	91.7	91.7	66.7	53.3	100.0	77.5

[a] Zamora: Zamora – Chinchipe province.

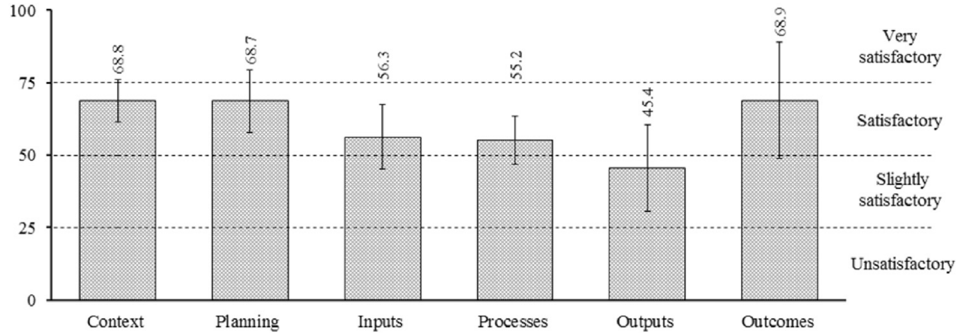

Fig. 3. Averages of the six management effectiveness evaluation indices in the protected areas studied.

adopting silvopastoral practices, paying for environmental services and the recovering of degraded pastures can prevent the expansion of the agricultural frontier at the expense of forests. Ecuador implemented such measures with the Sociobosque program and the National Forest Restoration Plan and reduced deforestation by 4% per year, while worldwide reduction was 1%.

3.3. Impact of extension, age and province on management effectiveness score

The coefficient of determination (R^2) was calculated to correlate management effectiveness scores and extension of protected areas. Correlation calculations were carried out for the dataset as a whole and for each type of protected area separately. Results show that management effectiveness and the extension of protected areas are uncorrelated. R^2 values are less than 0.1 in all cases. These results agree with those found by Kolahi et al. (2013) in Khojir National Park, Iran. This protected area showed low management effectiveness despite occupying 10,000 ha in the core of a broader protected area (Jajrud) with more than 72,000 ha.

Average extension in PANE areas (39,369 ha) is greater than in private reserves (3165 ha). While PANE areas are all over 3500 ha (except for Santa Clara) with most of them in the range of 3500 to 45,000, all private reserves are below 3000 ha (except for Tumbesina-La Ceiba-Zapotillo). The question whether private areas similar in extension to PANE areas would be equally effective emerges. Especially considering the difficulty for private entities to obtain funds compared to the State, allowing the latter to manage greater areas. Further research is necessary to elucidate this question.

Situation is similar when management effectiveness scores are correlated to the age of protected areas. Again, R^2 were calculated for the dataset as a whole and for each type of protected areas separately. R^2 obtained were lower than 0.15 in all cases, indicating that management effectiveness is independent of the age of protected areas. These results agree with those found by Kolahi et al. (2013) in the oldest protected area of Iran, the Khojir National Park, with a low management effectiveness (43%, slightly satisfactory).

The averages of management effectiveness scores depending on the provinces of southern Ecuador (El Oro, Loja and Zamora-Chinchipe) are very similar and show no significant differences ($p > 0.05$). The highest average corresponds to Zamora-Chinchipe (54.0% ± 17.7, satisfactory), followed by El Oro (53.8% ± 12.8, satisfactory) and Loja (50.2 ± 21.5%, satisfactory). Thus, the variables associated with the province described in materials and methods section, such as population density, can not be considered significant.

3.4. Methodology discussion

Hockings et al. (2000) and Stolton et al. (2003, 2007) discuss the difficulties and possibilities for distortion of integrating the scores obtained in the questions. Each evaluation index is composed of different number of questions. Thus, calculating the management effectiveness score as the arithmetic mean of the six evaluation indices, some questions are valued more than others. For example, questions being part of outcomes (2) will have seven times more relevance to the management effectiveness scores than those belonging to context (14). Thus, in this work weights have been assigned indirectly to each of the questions based on the grouping for the calculation of the management effectiveness evaluation

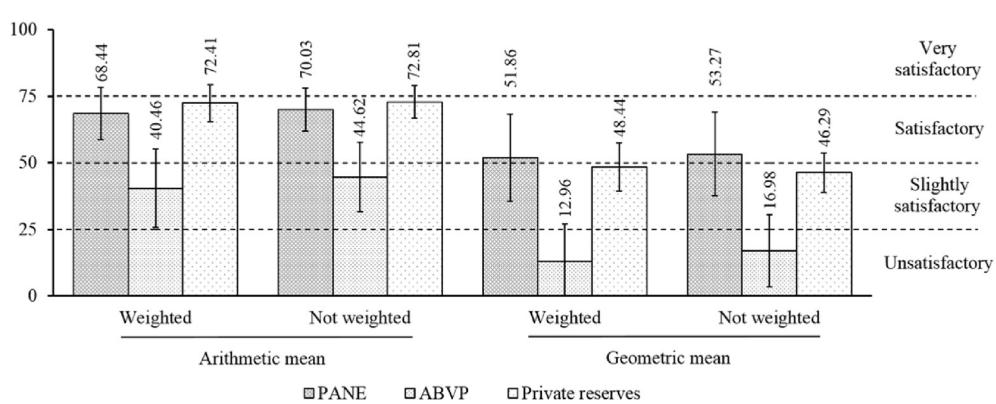

Fig. 4. Management effectiveness scores calculated by both arithmetic and geometric means and weighting (calculating management effectiveness evaluation indices as a previous step) and not weighting (calculating means over questions).

indices.

Weights could have being also added directly to each of the questions for calculating the management effectiveness evaluation indices or to the management effectiveness evaluation indices for calculating the management effectiveness scores. In these cases, weights can be added according to the number of questions, the expert criteria (for example, with the Delphi method) or statistical methods, such as the principal component analysis (PCA) (Böhringer and Jochem, 2007).

Fig. 4 compares the management effectiveness scores by the type of area as it is calculated in this work and as the arithmetic mean of all the questions, without the intermediate step of the management effectiveness evaluation indices. I.e., giving equal weight to all questions. Management effectiveness score increases in all three types of areas when all questions are weighted equally. This indicates that the questions with greater weight, such as those of inputs (4) and outcomes (2), decrease the arithmetic mean. Despite this, order in management effectiveness score remains equal: private areas maintain the highest management effectiveness score, followed very closely by the PANE areas and, lastly, ABVP areas.

Standard deviations have decreased in all three types of protected areas, facilitating to find significant differences in management effectiveness. However, there are no significant differences between the management effectiveness score in the areas according to the weighting method used ($p > 0.05$).

It is also necessary to discuss whether it is convenient to integrate the scores of questions using the arithmetic mean. This method allows total compensability between questions (OECD, 2008). However, protecting an area requires achieving relatively good scores in all questions. Low scores on some questions could make the protection of the area and its long-term survival unviable, although other questions achieve high scores.

Using the geometric mean instead of the arithmetic would reduce compensability. Lower results would reduce the management effectiveness score significantly (Ebert and Welsch, 2004). In addition, the generalized implementation of the geometric mean would encourage to balance all aspects of protection and prevent from excel only in some, ignoring others. Fig. 4 shows the management effectiveness score by the type of area calculated using the geometric mean for both management effectiveness evaluation indices and management effectiveness score. Nonetheless, geometric mean implies a higher dispersion of data, increasing standard deviation and making it more difficult to find significant differences. In this paper, the questions answered with 0 have been replaced by 0.01. Otherwise, it would not be possible to obtain a geometric mean.

Low scores on some questions could mean a serious threat for long-term survival of the protected area. Focusing on reducing compensability, this answers to the questions could be considered red flags. This would be a way of implementing a harder compensatory system, such as the non-compensatory multi-criteria approach (MEC) (OECD, 2008). Red flags could be also used as threshold scores for each management effectiveness evaluation index. Thresholds would be set by experts according to their relevance.

These results prove that it is important to justify the methodology used to aggregate and to weight the results. If a random approach is used, the conclusions of the indexes can lead to error.

4. Conclusions

The Heritage of Natural Areas of the Ecuadorian State (PANE, in Spanish) and private reserves have the same level of management effectiveness score, rated as satisfactory and very satisfactory.

The Forest and Protective Vegetation (ABVP, in Spanish) have lower management effectiveness score that PANE areas and private reserves, prevailing levels slightly satisfactory and unsatisfactory.

Higher management effectiveness scores are associated with the availability of resources. While all PANE areas and private reserves have resources available, they are only available in a few of the ABVP areas (those with better management effectivenesses).

Improving management effectiveness evaluation indices on the outputs, inputs and processes is necessary to enhance management effectiveness score. Improving planning and input evaluation effectivenesses in the PANE areas and inputs and outcomes on ABVP areas is required to achieve a similar management effectiveness in all types of protected areas.

The extension, age and province of location are not determining factors in the management effectiveness score of the protected areas.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jenvman.2016.12.043.

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