

The Management of Crocodilians in Venezuela

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WHEN a country wishes to manage crocodilians, regardless of whether the emphasis is to be on the protection and enhancement of depleted populations of an endangered species, or the formulation of a programme for utilising a species that is relatively common, the following questions will invariably arise:

1. Which species exist in the country?
2. Where are they found in the country?
3. How many individuals make up the populations?
4. Are the numbers stable, declining or increasing?
5. What factors are influencing population trends?
6. How do the public "perceive" crocodilians?

These six basic questions can only be answered with data on: taxonomy; geographical distributions; censuses; monitoring; the natural and man-induced factors that affect population trends; and, public opinion.

During the 7th Working Meeting of the IUCN/SSC Crocodile Specialist Group, held in Caracas in 1984, eight papers were given that summarized much of the present knowledge of Venezuela's crocodilians (Gorzula and Paolillo 1984; Mago de Perez 1984; Medina 1984; Quero de Peña 1984; Ramo and Busto 1984; Rivero Blanco and D'Andria 1984a; Seijas 1984a, b). From a management point of view, there remain notable gaps: the taxonomic status of the subspecies of *Caiman crocodilus* is unclear; about 72% of the country lacks records for *any* crocodilian species; some censusing methods are essentially untested and do not discriminate adequately between species and habitats; no long-term monitoring of crocodilian populations has been carried out; and, the recent positive change in public attitude towards crocodilians has about as much scientific basis as the negative view which existed previously.

Relative to some countries, a considerable research effort on crocodilians has been mounted in Venezuela, but the results have tended to be descriptive and intuitive, rather than comparative and experimental. Furthermore, a considerable body of

information on Venezuela's crocodilians remains unpublished or is at least very difficult to access.

The management of crocodilians in Venezuela has been aimed primarily at preservation, with a view to stimulating the recovery of species (particularly *Crocodylus intermedius*) that were over-harvested. However, *Caiman crocodilus* is now reasonably abundant in some areas and serious consideration is being given to a controlled harvest programme, in an atmosphere of debate and uncertainty. It is unclear as to whether the information currently available is sufficient to ensure that farming and/or a sustainable harvest can in fact be achieved, and thus whether or not the long-term conservation of *C. crocodilus* and Venezuela's other crocodilians will gain from such a project. The programme to ensure the conservation of *C. intermedius* has been unco-ordinated and largely unsuccessful.

This chapter highlights the gaps in our knowledge of Venezuela's crocodilians that are considered to have a significant bearing on management. The existing management programmes are critically reviewed, and an attempt is made to isolate the areas of study which should be given priority by the institutions involved in crocodilian research and management. The analysis will hopefully provide insights that are of use to others involved with crocodilian conservation and management, in different parts of the world.

SIGNIFICANT GAPS IN INFORMATION

Taxonomy

At the present time there are considered to be five species of crocodilians in Venezuela: *Caiman crocodilus*, *Paleosuchus palpebrosus*, *Paleosuchus trigonatus*, *Crocodylus acutus*, and *Crocodylus intermedius*. In addition, two subspecies of *Caiman crocodilus* (*Caiman crocodilus crocodilus* and *Caiman crocodilus fuscus*) are recognized (Medem 1983). At the time of writing, no taxonomic studies had been made on Venezuelan crocodilians at a regional level, yet the taxonomy of two species clearly needs attention.

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In the case of the *Caiman crocodilus* subspecies, it is assumed that *C. c. fuscus* inhabits the north-western part of the country, in the Maracaibo basin and in the States of Yaracuy and Falcón, and that it is "replaced" by *C. c. crocodilus* in the remainder of the country. In fact, it is pure speculation as to whether there is a zone of intergradation between these subspecies or if some geographical barrier, such as the Venezuelan Andes and the coastal range, separates them. The taxonomic status of *C. c. crocodilus* in Venezuela is also unclear. The ecology of *C. c. crocodilus* in the western Llanos of Venezuela (Ayarzagüena 1980; Godshalk 1976; Maness 1976; Marcellini 1979; Staton and Dixon 1975, 1977) varies considerably from the ecology of what is nominally the same subspecies in southeastern Venezuela (Gorzula 1978). There are differences in behaviour, population structure, population dynamics, and, in the average maximum size of adults. Anecdotal information from hunters indicates that the skins of *C. crocodilus* from the Orinoco Delta were of less value than those from the western Llanos, because they were smaller and more ossified (had more "buttons"). The basis for these differences is open to speculation, but significant taxonomic variation cannot be ruled out.

The Orinoco crocodile *C. intermedius*, has likewise been reported to have various "phases". Medem (1981) describes and illustrates three colour phases from Colombia: *mariposo*, with a grey or grey/green dorsum and black patches; *amarillo*, with a light brown or sand coloured dorsum and flanks and a few dark patches; and *negro* with a dark grey or black dorsum and flanks. However, Medem also noted that a captive male of the *negro* phase changed to the *amarillo* phase during two years in captivity. Lopez Corcuera (1984) reports that there were three varieties of Orinoco crocodile recognized by hide hunters in Venezuela: the green (*caimán verde*) of the Orinoco; the yellow (*caimán amarillo*) of the western Llanos; and, the tiger (*caimán tigrato*) that was apparently shorter, fatter and stronger than the other two varieties and had distinct round, black markings along its flanks. These differences, especially in colouration, could be environmentally induced (Kirshner 1985) but again there may be a more fundamental taxonomic basis.

Geographical Distribution

The known distribution of each species of crocodylian in Venezuela was plotted using a grid of 0.5 degrees of latitude by 0.5 degrees of longitude (Figs 1-6). Each grid square covers a little less than 3000 km², there being a total of 354 squares covering continental Venezuela and the island of Margarita. (The Venezuelan Esequibo Territory has not been included in this analysis). Squares are shaded to indicate the confirmed presence of the species under consideration at one or more localities within that square.

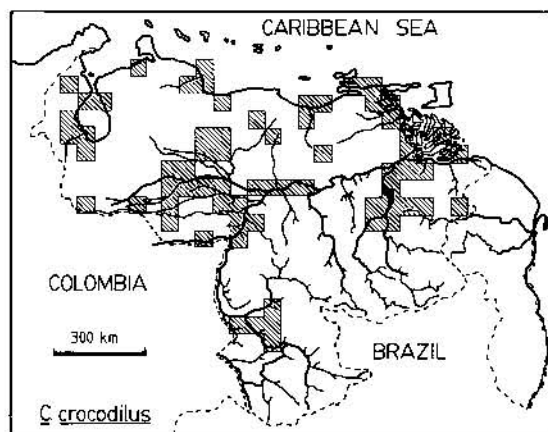


Fig. 1. The known distribution of *Caiman crocodilus* within Venezuela.

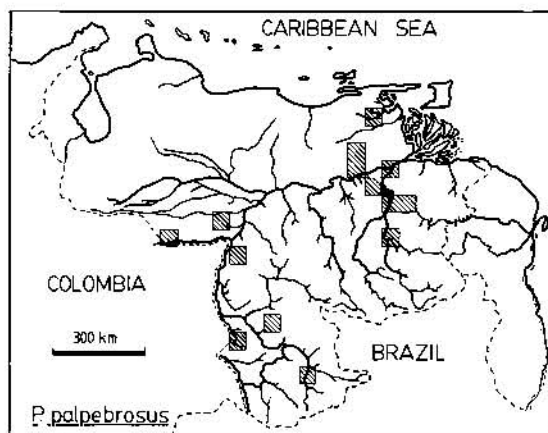


Fig. 2. The known distribution of *Paleosuchus palpebrosus* within Venezuela.

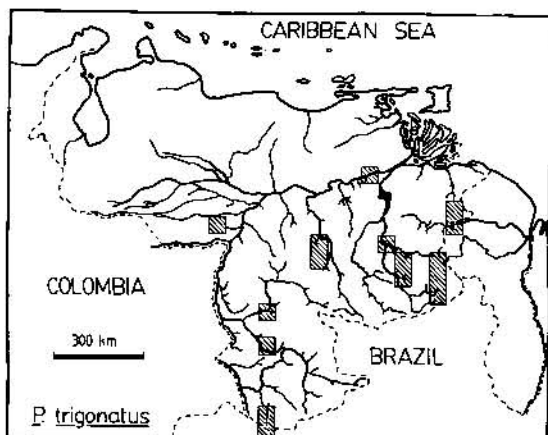


Fig. 3. The known distribution of *Paleosuchus trigonatus* within Venezuela.

Data for *C. crocodilus* (Fig. 1) was compiled from Ayarzagüena (1980), Gorzula and Paolillo (1984), Medem (1983), Ramos *et al.* (1981), Rivero Blanco and D'Andria (1984b), Rodriguez and Robinson (1984), Seijas (1984b,c) and Staton and Dixon (1975). Data for *P. palpebrosus* (Fig. 2) and

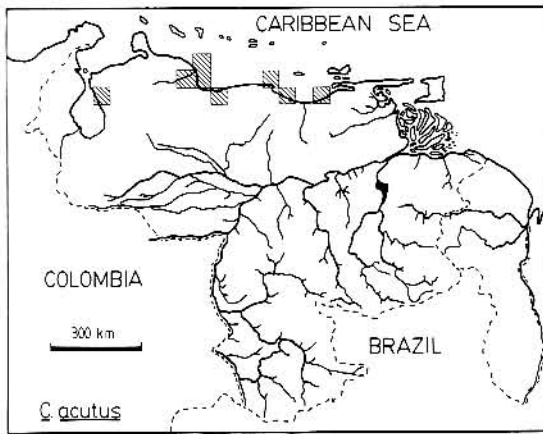


Fig. 4. The known distribution of *Crocodylus acutus* within Venezuela.

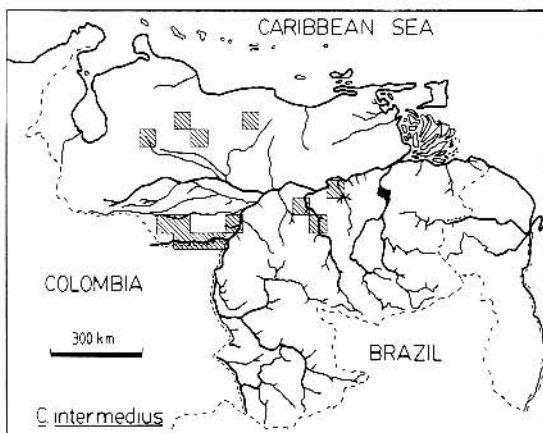


Fig. 5. The known distribution of *Crocodylus intermedius* within Venezuela.

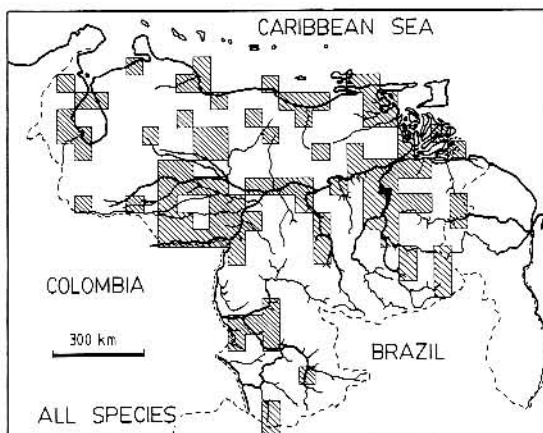


Fig. 6. The known distribution of the five species of crocodilian known to exist in Venezuela.

P. trigonatus (Fig. 3) are based on Gorzula and Paolillo (1984). The distribution of *C. acutus* is based on Seijas (1984a) and that of *C. intermedius* on information from Blohm (1982), Franz, Reid and Puckert (unpublished manuscript), Godshalk

(1982), Godshalk and Sosa (1978), Novoa (unpublished manuscript) and, Ramo and Busto (1984). For the two species of *Crocodylus*, records prior to 1974 have not been included.

All five species show a marked discontinuity of known localities within the probable range of each. When the information for all five species is pooled (Fig. 6), it can be seen that for 72% of Venezuela there are no records of any species of crocodilian being present, yet many such areas probably contain crocodilians.

A relatively large tract of land (some 20,000 km²) that merits specific attention is the Orinoco Delta. Large crocodilians are seen in that area occasionally, yet whether they are *C. acutus*, *C. intermedius*, or even *Melanosuchus niger* is unknown. During the period of intensive hide hunting (1930's and 1940's), skins of *Melanosuchus niger* were sold in San Fernando de Apure (Lopez Corcuera 1984), but it is not known if they originated in Venezuela.

Censuses

At present, there are four regional surveys being carried out to estimate the densities of crocodilian populations in Venezuela.

The first, and certainly the most intensive, is that of the National Wildlife Service of the Ministry of the Environment and Renewable Natural Resources (MARNR) in the western Llanos. The object of the census is to calculate the harvest levels for *C. crocodilus* within the ranches that have applied for licences for commercial hunting. The basic methodology has been direct counts of *C. crocodilus* by means of spotlight surveys at night, in lagoons where the caimans concentrate during the dry season (Figs 7 and 8). The results of the first year of this project have been published by Seijas (1984c).

The same institution is surveying *C. acutus* along the northern coast of Venezuela (Seijas 1984a), and as an incidental result, is obtaining counts of *C.*



Fig. 7. During the annual dry season, *Caiman crocodilus* congregate in high densities within the lagoons of the Llanos.

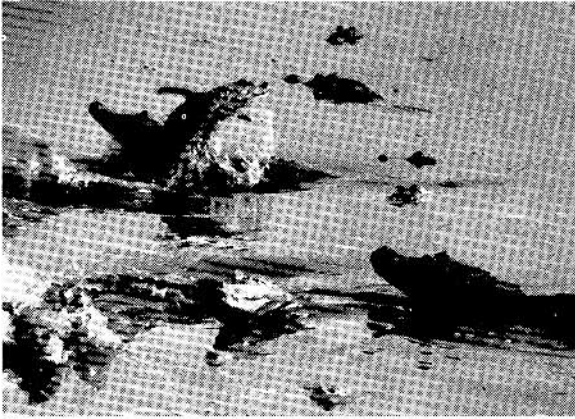


Fig. 8. Day counts and night counts of *Caiman crocodilus* are used to estimate population size.

crocodilus in the same habitats (Seijas 1984b). In this case the methodology consists of spotlight surveys, at various times of year, and the results are expressed as number sighted per kilometre of river or per kilometre of shore-line of lake.

The Universidad Nacional Experimental de los Llanos Occidentales "Ezequiel Zamora" (UNELLEZ) is surveying populations of *C. intermedius* in the western Llanos (Ramo and Busto 1984). This survey uses direct counts of crocodiles from a light aircraft and has quantified variation in numbers sighted with respect to the hour at which the survey is made.

Finally, the División de Cuencas e Hidrología of the State-owned company C.V.G. Electrificación del Caroní (EDELCA), which is responsible for the hydro-electric development of the Caroní River in southern Venezuela, has been censusing *C. crocodilus*, *P. palpebrosus* and *P. trigonatus* (Gorzula and Paolillo 1984) as part of a general inventory of terrestrial and aquatic ecosystems in the Caroní River basin. Spotlight counts are used and densities are expressed as numbers of individuals observed per kilometre of shore-line.

The survey of *C. crocodilus* in the western Llanos by MARNR is producing perhaps the most reliable results. Its methodology was designed on the basis of ecological studies in the area [particularly Ayarzagüena (1980), Godshalk (1976), Maness (1976), Marcellini (1979), and Staton and Dixon (1975)], which allowed the following generalisations about *C. crocodilus* in the western Llanos to be made:

1. Due to a marked dry season in that area, virtually all *C. crocodilus* concentrate in refuge lagoons during March and April;
2. Due to the characteristics of these lagoons, which are usually devoid of vegetation and have relatively clear banks, spotlight counts give a direct count of about 90% of the real population in any one body of water;

3. The counts do not detect hatchlings and thus represent a close approximation of the total number of juveniles, subadults and adults;
4. The size structure of these concentrations of caimans is relatively constant.

The National Wildlife Service of MARNR also derived a relationship between diurnal and nocturnal counts, and arrived at a formula for estimating the total population of non-hatchling *C. crocodilus* on a given ranch:

$$P = [N + (D \times 3.29)] / 0.9$$

where P = the estimated population for the ranch; N = the number of caimans counted by spotlight; D = the number of caimans counted in lagoons only visited during the day; 3.29 = the correction factor for converting day counts to night counts; and, 0.9 = the correction factor for converting observed counts to the estimated total numbers.

The other three censusing programmes are far from having formulae to predict absolute numbers. Some of the general problems encountered have been discussed by Gorzula (1984) and Magnusson (1984), and those relating specifically to Venezuela are:

1. In the case of species inhabiting riverine and coastal areas, it is not known if the counts are of static populations or of partially or totally migratory populations moving between rivers, adjacent marshes and streams;
2. For night surveys in general, factors such as the state of the tide, general weather conditions, hour of survey and the extent of moonlight could bias counts in one direction or the other. Individual workers tend to standardise these factors, but on the basis of experience and educated guess-work;
3. Most workers agree that there are behavioural differences between individuals of the one population, and between populations of the same species, that bias counts. Different responses to the approach of an observer on foot, in a launch with an outboard motor, paddling a canoe, in a helicopter, or in an aeroplane, mean that different proportions of the population may be seen. Differences in "wariness" sometimes appear to be the result of previous hunting pressure, but at other times they do not;
4. In the case of *C. crocodilus*, which occupies a wide variety of habitats, there is no single unit for expressing densities that permits inter-habitat comparisons. For example, densities in riverine habitats and large lakes are usually expressed as numbers of individuals per kilometre of shore-line. But in narrow rivers and streams, a caiman may use both banks. In shallow lagoons and vegetated marshes, individuals per unit of area may be more appropriate;

5. Seasonal changes in water levels have marked influences on density, which means that it is often difficult to standardise a "one-off" survey in a remote area, against other survey results. It is hard to predict how the area is likely to change with more or less water;
6. The effects of fragmentation of aquatic habitats are unknown. Would a series of twenty half hectare ponds hold more caimans than a single 10 hectare lagoon? If so, how should habitat fragmentation be measured?
7. Finally, the majority of crocodilian workers in Venezuela report densities and numbers of non-hatchlings, and seldom take into account the size- or age-structure of the population, yet these are fundamental descriptive statistics to obtain if one is assessing population dynamics.

Monitoring

The hunting to virtual extinction of both *C. acutus* and *C. intermedius* during the 1930's and 1940's, followed by very intense hunting pressure on *C. crocodilus* during the 1950's and 1960's, has been well documented (Lopez Corcuera 1984; Medem 1983; Mondolfi 1965; Rivero Blanco 1974). Although there are no records of population densities for this period, it is estimated that literally *millions* of individuals of these species were killed in Venezuela.

In 1974 a total ban on the hunting of crocodilians was imposed throughout Venezuela. In recent years isolated populations and individuals of *C. acutus* (Seijas 1984a) and *C. intermedius* have been reported within their respective historical ranges (Blohm 1982; Franz, Reid and Puckett, unpublished manuscript; Godshalk 1982; Godshalk and Sosa 1978; Novoa, unpublished data; Ramo and Busto 1984), but whether these indicate a "recovery" or are simply relict populations that are stable or still on the decline, is unknown.

In the case of *C. crocodilus* it is generally assumed that the wild populations have recovered since the ban on hunting was imposed. Large numbers of *C. crocodilus* are found in the Llanos today, and for example in 1982 a National Wildlife Service team counted 44,797 in 16 ranches (total area 2338 km²) and estimated the population of non-hatchlings to be 55,072 (Seijas 1984c). However, there are no data on population levels prior to the start of commercial hunting, or even prior to the implementation of the hunting ban, Gorzula and Paolillo (1984) suggest that populations of *C. crocodilus* may have increased in southern Venezuela during this century, due to the creation of new habitats by man (dams, cattle ponds and borrow pits).

Apart from the plans of the MARNR to monitor populations of *C. crocodilus* in the ranches where hunting was carried out in 1983 and 1984, no

long-term or even short-term monitoring of a population, of any species of crocodilian, has yet been carried out in Venezuela.

POPULATION DYNAMICS

1. Natural Factors

Most studies of wild crocodilian populations in Venezuela have been of a descriptive nature (Ayarzagüena 1980; Blohm 1948; Castroviejo *et al.* 1976, 1977; Godshalk 1976; Gorzula 1978; Maness 1976; Marcellini 1979; Ramos *et al.* 1981; Rivero Blanco 1974; Staton and Dixon 1975, 1977; Seijas 1979; Seijas and Ramos 1980). Apart from Blohm's (1948) paper on *C. intermedius*, all have dealt with *C. crocodilus*. Studies have tended to be restricted to a single locality, during a single season or year. Some authors have recognized differences in the ecology of *C. crocodilus* at both national and international levels, but have rarely attempted to explain them.

The only study examining the possible effects of environmental factors on population dynamics has been that of Staton (1976). He compared clutch sizes and mean egg sizes of *C. crocodilus* at two distinct localities in the western Llanos, over two years (1973 and 1976), and related differences to the amount of rainfall, flooding and the time of nesting.

2. Man-induced Factors

Illegal commercial hunting of crocodilians is known to occur in Venezuela. It is generally assumed to be most prevalent in the southwestern Llanos and Orinoco Delta, from where skins are exported, as contraband, to Colombia, Guyana and Trinidad. The hunting is assumed to be principally of *C. crocodilus*, but few data are available and the full extent of illegal hunting cannot be evaluated.

Subsistence hunting for food (eggs and meat) and for the supposed curative properties of teeth (Lopez Corcuera 1984) and eggs (Gorzula and Paolillo 1984) has been briefly examined (for the Alligatorinae) in southern Venezuela by Gorzula and Paolillo (1984).

The few data that do exist with respect to habitat modification by man have stressed the overall positive effect on populations of *C. crocodilus* in both the western Llanos (Ramos *et al.* 1981) and in southern Venezuela (Gorzula and Paolillo 1984).

PUBLIC OPINION

In the long-term, the survival of crocodilians in Venezuela will depend on the attitude of the general public and their politicians. These in turn quite often depend on "mental images" which may be very far from reality (Gould and White 1974). Lopez Corcuera (1984) summarized some of the popular views that existed with respect to crocodilians when they were abundant.

Humboldt stated: "It is improbable that the day will arrive to liberate from crocodiles a country in which the labyrinth of rivers without number bring every day fresh hoards from the eastern drainage of the Andes, by means of the Meta and Apure to the coasts of Spanish Guayana. All that will be brought with the progress of civilization will make these animals more timid and help with the task of putting them to flight".

The naturalist Father Gumilla wrote: "What definition could be found that would adequately embrace the frightful ugliness of the Caimán? It is the very same ferocity and the clumsy abortion of the greatest monstrosity, the horror of all living beings, so formidable, that if the Caimán looked at itself in a mirror, it would run away trembling. The most life-like fantasy could not paint a more appropriate Satan than by portraying itself with those characteristics of the Caimán".

A poem in a reading primer for children reads:

"Ferocious, warty and ugly
sleeping on the beach he shows
his two rows of teeth.
And everytime I see him
stretched out and sun bathing
with chills I think
of the innocent beings
that this monster has eaten
by the river side".

A school textbook taught the following about natural history:

"LESSON 25 — the piranhas.
The Llanos are beautiful.
But in the Llanos harmful animals abound.
In some rivers are found the piranhas.

LESSON 26 — the electric eel and the caiman.
In the Llanos live other dangerous animals.
They are savage animals, like the electric eel, the caiman, the jaguar and the snake.
The Llanos are beautiful but . . ."

Beliefs such as those above probably resulted in the general view that commercial hunting to extinction of crocodilians would be a service to public safety. Today public opinion seems to be moving to the other extreme and the "old myths" are being replaced by "new myths".

These new myths find their ways into films, popular books, and even grant proposals and scientific publications. They should be regarded as myths, because they are unsupported by scientific data, and because they carry with them misleading implications. For example:

1. The Orinoco crocodile is exclusively a fish-eater . . . implying that crocodiles are not usually dangerous to man and therefore we can repopulate rivers with them with no danger to the local inhabitants;
2. The Orinoco crocodile was very important in maintaining river courses in the Llanos because their movements aided the movement of sediments . . . implying that flash floods in the Llanos is the repayment for the overkill of crocodilians;
3. The Orinoco crocodile and the spectacled caiman were very important in controlling populations of piranhas, the latter being the principal predator of fishes that are of commercial value . . . implying that abundant crocodilians go hand in hand with the development of commercial fisheries;
4. The Orinoco crocodile maintained the ecological balance of the populations of fishes, birds and mammals in the Llanos . . . this vague statement implies that the reduction of crocodiles has resulted in a negative alteration of the Llanos ecosystems; and,
5. The Orinoco crocodile's excrement was very important for the primary productivity of the Llanos ecosystems . . . implying that the biological productivity of the Llanos was degraded with the extermination of crocodiles.

When and where these beliefs started is unknown: myths (2) and (3) seem to have some basis with phenomena observed by the inhabitants of one or more specific areas of the Llanos; (5) seems to have been borrowed from Fittkau's (1970) hypothesis on the role of caimans in the nutrient regime of the mouth-lakes of Amazon affluents.

The dissemination of factual information about crocodilians, rather than the inventing of some "new-fangled hyper-sophisticated preciousness" (Darling 1978) would seem an important way to both engender and maintain public support for crocodilian conservation and management. In this regard, those responsible for disseminating knowledge about Venezuela's crocodilians, tend to publish much of their research as internal manuscripts of universities and other organizations. Such publications are difficult to obtain, are often ignored, and often do not benefit from the reviewing processes so fundamental to maintaining an international standard of scientific inquiry.

MANAGEMENT PROGRAMMES

*The Conservation of *Crocodylus intermedius**

Although two endangered species of crocodilian, *C. acutus* and *C. intermedius*, are found in Venezuela and both are given a general umbrella protection by the law, specific conservation programmes exist only for *C. intermedius* (Fig. 9).

On the positive side it has been amply demonstrated in Venezuela that Orinoco crocodiles both survive and breed in captivity. The two female



Fig. 9. *Crocodylus intermedius* remains an endangered species within Venezuela.

crocodiles in the Parque Loeffling (Ramirez *et al.* 1977) both produced nests with fertile eggs in 1981, (56 and 36 eggs) showing that females over twenty-five years of age are still fertile. There are also motivated people (notably Tomás Blohm, Pedro Trebbau, Robert Godshalk, Evelio Sosa, and Iván Darío Maldonado) who have worked for the conservation of this species for many years.

Captive *C. intermedius* are held in the UNELLEZ, the Parque Loeffling, the Hato El Frío, the MARNR field station in Puerto Ayacucho, the Parque del Este (Caracas), the Parque El Pinar (Caracas), the Parque Zoológico Bararida (Barquisimeto), the private installations of Tomás Blohm, and in the private installations of Evelio Sosa. The total captive population has fluctuated between 40 and 60 adults and subadults between 1974 and 1984, and during these 10 years at least 24 nests have been produced. Fourteen of these nests are known to have contained fertile eggs. But there has been no significant production of young crocodiles! Furthermore, the only document that has been produced to date that deals with the husbandry of Orinoco crocodiles, and provides first-hand data, is that of Blohm (1982).

A variety of problems have contributed to the failure of a national captive breeding programme for *C. intermedius*:

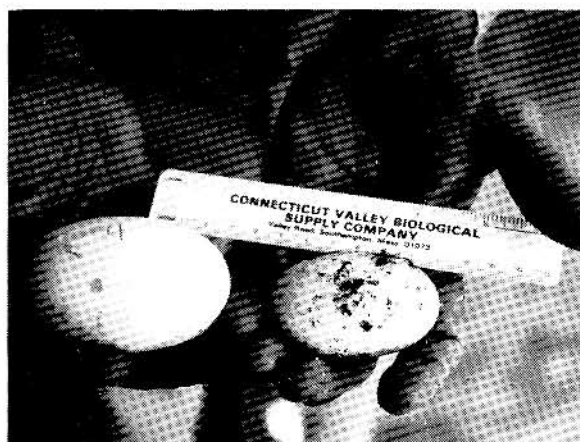


Fig. 10. Although fertile *Crocodylus intermedius* eggs (left) are laid in captivity each year, there has been no significant increase in the number of juveniles in captivity. The other egg (right) is from *Caiman crocodilus*.

1. Most of the crocodiles are kept as "curiosities", in concrete tanks, where nesting would be impossible;
2. The majority of captive crocodiles have not been marked, measured or sexed;
3. Where crocodiles have been paired and given adequate space for nesting, the nesting material available is usually construction sand (rather than river washed sand), which becomes water-logged, kills embryos and stops surviving hatchlings getting out of the nest;
4. Hatchlings are frequently left to the care of inexperienced labourers who do not know how to feed and care for them;
5. Captive crocodilians in general are inadequately fed. Those in one zoological park have been fed raw beef lung for ten years. The majority of subadults show growth deformities including curved snouts, shortened mandibles, and in three cases an apparent resorption of the base of the tail resulting in "hunched" lower backs;
6. In the Parque Loeffling there was reasonable hatchling success in 1974 and 1976. However, 24 individuals reported in 1977 (Ramirez *et al.* 1977) had dropped to 6 by 1980. Apparently there was competition between age classes that resulted in the establishment of one or two dominant individuals that prevented the others from feeding. Figure 11 shows size-age data for 14 *C. intermedius* in the Parque Loeffling, compared to the growth of a captive *Melanosuchus niger* (Dowling and Brazaitis 1966). The wide range of lengths for any one year class of *C. intermedius*, illustrates the extent of individual variation in growth;
7. Finally, the level of education of the people in charge of captive crocodiles in some institutions leaves much to be desired. In one place the

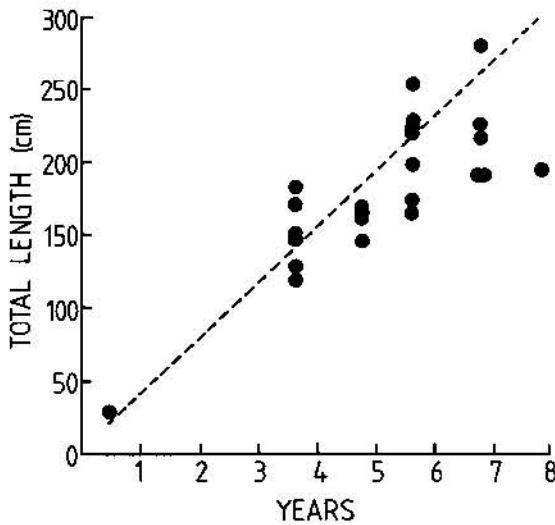


Fig. 11. The total lengths at different ages of 14 *Crocodylus intermedius* in the Parque Loefling, Ciudad Guayana, Venezuela, compared to the age size relationship of a captive *Melanosuchus niger* (line: adapted from Dowling and Brazaitis 1966).

veterinarian in charge donated the eggs of two nests to his family and friends — as food! In another, a crocodile in a pen was shot by persons unknown and its teeth removed. And, in yet another instance, a breeding female is totally blind because the keepers constantly throw sticks and stones at her head to make her move for the visitors.

The Utilization of *Caiman crocodilus*

That Venezuela's crocodilians are potentially a valuable, renewable natural resource is not a new idea. Over the years a series of publications (Blohm 1973; Brazaitis and Watanabe 1982; MARNR 1982; Rivero Blanco 1968, 1973) have put forward proposals for crocodilian management that incorporate utilization, and these in turn have stimulated research projects on crocodilian biology and/or ecology with a view of contributing to that future goal (Belda 1984; D'Andria 1980; Gutiérrez 1984; Ramos 1975; Rivero Blanco 1974; Rodríguez 1984; and Rodríguez and Robinson 1984). Although it is implicit in some of these studies that *C. intermedius* could theoretically be subject to utilization in the distant future, the species emphasized by all of them is *C. crocodilus*. At present there are three schools of thought with regard to a management programme for *C. crocodilus* that incorporates utilization.

1. Harvesting of Wild Populations

In 1982 Venezuela began an experimental programme for the commercial harvesting of *C. crocodilus* (Quero de Peña 1984). This programme was extensively discussed during the 7th working meeting of the IUCN/SSC Crocodile Specialist Group and the general consensus of opinion was that the

scientific basis for calculating harvest levels was sound, but that monitoring of hunted populations and strict controls on the harvest would be needed to prevent abuses.

The main criticisms of the programme related to its application to other areas of Venezuela, because it had been designed on the basis of data from the western Llanos. The plan is to harvest 50% of the "surplus males", which in that area is to be achieved by harvesting animals longer than 1.8 m total length. However, in southeastern Venezuela individuals of that size may not exist (Gorzula 1978). Only four individuals out of 137 captured were longer than 1.5 m and subsequent work (Gorzula and Paolillo, unpublished data) has yet to discover one *C. crocodilus* that would be close to the minimum legal size established for commercial hunting.

2. Captive Rearing

The supporters of this form of utilisation oppose the direct hunting of wild populations. They believe that there is not yet enough information about the biology of wild populations of *C. crocodilus* to permit a scientifically sound management plan to be designed; nor do they believe such a programme could ever be adequately controlled. Captive rearing on the other hand would enable not only ranchers, but also the national and international organizations involved in the trade of crocodilian products, to exert a very tight control over the resource. Critics state that it is doubtful whether the captive rearing of a slow-growing crocodilian, with a low quality skin, could ever be economically viable.

3. Opponents to Utilization

Medem (1983) stated: "Whilst subsistence hunting and fishing by Indians and colonists is not a determining factor in the extinction of animals, as soon as commerce appears the situation changes, and in a relatively short period of time, this strong negative impact obliterates the species and degenerates into the ecological disequilibrium of the ecosystem".

There is a genuine fear among some wildlife workers, both within and outside Venezuela, that if utilisation is incorporated into the management programme for *C. crocodilus*, regardless of the strategy employed, it may prove to be a Pandora's box, especially in areas where the target species and an endangered species are sympatric. They believe more crocodilian products on the international market will lead to more consumer demand and ultimately to increased poaching and contraband.

DISCUSSION AND CONCLUSIONS

There is a National Commission of Crocodilian Workers in Venezuela which discusses matters to do with the conservation and hence management of

crocodilians. This Commission is composed of members of governmental agencies, such as the Ministry of the Environment and the National Guard, the universities, the zoological parks, and other organizations, such as EDELCA. The Commission meets regularly under the co-ordination of the Fundación para la Defensa de la Naturaleza (FUDENA).

The Commission has discussed the areas of concern raised in this chapter, and has periodically formulated recommendations on the high-priority areas that need to be addressed by future research. The following are considered to be both necessary and achievable:

1. *A national project on the taxonomic status of Caiman crocodilus.* In the first instance, a morphometric and scale-count study carried out with populations in at least the Maracaibo Basin, the western Llanos, the Orinoco Delta, and the El Manteco Region would allow any major taxonomic subdivisions to be recognized. Ideally, the project would form part of a larger study, at a continental level, as the taxonomic dilemma posed by the *Caiman crocodilus* complex is not restricted to Venezuela.
2. *A national survey of crocodilians.* A more complete picture of the distribution of crocodilians within Venezuela is needed. Areas for which there are no records abound, and these should have priority. This project could be carried out in concert with (1) above, maximising the returns from what would be a logistically difficult and perhaps expensive undertaking.
3. *Censusing methods.* There is a paucity of data on the extent to which numbers sighted in surveys are affected by the survey conditions. This confounds comparisons between survey results from different habitat types, and results from the same habitat type over time. It is implicitly linked with maximising the value of data derived from (2) above. Research into practical methods for estimating the size- or age-structure of a population during a survey is a related area in urgent need of attention.
4. *Long-term monitoring.* Although the monitoring of commercially-hunted populations of *C. crocodilus* has already been programmed by the National Wildlife Service of the MARNR, there is a need for the monitoring of both the absolute numbers and the size-structure of control populations which are not harvested.
5. *Basic research into crocodilian biology.* An understanding of population dynamics is fundamental to both deriving and assessing management strategies. Yet there are few studies which quantify the essential dynamics: rates of reproduction; rates of mortality; rates of immigration; rates of emigration; and, sex ratios.
6. *Poaching.* There is a need to quantify the extent and possible impact of illegal hunting, which could perhaps be done with a co-operative effort between the Ministry of the Environment, the National Guard, and the international organizations that monitor trade in crocodilian products.
7. *Research publications.* Of the 45 references cited in this paper that deal with Venezuelan crocodilians, only 21 would be readily obtainable through the usual inter-library loan systems. People working on crocodilians in Venezuela need to publish their results in *obtainable* national or international scientific journals. In the interim, there would seem to be merit in collecting, collating and publishing the so far unpublished theses and reports, perhaps in a special volume of "collected papers".
8. *The conservation of Crocodylus intermedius.* A single national conservation programme, involving at least the MARNR and FUDENA, is long overdue. Wildlife cannot be owned in Venezuela, either by institutions or by individuals. Those *C. intermedius* currently being maintained in poor conditions, should be confiscated and transferred to places which are suitable for growth and general well-being, with the aim of developing an efficient captive breeding programme for what remains one of the rarest of world crocodilians.
9. *The utilisation of Caiman crocodilus.* The harvesting of wild populations and the captive rearing for commercial purposes of this species are potentially competitive and perhaps mutually exclusive. It is therefore necessary that the Venezuelan Government establish which form of utilisation is to be implemented over the next decade. With this clarified, research resources can be channelled effectively.

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