

Population status of *Caiman crocodilus* (Crocodylia: Alligatoridae) in Caño Negro, Costa Rica

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ABSTRACT

Caimans were censused by counting eyeshines with a headlamp from April to July 1986 in Caño Negro National Wildlife Refuge, in northern Costa Rica.

Estimated caiman population in the preliminary study area was 229 in the dry season and 23 in the wet season. Caiman density during the dry season was calculated in 3 sites as 83, 100, and 166 caimans/hectare. Total caiman population in the refuge was estimated in 1988 (2129) and 1989 (2438) during the dry season. Mean number of caimans per km of river was 53,0/km for 50,2 km of habitat in 1989. Percent of caimans that were visible during a count was 89,0 % (SD=6,62). We calculated the total caiman population at 3000 (2700-3300) within all transects in 1989. Caimans dispersed from dry season canals and lagoons into wet grasslands and swamps during seasonal flooding.

Surveys used to estimate total caiman population should be made during the dry season when caimans are concentrated in open bodies of water. Annual fluctuations in caiman numbers occurred between survey sites. Variable nesting success probably caused the juvenile size class to greatly increase or decrease between years.

Brown caimans (*Caiman crocodilus fuscus* Cope 1868) (= *chiapasius* Bocourt 1876) are increasingly endangered because of overexploitation and the loss of aquatic habitat (Groombridge 1987, King & Burke 1989). Caiman habitat includes small, slow-moving streams and rivers, lakes, interior lowland swamps, and coastal environments (Staton & Dixon 1983). Caño Negro National Wildlife Refuge (Caño Negro) is one of four protected areas in Costa Rica with over 1000 hectares of caiman habitat (Vaughan 1983). The refuge was created in 1984 to protect the abundant wildlife in the aquatic habitat of the Río Frío drainage. Caimans are recovering from decades of severe hunting in this region which stopped in 1980 when the illegal hide trade through Nicaragua terminated. The caiman population has subsequently increased from extremely low levels during 1970's. The objective of this study was to census the caiman population in the refuge.

STUDY SITE

Caño Negro National Wildlife Refuge (Caño Negro; 10°54'N, 84°47'W) includes 9969 hectares of pasture, swamp, and tropical moist forest (Fig. 1). Caño Negro is located west of a major river, Río Frío, which drains north into Lake Nicaragua. Caño San Sebastián and Caño Blanco channel most of the Río Frío water into the main canal, Caño Negro. Water returns to Río Frío by Caño Negro and Caño Los Patos. An 800 ha lake forms in the refuge in the wet season when water

level rises 2 to 4 m and flood over 90% of exposed land. Forests adjacent to the lake are flooded. During the dry season, the lake area reduces to drying lagoons, receding canals, and pasture. Annual precipitation is between 2500 and 3000 mm (Barrantes *et al.* 1985), and 80% falls during the wet season (May to December).

MATERIALS AND METHODS

Preliminary census was carried out in 1986 during the late dry season (22 April to 1 May) and the early wet season (27 June to 22 July) by boat and on foot using a 6-volt headlamp to count caiman eyeshines at night. We censused before and after the beginning of the wet season to determine how rising water levels affected our ability to count caimans. We divided river sections of Caño Negro into eight transects and made three counts in each site on different nights. Censuses were conducted in short time periods during each season to reduce any effects of long-term caiman movements between sites. We assumed insignificant caiman movement between sites on following nights.

Total caiman number was calculated by summing the mean eyeshine counts of the eight transects. We calculated caiman density during the 1986 dry season as the number of caimans per hectare of water surface in three canal sections.

We censused total caiman population in Caño Negro during the late dry season in 1988 and 1989. Brinkman Q-Beams and 6-volt headlamps were used to produce caiman eyeshines. We censused most transects from slowly moving motor driven boats by counting caimans along both banks simultaneously. Censuses were accomplished by one individual or by a two person team consisting of a spotter and a driver. The same spotter conducted each census from the front of the boat and recorded the counts in a notebook. We divided canals and rivers into large transects and censused each two or more times. The highest number of caimans counted in each site was recorded to estimate the total population.

Chi-square tests were used to test fluctuations in caiman numbers between identical sites on different years. Although statistical analysis was performed between corresponding transects, all census data are shown in detailed sub-transects for comparison with future studies.

All caiman size classes were included in the census (adults, sub-adults, juveniles, and hatchlings). We calculated the percent of caimans that were visible on a census (percent visibility) in eight sites using two methods: 1) we divided the mean census value for each site by its highest count (PV1), and 2) we used a formula, $PV2 = x/(2s + x)1.05$, where x = mean census value, and s = standard deviation (King *et al.* 1990). Mean percent visibilities of caimans were used to estimate the total caiman population within the study transects in Caño Negro. We calculated caiman density in 1989 as the mean number of caimans per km of river. Although the perimeter vegetation was variable along river banks in this study, we did not characterize habitat parameters; our main objective was to census the caiman population in Caño Negro.

RESULTS

Preliminary census

The caiman population in the preliminary study was estimated as 229 individuals in the dry season (Fig.2). Caimans were found in canals and lagoons. We counted only 23 caimans in the same study area during the wet season (Fig. 2), and only three of these caimans were actually counted in the dry season transect boundaries. Most caimans occupied heavily vegetated swamps, flooded grasslands, and flooded forests adjacent to but within sight of the dry season sites during the wet

season. In contrast to the wet season, caimans are crowded into diminishing aquatic habitat during the dry season. Caiman densities in Caño Negro were calculated in three sites during the dry season as 100, 166, and 83 caimans/hectare.

Population census

Total number of caimans observed during nocturnal surveys in Caño Negro was 258 in 1986, 2129 in 1988, and 2438 in 1989 (Figs. 3-5). Caiman population fluctuated from 1904 in 1988 to 2063 in 1989 in the same transects ($X^2=107.2$; $df=15$; $P=0.0001$). In 1989, caiman numbers declined by 67 in Caño San Sebastián and south Río Frío but increased by 226 in north Río Frío. Caiman numbers in the 1986 study sites remained stable in 1988 ($X^2=39.3$; $df=3$; $P=0.37$) excluding one site in which caimans increased from 8 to 50. Caiman numbers fluctuated in all 1986 sites from 1988 to 1989 ($X^2=22.4$, $df=4$; $P=0.0002$), but the total number increased by only seven caimans.

Caiman density during the dry season in Caño Negro was 53.0 caimans/km in 50.2 km of riverine habitat in 1989. Caiman density ranged from 14.3/km near the village of Caño Negro to 170.0/km in a northern segment of Río Frío. Percent visibility of caimans (PV1) in 8 study sites was 89.0% ($SD=6.62$) (Table 1).

Using this value, we calculated a total population within all study sites as 3000 (2700-3300) caimans in 1989. We calculated 3400 (2900-4100) caimans using the second percent visibility ($PV2=77.5\%$; $SD=8.36$).

DISCUSSION

Preliminary census

The decrease in caimans estimated from dry to wet season was due to caiman seasonal movement. As flooding drastically increased available habitat during the wet season, caimans dispersed from canals and lagoons into swamplands.

Food availability may also induce caiman seasonal movement. Flooding probably increases the vulnerability of small mammals, bird, reptiles, amphibians, and insects to caiman predation. Caimans are able to ambush prey species in shallow waters. Feeding caimans may derive thermoregulatory benefits from the shallow sun-warmed waters of flooded grasslands as most basking sites in Caño Negro are inundated in the wet season. Ouboter and Nanhoe (1988) suggested that caimans migrate to shallow waters primarily for resting and hunting purposes; caimans also abandoned riverine habitat to enter swamps during seasonal inundation in Suriname.

Caimans migrated seasonally from permanent dry season lagoons to temporary lagoons during the wet season in Venezuela (Gorzula 1978, Staton & Dixon 1975). Caiman densities in Venezuela were estimated during the dry season as 100 (Gorzula 1985), 113 (Staton & Dixon 1975), and 205 caimans/hectare (Seijas 1986).

Census of caiman populations is a needed tool to determine population parameters and, with other biological information, initiate management. The results of the census in Caño Negro suggest that more caimans can be counted during the dry season than the wet because caimans are found in drying pools and streams in the dry season. Wet season counts are inadvisable due to the increased surface area to sample. Moreover, caimans are difficult to illuminate with a spotlight because they inhabit areas of dense vegetation.

For these reasons, we suggest that the census used to estimate the total caiman population in Caño Negro be made in the dry season when caimans are concentrated in open bodies of water.

Population census

Total caiman population was estimated at 3000 using PV1 and 3400 using PV2 in Caño Negro. Our more conservative estimate near 3000 is probably the most reliable population estimate for caimans in Caño Negro. The formula for calculating PV2 takes into account that even for the highest survey of a site, there remain submerged caimans that are not counted. However, we feel that it would be a mistake to risk overestimating the caiman population for conservation purposes.

Fluctuations in caiman numbers in Caño Negro probably resulted from annual changes in the number of hatchling caimans due to variable nesting success. Wet season flooding destroyed 67% of caiman nests one year which affected population numbers the following dry season (Allsteadt, in press). Lower water levels during the 1988 wet season probably resulted in higher nesting success in 1989. A high influx of juvenile caimans may explain the increase of caimans surveyed in the northern segment of Río Frío. This area contained abundant riverine forest which was used by caimans for nesting in Caño Negro. Destruction of riverine forests along southern Río Frío and Caño Blanco may have reduced caiman numbers in those areas. Although numbers of juvenile caimans (20-40 cm SVL) may vary annually, they were not excluded from the survey because juvenile recruitment may be very high. We have observed large pods of first and second year caimans along river banks 6 to 18 months after hatching.

Reductions in caiman numbers were probably not due to unequal caiman movement between years. Previous studies found that caimans returned to the same dry season sites following annual migrations to wet season habitats (Gorzula 1978, Schaller & Crashaw 1982, Ouboter & Nanhoe 1988). Furthermore, caimans are sedentary reptiles once within their seasonal home ranges (Schaller & Crawshaw 1982, Ouboter & Nanhoe 1988). Should caiman movement occur in Caño Negro, we felt that it would be balanced between sites.

Variable densities of caimans in Caño Negro were probably due to different habitat parameters, such as water depth, riverbank vegetation, etc., among survey transects. Caiman densities in Caño Negro were high compared to *Caiman crocodilus* populations in other river systems. In Honduras, caiman population have been depleted by hunting; sighted density of caimans was 3,5/km (0 to 85,5/km) over 304,4 km of riverine habitat in the Atlantic drainage (King *et al.* 1990). Mean density in Suriname was 26,3 caimans /km (range = 3 to 96/km) and the highest densities were recorded in side creeks that contained numerous juvenile caimans (Ouboter & Nanhoe 1984). In Venezuela, mean caiman density was 7,1 /km for 143 km, but decreased to 1,5/km in 86,9 km of river co-inhabited by *Crocodylus acutus* (Seijas 1986). In Brazil, caiman densities ranged from 0,34 to 30/km (Brazaitis *et al.* 1990). Low caiman densities resulted in part from human exploitation of caiman skins and meat in these regions. Nonetheless, these comparisons may only be weakly related. The habitat parameters that influence the carrying capacity of caimans probably vary greatly between different geographic areas.

CONCLUSION

Nocturnal census in the dry season is an integral component of caiman management. The results of this study provide a reference for future monitoring of the caiman population in Caño Negro. Annual census should be designed to estimate the number of caimans that occur in different size classes as well as in the total population. Size estimates were difficult in this study because the spotter recorded the counts by hand and the caimans were extremely wary. Two methods would

facilitate caiman size estimates during a survey: 1) the spotter uses a tape recorder to note caiman sizes, or 2) a third person sits next to the spotter and records the data (King *et al.* 1990).

RESUMEN

Se efectuaron censos de caimanes, *Caiman crocodilus fuscus* (= *chiapasius*), entre abril y julio de 1986 en el Refugio Nacional de Vida Silvestre Caño Negro, en la Zona Norte de Costa Rica. La población de caimanes en el área del estudio fue de 229 individuos en la estación seca y de 23 en la estación lluviosa. La densidad de caimanes, calculada durante la estación seca en tres sitios, fue de 83, 100 y 166 caimanes/hectárea. La población total de caimanes se estimó en 1988 (2129) y en 1989 (2438), durante la estación seca. La densidad de caimanes fue, en promedio, 53,0 individuos/km en 50,2 km de hábitat ribereño muestreados en 1989. El porcentaje de caimanes visibles en los censos fue, en promedio, 89,0% (DE=6,62). Calculamos una población total de 3000 (2700-3300) caimanes en los sitios muestreados en 1989. Los caimanes migraron de los canales y las lagunas de la estación seca a los pantanos, durante las inundaciones de la época lluviosa. Los censos para calcular la población total de caimanes se deben hacer durante la estación seca, cuando los caimanes se encuentran en grupos concentrados en aguas abiertas. Hubo variaciones anuales en el número de caimanes entre los sitios muestreados. Las variaciones en el éxito de nidificación probablemente causaron que el número de caimanes juveniles aumentara o disminuyera en años diferentes.

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Tabla 1. Percent visibility (PV) and standard deviation (SD) of the number of caimans calculated from censuses in 8 sites in 1986 and 1988 in Caño Negro National Wildlife Refuge, Costa Rica. Mean PV1 was 89.0 % (SD=6,62) and mean PV2 was 77.5 % (SD=8,36).

Site	Censuses	Mean	SD	PV1	PV2
Caño Barbudero	27, 31, 34, 25, 32	27,8	3,56	86,9	75,8
Caño Negro	23, 30, 24	25,7	3,79	85,6	73,6
Río Frío	33, 28, 26	29,0	3,61	87,9	76,3
Río Frío	106, 93, 108	102,3	8,14	94,8	82,2
Caño Blanco	499, 551	525,0	36,77	95,3	83,5
Caño Blanco	23, 16, 28, 26	23,3	5,25	83,0	65,6
Caño los Patos	28, 25, 37, 28	29,5	5,20	79,7	70,4
Caño los Patos	93, 94, 96, 96	94,8	1,50	98,7	92,3

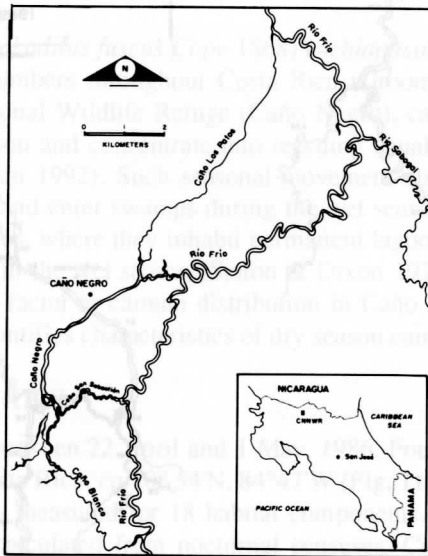
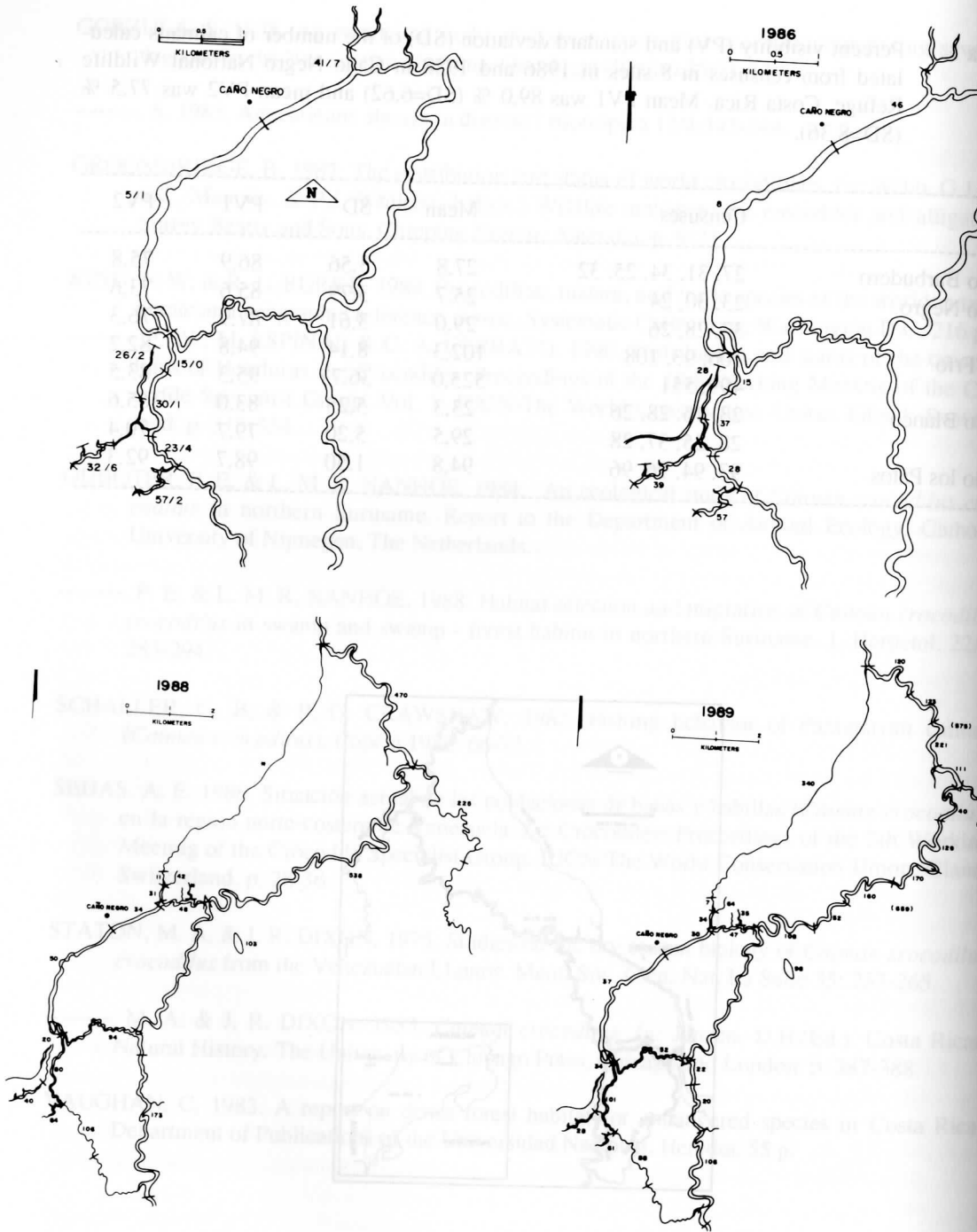


Fig.1. River system during the dry season in Caño Negro National wildlife refuge, Costa Rica (10°54'N, 84°47'W).



Figs.2-5. Average number of caimans observed during nocturnal survey in Caño Negro National Wildlife refuge, Costa Rica (10°54'N, 84°47'W). 2. in the dry (22 april to 1 may) and wet seasons (22 june to 22 july) in 1986, . dry season total=229. wet season total=23. Data=dry season/wet season. 3. from 22 april to 1 may, 1986, Total=258. 4. from 12 april to 10 may, 1988, Total=2129 *Missing data. 5. from 27 march to 26 april, 1989, Total=2438 *Missing data.