

Community perceptions of four protected areas in the Northern portion of the Cerrado hotspot, Brazil

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SUMMARY

Establishing effective networks of protected areas (PAs) is one of the major goals of conservation strategies worldwide. However, the success of PAs in promoting biodiversity conservation depends on their integration to local and regional contexts, reducing and mitigating human impacts originating from buffer zones. Community perceptions affect interactions between residents and PAs, and thereby conservation effectiveness. Research at Tocantins state (northern Brazilian Cerrado), aimed to analyse local community perceptions of four PAs, discussing how different factors may influence these. Perceptions were assessed through standardized interviews applied to PA employees and 275 local inhabitants. There was modest community participation in PA establishment and management. Residents were aware of the PAs' existence, but were unfamiliar with their goals. Length of residency and occupation of inhabitants influenced their PA perceptions, shaping different people-park relations in each of the four studied PAs. Involvement of local residents in PA planning and management represents a central strategy to strengthen local support for PAs over the long term. In those areas that still have settlements inside their boundaries, community relocation should follow a careful participatory process to avoid significant changes in local perceptions and attitudes towards these PAs, crucial for conserving Brazilian biodiversity.

Keywords: Cerrado, community perceptions, hotspot, people-park interactions, protected areas

INTRODUCTION

An effective global network of protected areas (PAs) is vital for the protection of biodiversity and the benefits that intact nature provides (Pimm *et al.* 1995; Balmford *et al.* 2002; Rodrigues *et al.* 2004). However, the success of PAs depends on integrating them with local human communities in order to reduce conflicts and mitigate impacts originating from buffer zones (Anthony 2007). Interactions between people and PAs are known to be influenced by perceptions that

communities have towards conservation projects and PAs (Ormsby & Kaplin 2005). Thus, the relationship between PAs and local residents must be clearly understood in order to achieve PA conservation goals (Newmark *et al.* 1993; Ormsby & Kaplin 2005).

The adoption of frameworks to address factors that influence perceptions towards PAs may help incorporate local communities' expectations into PA planning and management, increasing PA effectiveness over the long term (Brandon & Wells 1992; Newmark *et al.* 1993; Fiallo & Jacobson 1995). Many factors may influence perceptions and attitudes toward PAs, including history of PA management (Ormsby & Kaplin 2005; Allendorf 2007), benefits received from the PA (Bauer 2003; Ormsby & Kaplin 2005), relationships with PA staff (Ite 1996; Ormsby & Kaplin 2005), size of the area (Allendorf 2007), residents' age (Anthony 2007) and time of residence in the area (Newmark *et al.* 1993).

In developing countries, most studies on the relations between people and PAs have been in Africa (Infield 1988; Gillingham & Lee 1999; Bauer 2003; Ormsby & Kaplin 2005; Anthony 2007), with few studies performed in Asia (Heinen 1993; Walpole & Goodwin 2001; Allendorf *et al.* 2006; Allendorf 2007) and South America (Fiallo & Jacobson 1995; Naughton-Treves *et al.* 2006).

People-park interactions are poorly studied in Brazil and there is no published research for the entire Cerrado region, the second largest Neotropical domain and also the world's richest and most threatened tropical savannah (Klink & Machado 2005). Biological importance of the Cerrado savannahs is high, reflected in high levels of plant endemism and high species richness of invertebrates, fishes, reptiles, amphibians and birds (Myers *et al.* 2000; Oliveira & Marquis 2002; da Silva & Bates 2002; Klink & Machado 2005). However, agricultural expansion and human migration to central Brazil have caused high rates of habitat loss and severe changes in the Cerrado landscape during the last decades. Over half of the Cerrado has already been cleared or transformed (Machado *et al.* 2004), and conservation efforts are modest, with only 2.2% of the Cerrado area under legal protection (Klink & Machado 2005).

Tocantins state, in the northern region of Brazil, congregates important Cerrado-Amazonia transition areas and some of the largest blocks of Cerrado remnants (Machado *et al.* 2004). The state has 5.7% of its total area preserved as restricted-use PAs (IUCN categories I to III), one of the highest percentages of Cerrado conserved areas among

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Table 1 Summary description of PAs studied in Northern Brazil.

	<i>Cantão State Park</i>	<i>Jalapão State Park</i>	<i>Lajeado State Park</i>	<i>Árvores Fossilizadas Natural Monument</i>
IUCN category	II	II	II	III
Management objective	Biodiversity conservation	Biodiversity conservation	Biodiversity conservation	Fossilized forest protection
Year established	1998	2001	2001	2000
Habitat	Transition areas	Cerrado (savannah)	Cerrado (savannah)	Cerrado (savannah)
Size (ha)	90 019	158 885	9931	32 152
Human presence inside PA	Isolated families	Scattered villages	None	Scattered villages
PA permanent staff	15	5	12	2

Brazilian states. Besides their importance and potential for biodiversity conservation, PAs in Tocantins state face increasing threats owing to anthropogenic fires, cattle raising and agriculture expansion, as observed in other Cerrado areas (Klink & Machado 2005). Attempts to conserve biodiversity and at the same time promote local communities' development become especially challenging in highly biodiverse PAs subjected to significant pressure over natural resources and financial limitations to support management (Anthony 2007).

Inadequate implementation of PAs is particularly acute in developing countries, where many forces combine to threaten these areas, including poverty, landlessness, exhaustion of natural resources and overpopulation. PAs in the Cerrado also generally lack effective management and protection. Moreover, PAs in grassland ecosystems, such as the Cerrado savannahs, may be the most at risk since these regions have particularly high human population growth rates, which are associated with higher deforestation rates (Wittemyer *et al.* 2008).

PAs under Tocantins state administration were created in the last decade without any kind of participatory approach, and nowadays, despite some efforts to inform and engage local populations in PA management, local residents still live, exploit resources and claim for land rights within these areas, in a scenario of increasing people-park conflicts. Conflicting land-use practices compromise the achievement of conservation goals and PA management, especially due to agriculture, anthropogenic fires, illegal hunting and cattle raising, both within PAs and in their buffer zones.

Moreover, despite being managed by the same institution, each PA is subjected to a unique environmental and social context, determined by PA history, size, ecosystems, category of protection, buffer-zone land use and others (more details in Methods). Therefore, instead of adopting a single 'one size fits all' strategy, effective outreach depends on previous understanding of local communities' relationships with each PA.

This paper analyses the perceptions of local residents with respect to four restricted-use PAs in Tocantins state, in order to define priority of actions for PA managers and policy makers and identify opportunities to enhance local support for biodiversity conservation goals of these areas. The main research questions were: (1) What is the degree of local community awareness of the existence and goals of the PAs? (2) How do residents perceive the impact of PAs in their

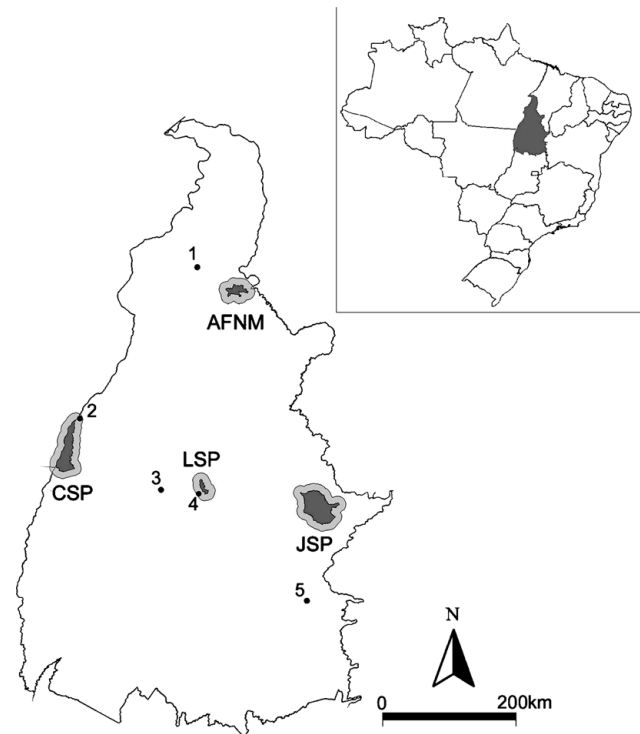


Figure 1 Location of Tocantins state in Brazil. Expanded view illustrates the studied PAs and their buffer zones. CSP = Cantão State Park, LSP = Lajeado State Park, JSP = Jalapão State Park and AFNM = Árvores Fossilizadas Natural Monument. Numbers represent major Tocantins cities (1 = Araguaína, 2 = Caseara, 3 = Paraíso do Tocantins, 4 = Palmas and 5 = Dianópolis).

livelihoods? (3) Which of the factors (age group, gender, time of residency, occupation and site-related issues) influence local communities' perceptions of PAs?

METHODS

Study site

Four PAs located at different regions in the state were chosen in order to achieve a broad representation of human perceptions of PAs in different contexts, including habitat, history, size and degree of legal access for communities (Fig. 1, Table 1).

All areas were created in the last decade and are managed by the Tocantins State Nature Institute (NATURATINS).

Cantão State Park (CSP) is located in Western Tocantins, in the transition zone between the Cerrado savannah and the Amazon forest. It is bounded by three major rivers (Araguaia, Coco and Javaés) and adjacent to the world's largest fluvial island (Ilha do Bananal). Araguaia River is one of the largest Brazilian rivers that still remains free of significant human impacts, such as hydroelectric dams or high levels of pollution. Main economic activities are irrigated agriculture, cattle raising and fishing. Local communities are sparsely distributed along CSP buffer zone, in small villages or settlements where mean human density is around 0.9 inhabitants km⁻² (IBGE [Instituto Brasileiro de Geografia e Estatística (Brazilian Institute of Geography and Statistics)] 2000). Park staff and local organizations support sustainable community activities, such as sustainable agriculture and handicraft making, while initiatives on environmental education are also being developed, mainly related to fire prevention during the dry season.

Jalapão State Park (JSP), in Eastern Tocantins, is part of the Jalapão-Mangabeiras biodiversity corridor, which holds the largest tracts of natural remnants and the largest PAs in Central Brazil, altogether protecting almost 1600 km², and also making this region extremely important to the conservation of Cerrado biodiversity. The JSP region consists of extensive quartzitic sand depressions resulting from erosion of isolated arenitic plateaus of the Serra Geral and Chapada das Mangabeiras, and is drained by the headwaters of the Tocantins and São Francisco river basins (SEPLAN [Secretaria de Planejamento (Secretary of Planning)] 2003). Vegetation is typical of the Cerrado and is dominated by extensive *campos sujos* (scrub grasslands) and open savannah interspersed by *veredas* (wet grasslands with *Mauritia flexuosa* palm trees) and gallery forests (Oliveira-Filho & Ratter 2002; SEPLAN 2003). Communities around JSP comprise small towns and rural settlements. PA boundaries include areas traditionally occupied by local communities, who are requesting changes in the PA design in order to avoid land-use restrictions. Human population density in the region is approximately 0.6 inhabitants km⁻² (IBGE 2000), and the local economy is based on subsistence agriculture, extensive cattle raising and, more recently, handicraft making and tourism (SEPLAN 2003; Schmidt *et al.* 2007). Several capacity building and integrated conservation-development projects were implemented in the JSP region by governmental and non-governmental institutions to improve handicraft design and production, tourist reception and sustainable exploitation of local products. Outreach activities are developed by the PA staff on a regular basis, especially in rural settlements and local schools.

Lajeado State Park (LSP) is the smallest PA surveyed and is located in the central portion of the state, close to its capital city (Palmas). It is composed of typical Cerrado vegetation, with wooded savannahs (cerrado *sensu strictu*) and forested habitats (gallery forests, see Oliveira-Filho & Ratter 2002) distributed along plateaus with mean altitudes of 500 m. LSP protects most of the headwaters that supply the city of Palmas (178 000 inhabitants; IBGE 2007). Local communities

occupy small towns and farms around LSP, but urban pressure from the capital city has caused landscape change over the last two decades. Mean human density in the region is approximately 36 inhabitant km⁻² (IBGE 2000), one of the highest levels among PA buffer zones in the state. Agriculture and cattle raising are the main activities in the area. Despite its privileged location, LSP still remains closed to public visitation and there are minor and isolated community outreach activities.

Arvores Fossilizadas Natural Monument (AFNM) is the only PA in this study that formally allows human settlements and private properties inside its boundaries. It was created in the northern portion of the state to protect a petrified forest that represents the most important Permian tropical-subtropical floristic record in the Southern Hemisphere (Dias-Brito *et al.* 2007). The AFNM region includes natural units interrupted by large cattle farms. Mean human density is approximately one inhabitant km⁻² (IBGE 2000). Natural areas are dominated by cerrado vegetation, although riparian forests and some small patches of semi-deciduous forests also occur. Local communities are distributed in small villages or rural settlements, and the economy is based on subsistence agriculture and cattle raising.

In all cases, PA boundary definition and establishment were conducted without local community participation, based mainly on biophysical information. Nowadays, management councils represent formal mechanisms of community involvement in PA planning and management. The management council is a legally instituted mechanism adopted in the administration of Brazilian PAs that provides a discussion forum on PA management for many segments of civil society, agencies, research institutions and private companies. In Brazil, these councils usually represent the main arena for participatory involvement in PA management. In the council, agreements, rules and direction of the actions to be undertaken are established, thereby reducing conflicts and impacts, aiming at sustainability and conservation of available resources by means of a shared process of management. The establishment of management councils involves preparatory meetings that are followed up by open election of representatives from local communities and other sectors or institutions that are in some way related to PAs. In Tocantins state, management councils have been established in CSP and JSP, even though participation is still modest and occasional.

Financial resources for all PA management are scarce; however CSP and LSP receive additional resources from compensatory measures (LSP) and Amazon conservation programmes (CSP) and have better area:staff ratios (827 ha per person in LSP and 6001 ha per person in CSP) when compared to AFNM (16 076 ha per person) and JSP (31 777 ha per person).

Sampling procedure

Perceptions of local people living adjacent to the four PAs were assessed through standardized interviews of both men and women over 18 years old, conducted between April 2007 and

Table 2 Respondents' profile related to each PA and in total. CSP = Cantão State Park; JSP = Jalapão State Park; LSP = Lajeado State Park; AFNM = Árvores Fossilizadas Natural Monument.

	<i>CSP</i>	<i>JSP</i>	<i>LSP</i>	<i>AFNM</i>	<i>Total</i>
Number of respondents	70	74	60	71	275
Mean age (\pm SD)	40.07 \pm 15.57	42.76 \pm 16.43	38.82 \pm 16.21	44.84 \pm 14.98	41.73 \pm 15.88
Time of residency in the area (\pm SD)	19.18 \pm 9.45	37.03 \pm 19.91	12.13 \pm 6.65	28.43 \pm 17.87	24.79 \pm 17.47
Female [<i>n</i> (%)]	49 (69.01)	51 (68.92)	30 (50)	46 (65.71)	176 (64.00)
Occupation: direct use of natural resources [<i>n</i> (%)]	16 (22.22)	63 (85.13)	5 (8.33)	29 (41.43)	113 (41.09)

March 2008. In total, 275 local inhabitants were interviewed, all living within a 12-km radius of the PAs.

Perceptions were analysed in order to better understand the beliefs, values and interactions between local communities and Tocantins state PAs (Appendix 1, see Supplementary material at URL http://www.ncl.ac.uk/icef/EC_Supplement.htm). PAs have increasingly become the means by which many people see, understand, experience and use the parts of the world that are often called nature and the environment (West *et al.* 2006). It is widely accepted that perceptions have a direct effect on residents' attitudes towards PAs (Allendorf 2006), and individual or group interviews have been largely applied to evaluate these (Ite 1996; Bauer 2003; Ormsby & Kaplin 2005; Anthony 2007).

The questionnaire included closed and open-ended questions and was divided in two major sections: sociodemographic variables (age, gender, duration of residency in the area and occupation) and PA perceptions (Appendix 1, see Supplementary material at URL http://www.ncl.ac.uk/icef/EC_Supplement.htm). Open questions examined the various dimensions of respondents' perceptions and enabled us to cross-check responses (as in Infield 1988; Bauer 2003).

The first and second questions assessed respondents' knowledge and awareness about the PA and represented important background to the interview. Question three aimed to assess the PA's value to local people (conservation value, financial value or other values). Questions four and five analysed how residents perceive the impacts of PA creation on their lives (either positive, negative or neutral). The final question concerned residents' perceptions of their relationship with PA staff, since previous studies suggested that this may have a strong influence on the relationships between people and PAs (Newmark *et al.* 1993; Ormsby & Kaplin 2005).

We adopted a proportional random sampling design (as in Newmark *et al.* 1993). Village population defined the number of interviews and we visited most villages located around the PAs. There were no precise estimates of population size for each site, so we employed demographic data from municipalities and PAs to define for the number of interviews in each area. In the main municipalities where PAs were situated, populations ranged between 1800 in JSP (IBGE 2007) and 7800 in AFNM (IBGE 2007), and population numbers inside PAs varied from zero in LSP to 1000 inhabitants in JSP (SEPLAN 2003).

Interviews were conducted by one of the three members of the research team, after a brief introduction explaining the form and purpose of the interview. Residents were approached in their households and interviews usually took from 30 minutes to an hour.

Field research was focused on villages, towns or rural settlements according to the context found in each PA buffer zone. For example, interviews in JSP were mainly applied to local communities living in settlements scattered inside and outside PA boundaries, including areas that were isolated and difficult to reach, while most interviews from LSP were conducted in farms and towns around the PA, including the state capital city.

Data analyses

Results are presented in relative frequencies (%) that were based upon the number of people surveyed in each area and the total number of interviewees for all questions. Analyses were performed to verify which factors were important in defining people's perception of PAs. Two main groups of factors were considered: social aspects (age group, gender, time of residency in the area and occupation) and PA context.

We analysed data with STATISTICA 6. Pearson chi-square tests (notation: χ^2_{df}) applied to all combinations of independent and dependent variables at the $p < 0.05$ significance level. Independent variables were: age group, gender, length of residency in the area, occupation and PA. For analyses, occupations were separated into direct (mainly handicraft making, agriculture and cattle raising) and indirect use of natural resources (mainly tourism-related services). Dependent variables were the answers to the perceptual questions. Answers to open questions were used for qualitative interpretation.

RESULTS

Characteristics of surveyed communities

Mean age was similar among respondents of all PAs, and length of residence was higher in JSP and AFNM (Table 2). The majority of respondents were female, mainly because most men were busy in the field or towns during the day,

Table 3 Respondents' perceptions within each PA and in total (responses to questions in Appendix 1, see Supplementary material at URL http://www.ncl.ac.uk/icef/EC_Supplement.htm). CSP = Cantão State Park; JSP = Jalapão State Park; LSP = Lajeado State Park; AFNM = Árvores Fossilizadas Natural Monument.

Questions	Answer	CSP [n (%)]	JSP [n (%)]	LSP [n (%)]	AFNM [n (%)]	Total [n (%)]
1. Do you know that you live inside/close to a PA?	Yes	61 (85.92)	72 (97.30)	37 (61.67)	55 (78.57)	225 (81.82)
	No	10 (14.08)	2 (2.70)	23 (38.33)	15 (21.43)	50 (18.18)
2. Do you know why it was created?	Yes	29 (40.85)	30 (40.54)	28 (46.67)	18 (25.71)	105 (38.18)
	No	42 (59.15)	44 (59.46)	32 (53.33)	52 (74.29)	170 (61.82)
3. Do you consider the creation of a PA important?	Yes	65 (91.55)	49 (67.12)	48 (80.00)	64 (91.00)	226 (82.18)
	No	6 (8.45)	24 (32.88)	12 (20.00)	6 (9.00)	48 (17.45)
4. Do you think your life conditions were better:	Before PA establishment	4 (5.63)	15 (20.27)	2 (3.33)	2 (2.86)	23 (8.36)
	After PA establishment	10 (14.08)	29 (39.19)	8 (13.33)	30 (42.86)	77 (28.00)
	It has not changed	32 (45.07)	30 (40.54)	28 (46.67)	37 (52.86)	127 (46.18)
	No response	25 (35.21)	0 (0.00)	22 (36.67)	1 (1.42)	48 (17.45)
5. Do you think that the PA influences your life and activities?	Yes (positive)	9 (12.68)	22 (29.73)	10 (16.67)	19 (21.14)	60 (21.82)
	Yes (negative)	4 (5.63)	24 (32.43)	1 (1.67)	4 (5.71)	33 (12.00)
	No	35 (49.30)	17 (22.97)	25 (41.67)	35 (50.00)	112 (40.73)
	No response	23 (32.39)	11 (14.86)	24 (40.00)	12 (17.24)	70 (25.45)
6. How is your relationship with PA staff?	Positive	27 (38.03)	54 (72.97)	13 (21.67)	40 (57.14)	134 (48.73)
	Negative	1 (1.41)	8 (10.81)	6 (10.00)	1 (1.42)	16 (5.82)
	No relationship	43 (60.53)	12 (16.22)	41 (68.33)	29 (41.43)	125 (45.45)

Table 4 Responses to open-ended questions concerning community perceptions of Tocantins PAs. *Respondents may have answered more than one reason to justify their perceptions.

Questions	Open-ended answers (n)*
Do you know why the PA was created? (question 2)	YES: To protect nature (107); to prevent deforestation of riparian forests (14); to avoid general landscape degradation (4); for tourism purposes (4)
Do you consider the creation of a PA important? Why? (question 3)	YES: To protect plants and animals (96); to reduce illegal fires (12); for tourism attraction (11); to support local communities (11); to improve enforcement/policing (10) NO: Because it limits communities' land use and activities (23); it promotes resettlements (6)
Do you think your life conditions were better: (question 4)	Before PA establishment: Limitations on land use (23) After PA establishment: conservation of natural resources (17); improvement of local roads (16); environmental education (4); reduction of anthropogenic fires (7); promotion of tourism (10)
Do you think that the PA influences your life and activities? (question 5)	YES (positive): Improvement in awareness (14); reduction of illegal activities (13) YES (negative): Limitations on land use (32); resettlement perspective (23)
How is your relationship with PA staff? (question 6)	POSITIVE: Suggestion of better land use practices (85); promotion of meetings to discuss local communities' problems (11) NEGATIVE: Contact only occurs during policing and enforcement actions (11)

while women were at home. However, since perceptions were not dependent on gender (all χ^2 results non-significant, over 0.05), this bias has not affected survey results.

Occupation varied substantially among the PAs. JSP presented the highest level of 'direct use' occupations, followed by AFNM, indicating that these communities were significantly more dependent on natural resources than those in CSP and LSP. The short distance between LSP and the capital city of Tocantins state may explain the low percentages

of 'direct use' occupations observed in communities around this park.

Residents' perceptions of PAs

Most respondents knew that they lived inside or adjacent to a PA (Table 3, question 1) and considered its creation important (Table 3, question 3) for conservation and economic purposes (Table 4, question 3), although most of them did not know the

reasons why the PA was created (Table 3, question 2). There were differences in the responses of each PA community for questions one ($\chi^2_3 = 29.59, p = 0.00$) and three ($\chi^2_3 = 21.42, p = 0.00$). People living next to JSP presented the highest level of awareness of the existence of the PA (97%) while LSP had the lowest level (62%). A great majority of people from CSP and AFNM (91%) stated that they considered the creation of a PA important, while this response was observed for only 67% of JSP interviewees.

In general, life conditions had not changed for almost half of the respondents after PA establishment (Table 3, question 4). Limitations on land use were the main reason for recognizing better life conditions before the PA, while conservation issues, tourism and local roads improvement were responsible for improving life conditions after PA creation (Table 4, question 4). Respondents views as to whether better life conditions existed before or after PA establishment varied significantly among PAs (Table 3), being higher for JSP, followed by AFNM. Perceptions also differed among PAs for question five ($\chi^2_8 = 62.26, p = 0.00$), with the proportion of respondents stating that the PA affected their life and activities being highest in JSP followed by AFNM (Table 3). This suggests that the creation of PAs has impacted (positively or negatively) the JSP and AFNM communities more than to those living nearby CSP and LSP.

When asked 'How is your relationship with PA staff?', only 6% of all respondents answered 'negative' stating that contact with PA staff only occurred during policing and enforcement actions (Table 4, question 6). Responses varied substantially among PAs (Table 3), with communities in JSP and LSP perceiving the more negative relationships with PA staff (over 10% of the interviewees), while many respondents (over 60%) did not have any kind of contact with CSP and LSP staff (Table 3, question 6).

Factors influencing PA perceptions

Perceptions were not significantly dependent on age or gender. However, perceptions were related to the respondent's length of residency and occupation. Long-term residents (people who had resided in the PA region for over 20 years) were more likely to acknowledge the existence of a nearby PA ($\chi^2_2 = 11.09, p = 0.04$), recognize better life conditions after PA establishment ($\chi^2_6 = 30.70, p = 0.00$) and consider their relationship with PA staff to be positive ($\chi^2_4 = 32.46, p = 0.00$).

'Direct-use' respondents were more aware that they lived nearby a PA ($\chi^2_1 = 7.80, p = 0.01$), were less likely to consider the creation of PAs as important ($\chi^2_1 = 7.59, p = 0.01$) and stated that the PA affected their lives and activities ($\chi^2_3 = 23.09, p = 0.00$). Answers to all questions (except question two) varied significantly among PAs.

DISCUSSION

PA awareness

There were higher levels of PA awareness in JSP and CSP when compared to LSP and AFNM. Several factors may affect

the degree of knowledge of the PAs among residents, including attendance at meetings, interaction with PA staff, village proximity to PA boundaries, participation in programmes such as community development and education efforts, PA visitation and informal community discussions (Ormsby & Kaplin 2005).

There are two factors that distinguish JSP and CSP from the other studied PAs and may help explain awareness, namely the existence of formal mechanisms of community participation in park management (management councils) and the greater development of tourism and research activities in those areas. Management councils, as previously stated, are one of the most powerful tools to ensure community involvement in PA issues and, even though their functioning is still precarious, they may be responsible for the higher awareness levels and some positive perceptions found in JSP and CSP. Management councils may potentially reduce conflicts and improve people-park relationships. However, to achieve these goals, management councils must represent community diversity and interests and be effectively the main forum for PA decision making. In Tocantins PAs, many management issues are not openly discussed within these councils, with management counsellors being solely informed about the latest developments in the PA and not actively participating in the decision process. Thus, a lack of effective participation in decisions may be interpreted as a major limitation to the effectiveness of PA participatory planning.

Tourism and research are also activities that promote awareness and possibly income generation for local populations. These factors may also contribute to positive perceptions concerning PAs. Tourism has become a major economic driver for JSP communities in the last decade, especially through the production and selling of art and crafts made of *capim-dourado* (*Syngonanthus nitens*), a herbaceous species (Poales: Eriocaulaceae) that is used locally to make purses, hats, bowls and a variety of handicrafts. The traditional use of *S. nitens* was incorporated into integrated conservation-development projects to simultaneously improve local population income and promote grasslands conservation and fire management practices.

In CSP, local residents work as guides and boatmen for tourists, fishers and researchers, most attracted to region owing to the diversity and productivity of aquatic ecosystems in the Araguaia basin.

Awareness may also be owing to the presence of human settlements inside CSP and JSP and the anguish residents feel about this situation, since most of them do not have any kind of formal land tenure and lack clear information on the conduction of the main processes concerning PA establishment and management. One of the respondents from JSP stated that, 'The park is good as long as I do not have to leave my place' (Local resident from JSP, Tocantins, personal communication April 2007, translation). This is a perception that is also expressed in answers given for questions three and five (Table 4), where resettlement issues are presented as reasons for negative attitudes towards PAs.

Most respondents in all PAs did not know why each PA was established in the first place. This seems to be a common trend in other areas (Fiallo & Jacobson 1995; Gillingham & Lee 1999; Ormsby & Kaplin 2005), and may be responsible for erroneous assumptions and negative attitudes towards PAs (Ormsby & Kaplin 2005). The establishment of management councils in AFNM and LSP, and also the implementation of outreach community activities, may help reduce these information gaps and misunderstandings about PAs goals and conservation values.

PA impact on residents' livelihoods

PAs are usually viewed as negatively impacting the livelihoods of local communities through loss of rights, exclusion from natural resources and displacement from traditional lands (Peluso 1993; Adams *et al.* 2004; Cernea & Schmidt-Soltau 2006). Communities whose livelihoods depend on the direct exploitation of local natural resources often come into conflict with PAs (Anthony 2007). However, PAs may also benefit rural inhabitants by providing access to road networks, employment, foreign aid, increasingly scarce ecosystem services and areas of safety during strife (Scherl *et al.* 2004).

In the present study, dependence on natural resources has strongly influenced residents' perception of PAs. In communities living adjacent or inside JSP (where proportions of direct use occupation were extremely high), a higher proportion of respondents stated that the PA negatively affected their life and activities, mainly owing to restrictions on harvesting, cattle raising and agriculture. Traditionally, PA regulations do not allow any kind of direct use activity inside restricted-use PA boundaries. However, as long as communities are still living in these areas, alternative approaches must be found to minimize resource use conflicts and human impacts on natural environments. Such approaches may include the identification of sustainable income opportunities, capacity building and the employment of local residents in conservation and PA management activities.

Conversely, a significant portion of people from JSP and AFNM (39% and 43%, respectively) also recognized better life conditions after PA establishment, maybe because both areas are situated in very poor regions where PA funding and integrated conservation and development projects represent direct and indirect benefits for local communities. This important finding should be better explored to minimize negative perceptions in all PAs, by stressing direct links between PAs and community gains, and also emphasizing non-economic benefits, such as the improvement of communication and health services and better road networks in JSP, or the conservation of the main water sources of Palmas promoted by LSP.

Moreover, several respondents that perceived better life conditions after PA establishment or positive influences from the PA on their lives and activities related it to the improvement in people's awareness concerning biodiversity conservation and a reduction in illegal activities, such as anthropogenic fires and hunting.

Fire is widely used to clear land and encourage new pasture growth, and considered one of the major problems that Brazilian reserves face today. Although the Cerrado is a fire-adapted domain and must burn on a regular basis, uncontrolled fires during the dry season can cause severe damage to its environments, including changes in flora composition, soil impoverishment, depletion of water sources and reduction of populations of some animal species. Illegal fires represent the most significant human impact on Tocantins PAs and may be a good indicator of community awareness and engagement in PA management and conservation.

Hunting is also still a common practice in most Brazilian PAs. Although hunting may be a source of food for some families in Tocantins PAs, in most cases, it represents a cultural habit. Deer, tapirs, wild pigs and armadillos are the main targets, and it is believed that their populations are severely depleted by decades of hunting in some of these areas (SEPLAN 2003).

Any strategy to reduce these impacts must include prevention actions (such as firebreaks) and continuous outreach activities. Management and communication initiatives should explore the finding that some local residents perceived the positive benefits that PAs promotes as reducing human impacts on biodiversity.

Perceptions and length of residency

Length of residency also apparently influenced local communities' perceptions of PAs. Newmark *et al.* (1993) suggested that long-term residents are probably more likely to have been adversely affected by PA establishment than short-term inhabitants. However, we identified higher proportions of positive perceptions among long-term residents (>20 years), especially related to staff interactions and better life conditions after PA establishment. Long-term residents lived in these areas when they were pristine and isolated from urban centres, without any infrastructure, transport or other facilities. Therefore, they tended to be more aware of some of the positive impacts of PA establishment, including health, education and transport services. Moreover, while short-term residents apparently do not show strong attachments to the area, long-term residents tend to know, value and even have an affectionate relationship with local wildlife and natural environments, favouring support for PA conservation goals.

Relationship with PA staff

The great majority of the respondents from LSP and CSP did not have any kind of contact with PA staff, while 10% of those in JSP and LSP stated they had negative relations with PA staff. Although proportions of negative perceptions may be considered modest, lack of contact or solely negative interactions between PA staff and local residents should be avoided, as this has been responsible for creating conflict and widening people-park splits in different

Table 5 Recommended strategies and actions to improve people-park relations in Tocantins PAs.

<i>PA</i>	<i>Strategies</i>	<i>Actions</i>
LSP and AFNM	Raise levels of PA awareness	Establish management councils Develop formal awareness and communication programmes Support community meetings and informal events
JSP	Reduce negative perceptions due to PA impact on resource-dependent stakeholders	Identify opportunities and support community development projects Promote capacity building Prioritize local residents to occupy PA job postings Emphasize PAs non-economic benefits Stress direct links between PAs and community benefits
CSP and JSP	Prevent conflicts during resettlement	Provide technical and economical feasible resettlement alternatives Provide full compensation for losses of assets Implement participatory resettlement planning
JSP and LSP	Improve relationship with PA staff	Develop environmental education and outreach programmes provided by PA staff Plan different strategies of regular non-enforcement interactions with local community
All PAs	Improve PA perceptions on short-term residents	Develop outreach programmes for younger generations Engage recent residents in PA management and community meetings
All PAs	Improve knowledge on PA goals and establishment reasons	Implement awareness and communication programmes to reduce this knowledge gap Encourage community participation in PA planning and management

studies (Newmark *et al.* 1993; Fiallo & Jacobson 1995; Ormsby & Kaplin 2005; Allendorf 2006). A continuous environmental education programme and regular outreach activities are essential to reduce this lack of interaction between local people and PA staff. It also importantly reduces negative perceptions owing to misunderstanding of the PA staff's role and poor understanding of PA limits, rules and natural values.

Suggesting better land-use practices (such as fire management, sustainable agriculture and water use) and promoting meetings to discuss local communities' problems were identified as the main activities developed by staff from Tocantins PAs. In AFNM, one of the respondents stated that, 'After the establishment of the Natural Monument, children are being involved in environmental programmes, we are getting more information about the area and the illegal extraction of fossils has been significantly reduced' (Local resident from AFNM, Tocantins, personal communication July 2007, translation). This is an important example of how education and public relations programmes may serve to improve people-park interactions and reduce PA impacts, complementing enforcement activities.

Resettlement issues

Although we did not directly investigate resettlement issues, they were raised by several interviewees from JSP and CSP, indicating that resettlement is an important factor influencing attitudes and perceptions towards these PAs. Compulsory

displacements and compensation initiatives have failed time and again to solve conflicts between reserves and local communities and have created greater impoverishment and negative attitudes towards PAs, especially when resulting from a top-down non-participatory approach (Cernea & Schmidt-Soltau 2006).

In JSP, Tocantins government and non-governmental organizations conducted a survey during 2007 to discuss and propose alternatives to resettlement and possible PA boundary changes to ensure community permanence in some areas. The study involved the local communities and has thus generated great expectations among residents. However, to date a consensual solution has not been achieved and mistrust and communication gaps exist concerning how final decisions will be made and instigated by the state government.

Some successful examples, such as the resettlement process in Grande Sertão Veredas National Park, another reserve in the Brazilian Cerrado, could be used as reference for Tocantins PAs. In this area, local residents participated in the relocation process, which lasted for 10 years and resulted in the designation of formal ownership of the land for local families relocated outside PA boundaries.

CONCLUSIONS

Residents' perceptions of PAs in Tocantins state were generally positive or neutral, despite modest community engagement in PA management and related benefits, and

the persistence of conflicts regarding natural resources exploitation and settlements inside PAs.

Although surveyed areas present several similarities (political jurisdiction, ecosystem types, establishment period and management institution), local people's relationships were remarkably distinct among PAs. This suggests that characteristics such as area, management goals, history and community aspects may have been responsible for shaping people-park relations in a very complex and singular way, reinforcing the need to understand each site-community context before the design and implementation of conservation-development projects.

Based on our findings and discussions with PA staff and residents, we propose some strategies and actions to improve people-park relations in Tocantins PAs (Table 5). Outreach programmes and formal mechanisms of community engagement should be implemented in order to achieve better PA awareness among local people, especially in LSP and AFNM (Table 5), and improve communication between residents and PAs, generally hampered both by lack of trust and the social and cultural differences between staff and local communities (Hough 1988). To reduce negative perceptions of resource-dependent stakeholders from JSP, several actions may be implemented, such as employment benefits, local capacity building and sustainable development projects (Table 5). Direct links between PAs and community benefits should be emphasized, especially non-economic benefits, which may depend less on outside intervention and may be more effective in strengthening the relationship between residents and PAs over the long term (Infield 2001; Kuriyan 2002; Bauer 2003; Allendorf 2007). We suggest that formal programmes and regular interaction with local people may improve relationships with PA staff in JSP, LSP and CSP. Finally, in Tocantins state PAs that still have settlements inside their boundaries, community relocation and compensation must occur through a careful participatory process, in order to avoid significant changes in local perceptions and attitudes towards PAs (Table 5).

Our findings may also guide PA establishment and management policies in the Cerrado. Results from Tocantins PAs demonstrate that management must address local residents' concerns, and community issues should be effectively integrated into management strategies. Higher levels of participatory planning may enhance local support for PA biodiversity conservation goals and reduce widely distributed conflicts between people and PAs in the Cerrado, such as low levels of awareness, poor community participation and misunderstanding of PA boundaries and regulations.

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References

- Adams, W.M., Aveling, R., Brockington, D., Dickson, B., Elliott, J., Hutton, J., Roe, D., Vira, B. & Wolmer, W. (2004) Biodiversity conservation and the eradication of poverty. *Science* **306**(5699): 1146–1149.
- Allendorf, T., Swe, K.K., Htut, T.O.Y., Aung, M., Allendorf, K., Hayek, L., Leimgruber, P. & Wemmer, C. (2006) Community attitudes toward three PAs in Upper Myanmar (Burma). *Environmental Conservation* **33**(4): 344–352.
- Allendorf, T. (2007) Residents' attitudes toward three PAs in southwestern Nepal. *Biodiversity and Conservation* **16**: 2087–2102.
- Anthony, B. (2007) The dual nature of parks: attitudes of neighbouring communities towards Kruger National Park, South Africa. *Environmental Conservation* **34**(3): 236–245.
- Balmford, A., Bruner, A., Cooper, P., Costanza, R., Farber, S., Green, R.E., Jenkins, M., Jefferiss, P., Jessamy, V., Madden, J., Munro, K., Myers, N., Naem, S., Paavola, J., Rayment, M., Rosendo, S., Roughgarden, J., Trumper, K. & Turner, R.K. (2002) Economic reasons for conserving wild nature. *Science* **297**: 950–953.
- Bauer, H. (2003) Local perceptions of Waza National Park, northern Cameroon. *Environmental Conservation* **30**(2): 175–181.
- Brandon, K.E. & Wells, M. (1992) Planning for people and parks: design dilemmas. *World Development* **20**: 557–570.
- Cernea, M.M. & Schmidt-Soltau, K. (2006) Poverty risks and national parks: policy issues in conservation and resettlement. *World Development* **34**(10): 1808–1830.
- Dias-Brito, D., Rohn, R., Castro, J.C., Dias, R.R. & Rössler, R. (2007) The Northern Tocantins petrified forest, state of Tocantins. The most luxuriant and important Permian tropical-subtropical floristic record in the Southern Hemisphere. In: *Geological and Palaeontological Sites of Brazil*, ed. M. Winge, C. Schobbenhaus, M. Berbert-Born, E.T. Queiroz, D.A. Campos, C.R.G. Souza & A.C.S. Fernandes, SIGEP 104, pp. 1–15 [www document]. URL <http://www.unb.br/ig/sigep/sitio104/sitio104english.pdf>
- Fiallo, E.A. & Jacobson, S.K. (1995) Local communities and PAs: attitudes of rural residents towards conservation and Machalilla National Park, Ecuador. *Environmental Conservation* **22**(3): 241–249.
- Gillingham, S. & Lee, P.C. (1999) The impact of wildlife-related benefits on the conservation attitudes of local people around the Selous Game Reserve, Tanzania. *Environmental Conservation* **26**: 218–228.
- Heinen, J.T. (1993) Park-people relations in Kosi Tappu Wildlife Reserve, Nepal: a socio-economic analysis. *Environmental Conservation* **20**(2): 25–34.
- Heinen, J.T. (1996) Human behaviour, incentives and PA management. *Conservation Biology* **10**: 681–684.
- Hough, J.L. (1988) Obstacles to effective management of conflicts between national parks and surrounding human communities in developing countries. *Environmental Conservation* **15**(2): 129–136.
- IBGE (2000) Censo demográfico 2000: resultados do universo por municípios. IBGE, Brazil [www document]. URL http://www.ibge.gov.br/home/estatistica/populacao/default_censo_2000.shtm

- IBGE (2007) Contagem da população: 2007. IBGE, Brazil [www document]. URL <http://www.ibge.gov.br/home/estatistica/populacao/contagem2007/default.shtm>
- Infield, M. (1988) Attitudes of a rural community towards conservation and a local conservation area in Natal, South Africa. *Biological Conservation* **45**: 21–46.
- Infield, M. (2001) Cultural values: a forgotten strategy for building community support for protected areas in Africa. *Conservation Biology* **15**: 800–802.
- Ite, U. (1996) Community perceptions of the Cross River National Park, Nigeria. *Environmental Conservation* **23**: 351–357.
- Klink, C.A. & Machado, R.B. (2005) Conservation of the Brazilian Cerrado. *Conservation Biology* **19**: 707–713.
- Kuriyan, R. (2002) Linking local perceptions of elephants and conservation: Samburu pastoralists in Northern Kenya. *Society and Natural Resources* **15**: 949–957.
- Machado, R.B., Neto, M.B.R., Pereira, P.G.P., Caldas, E.F., Gonçalves, D.A., Santos, N.S., Tabor, K. & Steininger, M. (2004) *Estimativas de perda da área do Cerrado brasileiro*. Conservation International, Brasília, DF, Brasil. 25 pp. [www document]. URL <http://www.conservation.org.br/RelatDesmatamCerrado.pdf>
- Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B. & Kent, J. (2000) Biodiversity hotspots for conservation priorities. *Nature* **403**: 853–858.
- Naughton-Treves, L., Alvares-Berrios, N., Brandon, K., Bruner, A., Holland, M., Ponce, C., Saenz, M., Suarez, L., & Treves, A. (2006) Expanding PAs and incorporating human resource use: a study of 15 forest parks in Ecuador and Peru. *Sustainability: Science, Practice, and Policy* **2**(2): 32–44.
- Newmark, W.D., Leonard, N.L., Sariko, H.I. & Gamassa, D.-G.M. (1993) Conservation attitudes of local people living adjacent to five PAs in Tanzania. *Biological Conservation* **63**: 177–183.
- Oliveira, P.S. & Marquis, R.J. (2002) *The Cerrados of Brazil*. New York, NY, USA: Columbia University Press.
- Oliveira-Filho, A.T. & Ratter, J.A. (2002) Vegetation physiognomies and woody flora of the Cerrado biome. In: *The Cerrados of Brazil*, ed. P.S. Oliveira & R.J. Marquis, pp. 91–120. New York, NY, USA: Columbia University Press.
- Ormsby, A. & Kaplin, B.A. (2005) A framework for understanding community resident perceptions of Masoala National Park, Madagascar. *Environmental Conservation* **32**(2): 156–164.
- Peluso, N.L. (1993) Coercing conservation: the politics of state resource control. *Global Environmental Change* **3**(2): 199–218.
- Pimm, S.L., Russell, G.J., Gittleman, J.L. & Brooks, T.M. (1995) The future of biodiversity. *Science* **269**: 347–350.
- Rodrigues, A.S.L., Akcakaya, H.R., Andelman, S.J., Bakarr, M.I., Boitani, L., Brooks, T.M., Chanson, J.S., Fishpool, L.D.C., da Fonseca, G.A.B., Gaston, K.J., Hoffmann, M., Marquet, P.A., Pilgrim, J.D., Pressey, R.L., Schipper, J., Sechrest, W., Stuart, S.N., Underhill, L.G., Waller, R.W., Watts, M.E.J. & Yan, X. (2004) Global gap analysis: priority regions for expanding the global protected-area network. *BioScience* **54**: 1092–1100.
- Scherl, L.M., Wilson, A., Wild, R., Blockhus, J., Franks, P., McNeely, J.A. & McShane, T.O. (2004) *Can PAs Contribute to Poverty Reduction? Opportunities and Limitations*. Gland, Switzerland: IUCN.
- Schmidt, I.B., Figueiredo, I.B. & Scariot, A. (2007) Ethnobotany and effects of harvesting on the population ecology of *Syngonanthus nitens* (Bong.) Ruhland (Eriocaulaceae), a NTFP from Jalapão Region, Central Brazil. *Economic Botany* **61**(1): 73–85.
- SEPLAN (2003) Plano de Manejo do Parque Estadual do Jalapão. Palmas, TO, Brazil [www document]. URL <http://central2.to.gov.br/arquivo/24/48>
- da Silva, J.M.C. & Bates, J.M. (2002) Biogeographic patterns and conservation in the South American Cerrado: a tropical savanna hotspot. *BioScience* **52**: 225–234.
- Walpole, M. & Goodwin, H. (2001) Local attitudes towards conservation and tourism around Komodo National Park, Indonesia. *Environmental Conservation* **28**: 160–166.
- West, P., Igoe, J. & Brockington, D. (2006) Parks and peoples: the social impact of protected areas. *Annual Review of Anthropology* **35**: 251–277.
- Wittemyer, G., Elsen, P., Bean, W.T., Coleman, A., Burton, O. & Brashares, J.S. (2008) Accelerated human population growth at PA edges. *Science* **321**: 123–126.