Population Ecology and Behaviour of *Caiman latirostris* in the Pirapitinga Ecological Station, Southeast Brazil.

Report to the Crocodile Specialist Group

IUCN/SSC

Student Research Assistance Scheme

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INTRODUCTION

Crocodilians ecology has a close dependence on ambient climatic conditions, especially thermal parameters and local hydrology (Markwick 1998). Different human activities have been altering habitat conditions and threatening crocodilians populations. The damming activity and its associated impacts such as the instability of the hydrological regime, is one of those activities that can have some serious consequences for caimans populations. A dam can be defined as a hybrid system between a river and a lake, providing a habitat that is completely different from the original (Baxter 1977).

Studies on the impact of the construction of large hydroelectric stations on the density and reproduction of broad-snouted caiman populations are scarce. For instance, Mourão and Campos (1995) based on aerial surveys data, alerted to a major impact caused by the damming activity such as the destruction of natural floating vegetation used as a important reproduction site (Verdade et al. 2010).

The aim of this project was to study the population status, survivorship and growth rates of the broad-snouted caiman at the Pirapitinga Ecological station, located at the Três Marias Reservoir aimed at increasing knowledge about this species and thereby, providing subsidies to the development of a management plan for the species in this reserve.

Study Area

The Três Marias Hydroeletric reservoir is located at Minas Gerais state, at 538 meters above sea level in the high São Francisco river region (S 18° 12’ 51” W 45° 15’ 51”) (BRASIL 1987). The dam was built during the period from 1957 to 1960, with the aim of improving navigation and to generate hydroelectric power (Companhia Energética de Minas Gerais, 2006). Pirapitinga Ecological Station (ESEC Pirapitinga) is an artificial island, which was formed as a result of filling the reservoir (Figure 1).

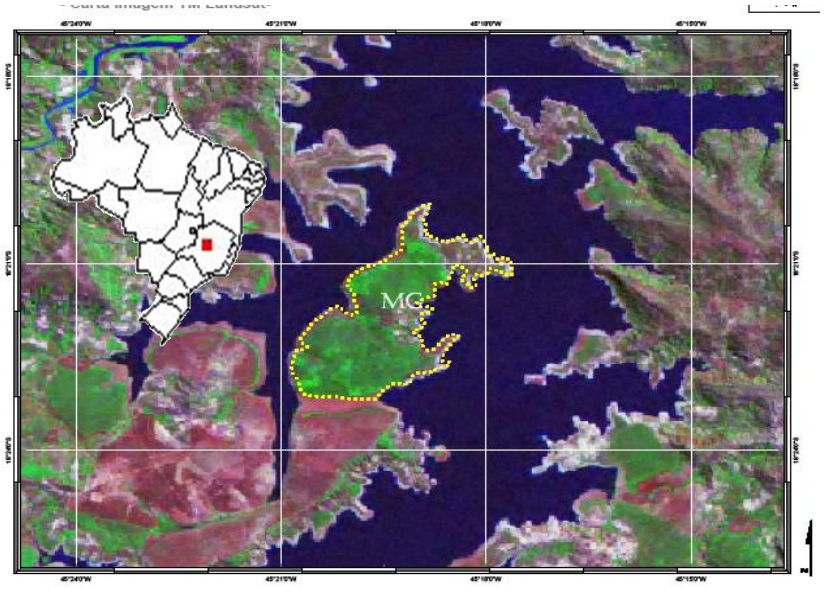


Figure 1. Pirapitinga Ecological Station geographic location.

The ecological station has an area of approximately 1.000 ha, which varies according to the reservoir water level. The vegetation of this artificial insular system comprises different Cerrado vegetation physiognomies (Sato and Sampaio 2006). To the east, the area is characterized by strong winds, presence of stones on the edge, while towards west the vegetation extends closer to the reservoir margins, is protected from winds and is marked by flooded areas covered with mud, grass and shrubs (Brasil 1987).

Study Species

Caiman latirostris is a highly aquatic species found primarily in densely vegetated and quiet waters including marshes, swamps and mangroves along the Brazilian Atlantic coast (Medem 1983). This species is widely distributed in the central-eastern South America (Figure 2). Despite the fact that the largest part of *C. latirostris* range is located within Brazil, information on the species population status in the country still scarce. Hydroelectric dams, wetlands drainage for agriculture, and pollution are affecting large portions of the species geographic distribution in the Brazil (Verdade et al. 2010).



Figure 2. *Caiman latirostris* geographic distribution.

The knowledge on *C. latirostris* biology in the wild comes mainly from the southern areas of its distribution range, (i.e. Argentina) and there are very few ecological studies conducted in Brazil (Moulton et al 1999, Filogonio et al. 2010). Filogonio (et al. 2010) found that, despite of the hunting pressure and the human impact on natural habitats, the populations of *C. latirostris* are widely distributed throughout the São Francisco basin (Southeast Brazil) and are not isolated.

MATERIALS AND METHODS

A total of 12 spotlight surveys were conducted from February 2010 to October 2011 with duration of 5 days each. Caimans surveys were conducted after dawn using a 4.8m long boat powered by a 15-hp outboard motor and a beam of a standard 12-V spotlight was used to locate the animals by "eyeshine". Whenever possible individuals were captured, water and air temperature was measured with a fast reading calibrated digital thermometer. Individuals were weighted, sexed and measured to their snout-vent length (SVL) using a measuring tape with an 0.5mm of accuracy (Figure 3). Individuals were categorized based in the snout-vent length: Class I (<25cm), Class II (25-<50cm), Class III (50 - <80) and Class IV (>80). Sexing technique is only reliable for individuals >40 cm SVL, therefore, smaller individuals were assigned as juveniles of undetermined sex. All captured individuals were marked by removing tail scutes according to a prescribed sequence. Information on growth, survivorship and movement patterns were obtained by mark-recapture study. Those individuals captured were released at their capture site on the same night they were marked, and all sites were marked using a GPS device (Garmin 60). The marking technique used has been widely used on crocodilian studies and having no effect on growth or survivor of marked individuals (Jennings et al 1991).



Figure 3. Field methods used during the caiman population monitoring.

Somatic growth rates (SGR) were expressed by changes in snout-vent-length (ΔSVL) measured from the snout to the rear of the cloacal slit. For each recapture interval (ΔT), the specific growth rate at time given by SGR = (1/SVL)(ΔSVL/ΔT), and defined as the proportional increase in SVL (mm) per unit of time (days), was plotted against mean SVL for each respective individual´s recapture interval. Growth rates were calculated using SVL rather than total length (TL) to avoid errors resulting from tail tip loss.

Age specific survival rates were calculated by applying a stepwise approach of the catch curve method, as described by Krebs (1989). Accordingly, instantaneous annual mortality rates were calculated separately for individuals from age class one and two and two to four years of age. For age class one, survival was calculated using the ratio method, whereas for age classes two to four, the regression method (log of frequency regressed against age) was applied (Coutinho 2000). We cannot assign whether the animals actually die or move outside the studied area. Nevertheless, the estimates are meaningful to foster the understanding of the effect of a protected area on caiman population dynamics.

The data were analyzed using Systat 11, with the significance level set at 5%. Mean values are presented followed by upper and lower interval using standard error of the mean.

RESULTS

Population surveys

Survey length ranged from 17.3 to 48.0 km and the number of caimans counted, including hatchlings, varied from 6 to 78 caiman. The rate of encounter ranged from 0.3 to 3.8 individual*km^{-1} (Table 1), with an average of 1.5 ± 0.38 individuals*km$^{-1.}$.

Table 1. Date of survey, length of survey, rate of encounter and number of broad-snout caiman observed for the Pirapitinga Ecological Station surveys, MG, Brazil.

Date of survey	Length of survey (km)	Number of caimans	Rate of encounter (ind/km)	Water Level S.L.	Air temperature range (°C)	Water Temperature range (°C)
Feb/2010	9.7	41	4.22	567.44	23.8 – 27.8	26.9 – 30.3
May/2010	20.2	42	2.07	568.1	16.4 – 22.4	22.6 – 26.9
Jul/2010	24.54	30	1.22	566.24	18.1 – 20.4	21.2 – 24.7
Oct/2010	17.25	41	2.37	562.98	23.1 – 27.4	25.1 – 28.0
Nov/2010	28.38	28	0.98	562.64	23.2 – 26.2	25.0 – 28.1
Dec/2010	28.02	12	0.42	564.11	22.7 – 25.6	29.4 – 31.3
Feb/2011	21.25	15	0.70	568.86	23.4 – 27.9	30.3 – 32.4
Mar/2011	48.14	23	0.47	571.01	21.4 – 24.6	26.7 – 27.4
May/2011	17.4	6	0.34	572.34	21.8 – 25.6	26.9 – 29.2
Jun/2011	20.75	13	0.62	571.88	17.8 – 22.2	23.6 – 24.6
Ago/2011	18.66	20	1.07	569.95	19.4 – 22.1	23.5 – 24.8
Oct/2011	20.55	78	3.79	567.35	21.6 – 24.3	24.5 – 27.3

Caiman population in Pirapitinga is composed mainly by juveniles (Figure 4) which, according to other monitoring studies, like Bradnt (1991), can be associated with an increasing population. Three clutches of known age individuals ranging from one to four years of age were monitored during the capture-recapture procedures. Adult animals were in low numbers (n=4), wary and difficult to catch. This low rate of encounter of sub adults and adults (Classes III and IV) may be related to wariness rather than to a lack of caimans representing these size classes. Although larger individuals generally occur in open water and should be easier to detect (Espinal and Escobedo-Galván 2011), adult individuals accounted for a small part of the ESEC Pirapitinga caiman population. The differences in wariness or activity level of these animals may have affected the count results during spotlight surveys.

The population sex ratio was estimated based on a sample of 22 individuals with svl>40 cm, in which sexes can be determine accurately. The overall sex ratio was 1.2:1 male/female. When considering juveniles and adults separately, the ratios are similar, 1.2:1 male/female for juveniles and 1:1 for adults.

The spotlight surveys covered the whole margins of Pirapitinga Island, however, we have observed that caimans were found only on the west side of the island, which was protected from winds and has muddy soil covered with aquatic grasses.

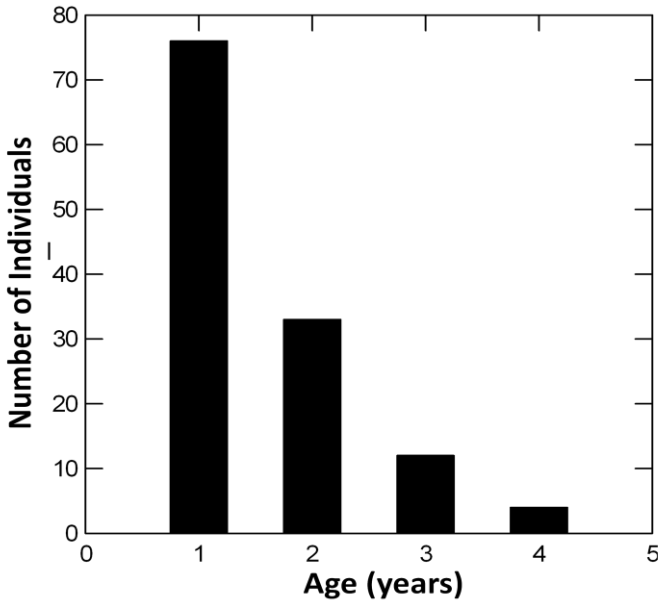


Figure 4. Age structure of *Caima latirostris* in Pirapitinga Ecological Station, MG Brazil, from February 2010 until October 2011.

Based on the population age structure a first estimate of age classes one to four survivorships were calculated. The estimate survivorship for age class one, obtained by the ratio method, was 0.433, whereas the regression method used to estimate the survival of age classes two to four was 0.456. In other words, 43.3% of new born caimans persisted to the following age class (two years of age), and 45.6% of the two years old individuals reach four years of age.

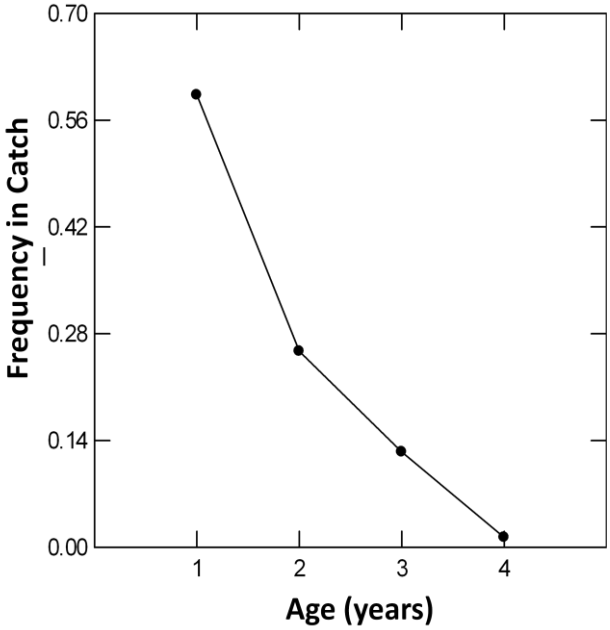


Figure 5. Catch frequency curve for *C. latirsotris* at Três Marias Reservoir during 2010 and 2011.

High mortality of caiman hatchlings during their first year of life was expected, theirs small size and the fact that they aggregate in crèches in the shallow waters make them an easy target for different predators (Coutinho 2000). In a predator free environment the survivorship rates for the first year tend to be higher. Piña et al, (2003) found that in captivity, depending on the incubation temperature, the *C.* latirostris survivorship rate in the first year can vary between 50 to 80 per cent.

As individuals grow they become more wary and difficult to catch, consequently affecting their frequency of catch (Pacheco 1996). Individuals may become wary of humans as a result of negative experiences associated with hunting, capture, surveys or habitat alteration (Espinal and Escobedo-Galván 2011, Webb and Messel 1979). Thus there was, probably, a problem with the sub-estimation of older individuals so, the data might be sub estimated for larger individuals and in reality, the survivorship rate could be higher.

Growth analysis

Growth rate varied between 0.0 to 0.3 cm*day^{-1} SVL, with a mean of 0.035 ±0.004) cm*day^{-1}. The variation in body mass varied between -6.0 to 8.0 g*day^{-1}, with a mean rate of 2.0 (±2.7 S.D.) g*day^{-1}. Table 2 shows the number of caimans captured and the mean SVL and mass value for each sampling period. During the study period three clutches were monitored, the data were analyzed first separately and then together for evaluating of a possible clutch effect on growth rate.

Table 2. Number of *Caiman latirostris* captured and recaptured, mean SVL and mass of captured animals for each month, in Pirapitinga Ecological Station, Três Marias dam, São Francisco river, MG Brazil.

	Month/Year	Δt	N capture	N Recapture	Mean SVL (cm)	Mean Mass ±SD (kg)
1	Feb/2010	-	39	-	26.27 ±1.54	0.84 ±0.46
2	May/2010	102	32	29	31.37 ±1.76	1.18 ±0.51
3	Jul/2010	60	21	20	31.15 ±0.84	0.74 ±0.07
4	Oct/2010	83	21	20	35.15 ±3.83	2.13 ±1.77
5	Nov/2010	49	17	17	31.14 ±0.76	0.72 ±0.07
6	Dec/2010	27	7	7	32.20 ±1.21	0.78 ±0.12
7	Feb/2011	43	8	5	61.61 ±11.79	14.37 ±7.58
8	Mar/2011	47	7	3	32.10 ±3.95	1.01 ±0.36
9	May/2011	43	3	2	33.83 ±5.80	1.02 ±0.42
10	Jun/2011	42	2	1	40.10 ±2.00	1.48 ±0.24
11	Aug/2011	65	5	5	43.12 ±1.97	1.94 ±0.30
12	Oct/2011	45	67	7	20.18 ±1.04	0.40 ±0.09

Δt = days between captures

The growth rate, expressed as centimeters of SVL per day, was plotted against mean SVL between captures; that is, $[(l_2 + l_1)/2]$, where l_1 and l_2 refer to lengths at capture and recapture, respectively. The relationship between growth rate and size was, firstly, examined fitting a distance weighted least square smoothing curve (DWLS) to the data set. From this analysis it was observed that no single growth model would fit the data set. In fact attempts to fit a linear regression equation to the entire data set revealed that it could not be used to generalize growth of these caimans (r^2=0.002; n=113; p=0.64).

Caimans in the Pirapitinga Ecological Station showed a polyphasic growth. Caimans´ polyphasic growth can be associated with different factors, including water level, size, age and dietary shifts (Coutinho 2000). At least three growth phases could be recognized. The first phase is characterized by high growth rate immediately after hatchling. Growth decreased in the second year of life, and then increased again during the third year of life, and by the end of the third year growth rate decreased again, when individuals reached about 40 cm SVL.

Effect of environmental variables on growth rates

The growth rate data set was also analyzed to verify the effect of environmental variables on individuals´ growth rate. The rainfall between recapture periods was analyzed to test its effects on caimans´ growth rate. Analyzes has showed that the relationship between rainfall and growth rate was positive and significant for both SVL (r^2=0.175; n=111; p<0.001; Figure 6) and Body Mass (r^2=0.207; n=111;

p<0.001; Fig. 7). Although the p values were significant the r^2 were low, which means that others important environmental factors that were not analyzed during this study may have a greater impact on growth rate.

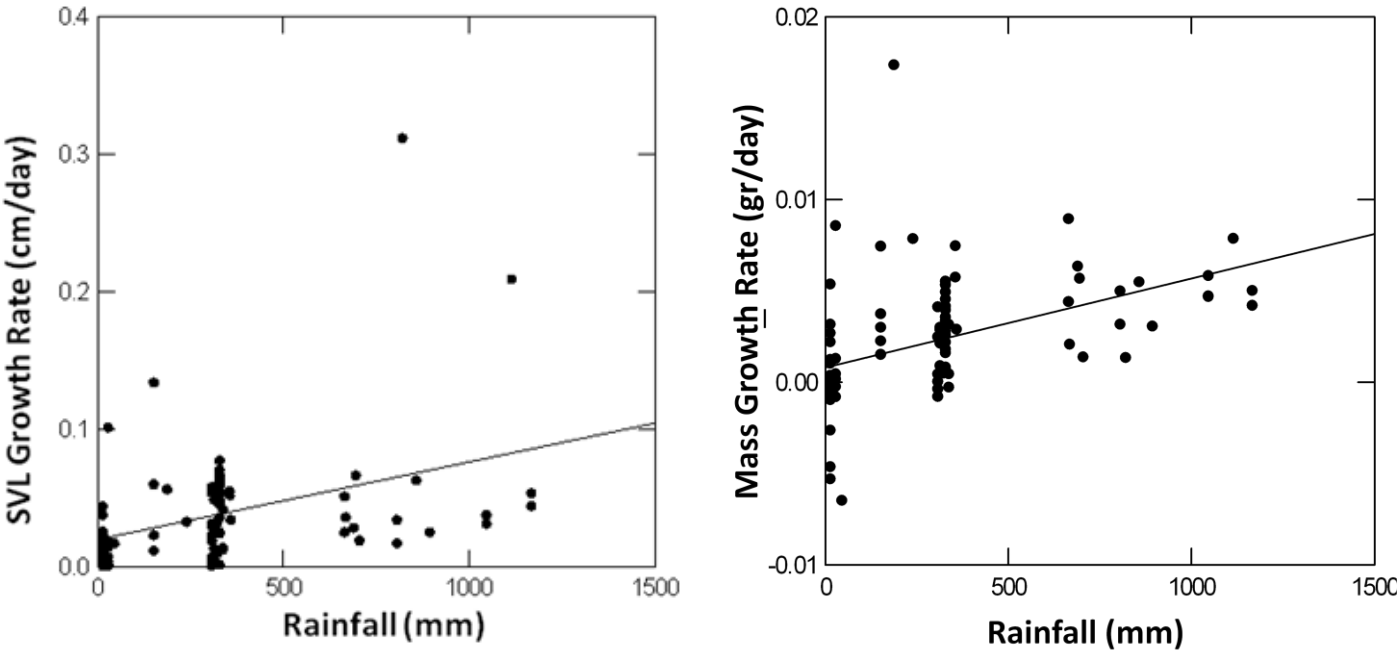


Fig 6 and 7. Relantioship between Pirapitinga Ecological Station rainfall between captures and *Caiman latirostris* snout-vent length(cm/day) and mass (gr/day) growth rates.

The effect of water level on growth rate was also studied. From a linear regression it was possible to observe the positive and significant relationship (r^2=0.12; n=104; p=0.001) between the SVL growth rate and variation in water level (Figure 8). A linear regression equation was also calculated for the relationship between mass growth rate and water level (Figure 9). This relation was also positive and significant (r^2=0.17, n=104, p=0.000), but again r^2 values were low.

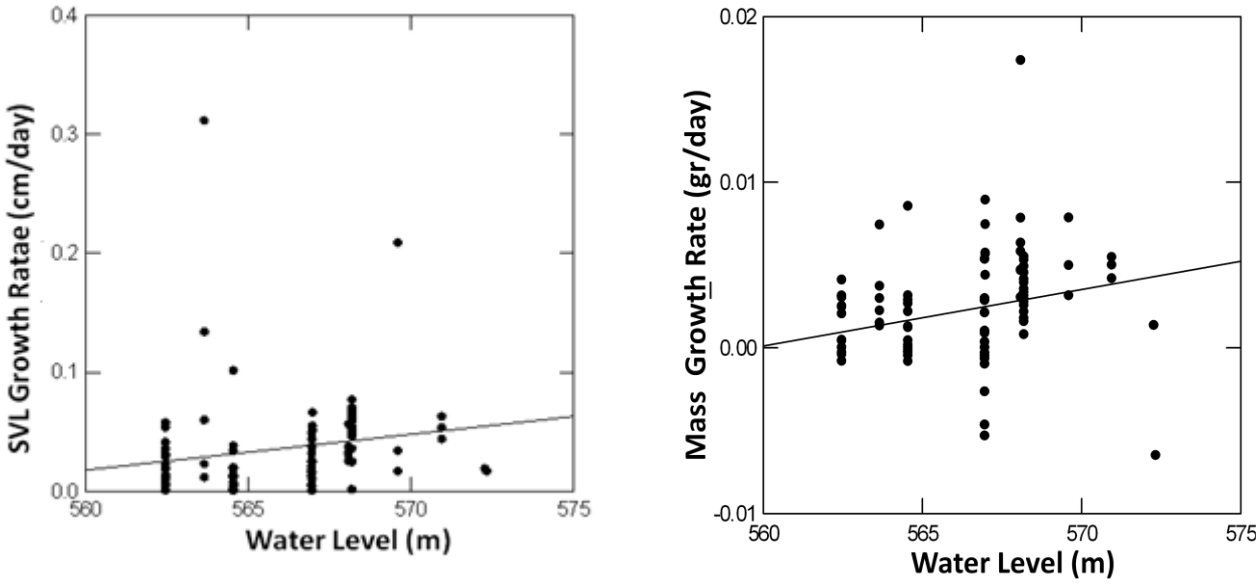


Fig 8 and 9. Relationship between Três Marias Reservoir´s water level and C*aiman. latirostris* snout-vent length (cm/day) and Mass (gr/day) growth rates.

Crocodilians are a climate-sensitive group, highly dependent on natural climatic conditions, especially thermal parameters and local hydrology (Markwick 1998), variations in water level and temperatures can affect their ability to find and digest food and consequently their growth (Webb et al. 1978, Piña and Larriera 2001).

Caimans have an opportunistic feeding habit which can be favored by the increase of plants along the margins associated with the rainy season (Fonseca, 2005), the vegetation growth can provide hiding places for individuals while they ambush theirs prey. The rainy season can also be associated with abundance of animal life (Fonseca, 2005), the increase of food availability promotes caimans growth.

The relationship between caiman growth rates and water level was significant and positive. The high water levels allowed caimans to exploit new feeding areas and to remain for long periods on the edge of or amongst the vegetation, in which insects, crustaceans and mollusks may have been abundant (Webb et al. 1978). The period of high water level is, normally, associated with the rainy season, which has higher temperatures, favoring caimans´ activity, food digestion and assimilation, and thus growth.

Conservation Implications

The broad-snouted caiman is a keystone species of great conservation concern due to its important role in the ecology of the watershed. Based on data collected during almost two years of field work, there is no doubt that the ecological station´s has a meaningful role on broad-snouted caiman conservation. The large number of juveniles indicates clearly that the area is a breeding site and trigger population growth.

Also, despite the impacts of damming and its effects on habitat modification, caimans are likely to be adapting to such changes. On the other hand, it is still premature to affirm that the reservoir has limited effect on the species population dynamics.

The ecological station has a great potential for caiman conservation and management and, therefore, it is suggested a long term monitoring program in other to understand the behavior of caiman population submitted to river dams impacts.

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