SPECTACLED *(Caiman crocodilus)* AND BLACK CAIMAN (*Melanosuchus niger*) POPULATIONS IN THE ABUFARI BIOLOGICAL RESERVE, AMAZONAS, BRAZIL

POPULAÇÕES DE JACARÉTINGA (*Caiman crocodilus*) E JACARÉ AÇÚ (*Melanosuchus niger*) NA RESERVA BIOLÓGICA DO ABUFARI, AMAZONAS, BRASIL

POBLACIONES DE BABILLAS (*Caiman crocodilus*) Y CAIMÁN NEGRO (*Melanosuchus niger*) EN LA RESERVA BIOLÓGICA DEL ABUFARI, AMAZONAS, BRASIL

PANTOJA-LIMA, JACKSON[1*] Mestre, REBÊLO, GEORGE HENRIQUE[1] Doutor, PEZZUTI, JUAREZ CARLOS BRITO[2] Doutor.

[1] Coordenação de Pesquisas em Ecologia, Laboratório de Manejo de Fauna, Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, Brasil. [2] Universidade Federal do Pará, Núcleo de Altos Estudos Amazônicos, Brasil.
*Correspondência: jacksonpantoja@yahoo.com.br

Resumen

En el presente estudio fueran investigadas la densidad, tallas de la población y la utilización de los ambientes por *Melanosuchus niger* y *Caiman crocodilus* en la Reserva Biológica de Abufari, situada en el bajo río Purus. El estudio fue desarrollado en septiembre de los años 2001 y 2003. Fueran observados 1.217 caimanes, donde *M. niger* y *C. crocodilus* corresponden al 76% y al 24%, respectivamente. Durante el estudio fueran investigados 33,3 km de margen del rio Purus y 28,3 km de margen en los lagos e tributarios. La abundancia relativa de caimanes observada en el año 2001 (24 caimanes /km) fueran mucho mayores que las del año 2003 (17 caimanes/km), pero las diferencias no fueran estadísticamente significativas. Los datos muestran que tanto la población de caimán negro como la población de los babas están compuestas por individuos de tallas grandes. Muchos *M. niger* y *C. crocodilus* observados estaban por encima de la menor talla reproductiva 30,85% y 27,73%, respectivamente. Las distribuciones de caimanes en los ambientes fueran basadas en dados de distribución y abundancia que mostraron tres agrupamientos, siendo uno de estos predominantemente ocupado por caimán negro (*M. niger*), otro tanto por caimán negro como por baba (*C. crocodilus*) e un tercero donde predominaban el baba (*C. crocodilus*). La interacción hombre-caimán medida por el índice de disturbación, que fue mayor en los ríos y áreas próximas a las comunidades ribereñas do que nos canales de pequeños riachos, playas y áreas remotas. Investigaciones posteriores son necesarias, porque permitirán de una forma más precisa una mejor evaluación de las proporciones sexuales y permitirán también identificar los ambientes importantes para la reproducción de estas dos especies de caimanes. Además, es importante incluir las comunidades ribereñas en el proceso de investigación, conservación y uso sostenible del recurso.

Palabras clave: caimán, abundancia relativa, índice de perturbación.

Abstract

Caiman population studies were carried out during the 2001 and 2003 dry seasons at the Abufari Biological Reserve (ABR), situated in lower Purus river, at 450 km Southwest of Manaus, to assess the distribution and abundance of caimans along different habitats. The Purus River is a white-water river, which during wet season is continuous with the floodplain (complex riparian streams and lake habitats). Spotlight surveys for counting caimans covered 33.3 km of the Purus River, and 28.3 km of lakes and tributaries. Of the 1,217 caimans counted, 872 were identified on the species level (76% black caiman, 24% spectacled caiman). The relative abundance of caimans observed in 2001 was higher than in 2003, but this difference was not significant. One third of the caimans observed were above minimum reproductive size. The caiman distribution based on distribution and abundance is described by three clusters that correspond to habitats where there is high biomass (*M. niger*), intermediate biomass (*M. niger* and *C*. *crocodilus*), and low biomass (*C*. *crocodiles*). Human-caiman interactions measured by the disturbance index were higher on the main river and in the neighborhood of settlements than in stream channels, beaches and remote areas. However, the caiman populations in the lower Purus River were notable in that black caiman abundance was higher when compared with other Amazon studies. Further studies on caiman population are necessary to evaluate the sex ratio and mainly the reproductive sites of these species. It is also important to insert the local community in conservation research programs of caimans in such a way as to promote sustainable use.

Key words: Caimans, population density, disturbance index.

Resumo

No presente estudo foram avaliadas a densidade, estrutura populacional e utilização de habitats por *Melanosuchus niger* e *Caiman crocodilus* na Reserva Biológica do Abufari, situada no baixo rio Purus. O estudo foi realizado em setembro de 2001 e 2003. Foram observados 1217 jacarés, *M. niger* e *C. crocodilus* representam 76% e 24%, respectivamente, do total de animais observados. Durante o estudo foram percorridos 33,3 km de margens do rio Purus e 28,3 km de margens em lagos e tributários. Densidade total de jacarés observada em 2001 (24 jacares/km) foi maior que a 2003 (17 jacarés/km), mas a diferença não foi significativa estatisticamente. Os dados preliminares mostram uma população composta por indivíduos de porte elevado. Muitos *M. niger* e *C. crocodilus* observados estavam acima do tamanho mínimo reprodutivo 30,85% e 27,73%, respectivamente. As distribuições de crocodilianos nos diferentes ambientes foram avaliadas a partir de dados de distribuição e abundância que mostraram a existência de três agrupamentos, sendo um deles ocupado predominantemente por jacaré-açú (*M. niger*), outro por duas espécies, o jacaré-tinga (*C. crocodilus*) e jacaré-açú e um terceiro agrupamento onde predominava o jacaré-tinga. A interação homem-crocodiliano foi medida pelo índice de distúrbio, o qual foi maior nos rios e áreas próximas das comunidades ribeirinhas do que nos canais de igarapés, praias e áreas remotas. Estudos posteriores são necessários para avaliar de forma mais precisa a estrutura populacional, razão sexual e identificar os habitats importantes para a reprodução

destas espécies no baixo rio Purus. Além disso, é importante inserir as comunidades ribeirinhas no processo de pesquisa, conservação e uso sustentável do recurso.

Palavras chave: jacarés, densidade populacional, índice de perturbação.

Introduction

There are 22 existing species of crocodiles and alligators in the world, with 17 considered endangered (GROOMBRIDGE, 1987). Six species of caimans belonging to the family Alligatoridae occur in Brazil, with five of those occurring in the Amazon floodplain (MEDEM, 1983; MAGNUNSON, 1992; CAMPOS 2003; RUEDA-ALMONACID *et al*. 2007). The well-preserved environment of the Purus River is home to at least four species of Amazon caimans, namely the black caiman (*Melanosuchus niger* SPIX 1825), spectacled caiman (*Caiman crocodilus* LINNAEUS 1758), Cuvier's dwarf caiman or Cuvier's smooth-fronted caiman (*Paleosuchus palpebrosus* CUVIER 1807), and Schneider's dwarf caiman (*P. trigonatus* SCHNEIDER 1801).

FARIAS *et al*. (2004) reported that uncontrolled commercial hunting for their hides has relegated the black caiman and the spectacled caiman to islands of residual populations in parts of their former distributions. Millions of skins of these two commercially valuable crocodilian species were harvested from the 1930s onward by foreign trading companies, resulting in a precipitous decline, particularly of *M. niger*, throughout the Amazon Basin (MEDEM, 1983; REBÊLO and MAGNUSSON, 1983).

All species are protected by Brazilian law since 1967 and commercial hunting was prohibited. Illegal hunting for skins ceased in the 1990's, when the market was saturated by skins from farming and ranching, as the dealers stopped buying skins from wild stocks. However, illegal caiman hunting for meat continues throughout the Amazon to supply a regional and border market. The purpose of this study is to identify the status of the caiman population in the Abufari Biological Reserve (ABR), which in the past suffered from commercial hunting, but today is an integral protection area of the Brazilian government.

Material and methods

Study area

Population studies were carried out during the 2001 and 2003 dry seasons (September) at the Abufari Biological Reserve (ABR) (Fig.1, 2), situated 450 km Southwest of Manaus (04º52'-5º29'S, 62º46'-63º20'W) to assess the distribution and relative abundance of caimans along different habitats.

The ABR was established in 1982 (Act nº 87.585) especially to preserve nesting beaches for the Giant River Turtle *Podocnemis expansa*. The Purus is a white-water (muddy) river that during the wet season is a flood plain. The annual water level variation is 12-14 m. The wet season is from December to June and the dry season is from July to November.

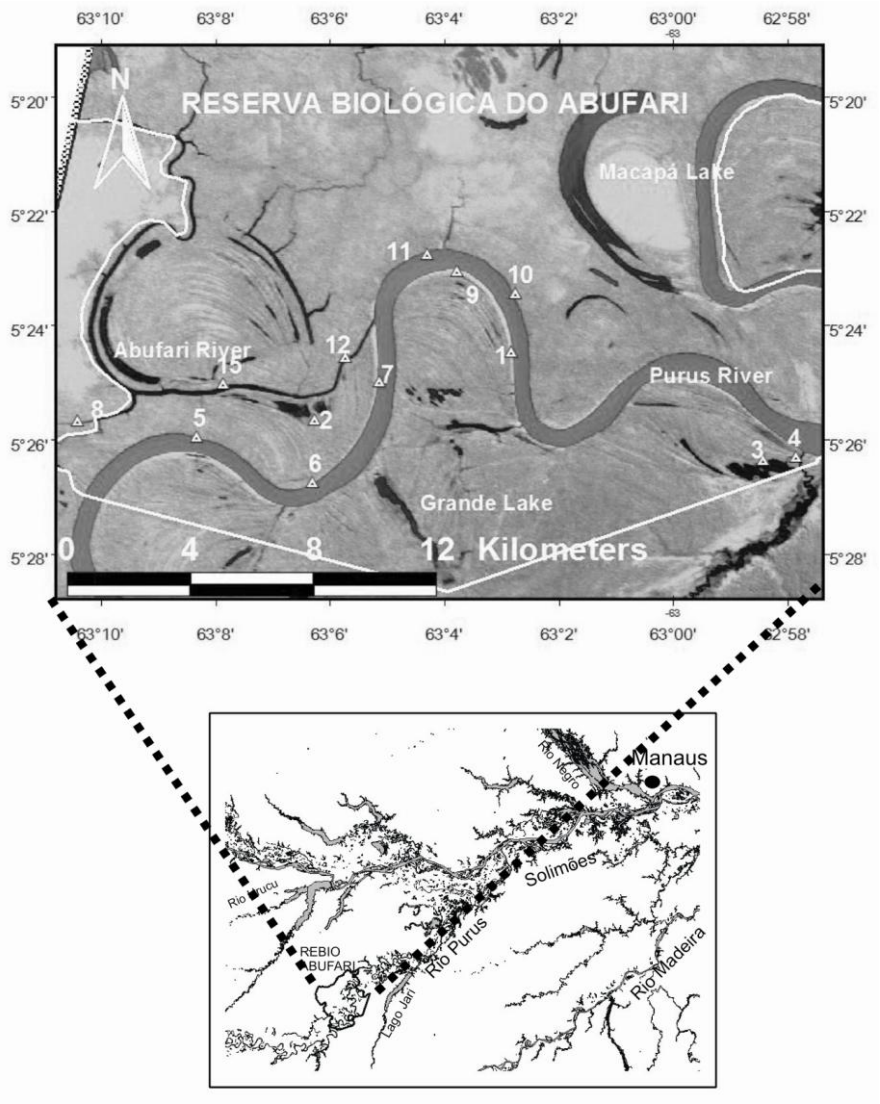

Figure 1. Surveys and habitats of the Abufari Biological Reserve. Riverbank habitats (5, 10, 11), river beach habitats (6=13, 9), Slopes of beach (1, 7= 14) stream habitats (8, 4), lake habitats (2, 3), Abufari River channel (12) and Abufari mouth (white dot). Survey number legend as Table 1, but counts 12 and 15 sites combined form 16 in Table 1).

Sampling

Nocturnal spotlight surveys were performed in open lakes, open rivers/banks, open streams, closed streams, river channels, beach slopes, and beaches along rivers, using aluminum boats (6 m) with 15-40 HP outboard engines as the only platform, at

a maximum velocity of 10 km/ hour. We used a GPS Garmim 12 receiver to register the site and to assess tracks.

The human impact was evaluated by comparing abundance of caimans between less and more disturbed areas (as REBÊLO and LUGLI, 2001). The Purus River and Tauamiri Lake, which are accessible to local inhabitants, were considered as more disturbed areas. Capitari Lake, Jacaré Stream, the Abufari River channel, and Abufari Beach and adjacent areas were considered as less disturbed areas, because of the low human influence in this area, according to KEMENES and PANTOJA-LIMA (2006). A number of unidentified caimans (proportion of eyes = wariness) were used to assess the human disturbance of the caiman populations, a disturbance index based on a presumed behavioral change (RON *et al*., 1998).

The habitats used by caimans and their microhabitats were identified. For every caiman sighted, we assigned one of seven microhabitat classifications designated as: riverbank; beach; lake; river; slope of beach; stream-lake; and stream combined with position in (W) water; (L) land; (S) sand; (A) river.

We used a matrix of quantitative measures of specie-relative abundance (surveys as columns and species as rows) to identify species correlations, and Cluster Analysis to examine crocodilian assemblage structure. The data of species relative abundances matrix were added to a constant (0.01) and were natural log-transformed. The distance measured used was Euclidian and the group linkage method was Ward.

Results

We covered 33.3 km in three areas at the main channel: (i) the banks of the Purus River (2001, 2003), (ii) Abufari Beach (2001, 2003) and (iii) slope of beaches along the Purus River (2001, 2003). We also covered 28.3 km of lakes and tributaries (iv) Jacaré Stream and Capitari Lake (2001), Abufari River and their tributaries (2001, 2003), and (v) Tauamirim Lake and the channel that linked this lake at the Tauamirim Stream (2001).

We counted 1.217 caimans, of which 872 individuals were identified at species level, 76% were black and 24% spectacled caimans (Table 1). The overall relative abundance (*i.e.* both species combined) observed in 2001 (24 caimans/km) was greater than in 2003 (17 caimans/km), but this difference was not significant ($t_{0.05(2),\ 14}$ = 0.5502, p=0.591). In only two surveys fewer than 08 caimans/km were observed. The black caiman relative abundance in 2003 (mean 14 caiman/km) was higher than in 2001 (9 caiman/km), but this difference was not significant ($t_{0.05(2),\ 14}$ = -1.059, p=0.307). On the other hand, the relative abundance of spectacled caiman observed in 2001 (7 caiman/km), was higher than in 2003 (2 caimans/km), but this difference was also not significant ($t_{0.05(2),\ 14}$ =1.184, p=0.256).

In Jacaré Stream a higher overall caiman relative abundance (90 caiman/km) was observed. The lakes exhibited intermediary abundance (29-30 caiman/km), and the main river sites, lower abundances: beaches (10-12 caiman/km), slopes of beach (13 caiman/km), the banks of the Purus River (6-13 caimans/km).

Table 1. Dry season surveys of caimans in the Abufari Biological Reserve in 2001 and 2003.

Cod.	Surveys	Habitat Type	Dates	H	km	Caimans/km		Eyes	Total	Hatchlings	
						MN	CC			Pods	Count
1	Abufari mouth at Jacaré mouth*	River/ Stream	Set,16,01	01:08	6.4	17.79	2.20	1.42	21.41		
2	Capitari Lake*	Lake	Set,16,01	00:30	1.5	0.67	28.67	0.00	29.33		
3	Tauamirim Lake**	Lake	Set,17,01	01:43	5.4	1.67	5.37	22.59	29.63	1	3
4	Tauamirim Stream at Lake**	Stream/lake	Set,17,01	00:06	0.5	3.70	1.85	1.85	7.41		
5	Camaleão Beach at Linda Vista Beach**	River/bank	Set,19,01	01:16	7.6	2.37	0.53	3.29	6.18		
6	Linda Vista Beach**	Beach	Set,19,01	00:07	1.0	2.00	6.00	5.00	13.00		
7	Linda Vista slope of beach at Abufari mouth**	Slope of beach	Set,19,01	00:52	5.3	6.04	2.45	4.91	13.40		
8	Jacaré Stream*	Stream	Set,20,01	01:28	2.6	33.18	18.69	38.52	90.39		
9	Abufari Beach*	Beach	Set,27,01	01:00	3.5	8.29	1.43	2.00	11.71		
10	Bem-Ti-Vi/Abufari Beach*	River/bank	Set,27,01	01:07	4.0	12.00	0.50	0.25	12.75		
11	Purus River/ Left Shoreline **	River/bank	Set,08,03	01:10	5.6	7.14	0.89	3.04	11.07		
12	Abufari River/channel**	River/Stream	Set,09,03	01:20	3.9	21.54	2.82	3.59	27.95	1	2
13	Linda Vista Beach**	Beach	Set,10,03	07:00	1.0	7.00	1.00	2.00	10.00		
14	Linda Vista slope of beach/Abufari mouth*	Slope of beach	Set,10,03	01:30	5.3	11.32	1.13	0.75	13.21		
15	Abufari River*	River/Stream	Set,10,03	00:39	5.4	14.81	0.19	1.85	16.85		
16	Jacaré Stream*	Stream	Set,10,03	00:55	2.6	20.21	6.48	0.38	27.08		

H: duration of observation period, CC: *Caiman crocodilus*, MN: *Melanosuchus niger*. * less disturbed localities, ** more disturbed localities.

Many of the black and spectacled caimans observed were above the minimum reproductive size, 30.85% and 27.73%, respectively (Fig. 2). We observed that total length estimated for the two species in both years remained similar, but the difference was not tested because it is possible that some of the animals observed in 2001 may be those found again in 2003.Most of the spectacled caimans were sighted in streams (47%) and lake margins (21%). They were sighted on sandbanks of beaches, while black caimans were not. Black caimans were frequent in the Abufari River channel (32%), streams (25%), riverbanks (18%) and slopes of beaches (17%) (Fig. 3). From the cluster analysis, three clusters recovered the patterns of distribution and relative abundance of caimans at ABR (Fig. 4). The first (Cluster A) included surveys with a large abundance of black caimans. The second (Cluster B) included the surveys with similar abundances of spectacled and black caiman. The

third (Cluster C) included the surveys at Tauamirim and Capitari Lakes and the Linda Vista Beach, where the spectacled caiman is more abundant.

The disturbance indexes (DI) were higher in more disturbed localities (36±20%) than in little disturbed areas (11±14%); the difference was significant ($t_{0.05(2),14}$ = -2.906, p = 0.0115) (Fig. 5). The high proportion of eyes observed in the Tauamirim Lake, in the neighborhood of the Tauamirim community, could be attributed to the regular traffic of regional ships, fishing floats, and the highly active of trade of manufactured and extractive products.

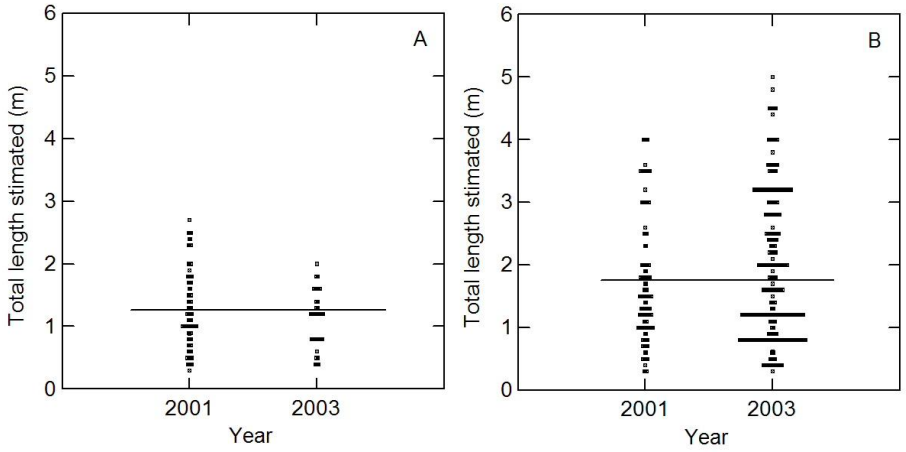

Figure 2. Distribution of length of (A) *C. crocodilus* (N=137) and (B) *M. niger* (N=551) determined per survey nights using spotlight in Abufari Biological Reserve. Horizontal lines indicate the minimum length of adult females.

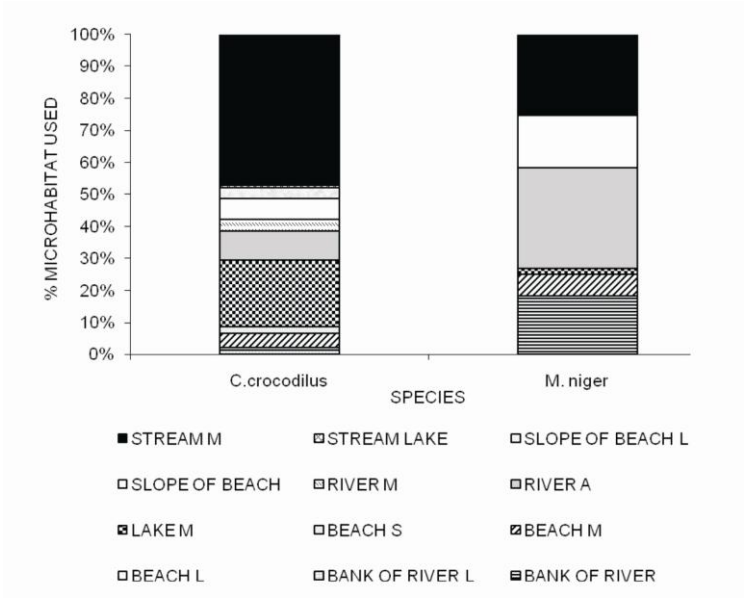

Figure 3. Microhabitats used by caimans in the Abufari Biological Reserve. Codes: (W) water; (L) land; (S) sand; (A) Abufari river.

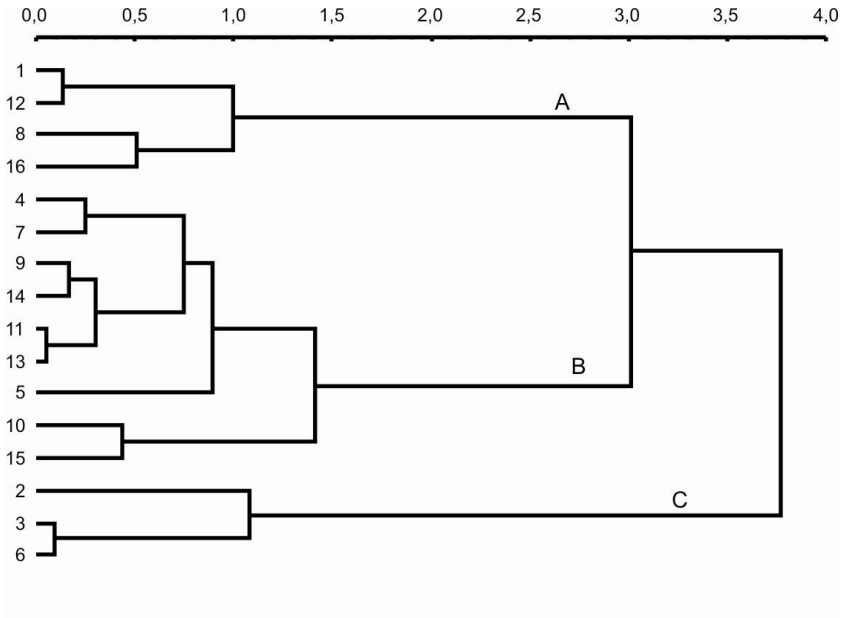

Figure 4. Cluster analysis of surveys of caimans of the Abufari Biological Reserve, based on the relative abundance data of Table 1. Distance measure was Euclidian and group linkage method was Ward. Cluster A: composed mainly of *Melanosuchus niger* set; B: surveys composed of *Caiman crocodilus* and *M. niger*; C: surveys composed mainly *Caiman crocodilus*. Survey number legend as Table 1.

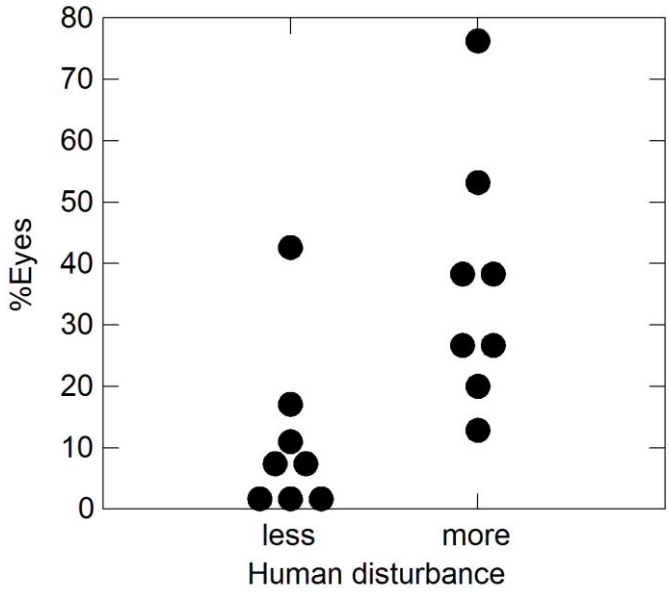

Figure 5. The proportion of eyes of caimans observed in the Abufari Biological Reserve in localities less and more human disturbanced.

Discussion

Despite the small area covered in this study, we concluded that caimans concentrate in large numbers along rivers, channels and lakes during the dry season, when water levels are low. In ABR the population of black caimans is large and the measured abundance is high, when compared to other studies in the Amazon (e.g. BRAZAITIS

et al., 1990; BRAZAITIS *et al*., 1996, DA SILVEIRA *et al.,* 1997; DA SILVEIRA and THORBJARNARSON, 1999; REBÊLO and LUGLI, 2001). Despite the high abundance of caimans, the history of local use, and the presence of many human communities within the reserve, the resources cannot be directly managed locally, except for subsistence (the Biological Reserve is a strict natural reserve/wilderness area, which is managed mainly for science and wilderness protection). However, in close proximity to ABR, the Piagaçú-Purus Sustainable Development Reserve (PPSDR) was created, which is a protected resource area that is managed mainly for the sustainable use of natural ecosystems.

Today the lower Purus Region is responsible for most of the illegal market of caiman meat in the world, and the small size of the individuals suggest that the caiman populations of this area seem to suffer over-hunting (MARIONE *et al.,* 2007) The Piagaçu-Purus Sustainable Development Reserve (PP-SDR) is situated between the Solimões (Amazon) and Purus Rivers and is the origin of many of the caiman that are involved in an extensive network of illegal trade (DA SILVEIRA, 2003), with an estimate of at least 50 tons of dried-salted caiman meat being traded from the area (MARIONI *et al*., 2006). The hunting monitoring program created in PPSDR showed that illegal trade of caiman meat in the region suggests that more than 60% of the harvested caimans were hunted in the northern sector of the PP-SDR (MARIONE *et al*., 2007). It is on some lakes from this region where MARIONE *et al.* (2007) realized surveys and found the highest relative abundance of caimans over a 2-year period, but the caimans densities still are less than those in ABR.

With regards to the structure of population, the size of the black and spectacled caimans observed in the ABR suggests that both populations are made up of many adults and juveniles. Both species have estimates of minimum reproductive length. ROSS (1989) suggest which females of *C. crocodiles* reach sexual maturity at around at 1.2m and obtain a total length of 1.4m, and the males reach 2.8m of maximum length. However, DA SILVEIRA (2001) reports one reproductive female with a total length of 1.0m that the author believes to have had an age of 5.5 years. In Suriname, OUBOTER and NANHOE (1984) observed that this length could be reached by females at around 4.5 years of age. According to DA SILVEIRA (2001) the males of *Melanosuchus niger* could reach 6.0m of total length, but the female do not grow to a length of more than three meters. Data on reproductive length of *M. niger* are rare. Some authors suggest that this length could be around 1.85m and that the mean length of mature females is 2.5m (THORBJARNARSON, 1996; ROSS, 1998).

In this study the proportion of eyes in the more- and less-disturbed localities in this study is similar to those found by REBÊLO and LUGLI (2001) in areas with higher human interference in the Jaú National Park (around 40%) but diverges from those found in less disturbed localities in the JNP. According to RON *et al*. (1998), behavior wariness tends to increase in sites with high disturbance factors, caused by hunting; nocturnal surveys with spotlights; and an increase in boat traffic in this region. DA

SILVEIRA *et al*. (2008) observed that in Mamirauá Sustainable Development Reserve the level of the Amazon River and lunar cycle explain the 91% and 73% variation in the number of *Melanosuchus niger* on the lake and in Cano Mamirauá, respectively, as well as the 60% and 76% variation in *Caiman crocodiles* in the same regions, respectively. These authors suggested that water level may have negative effects on the number of *M. niger* and *C. crocodiles* observed. In general, studies realized in the last 10 years in the Brazilian Amazon and in neighboring countries showed that *M. niger* populations were in optimum status of conservation in Bolivia, Brazil, Ecuador, Guyana, French Guiana, and Peru (DA SILVEIRA, 2003).

Overall, this study was important to show that a caiman management program for both protected areas should be created, designed to be managed as an integrated system. The PPSDR could become the “sink” for the ABR “source” of caimans, given that the areas are adjacent and gene flow is possible between them (FARIAS *et al.,* 2004; VASCONCELOS *et al*., 2006). Therefore, we suggest that a detailed study be undertaken in the Abufari Biological Reserve and the PPSDR, and that an integrated committee discuss the management program of caimans in the lower Purus River.

Acknowledgments

Leonardo Bruno Monteiro, Gelson Batista da Silva, Oziel Ferreira, Daniely Félix da Silva and Ronaldo Ferreira helped in the surveys. The CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico) supported the study through Programa do Trópico Úmido-Fase 2. IBAMA (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais) gave logistical support in the field and permitted access to ABR. Many thanks to Luiz Monjeló, of UFAM (Universidade Federal do Amazonas), who coordinated the project “Diagnostico da Criação de Animais Silvestres no Estado do Amazonas/Program PTU-F2”. George Nakamura and Harold Wright improved the English.

References

BRAZAITIS, P.; YAMASHITA, C.; REBÊLO, G.H. 1990. A summary report of the CITES central South American caiman study: Phase I: Brazi; pag. 100-115 in*: Crocodiles.* Proceedings of the 9th Working Meeting of Crocodile Specialist Group, IUCN - The World Conservation Union, Gland, Switzerland.

BRAZAITIS, P.; REBÊLO, G.H.; YAMASHITA, C. 1996. The status of *Caiman crocodilus crocodilus* and *Melanosuchus niger* populations in the Amazonian regions of Brazil. Amphibia-Reptilia 17:377-385.

CAMPOS, Z., 2003. *Observações sobre a biologia reprodutiva de 3 espécies de jacarés na Amazônia Central. Corumbá: Embrapa Pantanal*. Boletim de Pesquisa e Desenvolvimento 43.

DA SILVEIRA, R. 2001. Monitoramento, Crescimento e Caça de jacaré-açu (*Melanosuchus niger*) e de jacaré-tinga (*Caiman crocodilus crocodilus*). Tese de Doutorado, INPA/UFAM, Manaus, Brasil.

DA SILVEIRA, R. 2003. Avaliação Preliminar da Distribuição, Abundância e da Caça de Jacarés no Baixo Rio Purus. Pags.61-64 in: De Deus, C.P.; Da Silveira, R.; Py-Daniel, L.H.R. (eds.). *Piagaçu-Purus: Bases Científicas para a Criação de uma Reserva de Desenvolvimento Sustentável*. Instituto de Desenvolvimento Sustentável Mamirauá, Brasil.

DA SILVEIRA, R.; THORBJARNARSON, J.B. 1999. Conservation implications of commercial hunting of black and spectacled caiman in the Mamirauá Sustainable Development Reserve, Brazil. Biological Conservation 88:103-109.

DA SILVEIRA, R., MAGNUSSON, W.E.; CAMPOS, Z. 1997. Monitoring the distribution, abundance and breeding áreas of *Caimans crocodilus crocodilus* and *Melanosuchus niger* in the Anavilhanas Archipelago, Central Amazonia, Brazil. Journal Herpetology 31(4):514-520.

FARIAS, I.P., DA SILVEIRA, R.; THOISY, B.; MONJELÓ, L.A.S.; THORBJARNARSON, J.B.; HRBEK, T. 2004. Genetic diversity and population structure of Amazonian crocodilians. Animal Conservation 7:1-8.

GROOMBRIDGE, B., 1987. The distribution and status of world crocodilians. Pags. 43-47 in: Webb, G.J.; Manolis, S.C.; Whitehead, P.J. (eds.), *Wildlife Management: Crocodiles and Alligators*. Surrey Beatty and Sons. Chipping Norton.

KEMENES, A.; PANTOJA-LIMA, J. 2006. Tartarugas sob ameaça. Ciência Hoje 38(228): 70-72.

MARIONI, B.; MÜHLEN E.M. Von.; DA SILVEIRA, R. 2006. Illegal caiman hunting in the Sustainable Development Reserve Piagaçu-Purus, Brazilian Amazonia. In: Crocodiles. *Proceedings of the 18th Working Meeting of the IUCN-SSC Crocodile Specialist Group*. IUCN: Gland, Suiza.

MARIONE, B.E.; MUHLEN, E.M.Von, E.; DA-SILVEIRA, R. 2007. Monitoring caiman populations subject to high commercial hunting in the Piagaçu-Purus Sustainable Development Reserve, Central Amazonia, Brazil.. Crocodile Specialist Group Newsletter,26(1):6-8.

MEDEM, F. 1983. *Los Crocodylia de Sur America.* Vol. 2. Ed. Carrera. Bogotá, Colombia.

OUBOTER, P.E.; NANHOE, L.M.R. 1984. *An ecological study of Caiman crocodilus in northern Surinam. Publ. No 233.* Department of Animal Ecology, Catholic University of Nijmegen.

REBÊLO, G. H.; MAGNUSSON, W.E. 1983. An analysis of the effect of hunting on *Caiman crocodilus* and *Melanosuchus niger* based on the sizes of confiscated skins. Biological Conservation 26:95–104.

REBÊLO, G.H.; LUGLI, L. 2001. Distribution and abundance of four caiman species (Crocodilia: Alligatoridae) in Jaú National Park, Amazonas, Brazil. Revista de Biologia Tropical 49:1.019-1.033.

RON, S.R.; VALLEJO, A.; ASANZA, E. 1998. Human influence on the wariness of *Melanosuchus niger* and *Caiman crocodilus* in Cuyabeno, Ecuador. Journal of Herpetology 32:320-324.

ROSS, J. P. 1998. *Crocodiles: Status Survey and Conservation Action Plan*. 2nd ed. Crocodile Specialist Group IUCN/SSC. Gland, Switzerland.

RUEDA-ALMONACID, J. V.; CARR, J. L. ; MITTERMEIER, R. A. ; RODRIQUEZ MALECHA, J. V. ; MAST, R. C. ; VOGT, R. C. ; RHODIN, A. G. J ; DE LA OSSA, V. J.; OSSA ; RUEDA, J. N. ; MITTERMEIER, C. 2007. *Las tortugas y los cocodrilianos de los paises andinos del tropico*. Conservacion Internacional. Bogatá, D. C. Colombia.

THORBJARNARSON, J. B. 1996. Reproductive characteristics of the order Crocodylia. Herpetologica 52:8-24

VASCONCELOS, W. R., HRBEK, T.; DA SILVEIRA, R.; THOISY, B.; MARIONI, B.; FARIAS, I.P. 2006. Population genetic analysis of *Caiman crocodilus* (Linnaeus, 1758) from South America. Genetics and Molecular Biology 29(2):220-230.