



**Population Monitoring of *Melanosuchus niger* and *Caiman*
crocodilus (Crocodylia: Alligatoriadae) in the Cuyabeno Wildlife
Reserve, Sucumbíos, Ecuador**

Final Report submitted to the Rufford Small Grants foundation

By

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ABSTRACT

Population biology of *Melanosuchus niger* and *Caiman crocodilus* was studied in five lagoons within Reserva de produccion Faunistica Cuyabeno (RPFC), located in north-eastern ecuadorian amazonia, during the dry seasons of 2004, 2005 and 2006. Night light surveys, capture and marking of individuals were performed to asses the composition of species, size and sex of populations in different localities. Estimates of relative abundance were calculated and compared with estimates obtained from raw data of previous years in the same localities. Influence of abiotic factors and wariness of individuals in the estimates of relative abundance was determined.

Both species of Amazonian crocodilians were recorded in five localities. The relative abundance estimates suggest there is a recovery of populations of both species. Both *M. niger* and *C. crocodilus* populations showed size distribution curves characteristic of recovering or stable populations. At all localities males were more abundant than females

Water level and water temperature exert a major influence in relative abundance estimates, nevertheless the strength of this influence of this influence appears to be dependent on locality. Wariness of individuals did not influenced the estimates of abundance.

Key words: Abundance, *Caiman crocodilus*, *Melanosuchus niger*, population composition, wariness.

INTRODUCTION

Crocodylians are semi-aquatic reptiles distributed in the tropics and sub-tropics, being considered key species for the maintenance of the habitats that they occupy, (Ross, 1998). They have long parental care and complex intra/inter specific social interactions (Lang, 1987; Ross, 1998). They also have large body sizes, long reproductive time periods and oviparity with relatively small and numerous egg production. (Thorbjarnarson, 1996).

The Alligatoridae family consists of eight species (King & Burke, 1997), four of which inhabit in the Ecuadorian Amazonian region (Asanza, 1985). The current study is focused on:

Melanosuchus niger (Black Caiman) *Caiman crocodilus* (White Caiman).

Melanosuchus niger is the largest caiman species in the family. Commonly, the adult males can reach sizes of more than 4 m of total length (Thorbjarnarson, 1998). Its distribution includes the Amazonian basin plus the peripheral zones like the Guyanas (Thorbjarnarson, 1998). It is found preferably in rivers and lakes (Asanza, 1985, Magnusson, 1985, Groombridge, 1987) as much in black waters as white waters, commonly in deep areas with slow current (Herron, 1994; Rebelo & Lugli, 2001). In Ecuador, *M. niger* is listed in the appendix II of the Convention of International Trade in Endangered Species (CITES) (Villamarin-Jurado, 2006) and The World Conservation Union (IUCN) classify the Black Caiman as an endangered species at “low risk of extinction” with the additional criteria of “conservation dependent” (Ross, 2000).

Caiman crocodilus is the alligatorid with the most extended distribution range, ranging from the north of Argentina to the south of. Currently there is controversy about the existence of several sub-species the *Caiman crocodilus* complex (Busack & Pandya, 2001; Warren, 2006). The males reach a maximum size of 2,80 m (Espinosa, 1998). It can be found in lakes and rivers (Da Silveira et al. 1997; Rebelo & Lugli, 2001). This species is listed in the appendix II of the CITES (Da Silveira, 2001) and the IUCN considers it in “low risk of extinction” with additional criteria of “minor concern” (Crocodile Specialist Group, 1996).

Since the decade of 1930's to the beginnings of the 1980's of the 20th century, there was an intense exploitation of caimans in the entire Amazon, due to the boom of the hide industry (Asanza,

1985; Da Silveira, 2001). As consequence, the *M. niger* populations declined in part of its original geographic range (Plotkin et al. 1983; Groombridge, 1985; Asanza, 1992). Subsequently, the pressure for skin hunting switched to *C. crocodilus* (Rebêlo & Magnusson, 1983). However, hunting did not affected this species to the same extent because of biological reasons like growth and for its surprisingly adaptability (Ron, 1995; Da Silveira, 2001).

The creation of Convention of International Trade in Endangered Species (CITES) (Braziatis, et al. 1998), the promulgation of local decrees of hunting prohibition and trafficking of species (Asanza, 1992) and the change of smuggling routes towards Bolivia and Paraguay (Da Silveira, 2001) favored the decrease of hunting in Ecuador at the beginnings of the 70's of the last century. However, there is still considerable illegal hunting and trafficking of these species skin (Braziatis, et al. 1998), and exists hunting for the meat consumption in the Amazon (Da Silveira & Thorbjarnarson, 1999). The impact of this last phenomenon has not been quantified in Ecuador.

The reduction of hunting for skin and the apparent innocuousness of hunting for meat (Da Silveira, 2001), have allowed the recovery and expansion of the populations of the two species in part of its original range (Ross, 1998; Da Silveria, 2002; Vasconcelos et al. 2006).

MATERIALS AND METHODS

The study was conducted in five black water lakes within Cuyabeno reserve. (RPFC) which has an area of 655781 ha and is located in north east Ecuadorian Amazonia, 100 km east from Nueva Loja city.

Weather is characterized for a constant rain (~ 3000mm year) with high relative humidity and mean temperatures close to 25°C (Pourrut et al. 1995), nonetheless there is a marked seasonality (Asanza, 1985; Ron, 1995; Vallejo, 1995; Terneus, 2001). In this study two seasons will be defined:

- Dry Season: Goes from december until march. Precipitation levels are low and therefore water level decrease (Ron, 1995).
- Rainy season: Goes from april until november, being april, may and june the rainiest months. From july until november water level and precipitation is variable (Asanza, 1985; Terneus, 2001).

Laguna Canangüeno (CG) (0°4' S 76°19' W) and Laguna Mateococha (MT) (0°1' S 75°14' W) are a 96,9 ha and 28,8 ha lakes respectively, located within Río Cuyabeno lacustrine system (RCLS). Laguna Imuya (IM) (0°34' S 75°15' W) and Laguna Lagartococha-1 (LC-1) (0°56'S 75°23' W) are a 91,1 ha and 27,24 ha lakes, located within Río Lagarto lacustrine system (RLLS). Laguna Zancudococha (ZC) (0°35'S 75°30' W) is a 420 ha lake 3 km south from Río Aguarico.

During the dry seasons of 2004, 2005 and 2006 field work was carried on RCLS, RLLS and Laguna Zancudococha. This intended to reduce the error on abundance estimates resulting from low visibility due to high water levels (Ron, 1995; Vallejo, 1995; Ron et al. 1999; Villamarín–Jurado, 2006). In RCLS a maximum of two consecutive surveys where conducted, with 20 days period of separation. In RLLS and Laguna Zancudococha a single monthly survey was conducted, intending to reduce the influence of the researcher in the abundance estimates (Pacheco, 1996; Ron et al. 1998). In CG and MT a total of nine surveys were conducted (Ron et al. unpubl. data). In ZC, IM and LC-1 four surveys where performed.

Each survey consisted of a nocturnal spotlight count around the lake using a dugout canoe. Canoe velocity remained as constant as possible. Caimans where detected with the reflection of a 6 V lantern light and approached. When the distance between the researcher and the caiman was

less than 5 m, caiman species and an estimate of the total length (ETL) was determined as described in Ron (1995), Vallejo (1995) and Villamarín–Jurado (2006). The number of the caiman in the survey, geographic coordinates (GPS Garmin 12XL and Garmin Legend) and behavioral observations were recorded.

Individuals that did not allowed a close approach were recorded as Eyes Only (EO). Captures were performed simultaneously with the surveys. Hands, steel snares (Thompson® Steel Snares) and a Control Pole (Forestry Suppliers Animal Control Pole, 60'') were used to capture the small, mid sized and big individuals respectively. When captured the following measures were recorded:

- Real Total Length (RTL in cm): Distance between the proximal end of the snout and the distal end of the vent.
- Snout Vent Length (SVL in cm): Distance between the tip of the snout and the proximal end of the vent.
- Head length (cm): Distance between the beginning of the cranial plate and the tip of the snout.
- Sex: By direct observation or tact of the reproductive organs.
- Water temperature (RadioShack® Model: 63–1032) at 1 m deep.

Two marks were made in each captured animal:

1. Insertion of a RFID micro chip in the distal end of the thigh, between the muscle and the skin. Each chip have an ID number read by a scanner (Pocket Reader® HS 9000 BS 23).
2. Cutting of caudal and dorsal scales as described in Villamarín–Jurado (2006). Scales were collected in Eppendorf tubes and preserved in 90° ethanol (Farias, et al. 2004). Samples are stored in the Gen Bank of the Museo de Zoología de la Pontificia Universidad Católica del Ecuador (QCAZ).

The environmental variables water level, air and water temperature were recorded at the beginning and end of each survey.

All data were analyzed with program SPSS 13.0. χ^2 test were run when the minimum value of expected frequencies was equal to 5. If this condition was not met, a G test was performed.

Proportion of each species per survey and the mean and standard deviation were calculated for all localities. Size distribution patterns were calculated with data of all surveys (Canangüeno and Mateococha $n = 9$; Zancudococha and Imuya $n = 4$; Lagartococha-1 $n = 3$). Size estimates of all caimans recorded were corrected using linear regressions as described in Ron (1995) and Villamarín–Jurado (2006). Sex proportions for the different populations and species were calculated using the captures of animals bigger than 60 cm **RTL** (Ron, 1995; Vallejo, 1995; Villamarín–Jurado, 2006). There were 15 captures in Canangüeno, 26 captures in Mateococha, 12 captures in Imuya and 38 in Zancudococha. All samples were divided in two size classes: **RTL** \leq 120 cm and **RTL** $>$ 120 cm and sexual proportion were compared with G tests.

Relative abundance estimates were calculated as proposed in Villamarín–Jurado (2006) using the Corrected Total Length (CTL) of all individuals. Pods were considered as a single individual (Ron, 1995; Vallejo, 1995; Villamarín–Jurado, 2006). Relative abundance estimates of the two species combined (caimans/km) as well as for each species individually were calculated adding to the estimates the **EO** category proportionally as proposed in Villamarín–Jurado (2006). Species composition for each locality was used to assign the **EO**. Mean, standard deviation and rank of all estimates were calculated.

Influences of environmental factors in the abundance estimates were determined. An average of each environmental variable (independent variable) per survey was calculated and related by linear and multiple regressions with the relative abundance estimate calculated for the correspondent survey (dependent variable). ANOVAS were calculated for each regression model to test for the independence of variables.

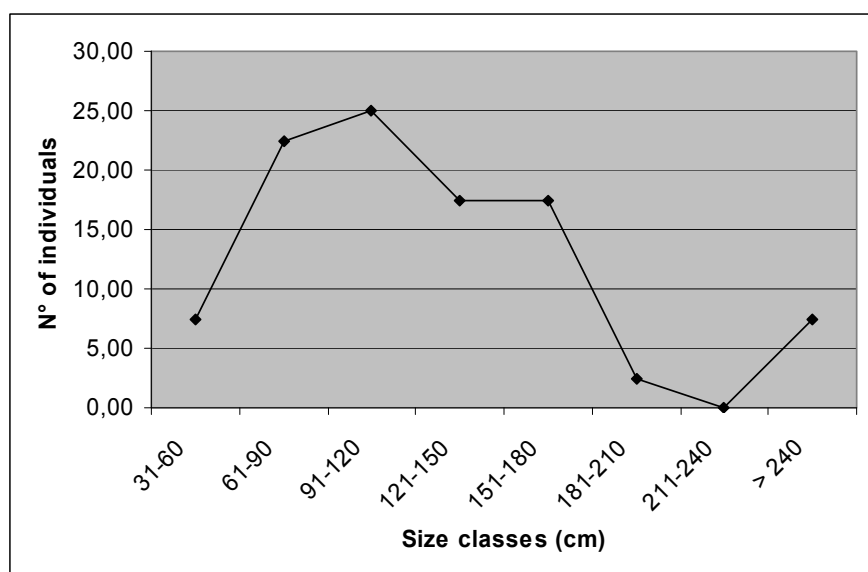
Influence of researchers on wariness of caimans and therefore in the relative abundance estimates was analyzed using methodologies described in Ron et al. (1998). Linear regression models were run to relate the number of survey (independent variable) with the number of caimans detected and the proportion of **EO** in each survey as dependent variables. Also ANOVA's were calculated for the regression models.

RESULTS

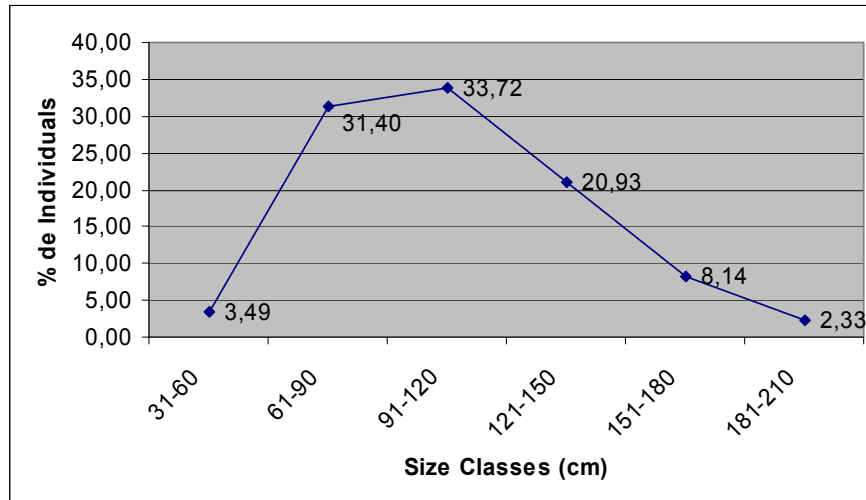
Both *Caiman crocodilus* and *Melanosuchus niger* were sympatric in all lakes surveyed. No other crocodilian species was recorded during fieldwork.

Lake	Percentage per species		S (among surveys)	Species proportion
	<i>Melanosuchus niger</i>	<i>Caiman crocodilus</i>		
Canangüeno	26,54%	73,46%	30,0	2,77:1
Imuya	93,07%	6,93%	4,50	13,42:1
Lagartococha 1	25%	75%	46,83	3:1
Mateococha	9,57%	90,43%	14,42	9,4:1
Zancudococha	98,72%	1,71%	1,86	57,75:1

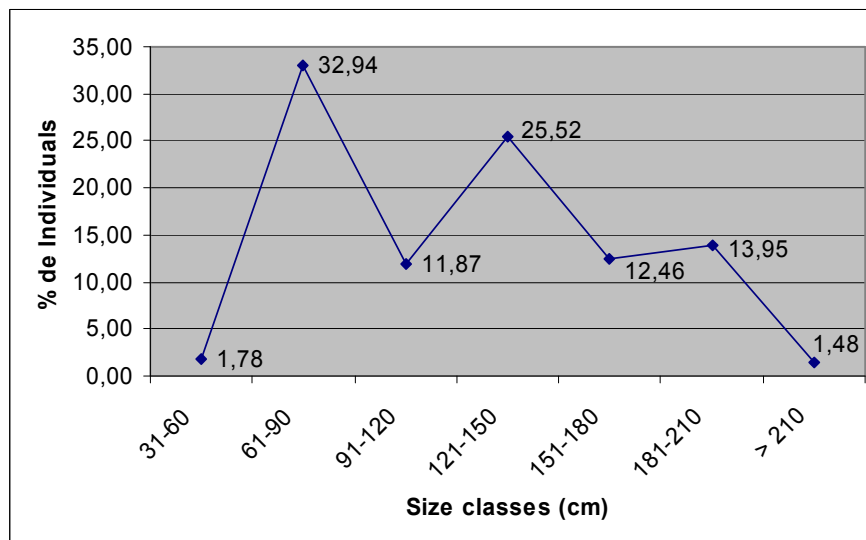
In Canangüeno size frequency distribution of *M. niger* shows two peaks. The first correspond to the size class 91–120 cm (25,00%) the second correspond to the size class of caimans bigger than 240 cm (7,50%). A pod with 13 hatchlings was found on march 13th of 2006.



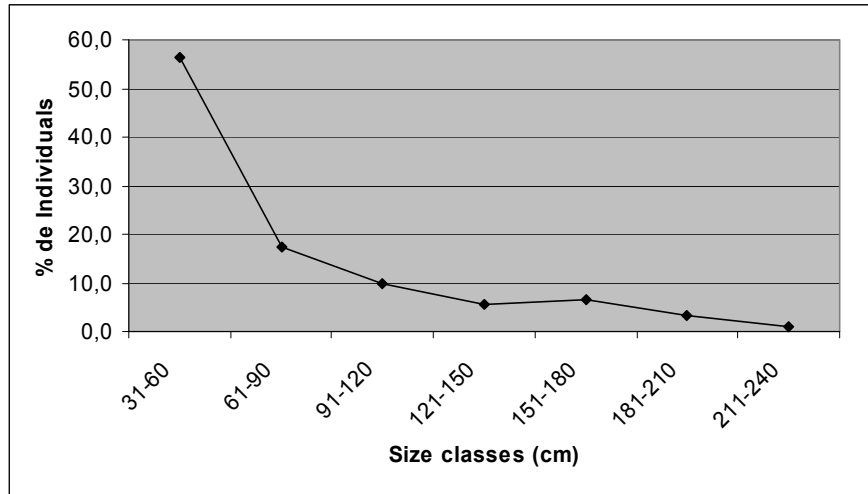
C. crocodilus size class distribution curve shows a single peak corresponding to the class 91–120 cm (40,87%).



In Mateococha size class distribution for *C. crocodilus* has two peaks. The first in the size class 61–90 cm (34,34%), the second in the size class 121–150 cm (29,52%). Size class corresponding to 31–60 cm shows a very low percentage (1,2%). No pods were detected on this lake during the fieldwork.

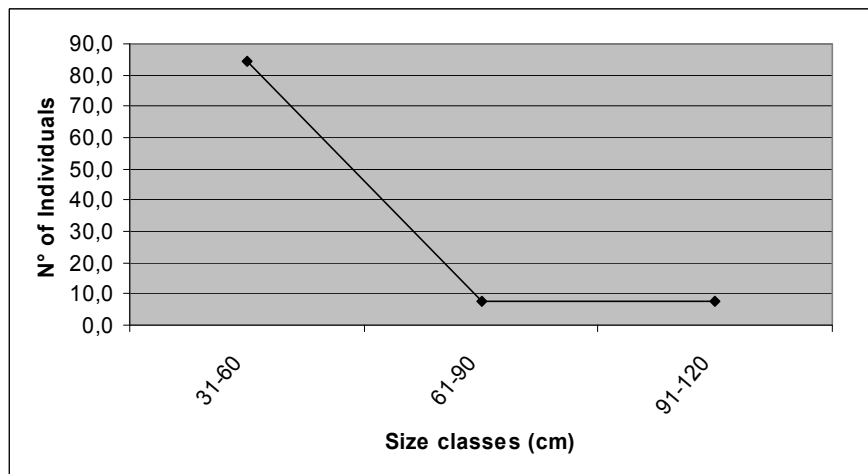


In Imuya size class distribution of *M. niger* shows that 50% of individuals recorded correspond to size class 31–60 cm and 6,50% correspond to the size class 151–180 cm.

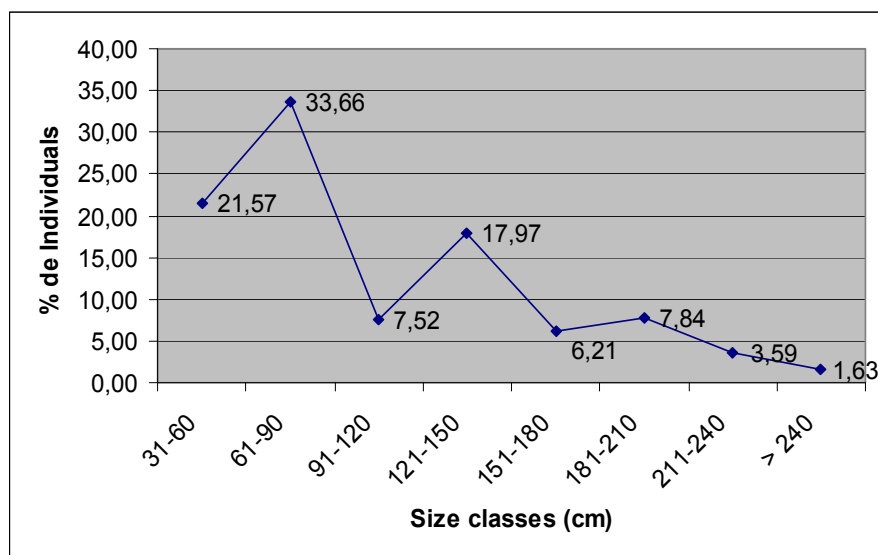


Two pods were detected on February 18th of 2006. A nest with 40 eggs was found on floating vegetation mats on November 18th of 2005. The nest had the following dimensions: Mound 1,70 x 1,23 m; egg chamber 38 x 40 cm. An adult *M. niger* of **ETL** 2,50 cm was seen patrolling the nest.

In Lagartococha-1 84,60% of the *C. crocodilus* population detected corresponded to the size class 31–60 cm. No pods were detected.



In Zancudococha size class distribution curve shows a single peak corresponding to 31–60 cm size class (37,50%). Three pods were detected on November 14th of 2005.



Sexual proportion of *Caiman crocodilus* in Canangüeno was 1,5:1. favoring males. There were 9 captures of males and 6 of females. There were no significant differences in sexual proportions among size classes. ($G = 0,187$; $df = 1$; $p = 0,66$). In Mateococha male/female proportion was 4,2:1. 21 males and 5 females were captured. There were no significant differences in sexual proportions among size classes ($G = 2,357$; $df = 1$; $p = 0,125$).

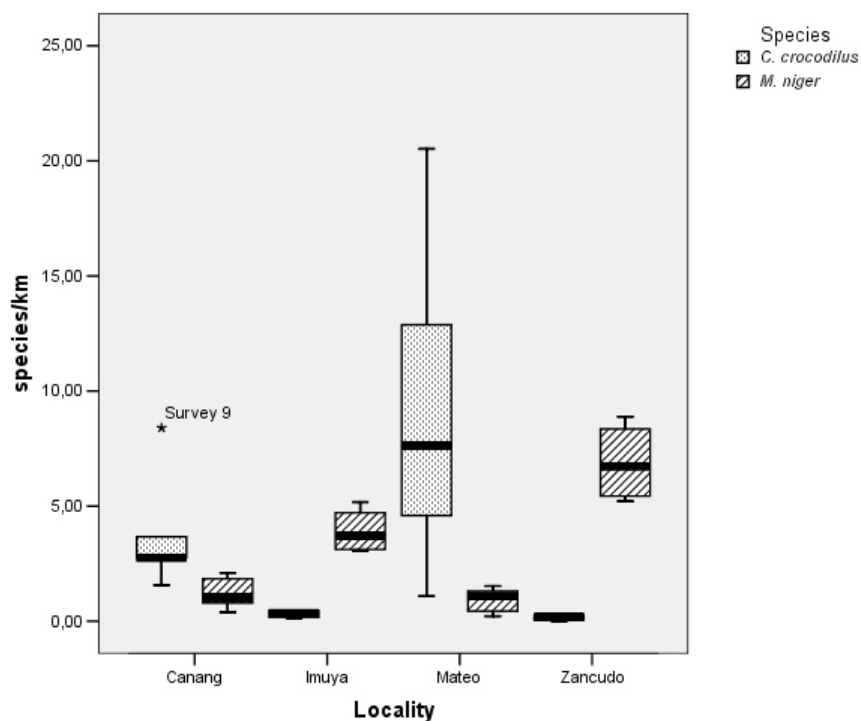
In Imuya, *M. niger* male/female proportion was 12:1. There were only 13 captures. No significant differences occurred among size classes ($G = 0,167$; $df = 1$; $p = 0,683$). In Zancudococha male/female proportion was 3,22:1. 29 males and 9 females were captured. No significant differences occurred among size classes ($G = 3,479$; $df = 1$; $p = 0,62$).

Relative abundance estimates are summarized in Table 2.

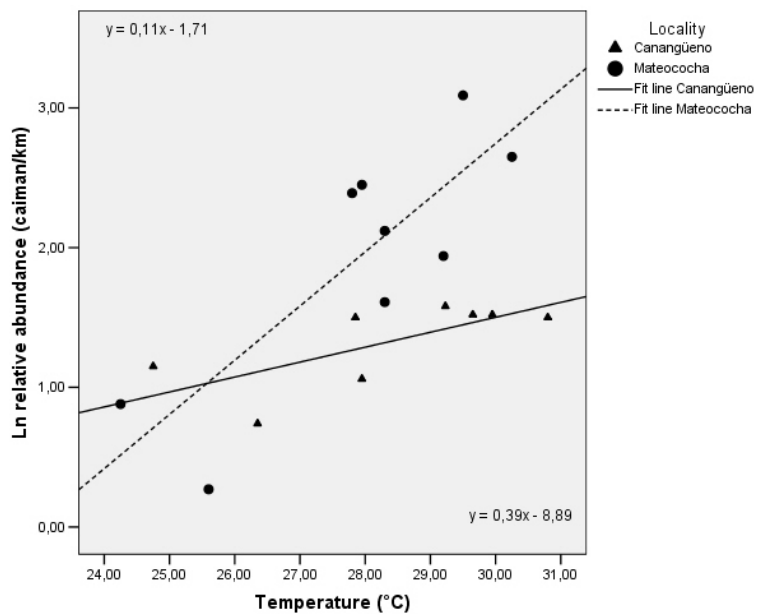
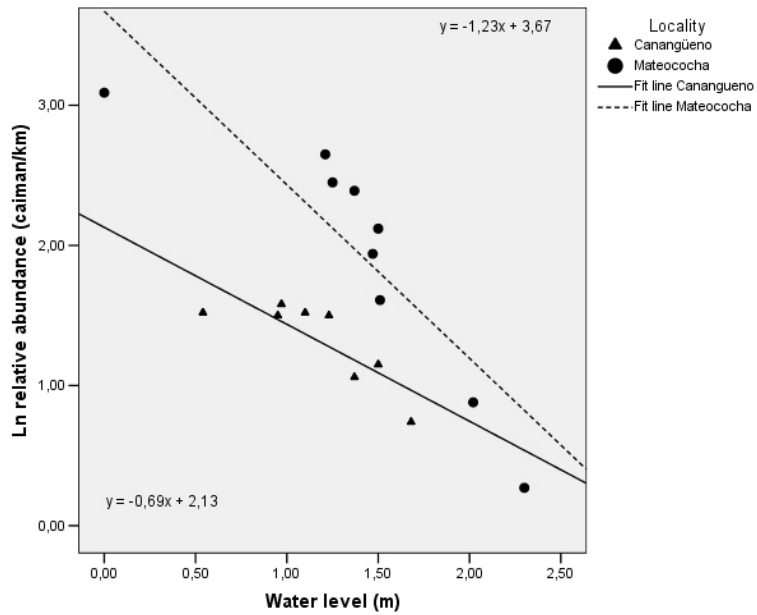
Lake/Species	Range	\hat{Y}	S
Canangüeno Caiman/km	2,10–10,37	4,61	2,36
Canangüeno <i>C. crocodilus</i> /km	1,57–8,40	3,43	2,00
Canangüeno <i>M. niger</i> /km	0,39–2,10	1,18	0,63
Imuya Caiman/km	3,18–5,65	4,24	1,16
Imuya <i>C. crocodilus</i> /km	0,12–0,47	0,32	0,18
Imuya <i>M. niger</i> /km	3,06–5,18	3,91	0,18
Lagartococha 1 Caiman/km	1,63–7,35	5,44	2,69
Lagartococha 1 <i>C. crocodilus</i> /km	0,82–6,12	4,08	2,33
Lagartococha 1 <i>M. niger</i> /km	0,82–2,04	1,36	0,51
Mateococha Caiman/km	1,31–22,05	9,19	6,43
Mateococha <i>C. crocodilus</i> /km	1,09–20,52	8,71	6,30

Lake/Species	Range	\hat{Y}	S
Mateococha <i>M. niger</i> /km	0,22–1,53	0,95	0,51
Zancudococha Caiman/km	5,21–9,07	6,98	1,85
Zancudococha <i>C. crocodilus</i> /km	0,00–0,18	0,13	0,09
Zancudococha <i>M. niger</i> /km	5,21–8,89	6,89	1,75

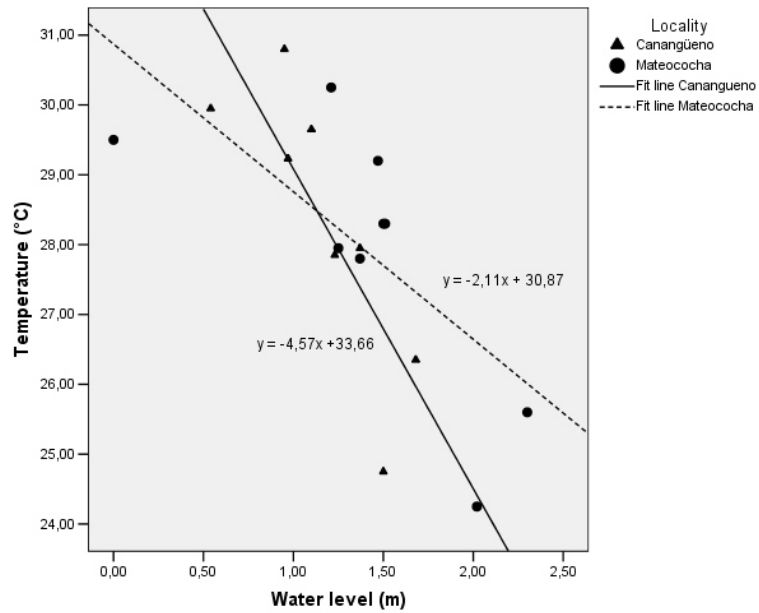
The following figure shows the variation of relative abundance estimates per species in the different lakes surveyed.



There is a significant relationship between water level and relative abundance estimates in RCLS.



The relation was also significant between water temperature and relative abundance estimates. The relationship is negative in the case of water level while positive for water temperature and abundance estimates. There is also a significant relationship between water level and water temperature.



There were no significant relationship between environmental variables and abundance estimates in the other lakes surveyed. A summary of the results is showed on Table 3.

Lake	# of Survey	df	Water level		Water Temperature (°C)	
			F	P	F	P
Canangüeno	8	7	12,17	0,01	6,078	0,04
Imuya	4	3	1,644	0,328	0,401	0,591
Mateococha	9	8	25,34	0,002	14,961	0,006
Zancudococha	4	3	15,598	0,059	0,001	0,977
Canangüeno (Water temp.)	8	7	11,988	0,01	n/a	n/a
Mateococha (Water temp.)	9	8	7,115	0,03	n/a	n/a

Wariness regression models showed no significant relationship for all localities surveyed between the number of caimans detected vs. the number of survey and the percentage of **EO** caimans recorded on each survey. Results are showed in the following two tables.

Lake	df	F	p
Canangüeno	8	2,008	0,199
Imuya	3	0,73	0,812
Lagartococha 1	2	1,815	0,407
Mateococha	8	2,761	0,141
Zancudococha	3	0,343	0,618

Lake	df	F	p
Canangüeno	8	2,118	0,189
Imuya	3	0,377	0,602
Lagartococha 1	2	3,000	0,333
Mateococha	8	1,704	0,233
Zancudococha	3	1,682	0,324

DISCUSSION

The dominant relationships of abundance of one species versus the other are maintained with respect to previous studies in the RPFC (Ron, 1995; Vallejo, 1995), but the proportions in which each species is found on each location have varied. In all lakes, the proportions favored the species that were found dominant in the past. This, apparently have to do with the history of hunting in the studied locations (Asanza, 1985; Ron, 1995; Vallejo, 1995). Nevertheless, it would be indicating a recovering of the populations of *M. niger*.

The determination of size class distribution in the order Crocodylia is of much importance for its conservation. For a group of animals in which the reproductive success is strongly related with the size/age (Da Silveira, 2001), the estimation of population curves allows to make accurate decisions about the management of this species. On the other hand, the estimates of population curves or demography are indirect indicators of the fluctuations in the abundance of a given crocodilian population and are difficult to interpret (Bayliss, 1987). A healthy population curve of crocodilians is characterized by presenting a major frequency of the small sizes, followed by a gradual decrease of bigger size classes (Herron, 1994; Ron, 1995).

The two curves of *C. crocodilus* in the RCLS are apparently healthy, having a pyramidal aspect, which corresponds to a healthy population according to Velasco et al. (2003). The low frequency of the smaller sizes could be reflecting a bias due to visibility and be a result of the behavior of this size classes. This are found isolated in less deep zones with dense vegetation, sheltered of predators (Ouboter & Nanhoe, 1988; Herron, 1994; Ron, 1995; Da Silveira et al. 1997), and not in open areas where the sampling is performed. The lagoons of Canangüeno and Mateococha possess vast areas of permanent flooded vegetation that allow this size classes to hide. Other reason could be that the period of eclosion of hatchling did not match with the sampling period. However, Asanza (1985) mentions that the lapse of time since the nesting starts and the last eclosion occurs in the CRLS are 8 months.

The size distribution of *C. crocodilus* in Lagartococha-1 shows a population with growth potential, more than 90% represents to the small and medium size classes. The absence of big size classes could be due to the short sampling effort ($n = 13$).

The size distribution curve of *M. niger* in Canangüeno appears healthy. The medium size classes represent more than 80% of the curve. The high percentage of bigger size classes observed and the location of a pod, is also a good sign indicating reproduction. However, the size of the sampling from which it was produced is small ($n = 40$).

The curves of *M. niger* in Zancudococha and Imuya also show healthy population structures. In both locations the small and medium sizes classes represent more than 50% of the population. Although, the class that corresponds to the size of hatchlings appears to be unrepresented. This could be an error of estimation due to correction of sizes given that in the two locations 10 hatchlings and a nest were found. Also, it has been stated that the most accessible habitats to humans, and therefore the samplings, are marginal habitats for caimans of intermediate sizes classes. The dominant males, the reproductive females and the nuclei of nesting sites of this species is found in flooded areas of difficult access and with certain independence to the hydric fluctuations of rivers (Thorbjarnarson & Da Silveira, 2000; Rufeill, 2004). This could be the case of Zancudococha that has sheltered an abundant population of *M. niger* through years. Furthermore, both locations have been cited as examples of healthy populations of this species in the past (Jahoda, 1990; Asanza, 1992; Ron, 1995; Vallejo, 1995).

In general, sexual proportions reported for this two species in other studies always favors males (Jahoda, 1990; Ron, 1995; Vallejo, 1995; Rufeill, 2004; Villamarín–Jurado, 2006).

The fact that more males than females have been captured could be due to various reasons. One is that the observed males were excluded of difficult access areas by dominant males who maintain territories where they could have access to females for reproduction (Lang, 1987; Ross, 1999; Da Silveira & Thorbjarnarson, 2000). Another is that the females could be more wary than males (Vallejo, 1995) or that the sample result of the captures is not representative of the entire population (Jahoda, 1990; Ron, 1995).

The relative abundance estimates compared with other locations where this species is distributed, are neither extremely abundant (Da Silveira, 2002; Cabrera–Peña, et al. 2003; Rufeill, 2004) nor low (Rebêlo & Lugli, 2001). However, the reported estimates in the majority of the studies about this species are based on samplings that most of the times include other water body types

plus lakes (Asanza, 1992; Da Silveira et al. 1997, Da Silveira & Thorbjarnarson, 1999; Rebêlo & Lugli, 2001; Velasco et al. 2003; Ruffeil, 2004). Besides, the methodologies used to obtain such estimates, although based on the same general principles, vary depending of the researcher and their objectives. Furthermore, the variability of the estimates often responds to local environmental facts (Pacheco, 1994; Ron et al, 1999; Da Silveira, 2001) and to the complexity of the ecosystem in study (Rebêlo & Lugli, 2001).

It is clear that in this case the estimate of relative abundance obtained are conservative, because in the periods of low water, when the majority of the population is visible are typically short (Da Silveira, 2001). Survey number 9 in Canangüeno and 11 in Mateococha reflect this fact. Both were performed with a very low water level and constitute outliers to the variation of estimates obtained in this study.

The recovery of *M. niger* populations in RPFC is important. Rebêlo & Lugli (2001), propose that the low abundance observed on their study site could be related with the low productivity observed for Igapó forests compared with the high productivity of Várzea forest (Da Silveira, 2002). It is also mentioned that extremely high abundances like the observed in certain zones of the Amazon basin corresponding to Varzea (e.g. Mamirauá lake) are rare events and that *M. niger* population are not fully recovered on its original range (Rebêlo & Lugli, 2001). However this study results are contrary to such statement. Furthermore, the results of this study are consistent with the hypothesis of the recovery of *M. niger* populations in the absence of hunting pressure due to skin trade (Asanza, 1985; Herron, 1994; Ron, 1995; Vallejo, 1995). It is also consistent with the hypothesis that *C. crocodilus* hinders the recovery of *M. niger* populations (Magnusson & Rebêlo, 1982; Rebêlo & Magnusson, 1983). Nonetheless, it is possible that the species composition observed in RPFC is just a consequence of the ecological characteristics of the studied lakes (Vallejo, 1995).

Influence of environmental factors in abundance estimates of crocodilians has been already proved in RPFC (Ron et al. 1999) and in other localities of the Amazon basin (Pacheco, 1994; Da Silveira et al. 1997; Da Silveira, 2001; Villamarín–Jurado, 2006). A common factor of all this studies is the level of water. This is consistent with the present study, at least in CRLS. During the dry

season the water bodies decrease their water level, reducing the area of flooded forest where caimans can shelter and feed. The drought obligates the animals to concentrate in the areas where water remains (Coutinho & Campos, 1996; Ron et al. 1999; Da Silveira, 2002).

The relationship between water temperature and water level has also being proved to influence the abundance estimates in RPFC (Ron et al. 1999) and in Añangu lake located at the center of Ecuadorian Amazon region (EAR) (Villamarín–Jurado, 2006). The results of this study reinforce this fact. However, that relationship appears to be dependent on the locality. In several lakes of EAR (Imuya, Zancudococha and Limoncocha), temperature of water does not influence the abundance of caimans observed (Ron et al. 1999; Villamarín–Jurado, 2006). Apparently, the influence of water temperature is related to particular characteristics of the water body surveyed and the biology of caimans. Temperature would affect the abundance estimates within certain threshold (Ron et al. 1999; Villamarín–Jurado, 2006). If the mean temperatures of Mateococha ($\bar{x}= 27,91^{\circ}\text{C}$; $S= 1,89$) are compared with the mean water temperature of Zancudococha ($\bar{x}= 30,67^{\circ}\text{C}$; $S= 0,28$), the difference is evident and therefore this will support the former statement. However, Imuya's mean temperature ($\bar{x}= 27,36^{\circ}\text{C}$; $S= 1,59$) that showed no influence on abundance estimates, will confront the hypothesis of a threshold. Possibly the case of Imuya is the minor number of repetitions of the sampling, and therefore an artifact or a failure of the analysis to detect any influence. Other reason could be the possibility of differential response of species to water temperature (Ron et al. 1999).

Ron et al. (1998) have showed that caimans increase their wariness level due to the effect of mark-recapture experiments in RPFC. This is consistent with the findings of similar studies in Brazilian Amazon (Rebêlo & Lugli, 2001). This shows that the wariness behavior is important because it affects not only the estimates of relative abundance (Pacheco, 1994), but shows learning capacity of caimans (Lang, 1987; Ross, 1999) and therefore their resilience over time. The result of this study showed that the researchers did not influence the wariness in the populations in study and therefore in the abundance estimates. This is a consequence of the longer periods between surveys compared with previous studies (Ron et al., 1999).

CONCLUSIONS

- Species composition and size structure suggest a healthy status of both species populations.
- Species proportions in RCLS and in Imuya and Zancudococha lakes have varied favoring the more abundant species in the past, although *M. niger* has shown a recovery in all lakes.
- Relative abundance estimates suggest a recovery of *M. niger* populations in Imuya and Zancudococha.
- Water level and water temperature influence the abundance estimates in RCLS.
- No environmental factor influenced the abundance estimates of Imuya and Zancudococha.
- There was no influence of researchers on wariness of caimans and therefore in relative abundance estimates.

RECOMENDACIONES

- Studies on illegal hunting, meat destination, techniques of hunting and final use of meat are needed.
- Canangüeno lake has to be constantly monitored to study the ecological relationships of *M. niger* and *C. crocodilus*.
- Zancudococha and Imuya lakes has should have an special status of protection due to their healthy populations of *M. niger*.
- Studies on population genetics, growth and nesting areas of both species are recommended.
- Population monitoring has to increase in area and in time to have a broader understanding of the status of both species.

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