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Notes on a Population of *Caiman crocodilus crocodilus* Depleted by Hide Hunting in Surinam

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ABSTRACT

In 1978 and 1979 large-scale hide-hunting took a heavy toll of a population of spectacled caimans Caiman c. crocodilus *in northern Surinam. In the first three months of 1981 a preliminary inventory was carried out on the remainder of this population by means of night counts and size estimates. Some ecological aspects of the exploitation are discussed. Under effective protection this population, now estimated at 1000–1500 individuals, is believed to be able to recover.*

INTRODUCTION

Surinam is located north of the Amazon basin and biogeographically forms part of the Guianan district. It is still largely covered with undisturbed neotropical rain forest (Fig. 1).

Since the virtual extinction of large crocodilians in Latin America, attention has shifted towards smaller species such as the spectacled caiman *Caiman crocodilus*, resulting in drastic population reductions in many countries. In IUCN (1979) the subspecies concerned is listed as endangered. The spectacled caiman reaches an average adult size of 150–200 cm, with a maximum recorded length of 250 cm (Brazaitis, 1973) or even 270 cm (Wermuth & Fuchs, 1978).

Its status in Surinam is not yet critical. The species can still be found throughout the northern coastal plains, where it is locally common. In the

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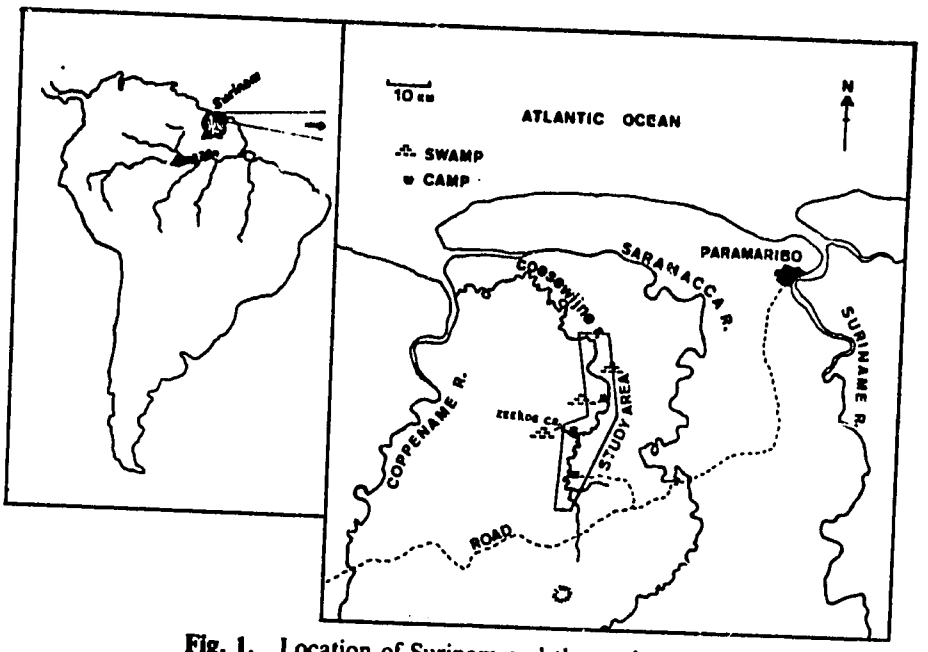

Fig. 1. Location of Surinam and the study area

Coesewijne river and swamp area (Fig. 1) a large population existed until large-scale hide-hunting in two consecutive dry seasons, around November 1978 and 1979, caused severe losses. Officials of the State Forest Service (LBB) estimated these losses at 1500–2000 caimans. Because the spectacled caiman was not yet legally protected, LBB and STINASU (Surinam's foundation for nature conservation) launched an active press campaign in an attempt to stop these activities. Around November 1980 no hunting was reported.

The present paper deals with a preliminary inventory on this population, carried out in the first three months of 1981 under the supervision of the institutions mentioned. The purpose of the inventory was to obtain an impression of the population status in the light of the exploitation in the preceding years. With regard to its size composition, it has been compared with two Venezuelan populations (Staton & Dixon, 1975; Gorzula, 1978). Attention was also paid to the possible causes of the reductions in fish populations after hunting, as reported by local fishermen. This may be related to the control of piscivorous fish species by caimans (Chirivi Gallego, 1973) and/or to the caiman's role in the nutrient regime of oligotrophic waters with allochthonous food sources (Fittkau, 1970, 1973).

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STUDY AREA

In the series of rivers flowing from south to north the Coesewijne is comparatively short, about 140 km. The river width varies from 15–50 m. It drains part of the northern fringe of the hill country and a vast swamp area in the coastal lowlands. From Paramaribo, the country's capital, the river can be reached by road in less than three hours. The study area covers about 80 km of river and creeks and downstream it extends to the first floating meadow covering a section of the Coesewijne. Hunting had taken place within this area.

The vegetation types in the study area range from open swamps and swamp forest to marsh forest and (on elevations such as old river banks, shoals and ridges, slopes and plateaus) mesophytic dryland forest and locally savannas (Teunissen, 1979).

Average monthly temperatures range between 25–29°C. Rainfall in this region varies between 1750–2250 mm annually and the monthly average is always more than 60 mm. There are four seasons; a long rainy season (April to August), a long dry season (August to December), a short rainy season (December and January) and a short dry season (February and March). The two short seasons are, however, often not as distinct as the long ones. The lower parts of the area are usually flooded during 3–5 months of the year.

METHODS

According to the location of the camp sites, the river was divided into six zones ranging in length from 10–17 km. Nocturnal eyeshine censuses were made on the river and on creeks, as far as these were navigable (this depended upon the water depth, with a minimum of 30 cm, and the density of water plants). Usually a census was carried out on one zone per evening up and down from one of the camps. For most zones this was done several times during the study period, with varying water levels. Censusing started half an hour after nightfall (between 1900 to 1930 h) and lasted 2–5·5 hours. A headlamp was used connected to a rechargeable motorcycle battery.

Caimans were captured by noosing and grabbing, and three were shot for the analysis of stomach contents. In the boat they were sexed (Brazaitis, 1968), measured and marked. The measurements taken were

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head length (from the tip of the snout to the posterior edge of the skull roof behind the ears) and total length. Marking was done by cutting one or two small triangles out of one or more scale crests on the tail with a tin-snipper. After noosing the caimans struggled for less than a minute and then usually became docile, as long as they were held in a firm grip. The capture and examination were done by two to three persons. Because of practical problems, such as the scarcity of suitable assistants, only 30 caimans could be captured.

As an alternative inventory method size estimations were made from within a range of a few metres, providing a sample comprising 213 caimans. Mostly only the head was clearly visible and the total length was then estimated by multiplying the estimated head length by 8 and then reducing this to the nearest 5 or 0. Estimation accuracy was tested and adjusted by comparing the estimated size of some arbitrary objects and of some caimans before capture with subsequent measurements.

RESULTS

Night counts

Because caimans retreat into swamps and forests when these are flooded, the numbers in the streams varied greatly, according to the area flooded; when this area dries up and the water level in the streams sinks, the numbers of caimans in the river will rise.

The sum of the numbers of caimans in all river zones and creeks in the study area ranged from 534 to 1025 in periods with high and low water levels respectively, on a total bank length of 160 km (one caiman per 281–146 m of bank). However, these are artificial totals, as it took several consecutive nights to census the whole study area, which may lead to double-counts or to overlooking animals, because of movements between zones. On the other hand, caimans were often found at the same spot on various nights. Considering that most hatchlings stayed hidden in the swamps and also that some older individuals may have remained in swamp depressions which still contained water, the total population in the study area was estimated at 1000–1500. Taking into account a loss of 1500–2000 caimans, this implies that at least half of the population was killed in 1978 and 1979.

During the study period the lowest number counted in one zone was

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seven caimans (on 10 km of river with flooded forest), while the highest was 313 (on 16·5 km of river with the swamps largely dried up). The density on the two navigable km of the Zeekoe creek, which drains a large open swamp, could reach very high levels; numbers counted on this section varied between 42 and 213 caimans, with varying water levels. The mean difference between the counts up and down from a camp on one evening was 5·3 (ranging from 0–23 individuals) on a mean highest count of 119 caimans.

The population density on the river was higher near the mouths of large side creeks and on sections bordered by large open swamps.

Captures

Capture success varied from 1:10 to 1:15 caimans which were approached. Thirty were captured, 29 spectacled caimans and 1 dwarf caiman *Paleosuchus palpebrosus*. One was found dead in a fisherman's net, 3 were shot, 4 hatchlings were grabbed and released, and the rest (22) were noosed and released. No marked animals were recaptured.

In 23 cases sex could be determined: 12 males and 11 females. The ratio head length: total length averaged 7·63 (SD 0·27), ranging from 7·2 to 8·1. The smallest hatchling captured measured 26·5 cm, the largest adult 193 cm (total length). More than half of the individuals (55 %) fell in the 80–100 cm size class. The dwarf caiman measured 42 cm.

The number of captures was too small and too biased to permit any further statistical analysis as a representative population sample.

Size estimates

The observer's estimate accuracy appeared to be reasonable, as shown, for instance, by comparing size estimates and measurements of 9 caimans before and after capture (measurement in cm followed by estimate in parentheses): 81 (80), 82 (80), 83 (80), 85 (90), 87 (80), 94 (80), 114 (120), 151 (140), 193 (175).

The results of the estimates are presented in Fig. 2. Because of the inaccuracy inherent in estimating, these data have not been put into size classes. A size histogram of estimates may distort information and this could lead to false interpretations. Moreover, a direct ordination facilitates comparisons with future inventories or with other populations.

The sample of size estimates comprises 213 spectacled caimans,

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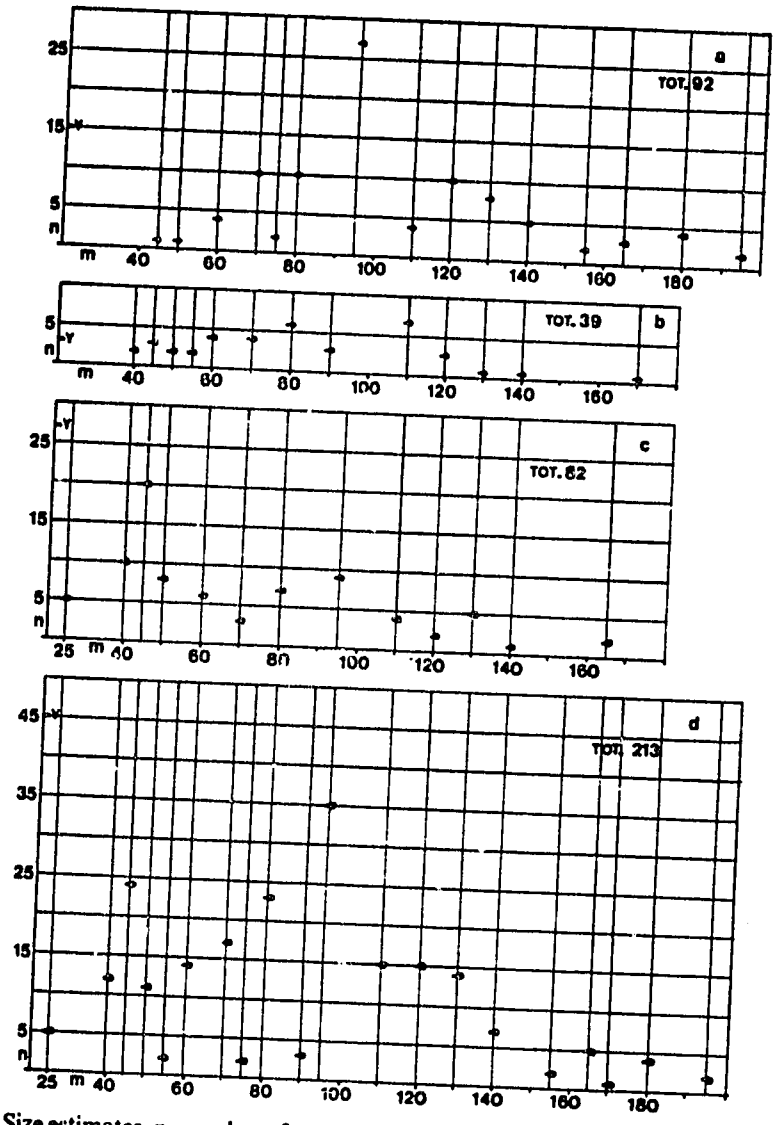

Fig. 2. Size estimates. n, number of spectacled caimans; m, estimated total length in cm in multiples of 5; y, number of caimans, of which the size could not be estimated (no included in the totals). (*a*) Sample fraction on a representative river section of 12·5 km (2(March); (*b*) sample fraction in a grass strip along the river of 1 km, bordered by oper swamp (25 March); (*c*) sample fraction on 3·5 km of the main creeks (23–26 March); (*d*) sample (= (*a*) + (*b*) + (*c*)).

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encountered on several nights between 18 and 26 March (Fig. 2d). On these occasions considerable numbers of caimans (45 against 213) could not be approached close enough to permit a size estimate (y in Fig. 2), mostly because they were hidden under dense scrub or because the creeks were too shallow. However, in similar circumstances when an estimate was just possible, individuals of all size classes were found. Therefore, I believe that this factor does not lead to strong bias of any size class.

A variety of habitats were covered in almost all of the creeks and about 13·5 km of the Coesewijne river itself. The risk of double counts was minimal, because the sections searched on different nights were usually far apart.

In two respects this sample is not representative; creeks are overrepresented compared with the main river and open grass swamps were not covered. Therefore two corrections were made.

First, the numbers on a representative section of the river (Fig. 2a) covered during estimating were multiplied by 4 and then added to the original sample (during night counts this was the approximate ratio of the number of caimans in this section to the number in the remaining zones). Thus an 'extrapolated' sample with a size of 581 was formed.

Secondly, there still exists a significant bias against hatchlings in the sample, because they must have stayed hidden in the grass swamps. Apart from five hatchlings in the Zeekoe creek, none were seen in the sample area (according to regular visitors this was also the case before hunting). Therefore two 'corrected' samples were formed with sizes of 640 and 720, assuming hatchling percentages of 10% and 20% respectively (cf. 12% and 30% as reported by Gorzula (1978) and Staton & Dixon (1975) respectively, while in the latter case first-year mortality and consequently reproduction were very high).

Heavy exploitation, such as the hunting in 1978 and 1979 on the Coesewijne, usually affects large-size adults first and thus the reproductive strength of the population. Therefore it is important to measure reproduction following these events and also the actual proportion of large animals in the population. Little is known about reproduction just before this study, because the habitat is extensive and access difficult, making it hard to detect hatchlings. The proportion of second-year juveniles must then be taken as an indication of post-hunting reproduction. Based on the results of Gorzula (1978) and Staton & Dixon (1975) and assuming hatching to take place at the end of the long dry season (November), individuals in the size range 40–55 cm are considered to be

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second-year juveniles. They were found significantly more often along the main river in grass strips bordered by large open swamps and in side creeks (96 % of this class and 46 % of the remaining size classes were found in these habitats (Fig. 2b, c)). Juveniles estimated at 40–55 cm constitute 8·6 % and 7·6 % of the 'corrected' samples, with 10 % and 20 % hatchlings respectively.

Large adults (estimated at 160 cm or longer) were significantly more numerous in the main river (Fig. 2a, b) than in side creeks (Fig. 2c): 7·6 % and 2·4 % of the sample fractions in the respective stream types belonged to this class ($p = 0{\cdot}05$). They constitute 7·5 % and 6·7 % of the respective 'corrected' samples.

While estimating sizes one night, three dwarf caimans *P. palpebrosus* were encountered on different sites with estimated total sizes of 80, 80 and 100 cm. The largest was found together with a spectacled caiman of about 80 cm. There was no difference in the habitat of either species.

Stomach contents

Of the four spectacled caimans analysed, the stomach of one sub-adult (89 cm) contained elytrae of three water beetles (Hydrophilidae: Coleoptera); that of another (87 cm) contained unidentifiable fish remains.

Each of the stomachs of two larger caimans (114 and 193 cm) contained an entire piscivorous fish of about 23 cm (*Hoplias malabaricus*, in Surinamese 'pataka'). The latter stomach also contained some crustacean remains (cf. *Uca* sp.).

Non-food items were only found in the stomachs of the two larger caimans, including plant material, some small nematodes (either stomach or *Hoplias* parasites) and a bottle fragment, but no gastroliths.

These data were too limited to permit generalisations, but it should be noted that *Hoplias* was a very abundant fish species. In the evenings, with a torch, many were seen lying in shallow water and were quite easy to catch, even with a cutlass, or by a skilled person with his hands.

DISCUSSION

Information about the size and composition of a population is essential to assess its status. Common methods of making an inventory of crocodilian populations are night count/size estimates and the recapture of marked

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animals (Chabreck, 1966). Both methods have their advantages and disadvantages. The size estimate method requires little equipment and time, one observer can be sufficient and there is little disturbance among the population. On the other hand, sex determination is impossible, the animals cannot be marked and the method is less accurate (although, as Chabreck (1966) states, 'skilled observers can make this estimate with surprising accuracy at distances up to 30 feet'). This method is useful to establish population trends from year to year; the system should then be standardised as much as possible (census routes, season, observer, equipment and other relevant factors, such as water level, which may influence dispersal). The recapture method is more accurate and it yields more information, but capturing and marking require much more time, equipment and assistance. Moreover, it is uncertain whether the chance of capture is the same for each age class or for individuals which have or have not been captured before. Both factors can lead to unrepresentative population samples. This method is more suited for a detailed inventory in a small area.

The scarcity of information on the past size and composition of the caiman population in the Coesewijne area makes it difficult to evaluate its present status. All that is known is that about 250 skins confiscated in 1978 ranged in size (total length) from 100–240 cm (Medem, 1979).

The following comparison of several gross size classes of the Coesewijne population with the populations studied by Gorzula (1978) and Staton & Dixon (1975) in Venezuela serves as a tentative evaluation (Table 1).

However, as Table 1 shows, the compositions of the two Venezuelan populations differ considerably. It should also be noted that the results from Staton & Dixon have two uncertain factors: the authors give only snout-vent lengths (SVL), which had to be extrapolated to total lengths, and, secondly, the size classes are unnecessarily wide (20 cm SVL), so that they had to be broken up more or less arbitrarily to enable the comparisons to be made (see Table 1).

Second-year juvenile caimans from the Coesewijne population were estimated to have a length of 40–55 cm, those from Gorzula's population, between 50 and 60 cm, and those from Staton & Dixon part of the 20–40 cm SVL class (Table 1). The lower limit of 40 cm in the Coesewijne population may seem too low, but it was the nearest class after the hatchlings (and the thin tail of these juveniles may have led to some underestimation).

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When comparing these estimated and measured sizes, the possibilities of over- and under-estimating should be taken into account. Therefore a range between two percentages is given in Table 1 for the larger sizes in the Coesewijne population (e.g. for the 70–120 cm size class percentages of caimans estimated between 75–110 cm and 60–130 cm have been calculated).

TABLE 1
Some Size Classes of the Coesewijne Population, Compared With Two Venezuelan Populations (in %)

Size class	*Coesewijne*			*Gorzula (1978)*	*Staton & Dixon (1975)*
	Sample	*'Corrected' (10% hatchlings)*	*'Corrected' (20% hatchlings)*		
Second-year juvenile	22	8·6	7·6	13	±2·5
70–120 cm	37–65	39–68	35–61	48	±28
>125 cm (adult)	16–23	20–29	18–26	14	±32
>160 cm	5·6–6·6	7·5–9·1	6·7–8·1	1·5	±14

Table 1 shows little difference between the assumptions of 10% or 20% hatchlings (in the 'corrected' Coesewijne samples). The only striking difference between the Coesewijne columns is the difference in second-year juvenile percentages between the uncorrected and the 'corrected' samples. This is due to the fact that this category is more abundant in side creeks and thus over-represented in the uncorrected sample.

The percentages of second-year juveniles in the 'corrected' samples are lower than reported by Gorzula (1978), but considerably higher than reported by Staton & Dixon (1975). The latter authors consider this very low percentage to be a result of the high hatchling mortality, especially during the dry season, when the remaining water bodies become very crowded. This poses a problem concerning the growth rate, which Gorzula concluded to be constant for the first six years; this constant growth rate cannot hold for the population studied by Staton & Dixon, considering increasing percentages of larger caimans. However, this aspect is not dealt with in either of the publications. The reproduction activity in the Coesewijne population seems to have been reasonable in

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terms of percentages and hunting did not have a drastic adverse effect in this sense.

The population studied by Gorzula was also affected by hunting, before the Venezuelan government put a moratorium on all wildlife hunting. This is reflected in the high proportion of subadults compared with adults, an indication of commercial exploitation. The percentage of large caimans is very low, although this may partially be a natural phenomenon. Keeping this in mind, the comparison between the three populations shows that the proportion of subadults in the Coesewijne population is relatively high and the proportion of large adults is on the low side.

Considering the actual number of spectacled caimans, estimated at 1000–1500, the apparently reasonable reproduction activity since hunting, and the size composition as discussed above, the Coesewijne population must be capable of a steady recovery, provided effective protection can be warranted.

Although the contents of only a few stomachs were analysed, the role of caimans in controlling piscivorous fish populations seems feasible in this area. Positive indications are the *Hoplias malabaricus* found in the stomachs of two caimans, the abundance of this species in the study area and the fact that they are relatively easy to catch. Various studies have shown a great variety in diet (Gorzula, 1978; Staton & Dixon, 1975) according to the locally differing prey fauna composition, but it is noteworthy that Seijas & Ramos (1980) identified *H. malabaricus* as the most frequent food item in the stomachs of spectacled caimans they studied. It is obvious that in such a case a drastic reduction of a caiman population changes the balance between fish species, first to be noticed by fishermen.

Fittkau (1970, 1973) presented an interesting hypothesis on the ecological role of caimans and other carnivores in the extreme oligotrophic mouth-lakes of Amazon affluents. He suggests that the primary production in these water bodies is based on nutrients supplied by the metabolic activity of carnivores with allochthonous food sources such as the surrounding forest and the Amazon itself. Further investigations might suggest an analogous situation in the Coesewijne area, with the flooded swamps in the wet season as stagnant oligotrophic water bodies, where fish species come to breed and thus forming an allochthonous food source for caimans. Some limnological data are known from the Coesewijne (Glastra, 1981), but their interpretation is limited by

the absence of data on organic dissolved nitrogen and phosphorus, and because of unusually high orthophosphate quantities (0·18–0·31 mg PO_4^{3-}/litre) and poor information on the chemical form of the N and P data by Fittkau (1973). The Coesewijne data suggest at best that a large caiman biomass could, under certain assumptions, have some stimulating effect on the primary production by the quantity of nitrogen produced. The original quantities of phosphorus and main cations in the water do not appear to be limiting factors for primary production.

In addition to the spectacled caiman, the dwarf caiman also occurs in the study area, although in very small numbers (during size estimations three dwarf caimans were encountered against at least 213 spectacled caimans). There was no biotope difference between the two species, as has also been reported by M. Hoogmoed (pers. comm.) from other sites in Surinam. This contrasts with the differences pointed out by Donoso-Barros (1965) and Medem (1958), who stated that *Paleosuchus* prefers narrow, rapidly flowing streams, whereas *C. crocodilus* is restricted to slowly flowing rivers, marshes and ponds.

If the remaining spectacled caimans were again to develop into a large population, this could be important for the survival of this endangered species. Future inventories in this area, preferably in the long dry season, are desirable in order to follow population trends. Better legal protection for this species and/or this area is necessary. The spectacled caiman will probably soon fall under some sort of hunting restriction. Fortunately in the beginning of 1981 Surinam ratified CITES (Convention on the International Trade in Endangered Species); this caiman species is included in Appendix II. Because of its exceptional beauty and the occurrence of populations of other endangered species, such as the manatee *Trichechus manatus* and the giant otter *Pteronura brasiliensis*, the Upper Coesewijne area has been proposed as a nature reserve (Schulz *et al.*, 1977; Teunissen, 1979).

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REFERENCES

Brazaitis, P. (1968). The determination of sex in living crocodilians. *Br. J. Herpet.*, **4**, 54–8.

Brazaitis, P. (1973). The identification of living crocodilians. *Zoologica, N.Y.*, **58**, 59–101.

Chabreck, R. H. (1966). Methods of determining the size and composition of alligator populations in Louisiana. *Proc. a. Conf. S. East. Ass. Game Fish Commnrs*, **20**, 105–12.

Chirivi Gallego, H. (1973). Contribución al conocimiento de la Babilla o Yacaré Tinga (*Caiman crocodilus*), con notas acerca de su manejo y de otras especies de crocodylia neotropicales. *Simposio Internacional sobre Fauna Silvestre y Pesca Fluvial y Lacustre Amazónica*. Manaus, Brasil.

Donoso-Barros, R. (1965). Contribución al conocimiento de los Cocodrilos de Venezuela. *Physis, B. Aires*, **25**, 387–400 and **26**, 15–32, 263–74.

Fittkau, E. J. (1970). Role of caimans in the nutrient regime of mouth-lakes of Amazon affluents (an hypothesis). *Biotropica*, **2**, 138–42.

Fittkau, E. J. (1973). Crocodiles and the nutrient metabolism of Amazonian waters. *Amazoniana*, **4**, 103–33.

Glastra, R. (1981). *De brilkaaiman in het Coesewijnegebied* (*Suriname*). *Unpublished report*. Paramaribo, Surinam.

Gorzula, S. J. (1978). An ecological study of *Caiman crocodilus crocodilus* inhabiting savanna lagoons in the Venezuelan Guayana. *Oecologia*, **35**, 21–34.

IUCN (1979). *Red Data Book, Vol. 3: Amphibia and Reptiles*. Gland, Switzerland, IUCN.

Medem, F. (1958). The crocodilian genus *Paleosuchus*. *Fieldiana Zool.*, **39**(21), 227–47.

Medem, F. (1979). *Report on the commission to Dutch Guiana* (*Surinam*) *in December 1978*. Paramaribo, LBB-archives.

Schulz, J. P., Mittermeier, R. A. & Reichart, H. A. (1977). Wildlife in Surinam. *Oryx*, **14**, 133–43.

Seijas, A. E. & Ramos, S. (1980). Caracteristicas de la dieta de la baba (*Caiman crocodilus*) durante la estación seca en las sabanas moduladas del Estado Apure, Venezuela. *Acta biol. venez.*, **10**, 373–89.

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Staton, M. A. & Dixon, J. R. (1975). Studies on the dry season biology of *Caiman crocodilus crocodilus* from the Venezuelan llanos. *Mems Soc. Cienc. nat. La Salle*, 35, 237–65.

Teunissen, P. A. (1979). *Aanbevelingen tot uitbreiding van het systeem van natuurreservaten en bosreserves in het surinaams laagland* (2e druk). Paramaribo, LBB/STINASU.

Wermuth, H. & Fuchs, K. (1978). *Bestimmen von Krokodilen und ihrer Häute*. Stuttgart, Gustav Fischer.

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